# Bank Runs and Macroprudential Instruments in a Global Game General Equilibrium Model

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# Motivation: Two Basic Facts

1. Primary objective of macroprudential policy: aligning financial system resilience with systemic risk to promote the real economy
    - Systemic risk event
    - Financial system resilience
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    - Systemic risk event
    - Financial system resilience
    - Market failures
2. Bank runs as a typical symptom of financial crises in history
    - Gorton (2012)
    - Reinhart and Rogoff (2009)

# What I Did

- Developed a two-period general equilibrium model that features
  1. Bank runs (systemic event) in a global game framework
  2. Endogenous probability of bank runs (banking system resilience)
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- Developed a two-period general equilibrium model that features
  1. Bank runs (systemic event) in a global game framework
  2. Endogenous probability of bank runs (banking system resilience)
  3. Market failures?
- Conducted welfare analyses and studied macroprudential instruments:
  - Leverage restriction (capital requirement)
  - Liquidity requirement
  - Sectoral requirement

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2. Insufficient bank liquidity
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5. Sources of inefficiencies: limited liability + externality specific to a global game; pecuniary externaility
6. Applications
   - Sectoral capital requirements and risk weights
   - Risk taking
   - Deposit insurance

# Literature and Road Map

- Literature
  - Rochet and Vives (2004)
    - Diamond and Dybvig (1983)
    - Carlsson and Van Damme (1993); Morris and Shin (1998)
  - Christiano and Ikeda (2013, 2016)

# Literature and Road Map

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- Road map
  - Benchmark model with a bank leverage choice only
  - Role of leverage restrictions (capital requirements)
  - Extended model to incorporate a bank liquidity choice
  - Extension to study sectoral capital requirements
  - Example of risk-taking
  - Preliminary result on the dynamic model

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- Ownership: banks are owned by households

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6. ($t = 2$) Fund managers decide whether to withdraw deposits or not
7. ($t = 2$) Households receive interest and profits and consume $c_2$

# Households

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

s.t.

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

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: Action and Payoff

- Fund managers are risk neutral
- Payoff structure for fund manager $i \in (0,1)$:

$$\text{Net benefit of ``Withdraw'' over ``Not withdraw''} = \begin{cases} \Gamma_0 & \text{if bank defaults} \\ -\Gamma_1 & \text{if bank survives} \end{cases}$$

- Fund manager $i$ withdraws iff

$$\underbrace{P_i}_{\text{Prob. of bank default perceived by } i} > \frac{\Gamma_1}{\Gamma_0 + \Gamma_1} \equiv \gamma,$$

$\gamma$ is exogenously given

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- Let $L \equiv (n+d)/n$. In period $t = 2$, bank defaults iff

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- Limit solution $\sigma_\epsilon \to 0$:

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

# Bank's Problem

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- Bank's problem:

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

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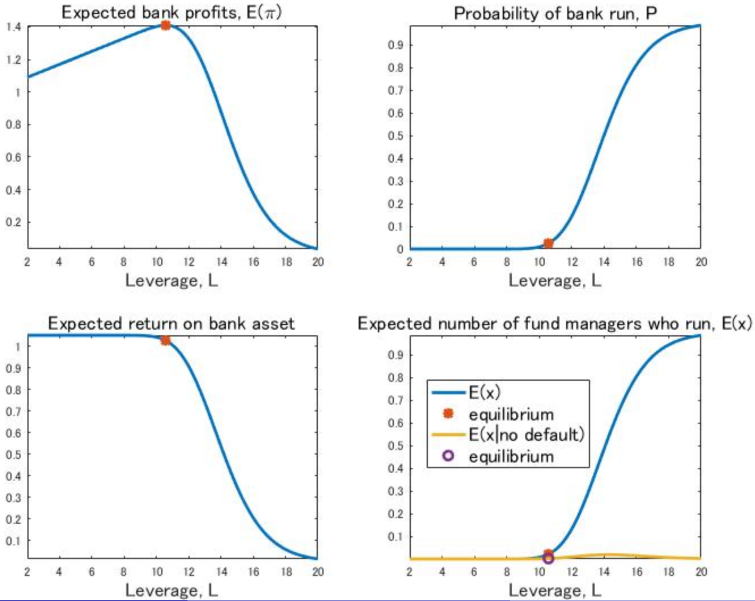
- Optimality condition:

