Bank Runs, Prudential Tools and Social Welfare in a Global Game General Equilibrium Model

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Financial crises: predictability, causes and consequences

The views expressed in this presentation are those of the author and should not be interpreted as those of the Bank of England or the Bank of Japan

Need a simple model of prudential tools

- 10 years since the crisis
- Recovery phase is over
- Evaluation phase of Basel III
- We are looking for a simple model
- Three essential ingredients:
  1. Systemic risk event
  2. Financial system resilience
  3. Sources of inefficiencies

Bank runs as a systemic risk event

- Most of the crises feature bank runs (Gorton 2012)
- Bank runs include 'market' runs

What I did

- Developed a two-period general equilibrium model that features
  1. Bank runs in a global game framework (systemic risk event)
  2. Endogenous probability of bank runs (banking system resilience)
  3. Some sources of inefficiencies
- Conducted welfare analyses and studied prudential instruments:
  - Leverage restriction (capital requirement)
  - Liquidity requirement
  - Bank-specific/sectoral capital requirement
  - Restriction on concentration risk

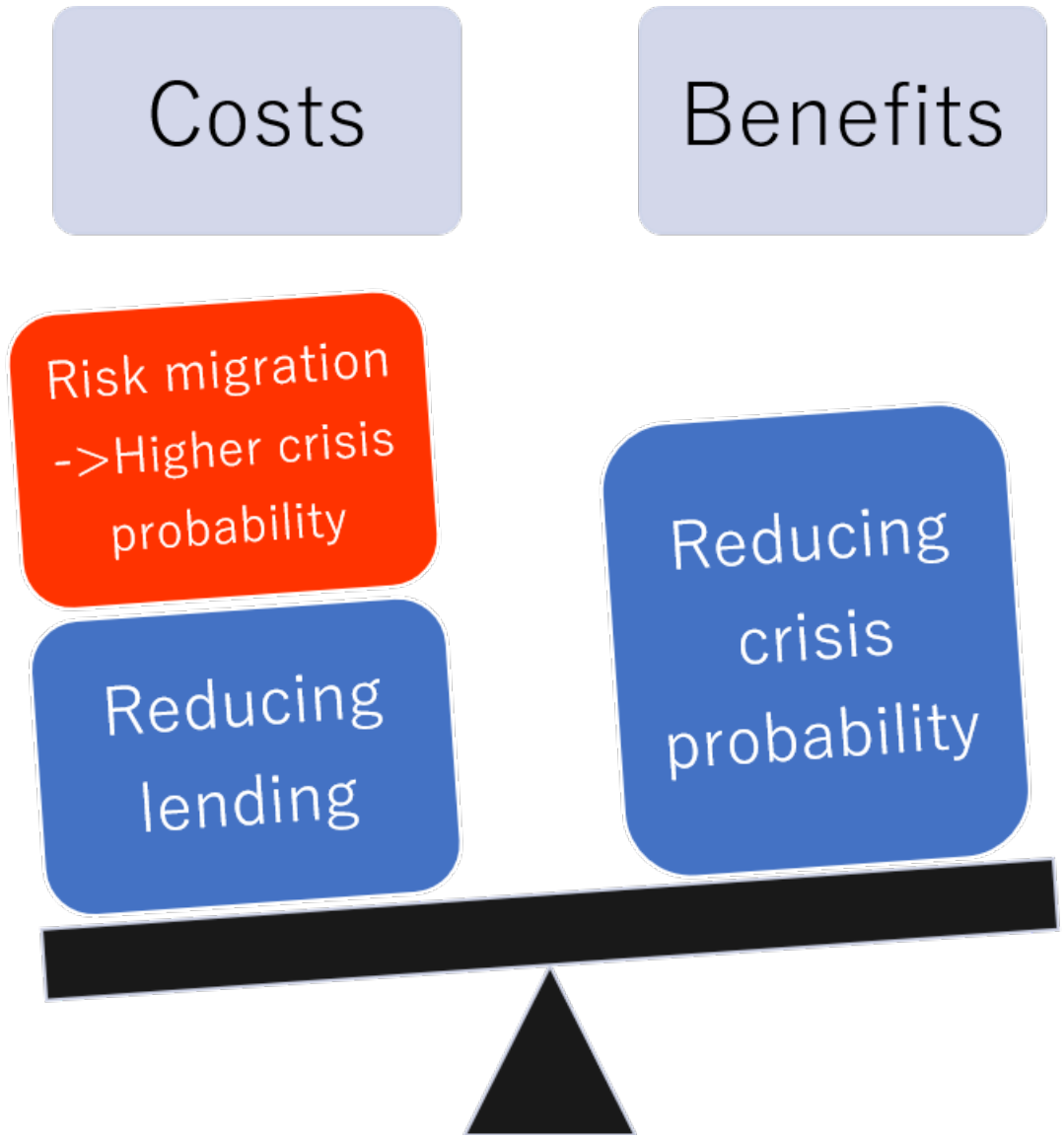
Main results

1. Excessive bank leverage and insufficient liquidity

   $\Longrightarrow$ Too high systemic risk

2. Two sources of inefficiencies
   1. Risk shifting (Jensen and Meckling 1976)
   2. Pecuniary externalities (Christiano and Ikeda 2016)
3. Multiple tools needed; risk migration
4. General equilibrium effect: which tool is more effective?
5. Applications
   - Bank-specific/sectoral capital requirements and risk weights
   - Concentration risk
   - Deposit insurance

Single takeaway: **risk migration**



Related literature

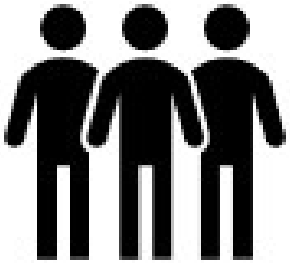
- Global game bank run models
  - **Rochet and Vives (2004)**
  - Goldstein and Pauzner (2005)
- A two-period general equilibrium model with financial frictions
  - **Christiano and Ikeda (2013, 2016)**
- Closely related papers
  - Kashyap et al. (2017); Vives (2014); Kara and Ozsoy (2016)
  - Allen and Gale (2017)
    'The literature on liquidity regulation is still at an early stage.'

