ROLE OF BANKS

- Select/monitor borrowers
  - Sharpe (1990)
- Reduce
  - asymmetric info
  - idiosyncratic risk
  by bundling assets/mortgages (security design)
  - Opaqueness is not necessarily bad
  - Gorton-Pennachi (1990)
- Insurer of idiosyncratic liquidity shocks
  - Diamond-Dybvig (1983), Allen-Gale, ....
Traditional Banking

- Role of banks

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Shadow Banking System

- Originate & distribute
  - Securitization
    - Pooling
    - Tranching
    - Insuring (CDS)
  - Dual purpose
    - Tradable asset
    - Collateral
  - feeds repo market for leveraging

Loans (long-term)
SIV/Conduit
AAA
BBB
…
Equity
**Traditional Banking**

- Role of banks

**Originate & distribute**

- Securitization
  - Pooling
  - Tranching
  - Insuring (CDS)
- Dual purpose
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*feeds repo market for leveraging*

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MATURITY MISMATCH: DIFFERENT THEORIES

- Diamond-Dybvig (1983)
  - Insure against liquidity shocks (sudden expenditures)

  - Control management – withdraw funds when CEO shirks

- Brunnermeier-Oehmke (2009)
  - Maturity rat race
  - Excessive short-term funding

- Extending leveraging theory
DIAMOND AND DYBVIG MODEL

- Three dates, \( t \in \{0, 1, 2\} \)
- Continuum of ex ante identical agents
- Everyone endowed with one unit good each
- Assume CRRA utility

\[
  u(c) = \frac{1}{1-\gamma} c^{1-\gamma} \quad \gamma > 0
\]

if \( \gamma = 1 \), log utility \( u(c) = \log(c) \)
Two assets are available

- **Short-term project**
  - one unit invested at $t$ gives 1 unit at $t+1$.

- **Long-term project**
  - one unit invested at $t$ gives $R$ units at $t+2$, but only $L \leq 1$ if liquidated early at $t+1$.

### Investment projects

<table>
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<th>t=0</th>
<th>t=1</th>
<th>t=2</th>
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<td><strong>Risky investment project</strong></td>
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<tr>
<td>(a) Continuation</td>
<td>-1</td>
<td>0</td>
<td>R&gt;1</td>
</tr>
<tr>
<td>(b) Early liquidation</td>
<td>-1</td>
<td>L</td>
<td>0</td>
</tr>
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<td><strong>Storage technology</strong></td>
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<td></td>
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</tr>
<tr>
<td>(a) From $t=0$ to $t=1$</td>
<td>-1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>(b) From $t=1$ to $t=2$</td>
<td>-1</td>
<td>1</td>
<td></td>
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At date 0, uncertainty over preferences

- With probability $\lambda$, “early consumers” only consume at $t=1$
- With probability $1-\lambda$, “late consumers” only consume at $t=2$

Uncertainty is resolved at date 1.

Agents try to insure themselves against their uncertain liquidity needs.

Independence across individual

No aggregate uncertainty. $\lambda$ of them are “early consumers” with certainty.
**CASE 1: AUTARKY CASE**

- No trading
- Each agent invests
  - \(x\) in the long-term project and
  - \((1-x)\) in the short-term project to maximize ex ante expected utility

\[
\max_x \lambda u(c_1) + (1 - \lambda)u(c_2)
\]

s.t. \(c_1 = xL + (1-x)\)

\(c_2 = xR + (1-x)\)

- Note that \(c_1 \in [L,1], c_2 \in [1,R]\)
- Welfare can be improved if trading of asset is allowed at \(t=1\)
Agents can sell their long-term project at $t=1$
Early consumers will sell their long-asset to late consumers and get short-asset to consume
Price of long-asset should be $p=1$
  - with $p=1$, investors are indifferent between short-term and long-term asset at $t=0$
  - for $p\neq 1$, investors either invest all in short-term asset or all in long-term asset

$\Rightarrow \quad c_1=1, \; c_2=R$. Better than autarky

Can this be improved?
By forming a bank, optimal insurance can be provided

Bank offers a deposit contract \((c^*_1, c^*_2)\) which maximizes the agents’ ex ante utility

\[
\begin{align*}
\max & \quad \lambda u(c_1) + (1 - \lambda)u(c_2) \\
\text{s.t.} & \quad \lambda c_1 = 1 - x \\
& \quad (1 - \lambda)c_2 = Rx
\end{align*}
\]
From the first order condition

\[
\left( \frac{c_1}{c_2} \right)^{\gamma} = \left( \frac{1}{R} \right)^{\frac{1}{\gamma}}
\]

- Mutual fund arrangement is optimal only if \( \gamma = 1 \) (log utility).
- If \( \gamma > 1 \), smoother consumption: \( c_1^* > 1, c_2^* < R \)

However, possibility of bank run
There is a bank run equilibrium where even late consumers withdraw early, fearing that others withdraw.

