# TARGETED RESERVE REQUIREMENTS FOR MACROECONOMIC STABILIZATION

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Abstract. We study the effectiveness of target reserve requirements (RR) for large versus small banks for macroeconomic stabilization. Such policy was implemented in China during the global financial crisis in 2008 and again during its 2018 slowdown and the COVID-19 pandemic periods. In our model, firms with idiosyncratic productivity borrow from two types of banks—local or national—to finance working capital and faces a credit spread stemming from equilibrium defaults. National banks face lower funding costs, while local banks have better monitoring technologies. Since switching banks incurs a fixed cost, firms would switch banks only if they face large shocks. This environment creates room for stabilizing policies through targeted RR adjustments. In particular, with sufficiently large shocks, an asymmetric feedback rule with differential RR adjustments is more effective for macroeconomic stabilization than a symmetric policy rule. Our analysis complements recent policy discussions concerning disparate capital requirements for large and small banks based on macro-prudential motivations.

## I. Introduction

Recent macro-prudential policy initiatives have attempted to mitigate financial instability through disparate capital requirements on large and small banks. For example, the Basel III framework called for large and systemically important banks to face higher capital requirements than their smaller counterparts. Corbae and D'Erasmo (2019) demonstrate that counter-cyclical adjustments in capital requirements that differ between large and small banks can lead to changes in the composition of lending within the banking industry with potentially-positive implications for allocative efficiency and welfare.

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Targeted adjustments in reserve requirements (RR) based on bank types have been implemented, most notably in China. For example, the People's Bank of China (PBOC) cut the RR more aggressively for small and medium-sized banks than large "national" banks during the 2008 global financial crisis, and again widened the RR wedge between small and large banks in response to the slowdown in 2008 and the COVID-19 pandemic. However, unlike the macro-prudential considerations that have driven the debate on bank-specific time-varying capital requirements, these adjustments appear to have been motivated by the desire to stabilize macroeconomic fluctuations.

In this paper, we study the effectiveness of differential RR adjustments as a policy tool for macroeconomic stabilization. We present a model that features two types of banks: national banks and local banks. Firms need to borrow from the banks to finance working capital. They face idiosyncratic productivity, leading to equilibrium defaults and credit spreads because of costly state verification (Bernanke, Gertler and Gilchrist, 1999). National banks face lower funding costs, but local banks have better monitoring technologies (e.g., because of superior information about the borrowers). Thus, the two types of banks can coexist in equilibrium. A firm in a relationship with a bank (local or national) can switch lenders subject to a fixed cost of switching. Firms have no incentive to switch the type of banks from which they borrow, unless the shocks that they face are sufficiently large (such as the 2008 financial crisis or the COVID-19 pandemic). The government provides deposit insurance for all bank deposits and sets differential RR and its cyclical sensitivity for the two types banks.

We calibrate the model to Chinese data and study the implications of differential RR adjustments both in the steady state and over the business cycles.

In the steady state, cutting the RR for local banks (denoted by $\tau_l$) while holding constant the RR for national banks (denoted by $\tau_n$) increases aggregate output and improves social welfare. If $\tau_l$ is sufficiently high, all firms borrow from national banks. When $\tau^l$ declines sufficiently, a fraction of firms begin to borrow from local banks since a reduction in $\tau_l$ lowers the local banks' funding cost and thus their required return on lending. Since local banks are more efficient in monitoring, shifting the funding sources from national banks to local banks expands firm leverage and increases output. At sufficiently low levels of $\tau^l$, all firms choose to borrow from local banks and the extensive-margin expansionary effect disappears. Under our calibration, reducing $\tau_l$ leads to an expansion of steady-state output and welfare improvements.

Cutting the RR ($\tau_n$) for national banks while holding constant the RR for local banks ($\tau_l$) have different steady-state implications. For sufficiently high $\tau_n$, all firms borrow from local banks. Since local banks have better monitoring technologies, they are willing to lend to riskier firms. As $\tau_n$ declines, the national banks reduce their required return on loans, inducing some firms to switch from local banks. In this region, cutting $\tau_n$ has two opposing effects on aggregate output. At the intensive margin, cutting $\tau_n$ lowers national banks' required return on lending and raises the leverage of firms that borrow from national banks. At the extensive margin, firms' shift from local banks to national banks leads to an decline in the average firm leverage ratio since local banks have better monitoring technology and are willing to take riskier borrowers with higher leverage. Under our calibration, the extensive-margin effect dominates the intensive-margin effect. Thus, cutting $\tau^n$ reduces total output and social welfare. At sufficiently low levels of $\tau_n$, all firms borrow from national banks because national banks charge lower net interest margin relative to local banks. Cutting $\tau^n$ further increases lending by national banks and reduces firms' funding costs, boosting leverage and output. In this region, a reduction in $\tau_n$ raises aggregate output and improves welfare.

To study the macro stabilization implications, we consider feedback rules for the RR policy. We postulate that the central bank can adjust the RR for each type of banks to respond to deviations of real GDP from its trend. We consider both symmetric rules with identical reaction coefficients in the two feedback RR policy and an asymmetric rules with differential reaction coefficients. We show that, if the economy is buffeted by large shocks, then the asymmetric RR rules outperform the symmetric rules for stabilizing macroeconomic fluctuations.

## II. The model

The economy is populated by a continuum of infinitely lived households. The representative household consumes homogeneous goods produced by firms using capital and labor.

Firms face working capital constraints. Each firm finances wages and rental payments using both internal net worth and external debt. Following Bernanke et al. (1999), we assume that external financing is subject to a costly state verification problem. In particular, each firm can observe its own idiosyncratic productivity shocks. Firms with sufficiently low productivity relative to their nominal debt obligations will default and be liquidated. The lender suffers a liquidation cost when taking over the project to seize available revenue.

Financial intermediation takes place two types of banks – national banks and local banks. There is a unit continnum of banks, indexed by $i \in [0, 1]$, for each type. Both types of banks intermediate between households and firms and compete with each other in the lending market and in the deposit market. The two types of banks differ in three dimensions: a) Local banks offer more differentiated deposit products and charge higher net interest margin than national banks. b) Local banks have advantages in monitoring firms compared to national banks. c) The government provides deposit insurance on both types of banks and impose differentiated reserve requirements (RR) to the two types of banks.

II.1. **Households.** There is a continuum of infinitely lived and identical households with unit mass. The representative household has preferences represented by the expected utility function

$$U = \mathrm{E}\sum_{t=0}^{\infty}\beta_t\left[\ln(C_t) - \Psi_h\frac{H_t^{1+\eta}}{1+\eta}\right], \tag{1}$$

where E is an expectation operator, $C_t$ denotes consumption, $H_t$ denotes labor hours. The parameter $\beta \in (0,1)$ is a subjective discount factor, $\eta > 0$ is the inverse Frisch elasticity of labor supply, and $\Psi_h > 0$ reflects labor disutility.

The household faces the sequence of budget constraints

$$C_t + I_t + D_{nt} + D_{lt} = w_t H_t + r_t^k K_{t-1} + R_{n,t-1}^d D_{n,t-1} + R_{l,t-1}^d D_{l.t-1} + M_{t-1} + T_t, \tag{2}$$

where $I_t$ denotes the capital investment, $D_{n,t}$ the deposits in national banks, $D_{l,t}$ the deposits in local banks, $w_t$ the real wage rate, $r_t^k$ the real rent rate on capital and $K_{t-1}$ the level of the capital stock at the beginning of period $t$. $R_{n,t-1}^d$ and $R_{l,t-1}^d$, respectively, denote the gross interest rate on deposits in national banks and local banks from period $t-1$ to period $t$. $T_t$ denotes the lump-sum transfers from the government and earnings received from firms based on the household's ownership share.

The capital stock evolves according to the law of motion

$$K_t = (1-\delta)K_{t-1} + [1 - \frac{\Omega_k}{2}\left(\frac{I_t}{I_{t-1}} - g_I\right)^2]I_t, \tag{3}$$

where we have assumed that changes in investment incur an adjustment cost reflected by parameter $\Omega_k$. The constant $g_I$ denotes the steady-state growth rate of investment.

The household chooses $C_t$, $H_t$, $D_{nt}$, $D_{lt}$, $I_t$, and $K_t$ to maximize (1), subject to the constraints (2) and (3). The optimization conditions are summarized by the following equations:

$$w_t = \frac{\Psi H_t^{\eta}}{\Lambda_t}, \tag{4}$$

$$1 = \mathrm{E}_t\beta R_{nt}^d\frac{\Lambda_{t+1}}{\Lambda_t}, \tag{5}$$

$$1 = \mathrm{E}_t\beta R_{lt}^d\frac{\Lambda_{t+1}}{\Lambda_t}, \tag{6}$$

$$1 = q_t^k\left[1 - \frac{\Omega_k}{2}\left(\frac{I_t}{I_{t-1}} - g_I\right)^2 - \Omega_k\left(\frac{I_t}{I_{t-1}} - g_I\right)\frac{I_t}{I_{t-1}}\right] + \beta\mathrm{E}_t q_{t+1}^k\frac{\Lambda_{t+1}}{\Lambda_t}\Omega_k\left(\frac{I_{t+1}}{I_t} - g_I\right)\left(\frac{I_{t+1}}{I_t}\right)^2 \tag{7}$$

$$q_t^k = \beta\mathrm{E}_t\frac{\Lambda_{t+1}}{\Lambda_t}[q_{t+1}^k(1-\delta) + r_{t+1}^k]. \tag{8}$$

where $\Lambda_t$ denotes the Lagrangian multiplier for the budget constraint (2), and $q_t^k \equiv \frac{\Lambda_t^k}{\Lambda_t}$ is Tobin's q, with $\Lambda_t^k$ being the Lagrangian multiplier for the capital accumulation equation (3).

II.2. **Firms.** Firms produce homogeneous goods using capital and labor inputs. Firms face working capital constraints. In particular, they need to pay wage bills and capital rents before production takes place. Firms finance their working capital payments through their beginning-of-period net worth and through borrowings from banks. Financial intermediation takes place through two types of banks, national banks (type $n$) and local banks (type $l$). In each period, one firm chooses one bank to borrow from.[1] Both firms and banks are perfectly competitive.

Consider a representative firm that borrows from a type-$b$ bank $b \in \{n, l\}$. Each firm produces a homogeneous wholesale good $Y_{b,t}$ using capital $K_{b,t}$ and two types of labor inputs—household labor $H_{b,ht}$ and entrepreneurial labor $H_{b,et}$, with the production function

$$Y_{b,t} = A_t \omega_{b,t} (K_{b,t})^{1-\alpha} \left[ (H_{b,et})^{1-\theta} H_{b,ht}^{\theta} \right]^{\alpha}, \tag{9}$$

where $A_t$ denotes aggregate productivity, and the parameters $\alpha \in (0,1)$ and $\theta \in (0,1)$ are input elasticities in the production technology. The term $\omega_{b,t}$ is an idiosyncratic productivity shock that is i.i.d. across firms and time, and is drawn from the distribution $F(\cdot)$ with a nonnegative support.