Road map

1. Model with leverage and liquidity
2. Main results
   - Excessive leverage and insufficient liquidity
   - Sources of inefficiencies
3. Applications
   - Bank-specific/sectoral capital requirements
   - Concentration risk
4. Preliminary result on the dynamic model

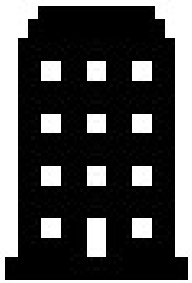
The two-period model: Overview

Households



- Consume
- Save

Banks

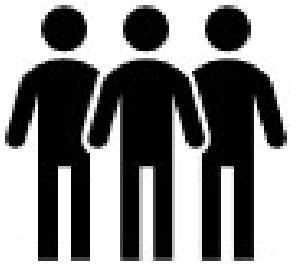


- Take in deposits
- Risky lending

Fund managers

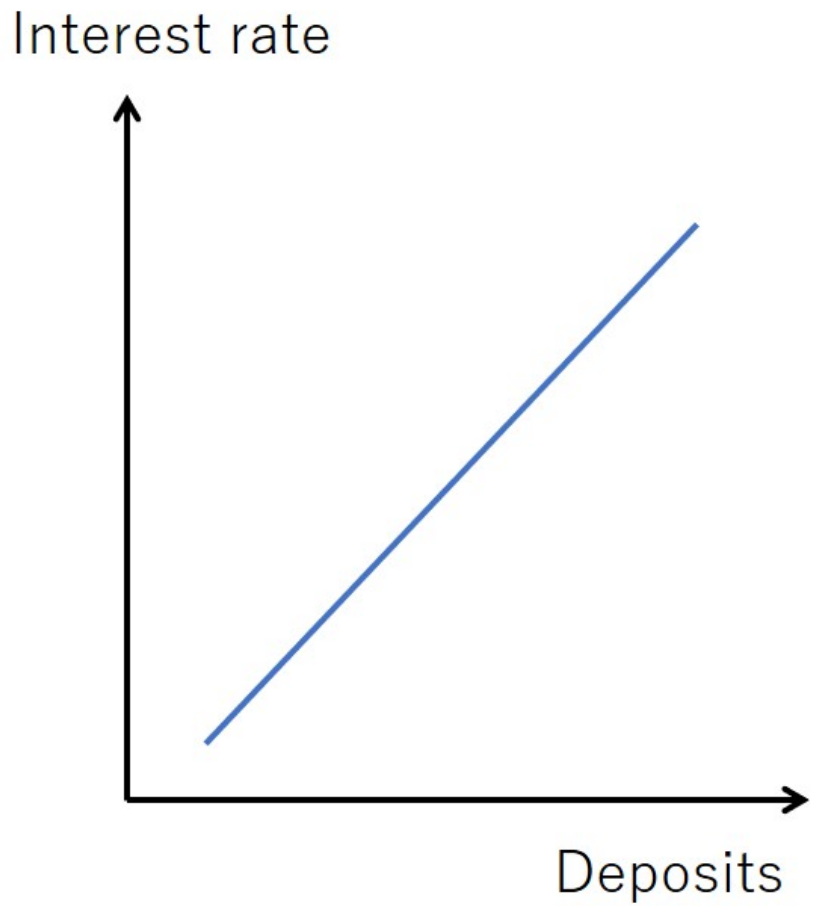
- Decide run or not
- Have private info

Households



- Price taker
- Exogenous income
- Utility over consumption in periods 1 and 2
- Deposit contract
- Aware of bank default risk
- Owner of banks

Supply curve of funds



Households: analytical expression

$$\max_{\{c_1,c_2,d\}} u(c_1) + \mathbb{E}(c_2),$$

s.t.

$$c_1 + d \leq y, \qquad c_2 \leq vRd + \pi,$$

where

$$v = \begin{cases} 1 & \text{with prob. } 1-P \text{ (no bank default)} \\ < 1 & \text{with prob. } P \text{ (bank default)} \end{cases}$$

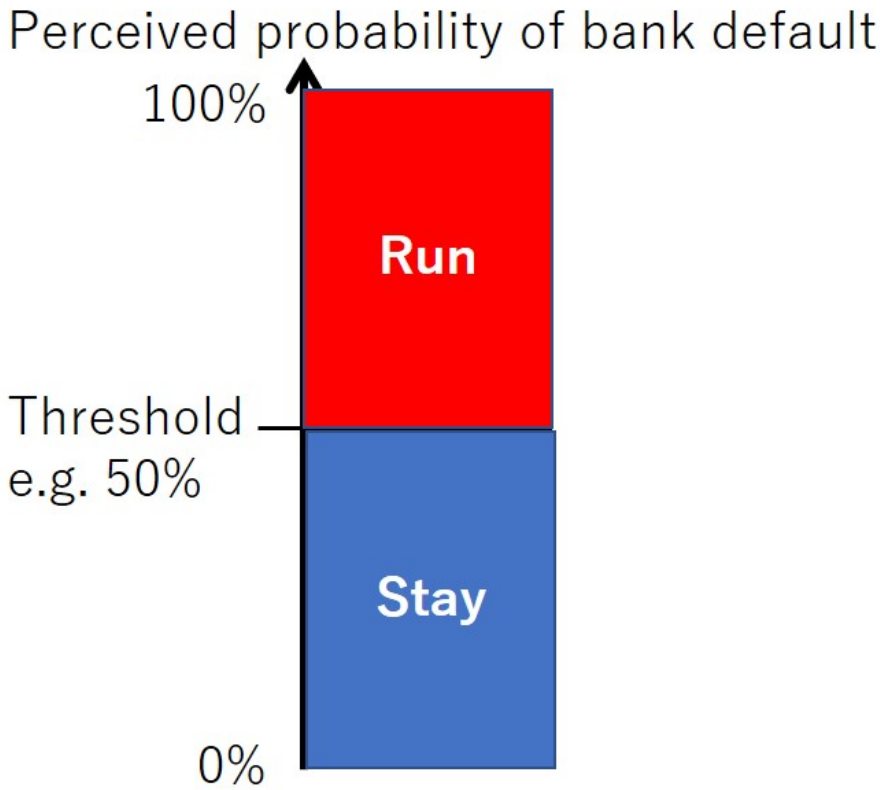
Solution: supply curve of funds:

$$R = \frac{u'(y-d)}{1 - P + \mathbb{E}(v|\text{default})P}$$

Fund managers

- Risk neutral
- Private info about bank return (normally distributed)
- Decide run or not
- Payoff is exogenous
- Rewarded if 'right' decision

