# Targeted Reserve Requirements for Macroeconomic Stabilization [1]

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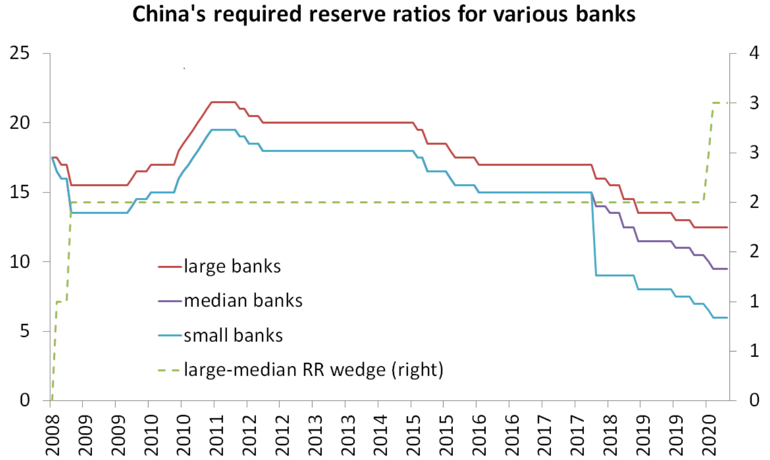
[1]The views expressed herein are those of the authors and do not necessarily reflect the views of the Federal Reserve Bank of San Francisco or the Federal Reserve System.

# Differential regulation on large and small banks

- Use of differential capital requirements or reserve requirements (RR) to mitigate financial instability
  - Basel III imposes higher capital requirements on large and systemically important banks than small banks.
  - Brazil's RR system partly exempts small banks on a variety of deposits (Glocker and Towbin (2015)) and reduced RR on large banks if they purchase assets of small banks (e.g. Tovar, Garcia-Escribano and Martin (2012)).
- Targeted reserve requirements have been implemented in China for macro stabilization.

# Targeted reserve requirements (RR) have also been used for macro stabilization




- The PBoC cut RR more for small and medium-sized banks than large during downturns.

# Our research questions

- Potential effectiveness of targeted RR adjustments as a policy tool for macroeconomic stabilization.
- We address the following questions:
    - How the economy responds to targeted RR adjustments?
    - How should the central bank adjust the RRs for large and small banks over the business cycle?
    - Can we explain the PBoC's different policy patterns in normal times and under deep depression?
    - Implications for government deposit insurance burden (financial stability)

# DSGE model with two types of banks

- National and local banks exist side by side
  - Differ in technology, funding costs, and potentially government treatment
- "Relationship banking": cost of switching banks.
  - Firms switch banks only under sufficiently large shocks
- Model calibrated to fit Chinese data.

# Differences between national and local banks

1. National banks provide superior liquidity services and enjoy lower funding costs
2. Local banks have superior monitoring technology
3. Both carry government provided deposit insurance, but in case of bankruptcies local banks are liquidated while national banks are recapitalized
4. National and local banks can face different government-imposed RR

# Main findings: Unexpected cut in RR (I)

- Compare two extreme cases: zero and infinite switching costs
- Cutting RR on local banks raises output in both cases
  - Intensive-margin: lowers local bank funding costs and encourages production by local-bank borrowers
  - Extensive-margin: shifts funding from national to local banks, expanding aggregate firm leverage and output

# Main findings: Unexpected cut in RR (II)

- Impact of cutting RR on national banks differs, depending on switching costs
- Zero switching cost case ambiguous
  - Intensive-margin: lowers national bank funding costs and encourages production by national-bank borrowers
  - Extensive-margin: shifts funding from local to national banks, reducing aggregate firm leverage and output.
  - Extensive-margin effect dominates under our calibration; output falls
- Under prohibitive switching cost case output increases
  - Intensive-margin similar, but extensive-margin shut off

# Main findings: Business cycle

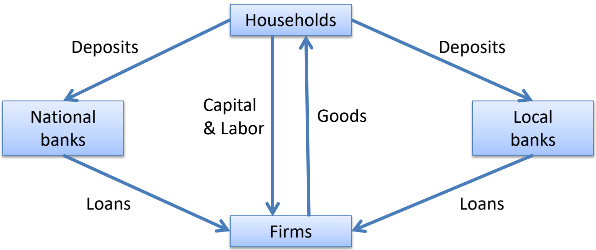
- Calibrated positive fixed cost of switching
- Focus on simple symmetric and asymmetric RR rules that respond to output gap.
- Asymmetric RR rules on local banks outperform symmetric rules for stabilizing macroeconomic fluctuations in environments with large shocks
    - Mitigate costly bank-switching that disrupts existing bank relationships.
    - Tradeoff between macro and financial stability, as burden on government increases

