Reserve Requirement Ratio and Capital Flows: A Regime-Switching DSGE Estimation for China

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Reserve Requirement Ratio and Capital Flows: A Regime-Switching DSGE Estimation for China [*]

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Abstract

We construct and estimate a small open economy DSGE model featuring a regime-switching reserve requirement (RR) ratio rule within a banking sector that has access to foreign assets. The model incorporates key financial characteristics of the Chinese economy and examines the implications of changes in the RR-ratio. Estimation results reveal that the RR-ratio follows a feedback rule with a regime-dependent coefficient on net foreign lending during two distinct phases between 2006 and 2017. The state-contingent rule is temporarily suspended during the Global Financial Crisis, but is reactivated in the post-crisis period amid recovered capital inflows. On the one hand, the RR-ratio has almost negligible real effects on output and inflation; but on the other hand, it proves effective as a macroprudential instrument by mitigating financial instability through a reduced risk of self-fulfilling bank runs by about 25%.

JEL classification: C11, E58, F41, G18

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1. Introduction

Since the early 2000s, China has experienced a prolonged period of "twin surpluses," with persistent current account surpluses driven by export-oriented growth and simultaneous capital account surpluses driven by sustained inflows of foreign direct investment and expectations of Chinese currency appreciation. These surpluses implied sustained net foreign exchange inflows:[1] while the People's Bank of China (PBoC) absorbed a large share through reserve accumulation, commercial banks also expanded their foreign asset positions, most notably through rising foreign lending amid China's "twin surpluses" conditions (see He and McCauley 2013; Horn et al. 2025).[2] Such lending tends to be more risky than domestic lending, arising from real exchange rate volatility, valuation uncertainty, and heightened exposure to external shocks. It's rapid expansion during the 2000s exacerbated financial fragility and heightened the potential for self-fulfilling runs in the banking sector characterized by liquidity mismatches.

Against this backdrop of capital inflows and overheating pressures, the PBoC raised the average reserve requirement (RR) ratio from 7% in 2003 to 21% in 2011.[3] While the RR policy has played a diminishing role in advanced economies, in China it emerged as a distinctive policy instrument. A notable development over this period was the shift in the use of the RR-ratio, common as a low-frequency tool, toward a state-contingent instrument explicitly aimed at financial stability concerns (see, e.g., He and Wang, 2012; Chen et al., 2018). This interpretation is consistent with a broader literature showing that RR-ratio have increasingly been employed in open-economy contexts—particularly in emerging markets—as a tool for mitigating capital flow volatility and external risks (Glocker and Towbin, 2012; Aizenman et al., 2015; Chi et al., 2025). As shown in Figure 1, we further find that adjustments in the RR-ratio are tightly related to fluctuations in banks' net foreign lending. While the RR-ratio is not announced to target foreign asset allocations, this observed co-movement points to a potential feedback mechanism to counter external imbalances and the risks associated with foreign lending. This interpretation is in line with the PBoC's official statements,

> *"In response to the continued expansion of the 'twin surpluses' and the significant influx of foreign exchange, a series of measures were implemented, primarily through increases*

[1] Capital inflows in the 2000s generated excess domestic liquidity via large-scale foreign exchange interventions, through which the PBoC passively injected base money into the system (PBoC, 2006, p. 9). This mechanism directly contributed to overheating pressures in the domestic economy. To address such imbalances, the authorities relied on a combination of measures, including outbound investment promotion (PBoC, 2005, p. 11), the issuance of central bank bills, and frequent adjustments in the RR-ratio. While the latter was officially framed primarily as a tool for liquidity sterilization, in practice, it has been deployed in a manner that closely tracks banks' net foreign lending, which is the focus of this paper.

[2] These foreign loans were largely extended by state-owned commercial banks to emerging economies, reflecting China's bank-centered—rather than bond-based—approach to overseas lending. (see Horn et al. 2025).

[3] Throughout the paper, the RR-ratio refers to the average reserve requirement ratio applied to the banking sector, excluding differentiated or targeted adjustments (see, e.g., Wei et al., 2020; Wei and Han, 2020).

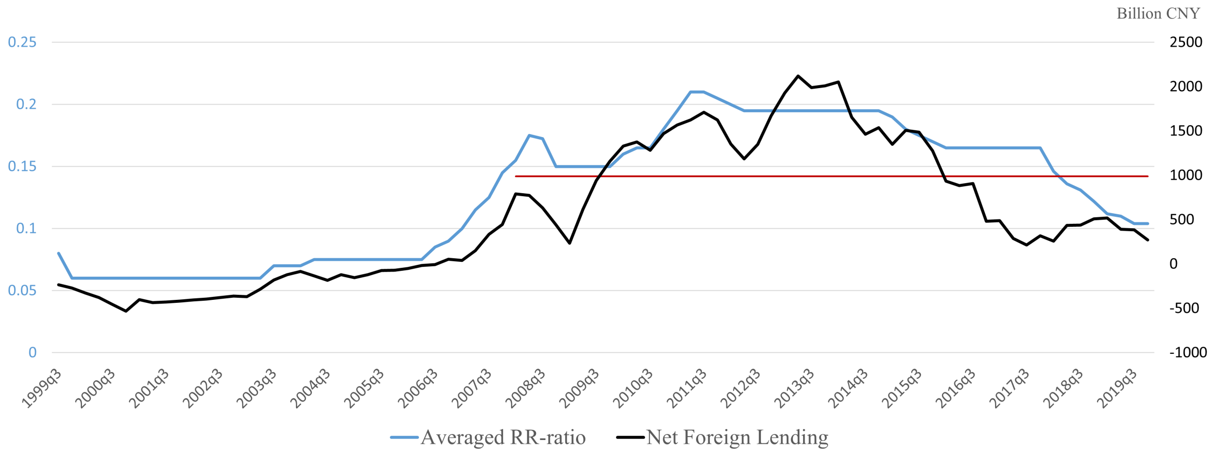

Figure 1: The blue line depicts the average reserve requirement ratio, while the black line shows commercial banks' net foreign lending, measured as foreign lending minus foreign deposits. *Source*: PBoC database.

in the reserve requirement ratio, to offset excess liquidity." (PBoC, 2009, p. 8)

Motivated by these observations, this paper investigates the impact of the RR policy on financial stability and macroeconomic dynamics. We develop and estimate a small open economy dynamic stochastic general equilibrium (DSGE) model in which banks use deposits to finance both domestic and foreign lending, operating under a moral hazard friction and facing the RR imposed by the central bank. The model embeds a regime-switching RR-ratio rule, with the feedback coefficient on net foreign lending evolving as a latent Markov process. The paper provides three novel findings.

First, we identify both the existence and timing of a state-contingent RR-ratio rule adopted by the PBoC—one that systematically responds to banks' foreign lending dynamics. The estimation identifies a regime shift in 2006–2008, a period characterized by externally driven economic overheating. The rule was temporarily suspended during the Global Financial Crisis, as PBoC eased RR to counter falling external demand and intensifying domestic liquidity constraints. It was subsequently reactivated in the post-crisis period amid recovered capital inflows. This regime remained in place until the end of 2017, after which it was gradually phased out and a new set of policy instruments—such as the PBoC's lending facilities (e.g., SLF, MLF)—were introduced, which fall beyond the scope of this paper.

Second, we compare alternative specifications of the RR-ratio rule and find that the version featuring a regime-dependent coefficient on net foreign lending—combined with inverse responses to output and inflation gaps—achieves the best empirical fit based on marginal data densities. This state-contingent specification outperforms alternative specifications in reducing the likelihood of bank runs in response to external shocks. Its effectiveness stems from sustained and sizable RR-ratio adjustments, which prompt banks to re-balance their portfolios by reducing exposure to risky assets and strengthening liquidity buffers. At the same time, a tighter RR leads banks to absorb more deposits—even as households demand higher returns—to maintain lending and avoid net worth deterioration. This mechanism echoes the PBoC's policy stance, which emphasizes the RR-ratio's role in absorbing excess liquidity amid persistent capital inflows and balance sheet expansion, and is consistent with our model's implication that the RR safeguards financial stability without distorting real activity.

Third, we assess the macroprudential role of the RR-ratio and find that it functions as a precautionary tool. Incorporating a self-fulfilling bank run framework à la Gertler and Kiyotaki (2015)—where the probability of a run depends on the endogenous distance to a threshold—we show that the RR enforces precautionary liquidity buffers, which enhance banks' ability to meet redemption needs under adverse conditions and reduce the likelihood of fundamental liquidity distress. This stabilizing impact may, at least in part, have contributed to the absence of major systemic banking crises in China over the past two decades, despite sustained twin surpluses and the associated buildup of foreign lending. Although the model incorporates two macroeconomic transmission channels of the RR-ratio—by raising funding costs directly and endogenously via deposit pricing adjustments—the estimation results indicate that its effects on output and inflation are almost negligible.[4] In contrast, its contribution to financial stability is quantitatively measurable, e.g., reducing the peak response of bank-run likelihood by about 25% under a TFP shock.[5]

The remainder of the paper is organized as follows. Section 2 presents a small open economy DSGE model with banking, featuring the moral hazard friction and a regime-dependent RR-ratio rule set by the central bank. Section 3 introduces the framework for analyzing self-fulfilling bank runs. Section 4 presents the estimation results, including the timing of the credit-based RR-ratio rule regime and the model's impulse responses to macroeconomic shocks. Section 5 concludes.

Related Literature Our study is related to the literature on the RR policy in emerging markets, which discusses its dual role in monetary transmission and macroprudential regulation. Empirical evidence shows that increases in the RR-ratio typically raise interest rate spreads and reduce bank profitability (Carvalho and Azevedo, 2008), while serving as a policy tool to manage capital flow volatility and financial instability (Cordella et al., 2014; He and Wang, 2012). In the context of China, Chang et al. (2019) shows in a macroeconomic model that RR-ratio adjustments can reallocate credit from state-owned firms toward privately owned, thereby enhancing aggregate efficiency. The macroprudential dimension of RR is further emphasized by

[4] A similar finding is reported in Sun and Liu (2023) based on a VAR analysis using Chinese data.

[5] According to this specific model, financial stability in terms of the reduction in the bank run likelihood can also be achieved through adjustments to the tightness of the endogenous incentive constraint; see the discussion in Appendix B4.

studies showing their effectiveness in alleviating liquidity pressures and stabilizing bank balance sheets during periods of exchange rate regime shifts and financial turbulence (Ma et al., 2013; Agénor et al., 2018), as well as in mitigating risks associated with volatile external financing and exchange rate fluctuations (Obstfeld et al., 2019; Hoffmann and Löffler, 2014). Our work is closely related to the works of Glocker and Towbin (2012) and Aizenman et al. (2015), who analyze RR policy in small open economy models with financial frictions. Glocker and Towbin (2012) demonstrate that the RR can contribute to price stability, but only when financial frictions are significant, as captured by liquidity management costs and the optimal loan contraction à la Bernanke et al. (1999). Their findings further suggest that the stabilizing effect of RR-ratio is particularly pronounced in the presence of foreign debt. An optimally designed credit-based RR-ratio rule can improve welfare by offsetting credit market distortions (Aizenman et al., 2015). While these studies offer valuable theoretical insights, our paper focuses on the ex-post regulatory outcomes of the RR in managing capital outflows and provides empirical evidence tailored to the institutional and macroeconomic features of China's economy.

This paper's analysis of financial stability draws on the self-fulfilling bank-run framework of Gertler and Kiyotaki (2015), which models the possibility of run equilibria whose likelihood varies endogenously with macroeconomic conditions. This form of instability depends on the state of bank balance sheets and the endogenously determined liquidation price of bank assets, with the self-fulfilling run mechanism enabled by the financial frictions in the Gertler and Karadi (2011). This type of bank run, arising from liquidity mismatches between liabilities and assets, results in significant inefficiencies in the financial system. Unlike the seminal framework proposed by Diamond and Dybvig (1983), which emphasizes the role of early withdrawals by depositors, the GK models (see also Gertler and Kiyotaki, 2015; Gertler et al., 2016a,b, in an infinite horizon endowment economy) shift the focus to a different mechanism. In this model, bank runs are characterized by a panic-induced failure to roll over short-term debt or deposits, underscoring the fragility of funding structures in the face of adverse expectations or shocks. Finally, this paper relates to the literature on capital controls, sterilization, and liberalization. Studies such as Devereux et al. (2019) and Liu et al. (2021) highlight the policy trade-offs faced by small open economies with financial frictions. Chang et al. (2015) shows that capital account and exchange rate liberalization would have allowed the PBoC to better stabilize the external shocks during the global financial crisis.

2. Model

In this section, we develop a small open economy model in which banks operate as financial intermediaries with access to foreign borrowers. The banking sector features a moral hazard problem in the spirit of Gertler and Karadi (2011), and is regulated by the central bank through a regime-dependent RR-ratio rule, in which the feedback coefficient on net foreign lending follows a latent Markov process with periods of policy activation identified from the data. The rest of the model consists of representative households and firms operating in standard production and pricing sectors. Several aggregate shocks are introduced to facilitate Bayesian estimation.

2.1. Households

The representative infinitely lived household chooses labor supply N_t, consumption of final goods C_t, and deposits held with bankers D_t in each period t. Instantaneous utility increases with habit-adjusted real consumption $C_t - hC_{t-1}$, where $h \in [0, 1)$ captures the degree of internal habit formation, and with real deposits, but decreases with labor effort. The household's lifetime preferences are given by,

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \psi_t^P \left[\log(C_t - hC_{t-1}) + \vartheta \frac{D_t^{1-\sigma_d} - 1}{1 - \sigma_d} - \chi \frac{N_t^{1+\sigma_n}}{1 + \sigma_n} \right], \tag{1}$$

where $\vartheta > 0, \chi > 0, \sigma_d > 0$, $\sigma_n \geq 0$, and ψ_t^P stands for an intertemporal preference shock. The concavity of utility in deposits implies that households require higher deposit rates to compensate for declining marginal utility, thereby imposing a cost on banks when attracting funds. This contrasts with Gertler and Karadi (2011), where deposit supply is perfectly elastic—implying that banks face no marginal funding cost and thus fundamentally limit the transmission of the RR policy to credit allocation and broader macroeconomic outcomes.

Let W_t denote the real wage, R_t^D the real gross return on deposits, and R_t the real interest rate on real risk-less bond B_t assumed to have zero net supply. Households also receive dividend income div_t from ownership of production firms, including importers div_t^{IG}, retail goods producers div_t^{RG}, capital producers div_t^{CP}, and retailers div_t^R. The government levies lump-sum taxes T_t on households, then a budget constraint can be expressed in real term,

$$C_t + D_t + B_t + T_t = W_t N_t + R_t^D D_{t-1} + R_t B_{t-1} + div_t. \tag{2}$$

Denoting by λ_t^H the Lagrange multiplier on the budget constraint (2), the household's first-order conditions with respect to consumption, labor, deposits, and bonds are:

$$\psi_t^P (\mathscr{C}_t)^{-\sigma_c} - \beta h \mathbb{E}_t \psi_{t+1}^P (\mathscr{C}_{t+1})^{-\sigma_c} = \lambda_t^H, \tag{3}$$

$$\lambda_t^H W_t = \chi \psi_t^P N_t^{\sigma_n}, \tag{4}$$

$$1 = \vartheta \psi_t^P \left(\lambda_t^H D_t^{\sigma_d} \right)^{-1} + \mathbb{E}_t \Lambda_{t,t+1} R_{t+1}^D, \tag{5}$$

$$1 = \mathbb{E}_t \Lambda_{t,t+1} R_{t+1}, \tag{6}$$

where the stochastic discount factor is defined as $\Lambda_{t,t+1} = \beta \mathbb{E}_t \lambda_{t+1}^H / \lambda_t^H$. Notably, the optimality condition (5) captures one channel through which the RR affects funding costs: as the deposit volume D_t increases, diminishing marginal utility prompts households to demand a higher deposit rate as compensation. Moreover, a higher elasticity parameter σ_d steepens the curvature of the deposit utility function, amplifying the sensitivity of the required deposit return R_t^D to changes in D_t.