Productivity $A_t$ contains a common deterministic trend $g^t$ and a stationary component $A_t^m$ so that $A_t = g^t A_t^m$. The stationary component $A_t^m$ follows the stochastic process

$$\ln A_t^m = \rho_a \ln A_{t-1}^m + \epsilon_{at}, \tag{10}$$

where $\rho_a \in (-1, 1)$ is a persistence parameter, and the term $\epsilon_{at}$ is an i.i.d. innovation drawn from a log-normal distribution $N(0, \sigma_a)$.

The firm's working capital constraint is then given by,

$$N_{b,t} + B_{b,t} = w_t H_{b,ht} + w_t^e H_{b,et} + r_t^k K_{b,t}. \tag{11}$$

where $N_{b,t}$ and $B_{b,t}$ denotes the representative firm's beginnning-of-period net worth and bank loans, respectively. $w_t^e$ denotes the real wage rate of managerial labor in sector $j$.

[1] A bank can lend to multiple firms.

Given the working capital constraints in Eq. (11), cost-minimization implies that factor demand satisfies

$$w_t H_{b,ht} = \alpha\theta(N_{b,t} + B_{b,t}), \tag{12}$$

$$w^e_{jt} H_{b,et} = \alpha(1-\theta)(N_{b,t} + B_{b,t}), \tag{13}$$

$$r^k_t K_{b,t} = (1-\alpha)(N_{b,t} + B_{b,t}). \tag{14}$$

Substituting these optimal choices of input factors in the production function (9), we obtain the firm's the rate of return on the firm's investment financed by external debt and internal funds

$$\tilde{A}_t = A_t \left(\frac{1-\alpha}{r^k_t}\right)^{1-\alpha} \left[\left(\frac{\alpha(1-\theta)}{w^e_{jt}}\right)^{1-\theta} \left(\frac{\alpha\theta}{w_t}\right)^{\theta}\right]^{\alpha}. \tag{15}$$

Following BGG, we assume that lenders can only observe borrowers' realized returns at a cost. In particular, if a firm defaults, the bank pays the liquidation cost and obtains the firm's generated revenue. In the process of liquidating, a fraction $m_b$ of output is lost, where $m_n > m_l > 0$ such that local banks can monitor and liquidate firms at a lower cost than national banks.

The bank charges a state-contingent gross interest rate $Z_{b,t}$ on the firm to cover monitoring and liquidation costs. Under this financial arrangement, firms with sufficiently low levels of realized productivity will not be able to make repayments. There is therefore a cut-off level of productivity $\bar{\omega}_{b,t}$ such that firms with $\omega_{b,t} < \bar{\omega}_{b,t}$ choose to default, where $\bar{\omega}_{b,t}$ satisfies

$$\bar{\omega}_{b,t} \equiv \frac{Z_{b,t}B_{b,t}}{\tilde{A}_t(N_{b,t} + B_{b,t})}, \tag{16}$$

We now describe the optimal contract. Under the loan contract characterized by $\bar{\omega}_{b,t}$ and $B_{b,t}$, the expected nominal income for a firm that borrow from a type-$b$ bank is given by

$$\begin{aligned}
&\int_{\overline{\omega}_{b,t}}^{\infty} \tilde{A}_t \omega_{b,t}(N_{b,t} + B_{b,t}) dF(\omega) - (1 - F(\overline{\omega}_{b,t}))Z_{b,t}B_{b,t} \\
&= \tilde{A}_t(N_{b,t} + B_{b,t})[\int_{\overline{\omega}_{b,t}}^{\infty} \omega dF(\omega) - (1 - F(\overline{\omega}_{b,t}))\overline{\omega}_{b,t}] \\
&\equiv \tilde{A}_t(N_{b,t} + B_{b,t}) h(\overline{\omega}_{b,t}),
\end{aligned}$$

where $h(\overline{\omega}_{b,t})$ is the share of production revenue going to the firm under the loan contract.

The expected nominal income for the lender is given by,

$$\begin{aligned}
&(1 - F(\overline{\omega}_{b,t}))Z_{b,t}B_{b,t} + \int_0^{\overline{\omega}_{b,t}} \{(1 - m_b)\tilde{A}_t \omega(N_{b,t} + B_{b,t})\}dF(\omega) \\
&= \tilde{A}_t(N_{b,t} + B_{b,t})\{[1 - F(\overline{\omega}_{b,t}) + (1 - m_b)\int_0^{\overline{\omega}_{b,t}} \omega dF(\omega)\} \\
&\equiv \tilde{A}_t(N_{b,t} + B_{b,t}) g_b(\overline{\omega}_{b,t}),
\end{aligned} \tag{17}$$

where $g_b(\overline{\omega}_{b,t})$ is the share of production revenue going to the lender. Note that

$$h(\overline{\omega}_{b,t}) + g_b(\overline{\omega}_{b,t}) = 1 - m_b \int_0^{\overline{\omega}_{b,t}} \omega dF(\omega). \tag{18}$$

Under the assumption that local banks are able to liquidate firms at a lower cost than national banks ($m_n > m_l > 0$), we have,

$$For \quad each \quad \overline{\omega}_t > 0, \quad g_n(\overline{\omega}_t) < g_l(\overline{\omega}_t) \tag{19}$$

The optimal contract is a pair $(\bar{\omega}_{b,t}, B_{b,t})$ chosen at the beginning of period $t$ to maximize the borrower's expected period $t$ income,

$$\max \tilde{A}_t(N_{b,t} + B_{b,t})h(\overline{\omega}_{b,t}) \tag{20}$$

subject to the lender's participation constraint

$$\tilde{A}_t(N_{b,t} + B_{b,t})g_b(\overline{\omega}_{b,t}) \geq R_{b,t}B_{b,t}. \tag{21}$$

where $R_{b,t}$ denotes the average loan return required by type-b bank.

The optimizing conditions for the contract characterize the relation between the leverage ratio and the productivity cut-off

$$\frac{N_{b,t}}{B_{b,t} + N_{b,t}} = -\frac{g_b'(\overline{\omega}_{b,t})}{h'(\overline{\omega}_{b,t})}\frac{\tilde{A}_t h(\overline{\omega}_{b,t})}{R_{b,t}}. \tag{22}$$

Denote $ROE_{b,t} \equiv h(\overline{\omega}_{b,t})\frac{\tilde{A}_t(N_{b,t}+B_{b,t})}{N_{b,t}}$ as a firm's ex-ante return to equity if the firm borrows from a type-$b$ bank, where $(\bar{\omega}_{b,t}, B_{b,t})$ are chosen to solve the firm's optimization problem given by (20) subject to (21).

We assume that borrowers face switching costs when switching from one bank to another.[2] In particular, consider an individual firm $i$ in period $t$. Denote $\mathcal{B}_t(i)$ as the choice of the bank type of the firm in period $t$. We assume that the firm incurs a cost equaling a fraction $\gamma > 0$ of the firm's net worth in the process of setting up relationship with a new bank if the type of the bank that the firm chooses in the current period $\mathcal{B}_t(i)$ differs from its choice in the previous period $\mathcal{B}_{t-1}(i)$. Then the firm's optimal choice of the bank type is summarized as follows,

[2]Asymmetric information between borrowers and banks create barriers for borrowers to switch banks and, therefore, borrowers incur switching costs when setting up a close tie with a bank.(Boot, 2000) Switching costs also play an important role in Chinese bank loan market. Yin and Matthews (2015) use a sample of found that matched data of firms-banks in China over the period 1999-2012 and found that around half of firms with bank credit history have switched to a new bank in the sample, and small, opeque firms are less likely to switch than large, transparent firms.

$$\begin{cases} \mathcal{B}_t(i) = \mathcal{B}_{t-1}(i), \quad \text{if } -\gamma \leq ROE_{l,t} - ROE_{n,t} \leq \gamma, \\ \mathcal{B}_t(i) = l, \quad \text{if } ROE_{l,t} - ROE_{n,t} \geq \gamma \quad \text{and} \quad \mathcal{B}_{t-1}(i) = n, \\ \mathcal{B}_t(i) = n, \quad \text{if } ROE_{l,t} - ROE_{n,t} \geq \gamma \quad \text{and} \quad \mathcal{B}_{t-1}(i) = l. \end{cases} \tag{23}$$

Following Bernanke et al. (1999), we assume that each firm manager survives at the end of each period with probability $\xi_e$, so that the average lifespan for the firm is $\frac{1}{1-\xi_e}$. The $1-\xi_e$ fraction of exiting managers is assumed to be replaced by an equal mass of new managers, so that the population size of managers stays constant.

Both survived managers and new managers earn managerial labor income $w_t^e H_t^e$. Consequently, both new managers and survived managers whose firm goes bankruptcy in the current period have start-up funds equal to their managerial labor income. For simplicity, we assume that both new managers that serves an existing firm and survived managers whose firm goes bankruptcy in the current period have set up relationship with the bank that the firm borrows from in the current period, so that they do not need to pay an additional cost if they choose the same bank to borrow from in the next period. We also follow the literature and assume that each manager supplies one unit of labor inelastically (so that $H_t^e = 1$).

Denote $\bar{N}_{b,t}$ as the end-of-period aggregate net worth of all firms financed with bank type $b$ in period $t$, which consists of profits earned by surviving firms plus managerial income,

$$\bar{N}_{b,t} = \xi_e[\tilde{A}_t h(\varpi_{b,t})(N_{b,t} + B_{b,t}) - \gamma \max\{N_{b,t} - \bar{N}_{b,t-1}, 0\}] + \frac{N_{b,t}}{N_{n,t} + N_{l,t}} w_t^e H_{et}. \tag{24}$$

where $N_{b,t} - \bar{N}_{b,t-1}$, if positive, measures the aggregate net worth of all firms that switch to bank type $b$ from another bank and incur a switching cost.