# Related themes in literature

- Stabilization policy
  - Interior solution for optimal capital and/or reserve requirements due to tradeoffs between prudential and macroeconomic goals [den Heuvel (2008), Nicolo, et al (2014), Gorton, et al (2012) and Christiano and Ikeda (2016)]
  - Market structure implications of targeted capital requirements on large and small banks [Corbae and Erasmo (2019)]
  - Reserve requirements for macro stabilization [Loungani and Rush (1995), Alper, et al (2018), Brei and Moreno (2019)]
- Changes in current account and capital flows
  - Macro stabilization through reserve requirements [Montoro and Moreno (2011), Federico, et al (2014), Chang, et al (2019)]
- Allocative effects
  - Lowering reserves supply or raising RR reduces share of bank lending [Kashyap and Stein (2000), Górnicka (2016)]

# A DSGE model with two types of banks

- Households consumes, saves and supplies labor and capital.
- Firms rely on external finance for working capital subject to costly state verification: financial accelerator (BGG, 1999)
- National and local banks compete in deposit and loan markets.



# Representative household

- Utility function

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

where $\Psi_h$ and $\Psi_n$ represent disutility of labor and liquidity services of national bank deposits, respectively

- Budget constraint

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

- Capital accumulation with adjustment costs (CEE 2005)

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

where $\Omega_k$ represents adjustment costs given steady-state investment growth $g_I$

# National banks enjoy lower funding costs

- Due to liquidity services of national bank deposits, optimal household saving decisions imply,

$$\mathrm{E}_t \Lambda_{t+1} \beta (R^d_{l,t} - R^d_{n,t}) = \Psi_n \frac{1}{D_{n,t}} > 0$$

- National banks enjoy lower funding costs, as $R^d_{l,t} - R^d_{n,t} > 0$

# Firms' production and financing activities

- At beginning of period, firm chooses type-b bank ($b = n, l$) to borrow needed working capital
- Firms produce homogenous goods using capital and labor

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

where $A_t$ is aggregate productivity and $\omega_{b,t}$ is idiosyncratic productivity shock

- Firm finances working capital with net worth $N_{b,t}$ and external debt $B_{b,t}$ (BGG)

$$N_{b,t} + B_{b,t} = w_t H_{b,t} + w_t^e H_{b,t}^e + r_t^k K_{b,t}$$

# Local banks have a monitoring advantage

- Firms default if realized productivity $(\omega_t)$ too low:

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

where $Z_{b,t}$ is contractual rate of interest

- Defaulting firms liquidated, with fraction $m_b$ output lost:

$$0 < m_l < m_n,$$

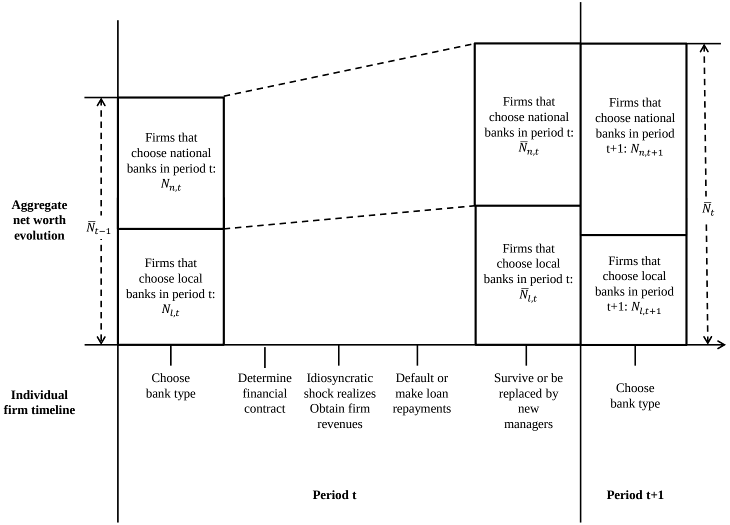
which implies local banks monitor and liquidate at lower cost.

