Bank Capital Regulation in a Monetary Union

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Motivation

- Significant regulatory efforts since the Global Financial Crisis
- Many countries tightened bank regulation to strengthen the resilience of their banking sector
- But how do domestic regulatory changes affect other countries?

This paper

Focus: understanding international spillovers of capital requirements

- What are the **cross-border effects** of capital requirement changes?
- Which economic and institutional features affect the **size of the spillovers**?
- What are the implications for the **optimal level** of capital requirements?

Framework

Our model features:

- **Monetary union: 2 symmetric countries**
  - Bank intermediation frictions
  - Bank default risk
- **Interlinkages**: Goods trade and cross border lending (and deposit insurance financing)
- **Domestic policy authority**: Sets bank capital requirements
- **International institutional framework** considers:
  - Reciprocity of macroprudential policy measures
  - Deposit insurance scheme (national vs common)

Main Findings

- Optimal capital requirements trade off two distortions
  - **Bank limited liability**: benefits of higher capital requirements
  - **Scarce bank equity**: costs of higher capital requirements
- Cross country spillovers:
  - **Trade** (negative)
  - **Cross border bank lending** (negative)
  - Under reciprocity: **Bank solvency** (positive)
  - Under common DI: **Bank solvency** (large and positive)
- Spillovers: wedge between single country and cooperative optimum
  - **National DI scheme** without **reciprocity**: CRs too high
  - **National DI scheme** with **reciprocity**: CRs about right
  - **Common DI**: CRs too low

Model

Model: Households

- **Household (HH)**: provides consumption insurance to 2 members
  - **Workers**: supply labor to firms and deposits to banks and consumes a CES basket of Home and Foreign goods
  - **Bankers**: inside equity providers (with limited net worth)
- **Banks**: domestic and foreign operations
- **Capital regulation**: set at country level (Nash) or Union-wide (Cooperative)
- **Deposit insurance (DI)**: national versus common (union-wide)

Households

The household value function (for each country) is

$$V_t = \left\{ \max_{C_{L,t}, C_{IM,t}, L_t, D_t, K_{H,t}} \quad \log\left(C_t\right) - \varphi \frac{L_t^{1+\eta}}{1+\eta} + \beta \mathbb{E}_t \left[V_{t+1}\right] \right\},$$

where

$$C_t = \left[\chi_c^{1/\gamma_c} C_{L,t}^{\frac{\gamma_c - 1}{\gamma_c}} + (1-\chi_c)^{1/\gamma_c} C_{IM,t}^{\frac{\gamma_c - 1}{\gamma_c}} \right]^{\frac{\gamma_c}{\gamma_c - 1}},$$

subject to the household budget constraint

$$\mathsf{C}_t + D_t + (1+s_t) K_{H,t} = R_{D,t-1} D_{t-1} + (r_{L,t} + 1 - \delta) K_{H,t-1} + W_t L_t + T_t$$

Home and Foreign Goods Choice

Standard consumption basket of Home and Foreign goods

$$\min_{C_{L,t}, C_{IM,t}} \quad P_{L,t} C_{L,t} + P_{IM,t} C_{IM,t},$$

$$\text{s.t.} \quad C_t = \left[\chi_c^{1/\gamma_c} C_{L,t}^{\frac{\gamma_c - 1}{\gamma_c}} + (1 - \chi_c)^{1/\gamma_c} C_{IM,t}^{\frac{\gamma_c - 1}{\gamma_c}} \right]^{\frac{\gamma_c}{\gamma_c - 1}}$$

First order conditions give

$$C_{L,t} = \chi_c P_{L,t}^{-\gamma_c} C_t$$

$$C_{IM,t} = (1 - \chi_c) P_{IM,t}^{-\gamma_c} C_t.$$

Banks

- Each bank maximizes the net present value (NPV) of the bankers' equity stake conditional on not defaulting

$$\max_{k_{j,t},d_{j,t}} \mathbb{E}_t \left[\Lambda_{B,t+1} \max \left\{ \omega_{j,t+1} R_{K,j,t+1} q_{j,t} k_{j,t} - R_{D,t} d_{j,t}, 0 \right\} \right] - \nu_t E Q_{j,t}$$

