Institutional Finance

Lecture 07 : Liquidity Spirals, Limits to Arbitrage

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LIMITS OF ARBITRAGE - ILLIQUIDITY

- Market liquidity provision =
  = (risky arbitrage) trading to exploit
    temporary mispricing…

- Very similar – just different language

- Why does temporary "mispricing" persist?

  - Illiquidity refers "more" to high frequency mispricing (daily, weekly)

  - Limits to arbitrage literature refers more to long-run mispricings phenomena

MARGINS

$

- No constraints

Initial Margin (50%) ———————— Reg. T   50 %

- Can't add to your position;
- Not received a margin call.

Maintenance Margin (35%) ——— NYSE/NASD
25% long

                    30% short

- Fixed amount of time to get to a specified point above the maintenance level before your position is liquidated.
- Failure to return to the initial margin requirements within the specified period of time results in forced liquidation.

Minimum Margin (25%)

- Position is always immediately liquidated

MARGINS – VALUE AT RISK (VAR)

- Margins give incentive to hold well diversified portfolio

- How are margins set by brokers/exchanges?

  - **Value at Risk**: $Pr\left(-(p_{t+1} - p_t) \geq m\right) = 1\ \%$

1%

Value at Risk
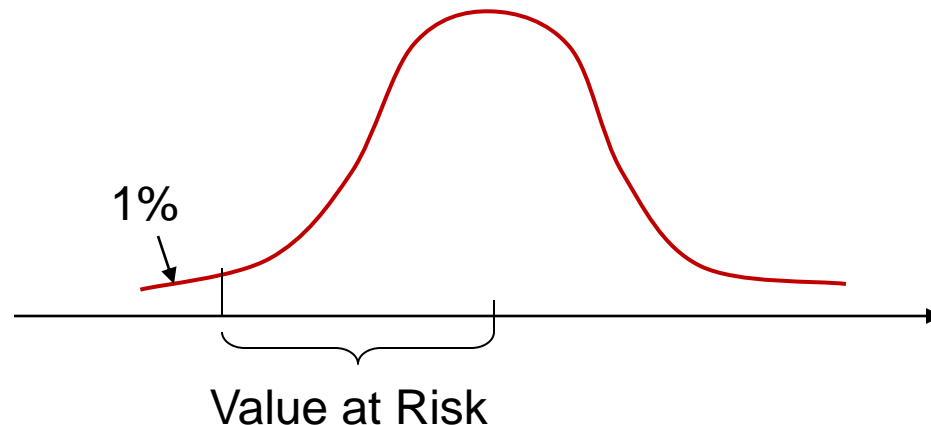
LEVERAGE AND MARGINS

- Financing a *long position* of $x^{j+}_t>0$ shares at price $p^j_t=100$:
  - Borrow \$90\$ dollar per share;
  - Margin/haircut: $m^{j+}_t=100-90=10$
  - Capital use: \$10 x^{j+}_t
- Financing a *short position* of $x^{j-}_t>0$ shares:
  - Borrow securities, and lend collateral of 110 dollar per share
  - Short-sell securities at price of 100
  - Margin/haircut: $m^{j-}_t=110-100=10$
  - Capital use: \$10 x^{j-}_t
- Positions frequently marked to market
  - payment of $x^j_t(p^j_t-p^j_{t-1})$ plus interest
  - margins potentially adjusted – *more later on this*
- Margins/haircuts must be financed with capital:

$$\sum_j \left(x^{j+}_t m^{j+}_t + x^{j-}_t m^{j-}_t \right) \leq W_t \text{, where } x^j = x^{j+}_t - x^{j-}_t$$

with perfect cross-margining: $M_t \left(x^1_t, \ldots, x^J_t \right) \leq W_t$

TWO CONCEPTS OF LIQUIDITY

- **Market liquidity**
  - Ease with which one can raise money by selling the asset

- **Funding liquidity**
  - Ease with which one can raise money by borrowing using the asset as collateral

Each asset has two values/prices
1. price
2. collateral value

A   L

Funding liquidity

- Can't **roll over** short term debt
- **Margin**-funding is recalled

LIQUIDITY PROBLEMS

A   L

Market liquidity

- Can only sell assets at

  fire-sale prices

Funding liquidity

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LIQUIDITY PROBLEMS

A   L

Market liquidity

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Funding liquidity

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measures	quantity	price	quantity	price
static	Trading volume	Bid-ask	Unsecured vs. collateralize funding	TED spread (term spread)
		VIX Downside correlation	Haircuts/ margins/LTV	
dynamic			Debt maturity to • Asset maturity • Asset market liq	

FUNDING LIQUIDITY FRICTIONS

- Illiquidity arises due to frictions which
  - prevent fund flows to investors with expertise
  - limits optimal risk sharing
- Causes of frictions
  - asymmetric information
    - market breakdowns/credit rationing, market for lemons
  - non-verifiable info - incomplete contracts/markets
- Speed of arbitrage (dynamic)
  - experts only build up capital slowly …

FLAVORS OF FUNDING LIQUIDITY

- **Margin funding risk**   *Prime broker*
  - Margin has to be covered by HF's own capital
  - Margins increase at times of crisis
- **Rollover risk**   *ABCP*
  - Inability to roll over short-term commercial paper
- **Redemption risk**   *Depositors, HF-investors*
  - Outflow of funds for HFs and banks

Essentially the same!

Maturity mismatch:

Long-term assets (with low market liquidity)
Short-term borrowing

*Maturity structure – **not** capital structure (leverage)!*

AMPLIFICATION MECHANISMS - OVERVIEW

1. Borrowers' Balance Sheet Effects
   - Loss Spiral
   - Margin/haircut Spiral de-leveraging
     - Higher margins/haircuts
     - Rollover risk
     - redemptions

   Level effects vs. volatility effects

2. Lending Channel Effects
   - static
   - dynamic: precautionary hoarding

   volatility effects of lender's balance sheet

3. Run on Financial Institutions
   - Coordination among multiple lenders

4. Network Effects: Gridlock Risk

1. BALANCE SHEET CHANNEL

- Borrowers' balance sheet
  - Loss spiral
    - Net wealth $> \alpha$ x
      for asym. info reasons
    - constant or increasing leverage ratio
  - Margin/haircut spiral
    - Higher margins/haircuts
    - No rollover
    - redemptions
    - forces to delever
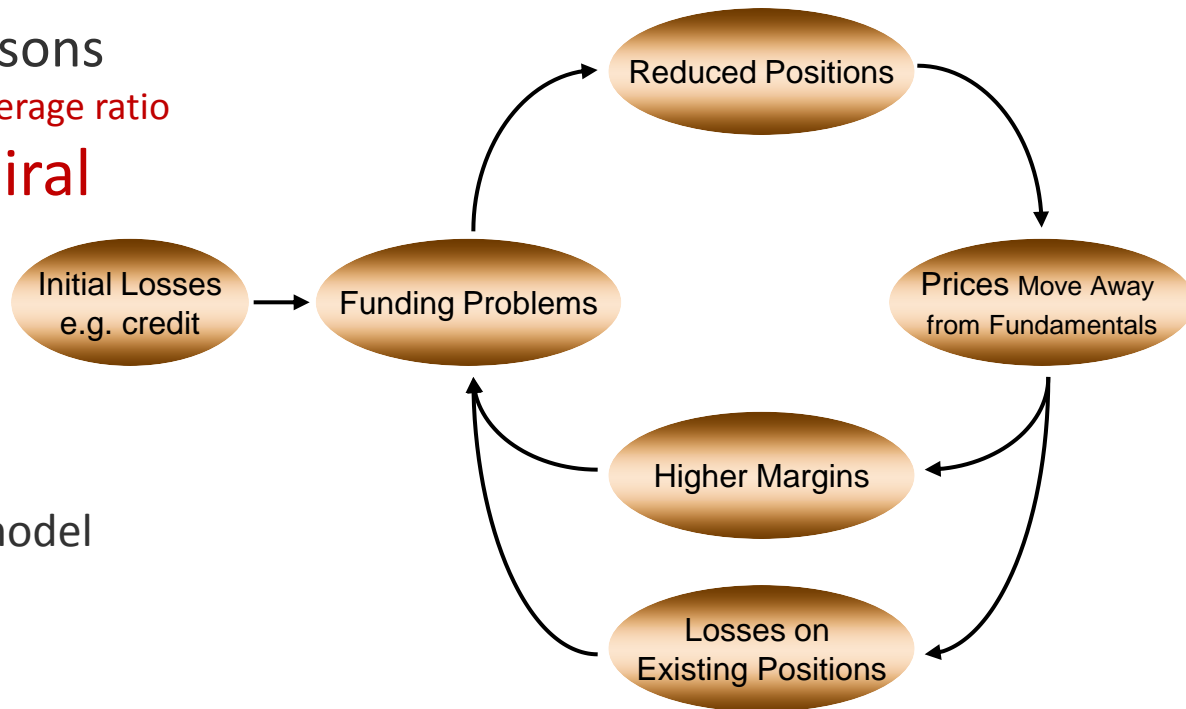
- Mark-to-market vs. mark-to-model
  - worsens loss spiral
  - improves margin spiral