Denote $\bar{N}_t$ as the net worth of all firms by the end of period $t$,

$$\bar{N}_t = \bar{N}_{n,t} + \bar{N}_{l,t}. \tag{25}$$

Figure 1 presents the timeline of individual firms' financing decisions and the evolution of the aggregate net worth of firms. Recall that $N_{b,t}$ denotes the aggregate net worth of firms that choose bank type $b$ at the beginning of period $t$, and therefore,

$$N_{l,t} + N_{n,t} = \bar{N}_{t-1}, \tag{26}$$

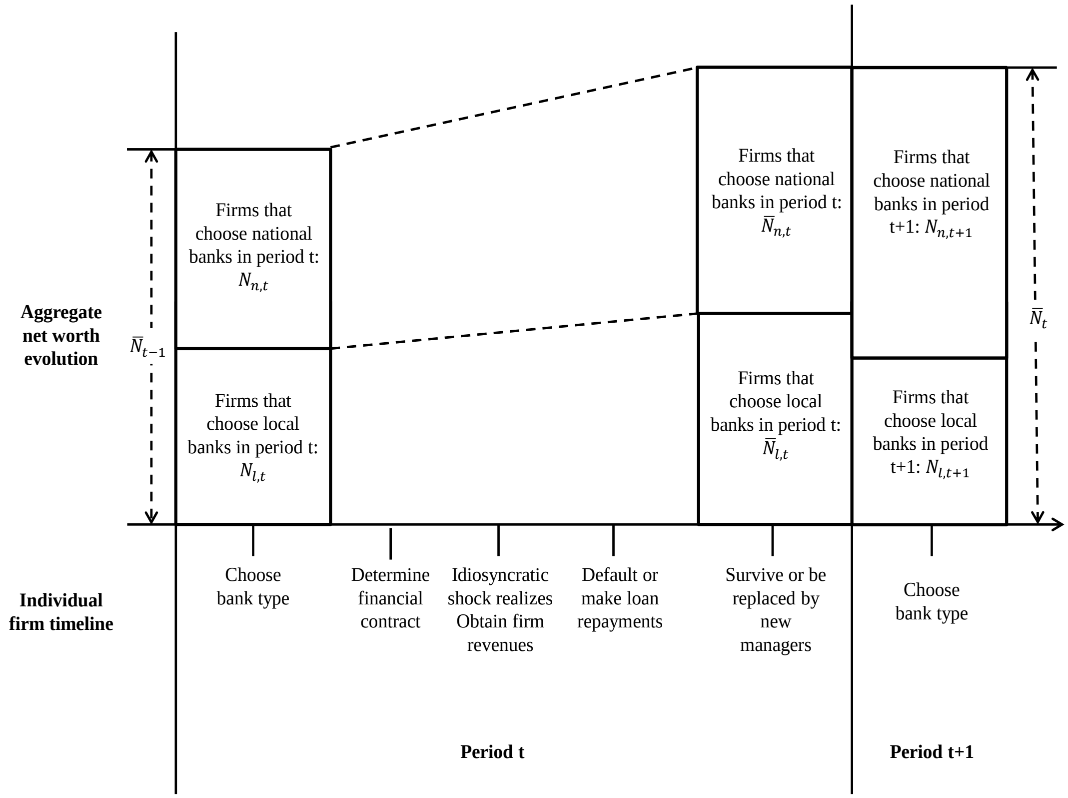


FIGURE 1. The timeline of individual firms' financing decisions and the evolution of the aggregate net worth of firms.

Given the borrowers' optimal choice of bank type (23), these aggregate beginning-of-period net worths are given by,

$$\begin{cases} N_{l,t} = 0, N_{n,t} = \bar{N}_{t-1}, & \text{if} \quad ROE_{l,t} - ROE_{n,t} < -\gamma, \\ N_{l,t} \in (0, \bar{N}_{l,t-1}), N_{n,t} \in (\bar{N}_{n,t-1}, \bar{N}_{t-1}), & \text{if} \quad ROE_{l,t} - ROE_{n,t} = -\gamma, \\ N_{l,t} = \bar{N}_{l,t-1}, N_{n,t} = \bar{N}_{n,t-1}, & \text{if} \quad -\gamma < ROE_{l,t} - ROE_{n,t} < \gamma, \\ N_{l,t} \in (\bar{N}_{l,t-1}, \bar{N}_{t-1}), N_{n,t} \in (0, \bar{N}_{n,t-1}), & \text{if} \quad ROE_{l,t} - ROE_{n,t} = \gamma, \\ N_{l,t} = \bar{N}_{t-1}, N_{n,t} = 0, & \text{if} \quad ROE_{l,t} - ROE_{n,t} > \gamma. \end{cases} \tag{27}$$

II.3. **Banks.** There are two types of competitive commercial banks, national banks (type $n$) and local banks (type $l$). There is a unit continuum of banks for each type. Consider a type-$b$ bank $i$, with $b \in \{n, l\}$, $i \in [0, 1]$. At the beginning of each period $t$, the bank obtains household deposits $d_{b,t}(i)$ at interest rate $r^d_{b,t}(i)$ subject to the demand schedule,

$$d_{b,t}(i) = \left( \frac{r^d_{b,t}(i)}{R^d_{b,t}} \right)^{-\epsilon_d} D_{b,t}, \tag{28}$$

The above demand schedule is derived under the assumption that the unit of type-b deposits held by the households is a composite CES basket of differentiated deposits supplied by individual banks, with elasticity of subsitution equal to $\epsilon_d^n < 0$ for national banks, and $\epsilon_d^l < 0$ for local banks.[3] Under this assumption, the aggregate-individual relations of deposits and deposit rates are given by,

$$D_{b,t} = \left[ \int_0^1 d_{bt}(i)^{\frac{\epsilon_d^b - 1}{\epsilon_d^b}} di \right]^{\frac{\epsilon_d^b}{\epsilon_d^b - 1}}, \tag{29}$$

$$R_{b,t}^d = \left[ \int_0^1 r_{b,t}^d(i)^{1-\epsilon_d^b} di \right]^{\frac{1}{1-\epsilon_d^b}}, \tag{30}$$

We assume that local banks provide more differentiated deposit products than national banks ($|\epsilon_d^l| < |\epsilon_d^n|$) and face a steeper demand schedule. This assumption makes local banks charge higher net interest margin than national banks in the general equilibrium.

The bank lends $b_{b,t}(i)$ to firms and is regulated by the RR $\tau_{b,t}$, which is set by the government. The bank's flow of funds constraint is then given by,

$$d_{b,t}(i) = \tau_{b,t} d_{b,t}(i) + b_{b,t}(i). \tag{31}$$

The bank faces default risk on firm loans. These firm loans generate a random return $\epsilon_{bt} R_{b,t}$ by the end of period $t$, where $R_{b,t}$ denotes the average return on POE loans of the representative type-$b$ bank, and $\epsilon_{bt}$ is an idiosyncratic shock to the loan quality of each individual bank and becomes observable to the bank only after the loans have been granted. The idiosyncratic shock $\epsilon_{bt}$ is i.i.d across banks and time, and is drawn the distribution $\Phi_b(\cdot)$ with a unity mean $E(\epsilon_{bt}) = 1$ and a nonnegative support $[\underline{\epsilon}_b, +\infty)$ where $\underline{\epsilon}_b \geq 0$ denotes the lower bound of the idiosyncratic shock $\epsilon_{bt}$.

The bank's payoff from its asset holdings by the end of period $t$ is then given by,

$$\tau_{b,t} d_{b,t}(i) + \epsilon_{bt} R_{b,t} b_{b,t}(i)$$

If the realized $\epsilon_{bt}$ is sufficiently low, the bank's payoff from its asset holdings will not be able to repay its deposits. Therefore there is a cut-off level $\bar{\epsilon}_{b,t}(i)$ such that the bank chooses to default if $\epsilon_{bt} < \bar{\epsilon}_{b,t}(i)$, where $\bar{\epsilon}_{b,t}(i)$ satisfies

$$\bar{\epsilon}_{b,t}(i) = \max\{\underline{\epsilon}_b, \frac{r_{b,t}^d(i) d_{b,t}(i) - \tau_{b,t} d_{b,t}(i)}{R_{b,t} b_{b,t}(i)}\}. \tag{32}$$

We assume that the distribution of the national banks' idiosyncratic shock on firm loans $\Phi_n(\epsilon_{nt})$ is concentrated enough such that national banks' bankruptcy ratio always equals

[3] This assumption is a useful modeling device to capture the existence of market power in the banking industry. For a similar approach, see, for example, Ulate (2021), Angelini, Neri and Panetta (2014), and Gerali, Neri, Sessa and Signoretti (2010).

zero in the equilibrium ($\bar{\epsilon}_{n,t}(i) \equiv \underline{\epsilon}_n$). This assumption is consistent with the observation that no national banks have gone bankruptcy or earned negative profit in the Chinese history.

In case of bank default, the government compensates depositors for any loss they made. The government does not charge an insurance premium ex-ante but, when needed, levies lump-sum taxes on households in order to break even in each period. The presence of deposit insurance distorts banks' lending decisions and justifies the use of RR in the banking sector.

When making lending decisions, the bank's expected value of its profit by the end of period $t$ is then given by,

$$\pi_t(i) = \mathrm{E}_t \int_{\bar{\epsilon}_{b,t}}^{+\infty} \left[\tau_{b,t} d_{b,t}(i) + \epsilon_{bt} R_{b,t} b_{b,t}(i) - r^d_{b,t}(i) d_{b,t}(i)\right] d\Phi(\epsilon_{bt}). \tag{33}$$

The bank maximize its expected profit subject to the flow of funds constraint (31) and the deposit demand schedule (28). The bank's optimal decisions imply that the average loan returns required by the bank are related to the bank's deposit rates and RR as follows,

$$\left[R_{n,t} - \frac{r^d_{n,t}(i) - \frac{1}{\epsilon^n_d} r^d_{n,t}(i) - \tau_{nt}}{1 - \tau_{nt}}\right] = 0, \tag{34}$$

$$\left[\frac{\int_{\bar{\epsilon}_{l,t}(i)}^{+\infty} \epsilon_{lt} R_{l,t} d\Phi(\epsilon_{lt})}{1 - \Phi(\bar{\epsilon}_{l,t}(i))} - \frac{r^d_{lt}(i) - \frac{1}{\epsilon^l_d} r^d_{lt}(i) - \tau_{lt}}{1 - \tau_{lt}}\right] = 0. \tag{35}$$

where $r^d_{nt}(i) = R^d_{nt}$ and $r^d_{lt}(i) = R^d_{lt}$ in a symmetric equilibrium.

The above equation (35) implies that, a local bank's valuation of its POE loans only reflects the state in which the realized return on its POE loans is high so that the bank does not default, leading to over-investment in POE loans. This over-investment problem can be mitigated by raising RR $\tau_b$, which makes the bank less likely to default. In the extreme case where $\tau_b$ is sufficiently high so that the possibility that a bank defaults becomes zero ($\bar{\epsilon}_{b,t} = 0$), the bank's valuation of POE loans reflects their true expected values and the over-investment problem is eliminated.

II.4. **Market clearing and equilibrium.** In an equilibrium, the markets for final goods, intermediate goods, capital and labor inputs, and loans all clear.