- Balance sheet constraint

$$q_{j,t} k_{j,t} = d_{j,t} + E Q_{j,t},$$

- Capital requirement constraint

$$E Q_{j,t} \geq \phi_j q_{j,t} k_{j,t}.$$

- No CSV deposit contract so capital requirement always binding

Bank default

- The bank receives iid shocks to capital returns ω_t which are lognormally distributed $\log(\omega) \sim \mathcal{N}\left(-\frac{\sigma_{B,t}^2}{2}, \sigma_{B,t}^2\right)$

- **Banks optimally default** when their asset returns are not enough to repay deposits

$$\omega_{j,t+1} R_{K,j,t+1} q_{j,t} k_{j,t} - R_{D,j,t} d_{j,t} < 0$$

- The default threshold is given by

$$\bar{\omega}_{j,t+1} = (1 - \phi_j) \frac{R_{D,j,t}}{R_{K,j,t+1}},$$

Cross border lending

- Two types of Home banks: one that lends at Home and one that lends in Foreign (cross-border loans): $j = L, EX$
- Key institutional feature in capital regulation: reciprocity
  - Under reciprocity, cross-border loans subject to **host** country ϕ
  - Without reciprocity, cross-border loans subject to **home** country ϕ
- Bank equity holders arbitrage between different types of banks

$$\mathbb{E}_t \left[\Lambda_{B,t+1} (\rho_{L,t+1} - \rho_{EX,t+1}) \right] = 0$$

Final goods production

- Use labor and capital services to produce the Home good

$$Y_t = A_t S_t^{\alpha} L_t^{1-\alpha}$$

- Capital services S_t are a CES of loans that come from Home $K_{L,t}$ and Foreign capital $K_{IM,t}$

$$\min_{K_{L,t}, K_{IM,t}} \quad r_{L,t} K_{L,t} + r_{IM,t} K_{IM,t},$$

$$\text{s.t.} \quad S_t = \left[\chi_k^{1/\gamma_k} K_{L,t}^{\frac{\gamma_k - 1}{\gamma_k}} + (1 - \chi_k)^{1/\gamma_k} K_{IM,t}^{\frac{\gamma_k - 1}{\gamma_k}} \right]^{\frac{\gamma_k}{\gamma_k - 1}}$$

- Foreign capital comes from Foreign banks while Home capital comes from Home banks and households

$$K_{L,t} = K_{B,L,t} + K_{H,t}$$

Capital accumulation

- Capital accumulation

$$K_{t+1} = (1 - \delta)K_t + I_t$$

- Capital market clearing: domestic capital is held by domestic households and domestic banks that lend in Home and in Foreign

$$K_t = K_{H,t} + K_{B,L,t} + K_{B,EX,t}$$

Calibration

- Cross border lending and banking market integration in the data
  - Domestic and cross-border (foreign) loans to non-financial corporations
  - Subsidiaries of foreign banks treated as domestic because they are domestically regulated even if they are foreign owned
  - Inter-bank lending is ignored: this is a short term market for sharing of liquidity not for taking credit risk
- Data from Individual Balance Sheet Items (IBSI) of EA Banks: bank-level information on lending to domestic and foreign firms (2003–2023)

$$\text{Share of cross-border loans}_t = \frac{\sum_b \text{Foreign Corporate Loans}_{b,t}}{\sum_b (\text{Domestic} + \text{Foreign Corporate Loans})_{b,t}}$$

- Data on Bank Default from Moody's Expected Default Frequency (EDF)

Model vs Data Moments

Targets	Definition	Data	Model
Real risk-free rate	$(\beta - 1) \times 400$	2.32	2.32
Capital requirement	ϕ	0.08	0.08
Banks' default	$F(\overline{\omega}) \times 400$	0.665	0.665
Real equity return of banks	$(\rho - 1) \times 400$	7.066	7.066
Banks' price to book ratio	ν	1.148	1.148
Share of cross-border loans	$K_{EX}/(K_{EX} + K_L)$	0.10	0.10

Note: Data targets used to calibrate the model as well as the corresponding model values.