Source: Brunnermeier & Pedersen (2007)

• Both spirals reinforce each other

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- Liquidity spiral
  - Loss spiral
  - Margin/haircut spiral

Margins/Haircuts:

Rating	Jan-May 2007	July-Aug 2007
	Bond	
Investment grade	0-3	3-7
High yield	0-5	10+
	Leveraged Loan	
Senior	10-12	15-20
2nd lien	15-20	20-30
Mezzanine	18-25	30+
	ABS and CDO	
AAA	2-4	8-10
AA	4-7	20
A	8-15	30
BBB	10-20	50
Equity	50	100
Source: Citigroup, IMF Stability report 2007		

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1. BALANCE SHEET - MARGIN SPIRAL
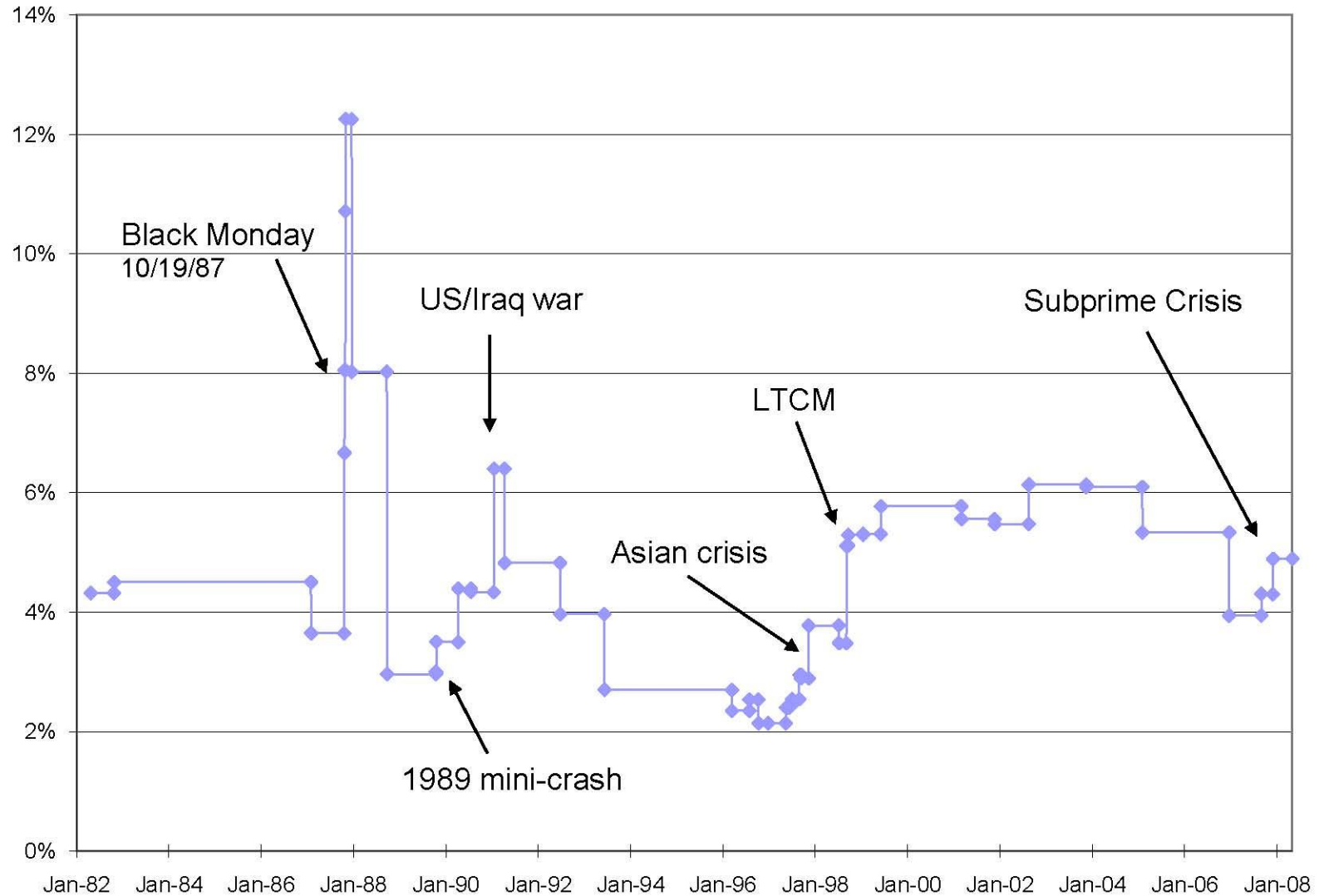
1. MARGIN SPIRAL – WHY?

1. ### Volatility of collateral increases
   - o Permanent price shock is accompanied by higher future volatility (e.g. ARCH)
     - • Realization how difficult it is to value structured products
   - o Value-at-Risk shoots up
   - o Margins/haircuts increase = collateral value declines
   - o Funding liquidity dries up
   - o Note: all "expert buyers" are hit at the same time, SV 92

2. ### Adverse selection of collateral
   - o As margins/ABCP rate increase, selection of collateral worsens
   - o SIVs sell-off high quality assets first (empirical evidence)
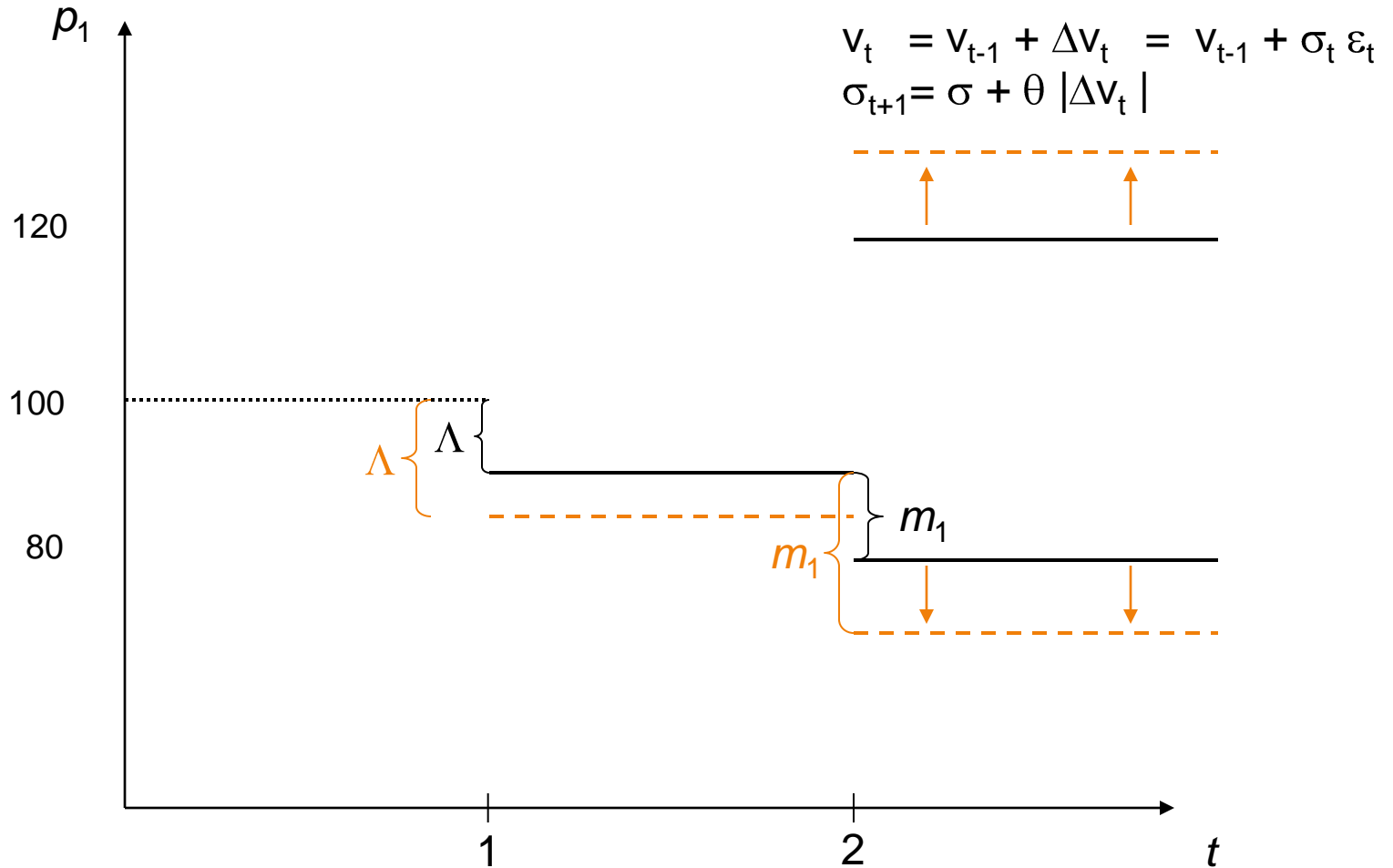   - o Remaining collateral is of worse quality

