Lecture 12: Bank Runs

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Financial Crises

- Financial crises have been common over the past 400 years
- Come in different flavors:
  - Banking crises
  - Currency crises
  - Sovereign debt crises
- Often associated with (the cause of?) major recessions/depressions
  - Great Depression, Great Recession
  - Sweden 91, Mexico 94, Thailand/Korea/etc. 97, Argentina 01, etc.

Suddenness of Financial Crises

- Financial crises often occur suddenly
  - Panics
  - Speculative attacks
- Two views:
  - Inevitable consequence of fundamental problems
    (e.g., bank solvency problem, unsustainable government policy)
  - Self-fulfilling panics
    (i.e., multiple equilibria events that need never occur)

Diamond-Dybvig Model

Key Elements:

- A theory of **maturity mismatch** in banking: banks lend long duration, borrow short duration
- A model of **liquidity preference** by consumers: Some consumers prefer callable deposits
- An explanation for **bank runs** as self-fulfilling panics

Seminar papers: Diamond and Dybvig (1983) and Bryant (1980)

My exposition follows Allen and Gale (2007, ch. 3)

The Liquidity Problem

- Three dates: $t = 0, 1, 2$
- Two assets:
  - Liquid asset: Invest 1 unit at t and get 1 unit at $t + 1$ (0 return)
  - Illiquid asset: Invest 1 unit at $t = 0$, get $R > 1$ units at $t = 2$ or $r < 1$ at $t = 1$
- Intuitively:
  - Selling assets as a solution to liability issues on the balance sheet (can liquidate illiquid assets)
  - Illiquid asset is a project that is costly to liquidate before it is complete ($r < 1 < R$)
  - Captures the possibility of “fire sales”
  - Makes liability problems more painful, creating net worth losses (liquidating illiquid assets generates losses)

The Liquidity Problem

- Continuum of households
- Each has endowment of 1 at $t = 0$ and 0 afterwards
- Subject to random time preference shocks realized after period 0
  - Value consumption only at $t = 1$ with probability λ
  - Value consumption only at $t = 2$ with probability $1 - \lambda$
  - Extreme versions of shocks to **marginal utility**
- Utility function:

$$u(c_1, c_2) = \begin{cases} U(c_1) & \text{with prob.} \quad \lambda \\ U(c_2) & \text{with prob.} \quad 1 - \lambda \end{cases}$$

The Liquidity Problem

- If household knew at $t = 0$ that it was an ...
  - Early consumer: It would invest in the liquid (short) asset
  - Late consumer: It would invest in the illiquid (long) asset
- Problem is that it doesn't know!
- Any investment strategy will yield regret in some state of the world

Autarky

- Household must invest at $t = 0$ but cannot retrade later (i.e., no trading markets at $t = 1$)
- But can receive payment in t=1 and hold it to t=2
- If hh invests a fraction θ in the short asset
- Expected utility is then (assuming $r = 0$ for simplicity)

$$\lambda U(\theta) + (1 - \lambda)U(\theta + (1 - \theta)R)$$

- If interior, optimal value of θ satisfies

$$\lambda U'(\theta) + (1 - \lambda)U'(\theta + (1 - \theta)R)(1 - R) = 0$$

Autarky

- With $U(C) = \log C$, this becomes

$$\frac{\lambda}{\theta} + \frac{1-\lambda}{\theta + (1-\theta)R}(1-R) = 0$$

or

$$\theta = \frac{R}{R-1}\lambda$$

- For reasonable values of R, most wealth in short asset
e.g., with $R = 1.2$, $R/(R-1) = 6$.

- Liquidity problem prevents autarky household from taking advantage of high returns on long-term projects

Equilibrium with Trading at $t = 1$

- Households can trade long and short assets at $t = 1$
(but no state-contingent assets at $t = 0$)

- No asset in period $t = 0$ that pays only if you are an early (or late) consumer

- Let's use P to denote the price of long assets at $t = 1$

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- No asset in period $t = 0$ that pays only if you are an early (or late) consumer
- Let's use P to denote the price of long assets at $t = 1$
- **Result**: The price of long asset at $t = 1$ must be $P = 1$
  - If $P > 1$: Long asset dominates short asset at $t = 0$. No one buys short asset at $t = 0$. At $t = 1$, early consumers offer long asset for sale, but no buyers. Price collapses to $P = 0$. Contradiction.
  - If $P < 1$: Short asset dominates long asset at $t = 0$. No one buys long asset at $t = 0$. At $t = 1$, late consumers try to buy long asset to realize a return of $R/P > R$, but no sellers. Price bid up to $P = R$. Contradiction.

