Institutional Finance

Lecture 09 : Banking and Maturity Mismatch

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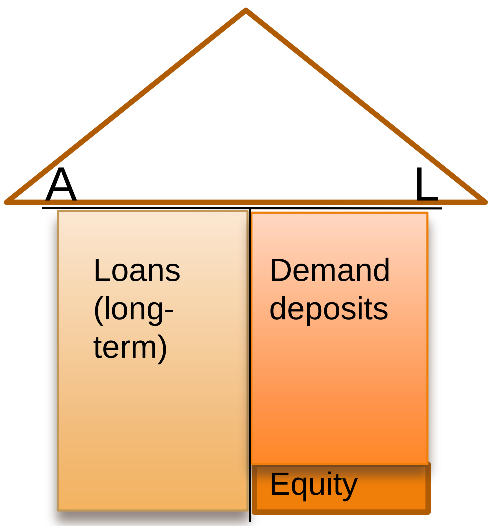
ROLE OF BANKS

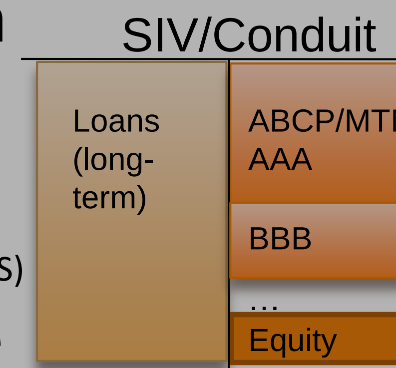
- Select/monitor borrowers
  - Sharpe (1990)
- Reduce
  - asymmetric info
  - idiosyncratic risk

  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



- Originate & distribute
  - Securitization
    - Pooling
    - Tranching
    - Insuring (CDS)
  - Dual purpose
    - Tradable asset
    - Collateral



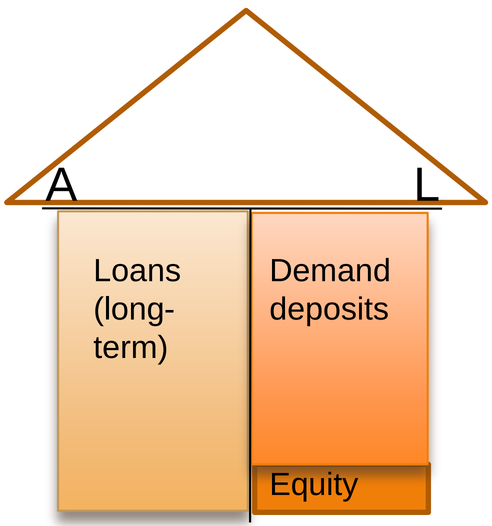
→ *feeds repo market for levering*

- Role of banks

Channel funds	Long-run repayment	Prospect of selling off
Maturity transformation	Retail funding	Wholesale funding (money market funds, repo partners, conduits, SIVs, …)
Info-insensitive securities	Demand deposits	ABCP, MTN, overnight repos, securities lending

CHANGING BANKING LANDSCAPE

- Traditional Banking



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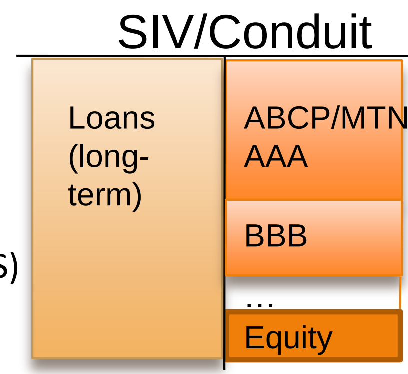

feeds repo market for levering

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MATURITY MISMATCH: DIFFERENT THEORIES

- Diamond-Dybvig (1983)
  - Insure against liquidity shocks (sudden expenditures)
- Calomiris-Kahn (1991), Diamond-Rajan (2001)
  - 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

$$u(c) = \frac{1}{1-\gamma} c^{1-\gamma} \qquad \gamma > 0$$

if $\gamma=1$, log utility $u(c)=\log(c)$

TECHNOLOGY

- 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≤1 if liquidated early at t+1.