The final goods market clearing implies that

$$\begin{aligned} Y^f_t = \;& C_t + I_t + \sum_{b=n,l} \tilde{A}_t (N_{b,t} + B_{b,t}) m_b \int_0^{\overline{\omega}_{bt}} \omega dF(\omega) \\ & + \sum_{b=n,l} \sum_{j=s,p} \gamma_j \max\{N_{b,t} - \bar{N}_{b,t-1}, 0\}. \end{aligned} \tag{36}$$

Factor market clearing implies that

$$K_{t-1} = K_{n,t} + K_{l,t}, \quad H_t = H_{n,ht} + H_{l,ht}. \tag{37}$$

The loans market clearing implies that,

$$\forall b \in \{n, l\}, B_{b,t} = \int_0^1 b_{b,t}(i) di. \tag{38}$$

For convenience of discussion, we define real GDP as the final output net of the costs of firm bankruptcies. In particular, real GDP is defined as

$$GDP_t = C_t + I_t. \tag{39}$$

## III. Calibration

We solve the model numerically based on calibrated parameters. Five sets of parameters need to be calibrated. The first set are those in the household decision problem. These include $\beta$, the subjective discount factor; $\eta$, the inverse Frisch elasticity of labor supply; $\Psi_h$, the utility weight on leisure; $\epsilon_d^n$ and $\epsilon_d^l$, the elasticity of substitution between differentiated individual bank deposits for national banks and local banks, respectively; $\delta$, the capital depreciation rate; and $\Omega_k$, the investment adjustment cost parameter. The second set includes parameters in the decisions for firms and financial intermediaries. These include $g$, the average trend growth rate; $F(\cdot)$, the distribution of the firm idiosyncratic productivity shock, respectively; $\alpha$, the capital share in the production function; $\theta$, the share of labor supplied by the household; $m_b$, the monitoring cost by type $b$ banks; $\xi_e$, the survival rates of firm managers;$\Phi_n(\cdot)$ and $\Phi_l(\cdot)$, the distribution of the idiosyncratic loan quality shock in national banks and local banks, respectively. The third set of parameters are those in government policy and the shock processes, which includes $\bar{\tau}_b$, the steady-state RR on national banks and local banks, respectively; $\rho_a$, $\sigma_a$, the persistence and standard deviation of the productivity shock. Table 1 summarizes the calibrated parameter values.

A period in the model corresponds to one quarter. We set the subjective discount factor to $\beta = 0.9975$. We set $\eta = 1$, implying a Frisch labor elasticity of 1, which lies in the range of empirical studies. We calibrate $\Psi_h = 7.5$ such that the steady state value of labor hour is about one-third of total time endowment (which itself is normalized to 1). We calibrate $\Psi_m = 0.02$ such that the ratio of currency holdings to annual consumption equals 0.25, as in the Chinese data. We calibrate national banks' deposit elasticity of substitution $\epsilon_d^n = -246$ such that national banks' net interest margin $4(R_s^n - R_d^n)$ equals 3% per annum, which is consistent with the historical average of the spread between policy lending rate and policy deposit rate in China. We calibrate local banks' deposit elasticity of substitution $\epsilon_d^l = -80$ such that the difference in required return on lending between national banks and local banks

$4(R_p^l - R_p^n)$ equals 4% per annum, which is consistent with the Chinese bank-level data.[4] For the parameters in the capital accumulation process, we calibrate $\delta = 0.035$, implying an annual depreciation rate of 14%, as in the Chinese data. We have less guidance for calibrating the investment adjustment cost parameter $\Omega_k$. We use $\Omega_k = 5$ as a benchmark, which lies in the range of empirical estimates of DSGE models (Christiano, Eichenbaum and Evans, 2005; Smets and Wouters, 2007).

For the technology parameters, we set the steady-state balanced growth rate to $g = 1.0125$, implying an average annual growth rate of 5%. We assume that firms' idiosyncratic productivity shocks are drawn from a unit-mean log normal distribution such that the logarithm of $\omega$ follows a normal distribution $N(-\sigma^2/2, \sigma)$. We calibrate the distribution parameter $\sigma$ to match empirical estimates of cross-firm dispersions of TFP in China's data. In particular, Hsieh and Klenow (2009) estimated that the annualized standard deviation of the logarithm of TFP across firms is about 0.63 in 2005. This implies that $\sigma = 0.63/2$. We calibrate the labor income share to $\alpha = 0.5$, consistent with empirical evidence in Chinese data (Brandt, Hsieh and Zhu, 2008; Zhu, 2012).

For the parameters associated with financial frictions, we follow Bernanke et al. (1999) and set the local banks' liquidation cost parameters to $m_l = 0.1$. We set the managerial labor share $1 - \theta = 0.04$ such that entrepreneurs' labor income account for 2% of the total output. The other two parameters (the national bank-POE monitoring cost $m_p^n$ and the firm survival rate $\xi_e$) are calibrated to target a number of steady-state values: (1) the firm loan default ratio is 0.10 (2) the fraction of firm loans granted by local banks is 0.5. The first number matches the loan delinquency ratio on business loan, reported by the People's Bank of China. The second number match the fraction of business loans granted by local banks (including city commercial banks and rural commercial banks) reported by China Banking Regulatory Commission.

For the parameters associated with the banking sector, we assume that local banks' idiosyncratic shock on firm loans $\epsilon_l$ are drawn from a unit-mean log normal distribution such that the logarithm of $\epsilon_l$ follows a normal distribution $N(-\sigma_l^2/2, \sigma_l)$. We set $\sigma_l = 0.01/2$ to match the annualized standard deviation of loan delinquency ratio in local banks (including city commercial banks and rural commercial banks) of 0.01 in the data. We assume that the distribution of the national banks' idiosyncratic shock on POE loans $\epsilon_n$ is concentrated enough such that the steady-state value of the national banks' bankruptcy ratio equals zero,

[4]Based on CSMAR data on Chinese individual banks, the difference of the return on lending between national banks (called state-owned large commercial banks) and local banks (including city commercial banks and rural commercial banks) averaged around 4% per annum over the last decade, which is largely driven by the difference the lending-deposit interest rate margin (averaged 3%).

Table 1. Calibrated values.

| Variable | Description | Value |
|---|---|---|
| | A. Households | |
| $\beta$ | Subjective discount factor | 0.9975 |
| $\eta$ | Inverse Frisch elasticity of labor supply | 1 |
| $\Psi_h$ | Weight of disutility of working | 7.5 |
| $\epsilon_d^n$ | National banks' deposit elasticity of substitution | $-246$ |
| $\epsilon_d^l$ | Local banks' deposit elasticity of substitution | $-80$ |
| $\delta$ | Capital depreciation rate | 0.035 |
| $\Omega_k$ | Capital adjustment cost | 5 |
| | B. Firms and financial intermediaries | |
| $g$ | Steady state growth rate | 1.0125 |
| $\sigma$ | Volatility parameter in log normal distribution of firm idiosyncratic shocks | 0.315 |
| $\alpha$ | Capital income share | 0.5 |
| $m_n$ | National bank monitoring cost | 0.22 |
| $m_l$ | Local bank monitoring cost | 0.1 |
| $\xi_e$ | Firm manager's survival rate | 0.88 |
| $\theta$ | Share of household labor | 0.96 |
| $\sigma_l$ | Volatility parameter in log normal distribution of local bank idiosyncratic shocks | 0.005 |
| $\gamma$ | Bank switching cost | 0.0017 |
| | C. Government policy and shock processes | |
| $\bar{\tau}_n$ | RR on National bank | 0.15 |
| $\bar{\tau}_l$ | RR on Local bank | 0.15 |
| $\rho_z$ | Persistence of TFP shock | 0.95 |

consistent with the observation that no national banks have gone bankruptcy or earned negative profit in the Chinese history. Firms' bank switching cost is set to $\gamma = 0.0017$ to match the estimates of the bank switching cost by Barone, Felici and Pagnini (2011).[5]

For the government parameters, we calibrate the steady-state RR to 0.15 for both national banks and local banks. For the paramters related to the shock process, we follow the standard business cycle literature and set the persistence parameter to $\rho_a = 0.95$ for the technology shock. In Section V We consider a variety of shock size for each shock to examine how the size of the shock affect the performance of the RR policy.

[5]Our calibration implies a steady state ratio of firms' equity to debt ratio of about $\frac{N}{B} = 0.6$. This value, together with $\gamma = 0.002$, implies the bank switching cost is around $4\gamma\frac{N}{B} = 0.004$ per unit of bank loans per annum, which is consistent with the estimate of the bank switching cost by Barone et al. (2011) using bank-firm level data on Italian local credit markets.

## IV. Steady state analysis

We now use the calibrated model to examine the steady-state implication of RR policies for equilibrium allocation and welfare. We assume that there are no switching costs when borrowers switch banks in the steady state equilibrium ($\gamma = 0$).

IV.1. **RR on local banks.** We begin by examining the steady-state implication of cutting RR on local banks ($\tau_l$), while holding the RR on national banks ($\tau_n$) constant.

Figure 2 and 3 display the relation between several key variables in the steady-state equilibrium (the vertical axis in each panel) and the required reseve ratio on local banks $\tau^l$ (the horizontal axis). If $\tau_l$ is sufficiently high, all firms borrow from national banks. When $\tau^l$ declines sufficiently, a fraction of firms begin to borrow from local banks. Reducing $\tau_l$ lowers the local banks' funding cost and thus their required return on lending. However, reducing $\tau_l$ also require local banks to hold less riskless bank reserves and hurts the financial stability among local banks by raising local banks' bankruptcy probabilities. The increased local banks' bankruptcy probabilities makes local banks overvalue firm loans and further reduce their required return on firm loans.

The fall in the local banks' required return on firm loans encourages more firms to borrow from local banks instead of national banks. Since local banks have better monitoring technology and are willing to take riskier borrowers with higher leverage and higher default ratio, firms' shift from national banks to local banks leads to increases in their average leverage ratio as well as the average default ratio. Despite the increase in firms' average default ratio, these increased firm defaults are occurring with local banks, who are more efficient in monitoring and liquidating firms relative to national banks. As a result, the impact of reducing $\tau^l$ on firms' liquidation cost is ambiguous. Overall, reducing $\tau_l$ raises firms' leverage and possibly reduces firms' liquidation cost, leading to welfare improvement and output rises.

At very low $\tau^l$ levels, however, all firms choose to borrow from local banks and the extensive-margin expansionary effect disappear. In this case, reducing $\tau_l$ lowers the local banks' required return on lending, and firms respond by taking higher leverage with higher default ratio. Reducing $\tau^l$ unambiguously raises the firms' liquidation costs, as well as the bankruptcy probability of local banks. Under our calibration, social welfare improves monotonically as $\tau_l$ falls.

IV.2. **RR on national banks.** Figure 4 - 5 display the steady-state relationship between the RR on national banks ($\tau^n$) and several macroeconomic variables. Given a sufficiently low $\tau^n$, all firms borrow from national banks because national banks charge lower net interest margin relative to local banks. Raising $\tau^n$ reduces the credit supply by national banks and raises firms' funding cost, discouraging their production activities. The consequence is declines in total output as well as the social welfare.

It is notable that, as the national banks raise their required return on firm loans, firms respond by taking lower leverage to avoid higher credit spread associated with the firm defaults, and, consequently, the firm loan default ratio falls.

When $\tau^n$ rises sufficiently, a fraction of firms begin to borrow from local banks. Raising $\tau_n$ have two opposite effects on total output. At the intensive margin, raising $\tau_n$ raises national banks' required return on lending and discourages firms that borrow from national banks to take higher leverage. At the extensive margin, firms' shift from national banks to local banks leads to an increase in the average firm leverage ratio since local banks have better monitoring technology and are willing to take riskier borrowers with higher leverage and higher default ratio. Under our calibration, the extensive-margin effect dominates the intensive-margin effect. In this case, raising $\tau^n$ raises total output and improves social welfare.