# Individual firm's bank choice

- Denote $ROE_{b,t}$ as the firm's expected return to equity under optimal financial contract.
- Relationship banking: $\gamma > 0$ of firm net worth lost when it switches to a new bank.
- $\mathcal{B}_t(i)$ is choice of the bank type of the firm $i$ in period $t$.
- A firm's optimal bank choice is given by

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

# Extensive form



# Banks

- Bank $i$'s flow of funds constraint $(b \in n, l)$

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

  where $\tau_{b,t}$ denotes reserve requirements (RR)
- Idiosyncratic shock on loan returns across banks; allows for bank defaults.
- Deposit insurance on all banks
  - Under default by either bank type, government compensates depositors for any losses
- But banks treated differently under default
  - Local banks liquidated, with fraction $\mu_l$ loan payoff lost.
  - National banks recapitalized, with no deadweight loss.

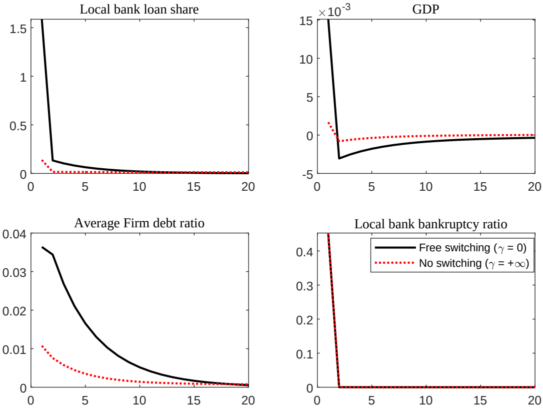
# Quantitative analysis

- Solve model numerically based on calibrated parameters
- Use model to evaluate dynamics from unexpected changes in RR
  - Consider cases with zero and prohibitive switching costs
- Then consider dynamic RR feedback rules
  - Symmetric feedback rule with sensitivity to GDP deviations are identical for local and national banks
  - Asymmetric feedback rule in which RR are responsive to output only for national banks
- Finally, consider optimal asymmetric rule under variety of shock sizes

# Calibration

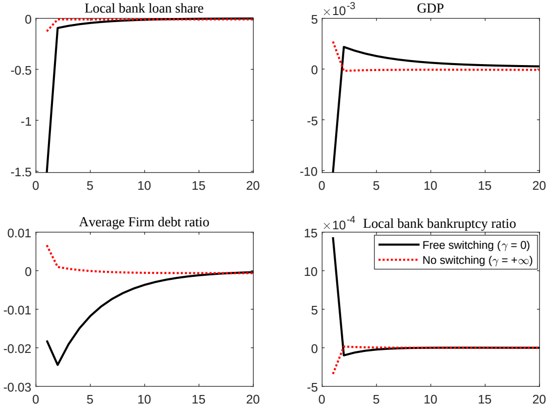
- Liquidation cost:
  - local bank $m_l = 0.1$: Bernanke et al. (1999)
  - national bank $m_n = 0.2$: average loan delinquency ratio $= 0.1$.
- Utility weight on liquidity services $\Psi_n = 0.005$:
  $4(R_n^d - 1) = 3\%$
- Deposit elasticity of substituion: $\theta_d = -163$:
  $4(R_n - R_n^d) = 3\%$.
- Distribution of idiosyncratic shock on loan quality: log normal with std $\sigma_l = 0.01/2$ to match std in loan deliquency ratio across banks.
- bank switching cost $\gamma = 0.002$: to match the volatility of the share of firm loans granted by local banks of 0.01 in the data.
- See Calibration for details

# Impulse response to unexpected RR cut on local banks




- Intensive-margin: local-bank borrowers take on more leverage.
- Extensive-margin: reallocation from national to local banks raises aggregate firm leverage
- Policy tradeoff: higher bankruptcy ratio for local banks

# Impulse response to unexpected RR cut on national banks




- Intensive-margin: national-bank borrowers take more leverage.
- Extensive-margin: reallocation from local to national banks reduces aggregate firm leverage.