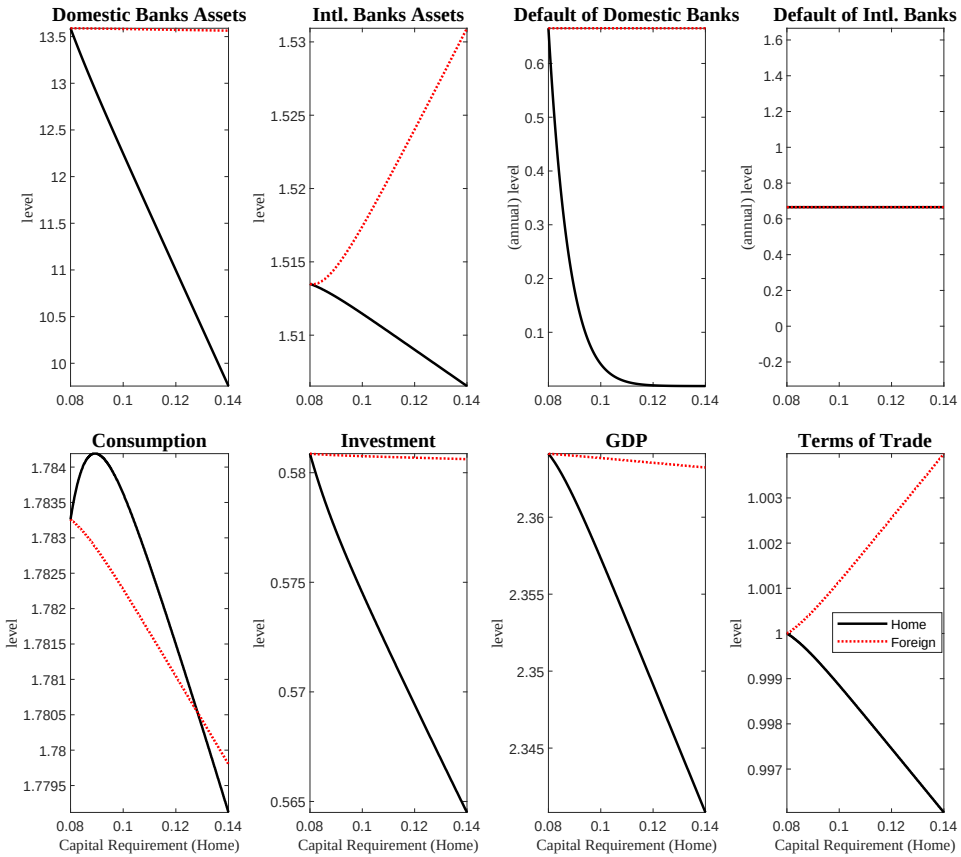
Model parameters

Baseline Calibration

Parameter	Notation	Value	Calibration
FINANCIAL			
Bank Survival	θ_B	0.9098	Calibrated
Start-Up Funding	ξ	0.8075	Calibrated
SS Capital Requirement	ϕ_{ss}	0.08	Calibrated
Default Costs	μ	0.3	Preset
SS IID Risk	$\sigma_{B,ss}$	0.0286	Calibrated
INTERNATIONAL			
Substitution Elasticity Goods	γ_c	2	Preset
Substitution Elasticity Capital	γ_k	1.5	Herreno (2023)
Home Bias for Consumption	χ_c	0.7	Preset
Home Bias for Capital	χ_k	0.92	Calibrated