Fund managers' behaviour

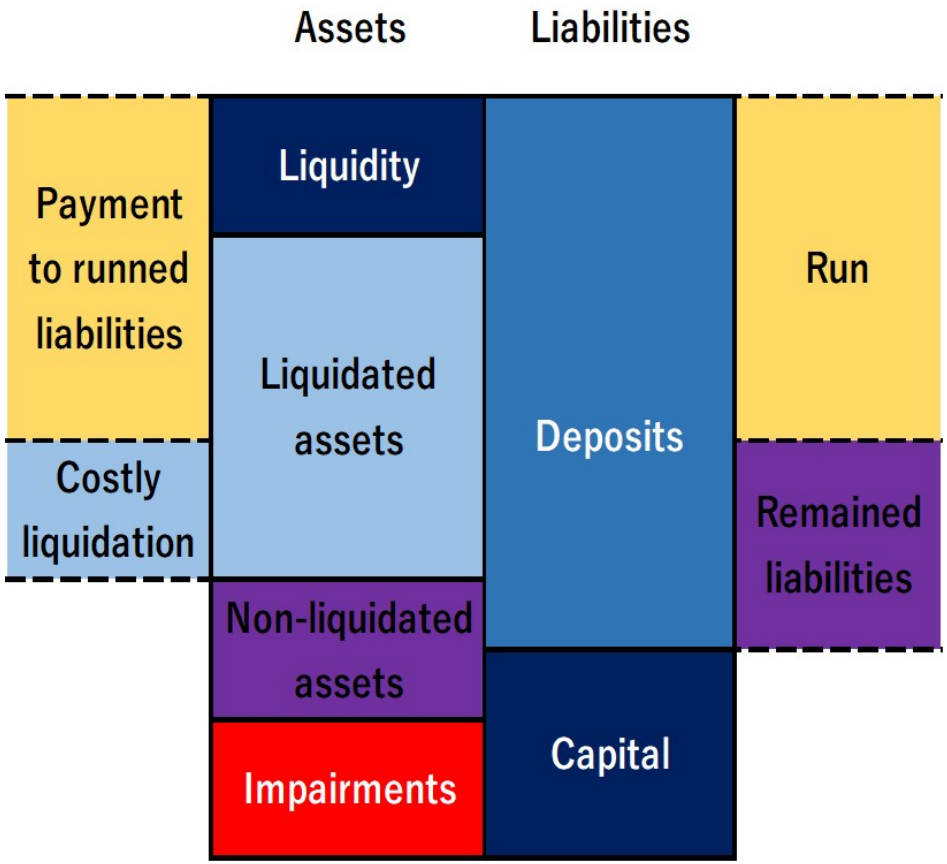


How do they form perceived probability of bank default?

Perceived prob is high when:

- Private info is bad
- More fund managers run
- Costly early liquidation
- Bank is risky
  - High leverage
  - Low liquidity
- High interest rate

Liquidity crisis



Fund managers' strategy

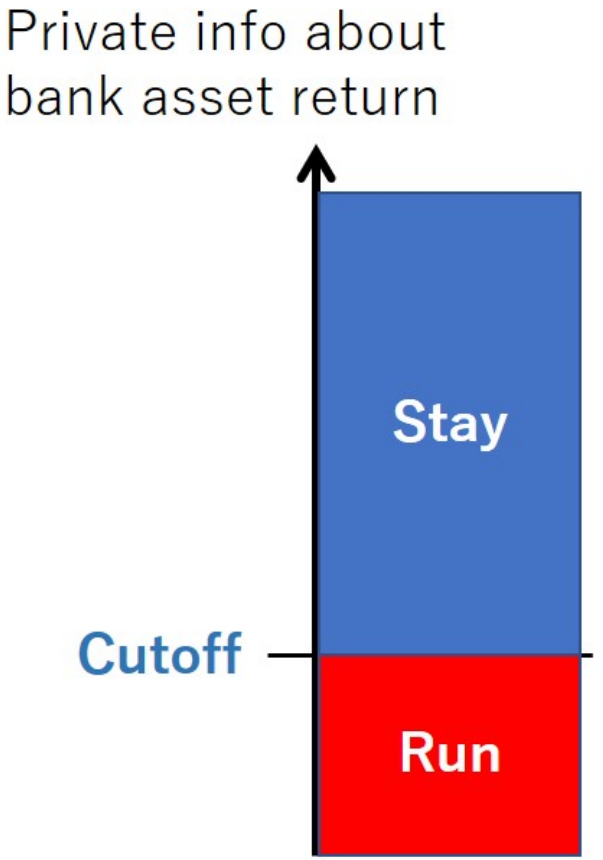
Cutoff is increasing in:

- Leverage
- Interest rate
- Cost of early liquidation

Cutoff is decreasing in:

- Liquidity

Equilibrium strategy



Fund managers: analytical expression (leverage only)

- Withdraw iff $P_i > \gamma$
- R^k = bank return; L = leverage; x = # of fund managers who run
- Threshold strategy: withdraw if private info $s_i < \bar{s}$
- Equilibrium threshold $\bar{s} = \bar{s}^*$:

$$Pr(R^k < R^{k*} | \bar{s}^*) = \gamma,$$

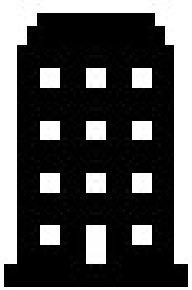
$$R^{k*} = R\left(1 - \frac{1}{L}\right)\left[1 + \lambda x(R^{k*}, \bar{s}^*)\right],$$

$$x(R^{k*}, \bar{s}^*) = Pr(\underbrace{R^{k*} + \epsilon_i}_{=s_i} < \bar{s}^*)$$

- Limit case in which private info becomes infinitely accurate:

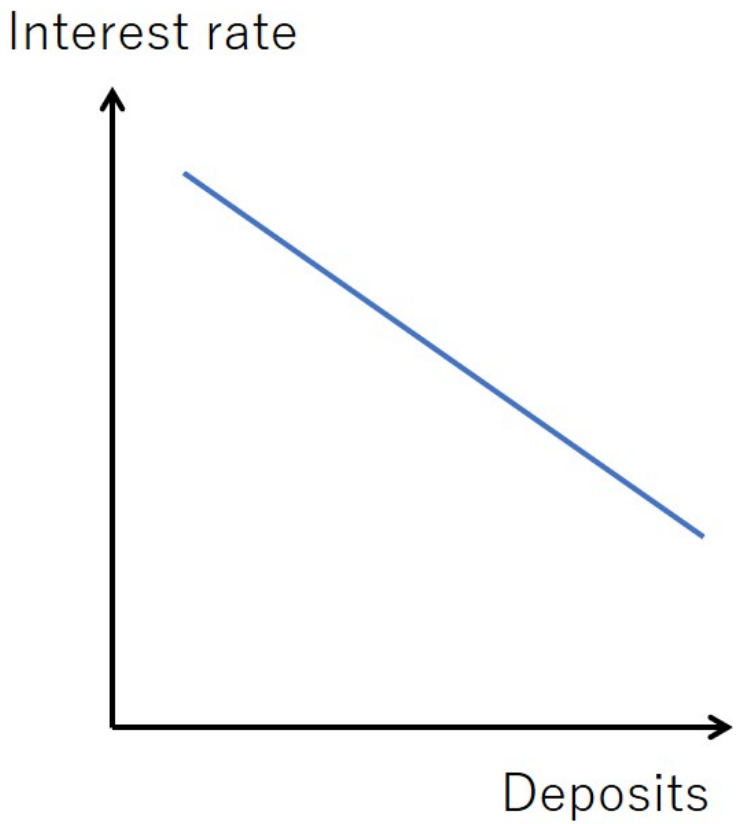
$$\bar{s}^* = R^{k*} = R\left(1 - \frac{1}{L}\right)[1 + \lambda(1 - \gamma)]$$

