Regulatory Arbitrage and Systemic Liquidity Crises

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Motivation/research question

Regulatory arbitrage and the 2007-09 financial crisis

Linkages commercial banks ↔ shadow banks identified as source of fragility
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Regulatory response

- Restrictions on explicit and implicit linkages
  (Volcker Rule, Vickers, Liikanen)
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How does regulatory arbitrage contribute to financial fragility beyond contractual linkages?
Consumers (Depositors)

Commercial Bank

Liquid Assets

Illiquid Assets

Deposits

Illiquid Assets

Secured Wholesale Funding

Fragility!

Insured Deposits

Moral Hazard!

Equity

Fragility: Runs on Shadow Banks

Fire Sales

Cash-in-the-market-pricing

Contagion w/o contractual linkages

Deterioration of funding conditions
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Illiquid Assets

- Secured Wholesale Funding
- Fragility!
- Runs on Shadow Banks
- Cash-in-the-market pricing
- Contagion without contractual linkages
- Deterioration of funding conditions

Fragility!

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Secured Wholesale Funding
Consumers (Depositors)

Commercial Bank

<table>
<thead>
<tr>
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</tr>
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<tbody>
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<td></td>
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- Cash-in-the-market-pricing
- Contagion without contractual linkages
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Market Liquidity

Shadow Bank

- Illiquid Assets
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Quasi Deposits

Deterioration of funding conditions
Contagion w/o contractual linkages
Fire sales
Runs on Shadow Banks
Cash-in-the-market pricing

Insured Deposits

Moral Hazard!
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- Runs on Shadow Banks
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Contagion w/o contractual linkages

Fire Sales

Cash-in-the-market-pricing

Deterioration of funding conditions
Result 1

Contagion from shadow banking sector to commercial banking sector despite absence of contractual linkages

- If shadow banking sector is large, runs imply cash-in-the-market pricing
- As banks rely on similar sources of funding, fire sales induce deterioration of funding conditions
  ⇒ Despite absence of *classic* bank runs, banks may yet turn illiquid and insolvent
  ⇒ Deposit insurance scheme becomes tested, i.e., costly
- Post-crisis reforms of limited efficacy
CTMP and deterioration of funding conditions

![Graph showing the relationship between fire sale price/Funding conditions secured wholesale and size of the shadow banking sector.](#)
Equilibrium size of shadow banking sector too large

- Atomistic agents; don’t internalize impact of fire sale price (Lorenzoni 08)
  ⇒ Excessive regulatory arbitrage in equilibrium
  ⇒ Fire sale prices are too low
    - Shadow banks too unattractive
    - Deposit insurance scheme too costly
Result 3

Liquidity regulation may backfire

- Effective in shielding banks from turmoil originating outside banking sector
- Allocative inefficiency and growth of shadow banking sector
- Welfare effect unclear and depends on how deposit insurance is financed
- Basel III
Banking model of maturity transformation

Setup similar to Diamond & Dybvig 1983
- Three time periods, $t = 0, 1, 2$

Three types of agents:
- Consumers
- Intermediaries
- Investors
Setup: technologies

Productive technology
- maturity of two periods, return $R > 1$
- “illiquid”: liquidation return of $\ell \rightarrow 0$ in period 1

Shirking technology
- maturity of two periods, return $R_{\text{Shirk}}$
- “illiquid”: liquidation return of $\ell \rightarrow 0$ in period 1
- private return $B$
- inefficient: $R_{\text{Shirk}} + B < R$

Storage
- “liquid”
Setup: consumers

Continuum of consumers, initial endowment of 1 unit

- A fraction $\pi$ is *impatient*, utility $u(c_1)$
- A fraction $1 - \pi$ is *patient*, utility $u(c_2)$