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

# Bank's Problem, cont'd



# Competitive Equilibrium

- Bank optimality condition (limit case $\sigma_\epsilon \to 0$):

$$\int_{R^{k*}}^{\infty} R^k dF(R^k) = \left[1 - F\left(R^{k*}\right)\right] R + \lambda(1-\gamma) f\left(R^{k*}\right)[1 + \lambda(1-\gamma)] R^2 \frac{L-1}{L^2}$$

- Household optimality condition:

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

- Recovery rate

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

# Welfare Analysis

- Social planner problem:

$$\max_L SW = u(\bar{y} - (L-1)n) + \left[\mathbb{E}(R^k)L - \lambda\mathbb{E}(x)R(L-1)\right] n,$$

s.t.

$$\begin{aligned} \mathbb{E}(x) &\equiv \mathbb{E}[x(R^k, \bar{s}^*(L))], \\ R &= u'(y-d)/[1 - P + \mathbb{E}(v|\text{default})P] \end{aligned}$$

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- In the limit equilibrium $\sigma_\epsilon \to 0$:

$$SW = \underbrace{u(y - (L-1)n) + \mathbb{E}(R^k)Ln}_{\text{Benefit of financial intermediation}} - \underbrace{P \times \lambda R(L-1)n}_{\text{Cost of crisis}}$$

# Excessive Bank Leverage

**Proposition (Excessive leverage)**

*Suppose that the supply curve is upward sloping. Then, the bank leverage is excessive. Restricting bank leverage can improve social welfare.*

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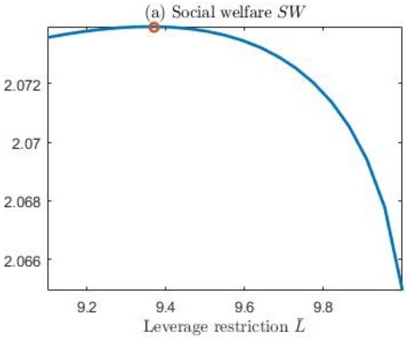
Intuition:

- Average cost of bank default is endogenised, but,
- Marginal effect (cost) of leverage is underestimated due to limited liability and the global game setup
- Default cost pecuniary externality

# Effects of Leverage Restrictions

Competitive equilibrium:

$$L = 10, \quad P = 5\%$$



# Extended Model with Leverage and Liquidity

- Banks have an access to safe asset technology with gross return 1
- Banks use safe assets in response to early withdrawals
- Trade-off: less return vs lower probability of bank runs
- Liquidity-deposit ratio $m \equiv M/d$

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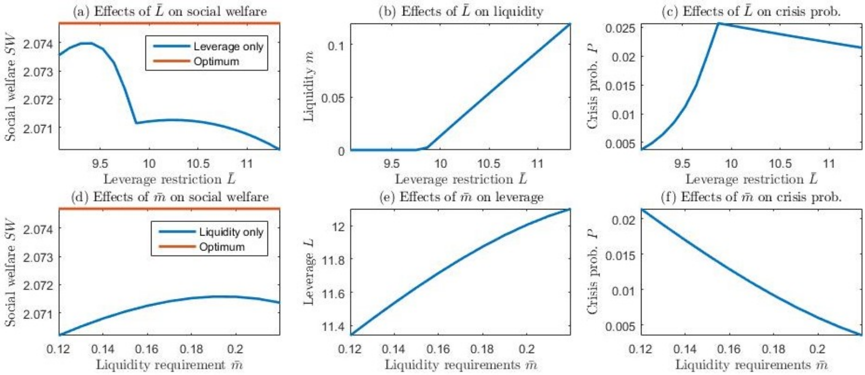
**Proposition (Excessive leverage and insufficient liquidity)**