Banks



- Exogenous bank capital
- Cannot commit to their actions
- Market signal: interest rate only
- Tradeoff: higher leverage
  - Higher return on equity
  - Higher default probability
- Tradeoff: more liquidity
  - Lower return on bank assets
  - Lower default probability

Demand curve for funds



Banks: analytical expression (leverage only)

- Bank defaults iff $R^k < R^{k*}$
- Deposits $d = (L-1)n$, where n is bank capital
- Bank's problem:

$$\mathbb{E}(\pi) = \max_{\{L\}} \int_{R^{k*}(L)}^{\infty} \left\{ R^k L - R\left[1 + \lambda x\left(R^k, \bar{s}^*(L)\right)\right](L-1) \right\} n dF(R^k).$$

- Optimality condition:

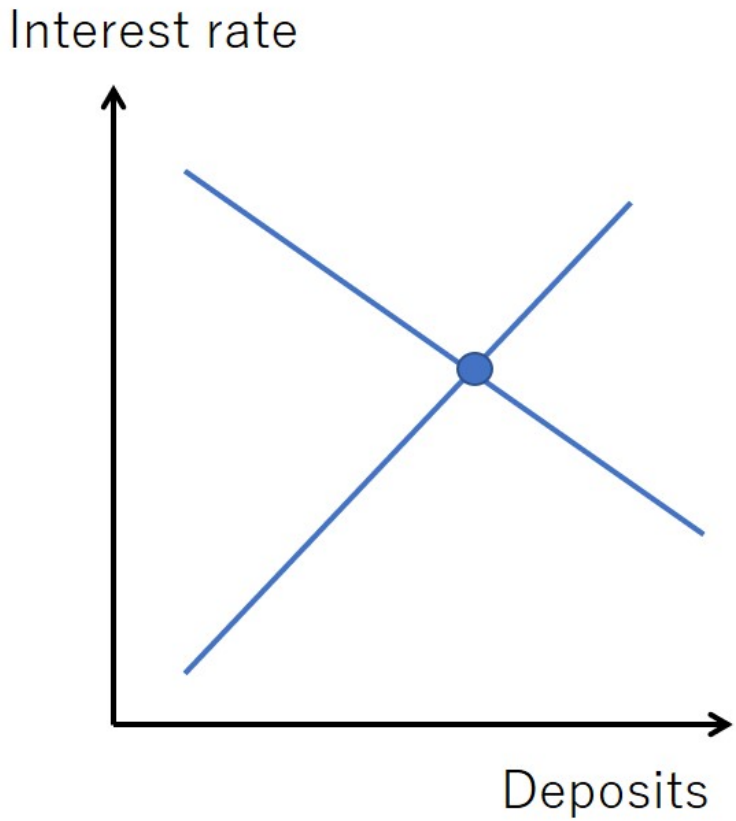
$$0 = \int_{R^{k*}}^{\infty} (R^k - R) dF(R^k) - R\lambda \int_{R^{k*}}^{\infty} x\left(R^k, \bar{s}^*(L)\right) dF(R^k),$$
$$-R\lambda(L-1) \int_{R^{k*}}^{\infty} \frac{\partial x\left(R^k, \bar{s}^*\right)}{\partial \bar{s}^*} \frac{\partial \bar{s}^*(L)}{\partial L} dF(R^k)$$

Competitive equilibrium

Endogenous variables

- Consumption in period 1, 2
- Deposits
- Leverage
- Liquid asset holdings
- Interest rate
- Recovery rate
- **Systemic risk**

Demand and supply curve for funds



Market clearing:
Deposits = (Leverage - 1)×capital

Competitive equilibrium: analytical expression (leverage only)

- Household optimality condition:

$$R = \frac{u'(y-(L-1)n)}{1-P+\mathbb{E}(v|\text{default})P}$$

- Bank optimality condition:

$$0 = \int_{R^{k*}}^{\infty}(R^k - R)dF(R^k) - R\lambda\int_{R^{k*}}^{\infty} x\left(R^k, \bar{s}^*(L)\right)dF(R^k),$$
$$-R\lambda(L-1)\int_{R^{k*}}^{\infty}\frac{\partial x\left(R^k,\bar{s}^*\right)}{\partial \bar{s}^*}\frac{\partial \bar{s}^*(L)}{\partial L}dF(R^k)$$

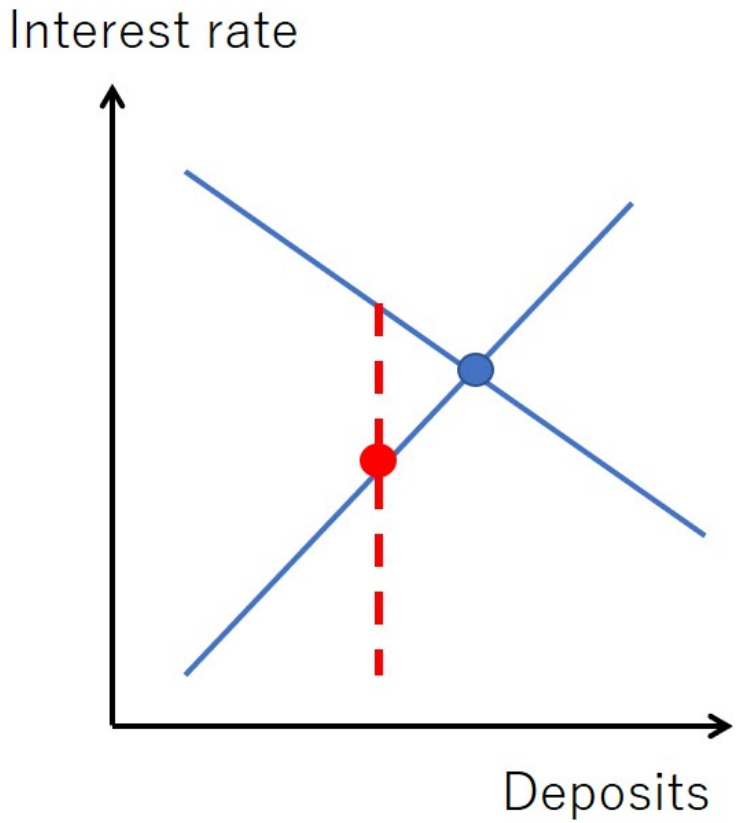
- Recovery rate

$$v = \min\left\{1, \max\left\{\frac{R^k}{R}\frac{L}{L-1} - \lambda x(R^k, \bar{s}^*), \frac{1}{1+\lambda}\frac{R^k}{R}\frac{L}{L-1}\right\}\right\}$$

Regulator's problem

- Leverage too high?
- Liquidity too low?
- Systemic risk too high?
- Improve social welfare?
- Sources of inefficiencies?