- Time: t=0,1,2
- One asset with final asset payoff v (later: assets j=1,...,J)
- Market illiquidity measure: $\Lambda_t = |E_t(v) - p_t|$

  (deviation from "fair value" due to selling/buying pressure)

- Agents
  - Initial customers with supply $S(z, E_t[v]-p_t)$ at t=1,2
  - Complementary customers' demand $D(z, E_2[v]-p_2)$ at t=2
  - Risk-neutral dealers provide *immediacy* and
    - face capital constraint
  - $xm(\sigma, \Lambda) \leq W(\Lambda)$:= $\max\{0, B + x_0(E_1[v]-\Lambda)\}$

    $\underbrace{}_{\text{cash}}$ $\underbrace{}_{\text{"price" of stock holding}}$

1. FINANCIERS' MARGIN SETTING

- Margins are set based on Value-at-Risk
- Financiers do not know whether price move is due to
  - *Likely*, movement in fundamental
  - *Rare*, Selling/buying pressure by customers who suffered asynchronous endowment shocks.

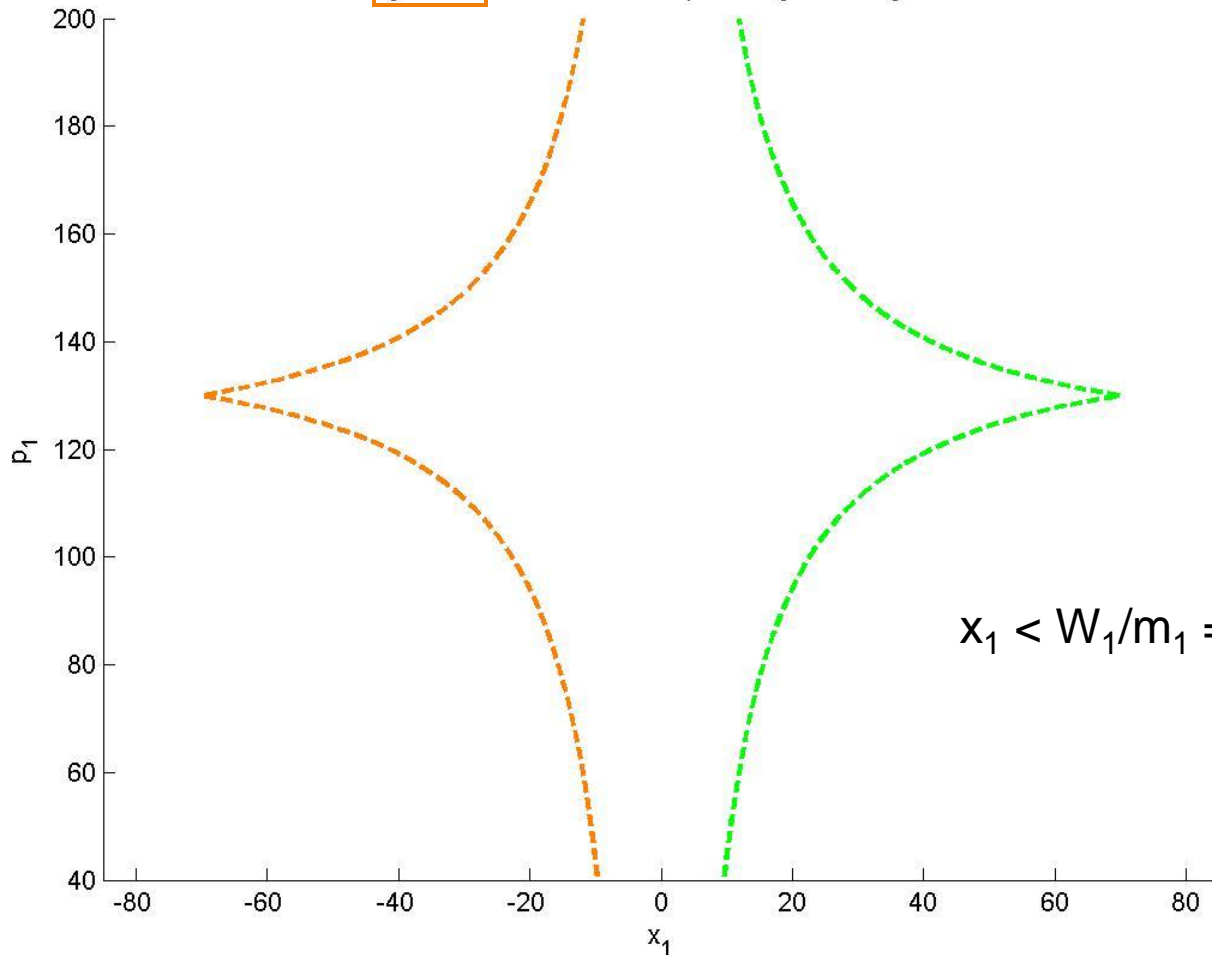$$m_1^{j+} = \phi^{-1}(1 - \pi)\sigma_2 = \bar{\sigma} + \bar{\theta}|\Delta p_1| = m_1^{j-}$$

$$v_t = v_{t-1} + \Delta v_t = v_{t-1} + \sigma_t \, \varepsilon_t$$
$$\sigma_{t+1} = \sigma + \theta \, |\Delta v_t|$$

Λ

Λ

m_1

m_1

Selling pressure initial customers

complementary customers

$\gamma = 0.01$ $\sigma^2 = 16$ $z_0 = 20$ $z_1 = 20$ $v_0 = 140$ $v_1 = 120$
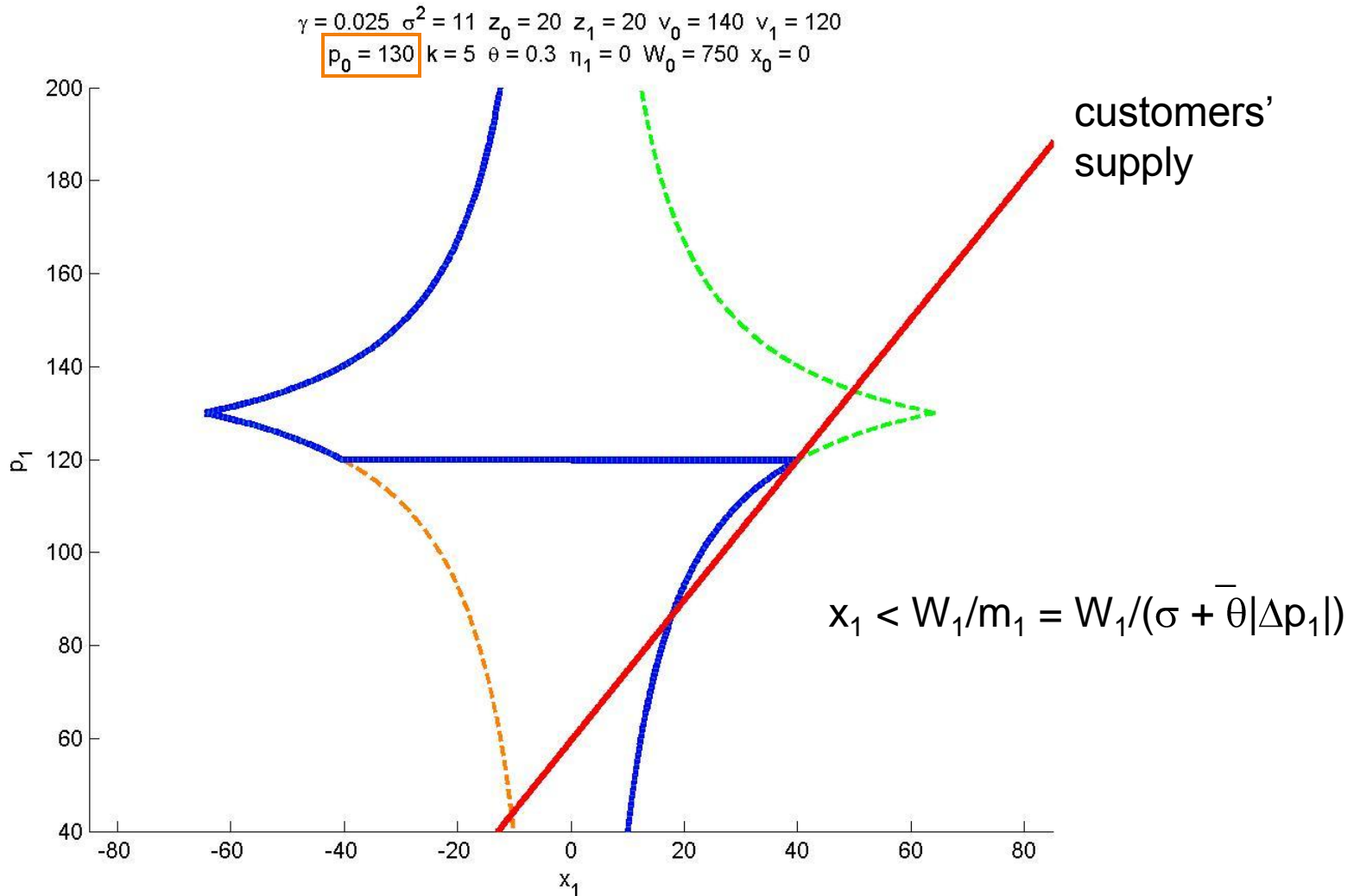$p_0 = 130$ $k = 10$ $\theta = 0.3$ $\eta_1 = 0$ $W_0 = 700$ $x_0 = 0$

