Motivation/research question

Regulatory arbitrage and the financial crisis of 2007-09

Linkages regulated banks ↔ shadow banks identified as source of fragility
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- “Volcker, Vickers, Liikanen”
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3. Policy implications
   - Macroprudential regulation, central bank interventions
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1  A banking model with systemic runs

2  Banks, shadow banks, and systemic liquidity crises

3  Policy implications
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1 A banking model with systemic runs

2 Banks, shadow banks, and systemic liquidity crises

3 Policy implications
Setup: primitives

Modified Diamond & Dybvig 83

- Three dates, $t = 0, 1, 2$
- One good, can be used for consumption and investment

Three types of agents:
- Depositors
- Intermediaries
- Investors

Three types of technologies
Setup: technologies

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<td>$R$</td>
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| Storage in $t = 0$ | -1 | 1 | 0 |
| Storage in $t = 1$ | 0  | -1 | 1 |
## Setup: technologies

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- **Storage in $t = 1$**: 0, -1, 1

- $R > 1 > R_{shirk} + B$
- $B$ not pledgeable
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- $R > 1 > R_{shirk} + B$
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Setup: depositors

Continuum of depositors, endowment of 1 unit each

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

- Types are initially unknown
- 1st key friction: privately revealed in $t = 1$
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- Expected utility $EU = U(c_1, c_2) = \pi u(c_1) + (1 - \pi) u(c_2)$
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Intermediary is required for investment
Setup: intermediaries

Continuum of intermediaries, competitive

- Endowment that may be invested in intermediation
- Required return $\rho > R$
  - skin-in-the-game costly
  - adverse selection, leverage-ratchet, non-pecuniary benefits, risk anomalies
Setup: investors

Continuum of investors, no market power

- Endowment $A$ at date $t = 1$, “market liquidity”
- Required rate of return $\mu \in [1, R]$

Assumption

$$\frac{R}{\mu} \geq A \geq \pi \frac{R}{\mu}$$

“market provides sufficient liquidity in normal times, but liquidity is scarce in crisis”
Setup: investors

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2nd key friction: investors born in $t = 0$ (Holmstrom and Tirole 1998)
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Disciplining short-term debt

Illiquid Investment Technologies
Depositors

Intermediaries

- Liquid Assets
- Illiquid Assets
- Demand Deposits

Illiquid Investment Technologies
Depositors

Intermediaries

Wholesale Funding Market

Illiquid Investment Technologies

Demand Deposits

Secured Wholesale Funding
Depositors

Intermediaries

Wholesale Funding Market

Secured Wholesale Funding

Demand Deposits

Illiquid Assets

Illiquid Investment Technologies
Bank runs and systemic runs

Intermediaries are financing illiquid asset by demand deposits \((c_1^*, c_2^*)\)

Mass of intermediaries that experience a run: \(\alpha \in [0, 1]\)

- \(c_i^* > R/\mu\): runs on single intermediaries always possible
Bank runs and systemic runs

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  - Systemic runs: runs on some intermediaries that affect other intermediaries
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**Proposition**

A run on \(\alpha\) intermediaries is systemic if \(\alpha > \tilde{\alpha}\), where

\[
\tilde{\alpha} = \frac{\Lambda - \pi c_1^*}{R/\mu - \pi c_1^*}.
\]
Bank runs and systemic runs

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**Proposition**

A run on \(\alpha\) intermediaries is systemic if \(\alpha > \bar{\alpha}\), where

\[
\bar{\alpha} = \frac{A - \pi c_1^*}{R/\mu - \pi c_1^*}.
\]
Systemic runs (‘‘proof’’)

$L$ units of the asset can be sold at $p = R/\mu$ (‘‘fundamental value’’) if

$$LR/\mu \leq A$$

Otherwise, the market clears via cash-in-the-market pricing (compare Allen and Gale 94)

Cash-in-the-market price is given by

$$p = A/L$$
Systemic runs ("proof")

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Systemic runs ("proof")

$\alpha$ intermediaries experience a run and sell all assets

$1 - \alpha$ intermediaries need to pay out $\pi c_1^*$ each

If $p = R/\mu$, the amount of assets sold in aggregate is:

$$\alpha + (1 - \alpha)\pi c_1^*/(R/\mu)$$
α intermediaries experience a run and sell all assets

1 − α intermediaries need to pay out πc₁* each

If \( p = R/\mu \), the amount of assets sold in aggregate is:

\[
\alpha + (1 - \alpha)\frac{\pi c_1}{(R/\mu)}
\]

Not compatible with \( p = R/\mu \) if:

\[
\frac{R}{\mu}[\alpha + (1 - \alpha)\frac{\pi c_1}{(R/\mu)}] > A
\]

\[
\alpha > \frac{A - \pi c_1}{R/\mu - \pi c_1} \equiv \bar{\alpha}
\]

Given our assumptions, \( \bar{\alpha} < 1 \)
Systemic runs ("proof")

\( \alpha \) intermediaries experience a run and sell all assets

1 – \( \alpha \) intermediaries need to pay out \( \pi c_1^* \) each

If \( p = R/\mu \), the amount of assets sold in aggregate is:

\[
\alpha + (1 - \alpha)\pi c_1^* / (R/\mu)
\]