Leverage restriction



Regulator's problem: analytical expression

- Regulator sets leverage and liquidity (liquidity-deposit ratio)
- Otherwise, everything is the same as competitive equilibrium
- Regulator does so to maximize social welfare:

$$\max_{\{L,m\}} SW = u(c_1) + \mathbb{E}(c_2),$$

subject to

Household optimality conditions

Bank run risk (fund managers' behaviour)

Analytical result 1: Elevated systemic risk

Proposition

In a competitive equilibrium:

- *Leverage is excessive, given any choice of liquidity*
- *Liquidity is insufficient, given any choice of leverage*
- *Consequently, systemic risk is too high*

Policy implications

- Need leverage restriction
- Need liquidity requirement
- **Need both**

Analytical results 2: Sources of inefficiencies

Proposition

There are two sources of inefficiencies:

1. *Bank risk shifting: affects both leverage and liquidity*
2. *Pecuniary externalities: affect only leverage*

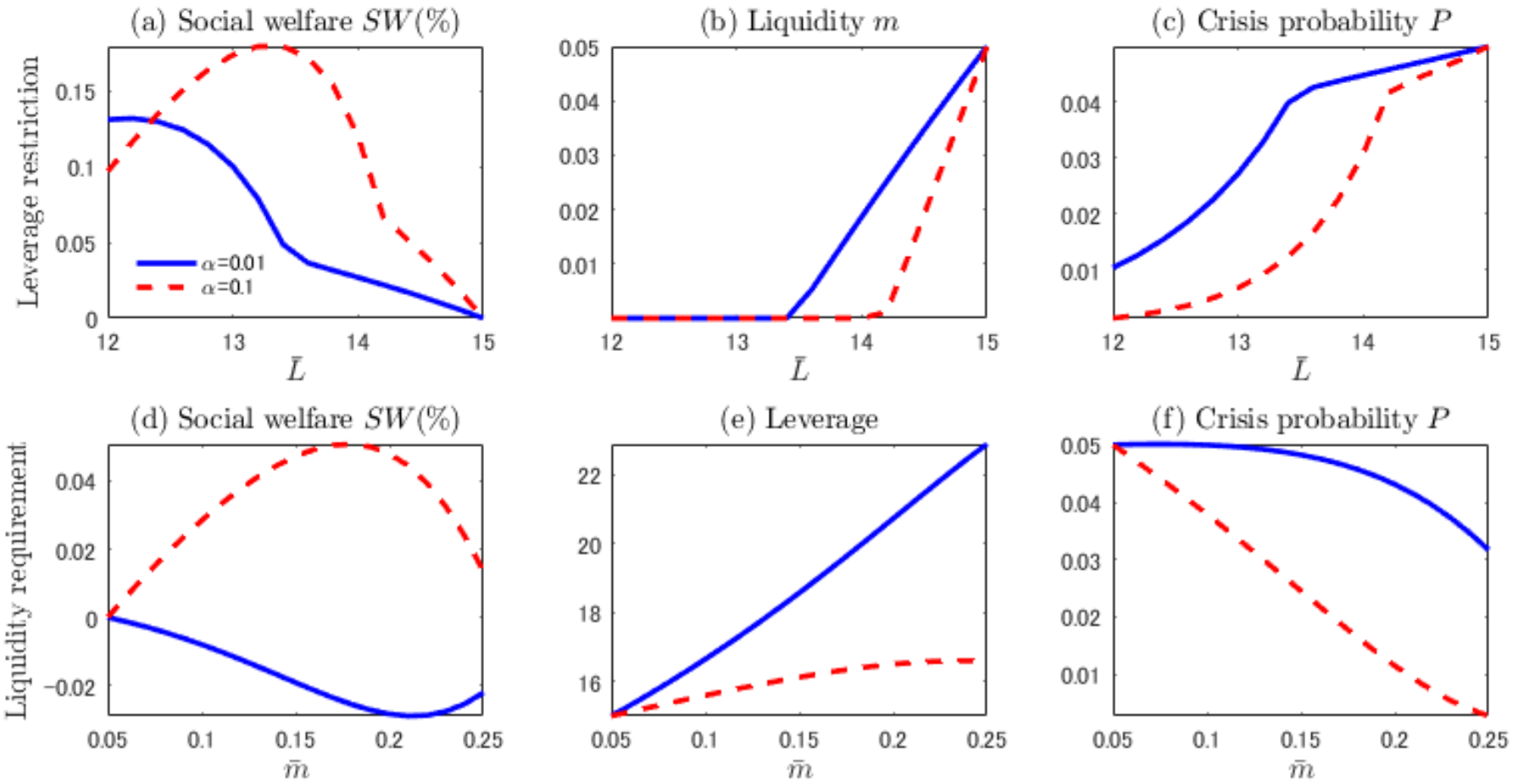
Intuition

1. Risk shifting: banks do not internalize their choice of riskiness (leverage and liquidity) on the (risky) interest rate
2. Pecuniary externalities: costs associated with bank runs depend on the (risk-neutral) interest rate (households' willingness to supply funds)

Parameterization for numerical analyses

- US banks 2008-2017 (Miller and Sowerbutts 2018)
- Target values
  - Leverage $= 15$
  - Liquidity ratio relative to deposits $= 5\%$
  - Crisis probability $= 5\%$ (BCBS 2010)
  - Deposit interest rate $= 2\%$
- Average bank asset return $= 3.5\%$ (after-taxed RoE $= 15\%$)
- Standard deviation of bank asset return $= 2.5\%$
- Supply curve of funds: relatively flat or steep

