Geanakoplos (and others): Emphasis on uncertainty during crises.

Next: Endogenous sources of uncertainty:

1. **Strategic uncertainty and bank runs.**
2. Counterparty risk/financial network (no time).
Liquidity demand and bank runs

Holmstrom-Tirole:

- Corporate liquidity demand and underinsurance wrt aggregate liquidity shocks.

Today: Diamond and Dybvig (1983) and subsequent literature.

- Financiers’ liquidity demand with idiosyncratic shocks.
- Banks’ role in liquidity provision.
- Coordination problems and runs/crises.
- Global games to link runs to fundamentals.
- Modern version of bank runs.
Roadmap

1. Consumer liquidity demand and liquidity insurance
2. Implementation by bank deposits
3. Coordination based runs
4. Perspectives on modern runs
Diamond-Dybvig (1983): Consumers with liquidity shocks

- Three dates $t \in \{0, 1, 2\}$ and a single consumption good (dollar).
- Measure one of ex-ante identical consumers (Fs) with unit endowment at date 0. Consume either at date 1 or 2.

**Liquidity shocks:** Preferences:

$$u(c_1, c_2) = \begin{cases} 
  u(c_1) \text{ with prob. } \lambda, \text{ (if impatient)}, \\
  u(c_1 + c_2) \text{ with prob. } 1 - \lambda, \text{ (if patient)}. 
\end{cases}$$

Assume $u'(0) = \infty$.

**Asymmetric information:** Types are consumers’ private information.

**Investment technology:** One dollar at date 0 yields $R > 1$ dollars at date 2 if project is completed, 1 dollar if terminated.
Consider autarky and optimal benchmarks

**Autarky:** Suppose each consumer acts in isolation. Consumer invests all endowment in the project and liquidates iff she is impatient. Yields:

\[ c_1 = 1 \text{ and } c_2 = R. \]  

(1)

**Optimal allocation:** Suppose a planner chooses \((c_1, c_2)\) along with the aggregate liquidation decision, \(y \in [0, 1]\). Solves:

\[
\max_{c_1, c_2, y \in [0, 1]} \lambda u(c_1) + (1 - \lambda) u(c_2) 
\]

(2)

\[
\begin{align*}
\text{(RC)} : & \quad \lambda c_1 \leq y, \\
& \quad \text{and } (1 - \lambda) c_2 \leq y - \lambda c_1 + R (1 - y), \\
\text{(IC)} : & \quad c_1 \leq c_2.
\end{align*}
\]

- Why is the last condition necessary?
Characterization of the optimal allocation

Optimal allocation:

- First ignore the IC constraint (will verify that it will hold).
- We must have $y = \lambda c_1$ and $R(1 - y) = (1 - \lambda) c_2$.
- Using FOC, solution is given by $c_1 \in (0, 1/\lambda)$ that satisfies:

$$u'(c_1) = Ru' \left( \frac{R(1 - \lambda c_1^*)}{1 - \lambda} \right).$$

- This can concisely be written as

$$u'(c_1^*) = Ru'(c_2^*).$$

- It follows $c_1^* < c_2^*$, i.e., **(IC) constraint is automatically satisfied.**
- Optimal allocation equates MRS with the technological price.
Define $\eta(c) \equiv -\frac{c u''(c)}{u'(c)}$ as the relative risk aversion coefficient.

**Assumption:** $\eta(c) > 1$ for each $c > 0$.

In this case, $c_1^* > 1$ and $c_2^* < R$. **Liquidity insurance.** (What happens if $\eta(c) = 1$ or $\eta(c) < 1$?)
Roadmap

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Next: How to implement the optimal contract?

