

Economics of Banking

Lecture 15

April 2025

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Another extension of the DD model

Source of uncertainty: *Random timing* of investment

Projects finish at 1 with probability θ and at 2 with probability $1 - \theta$.

Type of investment revealed at $t = \frac{1}{2}$.

Entrepreneurs get R , banks only γR .

Contracts in the model

Banks demand repayment γR at $t = 1$.

At $t = \frac{1}{2}$ projects may be *restructured* to give l_1 at 1, l_2 at 2,
 $l_1 + l_2 < 1 < \gamma R$.

Banks are funded by depositors, who may run the bank (at date $\frac{1}{2}$ or later).

There is an *interbank loan market* at date 1 – banks and entrepreneurs may lend money to banks at rate r .

Bank choices

At $t = 1$, bank maximizes

$$\theta\gamma R + \mu(1 - \theta) \left(l_1 + \frac{l_2}{r} \right) + (1 - \mu)(1 - \theta) \frac{\gamma R}{r}$$

wrt. $\mu \in [0, 1]$, fraction of late projects to be restructured.

By linearity optimal μ is either 0 (no restructuring) or 1 (all late projects restructured).

A **bank run** may occur:

Number of late projects in some bank very large

→ interbank market reacts with high repayment rates

→ banks otherwise solvent will be subject to runs.

Conditions for bank run

Entrepreneurs use outcome $(1 - \gamma)R$ from the early projects

If $r \geq 1$ entrepreneurs are lenders, and if

$$l_1 + \frac{l_2}{r} < \frac{\gamma R}{r},$$

banks will be borrowers.

Bank insolvent due to many late projects is subject to a run

Therefore projects must to be restructured at $t = \frac{1}{2}$

Entrepreneurs of early projects financed lose profits

→ Reduction in supply of funds

→ This changes the solvency position of other banks. So bank runs are *contagious*.

Shadow banks in a dynamic framework

Impatient depositors in a shadow bank are repo traders not willing to renew the contract. What can the bank do?

Economy over an infinitely many time periods $\dots, t-1, t, t+1, \dots$

At each t , investors enter with 1 unit of money.

They live in three periods: at $t+1$ a fraction π and want the investment back.

The technology transforms input I_t at date t to output at date $t+2$ is $R I_t$ for $I_t \leq \bar{I}$.

Repo trade

At t the bank sells securities b_t from the young investors at date t ,

Promises to buy them back for $r_{1,t}$ at $t + 1$ and $r_{2,t}$ at $t + 2$.

Cash flow at date τ will be

$$\Pi_\tau = RI_{\tau-2} + b_\tau - \pi r_{1,\tau-1} b_{\tau-1} - (1 - \alpha) r_{2,\tau-2} b_{\tau-2} - I_\tau.$$

We look at at *steady state* equilibrium (so that $(r_{1,t}, r_{2,t}) = (r_1, r_2)$):

Then repurchase rates satisfy

$$r_2 = r_1^2.$$

Equilibrium

Find the variables r , I and b :

If $r > 0$ then $b = 1$, and if $\Pi > 0$ then $I = \bar{I}$.

Discounted profits are

$$\beta^2(R - (1 - \pi)r^2) - \beta\pi r.$$

It can be shown that $r = \frac{1}{\beta}$.

Using this equilibrium rate, we find the profits of the bank as

$$\Pi = (R - 1)\bar{I} + 1 - \pi r - (1 - \pi)r^2 = (R - 1)\bar{I} + 1 - \frac{\pi}{\beta} - \frac{1 - \pi}{\beta^2},$$

If β is close to 1, then profits are positive.

Repo run

Suppose that t , the fraction $1 - \pi$ of patient investors from $t - 1$ want their money.

Then there are several possibilities:

- (1) Current profits are large enough:

$$(R - 1)\bar{I} \geq r + (1 - \pi)r^2.$$

No run will occur.

Using new funding

(2) If new repo trades can be initiated, then the bank may meet the demand by reducing investment:

If \bar{I} is reduced by $\frac{\Pi}{R}$, then profits in $t + 2$ are

$$R \left(\bar{I} - \frac{\Pi}{R} \right) - \bar{I} + 1 - \pi r - (1 - \pi)r^2 = 0,$$

and the bank is back at the steady state after two rounds.

By the same argument, investment at t can be reduced even more, namely to the extent that it needs $\frac{\Pi}{R}$ at $t + 2$,

Further reduction

Repeating the argument, date t can be reduced by

$$\frac{1}{R}\Pi + \frac{1}{R^2}\Pi + \dots = \frac{R}{R-1}\Pi$$

with return to the steady state path.

(3) Also profits at $t+1$ and $(1-\pi)r^2$ can be used at $t+2$, so date t investment can be reduced also with this amount.

Consequently, the run can be prevented if

$$(1-\pi)r \leq \frac{R+1}{R-1}\Pi + \frac{1}{R}(1-\pi)r^2.$$

Otherwise, the bank must close down.

Pricing deposit insurance

(1) The simplistic approach

Fair premium: If the risk of losing the deposits is p , then premium should be pD .

(2) The structural approach (Merton):

Deposit insurance is a *put option* on the assets:

The bank has obtained an *option* to sell its assets at date T at strike price $De^{r_D T}$.

Using option pricing

If the assets follow a geometric Brownian motion,

$$\frac{d\tilde{L}}{\tilde{L}} = \mu dt + \sigma dZ,$$

then by Black-Scholes the value of the deposit insurance is

$$P^* = De^{(r_D-r)T} N(d_2) - LN(d_1)$$

with

$$d_1 = \frac{\ln\left(\frac{De^{(r_D-r)T}}{L}\right) - \frac{1}{2}\sigma^2 T}{\sigma\sqrt{T}}, \quad d_2 = d_1 + \sigma\sqrt{T},$$

Ratio of premium and deposit (potential loss) depends loans-deposits ratio and asset volatility.

Moral hazard

A simple example:

Bank has equity E_0 , receives deposits D , and contract loans L_0 , pays premium P .

Next period, loans are \tilde{L} and value of the bank is

$$\tilde{E} = \tilde{L} - D + \max\{0, D - \tilde{L}\},$$

Inserting $D + E_0 = L_0 + P$ we get that profit is

$$\tilde{\Pi} = \tilde{E} - E_0 = (\tilde{L} - L_0) + [\max\{0, D - \tilde{L}\} - P].$$

How to maximize profits

Assume that

$$\tilde{L} = \begin{cases} A & \text{with probability } p \\ 0 & \text{otherwise.} \end{cases}$$

Then

$$E \tilde{\Pi} = E \left[\tilde{E} - E_0 \right] = (pA - L_0) + [(1 - p)D - P]. \quad (1)$$

Suppose that bank chooses engagements from loans (p, A) all with the same expected payoff.

Then p is chosen as small as possible!

Is fair pricing possible?

Let $D(p)$ be optimal deposits given the investment choices of the bank.

A pricing rule $P(D)$ is fair if

$$P(D(p)) = (1 - p)D(p)$$

for all p . Differentiating both sides we get

$$P'(D(p))D'(p) = (1 - p)D'(p) - D(p). \quad (2)$$

Since $D(p)$ is the level of D which maximizes profits
 $(pA - L_0) + (1 - p)D(p) - P(D(p))$, we have

$$(1 - p) - P'(D(p)) = 0.$$

Multiply by $D'(p)$ and insert (2) to get

$$D(p) = 0$$

for all p , a contradiction.