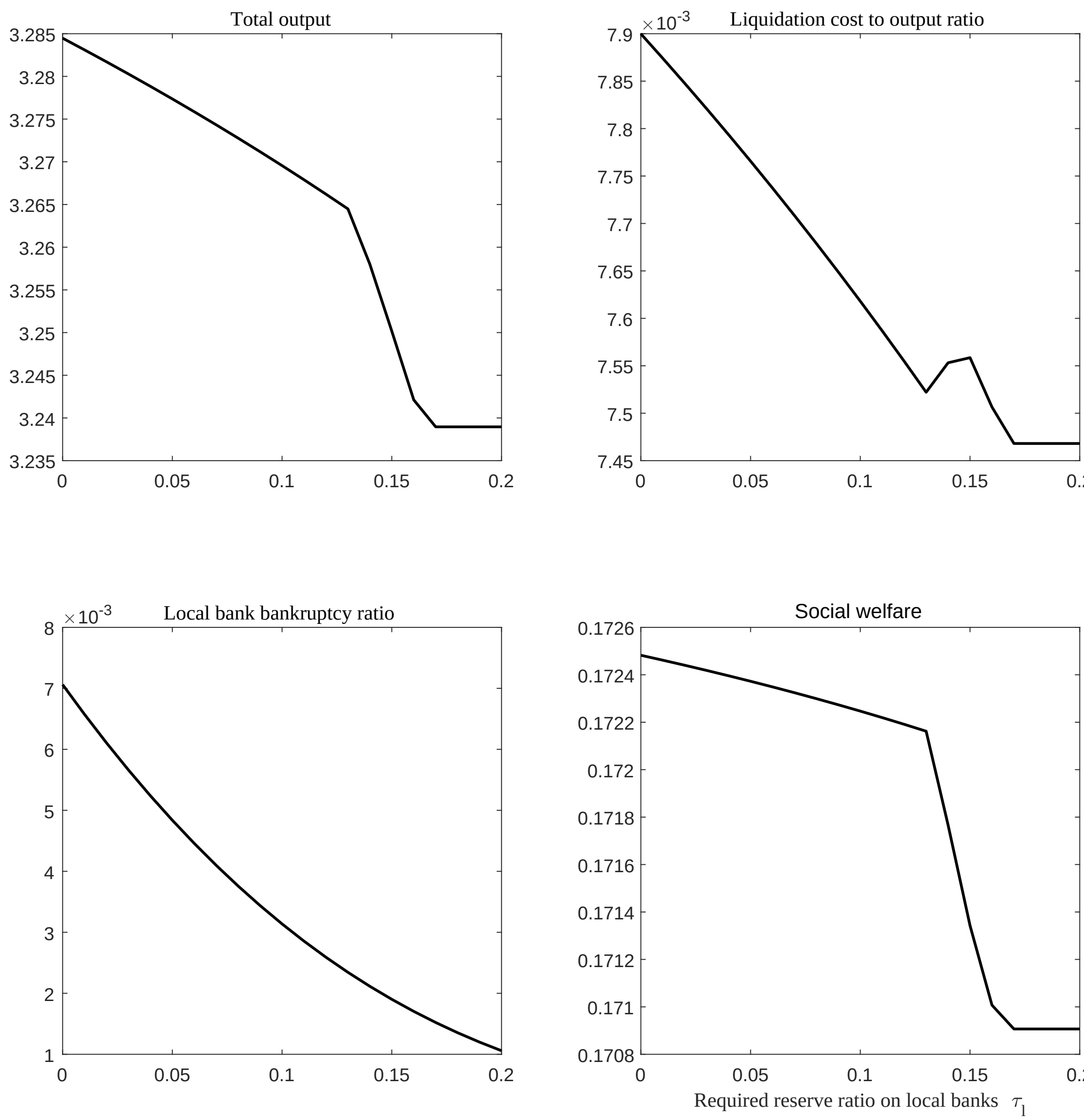


Figure 2. Steady-state implications of the required reseve ratio on local banks ($\tau^l$) for macroeconomic variables.

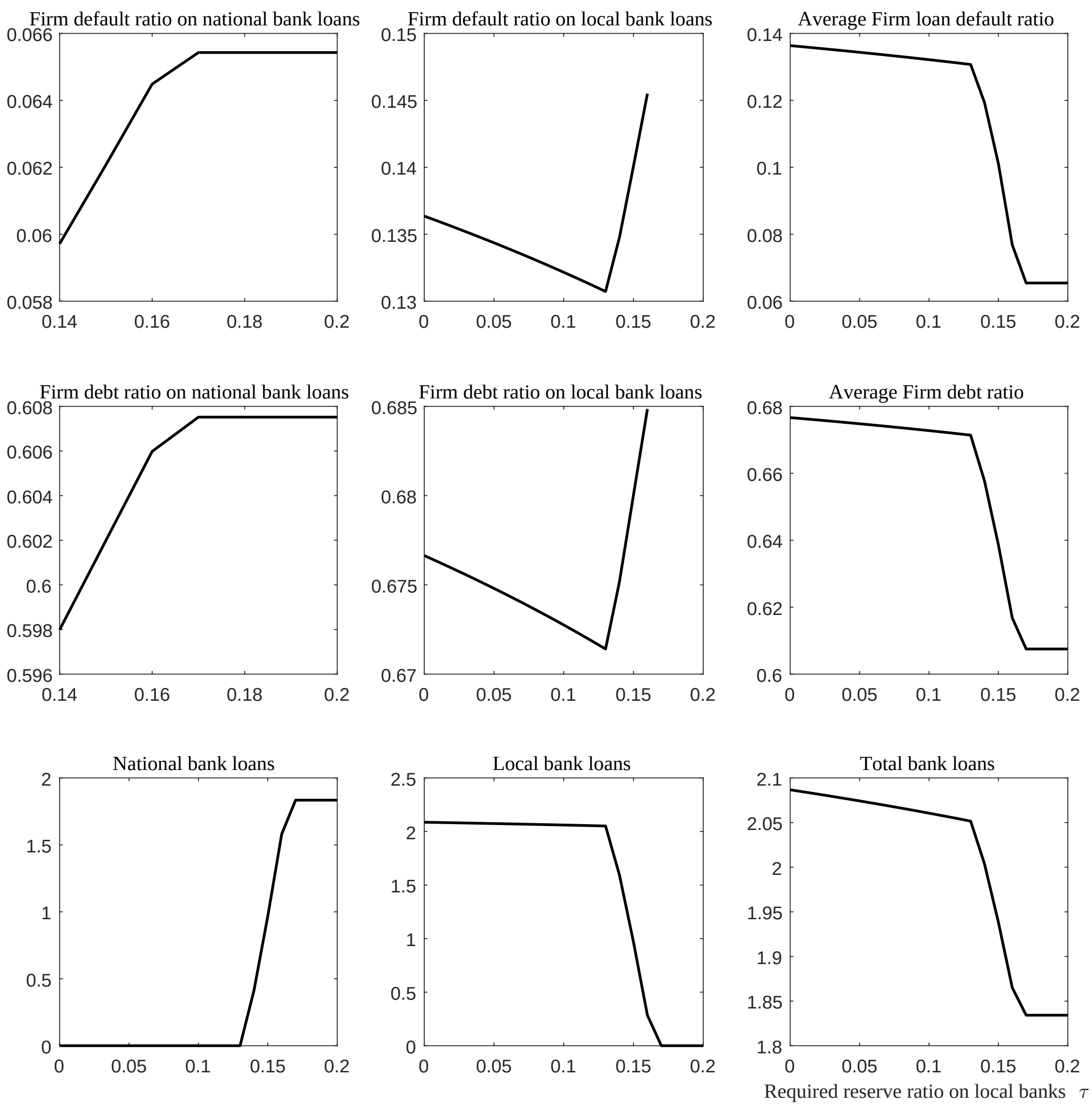


FIGURE 3. Steady-state implications of the required reseve ratio on local banks ($\tau^l$) for financial variables.

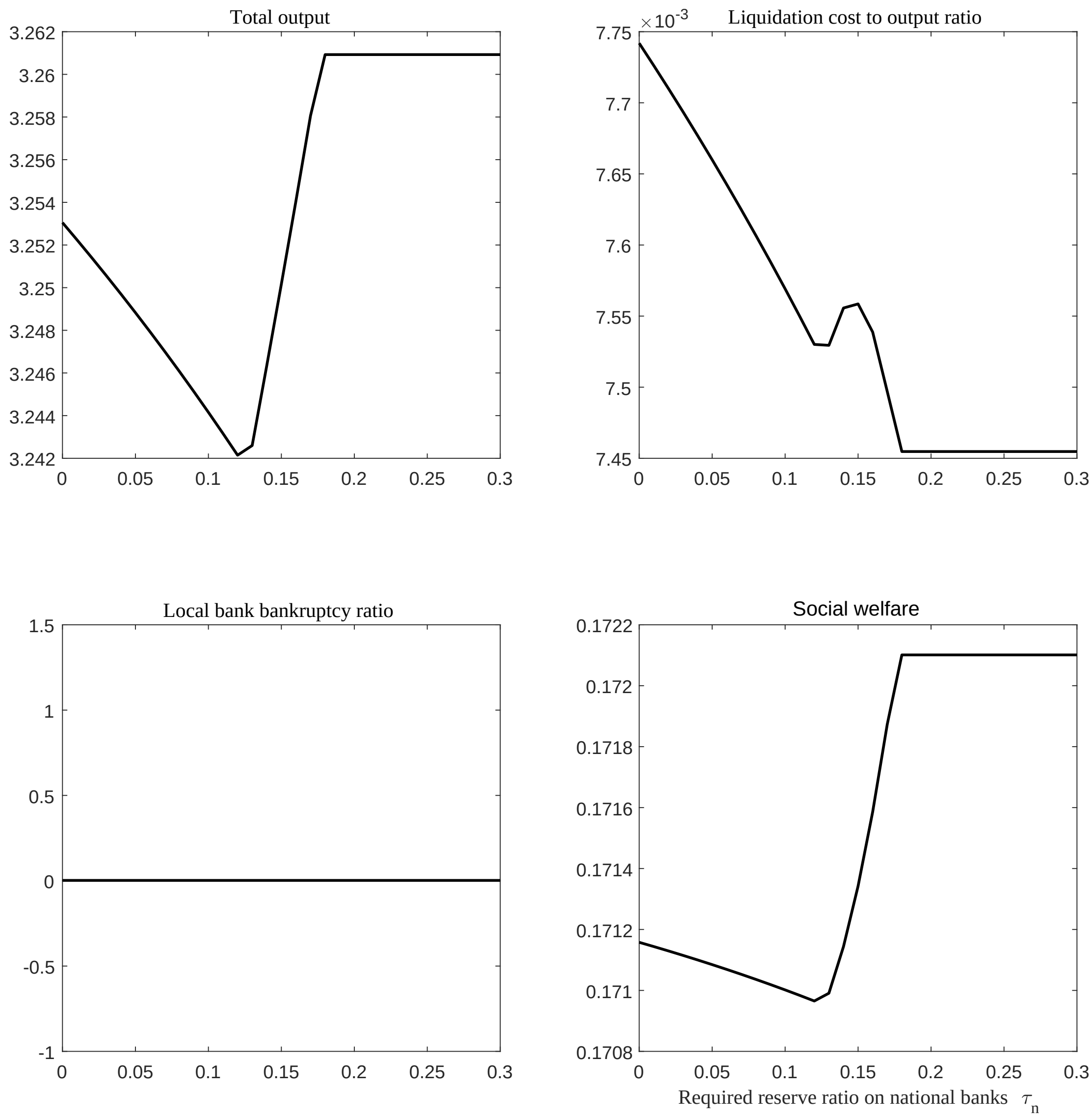


FIGURE 4. Steady-state implications of the required reseve ratio on national banks ($\tau^n$) for macroeconomic variables.