- Suppose there is a continuum of competitive banks that offer consumers a demand deposit contract at date 0.
- The contract, \((c_1, c_2)\), is sold at 1 dollar at date 0 and promises \(c_1\) if consumer withdraws at date 1, and \(c_2\) if withdraws at date 2.
- Bank liquidates \(y\) at date 1 to meet early withdrawals and uses the rest of resources to pay for late withdrawals.
- Formally (following Tirole), let \(\hat{\lambda} \geq \lambda\) denote the amount of consumers that withdraw. Then, a deposit contract pays:

\[
\hat{c}_1 = \min \left\{ c_1, \frac{1}{\lambda} \right\}, \\
\hat{c}_2 = \max \left\{ \left( \frac{1 - \hat{\lambda} \hat{c}_1}{1 - \hat{\lambda}}, 0 \right) \right\}.
\]
Definition of equilibrium

Let \((c_1, c_2) \equiv c \in \mathcal{C} \subset \mathbb{R}_{++} \times \mathbb{R}_{++}\) denote the set of feasible contracts [subject to (RC) and (IC)].

**Postdeposit equilibrium:** Given \(c \in \mathcal{C}\), collection of withdrawal decisions and actual payoffs, \((\hat{\lambda}, \hat{c}_1, \hat{c}_2)\), such that agents optimize and payoffs are given by (3).

**Predeposit equilibrium:** Given a collection of postdeposit equilibria, \((\hat{\lambda}(c), \hat{c}_1(c), \hat{c}_2(c))\) \(\forall c \in \mathcal{C}\), an equilibrium is \(c^* = (c_1^*, c_2^*)\) that maximizes consumers’ ex-ante utility:

\[
\max_{c \in \mathcal{C} \cup \{0\}} \lambda u (\hat{c}_1 (c)) + (1 - \lambda) u (\hat{c}_2 (c)),
\]

where \(c = 0\) captures autarky, i.e., \(\hat{c}_1 (0) = 1\) and \(\hat{c}_2 (0) = R\).
How to implement the optimal contract?

- For a feasible contract, the **no-run allocation** is always an equilibrium:
  
  \[
  \left[ \hat{\lambda} (c), \hat{c}_1 (c), \hat{c}_2 (c) \right] = [\lambda, c_1, c_2].
  \]

- With these postdeposit equilibria, banks’ problem (4) is identical to the planner’s problem (2).
- Predeposit equilibrium is then the same as the optimal allocation.

- Optimal allocation can be implemented with demand deposits.
- Banks might have a role in providing liquidity insurance.
Roadmap

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An additional bank-run equilibrium

- The above describes an equilibrium, but can there be more?
- Consider the postdeposit game given contract \((c_1^*, c_2^*)\).
- If all patients withdraw, early withdrawal yields \(\hat{c}_1 = 1\) but late withdrawal yields \(\hat{c}_2 = 0\).
- It becomes optimal to withdraw also for the patients!
- **Run equilibrium** (at date 1): \(\lambda = 1, \hat{c}_1 = 1\) and \(\hat{c}_2 = 0\).
- **Intuition:** Strategic complementarities: Propensity to run, \(\hat{c}_1 - \hat{c}_2\), is increasing in \(\lambda\) (over the relevant range).
Multiple equilibria from strategic complementarities

Hence, the above implementation of optimal allocation is “fragile.”

Asymmetric info plays a key role for fragility/runs. Why?
Bank runs and strategic uncertainty

- Coordination based runs. Not necessarily related to fundamentals.
- We need to also solve for ex-ante contract anticipating a run.
- There are equilibria in which there is a run with positive probability.
- Unrelated random variable (sunspot) can serve as coordination device.

**Strategic uncertainty:** Generated by coordination failures/runs.
Potential solutions to the coordination problem

1. **Suspension of convertibility**: Cyprus recently, US 1814-1907.
   - Bank gives $c_1^*$ to first $\lambda$ people and 0 to the rest.

2. **Public deposit insurance**: FDIC insurance in the US since 1933.
   - Additional early withdrawals are paid from insurance.
   - No intervention in equilibrium. But eliminates bad equilibrium.
   - Introduces moral hazard (rich literature).

3. **Lender of last resort** has a similar effect.
Gorton (1988): Runs are related to the business cycle: “Every time a variable predicting a recession reached a threshold level, a panic occurred.”

