Economics of Banking
Lecture 16

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Investment projects may have a liquidation value:

Two banks in two periods $t = 0, 1, 2$.

Investment: $R$ in next period with probability $\pi$, 0 otherwise.

Payoffs independent over time, but industry-dependent.

*Banks have specific skills:* When the investment is done by a non-bank, it yields $R - \Delta$.

Banks have fully insured deposits.

Bank failures

Expected net outlays of the insurer:

1. **FF** (two failures): Banks sold to private investors, paying at most

   $$ p = \pi(R - \Delta - 1) $$

2. **SF** or **FS** (one fails and the other succeeds): The other bank which take over the assets and can get

   $$ \bar{p} = \pi(R - 1) $$

   but may pay less, namely $p^*$ with

   $$ p < p^* < \bar{p}. $$

3. **SS** (both banks succeed): no liquidation.
Insurance premium

The premium depends on the correlation between banks.

If they invest in the same industry, then probability of FF at $t = 1$ is $\pi$.

Expected net outlays $q_s$ of the insurance:

$$q_s = (1 - \pi)(1 - p),$$

If they invest in different industries, then expected net outlays are instead

$$q_d = \pi(1 - \pi)(1 - p^*) + (1 - \pi)^2(1 - p) = q_s - \pi(1 - \pi)(p^* - p).$$

Fair premium depends on correlation!

Other factors influencing premium

Suppose that bank 1 is small and bank 2 is large:

If 1 fails, 2 may take over at some price $p^*$ with $p < p^* < \bar{p}$, and the expected net outlays of the insurance is

$$q^* = \pi(1 - \pi)(1 - p^*) + (1 - \pi)^2(1 - p) < (1 - \pi)(1 - p),$$

If 2 fails, 1 is too small to take over its investments, and the fair premium for 2 is $(1 - \pi)(1 - p)$.

Thus, the fair premium is smaller for 1 than for 2.
Possibility of bailout

Suppose that there is a lender of last resort (next chapter), supplying credits to banks at social cost $c$.

Bailing out if FF gives $\pi R - 1 - c$ per bank, liquidating gives a loss of $\pi \Delta$.

Premium if banks choose the same industry are

$$ q_s = (1 - \pi) \left[ (1 - p) + \min\{\pi \Delta, c\} \right] $$

and if different industries

$$ q_d = \pi (1 - \pi) (1 - p^*) + (1 - \pi)^2 \left[ (1 - p) + \min\{\pi \Delta, c\} \right]. $$

We have $q_s > q_d$, $q_s > q_d$, and $q_s > q_d$. Finally:

$$ q_s - q_d > q_s - q_d, $$

Difference becomes greater when all costs are taken into consideration.

Incentive compatibility

Premiums $\hat{q}_s$ and $\hat{q}_d$ designed so that banks to choose uncorrelated investments:

Profits if the banks invest in the same industry:

$$ \Pi_s = \pi E \left[ \tilde{n}_2 | SS \right] + (1 - \pi) E \left[ \tilde{n}_2 | FF \right] - \hat{q}_s, $$

and if they invest in different industries

$$ \Pi_d = \pi E \left[ \tilde{n}_2 | SS \right] + \pi (1 - \pi) E \left[ \tilde{n}_2 | SF \right] + (1 - \pi)^2 E \left[ \tilde{n}_2 | FF \right] - \hat{q}_d. $$

We have

$$ E \left[ \tilde{n}_2 | SF \right] = E \left[ \tilde{n}_2 | SS \right] + (\bar{p} - p^*), $$

so that

$$ \Pi_d = \pi E \left[ \tilde{n}_2 | SS \right] + \pi (1 - \pi) (\bar{p} - p^*) + (1 - \pi)^2 E \left[ \tilde{n}_2 | FF \right] - \hat{q}_d. $$
Incentive compatibility II

Then

$$\Pi_s - \Pi_d = \pi (1 - \pi) \left[ \mathbb{E} \left[ \tilde{n}_2 | FF \right] - (\bar{p} - p^*) \right] + \hat{q}_d - \hat{q}_s.$$  

and we can solve to get

$$\hat{q}_s = \pi (1 - \pi) \left[ \mathbb{E} \left[ \tilde{n}_2 | FF \right] - (\bar{p} - p^*) \right] + \hat{q}_d.$$  

Surcharge for correlated investments depends on the subsidy received through a bailout, which is

$$\mathbb{E} \left[ \tilde{n}_2 | FF \right]$$  

and on discount given to the surviving bank if only one failure.

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Another model of banking

There are $N$ households and $\mu$ banks, each endowed with 1 unit of money.

Investment gives a payoff $R > 0$ with probability $p_L$, 0 otherwise.

Households may invest on their own or sign a (deposit) contract with a bank taking care of investment.

Banks can choose to be sound: Success probability is $p_H = p_L + \Delta p > p_L$ at a cost $C$.

The households cannot observe whether a bank is sound or unsound.

Banks are allowed to invest their own unit and $k - 1$ units of deposit money.
**Incentive compatibility**

Banks get a fee $Q$ from the depositors.

Banks taking deposits $k$ will be sound only if

$$[R + Q(k - 1)]p_H - Ck \geq [R + Q(k - 1)]p_L,$$

or equivalently

$$Q \geq \frac{Ck - R\Delta p}{(k - 1)\Delta p}$$

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**Household demand for deposits**

If households believe that the fraction of sound banks is $g$, then deposits used only if

$$Q \leq \frac{Rg\Delta p}{p_L + g\Delta p} = R - \frac{Rp_L}{p_L + g\Delta p}. \tag{1}$$

We get a region of feasible $(k, Q)$-pairs:
Deposit insurance collects taxes from banks, depositors and individual investors, tax rates are $\tau_j$, for $j = B, D, S$.