2.2. Bankers

The banking sector consists of a unit-mass continuum of banks indexed by j, owned by households and operated by risk-neutral bankers with finite expected horizons. Following Gertler and Karadi (2011), each banker survives to the next period with probability $\theta \in (0,1)$, which prevents indefinite net worth accumulation. In each period, a fraction $1-\theta$ of bankers exit and are replaced by an equal measure of new bankers drawn from households, maintaining a constant mass over time. New entrants receive a start-up transfer from households equal to a fraction $\omega/(1-\theta)$ of the assets held by exiting bankers. Surviving bankers accumulate net worth through intermediation activities and consume their equity upon exit. Their expected lifetime utility can therefore be written recursively as,

$$V_{j,t}^B = \max \mathbb{E}_t \Lambda_{t,t+1} \left[(1-\theta) net_{j,t+1} + \theta V_{j,t+1}^B \right]. \tag{7}$$

To capture capital control tools' information beyond the RR in the China's economy, we introduce portfolio adjustment costs Ω_t for all bankers, following Chang et al. (2015). These costs penalize deviations in the composition of bank lending across domestic and foreign assets, with the degree of restriction governed by κ_b. Specifically, the cost function takes the form,

$$\Omega_{j,t} = \frac{\kappa_b}{2} \left(\Upsilon_{j,t} - \Upsilon \right)^2, \quad \Upsilon_t = \frac{Q_t^K L_{j,t}^H}{Q_t^K L_{j,t}^H + e_t L_{j,t}^F}, \tag{8}$$

where Υ_t denotes the share of domestic lending, $L_{j,t}^H$, priced at Q_t^K, in total bank lending. Net foreign lending $L_{j,t}^F$ is measured in terms of the real foreign consumption and may, in principle, take negative values—indicating net foreign borrowing. In this paper, we focus on episodes where banks maintain net foreign asset positions vis-à-vis the rest of the world.[6] The relative price of foreign assets in terms of the domestic consumption bundle is denoted by e_t. This term captures the real exchange rate and ensures consistent valuation of foreign asset positions from the perspective of domestic households.[7]

We model the RR-ratio as the fraction ρ_t of bank deposits that must be held in the form

[6] We abstract from the specific contractual forms of these foreign claims. They may be interpreted broadly—for example, as holdings of U.S. Treasury securities—with real exchange rate fluctuations serving as the primary source of valuation risk, informed by observed data.

[7] As consumption bundles differ across countries—for example, due to the presence of non-tradable goods priced locally—foreign and domestic goods are not priced identically across borders.

of reserves. Let $M_{j,t}$ denote the real reserve balance, which can be written as $M_{j,t} = \rho_t D_{j,t}$ under the assumption that the reserve requirement is always satisfied.[8] Following the related literature, the net worth of a surviving bank j evolves according to,

$$net_{j,t+1} = R^L_{t+1} Q^K_t L^H_{j,t} + R^L_{F,t+1} e_{t+1} L^F_{j,t} + R^R \rho_t D_{j,t} - R^D_{t+1} D_{j,t} - \Omega_{j,t}, \tag{9}$$

where R^L_t and $R^L_{F,t}$ denote the real returns on domestic and foreign lendings, respectively. The interest on required reserves R^R, is assumed constant, reflecting the PBoC's practice of not actively adjusting reserve remuneration as a policy instrument. Banks are subject to a standard balance sheet requirement in every period,

$$\rho_t D_{j,t} + Q^K_t L^H_{j,t} + e_t L^F_{j,t} = D_{j,t} + net_{j,t}. \tag{10}$$

To capture financial frictions that give rise to risk premiums in banking, we follow the moral hazard framework of Gertler and Karadi (2011). In this setup, sustainable intermediation requires that banks earn returns above their funding costs, reflecting the compensation for risk. After raising funds and acquiring assets at the beginning of the period, each banker chooses between acting honestly—holding assets until maturity and repaying depositors—or diverting a fraction of assets for private benefit by liquidating them prematurely, thereby defaulting on their obligations.[9] To formalize this incentive problem, we assume that bankers can divert a fraction ι^h of domestic lending and ι^f of foreign lending for personal gain. Upon diversion, depositors liquidate the bank and recover only the remaining assets, forcing the banker into bankruptcy. The banker thus faces a trade-off between the franchise value of continued operation, denoted by $V^B_{j,t}$—the expected present value of future net payouts—and the one-time benefit from asset diversion, given by $\iota^h Q^K_t L^H_{j,t} + \iota^f e_t L^F_{j,t}$. A rational depositor anticipates this behavior and supplies funds only if the banker prefers to operate honestly. As a result, the financial contract must satisfy the following incentive compatibility constraint,

$$V^B_{j,t} \geq \psi^F_t \left(\iota^h Q^K_t L^H_{j,t} + \iota^f e_t L^F_{j,t} \right), \tag{11}$$

where ψ^F_t denotes an exogenous shock to the tightness of the incentive constraint, capturing time-varying financial frictions. Given constant returns to scale in intermediation, we conjecture a linear value function of the form $V^B_{j,t} = \nu_t, net_{j,t}$, where ν_t represents the marginal value of bank net worth, i.e., the banker's Tobin's Q. To characterize optimal portfolio allocation, we

[8] Since the PBoC sets the interest rate on excess reserves as the lower bound of the interest rate corridor—unlike the U.S. framework—holding reserves is costly (e.g., Ennis, 2018; Diba and Loisel, 2021; Sims and Wu, 2021). Consequently, banks hold reserves solely to comply with regulatory requirements, implying that the reserve requirement is binding.

[9] This framework also underpins our later analysis of financial instability and bank-run dynamics.

define the following expected premia and costs,

$$\mu^L_{H,t} \equiv \mathbb{E}_t \tilde{\Lambda}_{t,t+1} \left(R^L_{t+1} - \bar{R}_{t+1} \right), \tag{12}$$

$$\mu^L_{F,t} \equiv \mathbb{E}_t \tilde{\Lambda}_{t,t+1} \left(R^L_{F,t+1} \frac{e_{t+1}}{e_t} - \bar{R}_{t+1} \right), \tag{13}$$

$$\mu^D_t \equiv \mathbb{E}_t \tilde{\Lambda}_{t,t+1} \bar{R}_{t+1}, \tag{14}$$

where $\tilde{\Lambda}_{t,t+1} = \Lambda_{t,t+1}(1 - \theta + \theta \nu_{t+1})$ is the effective stochastic discount factor, reflecting the weighted valuation of exiting versus continuing bankers. The effective marginal cost of funding, $\bar{R}_t$, adjusts for the presence of required reserves and is defined as,[10]

$$\bar{R}_t \equiv \frac{R^D_t - R^R \rho_{t-1}}{1 - \rho_{t-1}}. \tag{15}$$

This expression suggests that when the interest on reserves lies below the deposit rate, both an increase in the policy interest rate and a hike in the RR-ratio exert qualitatively similar contractionary effects on macroeconomic dynamics by raising $\bar{R}_t$. Each bank chooses domestic and foreign lending to maximize its franchise value, subject to the balance sheet identity (10) and the binding incentive constraint (11), yields,

$$\frac{\mu^L_{H,t} - \partial \Omega_t / \partial L^H_t}{\mu^L_{F,t} + \partial \Omega_t / \partial L^F_t} = \frac{\iota^h}{\iota^f}, \tag{16}$$

which characterizes the optimal allocation between domestic and foreign lending underlying asymmetries in diversion risks and portfolio frictions. Under the empirically supported assumption that $\iota^h > \iota^f$ (see Section 4), banks face tighter incentive constraints on domestic lending and thus require a higher marginal return on such assets to deter opportunistic behavior. Unlike the symmetric structure in Dedola et al. (2013), this asymmetry is intentionally incorporated to reflect institutional realities in China's banking system—where capital controls, supervisory stringency, and incomplete capital account convertibility distort cross-border portfolio allocation. In the short run, these effects are further amplified by valuation risk and capital flow management measures.

2.3. Importers

Following Chang et al. (2015), imported goods are not directly consumed by households but are processed by importers and used as intermediate inputs in retail goods production, reflecting their predominantly production-oriented use in China during the 2000s. Each importer combines domestically produced final goods $\Gamma_{H,t}$ and imported goods $\Gamma_{F,t}$ to produce intermediate inputs

[10] $\bar{R}_t$ is derived by substituting $D_{i,t}$ in (9) using the bank balance sheet identity (10).

Γ_t using a constant-returns-to-scale CES production technology:

$$\Gamma_t = \Gamma_{H,t}^{\alpha}\Gamma_{F,t}^{1-\alpha}, \tag{17}$$

where $\alpha \in (0,1)$ denotes the share of domestic input in the composite good. Let P_t^M denote the price of the composite good sold to retail goods producers. The importer's cost minimization yields the following first-order conditions:

$$1 = \alpha P_t^M \frac{\Gamma_t}{\Gamma_{H,t}}, \tag{18}$$

$$e_t = (1-\alpha) P_t^M \frac{\Gamma_t}{\Gamma_{F,t}}. \tag{19}$$

2.4. Other domestic firms

The representative **retail goods producer** operates in a perfectly competitive goods market to produce retail goods and engage in capital goods transactions with the capital producers. Building on the Gertler and Karadi (2011), we extend the framework by allowing producers to purchase intermediate goods Γ_t as an additional production input, which is used in combination with capital $K_{i,t}$ and labor $N_{i,t}$, forming a Cobb-Douglas production function,

$$Y_t = A_t K_{t-1}^{\alpha_k} \Gamma_t^{\alpha_\Gamma} N_t^{(1-\alpha_k-\alpha_\Gamma)}, \tag{20}$$

where α_k and α_Γ denote the input share of capital and intermediate goods, respectively. A_t denotes an exogenous process for total factor productivity. Capital depreciates after production and firms are assumed to sell the effective depreciated capital $(1-\delta)\,\psi_t^K K_{t-1}$ at a market price Q_t^K, where the valuation is affected by an exogenous capital quality shock ψ_t^K. Acquisition of new capital is financed through frictionless external funding, for simplicity, each claim $L_{i,t}^H$ is assumed to equal capital purchase,[11]

$$Q_t^K L_t^H = Q_t^K K_t. \tag{21}$$

Let MC_t denote the price of products sold to retailers. Then, profit maximization leads to the following first-order conditions for labor input and intermediate goods,

$$(1-\alpha_k-\alpha_\Gamma)\, MC_t \frac{Y_t}{N_t} = W_t, \tag{22}$$

$$\alpha_\Gamma MC_t \frac{Y_t}{\Gamma_{i,t}} = P_t^M, \tag{23}$$

[11] Similiar in Gertler and Karadi (2011), this simplification ensures a perfect state-contingent return on debt avoid further complexity from financial frictions or distortions.

as well as a zero profit condition

$$R_t^L = \frac{Z_t + (1-\delta) Q_t^K \psi_t^K}{Q_{t-1}^K}, \tag{24}$$

which implies the state-contingent return R_t^L depends on the productivity $Z_t \equiv \alpha^k MC_t Y_t / K_{t-1}$ of per unit capital, the value of leftover capital, the asset price, and capital quality.

At the end of the period, **capital producers** are replenishing depreciated capital by utilizing the final output (i.e., investment $I_{i,t}$). New capital is produced following a standard capital accumulation technique, $K_t = (1-\delta)\,\psi_t^K K_{t-1} + I_t$. Profits of capital producers are,

$$div_t^{CP} = Q_t^K K_t - (1-\delta)\,\psi_t^K Q_t K_{t-1} - (\Psi_t + 1)\,\frac{I_t}{\psi_t^I}, \text{ with } \Psi_t = \frac{\kappa_I}{2}\left(\frac{I_t}{I_{t-1}} - 1\right)^2, \tag{25}$$

where $\kappa_I > 0$ and ψ_t^I denotes an investment-specific technology shock. Given this, producers choose I_t to maximize the expected present value of profits, subject to the following condition,

$$Q_t^k \psi_t^I = 1 + \frac{\kappa_I}{2}\left(\frac{I_t}{I_{t-1}} - 1\right)^2 + \kappa_I \left(\frac{I_t}{I_{t-1}} - 1\right)\frac{I_t}{I_{t-1}} - \kappa_I \mathbb{E}_t \Lambda_{t,t+1}\left(\frac{I_{t+1}}{I_t} - 1\right)\left(\frac{I_{t+1}}{I_t}\right)^2 \frac{\psi_t^I}{\psi_{t+1}^I}. \tag{26}$$

Each **retailer**, indexed by $j \in [0,1]$, purchases intermediate goods from the intermediate goods firm at perfectly competitive prices MC_t. They re-package and resell them monopolistically in the final goods market, where final output Y_t is a CES composite of retailers' output $Y_{j,t}$ satisfying $Y_t = \left[\int_0^1 Y_{j,t}^{\frac{\eta_t - 1}{\eta_t}}\, dj\right]^{\frac{\eta_t}{\eta_t - 1}}$. The demand curve results from cost minimization by users of final outputs,

$$Y_{j,t} = \left(\frac{P_{j,t}}{P_t}\right)^{-\eta_t} Y_t, \tag{27}$$

$$P_t = \left[\int_0^1 P_{j,t}^{1-\eta_t} dj\right]^{\frac{1}{1-\eta_t}}, \tag{28}$$

where $P_{j,t}$ stands for the price of retail goods $Y_{j,t}$ and η_t denotes the elasticity of substitution. We consider nominal price rigidities following Rotemberg (1982) with indexation on long-run/steady-state inflation π and past inflation with a weight $\varpi \in [0,1]$ (see e.g. Bjørnland et al., 2018). Specifically, each period a retailer j chooses an optimal set of $(P_{j,t}; Y_{j,t})$ to maximize the present vale of profits as follow

$$\max_{P_{j,t}} \mathbb{E}_t \sum_{i=1}^{\infty} \Lambda_{t,t+i}\left[\left(\frac{P_{j,t}}{P_t} - MC_{t+i}\right) Y_{j,t+i} - \frac{\kappa_p}{2}\left(\frac{P_{j,t}}{\pi_{t-1}^{\varpi_b}\pi^{1-\varpi_b} P_{t-1}} - 1\right)^2 Y_{t+i}\right] \tag{29}$$

where κ_p measures the degree of nominal price rigidity and $\pi_t = P_t/P_{t-1}$ denotes the gross inflation rate. Under a symmetric equilibrium $P_{j,t} = P_t$, optimal price setting leads to a hybrid

New Keynesian Phillips curve,

$$\begin{aligned}\eta_t - 1 = \eta_t MC_t - \kappa_p \left(\frac{\pi_t}{\pi_{t-1}^{\varpi_b}\pi^{1-\varpi_b}} - 1\right)\left(\frac{\pi_t}{\pi_{t-1}^{\varpi_b}\pi^{1-\varpi_b}}\right) \\ + \kappa_p \mathbb{E}_t \Lambda_{t,t+1}\frac{Y_{t+1}}{Y_t}\left(\frac{\pi_{t+1}}{\pi_t^{\varpi_b}\pi^{1-\varpi_b}} - 1\right)\left(\frac{\pi_{t+1}}{\pi_t^{\varpi_b}\pi^{1-\varpi_b}}\right),\end{aligned} \tag{30}$$

with a positive cost-push shock ψ_t^η related to a decline in elasticity, such that $\eta_t = \eta(\psi_t^\eta)^{-\kappa_p}$.