Investment projects	**t=0**	**t=1**	**t=2**
Risky investment project			
(a) Continuation	-1	0	R>1
(b) Early liquidation	-1	L	0
Storage technology			
(a) From t=0 to t=1	-1	1	
(b) From t=1 to t=2		-1	1

PREFERENCE SHOCK

- At date 0, uncertainty over preferences
  - With probability λ, "early consumers" only consume at t=1
  - With probability 1-λ, "late consumers" only consume at t=2

$$U(c_1, c_2) = \begin{cases} u(c_1) & \text{with prob } \lambda \\ u(c_2) & \text{with prob } 1-\lambda \end{cases}$$

- Uncertainty is resolved at date 1.

➡ Agents try to insure themselves against their uncertain liquidity needs.

- Independence across individual

➡ No aggregate uncertainty.
λ 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

$$\max_{x} \quad \lambda u(c_1) + (1-\lambda)u(c_2)$$
$$\text{s.t. } c_1 = xL + (1-x)$$
$$c_2 = xR + (1-x)$$

- 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

CASE 2 : MUTUAL FUND ARRANGEMENT

- 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≠1, investors either invest all in short-term asset or all in long-term asset

➡ c_1=1, c_2 =R. Better than autarky

Can this be improved?

CASE 3 : BANK ARRANGEMENT

- 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

$$\max \quad \lambda u(c_1) + (1-\lambda) u(c_2)$$

$$\text{s.t.} \quad \lambda c_1 = 1 - x$$

$$(1-\lambda) c_2 = R x$$

BANK ARRANGEMENT

- From the first order condition

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

- 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

$\hat{\lambda}$

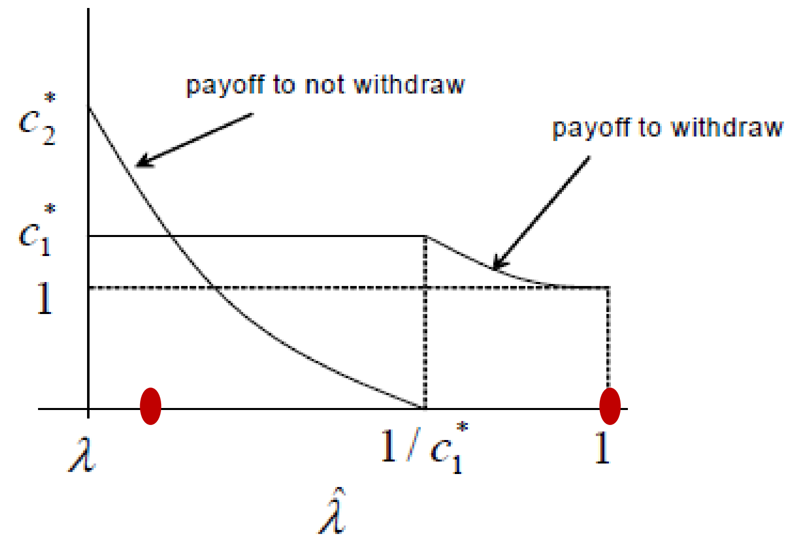
BANK RUN

- 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

	$\hat{\lambda} \leq 1/c_1^*$	$\hat{\lambda} > 1/c_1^*$
Withdraw	c_1^*	$\frac{1}{\hat{\lambda}}$
Not withdraw	$\frac{1-\hat{\lambda}c_1^*}{1-\hat{\lambda}}R_2$	0



- Bank run is also Nash equilibrium
- How to prevent run?
  - Suspension of convertibility
  - Deposit insurance

CASH IN THE MARKET PRICING-ALLEN AND GALE

- 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

PRICE OF LONG ASSET AT T=1

- If $\lambda=\lambda_{L,}$ enough "late consumers" (liquidity) to absorb selling from "early consumers"
  - $p_L = R$, since
    - if $p_L>R$ even late diers 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"

→ $p_H= (1- \lambda_H)(1-x)/ (\lambda_H x)$. Note that $p_H < p_L$

MATURITY RAT RACE

- 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*

MODEL SETUP: CREDIT MARKETS

- 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

MODEL SETUP: CREDIT MARKETS (2)

- 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

INTUITION BEHIND THE DEVIATION

- Rollover face value $D_{t,T}$ (promised interest rate)
  - is endogenous
  - adjusts to interim information

Interim Signal	$D_{t,T}$	default	no default
Negative	high	LT creditors lose	no effect
Positive	low	LT creditors gain	no effect

- Since default more likely after negative signals:
  - On average LT creditors lose

A SIMPLE EXAMPLE WITH ONE ROLL OVER DATE

- For now: focus on only one possible rollover date, $t < T$
- α 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 do deviate?