Tax revenue is

$$T = \mu \tau_B + N \rho \tau_D + N(1 - \rho) \tau_S.$$  

with $\rho$ fraction of households being depositors.

Each bank has $1 - \tau_B$ and can initiate investments to the amount of $k(1 - \tau_B)$, $(k - 1)\mu(1 - \tau_B)$ comes from depositors and from $T$, assume $T < (k - 1)\mu(1 - \tau_B)$.

After-tax wealth of depositors is $N(1 - \tau_D)$ and not all consumers can be depositors, so

$$\rho = \frac{(k - 1)\mu(1 - \tau_B) - T}{N(1 - \tau_D)} = \frac{\mu[k(1 - \tau_B) - 1]}{N(1 - \tau_S)} - \frac{\tau_S}{1 - \tau_S}.$$  

Expected return from investing $T$, $T(R - Q)(\rho_L + g \Delta p)$, can be transferred to depositors who get

$$\frac{T}{\rho N}(R - Q)(\rho_L + g \Delta p)$$  

if investment failed.

*Bank incentives* are as before (measured per unit invested), but household condition for bank use is

$$\rho \left[ \frac{T}{\rho N} + (1 - \tau_D) \right] (R - Q)(\rho_L + g \Delta p) + (1 - \rho)(1 - \tau_S) R \rho_L \geq R \rho_L (1 - \tau_S).$$
New region of feasible contracts

This condition can be rearranged to

\[ Q \leq R - \frac{R_{pL}}{p_L + g \Delta p} \frac{\mu(k(1 - \tau_B) - 1) - N_T S}{\mu(k(1 - \tau_B) - 1) + \mu T_B}. \]

Here

\[ \frac{\mu(k(1 - \tau_B) - 1) - N_T S}{\mu(k(1 - \tau_B) - 1) + \mu T_B} \leq 1 \]

increases in \( k \) towards 1.

Tax financed deposit insurance increases investment
A case where deposit insurance is suboptimal

As usually, there are three dates, $t = 0, 1, 2$.

Investments:
1. A storage technology,
2. A risky technology, one unit at $t = 0$ yields $\tilde{R}$ at $t = 2$, with

$$\tilde{R} = \begin{cases} \frac{1}{q}R & \text{with probability } q \\ 0 & \text{with probability } 1 - q \end{cases}$$

where $q$ can be chosen by the bank (private information).

Expected payoff is $R$ and variance is

$$\sigma^2(\tilde{R}) = q\left(R - \frac{1}{q}R\right)^2 + (1 - q)R^2 = \frac{1 - q}{q}R^2,$$

decreasing in $q$, 0 when $q = 1$.

Depositors’ choices

Households are impatient with probability $\pi$.

If the contracts satisfy standard constraints

$$\pi c_1 = 1 - I,$$
$$\left(1 - \pi\right) c_2 = I\tilde{R},$$

then date 2 expected utility is

$$qu\left(\frac{l}{1 - \pi} - \frac{1}{q}R\right) \leq u\left(q\frac{l}{1 - \pi} - \frac{1}{q}R\right) = u\left(\frac{l}{1 - \pi}R\right)$$

by concavity of $u$, so $q = 1$ is optimal.

Socially optimal investment is found by maximizing expected utility subject to (3).
Optimal contracts

Assume that banks maximize the utility of the representative consumer. The contract will specify withdrawal $c_E$ at date 1 and withdrawal $c_L$ at date 2, outcome risk must be absorbed by the bank.

There is a bank run if depositors observe a signal (a “sunspot”) at $t = 1$, probability of this signal is $p$.

If the fraction of depositors observing the signal is $\mu$, then we maximize

$$(1 - \mu p) [\pi u(c_E) + (1 - \pi) u(c_L)] + \mu \pi \hat{\pi} u(c_E).$$

with $\hat{\pi}$ is the probability that bank can satisfy the fraction $\mu$ of depositors,

$$\hat{\pi} = \frac{1 - L(1 - L)}{c_E}. \tag{4}$$

Banks will have no incentive to choose risky projects, they compete for depositors who are risk averse.

Introducing deposit insurance in this model

Deposit insurance promises $D$ to depositors in bankrupt banks.

Then bank runs are prevented if $D$ is large enough, but:

Bankruptcy may occur also if the bank has a risky project which fails.

The insurance scheme must be financed, assume that this is done by taxing depositors.

The tax $T$ collected should satisfy

$$TR = (1 - \pi)pD.$$  

If there no or few banks fail, surplus $B$ will be distributed among depositors in surviving banks.
A deviating bank

Consider a case where all banks have chosen the safe project with \( q = 1 \).

If a bank chooses \( q < 1 \), then the deposit contract should be suitably revised.

Assume that the bank proposes a contract with a markup \( 1/q \) on the repayment at \( t = 2 \).

The expected utility of a patient depositor is

\[
qu \left( \frac{1}{q} \left[ c_L - \frac{TR}{1 - \pi} \right] + \frac{B}{1 - \pi} \right) + (1 - q)u(D).
\]

Since we consider a deviation from \( q = 1 \), bankruptcy will occur only due to failed projects, so probability probability \( 1 - q \).

Also, since only one bank deviates, we have that \( B = TR \).

Thus \( q = 1 \) is not an equilibrium choice when there is deposit insurance.

Alternative: Liquidity provision

Banks can borrow specially issued money with their assets as collateral.

In next period, banks can change back to their original assets, if not able to pay back, it defaults.