2.5. Public Sector

The central bank supplies reserves to the banking sector in the form of non-repayable transfers and sets the policy interest rate, i.e., the nominal rate $R_t^M = \mathbb{E}_t R_{t+1}\pi_{t+1}$, which follows a standard Taylor rule,

$$R_t^M/R^M = \left(R_{t-1}^M/R^M\right)^{\gamma_r}\left[(\pi_t/\pi)^{\varphi_{r,\pi}}(Y_t/Y)^{\varphi_{r,y}}\right]^{1-\gamma_r}\exp(\varsigma^r\epsilon_t^R), \tag{31}$$

where $\gamma_r \in (0,1)$ denotes the interest rate smoothing parameter, $\varphi_{r,\pi}$ and $\varphi_{r,y}$ are the feedback coefficients that reflect the policy rate responses to inflation and the output gap. The monetary policy shock is assumed to be i.i.d. and normally distributed, i.e., $\epsilon_t^R \sim N(0,1)$.

Motivated by the discussion above, we introduce a state-contingent RR-ratio rule within a regime-switching framework governed by a two-state Markov chain, $\mathcal{S}_t^{RR} \in \{N, C\}$. In a normal state ($N$), the RR-ratio is assumed to follow a feedback rule in which the RR-ratio response to inflation gap and output gap (similar to Chang et al., 2019) with feedback coefficients $\varphi_{\rho,\pi}$ and $\varphi_{\rho,y}$, respectively—but not to net foreign lending, i.e., $\varphi_{(N)}^{\rho,f} = 0$. In contrast, the alternative regime (C) allows for an additional response to net foreign lending, such that $\varphi^{\rho,f}(C) \neq 0$. The RR-ratio rule can therefore be expressed as:

$$\rho_t/\rho = (\rho_{t-1}/\rho)^{\gamma_\rho}\left[(\pi_t/\pi)^{\varphi_{\rho,\pi}}(Y_t/Y)^{\varphi_{\rho,y}}\left(L_t^F/L^F\right)^{\varphi_{\rho,f}(\mathcal{S}_t^{RR})}\right]^{1-\gamma_\rho}\exp(\varsigma^\rho\epsilon_t^\rho). \tag{32}$$

In addition, the pre-specified shift in the policy structure is governed by an exogenous transition matrix.

$$\mathbb{Q}_{t,t+1}^{RR} = \begin{bmatrix} 1 - prob^{N,C} & prob^{N,C} \\ prob^{C,N} & 1 - prob^{C,N}\end{bmatrix}$$

where $prob^{N,C}$ denotes the probability of transitioning from the state N at time t to state C at time $t+1$ and $prob^{C,N}$ for the opposite direction. Finally, to close the model, we assume that the central bank transfers seigniorage revenue to the fiscal authority, which covers the interest remuneration on required reserves, as well as government spending G_t, through lump-sum taxation.

2.6. Equilibrium

The external demand for the home country's exports is modeled as a monotonic function of the relative price of exports, the foreign demand level, and domestic productivity:

$$EX_t = \left(\frac{P_t}{e_t^N P_t^F}\right)^{-\xi} Y_t^F A_t = e_t^{\xi} Y_t^F A_t \tag{33}$$

where ξ is a constant price elasticity of foreign demand and Y_t^F follows an AR(1) process capturing external demand shocks. The real exchange rate is determined by the nominal exchange rate e_t^N and foreign price level P_t^F.[12]

The final output is allocated to consumption, investment, government expenditure, intermediate inputs, and exports, as well as the costs associated with price adjustments, investment, and bankers' portfolio management. Aggregating all sectors' budget constraints, the national income identity can be expressed as follows,

$$Y_t = \Gamma_{H,t} + C_t + \left[1 + \Psi\left(\frac{I_t}{I_{t-1}}\right)\right]\frac{I_t}{\psi_t^I} + \frac{\kappa^p}{2}\left(\frac{\pi_t}{\pi_{t-1}^{\varpi_b}\pi^{1-\varpi_b}} - 1\right)^2 Y_t + EX_t + \Omega_t \tag{34}$$

The current account balance, comprising the trade surplus and interest income from foreign lending, is defined as $CA_t = EX_t - e_t\Gamma_{F,t} + \left(R_{F,t}^L - 1\right) e_t L_{t-1}^F$. In each period, a current account surplus (deficit) corresponds to an increase (decrease) in net capital outflows, captured by $CA_t = e_t L_t^F - e_t L_{t-1}^F$. GDP is defined as total output net of imports, while net GDP further adjusts this measure by excluding the social costs associated with portfolio adjustment, investment frictions, and nominal rigidities.

$$GDP_t = Y_t - e_t\Gamma_{F,t}; \quad GDP_t^{net} = \Gamma_{H,t} + C_t + I_t + EX_t - e_t\Gamma_{F,t} \tag{35}$$

The total amount of bank financing loan is defined as $L_t^H = \int_0^1 L_{j,t}^H dj$, $L_t^F = \int_0^1 L_{j,t}^F dj$. The aggregate net worth of the banking sector, NET_t is composed of the net worth of surviving bankers and that of newly entering bankers, $NET_t = \theta \int_0^1 net_{j,t} dj / \psi_t^{NW} + (1-\theta) NET_t^N$. The term $(1-\theta)NET_t^N = \omega\left(R_t^L Q_{t-1}^K L_{t-1}^H + R_{F,t}^L e_t L_{t-1}^F\right)$ denotes the the endowments of new bankers, which is transferred from households and assumed to be is a fraction of the asset return that the exiting bankers intermediate. ψ_t^{NW} denotes the quality of capital, which provides a simple source of exogenous variation in banks' net worth valuation. Using the balance sheet requirement, we know the aggregate deposits $D_t = \int_0^1 D_{j,t} dj$ equals $(1-\rho_t) D_t = Q_t^K L_t^H + e_t L_t^F - NET_t$. A full list of the equilibrium is provided in Appendix A.

[12] We abstract from nominal exchange rate pegging and formulate the model in real terms, allowing real exchange rate fluctuations to be matched with observed data.

Macroeconomic transmission of the RR-ratio To clarify the macroeconomic transmission of the RR-ratio adjustments, we summarize and analyze two key channels embedded in the model. The first operates through household-side deposit pricing, as implied by the optimality condition (5). Specifically, when the RR-ratio increases, banks are required to hold a larger share of non-remunerated reserves, thereby reducing the portion of deposit funding available for lending. To maximize the franchise value, banks seek to absorb a larger volume of deposits. However, given the concavity of deposit utility, households demand a higher return R_t^D—which banks take as given—thereby raising the effective funding cost $\bar{R}_t$, with the strength of this channel also governed by the deposit-utility curvature σ_d.

The second channel arises mechanically from the definition of the effective marginal cost of funding $\bar{R}_t$ (15), which increases directly with the RR-ratio. Formally, under $R_t^D - R^R > 0$, the derivative $\partial \bar{R}_t / \partial \rho_t = (R_t^D - R^R)(1-\rho_t)^{-2}$ is strictly positive and monotonically increasing in $\rho_t \in [0, 1)$. Hence, both the pricing-induced and mechanical channels operate in the same direction—by raising marginal funding costs, which compel banks to increase lending rates to preserve positive expected returns, thereby contracting aggregate output via the production sectors. It should be noted that, while the model exhibits these channels through which the RR-ratio influences output and inflation, with estimation we reveal whether these channels generate quantitatively measurable effects under plausible parameter values (see Section 4).

3. Bank Runs

In this section, we analyze financial instability in form of bank runs to assess the macroprudential effects of the RR policy. Building on Gertler and Kiyotaki (2015), we consider an unanticipated run scenario in which depositors (households) do not revise their expectations ex ante. Since a bank's survival relies on maintaining positive net worth, forced asset liquidation can wipe out equity and render the bank insolvent.

In particular, at the beginning of period t, before the realization of returns on bank assets, households decide whether to roll over their deposits with the bank. If a fraction $\varkappa$ of households expect that the bank cannot cover withdrawal demands—that is, if the liquidation value of bank assets falls short of outstanding liabilities—households seize bank capital (i.e., outstanding loan contracts) at a fire-sale discount q_t^* and directly operate it with their less efficient technology. Specifically, the liquidation value of bank loan contracts is expressed as,

$$\bar{Z}_t^* \bar{L}_{t-1} = \left[Z_t + q_t^*(1-\delta) Q_t^K \right] L_{t-1}^H + \left(R_{F,t}^L - 1 + q_t^* \right) e_t L_{t-1}^F, \tag{36}$$

where $\bar{Z}_t^*$ denotes the marginal return on the consolidated loan portfolio $\bar{L}_{t-1}$ under liquidation, with $\bar{L}_t = Q_t^K L_t^H + e_t L_t^F$.[13] Notably, since foreign lending is typically riskier than domestic loans, their liquidation prices would in principle be lower; however, we conservatively assume the same discount factor applies to both types of assets in the absence of more granular information. The assessment of bank cash flows under liquidation encompasses the payoff from required reserves, $R^R \rho_{t-1} D_{t-1}$. A run condition is then characterized by the recovery rate X_t satisfying,

$$X_t = \frac{\bar{Z}_t^* \bar{L}_{t-1} + R^R \rho_{t-1} D_{t-1}}{\varkappa R_t^D D_{t-1}} < 1. \tag{37}$$

Following Gertler and Kiyotaki (2015), we construct the variable $\Xi_t = \bar{q}_t - q_t^*$ as a measure of bank run likelihood, where $\bar{q}_t$ denotes the threshold fire-sale discount at which the recovery rate equals one ($X_t = 1$). In the steady state of our model, we impose $\Xi < 0$, which implies a bank run equilibrium does not exist in this situation. Yet, an unanticipated bank run can be possible at any point in time if severe economic shocks drive $\Xi_t > 0$. In this sense, a widening gap between $\bar{q}_t$ and q_t^* signals rising financial fragility: the lower the value of q_t^* relative to $\bar{q}_t$, the greater the repayment shortfall, intensifying solvency concerns and raising the latent probability of a run.

The valuation of liquidated capital is central to determining the feasibility of a bank run. In normal times, households do not engage in loan contracting due to their limited capacity in asset management relative to banks. Consequently, in the event of a run, forced liquidation to households incurs efficiency losses, reflected in a fire-sale discount ($q_t^* < 1$). Following Gertler and Kiyotaki (2015), we model these losses as capital management costs borne by households, captured by a quadratic cost function $f(\bar{L}_t)$ applied to the consolidated loan portfolio. In a run scenario, banks are forced to offload their entire asset portfolio to households, who only value capital net of associated management costs. Accordingly, the household's budget constraint can be expressed as,

$$C_t + q_t^* \bar{L}_t + B_t + f\left(\bar{L}_t\right) + T_t = W_t N_t + R_t B_{t-1} + \bar{Z}_t^* \bar{L}_{t-1} + div_t, \tag{38}$$

while the remaining structure and real allocations remain unaffected. The size of the fire-sale discount is pinned down by the household's optimality condition for the consolidated loan portfolio, given by,

$$q_t^* + f'(\bar{L}_t) = \mathbb{E}_t \Lambda_{t,t+1} \bar{Z}_{t+1}^*, \quad \text{with } f'(\bar{L}_t) = \zeta \bar{L}_t. \tag{39}$$

To connect the bank run mechanism with our research interest, we next assess the role of net foreign lending in shaping financial fragility. Since net foreign lending is fully endogenous in the model and no structural shock shifts this variable in isolation, we turn to a steady-state experiment. Figure A1 shows that higher steady-state levels of net foreign lending deterministi-

[13]The real exchange rate is not directly distorted by liquidation, since liquidation is modeled as a one-off domestic reallocation of claims from banks to households, while foreign payoffs and prices remain unchanged.

cally raise the steady-state probability of a bank run. This exercise demonstrates that the way larger foreign lending positions systematically increase run vulnerability is explicitly captured by the model, thereby providing a rationale for interpreting the RR-ratio as a macroprudential tool to contain such risk-taking.

4. Estimation Results

In this section, we first estimate the benchmark model using Chinese data, providing evidence that the regime-dependent RR-ratio rule captures key features of policy behavior, with estimated regime shifts closely tracking episodes of overheating. Second, we evaluate alternative rule specifications and find that a state-contingent RR-ratio rule with an endogenous response to net foreign lending best fits the data. Finally, we analyze the transmission of macroeconomic shocks under the estimated model, highlighting the RR's limited effects on output and inflation but a sizable effect in reducing financial instability. [14]

4.1. Prior and Posterior

The first-order perturbation solution for regime-switching rational-expectations models is derived through the functional-iteration method, and both posterior maximization and simulation are carried out using the RISE toolbox (Chang et al., 2021).[15] The Chinese quarterly data span 2000Q1–2019Q3, covering key episodes of capital flow volatility and policy shifts, while excluding the COVID-19 period to avoid distortions from extraordinary uncertainty. The data series are adjusted for population level and seasonal patterns, while an exogenous balanced growth path *bgp* is introduced and will be identified by data. The model is closed by specifying a set of measurement equations (B52) that map endogenous variables to observed data, including the real growth rates of GDP, consumption, investment, exports, imports, domestic deposits, domestic lending, foreign lending,[16] and the real exchange rate.

A subset of model parameters is calibrated based on empirical means and existing studies. The discount rate is set at $\beta = 0.998$, which equals the average ratio of the inflation to the policy rate (interbank pledged bond repo rate, R007). The steady-state values of inflation and the nominal policy rate are calibrated to their sample means, with annual inflation set at 2.26% and the policy rate at 2.8%. Common in the literature, capital depreciates at $\delta = 0.025$

[14]Tables B2–B3 in the Appendix show that these four shocks consistently explain most of the model's foreign-lending fluctuations across horizons and regimes.

[15]Bayesian estimation is performed using the stochastic global optimizer `bee_gate` available in the RISE toolbox (see Chang et al., 2021). This algorithm is designed to overcome the challenges of local optima often encountered with inappropriate prior settings and is particularly well-suited for complex DSGE models with regime-switching and multiple steady states, but comes at the cost of higher computational time.

[16]We use the growth rate of real foreign lending, rather than that of net foreign lending, to avoid complications arising from the presence of negative values in the latter. In equation (B52) foreign lending is defined as $\tilde{L}_t^F = L_t^F + d^F$, which is adjusted by the sample mean of foreign deposits.