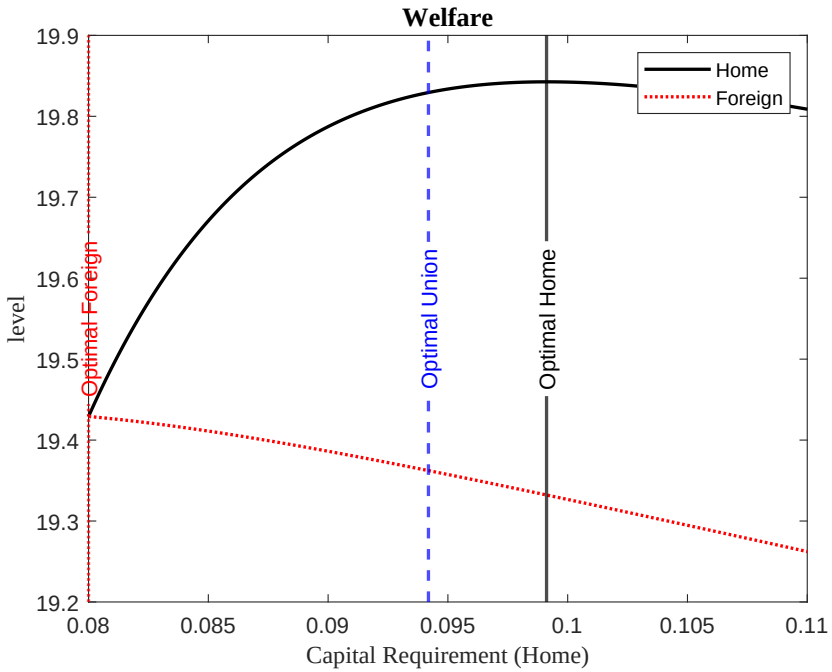
(1) Capital Requirements on Domestic Lending

CR Dom. Loans - Spillovers (w/o reciprocity)



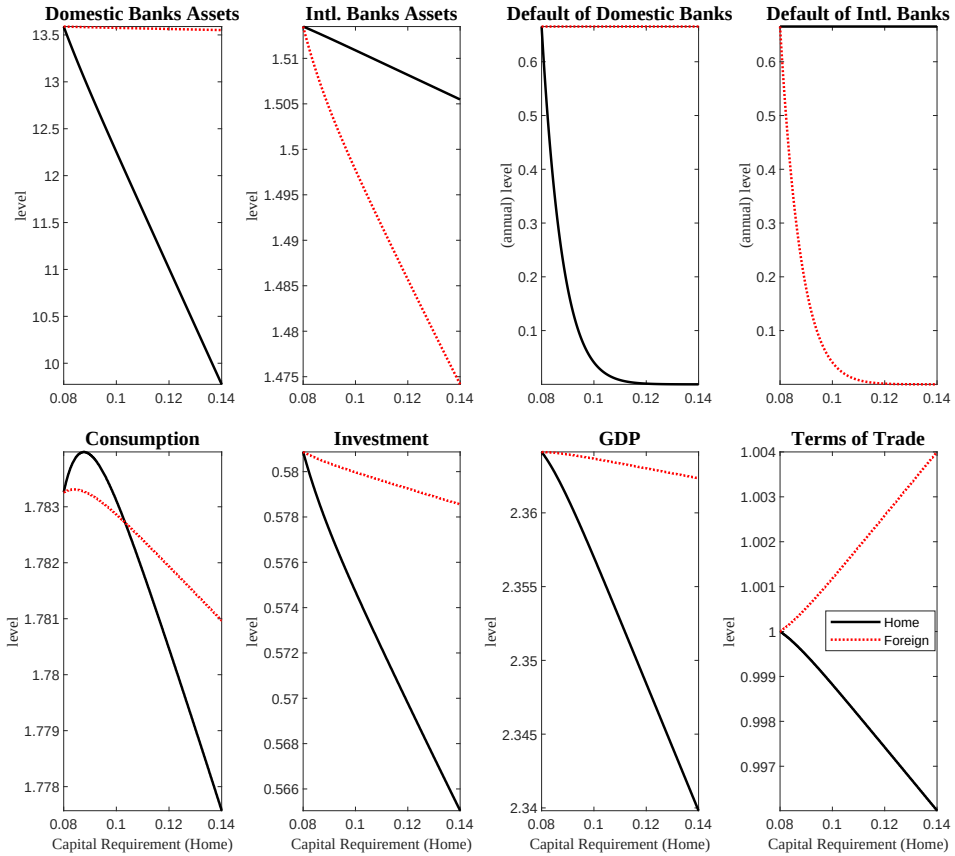
- **Trade spillovers (-)**: Lower supply of Home goods
- **Bank lending spillovers (-)**
  - Foreign banks increase international lending ('macropru leakages')
  - But Home banks reduce cross-country lending