A SIMPLE EXAMPLE WITH ONE ROLL OVER DATE

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

$$\frac{1}{2}\theta^L + \frac{1}{2}D_{0,T} = 1, \qquad D_{0,T} = 2 - \theta^L$$

- Break-even condition for first t-rollover creditor:

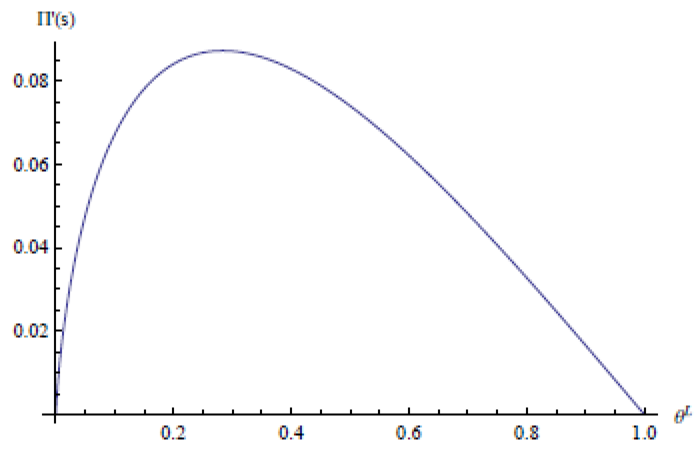
$$(1-p)\frac{D_{t,T}}{2-\theta^L}\theta^L + pD_{t,T} = \underbrace{D_{0,t}}_{=1}, \qquad D_{t,T} = \frac{2-\theta^L}{2p\left(1-\theta^L\right)+\theta^L}$$

A SIMPLE EXAMPLE WITH ONE ROLL OVER DATE

- Deviation payoff from all long-term financing by

$$\begin{aligned}\frac{\partial \Pi}{\partial \alpha} &= \int_0^1 p\left[D_{0,T} - D_{t,T}(p)\right] dp \\ &= \frac{1}{2} D_{0,T} - \int_0^1 p D_{t,T}(p)\, dp > 0?\end{aligned}$$

- Deviation from α=0?



GENERAL ONE-STEP DEVIATION

- Same argument for any maturity structure that involves some amount of long term financing with maturity T.

Proposition

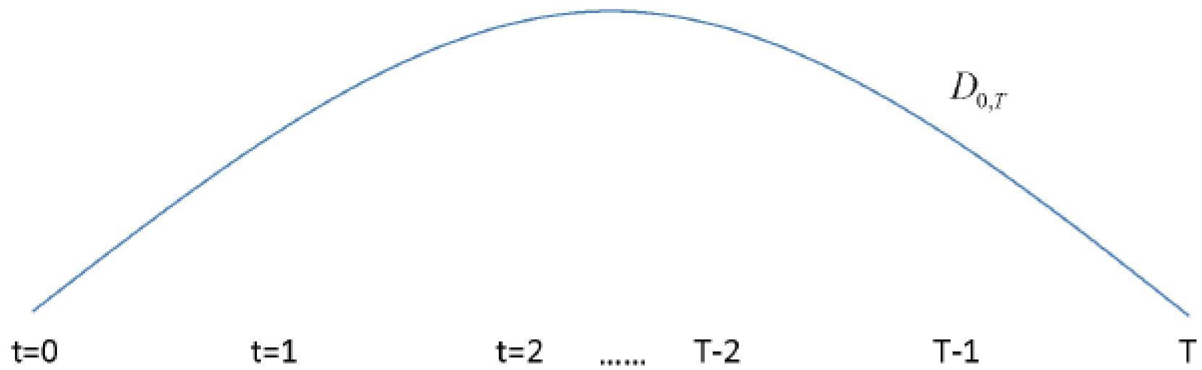
One-step Deviation. *Under a regularity condition on F(.), in any conjectured equilibrium maturity structure with some amount of long-term financing (α ϵ [0; 1)), the financial institution has an incentive to increase the amount of short-term financing by switching one additional creditor from maturity 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