Table 1: Calibration for Constant Parameters

Parameter	Value	Interpretation	Reference
β	0.998	Discount factor	Data
σ^n	0.276	Inverse Frisch elasticity	Gertler and Karadi (2011)
ϑ	0.037	Weight of deposit utility	$R - R^D = 0.13\%$
χ	4.488	Weight of labor disutility	8 working hours
θ	0.944	Steady-state survival rate	Gertler and Kiyotaki (2015)
ι^h	0.44	Domestic diversion rate	$R^L - R = 0.6\%$
ι^f	0.10	Foreign diversion rate	$R^L_F - R = 0.15\%$
R^R	1	Real return on required reserves	Data
ρ	0.11	Steady-state RR-ratio	Data
Φ^L_H	6.5	Steady-state domestic lending leverage	Gertler and Kiyotaki (2015)
Φ^L_F	0.1625	Steady-state net foreign lending leverage	Data
α_k	0.3	Effective capital share	Standard
α_Γ	0.3	Effective intermediate-goods share	Data
α	0.3827	Effective import-goods share	Data
δ	0.025	Depreciation rate	Standard
g	0.2	Government expenditure-output ratio	Standard
Ξ	-0.02	Steady-state likelihood of bank run	Gertler and Kiyotaki (2015)
ζ	0.005	Cost of household asset management	Gertler and Kiyotaki (2015)
$\varkappa$	0.8	Share of depositors that may run	Gertler and Kiyotaki (2015)

quarterly, and capital input share is $\alpha_k = 0.3$. The intermediate goods input share $\alpha_\Gamma = 0.3$ and the import goods share $\alpha = 0.3827$ are calibrated to match the import-to-output ratio of 0.2. Following Gertler and Karadi (2011), we set $\sigma^n = 0.276$, and calibrate the labor disutility weight $\chi = 4.488$ to match a steady-state labor supply of eight hours per day. The deposit utility weight is set to $\vartheta = 0.037$ such that the steady-state interest rate spread $R - R^D = 0.13\%$ is matched. We also follow Gertler and Kiyotaki (2015) in setting the steady-state domestic leverage ratio at $\Phi^L_H = 6.5$ and the bank survival rate $\theta = 0.944$, implying an average banking horizon of 18 quarters. The steady-state value of the RR-ratio takes average sample mean $\rho = 0.11$, and the domestic to (net) foreign lending ratio is calibrated, such that $\Phi^L_F = 2.5\%\Phi^L_H$. The diversion rates, $\iota^h = 0.44$ and $\iota^f = 0.10$, are calibrated to match the average domestic and foreign lending rate spreads of 0.6% and 0.15%, respectively. Regarding the parameterization of the bank-run analysis, we follow Gertler and Kiyotaki (2015) by setting the share of depositors who may run to $\varkappa = 0.8$ and the household asset management cost parameter to $\zeta = 0.005$, such that the steady-state likelihood of a run is $\Xi = -0.02$.

The remaining parameters are estimated using weakly informative priors, specified through 90-percent quantile intervals following Bjørnland et al. (2018), thereby allowing the data to primarily inform the posterior distributions. Table 2 reports the full set of priors and posterior summaries. Posterior distribution is obtained based on three parallel chains generated via a random-walk Metropolis-Hastings algorithm, each consisting of 250,000 draws, with the first 50,000 discarded as burn-in, and every fourth draw is retained. The proposal scale is tuned to target an acceptance rate of approximately 0.38.

The estimated RR-ratio rule features a clearly identified positive feedback on net foreign

Table 2: Prior and Posterior Distributions

Param.	Prior Dist.	Posterior Mode	Posterior Mean	Posterior 5%	Posterior 95%	Param.	Prior Dist.	Posterior Mode	Posterior Mean	Posterior 5%	Posterior 95%
bgp	G(1.01,1.03)	1.024	1.024	1.022	1.026	$100\varsigma^{r}$	IG(10^{-4},2)	0.293	0.300	0.252	0.347
σ_d	N(0.5,1.5)	1.141	1.059	0.845	1.266	$100\varsigma^{r,f}$	IG(10^{-4},2)	0.371	0.411	0.310	0.510
h	B(0.2,0.8)	0.108	0.149	0.052	0.237	$100\varsigma^{a}$	G(0.1,5)	2.746	2.859	2.410	3.278
$0.02\kappa_p$	B(0.2,0.8)	0.893	0.882	0.806	0.963	$100\varsigma^{y,f}$	G(0.5,10)	7.485	7.793	6.440	9.059
ϖ_b	IG(0.01,0.5)	0.015	0.065	0.004	0.154	$100\varsigma^{\psi,f}$	G(5,20)	19.47	21.02	16.87	25.39
η	N(8,12)	9.495	9.900	8.247	11.34	$100\varsigma^{\psi,k}$	G(0.1,5)	1.632	1.686	1.447	1.915
κ_I	N(2,10)	3.775	4.076	3.149	5.051	$100\varsigma^{\psi,I}$	G(0.5,10)	8.162	8.324	6.862	9.723
κ_b	B(0.5,1.4)	0.603	0.555	0.364	0.761	$100\varsigma^{\eta}$	G(0.1,5)	1.133	1.190	0.899	1.466
ξ	G(1.2,1.8)	1.514	1.516	1.274	1.728	$100\varsigma^{\psi,p}$	G(0.1,5)	3.142	3.772	3.053	4.454
γ_r	B(0.4,0.9)	0.815	0.851	0.808	0.890	$100\varsigma^{nw}$	G(0.5,10)	7.004	6.957	5.741	8.166
$\varphi_{r,\pi}$	G(1,3)	1.761	2.168	1.666	2.635	$100\varsigma^{\rho}$	G(0.5, 10)	4.193	4.398	3.723	5.045
$\varphi_{r,y}$	G(0.01,0.5)	0.001	0.006	0.000	0.013	γ_ρ	B(0.4, 0.9)	0.818	0.842	0.800	0.881
γ_a	B(0.6,0.9)	0.885	0.856	0.807	0.913	$\varphi_{\rho,\pi}$	N(-1,1)	0.249	0.540	-0.175	1.299
$\gamma_{y,f}$	B(0.6,0.9)	0.937	0.927	0.903	0.957	$\varphi_{\rho,y}$	N(-1,1)	2.016	1.765	1.160	2.385
$\gamma_{r,f}$	B(0.6,0.9)	0.944	0.933	0.918	0.950	$\varphi_{\rho,L}(N)$	Calibrated	0	–	–	–
$\gamma_{\psi,f}$	B(0.2,0.8)	0.981	0.975	0.965	0.986	$\varphi_{\rho,L}(C)$	G(0.2,0.8)	0.135	0.216	0.091	0.329
$\gamma_{\psi,k}$	B(0.2,0.8)	0.392	0.428	0.368	0.503	$prob^{N,C}$	B(0.01,0.15)	0.068	0.081	0.013	0.151
$\gamma_{\psi,I}$	B(0.2,0.8)	0.906	0.903	0.870	0.935	$prob^{C,N}$	B(0.01,0.15)	0.024	0.049	0.011	0.092
$\gamma_{\psi,p}$	B(0.2,0.8)	0.643	0.636	0.505	0.765	$100\varsigma^{e}_{data}$	G(0.1,5)	1.689	1.886	1.211	2.596
γ_η	B(0.6,0.9)	0.899	0.899	0.869	0.928	$100\varsigma^{f}_{data}$	G(0.1,5)	5.625	5.666	4.997	6.355
γ_{nw}	B(0.2,0.8)	0.661	0.673	0.623	0.731						

Note: B denotes the generalized Beta distribution, G the Gamma distribution, IG the Inverse Gamma distribution, and N the normal distribution. Values in parentheses indicate the lower and upper bounds of the 90% confidence interval for the quantile prior. Estimation is conducted using the RISE toolbox with the stochastic global algorithm `bee_gate`.

lending with a posterior mode at 0.189. Figure 2 shows the smoothed probability of being in the state C, in which this policy response is operative. The estimates imply that the RR-ratio, when systematically deployed as a tool of liquidity management, operated in two distinct phases. In the first phase (2006–2008), the twin surpluses and strong expectations of Chinese currency appreciation generated a surge in domestic liquidity and fueled a sharp increase in net foreign lending, leading the PBoC to raise the RR-ratio in order to freeze excess liquidity and limit banks' risk exposure. The model captures this period of strong positive co-movement between the RR-ratio and net foreign lending. With the onset of the global financial crisis, however, capital inflows reversed, and the credit-based regime was suspended. In this phase, the RR reverted to its conventional role of supporting credit and output growth, as liquidity tightening was replaced by policy accommodation.

Following China's strong rebound from the GFC after 2010 and a recovered wave of capital inflows, the linkage between the RR-ratio and foreign lending briefly re-emerged, echoing the pre-crisis pattern. This relationship, however, did not prove durable. The rapid expansion of shadow banking and the growing complexity of the financial system gradually eroded the effectiveness of traditional quantity-based instruments. At the same time, a new set of policy tools—such as the PBoC's lending facilities, which gained prominence after the 2015 exchange rate reform—progressively relegated the RR to a supplementary role. The introduction of macroprudential cross-border financing regulations in 2017 further consolidated this transition.

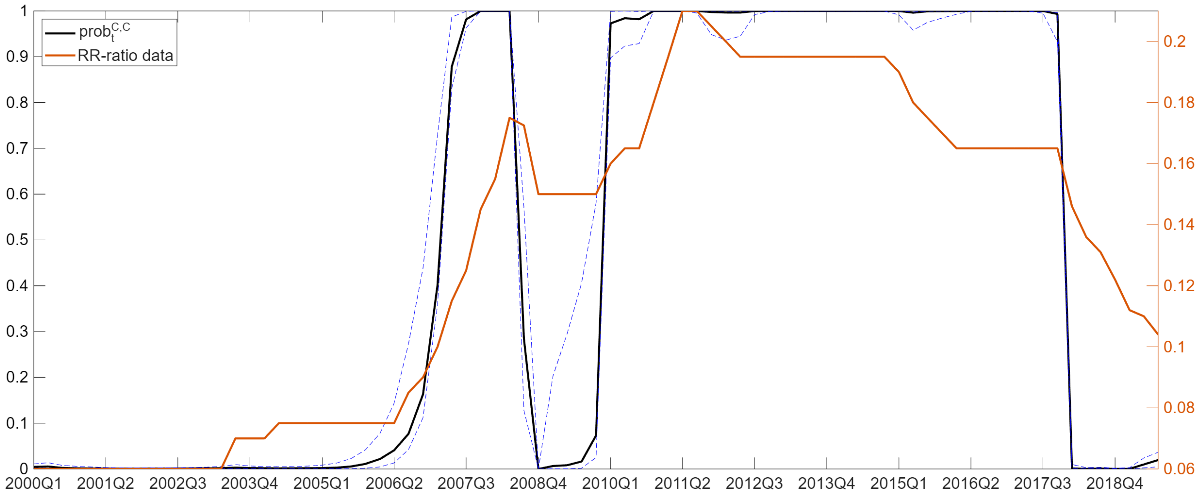

Figure 2: The black solid line represents the smoothed probability of being in the state C at the posterior mode, while the blue dashed lines represent the 68% probability band derived from retained parameter draws. The orange solid line represents the actual RR-ratio data.

By then, the policy linkage between the RR-ratio and foreign lending had largely disappeared. Consistent with these institutional developments, the model's smoothed probabilities identify a return to the normal regime after 2017.

We then turn to assessing the specification of the RR-ratio rule that best characterizes its implementation over the sample period, particularly with respect to conventional monetary policy objectives. As shown in Table 2, the estimated coefficients on both the inflation and output gaps are precisely identified and remain positive under a zero-mean prior, with posterior modes of 0.249 and 2.016, respectively. This contrasts with the procyclical optimal policy derived in Chang et al. (2019), and suggests that, in practice, China's RR policy has incorporated a counter-cyclical component into its response function. Nevertheless, we remain cautious about the broader macroeconomic effectiveness of this instrument. As emphasized by Glocker and Towbin (2012) and Aizenman et al. (2015), the aggregate effects of reserve requirements are likely to be limited—a concern corroborated by our quantitative analysis in the following subsection.

Turning to the posterior estimates of structural parameters, the internal habit formation parameter h implies a relatively low degree of consumption smoothing among households. The elasticity of deposit utility is estimated at a posterior mode of $\sigma_d = 1.141$, indicating a moderately concave utility function with diminishing marginal utility of deposits. The indexation parameter ϖ_b is estimated to be close to zero, suggesting minimal backward-looking behavior in price setting. The capital control tightness parameter, $\kappa_b = 0.603$, is broadly consistent with Chang et al. (2015), reflecting a substantial degree of financial account restrictions. Finally, the estimated Taylor rule coefficients confirm that the PBoC follows a moderately active stance toward inflation stabilization, consistent with previous studies.

Table 3: Model Comparison

Model	Description	Log MDD (Laplace)
dsge-cpy-2f	$\varphi^{\rho,\pi} \neq 0$, $\varphi^{\rho,y} \neq 0$, $\varphi^{\rho,f}(\mathcal{S}_t^{RR})$	1801.29
dsge-c-2f	$\varphi^{\rho,\pi} = \varphi^{\rho,y} = 0$, $\varphi^{\rho,f}(\mathcal{S}_t^{RR})$	1798.34
dsge-cpy-f	$\varphi^{\rho,\pi} \neq 0$, $\varphi^{\rho,y} \neq 0$, $\varphi^{\rho,f} \neq 0$	1797.44
dsge-cpy	$\varphi^{\rho,\pi} \neq 0$, $\varphi^{\rho,y} \neq 0$, $\varphi^{\rho,f} = 0$	1795.77
dsge-c-f	$\varphi^{\rho,\pi} = \varphi^{\rho,y} = 0$, $\varphi^{\rho,f} \neq 0$	1780.59
dsge-c	$\varphi^{\rho,\pi} = \varphi^{\rho,y} = \varphi^{\rho,f} = 0$	1770.10
dsge-2sf	$\varphi^{\rho,\pi} = \varphi^{\rho,y} = 0$, $\varphi^{\rho,f}(\mathcal{S}_t^{RR})$, $\rho(\mathcal{S}_t^{RR})$, $\gamma^{\rho}(\mathcal{S}_t^{RR})$, $\varsigma^{\rho}(\mathcal{S}_t^{RR})$	1720.52

Note: The models studied are variants of DSGE models with different specifications for the RR-ratio rule and the coefficient on net foreign lending. Model abbreviations are as follows: "p" denotes a non-zero coefficient on the inflation gap; "y" on the output gap; "f" on the net foreign lending gap; "c" indicates a constant steady-state value of ρ; "2s" allows the steady-state value, smoothed parameter, and standard deviation of ρ to be regime-dependent; "2f" allows the coefficient on the net foreign lending gap to be regime-dependent.

4.2. Model Comparison

To further validate our findings, we estimate a set of alternative model specifications and compare their fit using Laplace-approximated marginal data densities (MDD), as reported in Table 3 for different RR-ratio rules and feedback coefficients on net foreign lending. The results indicate that the benchmark specification—with positive coefficients on the inflation and output gaps, and a regime-dependent coefficient on the net foreign lending gap—provides the best fit to the data.