CR Dom. Loans - Welfare (w/o reciprocity)



- Net negative spillovers
  - Never optimal for Foreign to have higher CR in the other country

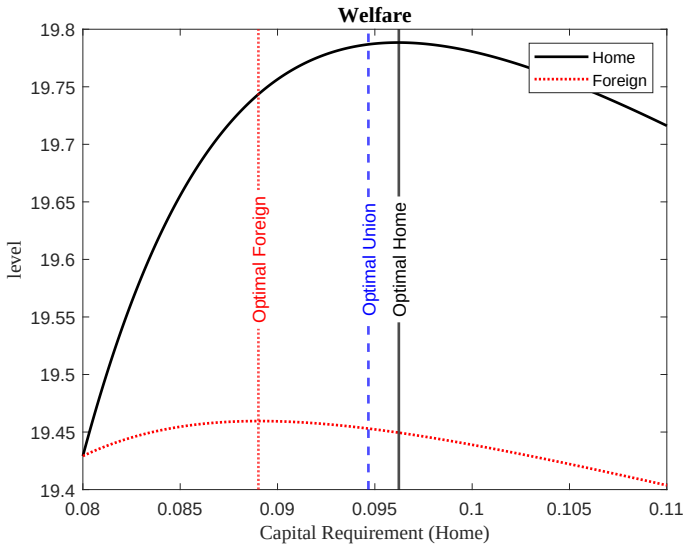
CR Dom. Loans - Spillovers (reciprocity)



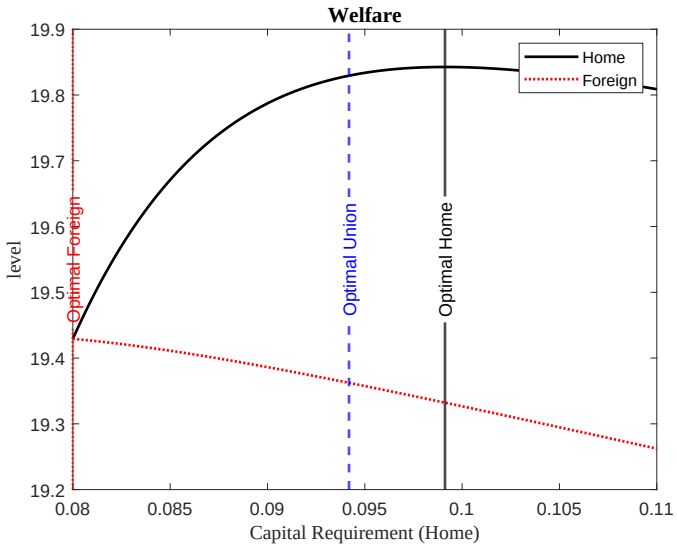
- **Bank solvency spillover (+)**: Foreign international banks become safer
- Offsetting positive spillover!

CR Dom. Loans - Welfare (reciprocity)

How do spillovers affect the optimal setting of CRs in the two countries?