Equilibrium with Trading at $t = 1$

- At $t = 0$, household invests in x units of long asset and y units of short asset with

$$x + y = 1$$

- If early consumer: Sells long assets at $t = 1$ and consumes

$$c_1 = y + Px = y + x = 1$$

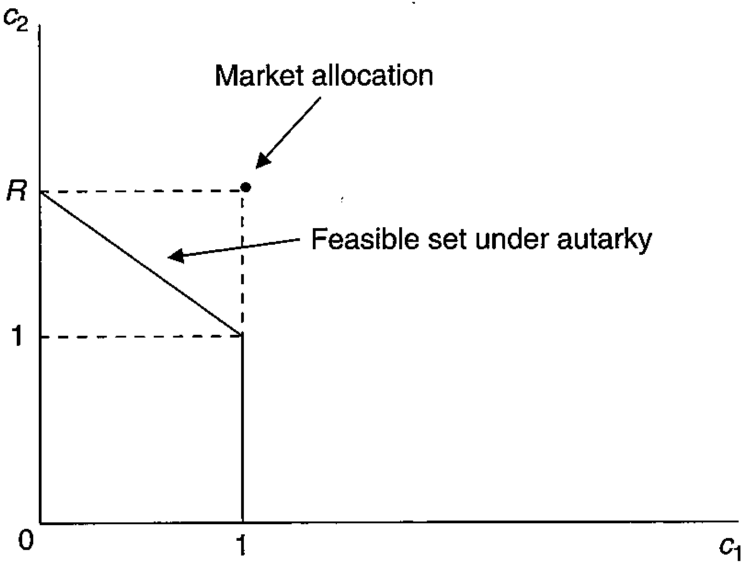
- If late consumer: Buys long assets at $t = 1$ and consumes

$$c_2 = (x + \frac{y}{P})R = (x + y)R = R$$

- Expected utility

$$\lambda U(1) + (1 - \lambda)U(R)$$

- Note that there is not perfect insurance. $c_2 > c_1$.



Source: Allen and Gale (2007)

Efficient Outcome

- Suppose central planner chooses investment and levels of consumption for early and late consumers to maximize household expected utility

- Chooses y to maximize

$$\lambda U\left(\frac{y}{\lambda}\right) + (1-\lambda)U\left(\frac{R(1-y)}{1-\lambda}\right)$$

- If solution in interior, must satisfy

$$U'\left(\frac{y}{\lambda}\right) - U'\left(\frac{R(1-y)}{1-\lambda}\right)R = 0$$

  or

$$U'(c_1) = U'(c_2)R$$

  where we use $c_1 = y/\lambda$ and $c_2 = Rx/(1-\lambda)$

- Early consumer get c_1, so consumption per capita in $t = 1$ is λc_1

Inefficiency of Trading Equilibrium

- Suppose

$$U(c) = \frac{1}{1-\sigma} c^{1-\sigma}$$

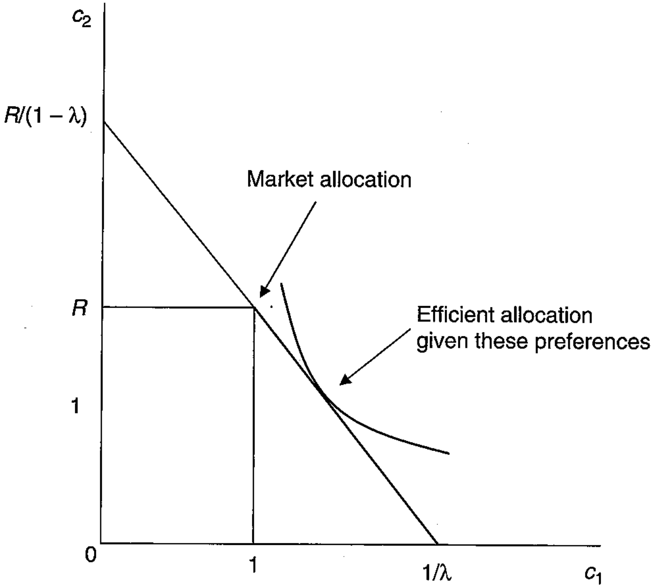
- Optimality condition becomes

$$\left(\frac{c_2}{c_1}\right)^{\sigma} = R$$

- Equilibrium with trading at $t = 1$ has $c_1 = 1$ and $c_2 = R$
- Replace the allocation with trading

$$R^{\sigma} = R$$

  which only holds for $\sigma = 1$ (log utility case)



Source: Allen and Gale (2007)