customers' supply
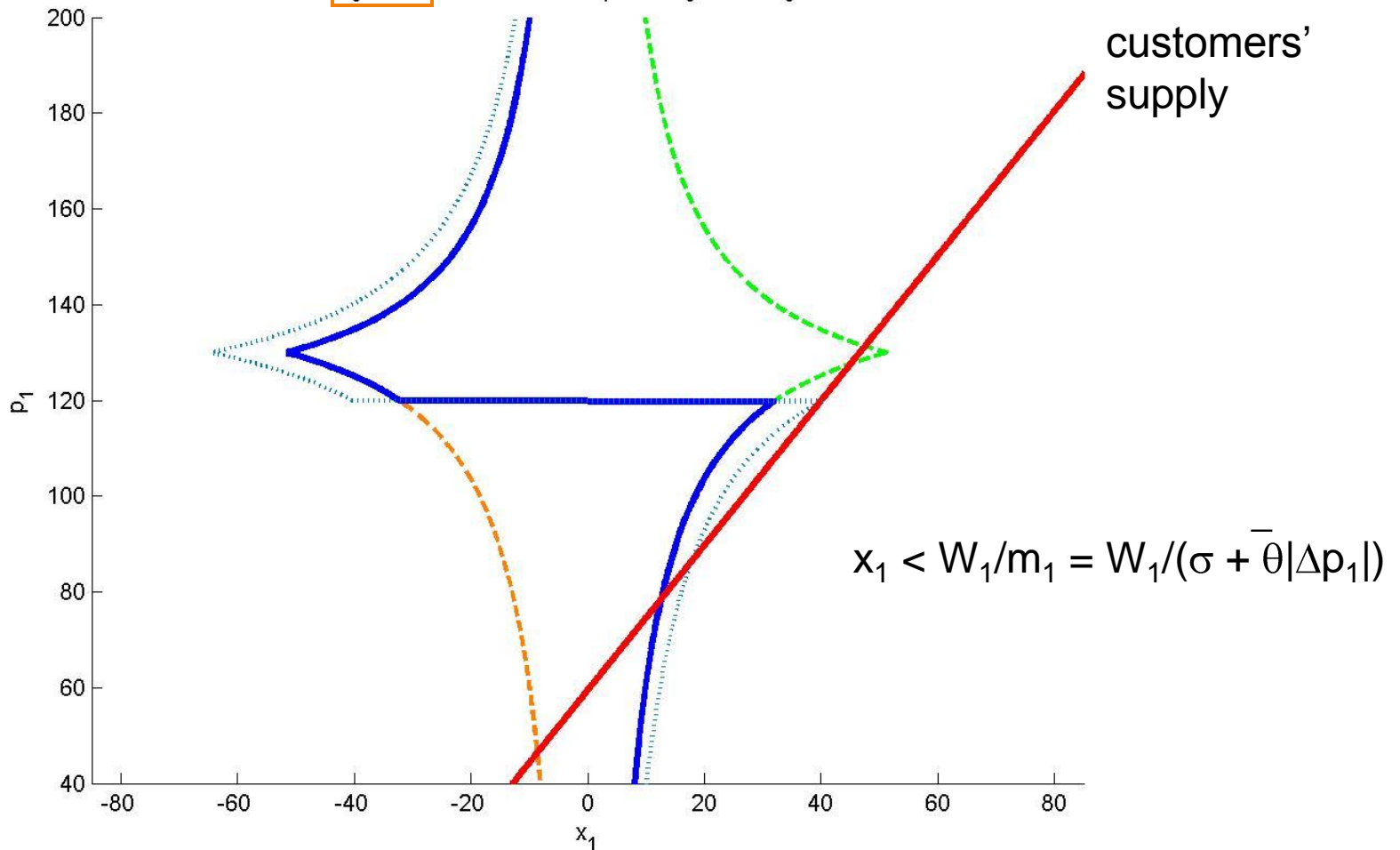
$x_1 < W_1/m_1 = W_1/(\sigma + \bar{\theta}|\Delta p_1|)$

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$\gamma = 0.025$ $\sigma^2 = 11$ $z_0 = 20$ $z_1 = 20$ $v_0 = 140$ $v_1 = 120$
$p_0 = 130$ $k = 5$ $\theta = 0.3$ $\eta_1 = 0$ $W_0 = 750$ $x_0 = 0$

customers'
supply

$x_1 < W_1/m_1 = W_1/(\sigma + \overline{\theta}|\Delta p_1|)$

$\gamma = 0.025$ $\sigma^2 = 11$ $z_0 = 20$ $z_1 = 20$ $v_0 = 140$ $v_1 = 120$
$p_0 = 130$ $k = 5$ $\theta = 0.3$ $\eta_1 = 0$ $W_0 = 600$ $x_0 = 0$

customers' supply

$x_1 < W_1/m_1 = W_1/(\sigma + \overline{\theta}|\Delta p_1|)$

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1. MULTIPLE ASSETS

- Dealer maximizes expected profit per capital use
  - Expected profit $\quad\quad$ $E_1[v^j] - p^j = \Lambda^j$
  - Capital use $\quad\quad\quad\quad$ m^j

- Dealers
  - Invest only in securities with highest ratio Λ^j/m^j

- Hence, illiquidity/margin ratio Λ^j/m^j is constant

m^2=Volatility of Security2 = 2 > 1 = Volatility of Security1=m^1
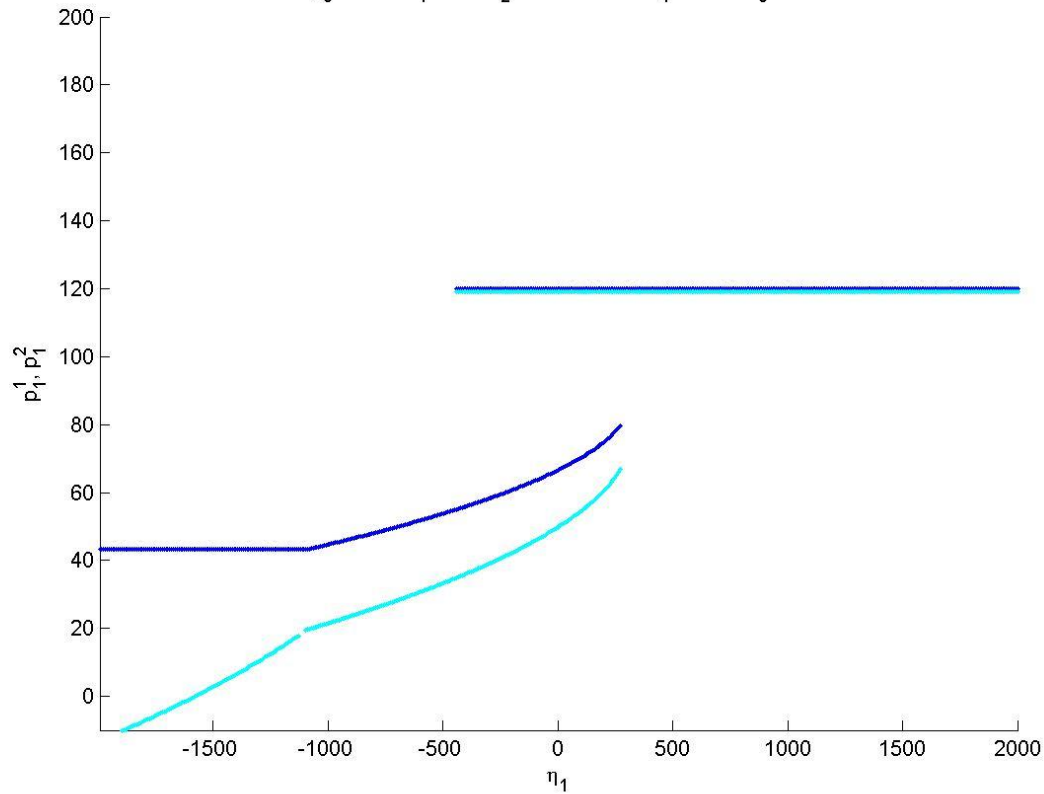
EXAMPLE: 1987 CRASH