Table 3 shows that models allowing for regime shifts in the coefficient on net foreign lending significantly outperform their non-switching counterparts. In particular, the log marginal data densities of the benchmark model "dsge-cpy-2f" and its restricted variant "dsge-c-2f" are 1801.29 and 1798.34, respectively—substantially higher than those of the corresponding constant-coefficient models "dsge-cpy-f" (1797.44) and "dsge-cpy" (1795.77). Moreover, comparing models with and without a constant positive coefficient on net foreign lending—specifically, "dsge-cpy-f" versus "dsge-cpy" and "dsge-c-f" versus "dsge-c"—reveals that the inclusion of a fixed feedback term improves model fit, as indicated by higher marginal data densities. These findings suggest that a feedback channel on net foreign lending is empirically relevant, but a constant-coefficient specification alone cannot adequately capture the nonlinear and state-contingent nature of the RR-ratio rule. A regime-switching formulation is therefore necessary to account for its conditional responsiveness.

In addition, the inclusion of monetary policy objectives in the RR-ratio rule (abbreviated "py")—where the RR-ratio responds positively to both inflation and the output gap—also receives empirical support. The model comparison results reinforce this finding: for instance, the marginal data density (MDD) of "dsge-cpy" is 1780.59, compared with only 1770.10 for "dsge-c." These positive coefficients indicate that the estimated RR-ratio rule incorporates a monetary-policy reaction component. Lastly, we allow both the steady-state level and other structure coefficients of the RR-ratio rule to follow a Markov-switching process ("dsge-2sf") to capture the transition of the RR-ratio from a passive to an active policy instrument. Although it seems to capture the pattern in Figure 1, the additional model complexity results in a substantial penalty in marginal data density, with an MDD of 1720.52—far below that of competing alternatives.

4.3. Transmission of macroeconomic shocks

In this section, we present the impulse responses of the estimated model to macroeconomic shocks that characterized China's overheating episode. We begin by analyzing the effects of export demand and foreign lending rate shocks, which potently affect net foreign lending, and confirm the macroprudential role of the RR in mitigating financial instability. We then turn to TFP and cost-push shocks, under which the RR is found to have only negligible effects on real aggregates.[17]

For comparison, we consider four specifications of the RR-ratio rule. The baseline rule responds to inflation, output, and net foreign lending gaps. In addition, we examine three reference specifications: (i) a rule that responds only to inflation and output gaps (Inflation-output); (ii) a rule that responds only to the net foreign lending gap (NFL-only); and (iii) a fixed RR-ratio that remains unresponsive throughout.

4.3.1. External shocks

Figure 3 (upper panels) shows the effects of a 10% export demand shock. Stronger external demand improves the trade balance and stimulates investment, thereby raising credit demand and output. The resulting current account surpluses, implied by the balance-of-payments identity, are endogenously channeled through the banking sector in the model, giving rise to an increase in net foreign lending. This growing relevance of foreign lending heightens financial instability and raises the likelihood of self-fulfilling runs, as reflected in upward shifts of Ξ_t signaling proximity to the run threshold.

When the RR-ratio responds to foreign lending, it cushions the short-run decline in consumption in small extent, yet the aggregate effects on output and inflation are not visible. This muted macroeconomic impact reflects the model's structural result that, although an adjustment in the RR-ratio can in principle affect real aggregates through two channels—directly via higher funding costs and indirectly via deposit pricing—the quantitative effects of both channels are almost negligible under the estimated parameters.[18] From a macroprudential perspective, however, the targeted tightening of the RR-ratio reduces domestic loan supply by compressing

[17] Tables B2–B3 in the Appendix show that these four shocks explain most of the foreign lending fluctuations across horizons and regimes.

[18] This finding is consistent with standard banking models (e.g., Ennis, 2018), in which reserve requirements have almost negligible effects on intertemporal consumption. Substantive quantitative effects of the RR-ratio adjustment can only be obtained under nonstandard parameterizations (e.g., unrealistically high σ_d) or stronger modeling assumptions, such as introducing a direct effect on the risk premium (Chang et al., 2019) or imposing ad hoc regulatory costs (Glocker and Towbin, 2012).

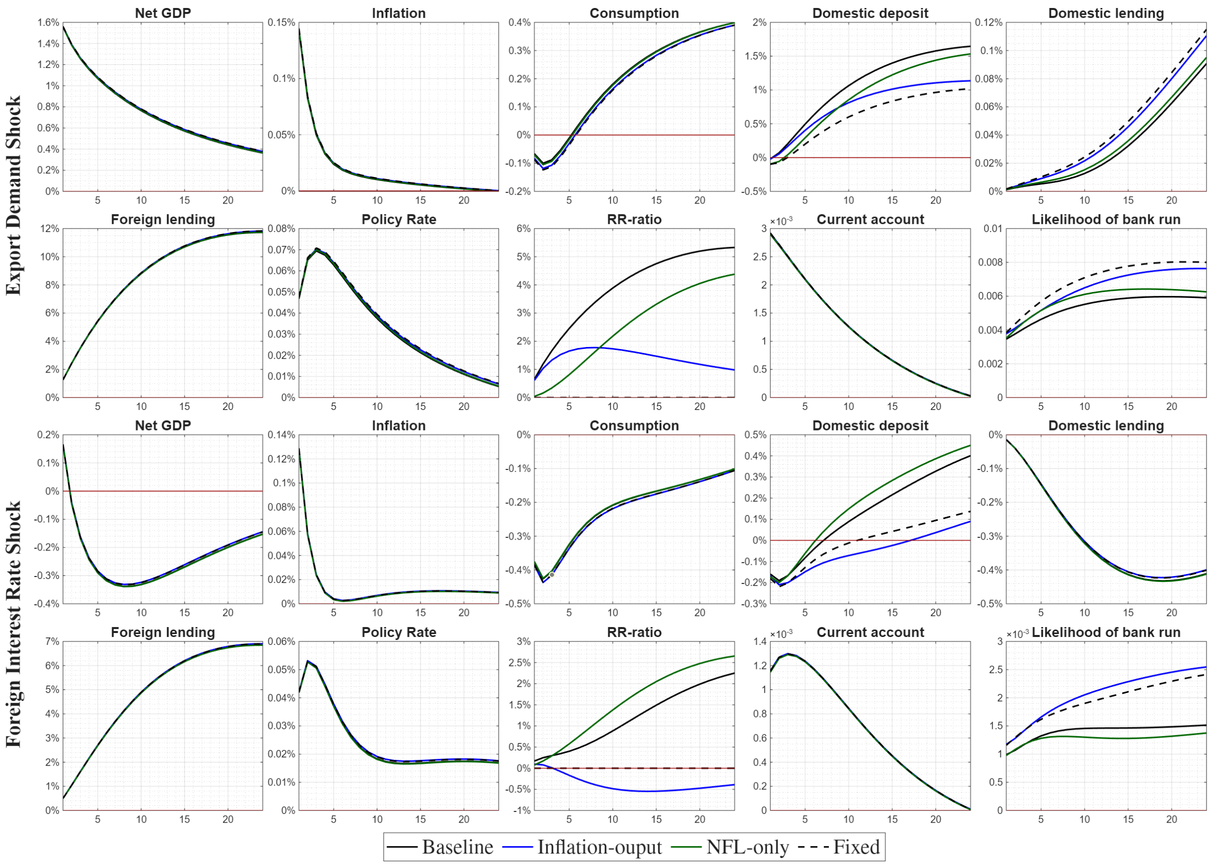

Figure 3: Impulse responses to a 10% increase in export demand (upper two panels) and a 20bps hike in foreign interest rate (lower two panels) under alternative RR-ratio specifications: the baseline rule (black solid), the inflation–output rule (blue solid), the NFL-only rule (green solid), and a fixed RR-ratio (black dashed). The vertical axis shows percentage deviations from steady state, except for the current account and the likelihood of a bank run, which are reported in absolute deviations.

the volume of loanable funds, thereby mechanically dampening the credit expansion triggered by the external shock. In doing so, the state-contingent RR policy acts as a precautionary buffer, aligning closely with the policy's intended design.

Figure 3 (lower panels) reports the impulse responses to a 20 bps hike in the foreign interest rate. The widening interest differential induces a depreciation of the domestic currency and raises the return on foreign lending, encouraging banks to reallocate their portfolios toward foreign assets. This shift, reinforced by the central bank's policy rate hike that increases domestic funding costs, crowds out domestic credit and weakens production, eventually pushing the economy into a protracted recession with heightened run risk as bank profitability deteriorates and liquidity mismatches. When the RR-ratio responds to foreign lending, this adverse amplification is effectively mitigated.

4.3.2. Domestic shocks

A 2% rise in TFP generates standard supply-side effects, raising output and exerting downward pressure on inflation (Figure 4 upper panels). The central bank accommodates by lowering the policy rate to stabilize prices, which fuels domestic credit growth and encourages banks to

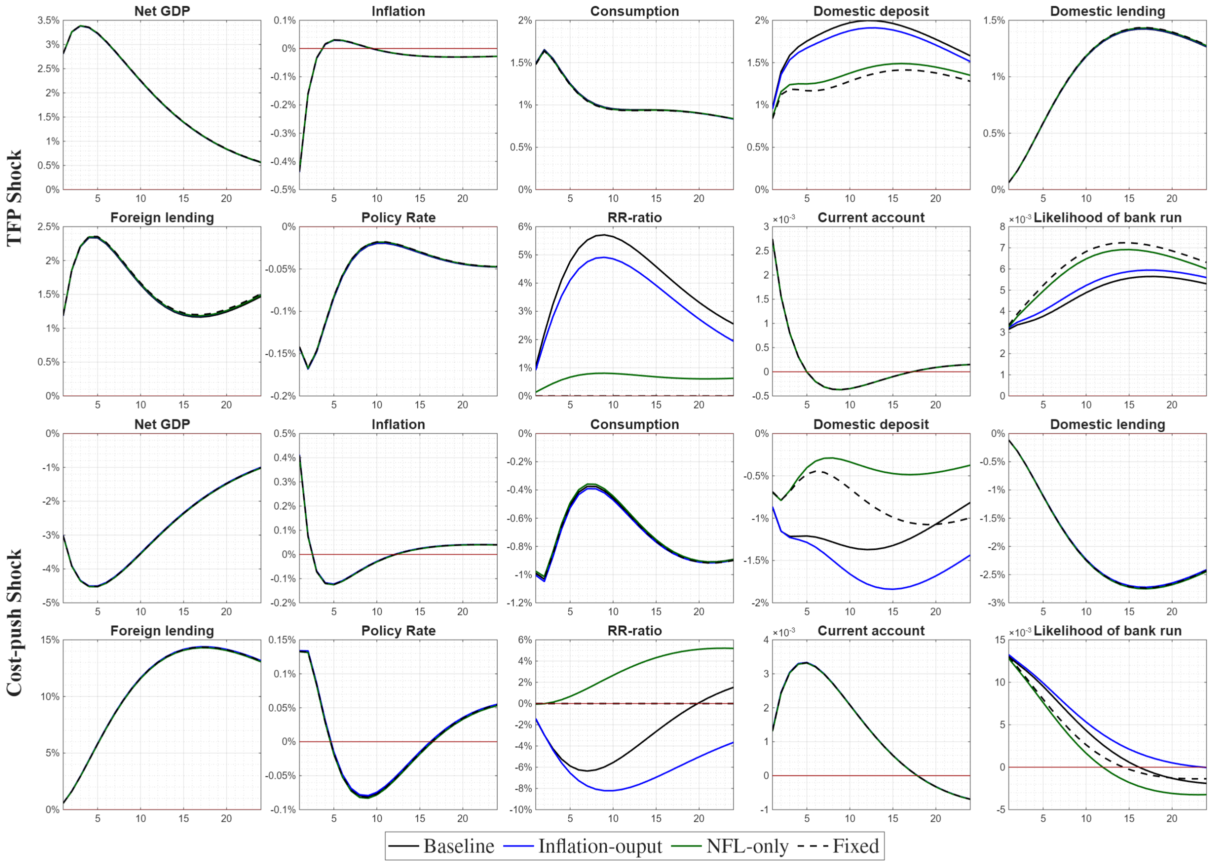

Figure 4: Impulse responses to a 2% TFP shock (upper two panels) and to a cost-push shock (lower two panels, modeled as a 40% reduction in the elasticity of substitution) under alternative RR-ratio specifications: the baseline rule (black solid), the inflation–output rule (blue solid), the NFL-only rule (green solid), and a fixed RR ratio (black dashed). The vertical axis reports percentage deviations from steady state, except for the current account and the likelihood of a bank run, which are in absolute deviations.

reallocate toward higher-yielding foreign assets. This rapid balance-sheet expansion, increasingly financed through short-term liabilities, thereby raising leverage and intensifying depositor concerns over banks' solvency.

Under a credit-based specification, capital outflows activate an endogenous increase in reserve requirements, forcing banks to hold a larger share of deposits as liquid reserves. Unlike in the case of an export demand shock, a positive productivity shock intrinsically raises the marginal return on capital, which sustains credit demand despite tighter reserve requirements. In this context, the RR-ratio functions less as a brake on credit creation and more as a buffer against balance-sheet fragility, thereby reducing the peak response of bank-run likelihood by about 25%.

A similar mechanism arises under a cost-push shock, representing a domestic negative supply disturbance (Figure 4, lower panels). Higher production costs and rising inflation trigger a policy-rate hike, which tightens funding conditions and compresses domestic credit. The policy-rate hike leads to a short-run appreciation of the domestic currency, which increases the expected home-currency return on foreign lending, encouraging banks to shift outward and thereby amplifying liquidity pressures. When the RR ratio adjusts endogenously to foreign lending, the resulting buildup of reserves offsets these pressures and limits excessive portfolio reallocation, thereby strengthening the system's resilience to run risk.

5. Conclusion

This paper presents a small open-economy DSGE model with banks that use deposits to finance both domestic and foreign lending under the moral hazard friction. The model allows the central bank to control the RR-ratio, which constrains bank liquidity management by directly increasing funding costs and indirectly inducing higher deposit rates through the pricing channel. Motivated by institutional features of China's economy, we further embed a regime-switching RR-ratio rule, allowing the feedback coefficient on net foreign lending to evolve as a latent Markov process, and incorporate a self-fulfilling bank-run analysis to assess the macroprudential role of the RR policy.

Our estimation results suggest that an RR-ratio rule characterized by positive responsiveness to net foreign lending first emerged between 2006 and 2008, coinciding with externally driven overheating pressures in China. The regime was suspended during the Global Financial Crisis, when external surpluses temporarily receded, but was subsequently reactivated in the early 2010s and remained in place until 2017, consistent with the recovered rise in net foreign lending and the attendant risks it posed to financial stability. In comparison with alternative specifications, the regime-dependent rule additionally featuring an inverse response to output and inflation gaps delivers the best performance in terms of marginal data density. Notably, adjustments in the RR-ratio do not generate sizable real effects on inflation and output. Instead, impulse response analysis shows that the RR-ratio primarily serves as a precautionary tool by enhancing banking sector resilience through the enforcement of endogenous liquidity buffers. By widening the distance to the run threshold, a tighter RR-ratio mitigates depositors' concerns about bank insolvency, and thereby lowers the likelihood of self-fulfilling runs. Moreover, when the central bank employs the RR-ratio to contain risk-taking in foreign lending, i.e., the feedback coefficient on net foreign lending is positive, the prudential effect is more pronounced: banks' liability-side volatility declines and a greater share of newly absorbed deposits is reallocated toward high-liquid reserve holdings, strengthening the system's capacity to withstand external shocks.