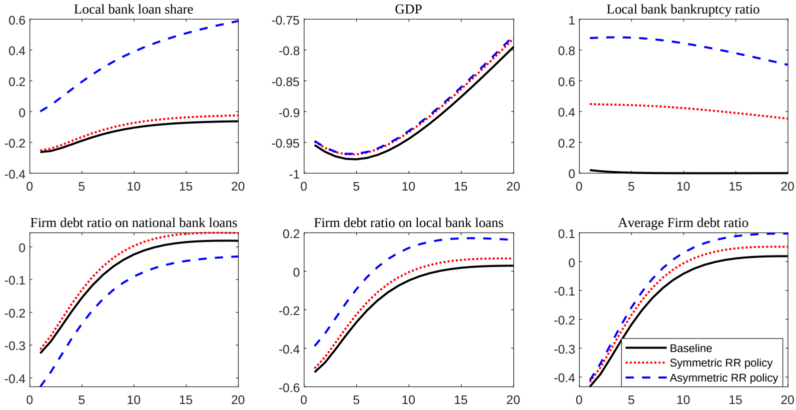
# Business cycle analysis

- Focus on the interior equilibrium where firms borrow from both types of banks.
- Assume simple policy rules on two types of RRs:
  - Local bank RR rule:
  $$\tau_t^l = \bar{\tau}^l + \psi_{ly} \ln\left(G\tilde{D}P_t\right)$$
  - National bank RR rule:
  $$\tau_t^n = \bar{\tau}^n + \psi_{ny} \ln\left(G\tilde{D}P_t\right)$$
  - Output gap $G\tilde{D}P_t$: deviation of real GDP from trend.
- Consider aggregate TFP shock with a variety of shock sizes.
- Solve model with occasionally binding constraints using OccBin [Guerrier and Iacoviello (2015)].

# RR policy regimes

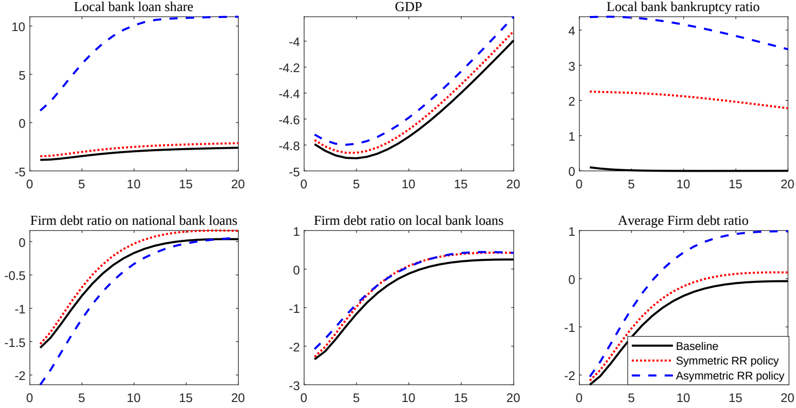
- Compare three RR policy regimes.
- Benchmark regime: $\psi_{ly} = \psi_{ny} = 0$.
- Symmetric RR rule: $\psi_{ly} = \psi_{ny} = 1$.
  - Captures PBoC RR adjustments in normal times.
  - Obtained by regressing the RR rule using Chinese quarterly data from 2000 to 2020.
- Assymmetric RR rule: $\psi_{ly} = 2$, $\psi_{ny} = 0$.
  - PBoC aggressively cuts RRs on local banks in response to downturns, but barely adjusts RRs on national banks.
  - Consistent with PBoC RR adjustments in the wake of deep adverse shocks.

# Impulse responses under a small negative TFP shock




- Local banks reduce credit supply more than national banks.
- No firms switch banks.
- Symmetric RR cut stimulates both types of banks and better stabilizes output.

# Impulse responses under a large negative TFP shock




- Firms switch from national banks to local banks.
- Persistent decline in firm aggregate debt ratio.
- Targeted RR cut on local banks better stabilizes output by mitigating firm switching to national banks.

# Optimal asymmetric RR adjustments

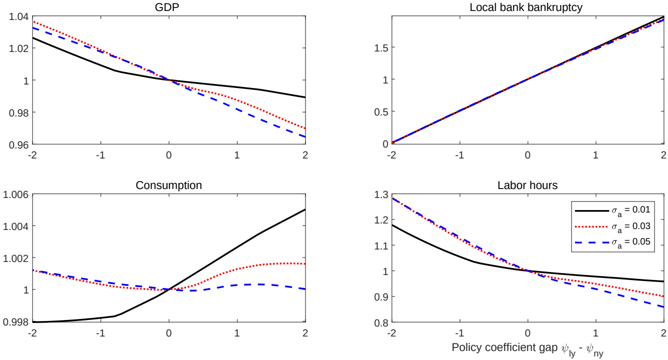
- Policy objective:

$$L = \mathrm{E}\left[(\tilde{C}_t)^2 + \Psi_h \eta \bar{H}^{1+\eta}(\tilde{H}_t)^2\right]$$