Not consistent with DD’s purely coordination based runs. Why?

Can we reconcile fundamental based and panic based views?

Yes, using global games techniques to select equilibrium in the latter:

- Negative shock to fundamentals $\implies$ Coordination on bad equilibrium $\implies$ Runs.

Roadmap

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Depositors outside the UK Bank, Northern Rock, September 2007.
First bank run in the UK since 1866.
Retail deposits small fraction of Northern Rock’s liabilities.
- Securitized deposits not the main problem since long term.
- Decline in retail deposits and wholesale funds.
A look at retail deposits

• But how about the timing of the reduction...
Retail deposits do not seem to be main problem

- Stressed start on August 9 when the short-term collateralized debt market almost froze.
- Depositor run much later (on September 14), and only after the public announcement of support by Bank of England.
- “The damage was already done well before the run by its retail depositors.”
- “Irony of TV images of depositors queuing at the branch offices was that it was the branch deposits that were the most stable.”
- “Although retail deposits can be withdrawn on demand, bankers have been heard to joke that a depositor is more likely to get divorced than to switch banks.”
The 2006 annual report: “Following substantial inflows from **securitization** during the first half, we repaid net £2.3 billion, **mainly short term funds**. In the second half we raised a net £5.2 billion, leading to a full year net funding of £2.9 billion. During the year, we raised £3.2 billion **medium term** wholesale funds from a variety of globally spread sources, with specific emphasis on the **US, Europe, Asia and Australia**.”

- Short term: Maturity less than 6 months. Medium: 6 months or longer.
- One source of short term funds is asset backed commercial paper...
A look at commercial paper market

Main problems appear to be in short-term debt markets.

Northern Rock did not hold subprime mortgages, but it was “fishing from the same pool of short-term funding.”
Bear Stearns episode also unrelated to deposits

As you will see, the conclusion to which these data point is that the fate of Bear Stearns was the result of a lack of confidence, not a lack of capital. When the tumult began last week, and at all times until its agreement to be acquired by JP Morgan Chase during the weekend, the firm had a capital cushion well above what is required to meet supervisory standards calculated using the Basel II standard.

Specifically, even at the time of its sale on Sunday, Bear Stearns’ capital, and its broker-dealers’ capital, exceeded supervisory standards. Counterparty withdrawals and credit denials, resulting in a loss of liquidity – not inadequate capital – caused Bear’s demise.

- Chairman Cox on Bear Stearns: Emphasis on liquidity problems.
- Bear Stearns was not even a commercial bank. No retail deposits.
There is a modern version of traditional runs

- Traditional run mechanism can still apply after some relabeling:

  \[
  \text{Short term debt} \quad \rightarrow \quad \text{Demand deposits,}\n  \text{Institutional investors} \quad \rightarrow \quad \text{Consumers.}
  \]


**Caveat:** Seems more relevant for **unsecured short term debt**:

- Mechanism relies on **cross pledging of collateral**.
- With collateralized loans, not much cross pledging.
Alternative view of modern runs: Credit crunch

Shin (2009) emphasizes: **Intermediation and credit crunch** as opposed to coordination problems.

- Northern Rock’s creditors in wholesale funds are themselves banks.
- Tightening of their constraints reduces Northern Rock’s pledgeability and liquidity (Holmstrom-Tirole, QJE), generating inefficient liquidations (Holmstrom-Tirole, JPE).
- Creditors’ constraints in turn exacerbated by several mechanisms (e.g., Kiyotaki and Moore, 1997, Geanakoplos, 2011 etc.)

Open question: Empirical relevance of different mechanisms. Coordination problems or credit crunch?
D-D: Consumers’ demand for liquidity insurance.
- Insurance can be provided via bank deposits.
- Can generate coordination failures/runs and strategic uncertainty.
- Modern version with short term debt instead of deposits.
- Credit crunch provides an alternative modern run mechanism.