Fear of Fire Sales and the Credit Freeze
by Diamond and Rajan (forthcoming, QJE)

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Introduction

- Paper is about interbank and C&I lending freeze during crisis.
- Common explanations:
  - Asymmetric information across banks.
    - Extreme to cause full market shut-down.
  - Fear of Bank Run.
    - Resolved by lending facilities.
    - Banks did not use all lending facilities.
In this paper...

- **Strategic behavior** by cash rich banks.
  - Distressed Banks → liquidate assets to meet demand.
  - Fire-sales → investment opportunity for solvent banks.
    - C&I lending may freeze → opportunity cost.
    - Interbank lending may freeze → low prices given future expected fire-sales.

- **Moral-Hazard behavior** by illiquid funds.
  - Selling before trouble is social optimum.
  - Selling before trouble not be private optimum:
    - Why sell cheap today if bailed out tomorrow?
  - If problems tomorrow → limited liability + FDIC insurance.
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- More structure.
  - To explain lending.
Environment

- 3 periods: $t=0,1,2$.
- **Population**: Liquid and Illiquid Banks.
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- Banks financed with deposits $D < Z$.
- $D$ withdrawn in $t = 1$ or 2.
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- Liquid banks: 
  - Deep pockets.
Liquidity Shock

- Fraction $f$ of deposits are recalled in $t = 1$.
- Probability $q$.
- Bank must sell assets to finance withdrawal.
Financing Withdrawals

- Banks can sell assets at $t = 0$.
  - $P_o$ per unit of $Z$.
- Sell asset at $t = 1$ (conditional on shock).
  - $P_1$ per unit of $Z$. 
T=0 Financing Demand

- Indifference Condition to buy in \( t = 0 \):

\[
\frac{1}{P_o} Z = q \frac{1}{P_1} Z + (1 - q) Z
\]

thus:

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P^\text{bid}_o = \frac{1}{q \frac{1}{P_1} + (1 - q)}
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- If $P_o \leq \min(P_o^{bid}, 1)$ infinitely elastic supply of funds.
- If $P_o > \min(P_o^{bid}, 1)$ no lending.
- In equilibrium: $P_o \leq 1, P_1 \leq 1$. 
\[ T=1 \text{ Financing Supply} \]

- Infinitely elastic supply if \( P_1 \leq 1 \).
T=1 Financing Demand

- If shock hits $\eta_1 ZP_1 \geq fD \rightarrow \eta_1 \geq \frac{fD}{ZP_1}$.
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- Payoff from only selling at $t = 1$.

$$q \left[ (1 - \eta_1) Z - (1 - f) D \right] + (1 - q) \left[ Z - D \right]$$

$$= Z - D - qfD \left( \frac{1}{P_1} - 1 \right)$$

- $\left( \frac{1}{P_1} - 1 \right)$ fire-sale loss.
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Assumption 1: Unlimited liability or Always Solvent.
$T=0$ Financing Demand

- Time 0 sales: $\eta_0 ZP_0 \geq fD$. 
\( T=0 \) Financing Demand

- Time 0 sales: \( \eta_0 Z P_0 \geq fD. \)
- Payoff \( t = 0 \) selling:
  \[
  (Z - D) - fD \left[ \frac{1}{P_0} - 1 \right]
  \]
- Recall Payoff \( t = 1 \) selling:
  \[
  (Z - D) - qfD \left( \frac{1}{P_1} - 1 \right)
  \]
- Indifference condition:
  \[
  P_o^{ask} = \frac{1}{q \frac{1}{P_1} + (1 - q)}
  \]
Equilibria I

- Equilibrium is indeterminate.
  - $P_1 = P_0 = 1$.
  - Quantities indeterminate.
- Why?
+ Limited Liability

- Insolvency → Limited liability → only internal funds used.
- FDIC guarantees deposits.
Proposition

Under LL, bank is liquidated upon liquidity shock. Bank never sells in \( t=0 \) even if it may become solvent by selling at \( t = 0 \). No trade occurs at \( t = 0 \).

▶ Why?
More Structure

- Finite pockets: liquid banks $\theta$ amount of cash.
  - Opportunity cost $\rightarrow I(R)$ downward sloping exogenous funds.
  - $I(1) = \bar{I}$.
  - Why? Induces interesting price effects.
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- Assume liquid banks can liquidate loans.
  - $\beta$ fraction of securities.
  - $(1 - \beta)$ fraction of loans.
    - Face value is $Z$.
    - Liquidation values $x \sim U[0, Z]$.
  - Why? insolvency.
## Timing

<table>
<thead>
<tr>
<th>Bank Type</th>
<th>t=0</th>
<th>t=1</th>
<th>t=2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illiquid Banks</td>
<td>Sell Securities</td>
<td>Loan Liquidation</td>
<td>Loans pay-off, dividends</td>
</tr>
<tr>
<td>Liquid Banks</td>
<td>Purchase of Securities, Loans or Cash</td>
<td>Purchase of Loans</td>
<td>Loans pay-off, dividends</td>
</tr>
</tbody>
</table>

$\text{(shocks arrive)}$
Which loans are sold?

Convenient for bank to sell assets with value $x \geq P_1Z$.

Thus, bank can raise:

$$\frac{1}{Z} \int_{P_1Z}^{Z} x\,dx = \frac{Z}{2} \left(1 - (P_1)^2\right)$$
Efficient equilibria

- Efficient Equilibria
- \( \theta - \bar{I} = \theta - I \quad (1) \geq fD \rightarrow P_1 = P_0 = 1. \)
Inefficient equilibria

- Inefficient equilibria: \( \theta - \bar{l} < fD \).
- Date 1 cash needs:
  \[
  (1 - \beta) \frac{Z}{2} \left( 1 - (P_1)^2 \right) + \left[ \theta - l \left( \frac{1}{P_o} \right) \right] = fD
  \]
- Price indifference condition:
  \[
  P_{o}^{Ask} = \frac{1}{q \frac{1}{P_1} + (1 - q)}
  \]
- Conditions pin-down prices.
- Bank solvency:
  \[
  (1 - \beta) P_1 Z \cdot P_1 + (1 - \beta) \frac{Z}{2} \left( 1 - (P_1)^2 \right) + \beta P_2 Z > (1 - f) DP_1 + fD
  \]
Results

1. $\uparrow f, \uparrow D \text{ or } \downarrow \theta \rightarrow \downarrow P_0 \text{ and } \downarrow P_1$.
2. $\uparrow q \rightarrow \downarrow P_0 \text{ and } \uparrow P_1$.
3. $\uparrow f, \uparrow D, \uparrow q \text{ or } \downarrow \theta \rightarrow \text{Time 0 lending.}$
Bank Runs

- Assume that insolvency implies all agents withdraw $D$. 
Example Prices
Example Lending