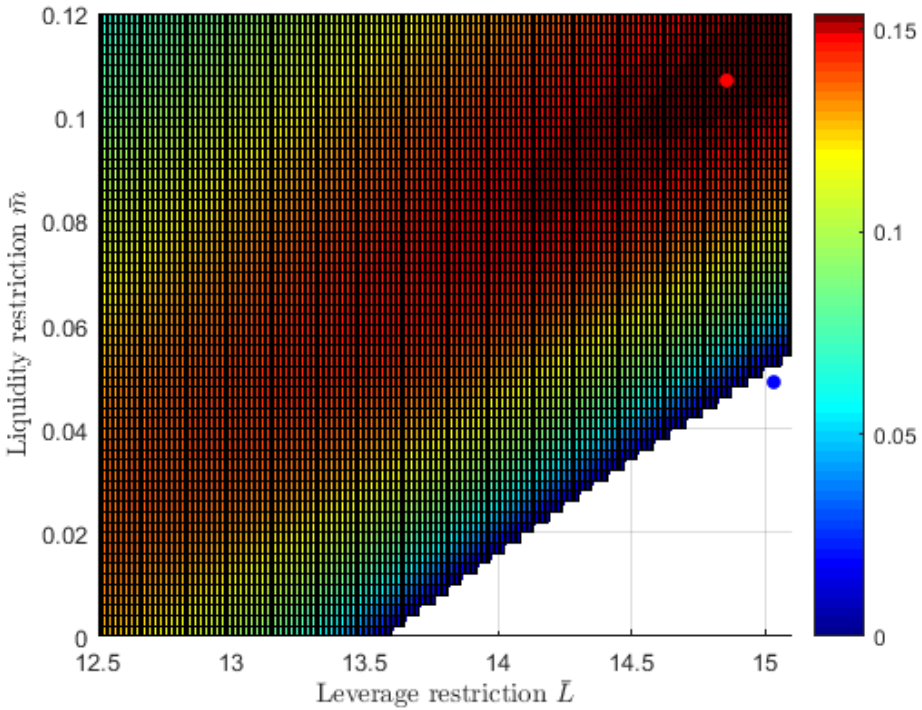
Risk migration: leverage or liquidity requirements only



- Risk migrates from one area to another
- Tightening liquidity requirement worsens welfare when the supply curve is relatively flat ($\alpha = 0.01$).

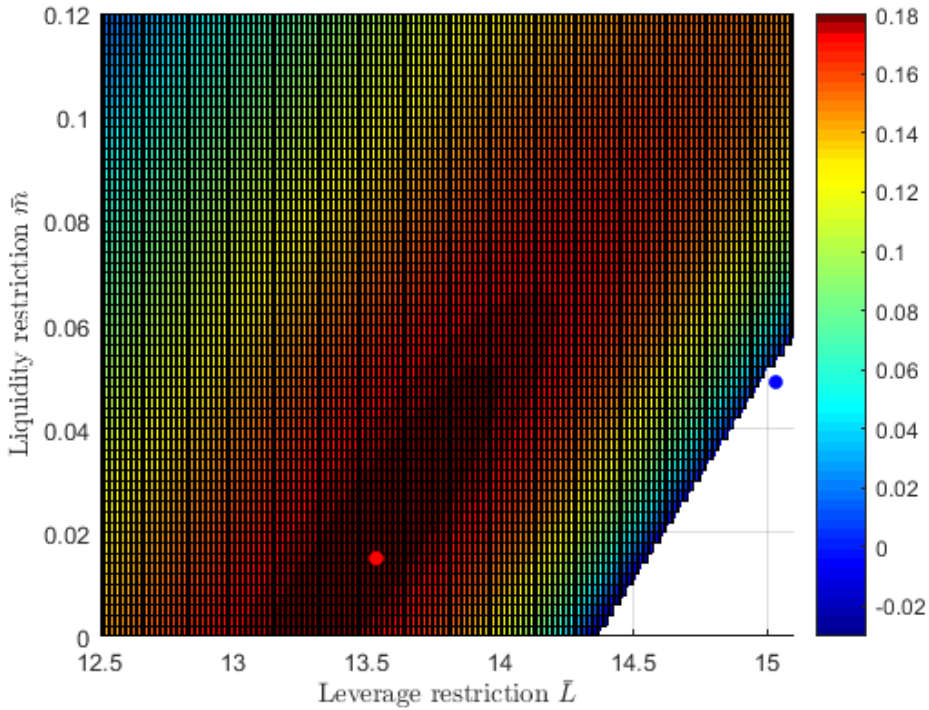
Joint effects of leverage and liquidity requirements on social welfare

$\alpha = 0.01$ (flat supply curve)



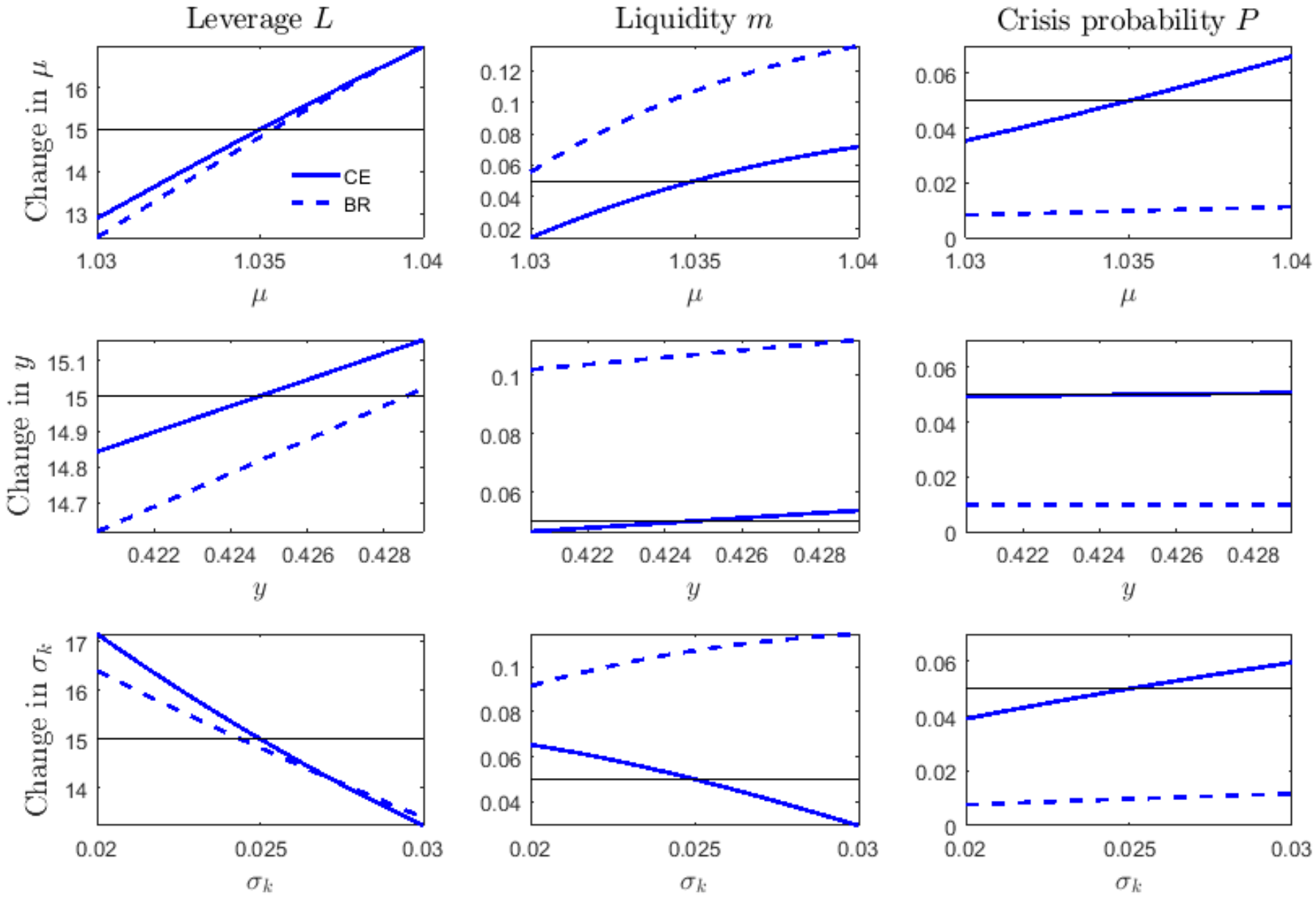
- Liquidity requirement is more tightened.