(a) With Reciprocity

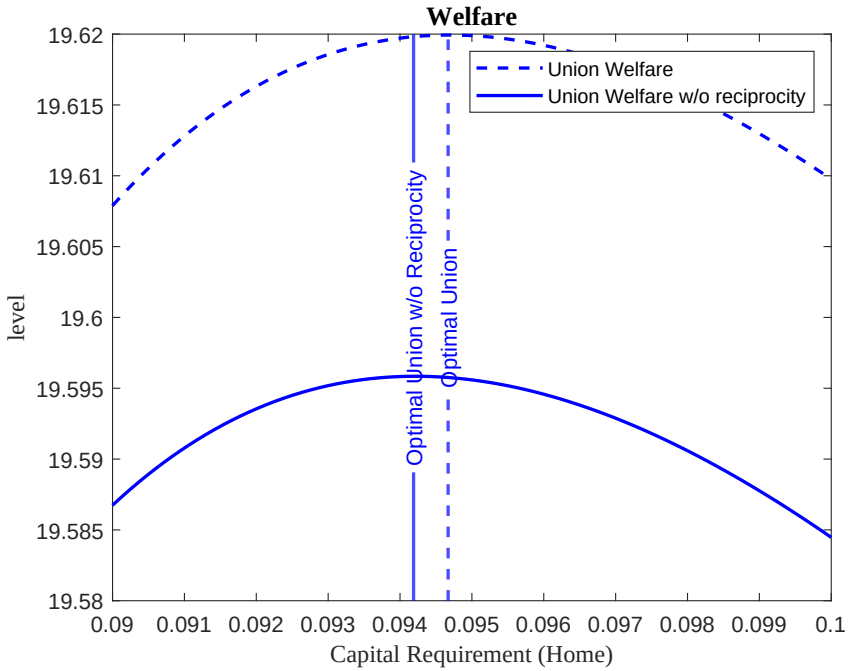


(b) W/o Reciprocity

- **With reciprocity**: offsetting negative and positive spillovers
- Smaller welfare cost from non-cooperative choices

CR Dom. Loans - Reciprocity Framework

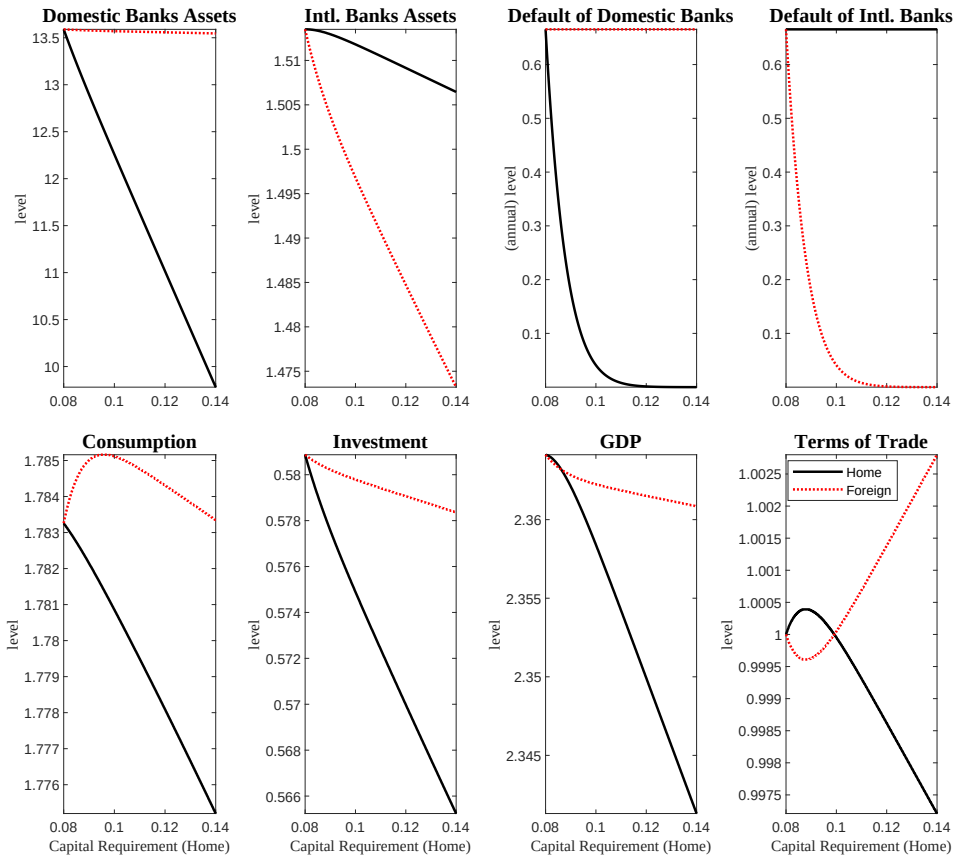
Is is beneficial to reciprocate capital requirement tightenings?