- Increased volatility caused banks to require more margin
- funding problems for market makers
  - failures at NYSE, Amex, OTC, trading firms, etc.
  - "thirteen [NYSE specialist] units had no buying power" because of their funding constraint (SEC (1988))

  $\rightarrow$ mutually reinforcing
- Fed Response
  - "calls were placed by high ranking officials of the FRBNY to senior management of the major NYC banks, indicating that ... they should encourage their Wall Street lending groups to use additional liquidity being supplied by the FRBNY to support the securities community"
- Read Wigmore (1998 FAJ)

... FURTHER RESULTS

- Sudden liquidity "dry-ups" – fragility
  - Fragility
  - Liquidity spirals
  - Due to destabilizing margins
- Commonality of liquidity
  - Funding problems affect many securities
- Correlated with volatility
  - Volatile securities require more capital to finance
- Flight to quality
  - When capital is scarce, traders withdraw from "capital intensive" high-margin securities
- Moves with the market
  - Because funding conditions do

    - Driven by volatility increase!

AMPLIFICATION MECHANISMS - OVERVIEW

1. Borrowers' Balance Sheet Effects
   - Loss Spiral
   - Margin/haircut Spiral ➡ de-leveraging
     - Higher margins/haircuts
     - Rollover risk
     - Redemptions
2. Lending Channel Effects
   - static
   - dynamic: precautionary hoarding
3. Run on Financial Institutions
4. Network Effects: Gridlock Risk

FLAVORS OF FUNDING LIQUIDITY

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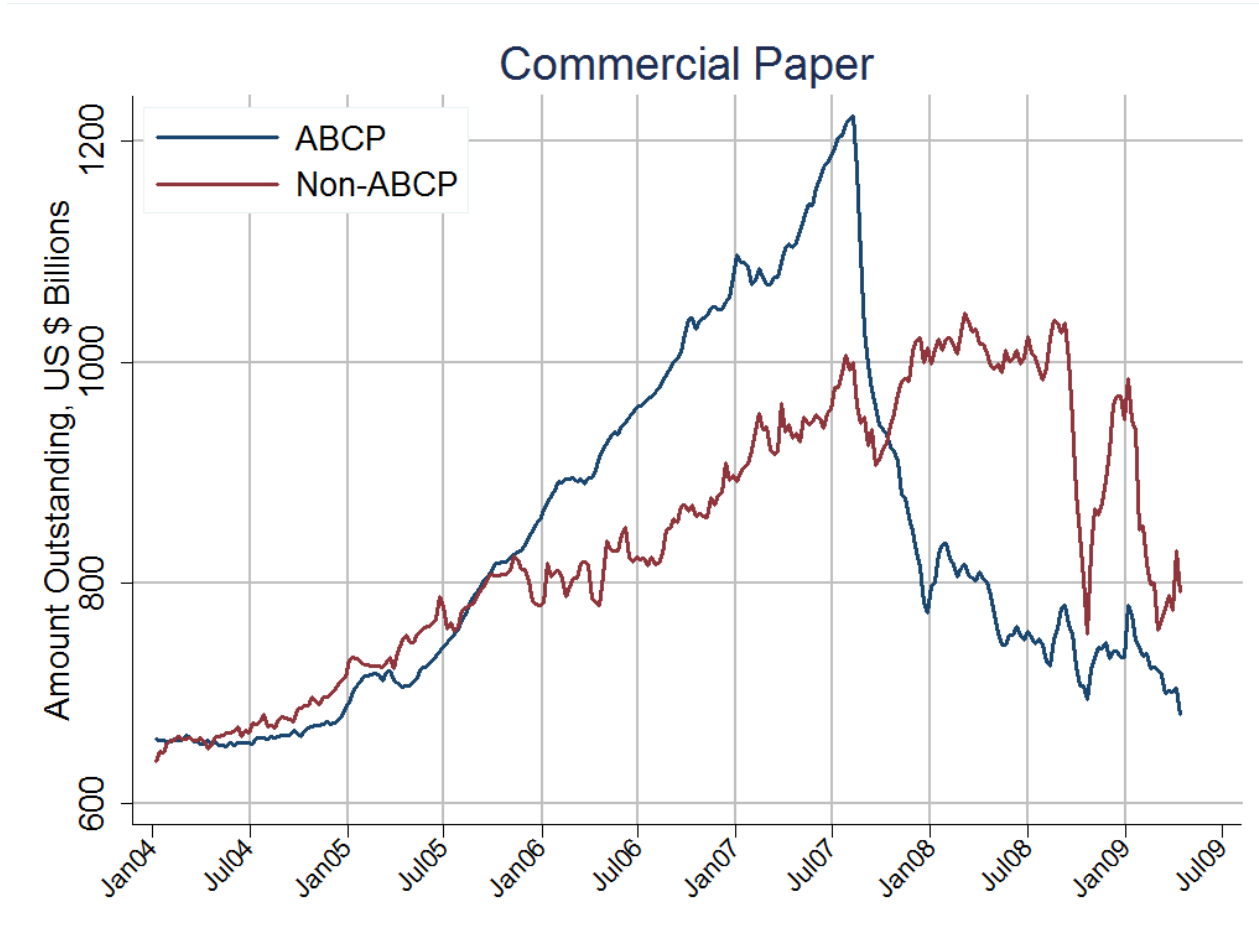 - Outflow of funds for HFs and banks

Essentially the same!

Maturity mismatch:

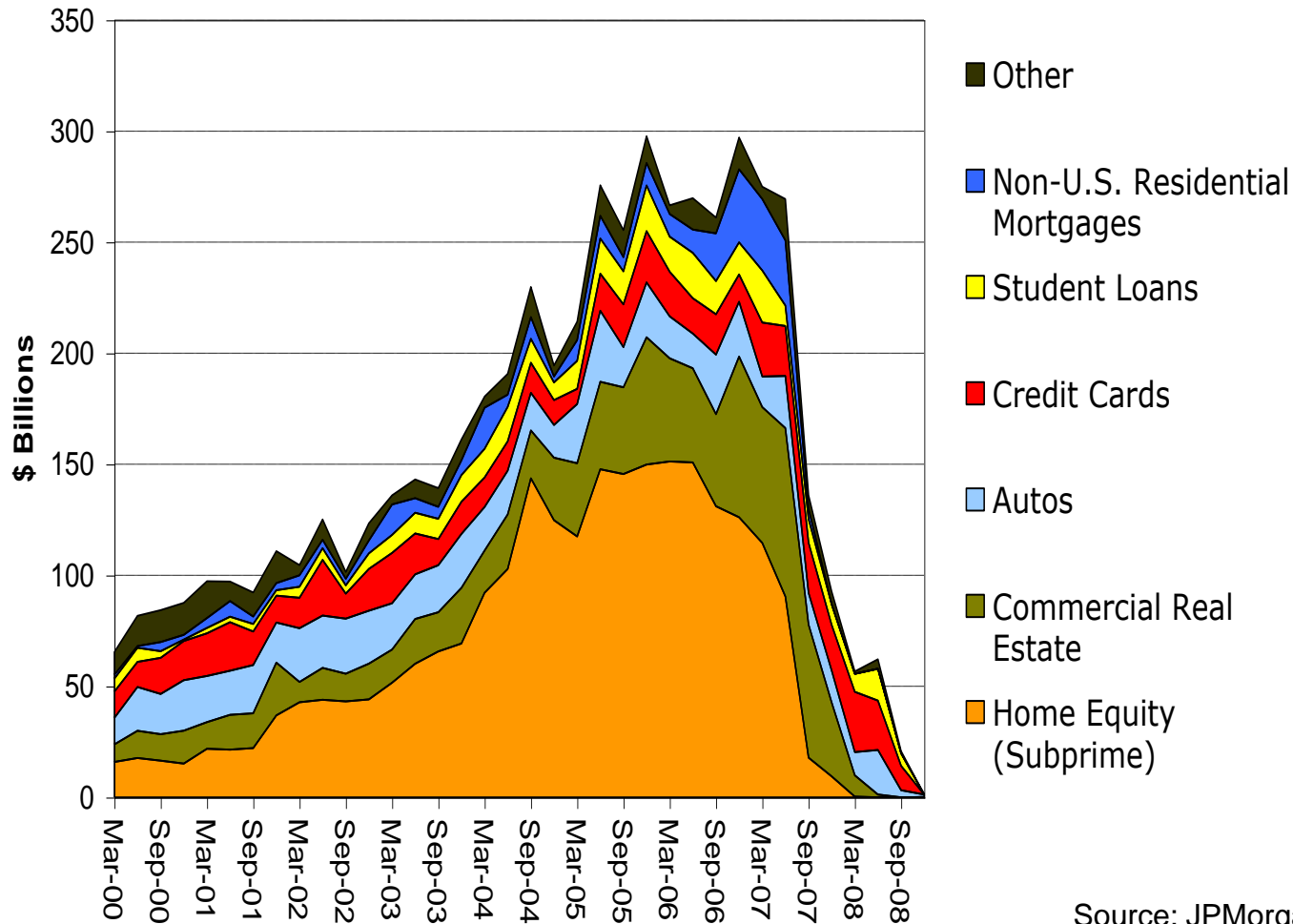Long-term assets (with low market liquidity)
Short-term borrowing