Types are initially unknown, privately revealed in $t = 1$

CRRA baseline utility: $u(c) = \frac{1}{1-\eta} c^{1-\eta}$, with $\eta > 1$

Objective: Maximize consumers’ welfare
Setup: intermediaries

Continuum of intermediaries, no market power
- Endowment that may be invested in intermediation
- Required return $\rho > R$

Investment in technologies, revealed in $t = 1$

Intermediaries offer demand-deposit contract $(c_1, c_2)$
Setup: investors

Continuum of investors, competitive

“Market liquidity”: Endowment $A$ in period 1
- Required rate of return $\gamma \in [1, R]$

Secured wholesale funding
- Asset purchases/collateralized lending
- Willingness to pay for assets is $R/\gamma$
- “Price of market liquidity”: $p \leq R/\gamma$
First-best program

No use of equity: \( e_0 = e_2 = 0 \)

\[
\begin{align*}
\text{max} \quad & \pi u(c_1) + (1 - \pi) u(c_2), \\
\text{subject to} \quad & \pi c_1 = (1 - I) + LR/\gamma, \\
& (1 - \pi) c_2 = (I - L) R, \\
& I \leq 1, \\
& p \leq R/\gamma, \quad \text{(IR Investors)} \\
& pL \leq A. \quad \text{(Budget Investors)}
\end{align*}
\]

Assumption

\[
A \geq \xi \equiv \pi \gamma^{-\frac{1}{n}} \frac{R}{(1 - \pi) + \pi \gamma^{1 - \frac{1}{n}}}
\]
First-best allocation

**Lemma**

The first-best allocation is characterized as follows

- **Investment**: \( l^* = 1 \), no storage
- **Secured wholesale funding**: \( L^* < 1 \) at price \( p = R/\gamma \)
- **FOC**: \( u'(c_1^*) = \gamma u'(c_2^*) \) and consumption allocation:

\[
c_1^* = \gamma^{\frac{1}{\eta}} \frac{R}{(1 - \pi) + \pi \gamma^{1 - \frac{1}{\eta}}} \quad \text{and} \quad c_2^* = \frac{R}{(1 - \pi) + \pi \gamma^{1 - \frac{1}{\eta}}}.\]

- **Risk sharing**: \( c_1^* \geq R/\gamma \)
Implementation

Proposition

*Intermediaries can implement the first-best allocation by offering a demand-deposit contract \((c_1^*, c_2^*)\)*

- Intermediary uses market liquidity to pay out early consumers
- IC condition of consumers is satisfied
- Short-term debt is disciplining
Lemma

Assume that intermediaries choose the first-best investment level and demand-deposit contract.

- There exists a Nash equilibrium in the period-1 subgame in which there is a run on some intermediary $i$,
- inducing a complete asset sale and immediate illiquidity and insolvency of this intermediary.
- In particular, there exists an equilibrium in which there is a run on all intermediaries.
Systemic fragility

Proposition

Assume that \( A < \frac{R}{\gamma} \), and assume that intermediaries choose the first-best investment level and demand-deposit contract.

- There exist “systemic runs”, i.e., an economy-wide runs in the period-1 subgame
- which lead to cash-in-the-market pricing
- and thus a deterioration of overall funding conditions.
Key mechanism: Cash-in-the-market pricing

\[ \frac{R}{\gamma} \]

\[ A \]

\[ L^* \quad A\gamma/R \quad I^* = 1 \]

\[ L: \text{Assets on the market} \]
Deposit insurance and moral hazard

Fragility (bank runs) can be eliminated by a safety net/deposit insurance

E.g., a credible promise by government that a bank customer will receive \((c_1^b, c_2^b)\) at any contingency

But: “disciplining effect” of short-term debt is lost
- Insured depositors do not care
- Intermediaries have an incentive to shirk, private benefit \(B\)

Equity regulation becomes necessary (“skin in the game”)
Optimal regulation

Incentive Compatibility: \( e_2 \geq (1 + e_0)B \)

Participation Constraint: \( e_2 \geq \rho e_0 \)