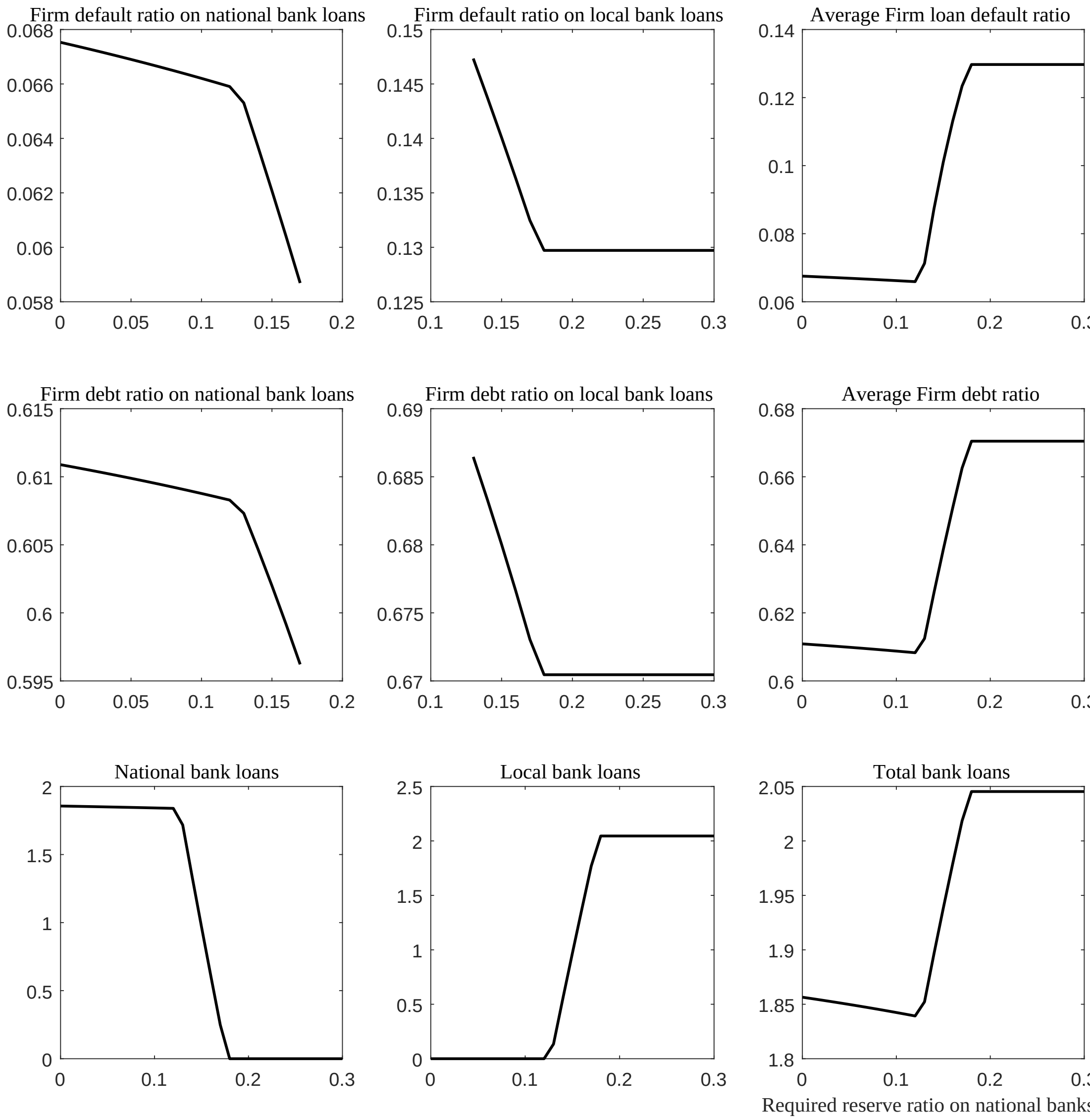


FIGURE 5. Steady-state implications of the required reseve ratio on national banks ($\tau^n$) for financial variables.

## V. Business cycle analysis

V.1. **RR rules.** The central bank follows simple reserve requirement rules under which it adjusts the required reserve ratio ($\tau_t^n$ or $\tau_t^l$) to respond to deviations of the real GDP from its trend.

$$\tau_t^l = \bar{\tau}^l + \psi_{ly} \ln\left(\tilde{GDP}_t\right) \tag{40}$$

$$\tau_t^n = \bar{\tau}^n + \psi_{ny} \ln\left(\tilde{GDP}_t\right) \tag{41}$$

where the parameters $\psi_{ly}$ and $\psi_{ny}$ measure the responsiveness of the require reserve ratios to the output gap.

In what follows, we focus on the equilibrium where SOEs borrow from only national banks while POEs borrow from both types of banks. We compare the macro implications of two alternative policy regimes relative to the benchmark regime where RR of both types of banks are kept constant at their steady state levels. The first alternative policy is a symmetric RR rule, under which the reaction coefficients $\psi_{ly} = \psi_{ny} = 1$. This policy regime refers to the PBoC's RR adjustments in normal times and the value of reaction coefficient are obtained by regressing the RRs on the real GDP gap and the CPI inflation rate using Chinese quarterly data from 2000 to 2020. The second alternative policy is an assymmetric RR rule, under which the reaction coefficients $\psi_{ly} = 1$ and $\psi_{ny} = 0$. This policy regime refers to the PBoC's RR adjustments in times of economic depression. In particular, the PBoC aggressively cut RRs on local banks but barely adjusted RRs on national banks during the 2008 global crisis and in the recent global coronavirus recession.

Under our calibration, firms borrow from both types of banks and are indifferent between the two types of banks in the initial steady state. As is implied by (27), they switch across banks only when the economy is hit by a large shock so that the improvement in the their return to equity of switching from one bank to another exceeds the switching cost. This implies that our model contains occasionally binding constraints. We solve the model using a popular model solution toolbox called OccBin developed by Guerrieri and Iacoviello (2015). The toolbox adapts a first-order perturbation approach and applies it in a piecewise fashion to solve dynamic models with occasionally binding constraints.

V.2. **Impulse responses and volatilities.** Let's first consider a relatively small negative technology shock $\epsilon_{at} = -0.01$. Figure 6 display the impulse responses to the shock.

Under the benchmark regime, a negative technology shock reduces firms' return to investment, imposing upward pressure on firm default possibilities. To avoid higher credit spread associated with firm defaults, firms respond by reducing their leverage ratio, leading to a decline in their return to equity. It is notable that firm loans with local banks are more negatively affected than those with national banks. This is because, local banks, with their advantage for monitoring firm loans, grant firm loans with higher leverage and higher default ratio than national banks in the steady state, making these firm loans more sensitive to economic shocks than those granted by national banks in the dynamics. However, although firms with local banks loans are able to obtain higher return to equity if they switch to national banks, the improvement in return to equity is relatively small compared with the switching cost. As a consequence, no firms switch banks, and firm loans fall with both types of banks, depressing the production activities.

Overall, the decline in the aggreagete TFP leads to a fall in the real GDP. In this case, the RR cut on both types of banks help reduce the funding cost on both types of banks and mitigate the fall in the real GDP. In particular, the symmetric cut on both types of RRs help stabilize the real GDP better than the assymmetric cut, as the symmetric cut reduces the funding cost and raises the credit supply in both banking sectors, while the assymmetric cut only benefits the local banks.[6]

Now let's consider a relatively large negative technology shock $\epsilon_{at} = -0.05$. Figure 7 display the impulse responses to the shock in an economy with flexible prices.

Under the benchmark regime, the negative technology shock reduces firms' return to equity, with a much larger magnitude for firms that borrow from local banks. In this case, the improvement in firms' return to equity by switching from local banks to national banks are large enough to cover the switching cost. As a result, while total firm loans fall, firm loans granted by national banks rise. Firms' shift from local banks to national banks also leads to a decline in their average leverage ratio, amplifying the contractionary impact on total output. It is also notable that, unlike the previous case with a smaller shock, firms' average leverage do not recover to its orginal level in the long run because the presence of the switching cost prevents firms that shift to national banks from shifting back to local banks.

In this case, the RR cut on both types of banks help reduce the funding cost on both types of banks and mitigate the fall in the real GDP. In particular, the assymmetric cut help stabilizes the real GDP better than the symmetric cut on both types of RRs. This is because, the assymmetric RR cut on local banks helps reduce the lending rate required by local banks compared with those by national banks, and prevent POEs from switching to national banks. By comparison, although the symmetric cut stabilizes both the SOE sector and the POE sector, it does not stabilize the POE sector as much as the assymmetric RR cut does because it fails to prevent POEs from switching to national banks.

[6]The symmetric cut stabilizes the firm debt ratio in both types of bank loans. By comparison, under the assymmetric cut, the firm debt ratio in local banks becomes higher because local banks require lower lending rate. However, the firm debt ratio in national banks becomes even lower. This is because the assymmetric cut stimulates the production activities and reduces firms' profitability, but does not lower national banks' lending rate.

Table **??** consider a variety of shock size and shows the performance of the various policy regimes under technology shocks in an economy with flexible prices. Both symmetric RR rule and the assymmetric RR rule help stabilize the output and improve the social welfare. As is discussed before, the assymmetric RR rule helps prevent firms from switching between banks and from amplifying the macro fluctuations in times of large shocks. Therefore, the larger the shock, the better the assymmetric RR rule stabilizes the economy relative to the symmetric rule.

It is also notable that, the assymmetric RR rule stabilize the GDP fluctuations better than they stabilize the the fluctuations in the final output. In particular, in the case with $\sigma_a = 0.003$, the assymmetric RR rule stabilize the GDP fluctuations better than the symmetric RR rule, but the latter stabilizes the final output fluctuations better than the former. In our model, the difference between the GDP and the final output is contributed by the variation in the firm bankruptcy costs. This result is consistent with the impulse responses where the assymmetric adjustments in RR help reduce bankruptcy costs by encouraging the firms to borrow from more efficiently-monitoring local banks in times of economic depression.