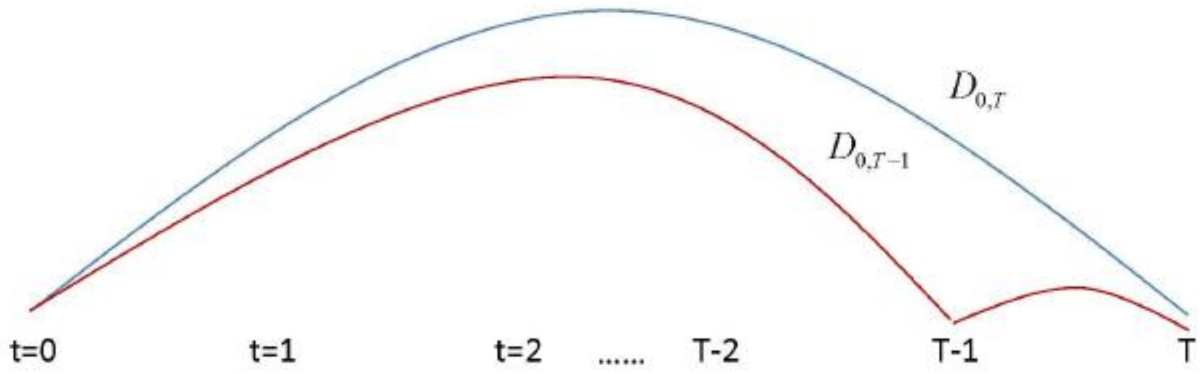
- Up to now: focus on one potential rollover date
  - Assume everyone has maturity of length T
  - Show that there is a deviation to shorten maturity to t
- This extends to multiple rollover dates
  - Assume all creditors roll over for the first time at some time $\tau < T$
  - By same argument as before,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

→ *Successive unraveling of maturity structure*

THE MATURITY RAT RACE: SUCCESSIVE UNRAVELING



THE MATURITY RAT RACE: SUCCESSIVE UNRAVELING



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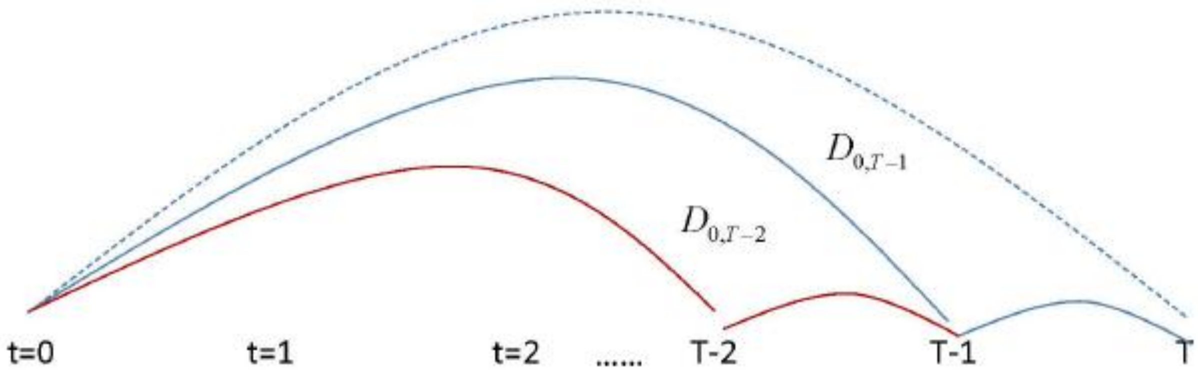

