Diamond-Dybvig (1983) model

- A model of banking.
- Financial instability (bank runs).
- *Maturity mismatch*: long-term assets vs short-term liabilities.
- Justifies deposit insurance schemes.
- 2022 Nobel Prize (with Ben Bernanke).

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Prize share: 1/3

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Assumptions

- One-good economy with a continuum of agents.
- Three periods (0, 1 and 2).
- Each agent endowed with 1 good in period 0.
- If 1 good invested until period 2, yields $R > 1$ goods.
- Two types of agents
  - Type-a: values only consumption in period 1
  - Type-b: values consumption in both periods
- Share of type-a = θ
- Individual learns its type in period 1, but not visible to others.

Utility functions

Utility of a type-a individual:

$$U^a = \ln c_1^a$$

Utility of a type-b individual:

$$U^b = \rho \ln(c_1^b + c_2^b)$$

where $0 < \rho < 1$ and $\rho R > 1$.

Benchmark case 1: Autarchy

- Agents cannot trade, each just manages her own wealth.
- Optimal choice of type-a agents:
  - Consume 1 in period 1.
  - Consume 0 in period 2.
- Optimal choice of type-b agents:
  - Consume 0 in period 1.
  - Consume R in period 2.
- Ex-ante expected utility (computed at period 0):

$$E(U^{AUTARCHY}) = \theta \ln 1 + (1-\theta)\rho \ln R$$

$$= (1-\theta)\rho \ln R$$

- Type-b gets more consumption than type-a.

Benchmark case 2: Social planner

- Social planner maximizes individual's ex-ante expected utility.
- Will obviously set $c_2^a = 0$ and $c_1^b = 0$.
- Share of total endowments liquidated early: θc_1^a.
- Share of total endowments kept invested: $1 - \theta c_1^a$.
- So, the social planner problem is:

$$\max_{c_1^a, c_2^b} E(U) = \theta \ln c_1^a + (1-\theta)\rho \ln c_2^b \quad (1)$$

$$\text{s.t.} \quad (1-\theta)c_2^b = (1-\theta c_1^a)R \quad (2)$$

Socially-optimal allocation

- Substituting the resource constraint into expected utility:

$$\max_{c_1^a} E(U) = \theta lnc_1^a + (1-\theta)\,\rho\left[\ln\left(1-\theta c_2^a\right) + \ln R - \ln\left(1-\theta\right)\right]$$

- Solution:

$$c_1^{a\star} = \frac{1}{\theta + (1-\theta)\rho} > 1$$

$$c_2^{b\star} = \frac{\rho R}{\theta + (1-\theta)\rho} < R$$

- c_1^a higher than in autarchy case, c_2^b lower.
- Social planner transfers some resources in favor of type-a.
- Reason: type-a likes consumption more ($\rho < 1$).
- But still $c_2^{\star b} > c_1^{\star a}$.

Case 3: A bank

- At time 0, individuals deposit their endowments in the bank.
- Can withdraw $c_1^{a\star} > 1$ at period 1.
- Funds that are not withdrawn are invested by the bank.
- All returns are divided up between remaining depositors in period 2:

$$c_2 = \frac{1 - \phi c_1^{\star a}}{1 - \phi}, \text{ where } \phi \text{ is the share of agents withdrawing early}$$

  - So the return from holding until maturity depends (negatively) on the share that withdraws early.
- If bank cannot meet all period 1 withdrawals, it gives $c_1^{a\star}$ to some and 0 to the rest.

The choice to withdraw or hold

- Will depositors withdraw or hold?
- Type-a will always want to withdraw in period 1.
- Type-b will hold if she expects $c_2 > c_1^{a\star}$.
- So a type-b agent will hold if the following is expected to be true
$$c_2 = \frac{1 - \phi c_1^{\star a}}{1 - \phi} > c_1^{\star a}$$
- This holds if ϕ is not too high.
- Type-b agent will hold if they expect enough other people to hold too.

The ‘good’ equilibrium

- The following is an equilibrium outcome:
  - Type-a individuals withdraw and all get $c^{a\star}$
  - Type-b individuals hold and receive $c_2 = \frac{1-\theta c_1^a}{1-\theta} R = c_2^{b\star}$.
- Nash Equilibrium: If type-b expects $\phi = \theta$, best response is holding.
  - because $c_2^{b\star} > c_1^{a\star}$.

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  - because $c_2^{b\star} > c_1^{a\star}$.
- The bank *can* realize the social optimum (maximize the expected utility of a representative agent).
- Basically, bank provides insurance against the possibility that you might end up being type-a.

The ‘bank run’ equilibrium

- However, also the following is an equilibrium:
  - Everybody tries to withdraw
  - Since $c_1^{a\star} > 1$, bank cannot meet all withdrawals.
- Nash equilibrium: if you expect everybody else to try to withdraw, you are better off trying to withdraw too.
  - with ϕ close to one, c_2 is close to zero.

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- Nash equilibrium: if you expect everybody else to try to withdraw, you are better off trying to withdraw too.
  - with ϕ close to one, c_2 is close to zero.
- Bank run can be a self-fulfilling prophecy: the expectation that everyone will withdraw causes everyone to withdraw.
- Many examples in history (recently Northern Rock 2007, Silicon Valley Bank 2023)

- *Liquidity mismatch* is the source of the problem: the bank uses short-term borrowing to finance long-term investment.
- A bank run can happen even if the bank does nothing wrong, just because of self-fulfilling expectations.
- Some possible solutions to eliminate the bad equilibrium:
  1. *Suspension of payments*: bank pays $c_1^{a\star}$ to a maximum of θ agents, the others are forced to wait.
  2. *Deposit insurance:* If bank doesn't have enough funds to pay $c_2^{b\star}$, government will pay them (financed by taxes on type-a agents).
  3. *Lender of last resort:* CB lends resources to the bank in case $\phi > \theta$, so the bank can pay all depositors and keep a share θ of its investments, which will be used to repay depositors who hold and the CB loan.