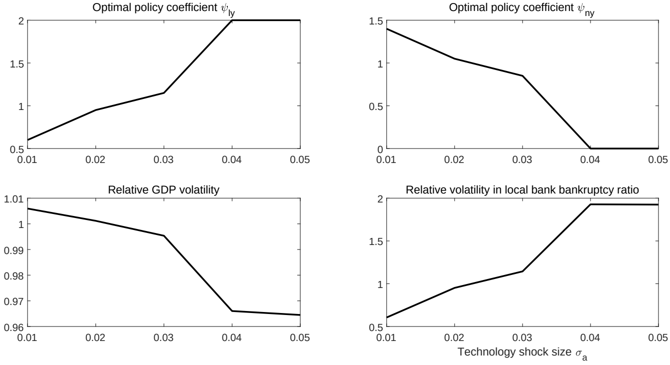
  where $\tilde{C}_t$ denotes deviation of consumption from trend; $\bar{H}$ and $\tilde{H}_t$, respectively, denote steady-state value of labor hours and deviation from the steady state
- Loss function derived from the second-order approximation of the household's welfare, excluding national bank deposits
- Restrict $\frac{\psi_{ny}+\psi_{ly}}{2} = 1$ and solve for optimal $\psi_{ly}$ and $\psi_{ny}$ under various shock sizes
- Symmetric RR rule if $\psi_{ly} = \psi_{ny} = 1$.

# Policy evaluation: volatilities (relative to symmetric rule)

- Tradeoff between macro stability and financial stability
  - Negative technology shock ↓ output and ↑ local bank bankruptcy
  - ↓ local bank RR ↑ output, but ↑ local bank bankruptcy
- Macro stability effect stronger under large shocks.
  - Asymmetric RR mitigates costly bank switching



# Optimal policy rules




- Optimal RR rule on local banks responds more (less) aggressively than on national banks under large (small) shocks.

# Conclusion

- Examine targeted RR policy in DSGE model with local banks and national banks
- RR policy transmission mechanism:
  - Reducing RR on local banks raises aggregate output
  - Reducing RR on national banks has ambiguous effects on output
  - Extensive margin: borrowers can switch between national banks and local banks
- Targeted (asymmetric) RR policy can better stabilize business cycles and avoid social costs of bank switching
- Optimal RR rule on local banks responds more (less) aggressively than on national banks under large (small) shocks

# Parameter calibration I

Back

| Variable | Description | Value |
|---|---|---|
| | A. Households | |
| $\beta$ | Subjective discount factor | 0.9975 |
| $\eta$ | Inverse Frisch elasticity of labor supply | 1 |
| $\Psi_h$ | Weight of disutility of working | 7.5 |
| $\Psi_n$ | Weight of utility of liquidity services | 0.005 |
| $\theta_d$ | Deposit elasticity of substitution | $-163$ |
| $\delta$ | Capital depreciation rate | 0.035 |
| $\Omega_k$ | Capital adjustment cost | 5 |
| | B. Firms and financial intermediaries | |
| $g$ | Steady state growth rate | 1.0125 |
| $\sigma$ | Volatility parameter in log normal distribution of firm idiosyncratic shocks | 0.315 |
| $\alpha$ | Capital income share | 0.5 |
| $m_n$ | National bank monitoring cost | 0.2 |
| $m_l$ | Local bank monitoring cost | 0.1 |
| $\xi_e$ | Firm manager's survival rate | 0.86 |
| $\theta$ | Share of household labor | 0.96 |
| $\sigma_l$ | Volatility parameter in log normal distribution of local bank idiosyncratic shocks | 0.005 |
| $\gamma$ | Bank switching cost | 0.002 |
| | C. Government policy and shock processes | |
| $\bar{\tau}_n$ | RR on National bank | 0.15 |
| $\bar{\tau}_l$ | RR on Local bank | 0.15 |
| $\mu_l$ | Liquidation cost of local banks | 0.03 |
| $\rho_z$ | Persistence of TFP shock | 0.95 |

# Firms' production and financing activities

- Firms produce homogenous goods using capital and labor,

$$Y_t = A_t \omega_t (K_t)^{1-\alpha} \left[ (H_t^e)^{1-\theta} H_t^\theta \right]^\alpha ,$$

- A firm that borrows from a type-b bank finances working capital with net worth $N_{b,t}$ and external debt $B_{b,t}$ (BGG)

$$N_{b,t} + B_{b,t} = w_t H_{b,t} + w_t^e H_{b,t}^e + r_t^k K_{b,t}$$

where $b = n$ for national banks and $b = l$ for local banks.