- *Given bank liquidity, bank leverage is excessive*
- *Given bank leverage, bank liquidity is insufficient*

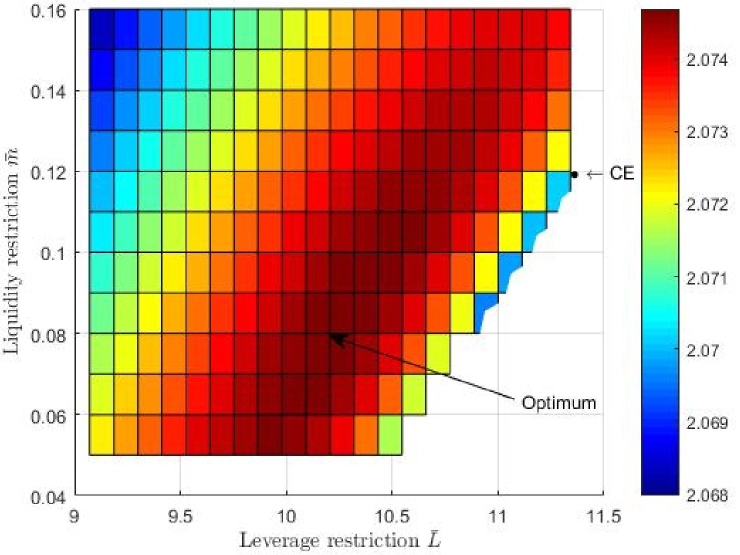
# Leverage or Liquidity Requirements Only: Risk Migration

Competitive equilibrium:

$$L = 11.3, \quad m = 0.12, \quad P = 2.2\%$$



# Joint Effects of Leverage and Liquidity Requirements

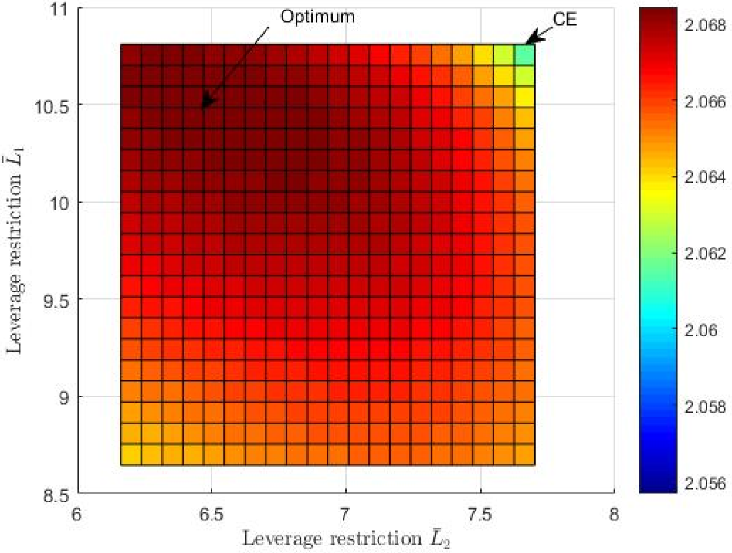


# Application 1: Sectoral Capital Requirements

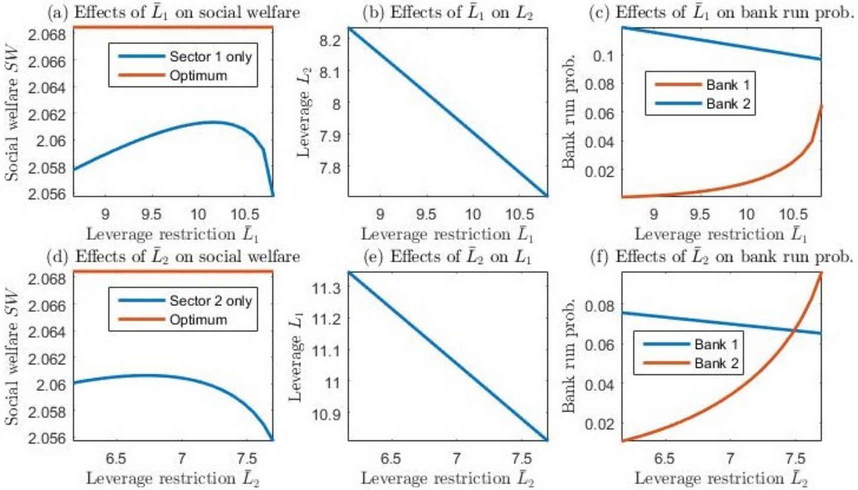
- Two sectors and two types of banks
- Type-$j$ bank specializes in lending to sector $j \in \{1, 2\}$
- Sector 2 is risker than sector 1
- Competitive equilibrium:

$$L_1 = 10.8, \quad P_1 = 6.5\%, \quad L_2 = 7.7, \quad P_2 = 9.6\%$$

# Effects of Sectoral Leverage Restrictions



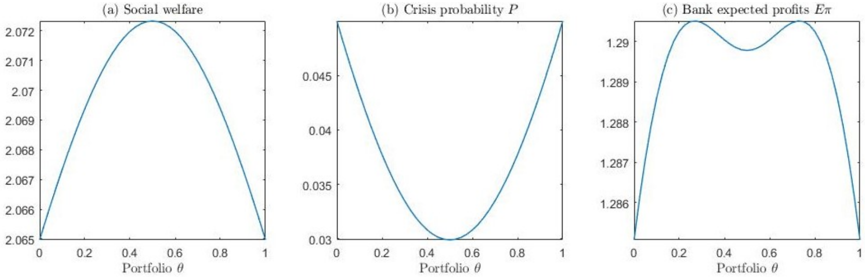
# Effects of Leverage Restrictions in One Sector Only



# Application 2: Risk Taking

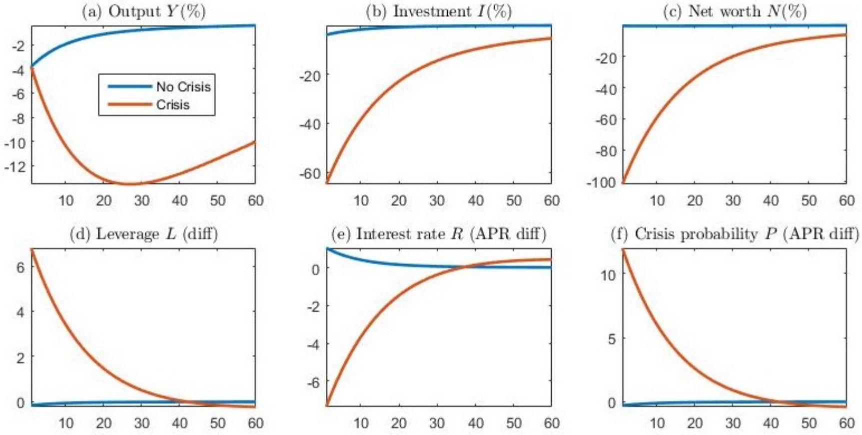
- One type of bank but two types of loans
- For simplicity, $R_j^k \sim N(\bar{R}^k, \sigma^2_{R^k})$ for $j \in \{1, 2\}$.
- Loan portfolio $[\theta, 1-\theta]$ on loans 1 and 2
- Portfolio $\theta = 1/2$ minimizes the risk (volatility) of bank loans
- Social optimum: $\theta = 1/2$. Do banks choose $\theta = 1/2$?

# Banks prefer a higher risk than the socially optimal level



# Bank Runs in an Infinite Horizon Model (work in progress)

Figure: Impulse responses to a severe negative TFP shock



# Conclusion and Future Research Agenda

- This model provides a unified framework for analysing banking crises, banks' behaviour and macroprudential policy

- Further research

  1. Ex-ante and ex-post policy coordination
  2. Dynamic model; dynamic properties of macroprudential policy
  3. Macroprudential policy and monetary policy