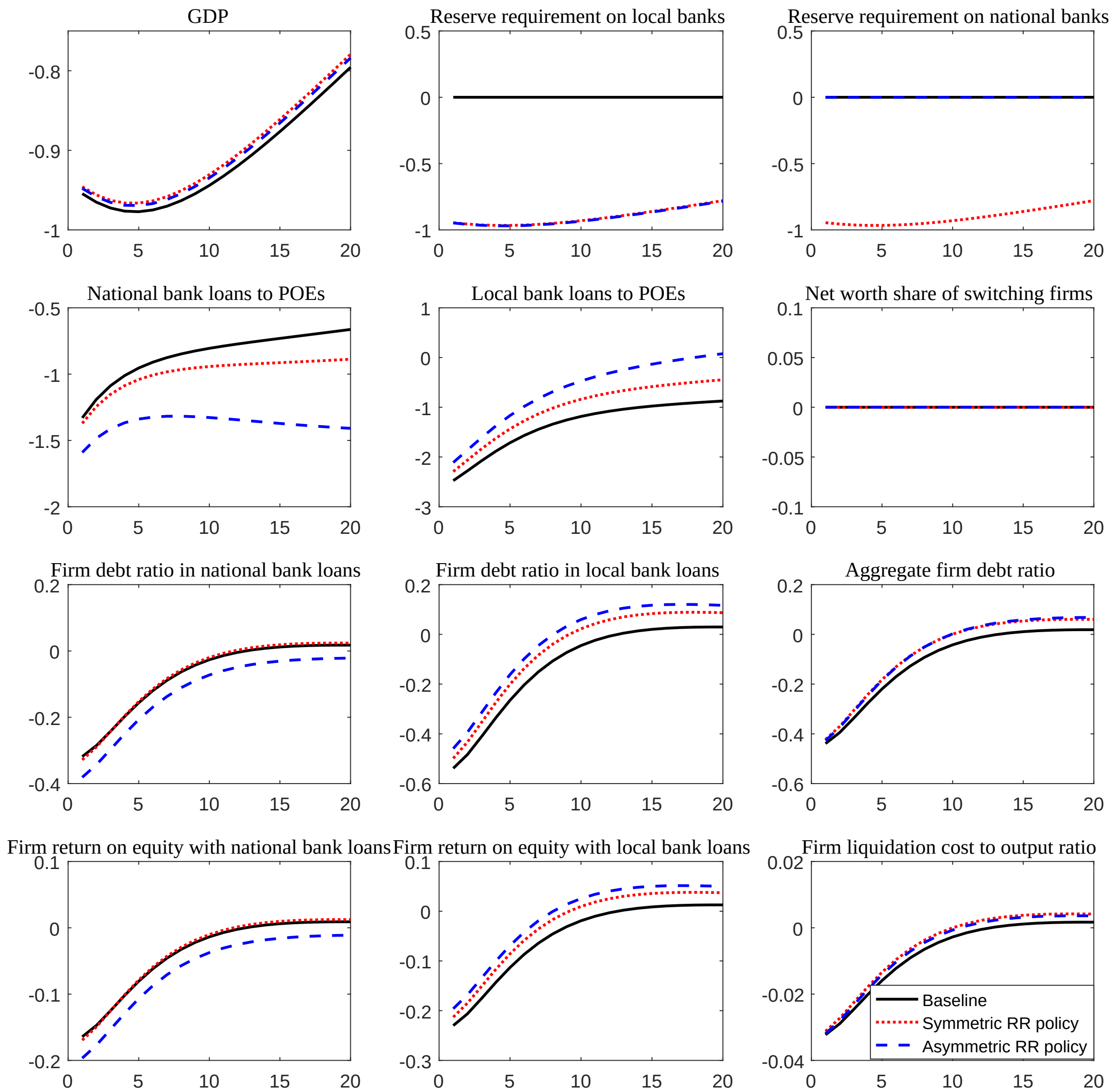


FIGURE 6. Impulse responses of a small negative technology ($\epsilon_{at} = -0.01$) under alternative policy rules. Benchmark rule: black solid lines; symmetric RR rule: blue dashed lines; assymmetric rule: red dashed lines. The horizontal axes show the quarters after the impact period of the shock. The units on the vertical axes are percentage-point deviations from the steady state levels for firms' return to equity, firms' debt ratios, reserve requirements and firm liquidation cost to output ratio. The units on the vertical axes are percent deviations from the steady state levels for other variables. The variable "Net worth share of switching firms" refers to the ratio of the net worth of firms that switch from local banks to national banks to the net worth of all firms.

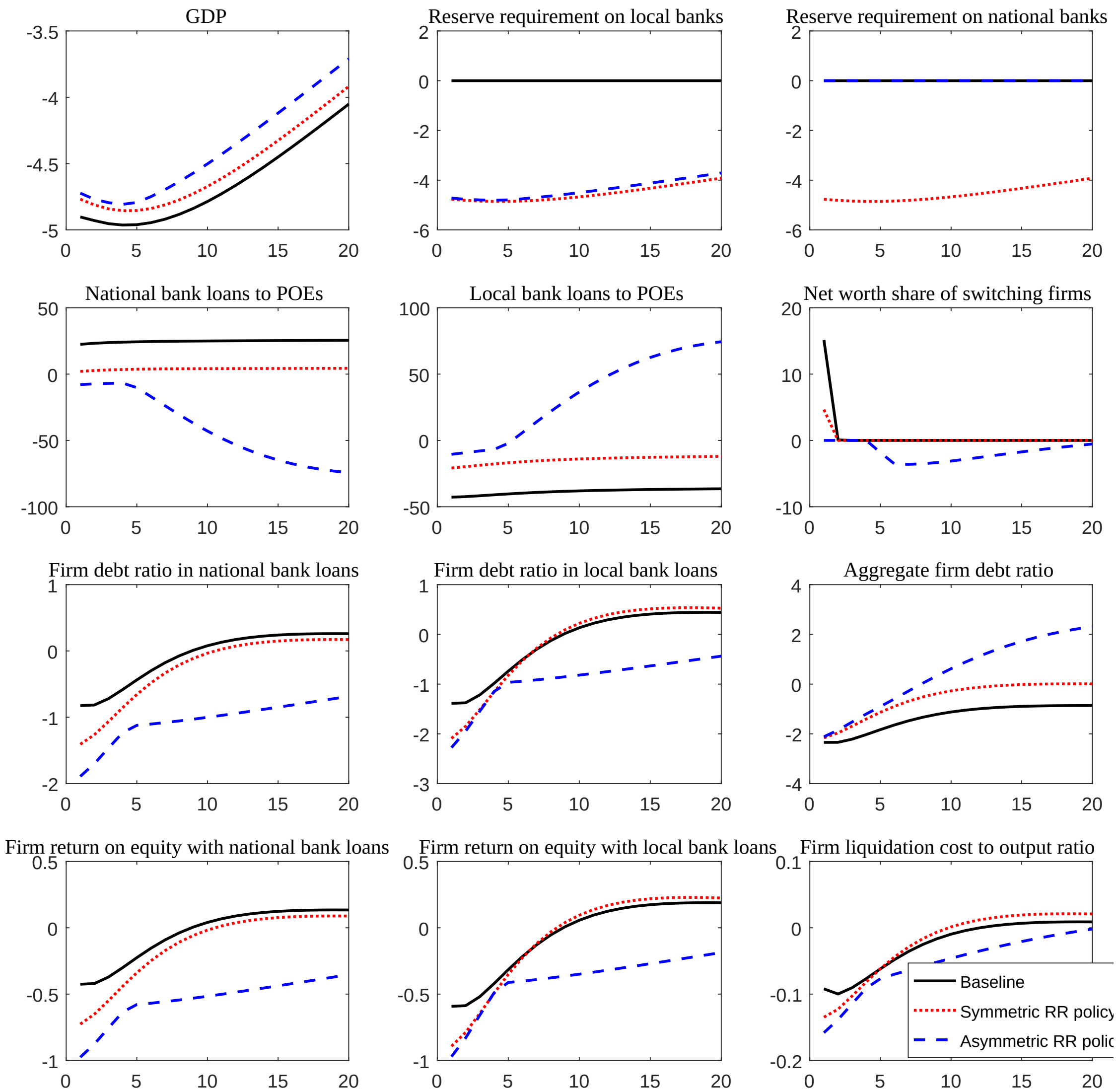


FIGURE 7. Impulse responses of a large negative technology ($\epsilon_{at} = -0.05$) under alternative policy rules. Benchmark rule: black solid lines; symmetric RR rule: blue dashed lines; assymmetric rule: red dashed lines. The horizontal axes show the quarters after the impact period of the shock. The units on the vertical axes are percentage-point deviations from the steady state levels for firms' return to equity, firms' debt ratios, reserve requirements and firm liquidation cost to output ratio. The units on the vertical axes are percent deviations from the steady state levels for other variables. The variable "Net worth share of switching firms" refers to the ratio of the net worth of firms that switch from local banks to national banks to the net worth of all firms.