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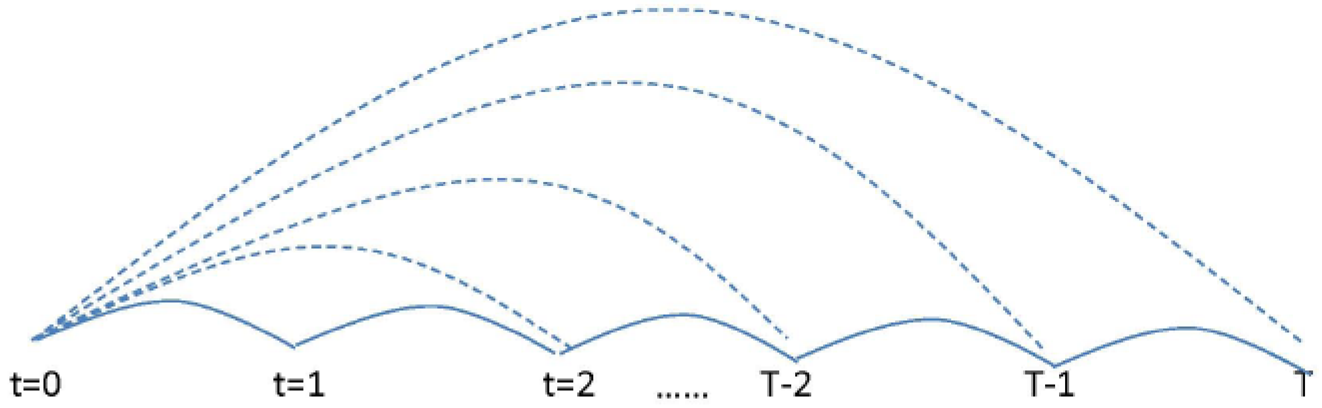


RAT RACE STRONGEST DURING CRISES

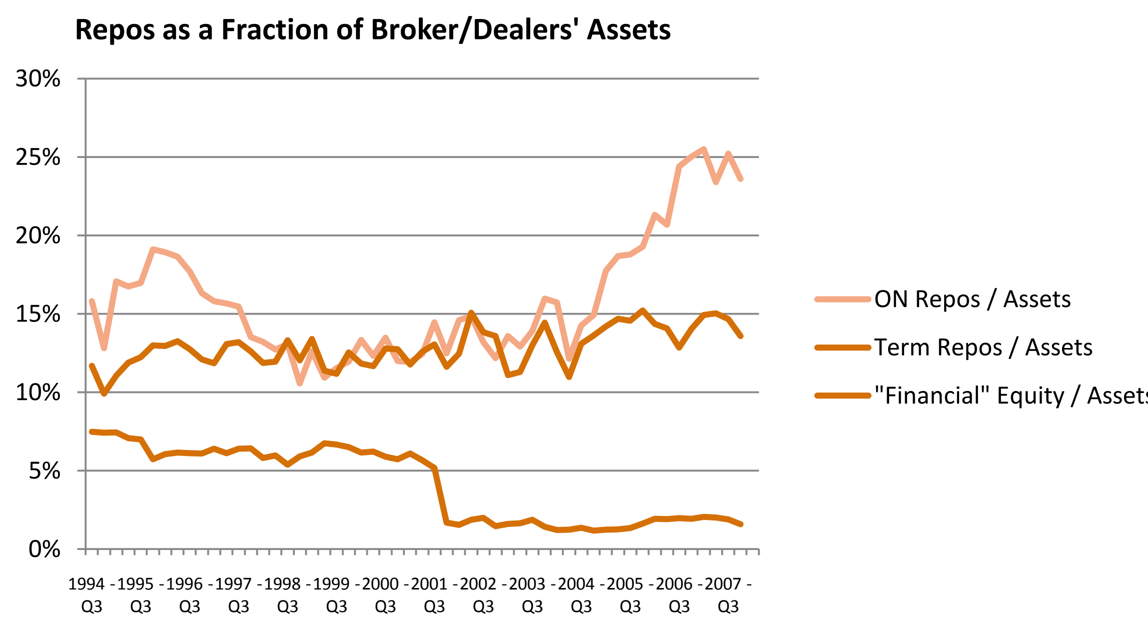
- Rat race stronger when more information is released at interim dates
  - ability to adjust financing terms becomes more valuable

  → *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 tranch 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 tranch 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 β, increase α
    - 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