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A Appendix to the Model

A1 Rational expectation equilibrium

The REE consists of sequences of quantities $\{Y_t,\, C_t,\, G_t,\, EX_t,\, I_t,\, N_t,\, K_t,\, L_t^H,\, L_t^F,\, D_t,\, NET_t,$ $\Gamma_t,\, \Gamma_{H,t},\, \Gamma_{F,t},\, \rho_t,\, \Phi^L_{H,t},\, \Phi^L_{F,t},\, \Upsilon_t\}$, prices $\{\pi_t,\, MC_t,\, W_t,\, Z_t,\, P_t^M,\, Q_t^K,\, R_t^M,\, R_t,\, R_t^D,\, R_t^L,\, \bar{R}_t,\, e_t,$ $\nu_t,\, \mu^L_{H,t},\, \mu^L_{F,t},\, \mu^D_t,\, \lambda^H_t,\, \Lambda_{t,t+1},\, \eta_t\}$, and bank-run-related variables $\{\bar{L}_t,\, \bar{Z}^*_t,\, q^*_t,\, \bar{q}_t,\, \Xi_t\}$, satisfying the following system of conditions,

$$\psi_t^P (C_t - hC_{t-1})^{-1} - \beta h \mathbb{E}_t \psi^P_{t+1} (C_{t+1} - hC_t)^{-1} = \lambda_t^H, \tag{A1}$$

$$\lambda_t^H W_t = \chi \psi_t^p N_t^{\sigma^N}, \tag{A2}$$

$$1 = \mathbb{E}_t \Lambda_{t,t+1} \pi^{-1}_{t+1} R_t^M, \tag{A3}$$

$$1 = \vartheta \psi_t^P \left(\lambda_t^H D_t^{\sigma_d}\right)^{-1} + \mathbb{E}_t \Lambda_{t,t+1} R^D_{t+1}, \tag{A4}$$

$$\Lambda_{t,t+1} = \beta \lambda^H_{t+1} / \lambda^H_t, \tag{A5}$$

$$\Phi^L_{H,t} = Q_t^K L_t^H / NET_t, \tag{A6}$$

$$\Phi^L_{F,t} = e_t L_t^F / NET_t, \tag{A7}$$

$$\bar{R}_t = (R_t^D - R^R \rho_{t-1})/(1 - \rho_{t-1}), \tag{A8}$$

$$\mu^L_{H,t} = \mathbb{E}_t \Lambda_{t,t+1} (1 - \theta + \theta \nu_{t+1}) \left(R^L_{t+1} - \bar{R}_{t+1}\right), \tag{A9}$$

$$\mu^L_{F,t} = \mathbb{E}_t \Lambda_{t,t+1} (1 - \theta + \theta \nu_{t+1}) \left(R^L_{F,t+1} e_{t+1}/e_t - \bar{R}_{t+1}\right), \tag{A10}$$

$$\mu^D_t = \mathbb{E}_t \Lambda_{t,t+1} (1 - \theta + \theta \nu_{t+1}) \bar{R}_{t+1}, \tag{A11}$$

$$\nu_t = \psi_t^F \left(\iota^H \Phi^L_{H,t} + \iota^F \Phi^L_{F,t}\right), \tag{A12}$$

$$\nu_t = \mu^L_{H,t} \Phi^L_{H,t} + \mu^L_{F,t} \Phi^L_{F,t} + \mu^D_t - \frac{\kappa^b}{2} \frac{(\Upsilon_t - \Upsilon)^2}{NET_t}, \tag{A13}$$

$$\frac{\iota^H}{\iota^F} = \frac{\mu^L_{H,t} - \kappa^b (\Upsilon_t - \Upsilon) \left(e_t L_t^F\right) \left(Q_t^K L_t^H + e_t L_t^F\right)^{-2}}{\mu^L_{F,t} + \kappa^b (\Upsilon_t - \Upsilon) \left(Q_t^K L_t^H\right) \left(Q_t^K L_t^H + e_t L_t^F\right)^{-2}}, \tag{A14}$$

$$\Upsilon_t = \frac{Q_t^K L_t^H}{Q_t^K L_t^H + e_t L_t^F}, \tag{A15}$$

$$NET_t = \theta \begin{bmatrix} \left(R_t^L - \bar{R}_t\right) \Phi^L_{H,t-1} + \bar{R}_t \\ + \left(R^L_{F,t} e_t / e_{t-1} - \bar{R}_t\right) \Phi^L_{H,t-1} \end{bmatrix} \frac{NET_{t-1}}{\psi_t^{NW}} + \omega \left(R_t^L Q^K_{t-1} L^H_{t-1} + R^L_{F,t} e_t L^F_{t-1}\right), \tag{A16}$$

$$D_t (1 - \rho_t) = Q_t^K L_t^H + e_t L_t^F - NET_t, \tag{A17}$$

$$\Gamma_{H,t} = \alpha P_t^M \Gamma_t, \tag{A18}$$

$$e_t \Gamma_{F,t} = (1 - \alpha) P_t^M \Gamma_t, \tag{A19}$$

$$\Gamma_t = \Gamma^{\alpha}_{H,t} \Gamma^{1-\alpha}_{F,t}, \tag{A20}$$

$$P_t^M \Gamma_t = \alpha^{\Gamma} MC_t Y_t, \tag{A21}$$

$$W_tN_t = (1-\alpha_k-\alpha_\Gamma)\, MC_tY_t, \tag{A22}$$

$$R^L_tQ^K_{t-1} = Z_t + (1-\delta)Q^K_t\psi^K_t, \tag{A23}$$

$$Y_t = A_tK^{\alpha_k}_{t-1}\Gamma^{\alpha_\Gamma}_tN^{(1-\alpha_k-\alpha_\Gamma)}_t, \tag{A24}$$

$$K_t = (1-\delta)\psi^K_tK_{t-1} + I_t, \tag{A25}$$

$$K_t = L^H_t, \tag{A26}$$

$$\begin{aligned}\eta_t - 1 = \eta_tMC_t - \kappa_p\left(\frac{\pi_t}{\pi^{\varpi_b}_{t-1}\pi^{1-\varpi_b}} - 1\right)\left(\frac{\pi_t}{\pi^{\varpi_b}_{t-1}\pi^{1-\varpi_b}}\right)\\ + \kappa_p\mathbb{E}_t\Lambda_{t,t+1}\frac{Y_{t+1}}{Y_t}\left(\frac{\pi_{t+1}}{\pi^{\varpi_b}_t\pi^{1-\varpi_b}} - 1\right)\left(\frac{\pi_{t+1}}{\pi^{\varpi_b}_t\pi^{1-\varpi_b}}\right),\end{aligned} \tag{A27}$$

$$\eta_t = \eta(\psi^\eta_t)^{-\kappa_p}, \tag{A28}$$

$$Q^K_t\psi^I_t = 1 + \frac{\kappa_I}{2}\left(\frac{I_t}{I_{t-1}} - 1\right)^2 + \kappa_I\left(\frac{I_t}{I_{t-1}} - 1\right)\frac{I_t}{I_{t-1}} - \kappa_I\mathbb{E}_t\Lambda_{t,t+1}\left(\frac{I_{t+1}}{I_t} - 1\right)\left(\frac{I_{t+1}}{I_t}\right)^2\frac{\psi^I_t}{\psi^I_{t+1}}, \tag{A29}$$

$$EX_t = e^\xi_tY^F_tA_t, \tag{A30}$$

$$G_t = \bar{g}Y_t, \tag{A31}$$

$$R^M_t/R^M = \left(R^M_{t-1}/R^M\right)^{\gamma_r}\left[(\pi_t/\pi)^{\gamma_{r,\pi}}(Y_t/Y)^{\gamma_{r,y}}\right]^{1-\gamma_r}\exp(\varsigma_r\epsilon^R_t), \tag{A32}$$

$$\rho_t/\rho = (\rho_{t-1}/\rho)^{\gamma_\rho}\left[(\pi_t/\pi)^{\varphi_{\rho,\pi}}(Y_t/Y)^{\varphi_{\rho,y}}\left(L^F_t/L^F\right)^{\varphi_{\rho,f}(\mathcal{S}^{RR}_t)}\right]^{1-\gamma_\rho}\exp(\varsigma^\rho\epsilon^\rho_t), \tag{A33}$$

$$R_t = R^M_{t-1}/\pi_t, \tag{A34}$$

$$C_t + \left[\Psi\left(\frac{I_t}{I_{t-1}}\right) + 1\right]\frac{I_t}{\psi^I_t} + G_t + \frac{\kappa_p}{2}\left(\frac{\pi_t}{\pi^{\varpi_b}_{t-1}\pi^{1-\varpi_b}} - 1\right)^2Y_t + EX_t + \Omega_t = Y_t - \Gamma_{H,t}, \tag{A35}$$

$$EX_t = e_t\Gamma_{F,t} + e_tL^F_t - R^L_{F,t}e_tL^F_{t-1}, \tag{A36}$$

$$Z_t = \alpha_kMC_tY_t/K_{t-1}, \tag{A37}$$

$$\bar{L}_t = Q^K_tL^H_t + e_tL^F_t, \tag{A38}$$

$$q^*_t + f'(\bar{L}_t) = \mathbb{E}_t\Lambda_{t,t+1}\bar{Z}^*_{t+1}, \quad \text{where} \quad f'(\bar{L}_t) = \zeta\bar{L}_t, \tag{A39}$$

$$\bar{Z}^*_t\bar{L}_{t-1} = \left[Z_t + q^*_t(1-\delta)Q^K_t\right]L^H_{t-1} + \left(R^L_{F,t} - 1 + q^*_t\right)e_tL^F_{t-1}, \tag{A40}$$

$$\left[Z_t + \bar{q}_t(1-\delta)Q^K_t\right]L^H_{t-1} + \left(R^L_{F,t} - 1 + \bar{q}_t\right)e_tL^F_{t-1} + R^R\rho_{t-1}D_{t-1} = \varkappa R^D_tD_{t-1}, \tag{A41}$$

$$\Xi_t = \bar{q}_t - q^*_t, \tag{A42}$$

the transversality conditions, given exogenous AR(1) processes $\{A_t,\ \eta_t,\ \psi^\eta_t,\ \psi^F_t,\ \psi^K_t,\ \psi^I_t,\ \psi^P_t,\ \psi^{NW}_t,\ Y^F_t,\ R^L_{F,t}\}$. For the specification "dsge-2s-fl" used in Section 4.2, the RR-ratio rule takes form,

$$
\rho_t/\rho_{(\mathcal{S}_t^{RR})} = \begin{cases} \left(\rho_{t-1}/\rho_{(N)}\right)^{\gamma^{\rho}_{(N)}} \exp(\varsigma^{\rho}_{(N)}\epsilon^{\rho}_t), & \text{if} \quad \mathcal{S}_t^{RR} = N, \\ \left(\rho_{t-1}/\rho_{(C)}\right)^{\gamma^{\rho}_{(C)}} \left(L_t^F/L^F_{(C)}\right)^{\gamma^{\rho,L}_{(C)}\left(1-\gamma^{\rho}_{(C)}\right)} \exp(\varsigma^{\rho}_{(C)}\epsilon^{\rho}_t), & \text{if} \quad \mathcal{S}_t^{RR} = C. \end{cases} \tag{A43}
$$

Specifically, the feedback coefficient $\gamma^{\rho,L}_{(\mathcal{S}_t^{RR})}$ and the auto-correlation parameter $\gamma^{\rho}_{(\mathcal{S}_t^{RR})}$ are allowed to be regime-dependent, governed by the same Markov chain ($\mathcal{S}_t^{RR}$)—implying that both parameters switch simultaneously across regimes. Moreover, as indicated by data, the steady-state value $\rho_{(\mathcal{S}_t^{RR})}$ and net foreign lending $L^F_{(\mathcal{S}_t^{RR})}$ are specified to adapt in response to changes in the prevailing policy regime.

A2 The steady state model

In the steady state, all variables are constant over time, and time subscripts are omitted. The steady-state values of the exogenous shocks are normalized to unity, i.e., $A = \psi^{\eta} = \psi^F = \psi^K = \psi^I = \psi^P = \psi^{NW} = 1$. Taking the long-run inflation π and the nominal interest rate R^M as given, there are

$$
\Lambda = \beta = \pi/R^M, \quad R = R^M/\pi, \quad \bar{R} = (R^D - R^R\rho)/(1-\rho).
$$

The real exchange rate is normalized to $e = 1$ in steady state. The steady-state value of the marginal return on net worth ν is calculated from (A13) together with the marginal costs and benefits (A9)–(A11), which yields

$$
\nu = \frac{\beta(1-\theta)\left(s_H\Phi^L_H + s_F\Phi^L_F + \bar{R}\right)}{1-\beta\theta\left(s_H\Phi^L_H + s_F\Phi^L_F + \bar{R}\right)}.
$$

where $s_H = R^L - \bar{R}$, $s_F = R^L_F - \bar{R}$, and $s^H_F = s_H/s_F$. In the above expression, Φ^L_H, Φ^L_F, R^L, and R^L_F are parameters calibrated to match target moments. And thereby,

$$
\mu^L_H = \beta(1-\theta+\theta\nu_t)s_H, \quad \mu^L_F = \beta(1-\theta+\theta\nu_t)s_F, \quad \mu^D = \beta(1-\theta+\theta\nu_t)\bar{R}.
$$

The incentive constraint and banks' optimality condition further imply,

$$
\iota^F = \nu/(s^H_F\Phi^L_H + \Phi^L_F), \quad \iota^H = s^H_F\iota^F.
$$

Importers' optimality conditions and production imply,

$$
\frac{\Gamma_H}{\Gamma_F} = \frac{\alpha}{1-\alpha}, \quad \frac{\Gamma}{\Gamma_H} = \left(\frac{\Gamma_H}{\Gamma_F}\right)^{\alpha-1}, \quad P^M = \frac{\Gamma_H}{\alpha\Gamma}, \quad \frac{Y}{\Gamma} = \frac{P^M}{\alpha^{\Gamma}MC}. \tag{A44}
$$

The New Keynesian Phillips curve further implies, $MC = (\eta-1)/\eta$. Retail goods producers' optimality conditions and the production technology yield,

$$\frac{Y}{K} = \frac{R^L - (1-\delta)}{\alpha^K MC}, \quad W = \left(1 - \alpha^K - \alpha^\Gamma\right) MC \frac{Y}{N}, \tag{A45}$$

$$\frac{K}{N} = \left[\frac{Y}{K}\left(\frac{K}{\Gamma}\right)^{\alpha^\Gamma}\right]^{\frac{1}{\alpha^K+\alpha^\Gamma-1}}, \quad \frac{\Gamma}{N} = \left[\frac{Y}{\Gamma}\left(\frac{\Gamma}{K}\right)^{\alpha^K}\right]^{\frac{1}{\alpha^K+\alpha^\Gamma-1}}, \tag{A46}$$

where $Q^K = 1$. We set the parameter χ such that the steady-state level of labor supply corresponds to a normalized 8-hour workday $N = 1/3$. Then, the steady-state values $\{K, Y, \Gamma, \Gamma_H, \Gamma_F\}$ are determined using (A44) - (A46). Capital accumulation implies $I = \delta K$, and that capital is fully externally funded, $L^H = K$. Therefore, the steady-state values of the banks' balance sheet components are determined accordingly,

$$NET = L^H/\Phi^L_H, \quad L^F = \Phi^L_F NET, \quad D = (L^H + L^F - NET)/1 - \rho,$$

