Financial Crisis

Two different approaches on what causes them, stops them

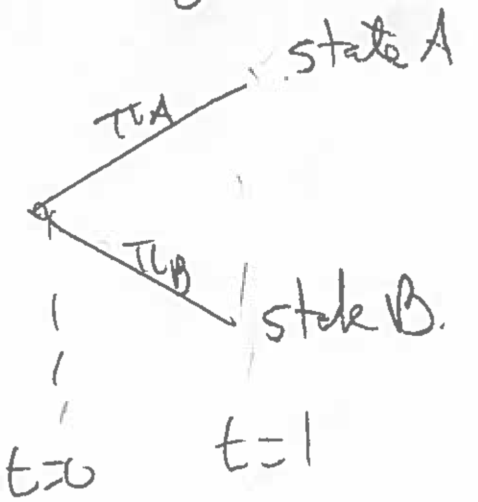
1) Moral Hazard. (Karaken-Wallace).
2) Deposit insurance and Bank runs (Diamond-Dybvig)

Karaken-Wallace 1977

Deposit insurance without regulation creates incentives for banks to take too much risk.

Model

- 2 periods: today $t=0$, tomorrow $t=1$
- 2 states at $t=1$, $S=\{A, B\}$, $Prob(A)=\pi_A$, $Prob(B)=\pi_B$
- State contingent claims: p_A, p_B in terms of time 0 goods (which is numeraire). Exogenous.



What is the risk-free rate? From previous,

$$\frac{1}{1+r} = P_A + P_B = \text{price of 1 unit of consumption in time 1 for sure in } t=0 \text{ consumption units.}$$

- A risk-free bond can be created by purchasing both. Complete markets ⟹ incomplete markets.

Model of Bank

At $t=0$:

1) Recieves deposits D.
2) Chooses portfolio at $t=1$: $Q_A \leftarrow P_A$, $Q_B \leftarrow P_B$] price

quantities.

Budget Constraint:

$$P_A Q_A + P_B Q_B = D.$$

Liabilities:

To get deposits, return must be at least $(1+r)D$ or else everyone would buy risk free bonds.

At $t=1$, in state S.

1) collect Q_S from state contingent asset
2) Pay depositors $(1+r)D$
3) Keep profits: $Q_S-(1+r)D$.
4) If $Q_S-(1+r)D<0$, pay depositors Q_S, i.e. liquidate bank, defaults on promised interest.

Profits of Bank

$$\text{Profit} = \max\{Q_S-(1+r)D, 0\}$$

Assume:

1) No deposit insurance.
2) Depositors will put D into the bank at $t=0$ only if
   in state A: $Q_A \geq (1+r)D$, i.e. no default
   in state B: $Q_B \geq (1+r)D$

Guess and Verify

the only portfolio that fulfills conditions is $Q_A = Q_B = \overline{Q}$, this is a risk-free portfolio.

$$P_A \overline{Q} + P_B \overline{Q} = D \quad \text{from budget of bank.}$$

$$(P_A + P_B)\overline{Q} = D$$

$$\overline{Q} = \frac{D}{P_A + P_B} = (1+r)D.$$

so, in state A: $Q_A = \overline{Q} = (1+r)D$

B: $Q_B = \overline{Q} = (1+r)D.$

Expected profits

$$\pi_A \max\{\underbrace{Q_A - (1+r)D}_{0}, 0\} + \pi_B\{\underbrace{Q_B - (1+r)D}_{0}, 0\}$$

$= 0.$

Any other portfolio has bank taking on risk and leads depositors to flee the bank.

- Free entry into the banking sector can rationalize this condition.

With Deposit Insurance:

- The government offers deposit insurance that guarantees a return of $(1+r)$ to depositors if the assets can't cover liabilities at $t=1$.
- The gov't makes up the difference.

Consider Risky Portfolio

$$Q_A > \bar{Q} \quad Q_B < \bar{Q} \quad , \quad \bar{Q} = \frac{D}{p_A + p_B}$$

If $S = B$ occurs:

→ Bank defaults at $t=1$, activating the deposit insurance

→ As the consumer always gains the returns $(1+r)D$, the bank can attract customers even with its risk portfolio.