- Under optimal production decisions, the production revenue is:

$$Y_{b,t} = \tilde{A}_t \omega_t (N_{b,t} + B_{b,t})$$

where $\tilde{A}_t$ denotes the aggregate return to investment, $\omega_t$ denotes firm-specific idiosyncratic productivity shock .

# Financial frictions and defaults

- Firms default if realized productivity $\omega_t$ sufficiently low:

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

  where $Z_{b,t}$ is contractual rate of interest
- Defaulting firms liquidated, with fraction $m_b$ output lost:

$$0 < m_l < m_n$$

- Implies **local banks can monitor and liquidate firms at lower costs than national banks**.
- Denote $ROE_{b,t}$ as the firm's expected return to equity under optimal financial contract.

$$ROE_{b,t} \equiv \frac{\mathrm{E}\max\{\omega_t \tilde{A}_t (N_{b,t} + B_{b,t}) - Z_{b,t} B_{b,t}, 0\}}{N_{b,t}}$$

# Financial contracts

Back

- Optimal financial contract is a pair $(\bar{\omega}_{b,t}, B_{b,t})$ that solves

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

- subject to the lender's participation constraint

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

where

- $R_{b,t}$ denotes the average loan return required by type-b bank.
- $f(\overline{\omega}_{jt})$ and $g(\overline{\omega}_{jt})$ denote profit share of firm and lender, respectively.
- Denote $ROE_{b,t} \equiv h(\overline{\omega}_{b,t})\frac{\tilde{A}_t(N_{b,t}+B_{b,t})}{N_{b,t}}$ under optimal financial contract.

# Banking sector

- $b = n$ for national banks and $b = l$ for local banks.
- Bank $i$'s flow of funds constraint

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

  where $\tau_{b,t}$ **denotes government-imposed reserve requirements (RR)**.
- Each bank faces deposit demand schedule:

$$d_{b,t}(i) = \left( r^d_{b,t}(i) / R^d_{b,t} \right)^{-\theta_d} D_{b,t}.$$

  where $\theta_d < 0$ is elasticity of substitution across deposits.

# Bank defaults

- Payoff from asset holdings by the end of period $t$:

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

  - $\epsilon_{b,t}$ idiosyncratic shock to the loan quality, drawn from $\Phi(\cdot)$
- Bank default if realized loan quality $\epsilon_{b,t}$ sufficiently low:

$$\epsilon_{b,t} < \bar{\epsilon}_{b,t}(i) = \frac{r^d_{b,t}(i) d_{b,t}(i) - \tau_{b,t} d_{b,t}(i)}{R_{b,t} b_{b,t}(i)}.$$

- **Different treatments in case of bank default**:
  - Government compensates depositors if bank defaults.
  - Local banks are liquidated, with fraction $\mu_l$ loan payoff lost.
  - National banks are recapitalized, with no deadweight loss.

# Market clearing and equilibrium

- Final goods marke clearing

$$Y_t^f = C_t + I_t + \sum_{b=n,l} \tilde{A}_t (N_{b,t} + B_{b,t}) m_b \int_0^{\overline{\omega}_{bt}} \omega dF(\omega)$$

$$+\mu_l \int_0^{\bar{\epsilon}_{l,t}} \epsilon_{l,t} R_{l,t} b_{l,t} d\Phi(\epsilon_{l,t}) + \sum_{b=n,l} \gamma \max\{N_{b,t} - \bar{N}_{b,t-1}, 0\}.$$

- Capital and labor market clearing

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

- Credit market clearing

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

- Real GDP

$$GDP_t = C_t + I_t.$$

# Aggregate firm net worth under optimal bank choices

Back

- When $ROE_{l,t} - ROE_{n,t} > \gamma.$, all firms choose local banks.

$$N_{l,t} = \bar{N}_{t-1}, N_{n,t} = 0$$

- When $ROE_{l,t} - ROE_{n,t} = \gamma$, some firms switch to local banks.

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

- When $-\gamma < ROE_{l,t} - ROE_{n,t} < \gamma$, no firms switch banks.

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

- When $ROE_{l,t} - ROE_{n,t} = -\gamma$, some firms switch to national banks.

$$N_{l,t} \in (0, \bar{N}_{l,t-1}), N_{n,t} \in (\bar{N}_{n,t-1}, \bar{N}_{t-1})$$

- When $ROE_{l,t} - ROE_{n,t} < -\gamma$, all firms choose national banks.

$$N_{l,t} = 0, N_{n,t} = \bar{N}_{t-1}$$