Bank Runs, Deposit Insurance, and Liquidity

Diamond and Dybvig (1983)

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Introduction

- This paper gives explicit analysis of the demand for liquidity and the transformation of illiquid assets into liquid liabilities provided by banks.
- Uninsured demand deposit contracts are able to provide liquidity but leave banks vulnerable to runs:
  there are multiple equilibria with differing levels of confidence.

Introduction: main results

- Banks issuing demand deposits can improve on a competitive market by providing better risk sharing among people who need to consume at different random times.
- The demand deposit contract providing this improvement has multiple equilibria.
  - If confidence is maintained, there can be efficient risk sharing.
  - If agents panic, there is a bank run and incentives are distorted.
- Bank runs cause real economic problems because even "healthy" banks can fail.

Model: production

- One good, 3 periods. $(t = 0, 1, 2)$
- A continuum of ex ante identical agents, each of whom receives 1 unit of endowment at period 0.
- Production technology:

$$
\begin{array}{cccccl}
t=0 & & t=1 & t=2 & & \\
-1 & \left\{ \begin{array}{c} \\ \\ \end{array} \right. & 0 & R & & \text{(long-term illiquid investment)} \\
 & & 1 & 0 & & \text{(short-term liquid investment)}
\end{array}
$$

Model: liquidity shocks

- iid liquidity shocks: an agent wants to consume in period 1 with probability ρ, and wants to consume in period 2 with probability $1-\rho$.
- Ex ante all agents have the same utility (we do not consider discounting):

$$\begin{aligned} U &= \rho u(c_1) + (1-\rho)u(c_2) \\ &\quad u' > 0; u'' < 0. \end{aligned}$$

Model: liquidity shocks (con't)

Ex post agents can be of two types:

- Type 1 agents care only about consumption at $t = 1$.
  - Due to the law of large number, a fraction ρ of agents are type 1 agents, and a fraction $(1 - \rho)$ of agents are type 2 agents.
- Type 2 agents care only about consumption at $t = 2$.

Market allocation

The allocation obtained when a financial market is opened.

- Consider a bond market opened at $t = 1$, whereby q units of good at $t = 1$ are exchanged against the promise to receive 1 unit of good at $t = 2$.

Market allocation (con't)

- At $t = 1$:
  - each agent chooses to invest x units of endowed good in the long-term technology.
  - Type 1 sold Rx units of bonds, and received Rxq units of goods at $t = 1$.
  - Type 2 bought $\frac{1-x}{q}$ units of bonds, that promised $\frac{1-x}{q}$ units of goods at $t = 2$.
- $$\begin{aligned} c_1 &= (1-x) + Rxq \\ c_2 &= Rx + \frac{1-x}{q} \end{aligned}$$
- $c_1 = qc_2$

Market allocation: $c_1 = 1; c_2 = R$

- $q = \frac{1}{R}$. Why?
  - If $qR > 1$, then $x\uparrow \Rightarrow c_1\uparrow, c_2\uparrow$.
  - If $qR < 1$, then $x\uparrow \Rightarrow c_1\downarrow, c_2\downarrow$.
  - To have an interior maximum, we need $qR = 1$, and the only (interior) equilibrium price of bonds is $q = \frac{1}{R}$.
- $q = \frac{1}{R} \Rightarrow c_1 = 1$, $c_2 = R$
  Agents can do no better or worse than if they produced only for their consumption.
- This market allocation is not Pareto-optimal in general, because liquidity risk is not properly allocated.

Optimal insurance contracts under publicly observable types

- The optimal consumption for type i in period k, $\{c_k^{i^*}\}$, satisfies
  (1) $c_1^{2^*} = c_2^{1^*} = 0$
  (2) $u'(c_1^{1^*}) = Ru'(c_2^{2^*})$ (MRS=MRT).
  (3) $\rho c_1^{1^*} + \frac{(1-\rho)c_2^{2^*}}{R} = 1$ (Resources constraint)
- $R > 1$ and relative risk aversion > 1
  $\Rightarrow$ (1),(2),(3) imply $c_1^{1^*} > 1$, $c_2^{2^*} < R$.
- (2) $\Rightarrow c_2^{2^*} > c_1^{1^*}$ because $R > 1$ and $u'' < 0$.

Optimal outcome is implementable

- The optimal outcome is implementable (e.g. under demand deposits contracts) as a Nash equilibrium, since it satisfies self-selection constraints.
  - $c_1^{1^*} > 1$ and $c_1^{2^*} = 0$
    $\Rightarrow$ type 1 does not envy type 2.
  - $c_1^{2^*} + c_2^{2^*} = c_2^{2^*} > c_1^{1^*} = c_1^{1^*} + c_2^{1^*}$
    $\Rightarrow$ type 2 does not envy type 1.
- The optimal insurance contract insures agents against the unlucky outcome of being a type 1 agent.

Bank's role in providing liquidity

deposits		withdrawal	withdrawal
$t = 0$		$t = 1$	$t = 2$
-1	$\{$	0	r_2
		r_1	0

- The demand deposit contract satisfies a sequential service constraint.
- Bank is mutually owned and liquidated in period 2, so that agents not withdrawing in period 1 get a pro rata share of the bank's assets in period 2.

Equilibrium: optimal outcome

- The demand deposit contract with $r_1 = c_1^{1^*}$ can achieve the full-information optimal risk sharing as an equilibrium (pure strategy Nash equilibrium) in which type 1 withdraws at $t = 1$ and type 2 waits till $t = 2$ to get $c_2^{2^*}$.

Equilibrium: bank runs

- Another equilibrium has all agents panicking and trying to withdraw their deposits at $t = 1$, and if this is anticipated, all agents will prefer to withdraw at $t = 1$.

Why are "bank runs" an equilibrium?

- For all $r_1 > 1$, runs are an equilibrium, because the face value of deposits is larger than the liquidation value of the bank's assets. (Recall the "first-come-first-serve" constraint.)
- If $r_1 = 1$, a bank is not susceptible to runs; but then, there is no improvement on competitive market allocation; i.e. banks provides no liquidity services.
- Bank run equilibrium reduces production efficiency, and allocation are worse than what would be obtained without the bank (e.g. trading in the competitive claims market).

Self-fulfilling equilibrium

- In this model, the investment is riskless. There is no moral hazard. Bank runs occur even though there is nothing wrong with the bank's investment.
- Banks runs is a self-fulfilling prophecy (a crisis of confidence).

Regulatory responses: suspension of convertibility

- If liquidity shocks are perfectly diversifiable, and if the proportion ρ of type 1 agents is known ex ante, suspension of convertibility contract achieves optimal risk sharing.
- e.g. the bank announces it will not serve more than $\rho c_1^{1^*}$ withdrawals at $t = 1$.
- In equilibrium, suspension never occurs, and the bank can follow the optimal asset liquidation policy.

Proposition 1: suspension of convertibility

Bank contracts (which must obey the sequential service constraint) cannot achieve optimal risk sharing when ρ is stochastic and has a nondegenerate distribution.

- No bank contract, including suspension convertibility, can achieve the full-information optimum.
- Suspension can generally improve on the uninsured demand deposit contracts by preventing runs.

Proposition 2: deposit insurance

Demand deposit contracts with government deposit insurance achieve the unconstrained optimum as a unique Nash equilibrium if the government imposes an optimal tax to finance the deposit insurance.

- As the government can impose a tax on an agent after he has withdrawn, it can base its tax on the realized total value of $t = 1$ withdrawals.
- This is in contrast to privately provided deposit insurance. Because insurance companies do not have the power of taxation, they must hold reserves to make their promise credible.