Optimal equity requirement of \( e_0 \geq \frac{B}{\rho - B} \)
Second-best program

\[
\begin{align*}
\text{max } & \pi u(c_1) + (1 - \pi) u(c_2), \\
\text{subject to } & \pi c_1 \leq (1 - l) + Lp, \\
& (1 - \pi) c_2 \leq (l - L)R - e_2, \\
& l \leq 1 + e_0, \\
& e_0 \geq \frac{B}{\rho - B}, \\
& e_2 \geq \rho e_0, \\
& p \leq \frac{R}{\gamma}, \quad \text{(IR Investors)} \\
& pL \leq A. \quad \text{(Budget Investors)}
\end{align*}
\]
Lemma

Assume that demand deposits are protected by a credible deposit insurance.

- Optimal bank regulation requires intermediaries to satisfy an equity-to-debt ratio of $B/(\rho - B)$
- There exists no run equilibrium in the period-1 subgame
- Consumption is given by

$$c_1^{**} = \gamma^{-\frac{1}{\eta}} \frac{R - \frac{B}{\rho - B}(\rho - R)}{(1 - \pi) + \pi \gamma^{1-\frac{1}{\eta}}} < c_1^* \quad \text{and} \quad c_2^{**} = \frac{R - \frac{B}{\rho - B}(\rho - R)}{(1 - \pi) + \pi \gamma^{1-\frac{1}{\eta}}} < c_2^*.$$
Regulatory arbitrage: coexistence

Assume that intermediaries can place themselves outside the regulatory perimeter of banking

I.e., an intermediary can decided whether he wants to be regulated or not

Commercial banks offer second best, $(c_1^b, c_2^b) = (c_1^{**}, c_2^{**})$, insured

A shadow bank offer first best, $(c_1^{sb}, c_2^{sb}) = (c_1^*, c_2^*)$, uninsured
Let $\sigma \in [0, 1]$ denote the size of the shadow banking sector.

What happens in case of a run on shadow banks?

Is the run systemic? Cash-in-the-market pricing?

- Shadow banks sell all their assets
- At $p = \frac{R}{\gamma}$, they absorb liquidity $\sigma R / \gamma$
- Commercial banks need $(1 - \sigma) \pi c_1^{**}$
- Is the market liquidity $A$ sufficient?

**Proposition**

A run on shadow banks is systemic if $\sigma > \bar{\sigma}(A)$, i.e., if the shadow banking sector is larger than the threshold

$$\bar{\sigma}(A) = \frac{A - \pi c_1^{**}}{R/\gamma - \pi c_1^{**}}$$
Contagion mechanism: deterioration of funding conditions

Market Liquidity becomes scarce:
- Depressed asset prices, or
- Deteriorated conditions of wholesale funding

Fire sale price $p$

$R/\gamma$

$\bar{\sigma}(A)$

$\sigma$: Size of the shadow banking sector

$\bar{\sigma}(A)$

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Contagious runs

What happens in case of contagious runs?

- Bank customers will still get \((c_1^b, c_2^b)\)
- But: deterioration of funding condition will make safety net costly
- Against conventional wisdom
- Let \(DI(p(\sigma))\) denote the funds needed to finance the deposit insurance scheme:

\[
DI(\sigma) = (1-\sigma) \max \left[ (1-\pi)c_2^b + \pi c_1^{**} - p(\sigma), (1-\pi)c_1^b - (1 + e^* - \frac{\pi c_1^b}{p(\sigma)})R, 0 \right]
\]

- \(DI(\sigma)\) is increasing in \(\sigma\)
Sunspot runs

Without further assumptions $\sigma = 1$, as

$$(c_1^*, c_2^*) \succ (c_1^{**}, c_2^{**})$$

Assumption

*With probability $q$ agents coordinate on withdrawing from the shadow banking sector in $t = 1$.*