- Reciprocation of macroprudential measures leads to higher welfare from cooperation

(2) Common Deposit Insurance

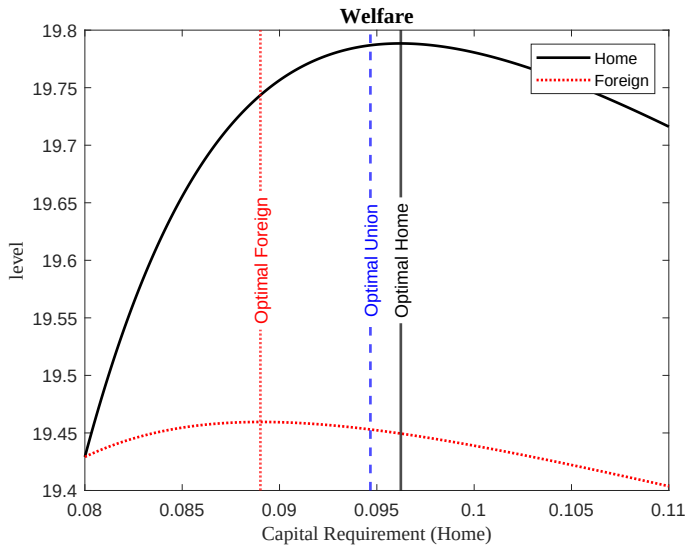
CR Dom. Loans - Common DI: Spillovers (rec.)



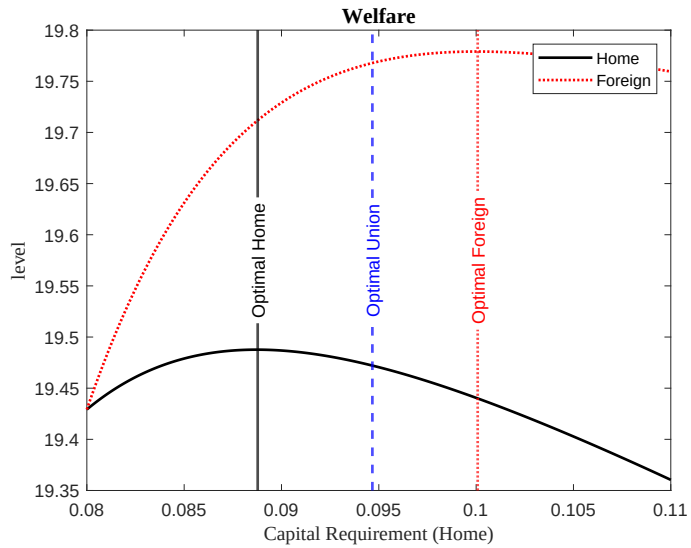
Common DI fundamentally changes the way the costs and benefits are distributed

- Home suffers most of the cost in terms of bank intermediation
- Half the benefit accrues to the Foreign fiscal authority

CR Dom. Loans - Common DI: Welfare (rec.)



(a) National DI



(b) Common DI

- Sharing of DI payments, creates very large (+) bank solvency spillovers
- Net cross-country spillovers become positive
- Larger Welfare losses from non-cooperatively chosen CRs

Conclusions

- **Cross-border Spillovers of CR**
  - **Without Reciprocity**: Spillovers always negative
    - **Trade spillover (-)**: lower supply of domestic goods also consumed abroad
    - **Bank lending spillover (-)**: lower supply of foreign loans by domestic banks
  - **With Reciprocity**: Partially offsetting spillovers
    - **Solvency spillover (+)**: higher CRs in one country makes the subsidiaries of foreign banks safer too
- **Reciprocation** of capital requirement increases beneficial
- **Common DI** amplifies positive spillovers
  - Net spillovers always positive also w/o reciprocity
  - Reciprocity remains optimal

Background Slides

Bankers

- Bank equity held by a special set of households named Bankers
- Each period, some Bankers continue to be Bankers while others 'retire' and bring their accumulated wealth back to the representative household
- Supply of bank equity limited by Bankers' wealth
- Decide whether to invest equity in Home banks that lend at Home and Home banks that lend to Foreign