Let \( y \) be proportion of late consumers who withdraw. Total withdrawal at date 1 is \( \hat{\lambda} = \lambda + (1 - \lambda)y \). Let \( L=1 \).

Sequential servicing constraint!

Payoffs
BANK RUN

- Payoffs

<table>
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<tr>
<th></th>
<th>( \hat{\lambda} \leq 1/c_1^* )</th>
<th>( \hat{\lambda} &gt; 1/c_1^* )</th>
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<tbody>
<tr>
<td>Withdraw</td>
<td>( c_1^* )</td>
<td>( \frac{1}{\hat{\lambda}} )</td>
</tr>
<tr>
<td>Not withdraw</td>
<td>( \frac{1 - \hat{\lambda} c_1^* R_2}{1 - \hat{\lambda}} )</td>
<td>0</td>
</tr>
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</table>

- Bank run is also Nash equilibrium
- How to prevent run?
  - Suspension of convertibility
  - Deposit insurance
- Aggregate risk is introduced $\rightarrow \lambda_L < \lambda_H$
- Uncertainty revealed at $t=1$
- Price of long-asset
  - $p_H$ if $\lambda = \lambda_H$
  - $p_L$ if $\lambda = \lambda_L$
- At $t=0$,
  - aggregate investment in short term project: $1-x$
  - aggregate investment in long term project: $x$
If $\lambda = \lambda_L$, enough “late consumers” (liquidity) to absorb selling from “early consumers”

- $p_L = R$, since
  - if $p_L > R$ even late diuers will sell long-term asset and
  - if $p_L > R$ excessive demand for long asset once L is realized.

If $\lambda = \lambda_H$, too many sellers (“early consumers”) but not enough liquidity (“late consumers”)

- Supply of asset = $\lambda_H x$
- Supply of cash = $(1 - \lambda_H)(1-x)$
- Market clearing, “cash in the market pricing”
  \[ p_H = \frac{(1 - \lambda_H)(1-x)}{\lambda_H x}. \]  
  Note that $p_H < p_L$
A financial institution can borrow
  • from multiple creditors
  • at different maturities

Negative externality causes excessively short-term financing:
  • shorter maturity claims dilute value of longer maturity claims

Externality arises
  • for any maturity structure
  • particularly during times of high volatility (crises)

Successively unravels all long-term financing:
  → A Maturity Rat Race
Risk-neutral, competitive lenders

All promised interest rates
  • are endogenous
  • depend aggregate maturity structure

Debt contracts specifies maturity and face value:
  • can match project maturity: $D_{0,T}$
  • or shorter maturity $D_{0,t}$, then rollover $D_{t,t+\tau}$ etc.
  • lenders make uncoordinated rollover decisions

Maturing debt has equal priority in default:
  • proportional to face value
Financial institution deals bilaterally with multiple creditors:
  • simultaneously offer debt contracts to creditors
  • cannot commit to aggregate maturity structure
  • can commit to aggregate amount raised

An equilibrium maturity structure must satisfy **two conditions:**

1. **Break even:** all creditors must break even
2. **No deviation:** no incentive to change one creditor's maturity
Rollover face value $D_{t,T}$ (promised interest rate)
- is endogenous
- adjusts to interim information

Since default more likely after negative signals:
- On average LT creditors lose
For now: focus on only one possible rollover date, \( t < T \)

\( \alpha \) is fraction of `short-term' debt with maturity \( t \)

Outline of thought experiment:

- Conjecture an equilibrium in which all debt has maturity \( T \)
- Calculate break-even face values
- At break-even interest rate, is there an incentive to deviate?
A SIMPLE EXAMPLE WITH ONE ROLL OVER DATE

- \( \theta \) (investment payoff at T) only takes two values:
  - \( \theta^H \) with probability \( p \)
  - \( \theta^L \) with probability \( 1 - p \)
- \( p \sim \text{uniform on } [0; 1] \), realized at \( t \).
- If all financing has maturity \( T \):

\[
\frac{1}{2} \theta^L + \frac{1}{2} D_{0,T} = 1, \quad D_{0,T} = 2 - \theta^L
\]