As in Cooper Ross 98, Gertler Kiyotaki 15

- Let $q$ denote the probability of a sunspot (coordination on run)
- In case of a systemic run, the payoff at a bank is $(c_1^b, c_2^b)$
- at a shadow bank:

$$(\tilde{c}_1^{sb}(\sigma), \tilde{c}_2^{sb}(\sigma)) = \begin{cases} (R/\gamma, R/\gamma) & \text{if } \sigma < \bar{\sigma} \\ (p(\sigma), p(\sigma)) & \text{otherwise.} \end{cases}$$
The expected utility for a bank customer and a shadow bank customer are:

\[ EU_b = U(c_1^b, c_2^b) \]

\[ EU_{sb}(\sigma) = (1 - q)U(c_1^*, c_2^*) + qU(\tilde{c}_1^{sb}(\sigma), \tilde{c}_2^{sb}(\sigma)) \]

The equilibrium size of the shadow banking sector is given by \( \sigma^* \) such that

\[ EU_b = EU_{sb}(\sigma^*) \]
The equilibrium size of the shadow banking sector

### Proposition

It holds that $\sigma^* > \bar{\sigma}$ if and only if $q \leq \bar{q}$, where

$$\bar{q} = \frac{U(c_1^*, c_2^*) - U(c_1^b, c_2^b)}{U(c_1^*, c_2^*) - U(R/\gamma)}.$$

Moreover, it holds that

$$\frac{\partial \sigma^*}{\partial \rho} > 0, \quad \text{and} \quad \frac{\partial \sigma^*}{\partial q} \leq 0.$$
Equilibrium size and sunspot probability
Social optimum

Assume the social planner chooses $\sigma^{SP}$ to solve the following problem:

$$\max_{\sigma} (1 - \sigma)EU_b + \sigma EU_{sb}(\sigma) - qDI(\sigma)$$

Proposition

*It holds that*

$$\sigma^* > \sigma^{SP}.$$  

The corresponding FOC implies that $\sigma^{SP}$ satisfies

$$\frac{EU_b}{EU_{sb}(\sigma)} = 1 + \frac{1}{EU_{sb}(\sigma)} \left[ \sigma qU_{\sigma}(\tilde{c}_{1}^{sb}(\sigma), \tilde{c}_{2}^{sb}(\sigma)) - qDI'(q) \right]$$

direct fire-sale effect

indirect safety net effect

Recall, in equilibrium:

$$\sigma^* : \frac{EU_b}{EU_{sb}(\sigma)} = 1$$

- As in Lorenzoni (2008), agents are atomistic and do no internalize impact of fire sale price
Restrictions on wholesale funding

- Assume regulated banks are required to provide liquidity via storage, $L = 0$

Proposition

- Wholesale funding restrictions shield regulated banks from adverse consequences of runs
- However, shadow banking sector grows, i.e.,
  \[ \sigma^r > \sigma^* > \sigma^{SP} \].

- Welfare: Lower utility in regulated banking sector and shadow banking sector
- However, $DI(p(\sigma)) = 0$
- Financing mechanism matters, complex trade-off
Liquidity Guarantees

Assume:
- Intermediaries can operate a shadow bank and a regulated bank
- Both idiosyncratic and sector-wide runs are possible

Privately optimal: Use a commercial bank to provide liquidity guarantees to a shadow bank
- Micro-Stability increases
- Elimination of individual runs on a shadow bank

But:
- Macro-Stability decreases
- Threshold for systemic runs decreases
- More systemic risk

Regulation has addressed this issue, but for a different reason
"chicken model"

**LOLR:**
- Eliminates panic-based runs in banking sector
- This implies $DI(\sigma) = 0$
- However, shadow banking sector grows further!

**MMLR**
- Eliminates panic-based runs in banking sector
- This also implies $DI(\sigma) = 0$
- Leads to further growth of shadow banking

Policy uncertainty