, and ω is calibrated such that,

$$\omega = \frac{1 - \theta\left[\left(R^L - \bar{R}\right)\Phi^L_H + \left(R^L_F - \bar{R}\right)\Phi^L_F + \bar{R}\right]}{R^L \Phi^L_H + R^L_F \Phi^L_F}.$$

Trade balance and market clearing further imply,

$$EX = \Gamma_F + \left(1 - R^L_F\right) L^F, \quad G = \bar{g}Y, \quad C = Y - I - G - \Gamma_H - EX, \quad Y^F = e^{-\xi} EX.$$

The household's optimality conditions imply,

$$\lambda^H = \frac{1-\beta h}{(1-h)C}, \quad \chi = \frac{W\lambda^H}{N^{\sigma^N}}, \quad \vartheta = (1 - \beta R^D)\lambda^H D^{\sigma_d}.$$

Finally, the steady-state values of the endogenous variables relevant for the bank run analysis are determined sequentially. Combining the definition of the fire-sale discount threshold with the corresponding steady-state conditions yields

$$\bar{q} = \left[\varkappa R^D D - R^R \rho D - Z L^H - \left(R^{F,L} - 1\right) L^F\right] \left[(1-\delta)L^H + L^F\right]^{-1}, \tag{A47}$$

where the marginal productivity $Z = \alpha^K MCY/K$. Taking the steady-state value of the likelihood of bank run Ξ, the fire-sale discount is identified according to $q^* = \bar{q} - \Xi$. Therefore, the consolidated loan portfolio and it marginal return are determined by,

$$\bar{L} = L^H + L^F, \quad \bar{Z}^* = \left[\left(Z + q^*(1-\delta)\right) L^H + (R^{F,L} - 1 + q^*) L^F\right]/\bar{L},$$

and the scale parameter of the asset management cost yields, $\zeta = (\beta \bar{Z}^*_t - q^*)/\bar{L}$.

A3 Appendix to model details

Public sector Here, we provide a detailed description of reserve formation and the public sector budget constraint. Reserve supply M_t takes the form of an outright transfer from the central bank to the banking sector, subject to a reserve requirement $M_t = \rho_t D_t$. Each period, the central bank remunerates required reserves at a nominal rate $1+i_t^R$ that is below the market interest rate. Consistent with standard arrangements, the central bank's remittance to the fiscal authority $P_t div_t^C$ is defined as net seigniorage revenue:

$$P_t div_t^C = P_t M_t - (1 + i_{t-1}^R) P_{t-1} M_{t-1}, \tag{A48}$$

where $(1 + i_{t-1}^R)\pi_t^{-1} = R^R$. In line with standard treatments in the literature, government expenditure and interest payments are financed by lump-sum taxes and seigniorage revenue, i.e., the government's flow budget constraint can thus be written as

$$P_t G_t + R_t^M P_{t-1} B_{t-1} = P_t div_t^C + P_t B_t + T_t. \tag{A49}$$

Bankers The law of motion for bankers' net worth is obtained by substituting the balance sheet identity (10) into the definition of net worth in (9),

$$net_{j,t+1} = \left(R_{t+1}^L - \bar{R}_t\right) Q_t^K L_{j,t}^H + \left(R_{F,t+1}^L \frac{e_{t+1}}{e_1} - \bar{R}_t\right) e_t L_{j,t}^F + \bar{R}_t net_{j,t} - \Omega_{j,t}.$$

Assuming a linear conjecture for bank value, $V_{j,t}^B = \nu_t net_{j,t}$, the franchise value implies,

$$V_{j,t}^B(net_{j,t}) = \max_{L_{j,t}^H; L_{j,t}^F} \mathbb{E}_t \Lambda_{t,t+1} \left[(1 - \theta + \theta \nu_t) \begin{pmatrix} \left(R_{t+1}^L - \bar{R}_t\right) Q_t^K L_{j,t}^H + \left(R_{F,t+1}^L \frac{e_{t+1}}{e_1} - \bar{R}_t\right) e_t L_{j,t}^F \\ + \bar{R}_t net_{j,t} - \Omega_{j,t} \end{pmatrix} \right]$$

Using the definitions of expected returns and funding costs, $\mu_{H,t}^L$, $\mu_{F,t}^L$, and μ_t^D, the value function can be expressed as

$$V_{j,t}^B = \nu_t net_{j,t} = \mu_{H,t}^L Q_t^K L_{j,t}^H + \mu_{F,t}^L e_t L_{j,t}^F + \mu_t^D net_{j,t} - \Omega_{j,t},$$

The banker chooses domestic and foreign lending to maximize

$$\max_{L_{j,t}^H; L_{j,t}^F} V_{j,t}^B + \lambda_t^B \left[V_{j,t}^B - \psi_t^F \left(\iota^h Q_t^K L_{j,t}^H + \iota^f e_t L_{j,t}^F \right) \right].$$

The first-order conditions with respect to $L_{j,t}^H$ and $L_{j,t}^F$ are

$$\partial L_{j,t}^H: \quad (1 + \lambda_t^B) \left[\mu_{H,t}^L Q_t^K - \theta \kappa^b Q_t^K (\Upsilon_t - \Upsilon) \frac{e_t L_t^F}{(Q_t^K L_t^H + e_t L_t^F)^2} \right] = \lambda_t^B \psi_t^F \iota^h Q_t^K, \tag{A50}$$

$$\partial L_{j,t}^F: \quad (1 + \lambda_t^B) \left[\mu_{F,t}^L e_t + \theta \kappa^b e_t (\Upsilon_t - \Upsilon) \frac{Q_t^K L_t^H}{(Q_t^K L_t^H + e_t L_t^F)^2} \right] = \lambda_t^B \psi_t^F \iota^f e_t. \tag{A51}$$

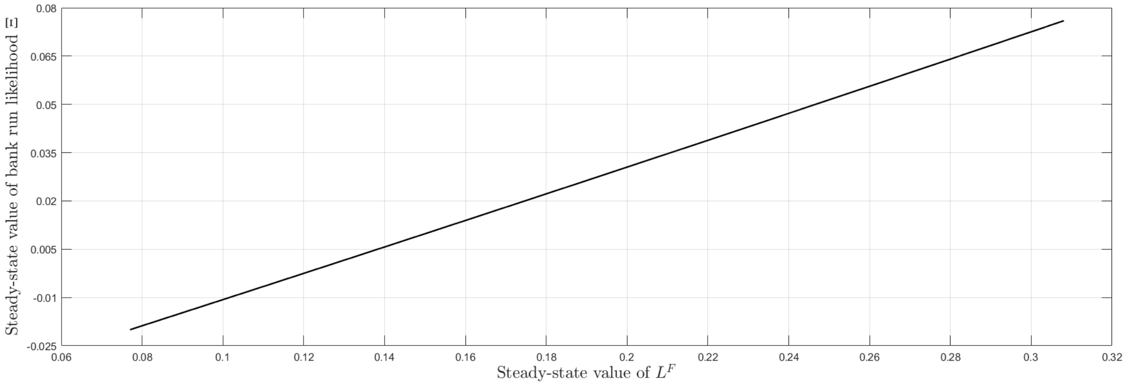

Figure A1: Steady-state experiment: net foreign lending and the bank run likelihood.

where λ_t^B denotes the multiplier associated with the incentive compatibility constraint. The slackness conditions imply that the incentive constraint binds if

$$\frac{\partial \Omega_t}{\partial L_t^H} < \mu_{H,t}^L Q_t^K < \iota^h Q_t^K + \frac{\partial \Omega_t}{\partial L_t^H},$$
$$-\frac{\partial \Omega_t}{\partial L_t^F} < \mu_{F,t}^L e_t < \iota^f e_t - \frac{\partial \Omega_t}{\partial L_t^F},$$

which could be ensured by the empirically supported calibration approach. Substituting out the multiplier yields the optimal portfolio condition (16).

Net Foreign Lending and Run Likelihood in Steady State Figure A1 shows the comparative statics of net foreign lending and the likelihood of a bank run in steady state, with the household management cost parameter ζ held fixed. As the steady-state level of net foreign lending increases, the run likelihood monotonically rises and eventually crosses the threshold ($\Xi > 0$). In particular, once net foreign lending exceeds 50% above its baseline steady-state value, the model implies that the economy enters a region where liquidity-driven crises may occur at any time.

B Appendix to Section 4

B1 Data

The quarterly dataset for the Bayesian estimation is drawn from the CEIC database for China's economy span from 2000Q1 to 2019Q3. All variables, except for the policy rate and the RR-ratio, are seasonally adjusted. Specifically, ρ_{data} denotes the average RR-ratio for all commercial banks, while R_{data}^M refers to the interbank pledged bond repo rate (R007). The observed inflation series, π_{data}, is measured as the quarter-over-quarter change in the consumer price index (CPI). Per capita real growth rates are obtained by adjusting nominal series for population size and deflating by the CPI. These include ΔGDP_{data}, ΔC_{data}, ΔL_{data}^H, ΔD_{data}, ΔI_{data}, ΔEX_{data},

Figure B2: Data used in estimation

ΔIM_{data}, and $\Delta\tilde{L}^F_{data}$, corresponding to GDP, consumption, domestic lending, domestic deposits, aggregate fixed-asset investment across three industries, exports, imports, and foreign lending, respectively. The last three series are USD-denominated. Δe_{data} denotes the growth rate of the real exchange rate, adjusted for inflation differentials between China and the United States. The processed data are presented in Figure B2.

The observed data are linked to the model through the following measurement equations:

$$\begin{bmatrix} \log \rho_{t,\text{data}} \\ \log R^M_{t,\text{data}} \\ \log \pi_{t,\text{data}} \\ \Delta \log GDP_{t,\text{data}} \\ \Delta \log C_{t,\text{data}} \\ \Delta \log I_{t,\text{data}} \\ \Delta \log EX_{t,\text{data}} \\ \Delta \log IM_{t,\text{data}} \\ \Delta \log D_{t,\text{data}} \\ \Delta \log L^H_{t,\text{data}} \\ \Delta \log \tilde{L}^F_{t,\text{data}} \\ \Delta \log e_{t,\text{data}} \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ \log bpg \\ \log bpg \\ \log bpg \\ \log bpg \\ \log bpg \\ \log bpg \\ \log bpg \\ \log bpg \\ 0 \end{bmatrix} + \begin{bmatrix} \log \rho_t \\ \log R^M_t \\ \log \pi_t \\ \log GDP_t - \log GDP_{t-1} \\ \log C_t - \log C_{t-1} \\ \log I_t - \log I_{t-1} \\ \log EX_t - \log EX_{t-1} \\ \log \Gamma_{F,t} - \log \Gamma_{F,t-1} \\ \log D_t - \log D_{t-1} \\ \log L^H_t - \log L^H_{t-1} \\ \log \tilde{L}^F_t - \log \tilde{L}^F_{t-1} \\ \log e_t - \log e_{t-1} \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ \sigma^f_{\text{data}}\epsilon^f_t \\ \sigma^e_{\text{data}}\epsilon^e_t \end{bmatrix} \tag{B52}$$

where σ^f_{data} and σ^e_{data} denote measurement errors that account for the influence of factors outside the model.