Not compatible with \( p = R/\mu \) if:

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R/\mu [\alpha + (1 - \alpha)\pi c_1^* / (R/\mu)] > A
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$$\alpha > \frac{A - \pi c_1^*}{R/\mu - \pi c_1^*} \equiv \bar{\alpha}$$

Given our assumptions, $\bar{\alpha} < 1$
Systemic runs: an illustration

Market for Wholesale Funding

Consumers

Consumers

Consumers

Consumers

Consumers

Consumers

Consumers
Systemic runs: an illustration
Systemic runs: an illustration
Systemic runs: an illustration
Systemic runs: an illustration
Interaction of two frictions

- **1st friction:** Types are private information (Diamond and Dybvig 1983)
- **2nd friction:** Cannot contract with investors in $t = 0$ (Holmstrom and Tirole 1998)
Systemic runs: deterioration of funding conditions

Fire-sale price is given by

\[
p(\alpha) = \begin{cases} 
\frac{R}{\mu} & \text{if } \alpha \leq \bar{\alpha} \\
\frac{A - (1 - \alpha)\pi c_1^*}{\alpha} & \text{if } \alpha > \bar{\alpha}.
\end{cases}
\]

For \(\alpha > \bar{\alpha}\), market liquidity becomes scarce:

- depressed asset prices, or
- deteriorated conditions of wholesale funding

\(\bar{\alpha}\): fraction of intermediaries subject to a run
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Fragility:
- Runs on Shadow Banks
- No Runs

- Fire sale
- Cash-in-the-market pricing
- Deterioration of funding conditions
- Contagion without contractual linkages
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Shadow Banks

Illiquid Assets

Quasi Deposits

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Illiquid Investment Technologies

Regulated Banks

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Illiquid Assets

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Disciplining short-term debt

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Disciplining short-term debt

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Diligence induced via skin-in-the-game

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<table>
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Diligence induced via skin-in-the-game
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Fragility: Runs on Shadow Banks

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Fire sale
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Fragility:

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Diligence induced via skin-in-the-game

Disciplining short-term debt

Fragility:

Runs on Shadow Banks

Wholesale Funding

Deterioration of funding conditions

No Runs

Contagion w/o contractual linkages
Result 1: Systemic Runs

Contagion from the shadow banking sector to regulated banks, even without contractual linkages

- Deterioration of funding conditions for regulated banks
- Even without aggregate risk and *classic* bank runs
  - Banks may turn illiquid and insolvent
  - Deposit insurance may become tested and costly
Fire sales and deterioration of funding conditions

Diagram showing the relationship between fire-sale price, funding conditions, and the relative size of the shadow banking sector. The diagram includes a line representing the relationship between fire-sale price and funding conditions, with equilibrium size and relative size of the shadow banking sector indicated on the axes.

Key points:
- Fire-sale price / Funding conditions
- Fundamental Value
- Eq. fire sale price

Equilibrium size and relative size of the shadow banking sector are marked on the x-axis.
Fire sales and deterioration of funding conditions

- Fire-sale price / Funding conditions
- Fundamental Value
- Optimal fire sale price
- Eq. fire sale price

- Social optimum
- Equilibrium size
- Relative size of the shadow banking sector
Shadow banking sector is too large in equilibrium

- Atomistic agents and incomplete markets; pecuniary externality has effect on welfare (Lorenzoni 08)

⇒ Excessive regulatory arbitrage

⇒ Low fire-sale price

- Probability of runs in the shadow banking sector is too high
Determinants of composition of financial system

Consumers face the following trade-off

a) Deposit at regular bank
   - Low interest due to regulatory requirements
   - No risk

b) Deposit at shadow bank
   - Higher interest as no regulatory cost
   - Face prospect of panic-based run
     - Coordination with sunspots á la Gertler and Kiyotaki (2015)
Social optimum and equilibrium

\[ EU^{sb} \]

\[ EU^b \]

\[ DI(\sigma) \]

Equilibrium Size

\[ \bar{\sigma} \]

\[ \tilde{\sigma} \]

\[ \sigma^* \]

Size of SB-sector

\[ 1 \]
Social optimum and equilibrium

\[ \sigma_{EU^{sb}} + (1 - \sigma)EU^b \]

\[ DI(\sigma) \]

Size of SB-sector

Social optimum

Equilibrium Size
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Policy Implications

Addressing regulatory arbitrage

- Some regulatory arbitrage may be efficient
- But: regulatory arbitrage has negative externalities
- Possible?

Macroprudential liquidity regulation – Basel III?

- Restricting wholesale funding: shields banks from turmoil originating outside the banking sector
- But: allocative inefficiency and growth of shadow banking sector
- Welfare effects are ambiguous, may backfire
  - Ring-fencing/shielding banks is no end in itself
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Lender of last resort, Market maker of last resort
- Shields banking sector, but also change of composition of financial system
- Market maker of last resort: crowding out of regulated banks
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**Lender of last resort, Market maker of last resort**
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- Market maker of last resort: crowding out of regulated banks
Shadow banking remains important (FSB 2014)
- 25% of total (global) financial assets
- 50% of assets held by the (global) banking system
- and 120% of GDP on average

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