*Maturity structure – **not** capital structure (leverage)!*

1. ROLLOVER RISK: ABCP

Commercial Paper

Legend:
- ABCP
- Non-ABCP

Y-axis: Amount Outstanding, US $ Billions (600, 800, 1000, 1200)

X-axis: Jan04, Jul04, Jan05, Jul05, Jan06, Jul06, Jan07, Jul07, Jan08, Jul08, Jan09, Jul09

1. ROLLOVER RISK: COMPOSITION OF ABCP

ABS issuance

Source: JPMorgan

1. SELLERS OF ABCP - SIVS ET AL.

	Conduits	SIVs	SIV-lites
assets	■US$ ≈1,400bn ■not tradable loans ■less risky •≈11% RMBS •≈11% ABS/CDOs	■US$ ≈400bn ■assets are traded ■less risky •≈ 43% fin. Inst. Debt •≈ 23% RMBS •≈ 11% CDOs	■US$ ≈12bn ■assets are traded ■risky • >95% US RMBS
liabilities		■26% ABCP ■68% MTN ■ 7% capital/mez.notes	
capital structure	■non-structured	■structured ■open ■dynamic (change size/financing)	■structured (aggressively) ■closed ■static (like CDOs)
Credit enhancement	■Some (sponsoring bank)	■No (but overcollateralized)	■No
Liquidity enhanc. (credit line)	■Contractual 100%	■Contractual < outstanding ABCP ■Reputational	■Contractual credit line is subject to market value tests
			SIV with CDO features 33

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

                      banks held leveraged AAA assets – tail risk

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

  - …

DIGRESSION: 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

- Money market funds were established in the
- As an alternative to bank deposits with higher interest
  - No FDIC insurance
  - But break the buck-rule
    (useful marketing device)
  - Forces money market funds, to delever when price declines
    - Creates upward sloping demand curve

1. ROLLOVER RISK: ABCP

- *CP stops to be viewed as "cash substitute"*
  - Buyers of ABCP do not have expertise in credit quality evaluation
    – just use it to temporarily park funds
  - Overcollateralization vanishes
    - o Collateral is more volatile
  - SIVs sell more liquid "sellable" assets
    - o Quality of assets pool worsens

    → Withdrawal from ABCP market
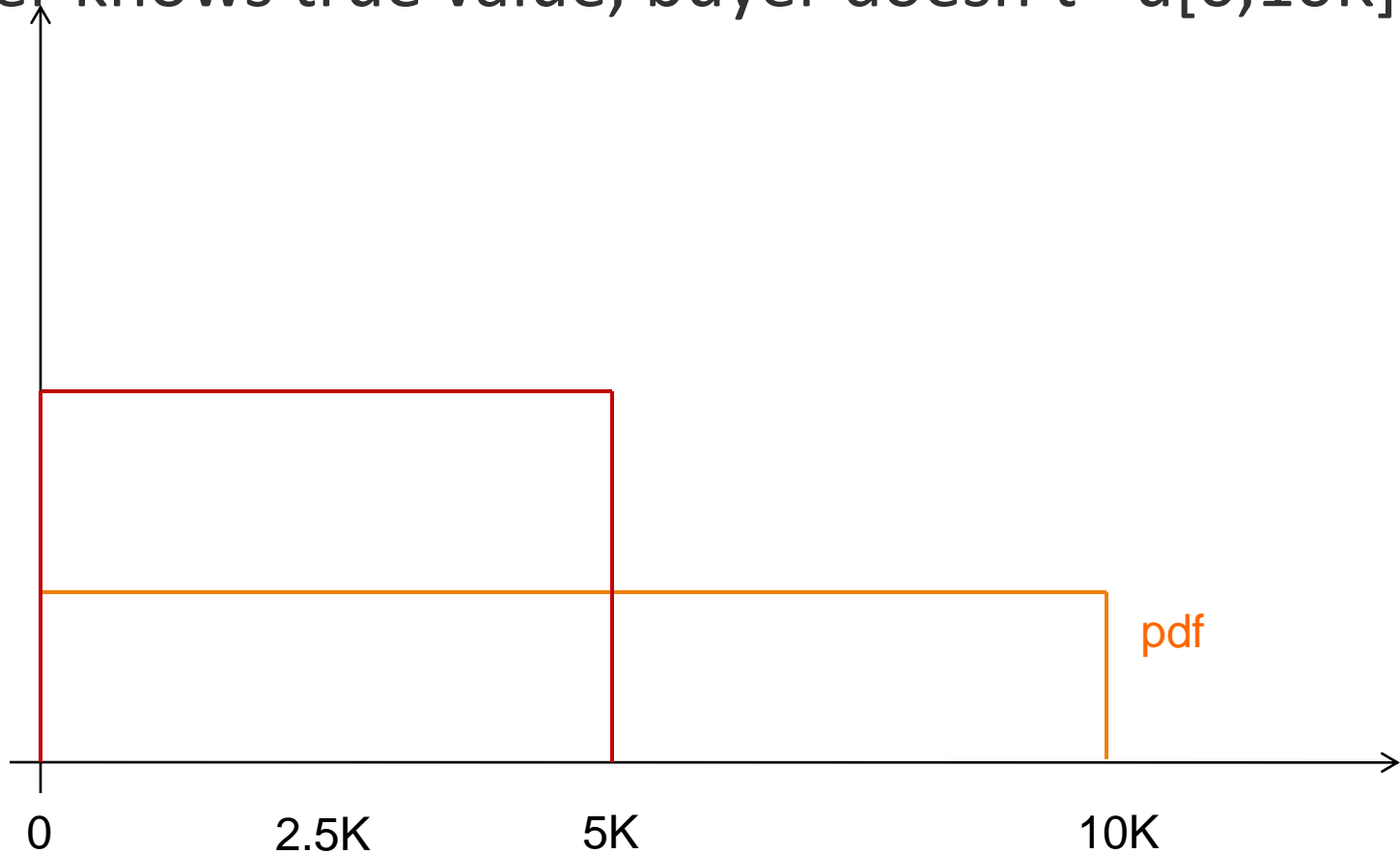   by firms and money market funds