Inefficiency of Trading Equilibrium

- In trading equilibrium $c_1 = 1 < R = c_2$
- In efficient equilibrium $U'(c_1) = RU'(c_2)$. So, $c_1 < c_2$
- Consumption stream risky in both cases
- When does efficient equilibrium provide more liquidity insurance than trading equilibrium? $(c_2^e / c_1^e < c_2^m / c_1^m)$
  - When $\sigma > 1$ (agent more risk averse than log-utility)
- When $\sigma < 1$, trading equilibrium provides too much liquidity
  - Providing liquidity insurance is expensive
  - Short asset has low return

Banking Solution

- Large banks:
  - Take deposits: Take in 1 at $t = 0$, give back c_1 at $t = 1$ or c_2 at $t = 2$
  - Invest in a portfolio (x,y) of long and short assets
- Free entry forces banks to maximize household utility (zero profits)
- Banking solution same as central planning solution!
  - Banks face no risk since they are large
  - Able to fully diversify liquidity risk of households
- One wrinkle: If banks don't observe household type,
  deposit contract must be **incentive compatible**

Incentive Compatibility

- Early consumers won't misrepresent themselves as late consumers
  - Would result in zero consumption at time 1
- Late consumer could pretend to be early consumer, receive c_1 at $t = 1$, store it until $t = 2$ using short asset
- Deposit contract is incentive compatible if

$$c_1 \leq c_2$$

- This is the case, as we have seen above

Banking in Diamond-Dybvig Model

- Model of maturity mismatch
  - Bank assets are less liquid than bank liabilities
- Model of liquidity preference
  - Why are bank liabilities so liquid?
  - Liquidity shock model provides a theory for this
- Banks as intermediaries
  - Facilitates investment in high return illiquid assets
  - Provide households insurance against liquidity shocks
  - Depositor does better than in autarky or trading equilibrium

Bank Runs

- Let's now consider case were $0 < r < 1$
  - I.e., long asset can be liquidated for $0 < r < 1$ at $t = 1$
- Bank must liquidate assets to meet demand for withdrawals at $t = 1$
- Depositors arrive at teller to withdraw one after another in random order (sequential service constraint)

Bank Runs

- If everyone runs, bank can only pay out

$$rx + y < 1$$

- If

$$rx + y < c_1$$

  - bank will run out of resources before all depositors have been paid
  - Some depositors that run will get nothing
  - Depositors have incentives to run if everybody is running

- In this case, a bank run equilibrium exists

Bank Runs

	Run	No Run
Run	$(rx + y, rx + y)$	(c_1, c_2)
No Run	$(0, rx + y)$	(c_2, c_2)

- Rows: Strategy of depositor A (late consumer)
- Columns: Strategy of all other late consumers
- Payoffs:
  - First entry: Payoff of a depositor A (late consumer)
  - Second entry: Payoff of all other late consumers

Bank Runs

- Run equilibrium is a pure coordination problem
- Bank has no “fundamental” problem
- If no one runs, everything would be fine
- Pure waste. Completely inefficient.
- Example of multiple equilibria due to strong strategic complementarity

Fundamental Fragility of Banks

- Even strong banks are fragile to runs
- Arises due to maturity mismatch of bank assets and liabilities
- Maturity mismatch is due to:
  - Household demand for liquidity (due to liquidity shocks)
  - Desire to take advantage of high return on illiquid asset

Preventing Bank Runs

How can we prevent bank runs?

Preventing Bank Runs

How can we prevent bank runs?

- Suspension of Convertibility (from deposits to cash)
  - Bank refuses to honor depositor withdrawal requests (in the model: in T=1)
  - Common in US prior to founding of the Federal Reserve
  - If bank commits to suspend convertibility before it needs to engage in costly liquidation of long asset, late consumers have no need to run
  - Eliminates the run equilibrium
  - But if there is uncertainty about how many withdrawals constitute a run, i.e., uncertainty about λ, this might not work
  - Big costs of suspension in this case for those that need liquidity
  - And impair the supply of deposits, and of credit as a consequence

Preventing Bank Runs

- Deposit insurance
  - If government insures that late consumers will get there money back even if bank fails, late consumers no long have an incentive to run
  - This eliminates the run equilibrium
  - But insured depositors will not monitor the bank. This invites moral hazard on the part of the bank (Calomires-Kahn 91)
  - Also, deposit insurance doesn't cover wholesale repo financing

Preventing Bank Runs

- Lender of Last Resort
  - Central bank commits to lend to bank enough so that bank can honor deposits withdrawn at $t = 1$ without liquidating long asset
  - Late consumers can rest easy. No run equilibrium.
  - But is crisis a liquidity or solvency crisis?
  - Bagehot’s rule:
    - Lend freely, but at a penalty rate, and against good collateral
  - Tricky issue: How good is the collateral?
    Difficult to value in the midst of a crisis