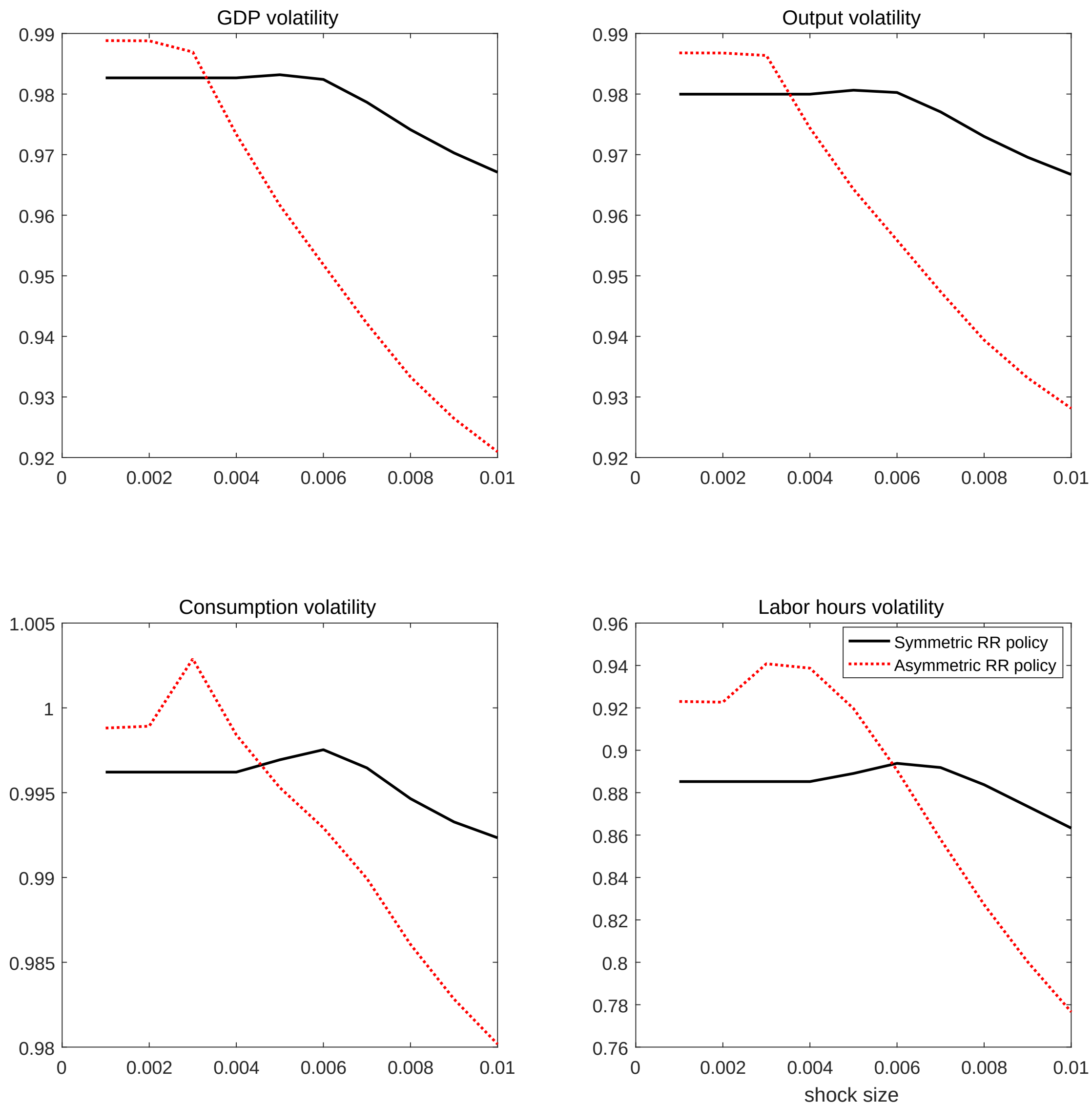


Figure 8. Macro volatility under technology shocks with flexible prices. Symmetric RR rule: black solid lines; assymmetric rule: red dashed lines. The horizontal axes show the size of the technology shock $\sigma_a$. The vertical axes show the standard deviation of the corresponding variable under the alternative policy regime scaled by the standard deviation of the variable under the benchmark regime.

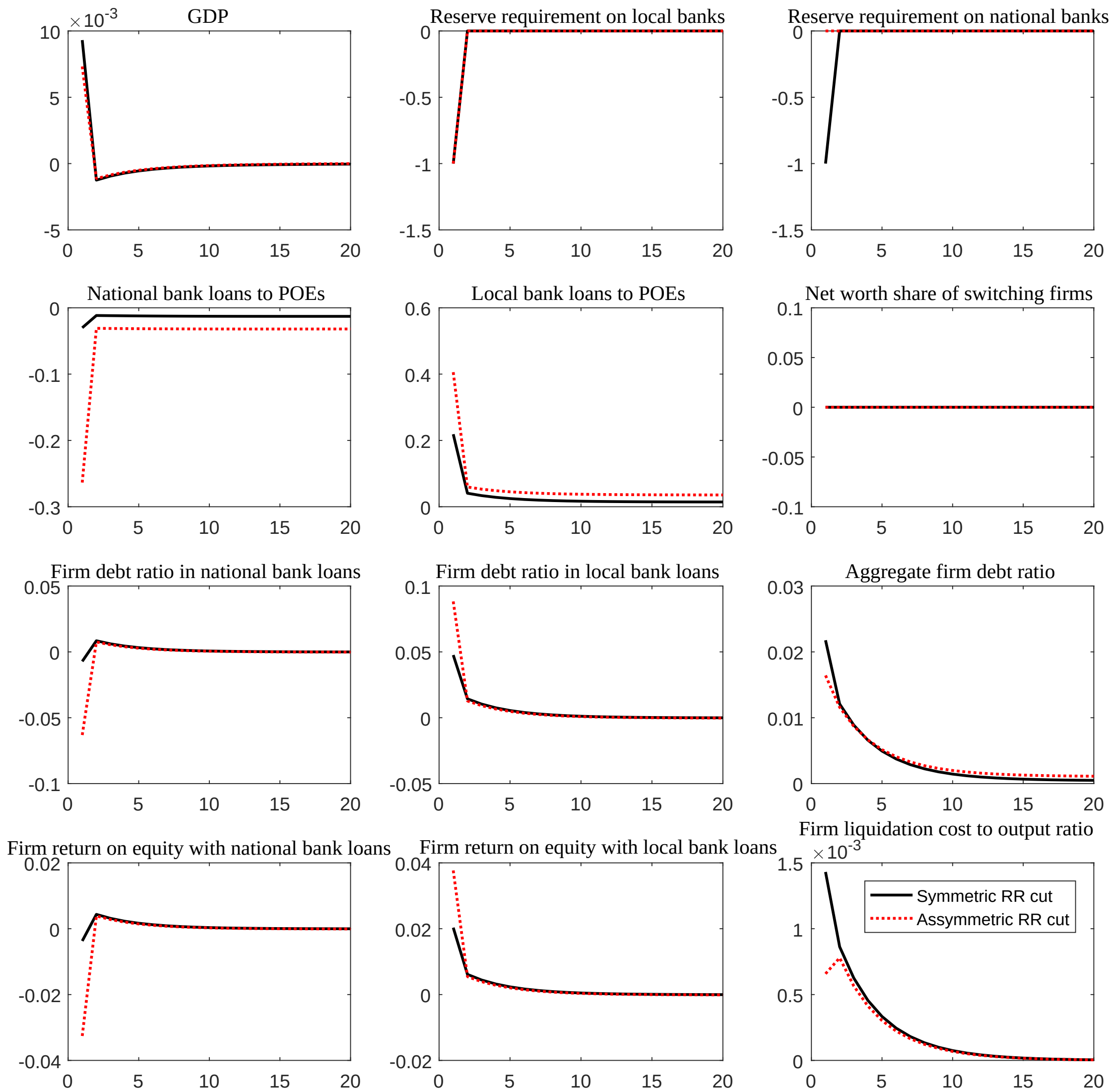


FIGURE 9. Impulse responses of RR cut in an economy where the bank switching cost is infinite. The horizontal axes show the quarters after the impact period of the shock. The units on the vertical axes are percentage-point deviations from the steady state levels for firms' return to equity, firms' debt ratios, reserve requirements and firm liquidation cost to output ratio. The units on the vertical axes are percent deviations from the steady state levels for other variables. The variable "Net worth share of switching firms" refers to the ratio of the net worth of firms that switch from local banks to national banks to the net worth of all firms.

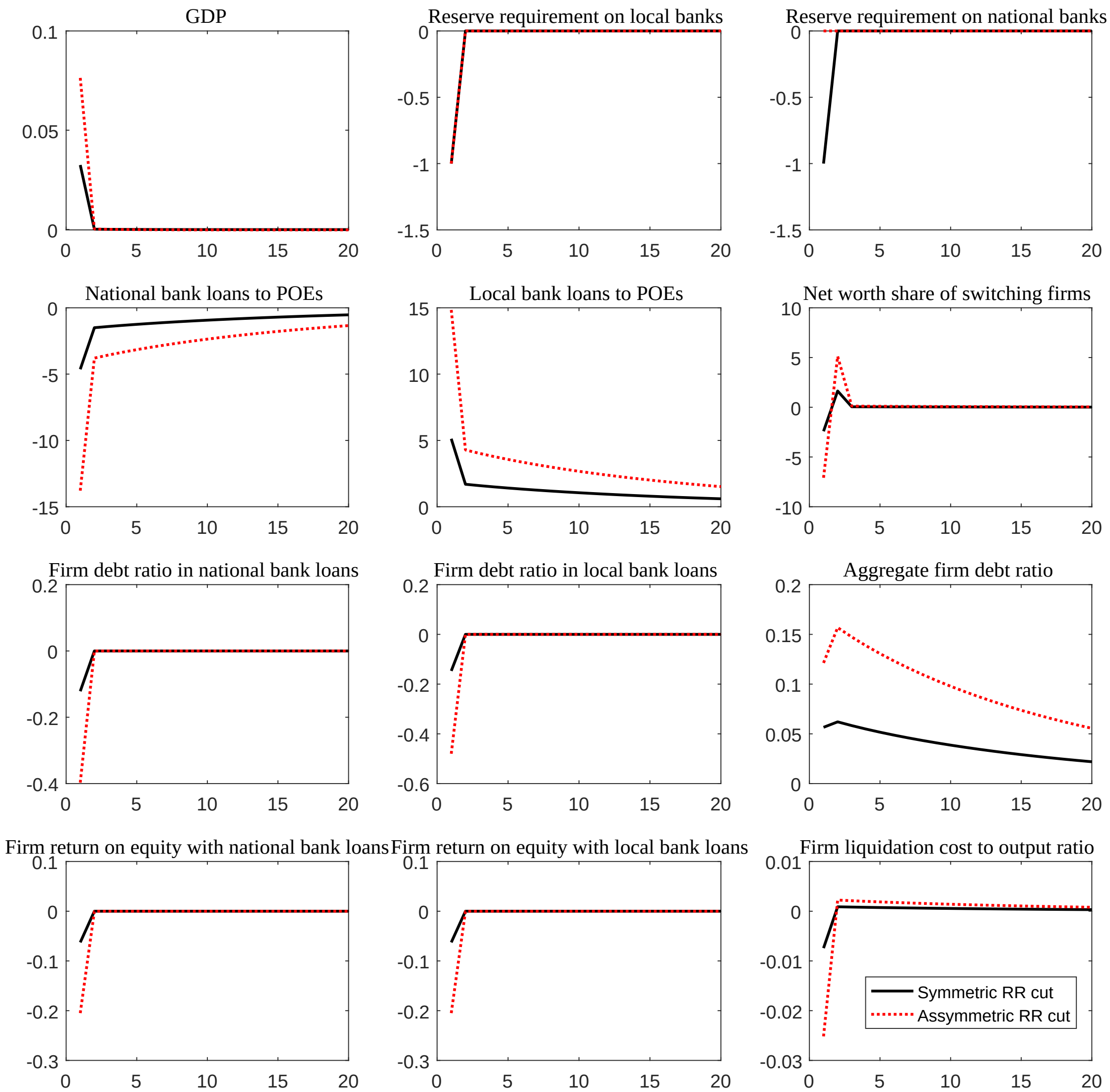


FIGURE 10. Impulse responses of RR cut in an economy where the bank switching cost is zero. The horizontal axes show the quarters after the impact period of the shock. The units on the vertical axes are percentage-point deviations from the steady state levels for firms' return to equity, firms' debt ratios, reserve requirements and firm liquidation cost to output ratio. The units on the vertical axes are percent deviations from the steady state levels for other variables. The variable "Net worth share of switching firms" refers to the ratio of the net worth of firms that switch from local banks to national banks to the net worth of all firms.

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