DIGRESSION: LEMON'S PROBLEM
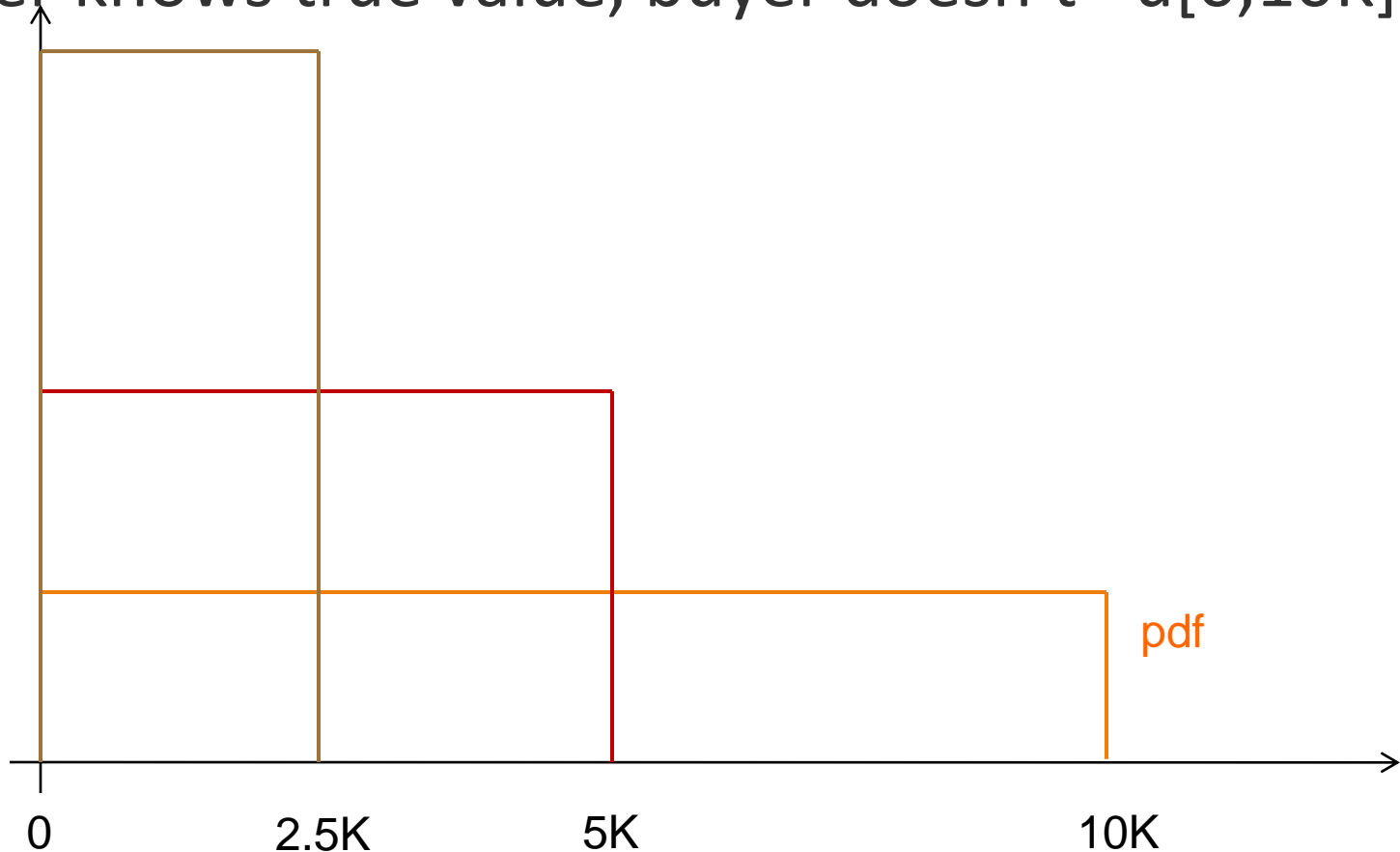
- Seller knows true value, buyer doesn't ~u[0,10K]

pdf

0   2.5K   5K   10K

- .
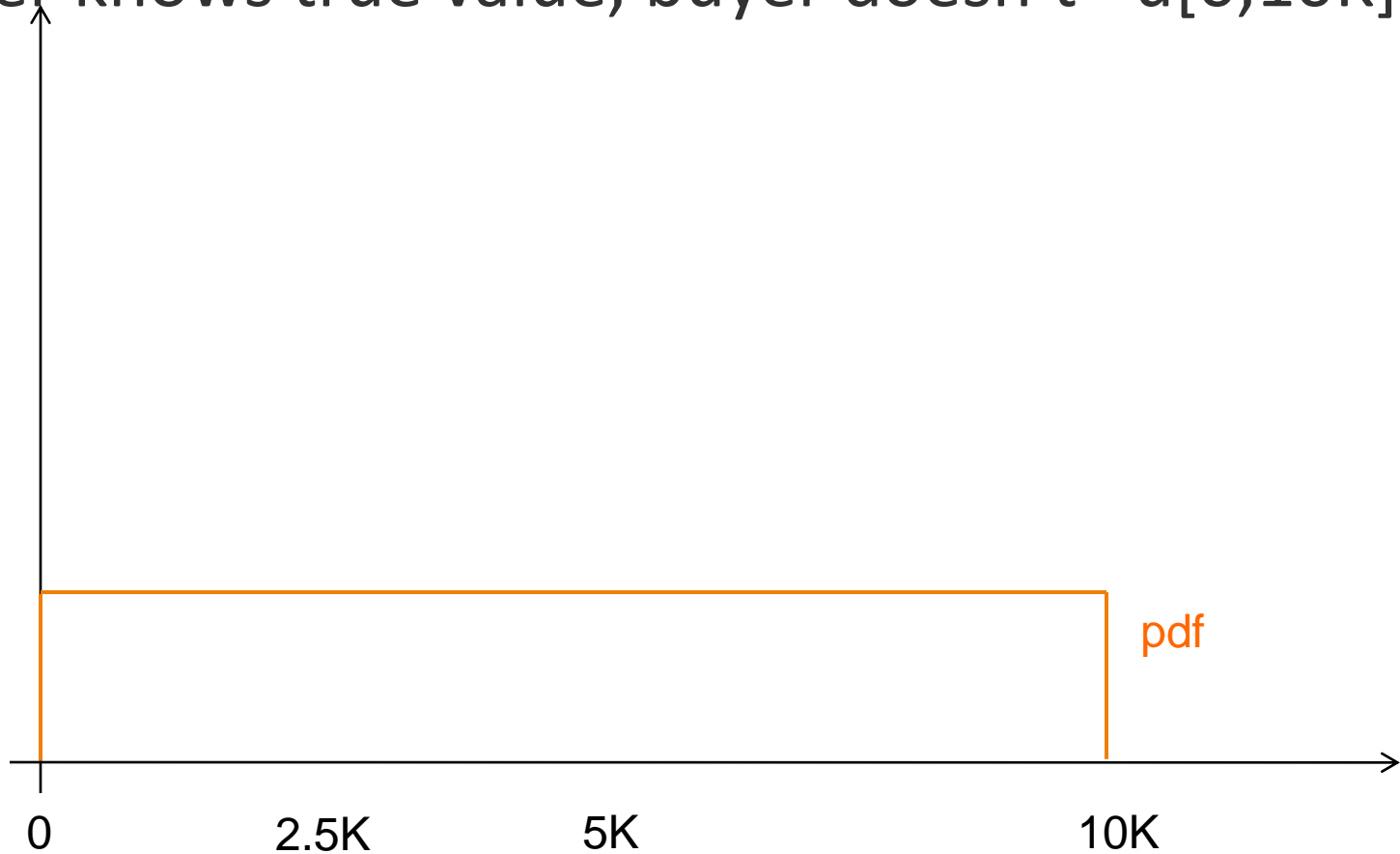
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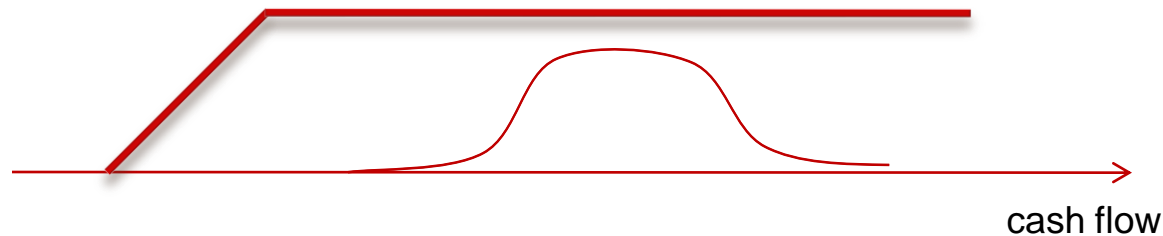

- .

DIGRESSION: LEMON'S PROBLEM

- Seller knows true value, buyer doesn't ~u[0,10K]

pdf

0   2.5K   5K   10K

- Only equilibrium p=0, no trade
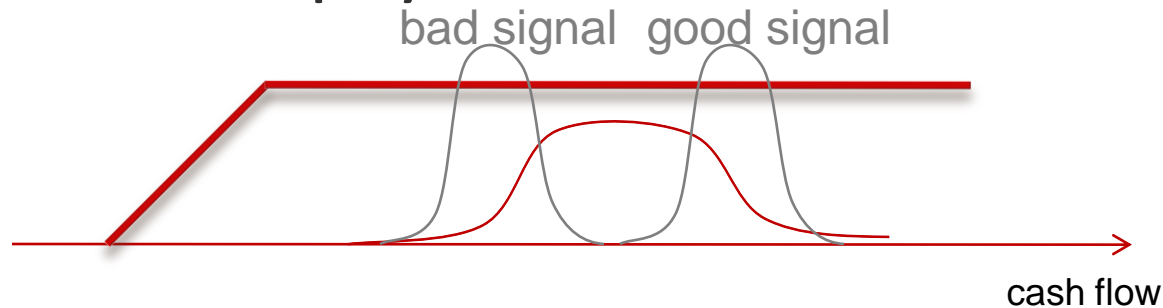
1. ROLLOVER RISK