Table B1: Prior and Posterior Modes

Param.	Initial	Prior	Posterior modes						
			dsge-cpy-2f	dsge-c-2f	dsge-cpy-f	dsge-cpy	dsge-c-f	dsge-c	dsge-2s
bgp	1.027	G(1.01,1.03)	1.0235	1.0239	1.0244	1.0241	1.0241	1.0236	1.0244
σ_d	1	N(0.5,1.5)	1.1413	1.1124	1.2171	1.1516	1.1892	1.1281	1.1514
h	0.5	B(0.2,0.8)	0.1080	0.1295	0.0593	0.1076	0.1196	0.1259	0.1197
$0.02\kappa_p$	0.5	B(0.2,0.8)	0.8931	0.8875	0.8780	0.8910	0.8888	0.8903	0.8915
ϖ_b	0.2	IG(0.01,0.5)	0.0152	0.0150	0.0155	0.0152	0.0150	0.0150	0.0013
η	10	N(8,12)	9.4954	9.3993	8.6052	9.4035	9.3485	9.3429	9.2935
κ_I	6	N(2,10)	3.7753	3.9593	1.7775	3.7780	3.9714	3.8169	3.8411
κ_b	0.6	B(0.5,1.4)	0.6025	0.6110	0.6021	0.5964	0.5665	0.6086	0.7171
ξ	1.5	G(1.2,1.8)	1.5143	1.4749	1.4769	1.4764	1.4592	1.4691	1.4649
γ_r	0.8	B(0.4,0.9)	0.8148	0.8623	0.7851	0.8185	0.8472	0.8546	0.8568
$\varphi_{r,\pi}$	1.8	G(1,3)	1.7606	2.1268	1.3050	1.7937	1.9769	2.0747	2.0845
$\varphi_{r,y}$	0.125	G(0.01,0.5)	0.0006	0.0003	0.0003	0.0004	0.0003	0.0004	0.0003
γ_a	0.8	B(0.6,0.9)	0.8854	0.8736	0.8542	0.8691	0.8694	0.8585	0.8540
$\gamma_{y,f}$	0.8	B(0.6,0.9)	0.9371	0.9367	0.9323	0.9367	0.9380	0.9361	0.9357
$\gamma_{r,f}$	0.8	B(0.6,0.9)	0.9436	0.9358	0.9101	0.9466	0.9492	0.9454	0.9326
$\gamma_{\psi,f}$	0.5	B(0.2,0.8)	0.9808	0.9789	0.9643	0.9800	0.9794	0.9796	0.9788
$\gamma_{\psi,k}$	0.5	B(0.2,0.8)	0.3924	0.4082	0.4316	0.3980	0.3991	0.4007	0.4029
$\gamma_{\psi,I}$	0.5	B(0.2,0.8)	0.9056	0.9072	0.9986	0.9086	0.9045	0.9057	0.9067
$\gamma_{\psi,p}$	0.5	B(0.2,0.8)	0.6429	0.6266	0.7274	0.6440	0.6294	0.6380	0.6330
γ_η	0.8	B(0.6,0.9)	0.8993	0.8897	0.8618	0.8882	0.8876	0.8817	0.8788
γ_{nw}	0.5	B(0.2,0.8)	0.6610	0.6638	0.6706	0.6573	0.6656	0.6549	0.6542
$100\varsigma^r$	0.2	IG(10^{-4},2)	0.2930	0.2850	0.2732	0.2933	0.2870	0.2876	0.2866
$100\varsigma^{r,f}$	0.2	IG(10^{-4},2)	0.3713	0.4219	0.354	0.3572	0.3613	0.3670	0.4403
$100\varsigma^a$	2	G(0.1,5)	2.7457	2.7612	2.7081	2.7348	2.7034	2.7556	2.7333
$100\varsigma^{y,f}$	5	G(0.5,10)	7.4849	7.6032	7.5520	7.4958	7.6502	7.5151	7.6224
$100\varsigma^{\psi,f}$	10	G(5,20)	19.471	20.326	9.6425	19.334	19.780	19.813	19.694
$100\varsigma^{\psi,k}$	2	G(0.1,5)	1.6322	1.6548	1.6252	1.6412	1.6461	1.6474	1.6450
$100\varsigma^{\psi,I}$	5	G(0.5,10)	8.1623	8.0967	7.7426	8.0744	8.1493	8.1726	8.1329
$100\varsigma^\eta$	2	G(0.1,5)	1.1328	1.0916	1.0901	1.0988	1.0780	1.0899	1.0717
$100\varsigma^{\psi,p}$	2	G(0.1,5)	3.1421	3.3460	3.0406	3.2215	3.2880	3.3908	3.3292
$100\varsigma^{nw}$	5	G(0.5,10)	7.0038	7.0358	8.1667	7.0970	7.1419	7.0866	7.3752
$100\varsigma^\rho$	5	G(0.5,10)	4.1927	4.4775	5.4879	5.5959	5.9951	6.7026	–
γ_ρ	0.8	B(0.4,0.9)	0.8179	0.9613	0.9126	0.9389	0.9189	0.9732	–
$\varphi_{\rho,\pi}$	0	N(-1,1)	0.2491	0 (Calib.)	0.3833	0.2843	0 (Calib.)	0 (Calib.)	0 (Calib.)
$\varphi_{\rho,y}$	0	N(-1,1)	2.0155	0 (Calib.)	1.8487	1.6453	0 (Calib.)	0 (Calib.)	0 (Calib.)
$\varphi_{\rho,L}$	0.5	G(0.2,0.8)	–	–	0.1761	0 (Calib.)	0.4494	0 (Calib.)	–
$prob^{N,C}$	0.125	B(0.01,0.15)	0.0675	0.0360	–	–	–	–	0.0549
$prob^{C,N}$	0.015	B(0.01,0.15)	0.0240	0.0743	–	–	–	–	0.0101
$\varphi_{\rho,L}(N)$	0	Calibrated	–	–	–	–	–	–	–
$\varphi_{\rho,L}(C)$	0.5	G(0.2,0.8)	0.1352	0.2503	–	–	–	–	0.3363
$\gamma_\rho(N)$	0.8	B(0.4,0.9)	–	–	–	–	–	–	0.8056
$\gamma_\rho(C)$	0.8	B(0.4,0.9)	–	–	–	–	–	–	0.9078
$100\varsigma^\rho(N)$	5	G(0.5,10)	–	–	–	–	–	–	2.7806
$100\varsigma^\rho(C)$	5	G(0.5,10)	–	–	–	–	–	–	4.4076
$100\varsigma^e_{data}$	2	G(0.1,5)	1.6887	1.7242	1.7076	1.6728	2.2503	1.6804	1.8847
$100\varsigma^f_{data}$	2	G(0.1,5)	5.6252	5.6750	5.6042	5.6777	5.4078	5.6812	7.8446
Log MDD (Laplace)			1801.30	1798.34	1797.44	1795.77	1780.59	1770.10	1720.52

Note: B denotes the generalized Beta distribution, G the Gamma distribution, IG the Inverse Gamma distribution, and N the normal distribution. Models refer to the baseline and five alternative specifications.

B2 Additional Estimation Results

In this subsection, we report the estimates for the models with alternative specifications of the RR-ratio rule. Table B1 presents the full set of prior and posterior modes for the estimated parameters across three model specifications, each initialized with identical starting values to

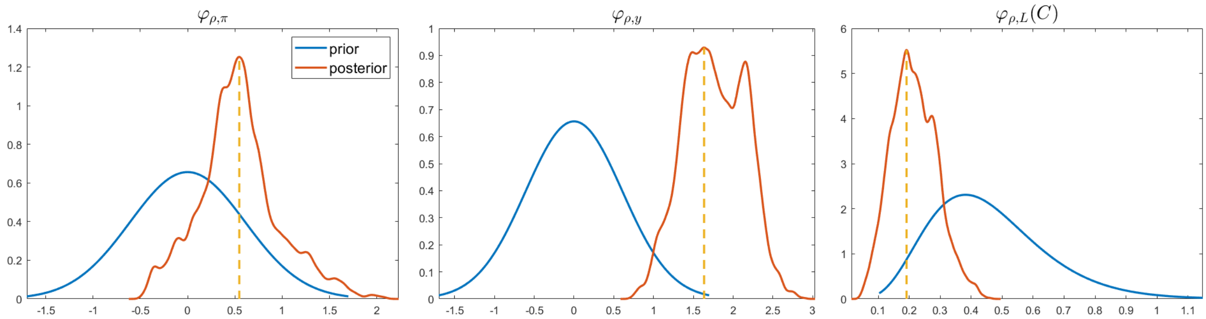

Figure B3: Prior and Posterior Distributions of the Feedback Coefficients of the RR-ratio Rule

ensure comparability. The initial values for mode maximization are selected to align with commonly used values in the literature. Each run of the global optimizer entails millions of likelihood evaluations, and the procedure is repeated multiple times for each model to ensure the stability of locating a high-density region in the posterior landscape. Among the resulting candidates, the mode corresponding to the highest posterior density is retained and reported. This computationally intensive process spans several weeks to complete. Comparing the posterior modes across specifications reveals that most structural parameter estimates align closely with those obtained from the benchmark model dsge-cpy-2f, indicating that the improvement in fit is largely driven by the specification of the RR-ratio rule.

Figure B3 visualizes the prior and posterior distributions of the key parameters of interest—namely, the feedback coefficients on inflation $\varphi_{\rho,\pi}$, output $\varphi_{\rho,y}$, and net foreign lending $\varphi_{\rho,L}(C)$ gaps in the RR-ratio rule—generated from the random-walk Metropolis–Hastings sampling results.

Table B2: Variance decomposition of net foreign lending in state N

	1	4	8	12	16	20	40
Export demand shock	20.77%	19.69%	15.87%	14.00%	13.37%	13.38%	15.78%
TFP shock	24.04%	10.45%	3.71%	1.78%	1.11%	0.84%	0.90%
Cost-push shock	14.87%	32.74%	39.62%	40.19%	39.43%	38.38%	33.30%
Foreign interest rate shock	22.88%	27.62%	26.40%	25.53%	25.68%	26.44%	31.92%

Table B3: Variance decomposition of net foreign lending in state C

	1	4	8	12	16	20	40
Export demand shock	18.77%	20.68%	16.64%	14.32%	13.45%	13.33%	15.65%
TFP shock	29.74%	13.99%	4.68%	2.08%	1.22%	0.88%	0.88%
Cost-push shock	6.98%	28.37%	38.89%	40.26%	39.67%	38.56%	33.52%
Foreign interest rate shock	18.08%	27.18%	26.77%	25.63%	25.56%	26.20%	31.68%

Table B2 and Table B3 report the variance decomposition of net foreign lending under the two policy states (N and C), showing that four shocks—export demand, total factor productivity

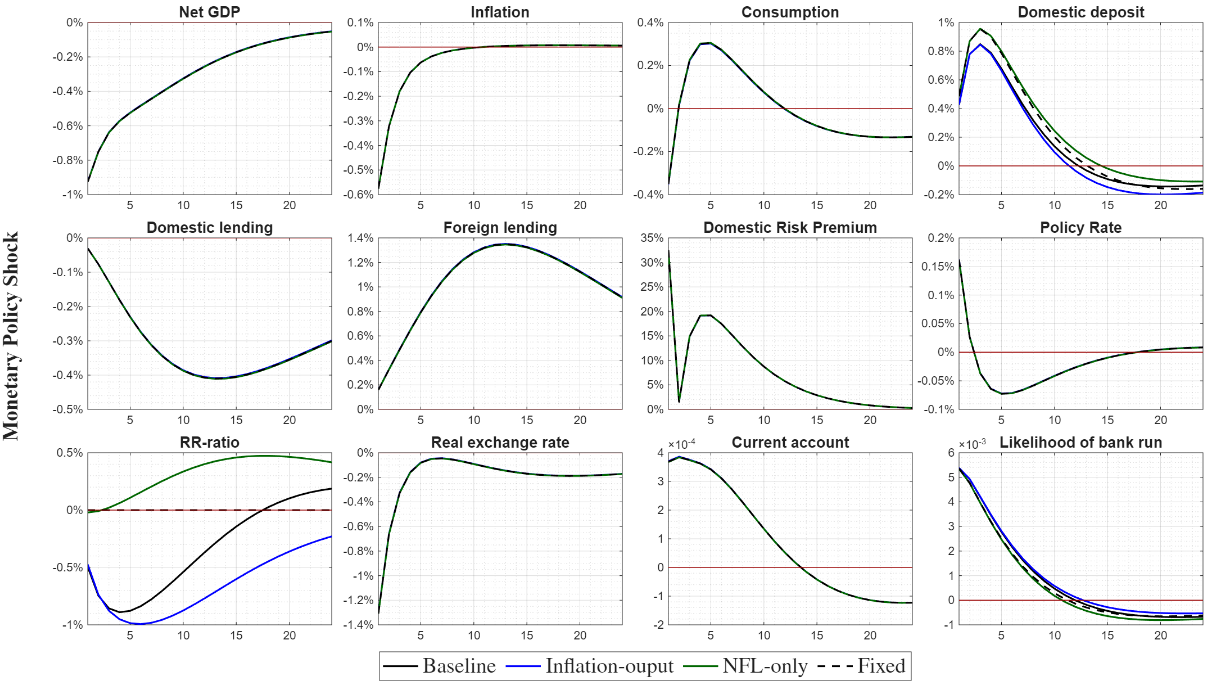

Figure B4: Impulse responses to a 20 basis point policy rate hike under alternative RR-ratio specifications: the baseline rule (black solid), the inflation–output rule (blue solid), the NFL-only rule (green solid), and a fixed RR-ratio (black dashed). The vertical axis shows percentage deviations from steady state, except for the current account and the likelihood of a bank run, which are reported in absolute deviations.

(TFP), cost-push, and the foreign interest rate—consistently account for the majority of its fluctuations across horizons and regimes. These constitute the key structural shocks of interest in the present analysis.

B3 Macroeconomic Responses to Alternative Shocks

Figure B4 reports the effects of a 20-basis-point increase in the policy rate, which generates standard aggregate demand effects—net GDP falls by 0.9% and inflation by 0.6%—and, via the uncovered interest parity channel, lowers external risk premia (foreign lending rate net domestic deposit rate) and induces real appreciation. Meanwhile, tighter monetary policy also raises funding costs, erodes bank net worth, and amplifies financial frictions.[19] With weaker domestic loan demand, banks reallocate additional deposit funding into foreign assets, thereby deepening liquidity mismatches and increasing exposure to foreign-lending risk, which heightens solvency concerns.

By contrast, when the RR-ratio systematically responds to net foreign lending, it dampens the financial instability induced by policy tightening while leaving real activity largely unaffected. This reflects a fundamental distinction between the RR-ratio and policy rates in their effects on bank liquidity: policy rate hikes compress intermediation margins without improving liquidity coverage (the reserves-to-deposits ratio), whereas higher reserve requirements are

[19]The overshooting of consumption is due to an excessively large drop in investment, a similar pattern appears in Gertler and Karadi (2011).

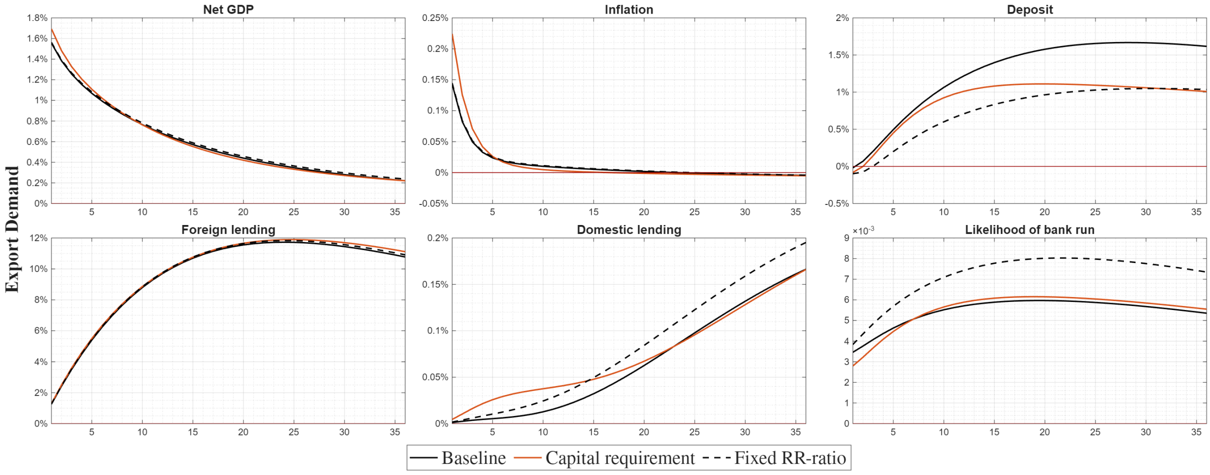

Figure B5: Impulse responses to a 10% increase in export demand under the RR-ratio rule compared with a calibrated tightening of the capital requirement.

explicitly designed to strengthen liquidity buffers. Such buffers increase the distance from the run threshold by ensuring that a larger share of assets is held in the form of non-risky, highly liquid reserves, thereby lowering the likelihood of self-fulfilling bank runs and highlighting the RR-ratio's role as a macroprudential tool rather than a channel for real-side stabilization.

B4 Discussion on the capital requirement

This section discusses the effects of the RR policy relative to a tighter capital requirement under an export demand shock, noting that both regimes are capable of delivering financial-stability benefits. Specifically, we conduct a counterfactual analysis by increasing the weight of foreign lending (ι^f) in the incentive constraint (11), which effectively tightens the capital requirement on foreign lending exposures. A higher ι^f raises the net-worth backing required for each unit of foreign lending, thereby tightening the funding constraint and lowering banks' effective leverage on foreign lending. The parameter is calibrated so that, under the same export-demand shock, the implied cumulative reduction in the bank-run likelihood matches that generated by the baseline RR-ratio rule.

Figure B5 reports the resulting impulse responses. Although both regimes achieve a similar reduction in the bank-run likelihood by construction, their macroeconomic transmission differs. Under the tighter capital requirement, banks allocate relatively less credit to foreign lending and expand domestic loans, reflecting the higher net-worth backing required for foreign lending exposures. This shift in the composition of lending increases the availability of domestic credit and produces an expansion in output. Meanwhile, the rise in domestic demand puts upward pressure on marginal costs, leading to an inflationary response relative to the RR-ratio rule. Hence, even though the two policies generate comparable improvements in financial stability, they operate through distinct balance-sheet channels that shape the macroeconomic effects in different ways.