Key fact: It can happen that,

$$D > P_A Q_A + P_B Q_B.$$

or

$$D - \underbrace{(P_A Q_A + P_B Q_B)}_{\text{value of bank's portfolio}} = \text{value of deposit insurance to the bank.}$$

<u>Expected Profits</u>

Assume $Q_A > \bar{Q}$, $Q_B < \bar{Q}$.

$$= \pi_A \max\{\underbrace{Q_A - (1+r)D, 0}_{>0}\} + \pi_B \max\{Q_B - (1+r)D, 0\}$$

$$= \pi_A (Q_A - (1+r)D\} > 0$$

Maximize expected profits at $\underbrace{Q_A = \frac{D}{P_A}}$, $Q_B = 0$

very risky!

$\Rightarrow$

$$E(\text{profits}) = \pi_A D\left(\frac{1}{P_A} + \frac{1}{P_A + P_B}\right) > 0$$

Conclusion

- Banks will want to grow as large as they can and take the riskiest portfolio possible, exposing government to all of the risk.
- Without deposit insurance and regulation, bankruptcy doesn't occur since banks take on no risk, or depositors would flee.
- How to fix: banking regulation on capital requirements or on riskiness of portfolios.

Diamond-Dybvig.

Model of Bank panics, no moral hazard.
- Benefits of societal risk-sharing achieved through financial intermediaries
- Individuals make best responses to their conjectures about aggregate behavior given private info.
- Has multiple equilibria. (i.e. conjectures and responses coinciding)
- The "bad" equilibria is interpreted as a banking panic. Gov't policy can help select "good" o

3 periods: $t = 0, 1, 2$.

- Large #, D, of depositors with one unit of good at time 0. Live for 3 periods.
- Are ex-ante identical.

- With probability $\pi \in (0,1)$ each consumer wants to consume at $t=1$ and gets no utility of consumption at $t=2$, so chooses $c_2 = 0$.
- With probability $1-\pi$ wants to consume at ~~time~~ $t=2$. (Discounting is not strictly necessary)

Assume $u(c) = \frac{1}{1-\gamma} c^{1-\gamma}$.

Interpretation:

1) At time $t=0$, all agents are a-prior identical and do not know their type. Choose investments
2) At time $t=1$, a fraction π of D are revealed as "early" type consumers, $1-\pi$ of D are "late". Interpret as liquidity shock. Private information.

Investment Technology

Investing 1 unit at time 0 gives:

$(t=1)$ 1 unit if the project is terminated at $t=1$

$(t=2)$ $1+r$ units if left until $t=2$.

(i.e. can withdraw to forgo $t=2$ payoff.

If the ~~in~~investment was withdrawn at $t=1$, the good can be stored until $t=2$ without any returns/loss/gain through an outside market

Timing

time	0	1	2	
input/output	$1 \rightarrow$	1		← early withdrawal
	$1 \longrightarrow$		$1+r$	← maturing investment
		$1 \rightarrow$	1	← outside storage.

Remarks,

1) Preference shocks π intended to capture "liquidity shocks"; impulses for early withdrawal

2) The returns of $1 < 1+r$ for early withdrawal mimic cost of financial intermediary to do premature liquidation of assets

3) There are a large, continuum of D, scope for social insurance arrangement

→ A bank.

Autarky

If every individual is alone:

1). At $t=0$, invest 1 in the investment technology

2) At $t=1$, if "early" type, withdraws all to get $c_1 = 1$,

if "late" type, leaves the investment until mature and consumes $c_2 = (1+r)$ $t=2$.

Note:

$$\frac{u'(c_1)}{u'(c_2)} = \frac{1}{(1+r)^{-\gamma}}$$ in the autarky allocation, γ is distorting here

Planner

Let c_1 = consumption of type $t=1$ consumption

c_2 = " of type $t=2$ consumption.