- Break-even condition for first \( t \)-rollover creditor:

\[
(1 - p) \frac{D_{t,T}}{2 - \theta^L} \theta^L + p D_{t,T} = D_{0,t}, \quad D_{t,T} = \frac{2 - \theta^L}{2p(1 - \theta^L) + \theta^L}
\]
Deviation payoff from all long-term financing by

\[ \frac{\partial \Pi}{\partial \alpha} = \int_{0}^{1} p [D_{0,T} - D_{t,T}(p)] \, dp = \frac{1}{2} D_{0,T} - \int_{0}^{1} p D_{t,T}(p) \, dp > 0? \]

Deviation from \( \alpha = 0? \)
• Same argument for any maturity structure that involves some amount of long term financing with maturity T.

**Proposition**

**One-step Deviation.** *Under a regularity condition on F(.), in any conjectured equilibrium maturity structure with some amount of long-term financing ($\alpha \in [0; 1]$), the financial institution has an incentive to increase the amount of short-term financing by switching one additional creditor from maturity $T$ to the shorter maturity $t < T$, since $\frac{\partial \pi}{\partial \alpha} > 0$. As a result, the maturity structure of the financial institution shortens to time-$t$ financing.*
MANY ROLLOVER DATES: THE MATURITY RAT RACE

- Up to now: focus on one potential rollover date
  Assume everyone has maturity of length $T$
  Show that there is a deviation to shorten maturity to $t$
- This extends to multiple rollover dates
  Assume all creditors roll over for the first time at some time $\tau < T$
  By same argument as before, there is an incentive to deviate

$\rightarrow$ Successive unraveling of maturity structure
THE MATURITY RAT RACE: SUCCESSIVE UNRAVELING
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Rat race strongest when more information is released at interim dates
  • ability to adjust financing terms becomes more valuable

→ Volatile environments, such as crises, facilitate rat race

Explains drastic shortening of unsecured credit markets in crisis
  • e.g. commercial paper during fall of 2008
1.2 SHORTENING MATURITY: I-BANKS

Investment banks’ main financing in 2007

- Repos 1150.9bn
- Security credit (subject to Reg T)
  - Margin accounts from HH or non-profit 853.5bn
  - From banks 335.7bn
- “Financial” equity 49.3bn

Increase in repo is due to overnight repos!

See also Adrian and Fleming (2005)
1.3 WHY STRUCTURED PRODUCTS?

- **Good reasons**
  - Credit risk transfer risk who can best bear it
    - Banks: hold equity tranche to ensure monitoring
    - Pension funds: hold AAA rated assets due to restriction by their charter
    - Hedge funds: focus on more risky pieces
    - *Problem:* risks stayed mostly within banking system
      - banks held leveraged AAA assets — tail risk

- **Bad reasons - supply**
  - **Regulatory Arbitrage** — Outmaneuver Basel I (SIVs)
    - esp. reputational liquidity enhancements
  - **Rating Arbitrage**
    - Transfer assets to SIV and issue AAA rated papers
    - instead of issuing A- minus rated papers
    - + banks’ own rating was unaffected by this practice
    - ++ buy back AAA has lower capital charge (Basel II)
1.3 WHY STRUCTURED PRODUCTS?

- **Bad reasons - demand**
  - **Naiveté – Reliance on**
    - past low correlation among regional housing markets
      - Overestimates value of top tranches
      - explains why even investment banks held many mortgage products on their books
    - rating agencies - rating structured products is different
      - Quant-skills are needed instead of cash flow skills
      - **Rating at the edge** – AAA tranche just made it to be AAA
  - **Trick your own fund investors – own firm** (in case of UBS)
    - “Enhance” portfolio returns e.g. leveraged AAA positions – extreme tail risk
      - searching for yield (mean)
      - track record building (skewness: picking up nickels before the steamroller)
    - Attraction of illiquidity (no price exists) (fraction of “level 3 assets” went up a lot)
      - difficulty to value CDOs (correlation risk)
        - “mark-to-model”: Mark “up”, but not “down”
        - smooth volatility, increase Sharpe ratio, lower $\beta$, increase $\alpha$
    - Implicit (hidden) leverage
1.4 CONSEQUENCES OF “ORIGINATE AND DISTRIBUTE BANKING MODEL”

- Banks focus only on “pipeline/warehouse risk”
- Deterioration of lending standards
  - Housing Frenzy
  - Private equity bonanza – “going private trend”
    - LBO acquisition spree