Bankers' problem

- Objective function

$$V_{B,t} = \max_{EQ_{L,t}, EQ_{EX,t}, dv_t} \left\{ dv_t + \mathbb{E}_t \left[\Lambda_{t+1} \left[(1-\theta_b)\, n_{t+1} + \theta_b V_{B,t+1} \right] \right] \right\}$$

- Budget constraint:

$$EQ_{L,t} + EQ_{EX,t} + dv_t = n_t$$

- Net worth evolution

$$n_{t+1} = \rho_{L,t+1} EQ_{L,t} + \rho_{EX,t+1} EQ_{EX,t}$$

Bankers

- Value function:

$$V_{B,t} = \nu_t n_t$$

- Dividends are zero when bank capital is scarce and $\nu_t > 1$

- First order condition

$$\mathbb{E}_t \left[\Lambda_{t+1} \left(1 - \theta_b + \theta_b \nu_{t+1} \right) \left(\rho_{L,t+1} - \rho_{EX,t+1} \right) \right] = 0$$

- Value of net worth

$$\nu_t = \mathbb{E}_t \left[\Lambda_{t+1} \left(1 - \theta_b + \theta_b \nu_{t+1} \right) \rho_{L,t+1} \right]$$

Model: First order conditions

$$1 = \mathbb{E}_t \left[\Lambda_{H,t+1} R_{t+1} \right] \frac{1}{1 + X_t}, \tag{2}$$

$$1 = \mathbb{E}_t \left[\Lambda_{H,t+1} \tilde{R}_{D,t+1} \right], \tag{4}$$

$$W_t = \varphi L_t^{\eta} C_t, \tag{6}$$

where we define the real stochastic discount factor

$$\Lambda_{H,t} = \beta_t \frac{C_{t-1}}{C_t}. \tag{8}$$

Model: Bankers

- Local banks: bankers in each country provide equity funding for banks
- Net worth evolution

$$N_t = [\theta_B + \xi(1-\theta_B)]\rho_t N_{t-1}, \tag{9}$$

(10)

- Transfers back to the household in each country

$$T_B = (1-\theta_B)(1-\xi)\rho_t N_{t-1} \tag{11}$$

(12)

- Charter value of banker net worth

$$\nu_t = \mathbb{E}_t \left[\Lambda_{B,t+1}\rho_{t+1}\right], \tag{13}$$

where

$$\Lambda_{B,t} = \Lambda_{H,t}(1-\theta_B+\theta_B\nu_t) \tag{14}$$

Model Variant 1: MU-wide DI

Deposit insurance costs shared between Home and Foreign

$$T_G = \mathcal{S} T_G^{MU} \tag{15}$$

$$T_G^* = \frac{1-\mathcal{S}}{\mathcal{S}} RER_t^* T_G \tag{16}$$

Model parameters

Baseline Calibration

Parameter	Notation	Value	Calibration
PREFERENCES			
Discount Factor	β	0.9942	Calibrated
Frish Elasticity	η	1	Preset
Dis-Utility Labour	φ	1	Preset
Portfolio Adjustment Costs	$\varkappa_X$	1	Preset
TECHNOLOGY			
Capital Share	α	0.3	Preset
Depreciation	δ	0.03	Preset
Capital Adjustment Cost	ψ	2	Preset
Capital Service Cost	ζ	0.00022	Calibrated

Model parameters (2)

Baseline Calibration

Parameter	Notation	Value	Calibration
FINANCIAL			
Bank Survival	θ_B	0.9098	Calibrated
Start-Up Funding	ξ	0.8075	Calibrated
SS Capital Requirement	ϕ_{ss}	0.08	Calibrated
Default Costs	μ	0.3	Preset
SS IID Risk	$\sigma_{B,ss}$	0.0286	Calibrated
INTERNATIONAL			
Trade Elasticity	γ	2	Preset
Home Bias	χ	0.7	Preset
Home Bias for Capital	χ_K	0.92	Calibrated
STEADY STATES			
Net Foreign Assets	B_{ss}	0	Preset
Inflation	Π^*_{ss}	1.0044	Calibrated