Let the planner choose c_1, c_2 to maximize ex-ante expected utility.

$$\pi u(c_1) + (1-\pi) u(c_2)$$ since π proportion of early.

s.t. resource constraint:

12

The full problem:

$$\max_{c_1, c_2} \pi u(c_1) + (1-\pi) u(c_2)$$

$$\text{s.t. } \underbrace{(1-\pi)c_2}_{\text{splits between}} = \underbrace{(1+r)}_{\text{return}} \underbrace{(1-\pi c_1)}_{\text{amount left after withdrawals}}$$

Resource control

$c_2 \geq c_1$, (incentive constraint, otherwise type 2 says they are type 1 but store in bank on their own.
"truth telling"
Necessary due to hidden information.

$$\mathcal{L} = \pi u(c_1) + (1-\pi) u(c_2) + \theta \left(1 - \pi c_1 - \frac{1-\pi}{1+r} c_2\right]$$

LM.

$$\Rightarrow u'(c_1) = \theta,$$

$$u'(c_2) = \theta \frac{1}{1+r}$$

$$\Rightarrow \frac{u'(c_1)}{u'(c_2)} = \frac{1}{1+r}$$

Different from autarky if $\gamma \neq 1$,
i.e. risk averse.
i.e. room for smoothing

if $u'(c) = c^{-\gamma} \Rightarrow$

$$\left(\frac{c_2}{c_1}\right)^{\gamma} = 1+r \Rightarrow c_2 = c_1 (1+r)^{\frac{1}{\gamma}}$$

This is incentive compatible, $c_2 > c_1$, if $\gamma \geq 1$

substitute into feasibility,

$$1 = \pi c_1 + \frac{1-\pi}{1+r}(1+r)^{\frac{1}{\gamma}} c_1$$

$$\Rightarrow \boxed{c_1 = \frac{1}{\pi + \frac{1-\pi}{(1+r)^{1-1/\gamma}}}}$$

If $\gamma > 1 \Rightarrow c_1 > 1$

and $c_2 < 1+r$.

Compare to autarky allocation: $c_1 = 1$, $c_2 = 1+r$,

more smoothing of consumption.

(Similar techniques work for $0 < \gamma < 1$.

Can this risk sharing be done with a banking deposit contract?

→ will assume a sequential service contract

a "first come, first served".

Let $q = c_1$ from planning problem.

Let D = deposits

W = withdrawals at $t=1$

Bank offers q to early withdrawers

and $\max\{\underbrace{D - qW}_{\text{whatever is left}}, \underbrace{0}_{\text{bankrupt.}}\}\underbrace{(1+r)}_{\text{interest on this.}}$ to late withdrawers

- there is now the possibility that late types withdraw early, because they are worried about bankruptcy.

- If only the early types withdraw:

$W = \pi D.$

Then the payout to late is:

$$(1+r)\left[D - q\,W\right] = (1+r)\,D\,(1-\pi q)$$

Divide by $\underbrace{(1-\pi)D}_{\text{mass of type 2.}}$; use $q = c_1$ from planner.

$$\frac{1+r}{1-\pi}(1-\pi c_1) = c_2$$

This will be the same as in planner, $1 < c_2 < 1+$

So this planner's problem can be implemented with $q = c_1$ if all type 2 think other type 2 will wait
$\rightarrow$ Equilibrium!

<u>However:</u>
Is there another equilibrium with bank runs?

- Same setup, if $qW < D$, no problem, can pay all early adopters. But if $qW > D$, can't pay everyone.

Will pay first "x" to the bank to withdraw where $qx = D \Rightarrow$ $\boxed{x = \frac{D}{q}}$ $< D$

since > 1

In that case, the fraction of D people getting paid is: $\frac{X}{D} = \frac{1}{q}$.

and fraction getting 0 is $1-\frac{1}{q}$.

Cases

- Early types always withdraw
- If a late type expects all to run to the bank:

money run out.

$$\mathbb{E}(\text{running}) = q \cdot \frac{1}{q} + 0 \cdot \underbrace{\left(1-\frac{1}{q}\right)}_{\text{got late}} = 1$$

got q lucky, got early

$$\mathbb{E}(\text{not running}) = 0$$

Summary: 2 equilibrium.

1) No type 2 run to bank as they don't expect others to. Everyone paid socially optimal allocation. (Deviating to run to bank less profitable)

2) Everyone expects everyone to run to the bank, and it is confirmed in equilibrium.

Solution

Deposit Insurance:

- Gov't promises to pay out q to everyone who runs to the bank, even if the bank goes broke.
- In equilibrium, there will be no runs and it costs the gov't nothing. Only in off equilibrium that money is transferred.
- Hence, in absence of moral hazard, deposit insurance and bailouts prevent "bad" equilibria