$\alpha = 0.1$ (steep supply curve)



- Leverage restriction is more tightened.

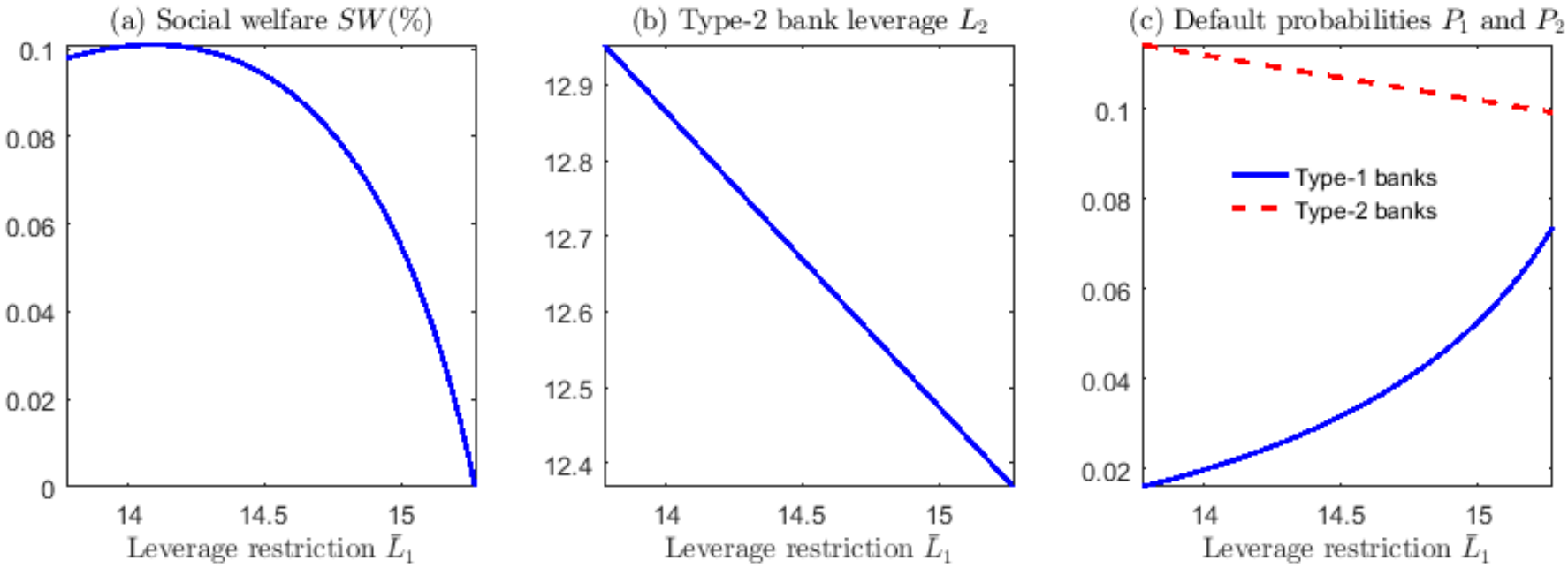
Comparative statics: constrained optimal allocation



Application 1: Regulated banks and shadow banks

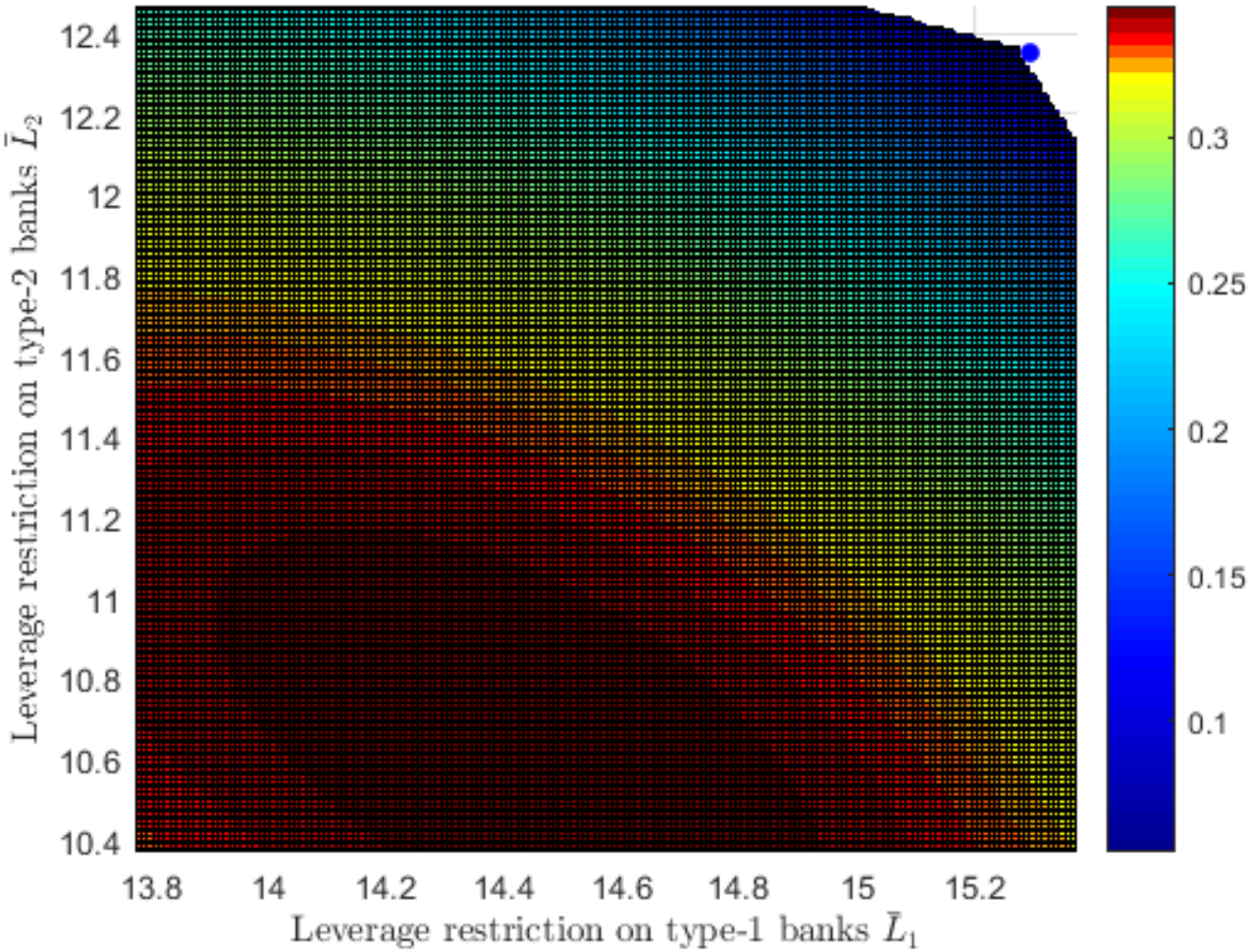
- Two types of banks; leverage choice only
- Type-j bank specializes in lending to sector $j \in \{1, 2\}$
- Sector 2 is risker than sector 1

