Bank Runs, Deposit Insurance, and Liquidity

Diamond and Dybvig (1983)

October 2011
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:

\[
\begin{align*}
  t = 0 & \quad t = 1 & \quad t = 2 \\
-1 & \quad 0 & \quad R & \text{ (long-term illiquid investment)} \\
& \quad 1 & \quad 0 & \text{ (short-term liquid investment)}
\end{align*}
\]

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Model: liquidity shocks

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

$$U = \rho u(c_1) + (1 - \rho) u(c_2)$$

$u' > 0; u'' < 0.$
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 $\rho$ 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 $t = 2$.

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\[
\begin{align*}
  c_1 &= (1 - x) + Rxq \\
  c_2 &= Rx + \frac{1-x}{q}
\end{align*}
\]

- $c_1 = qc_2$

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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.

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The optimal consumption for type $i$ in period $k$, $\{c^i_k\}$, satisfies

1. $c^{2*}_1 = c^{1*}_2 = 0$
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 $c^{1*}_1 > 1$, $c^{2*}_2 < R$.

$\Rightarrow$ (2) $c^{2*}_2 > c^{1*}_1$ because $R > 1$ and $u'' < 0$. 

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The optimal outcome is implementable (e.g. under demand deposits contracts) as a Nash equilibrium, since it satisfies self-selection constraints.

- $c_1^* > 1$ and $c_1^* = 0$
  - $\Rightarrow$ type 1 does not envy type 2.
- $c_2^* + c_2^* = c_2^* > c_1^* = c_1^* + c_2^*$
  - $\Rightarrow$ 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

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.
The demand deposit contract with $r_1 = c_1^*$ 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 $c_2^*$. 

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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 $t = 1$. 

According to Diamond and Dybvig (1983) in their work on Bank Runs, Deposit Insurance, and Liquidity.
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 $\rho$ 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 $\rho$ 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.