Risk migration: leverage restriction on type-1 banks only



Application 1 (cont'd): Bank-specific/sectoral capital requirements

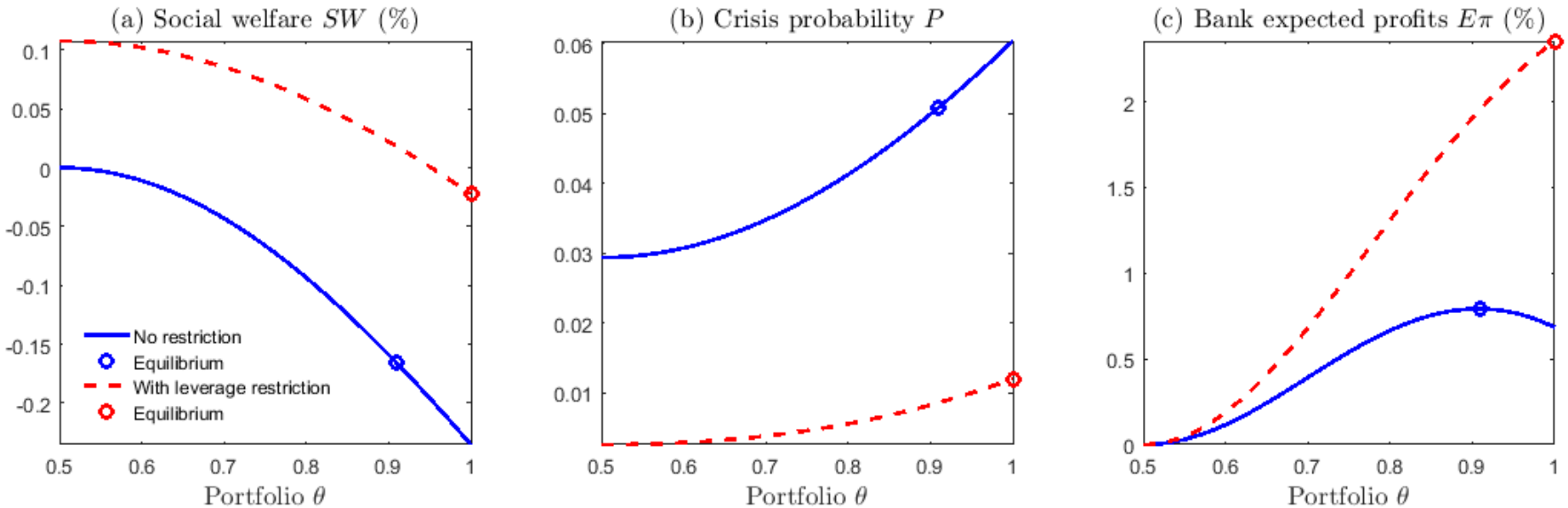
Joint effects of type-specific leverage restrictions



Application 2: Concentration risk

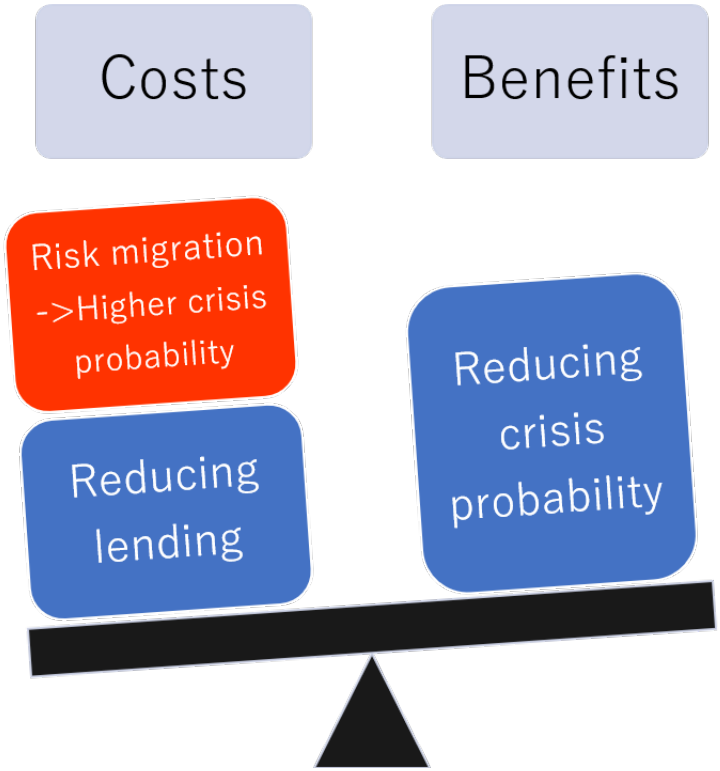
- One type of banks; leverage and portfolio choices
- Identical and independent two types of lending
- Portfolio $[0.5, 0.5]$ minimizes the riskiness of bank assets

Risk migration: leverage restriction and portfolio choice



Recap: Mind risk migration

- Leverage and liquidity
- Regulated banks and shadow banks
- Leverage and portfolio choice



Future work: dynamic model

- Endogenous bank capital, household income and bank asset return

Impulse responses to a severe TFP shock