- Debt contract payoff – prior distribution of cash flow

cash flow

- Asymmetric info (lemons') problem kicks in
  - No more rollover
- Maturity choice:
  - Short-term debt: distribution shrinks (less info-sensitity)
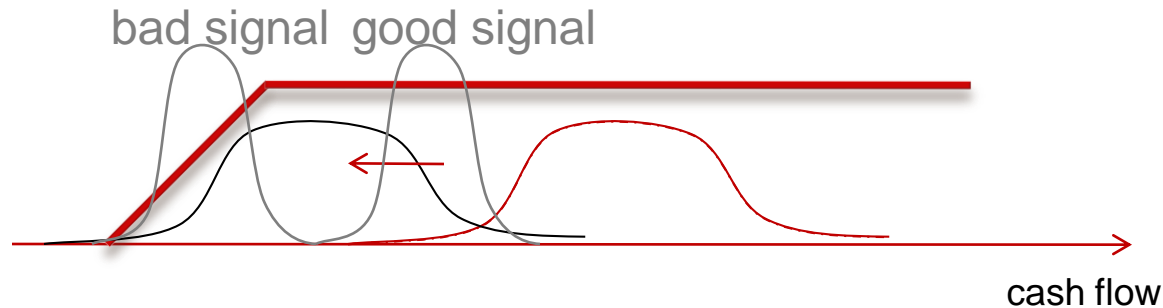
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1. ROLLOVER RISK

- Debt contract payoff

- Informational value of signal is extremely low (in flat part of contract payoff

1. ROLLOVER RISK

- Increasing the information sensitivity of debt

bad signal good signal

cash flow

- Now signal is very valuable

- Asymmetric info (lemons') problem kicks in
  - No more rollover

- Maturity choice:
  - Short-term debt: distribution shrinks (less info-sensitity)

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1. REPO MARKET

- ## Repurchase agreement
  - Borrow: sell assets with a agreement to repurchase it in one day/months
  - Repo types:
    - General collateral (GC) repos
      collateral are treasuries, agency papers
    - MBS repos
      collateral are mortgage backed securities
  - Outside of bankruptcy protection(in US not in UK)

- ## Repo haircuts widened sharply

1. REDEMPTIONS OF FUNDS

- Investors might redeem also equity capital when balance sheet of "borrower" worsens.
  - Shleifer-Vishny 1997:
    (see next lecture)

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2. Lending Channel Effects
   - static
   - dynamic: precautionary hoarding

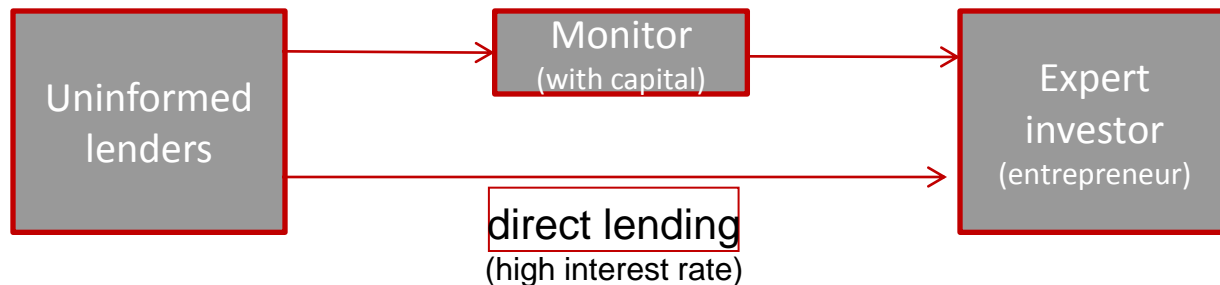3. Run on Financial Institutions

4. Network Effects: Gridlock Risk

2. LENDING CHANNEL - HOARDING

- Balance sheet of lenders/banks worsens   No deep pocket
  - Cut down on lending
- Mechanisms
  - Static - moral hazard in monitoring by lenders

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┌──────────────┐        ┌──────────────┐        ┌──────────────┐
│              │───────▶│   Monitor    │───────▶│    Expert    │
│  Uninformed  │        │ (with capital)│       │   investor   │
│   lenders    │        └──────────────┘        │(entrepreneur)│
│              │──────────────────────────────▶ │              │
└──────────────┘         direct lending         └──────────────┘
                        (high interest rate)
```

  - Dynamic - precautionary hoarding

    - Afraid of interim shock (state at which refinancing is difficult)

    - ...

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- **Mechanisms (ctd.)**
 2. **Dynamic:** Interim shock $\Rightarrow$ larger "funding cushion"
     - SIVs might draw on credit lines
     - Borrowing at interbank lending market might be more difficult/ volatile (since other banks might have SIV exposure then)
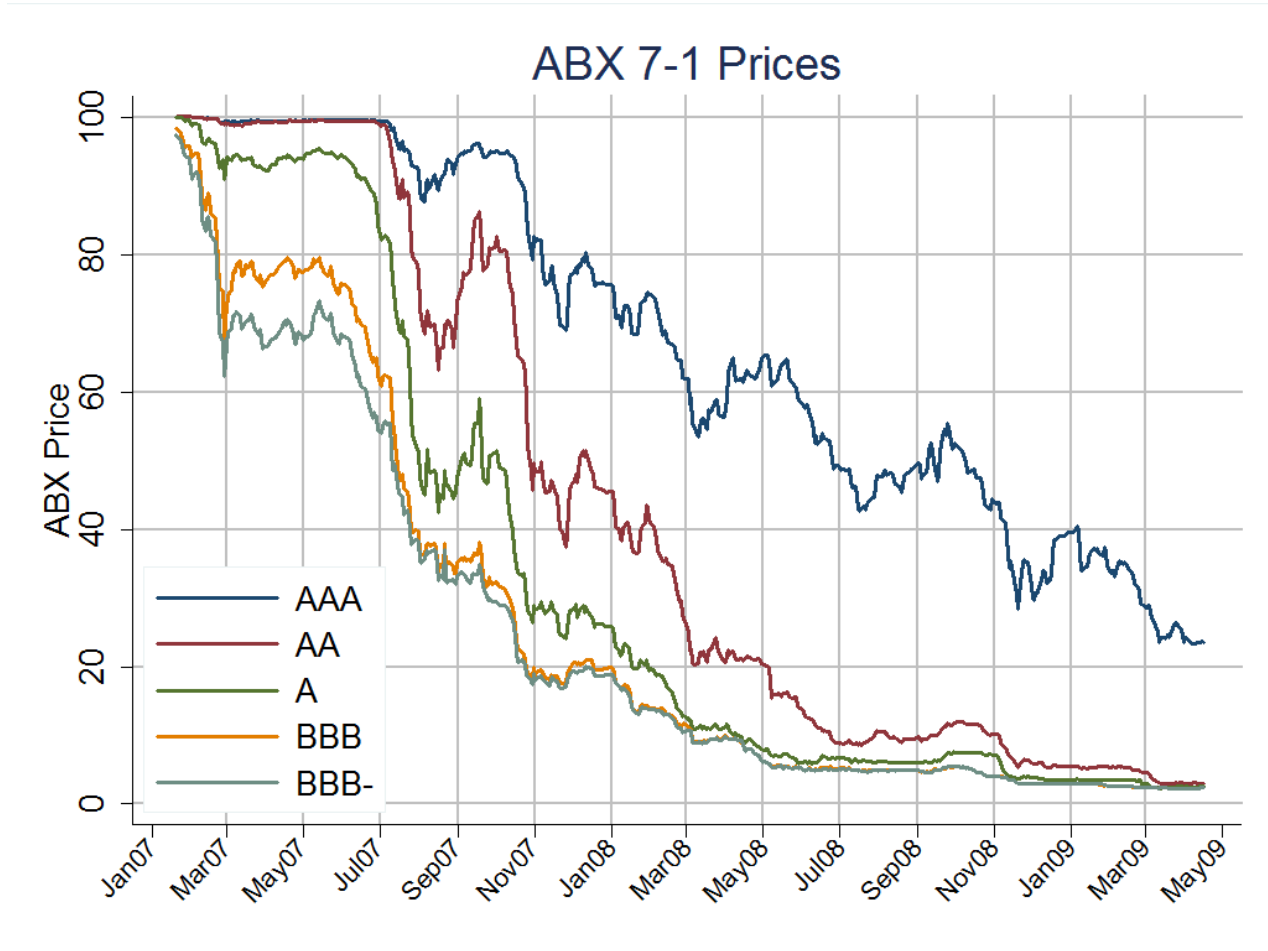   - Increased counterparty credit risk

  o **Asymmetric information worsens situation**
     - Lemon's problem "troubled" banks feel biggest urge to borrow

  o **Example: Interbank market** (LIBOR-OIS Spread)
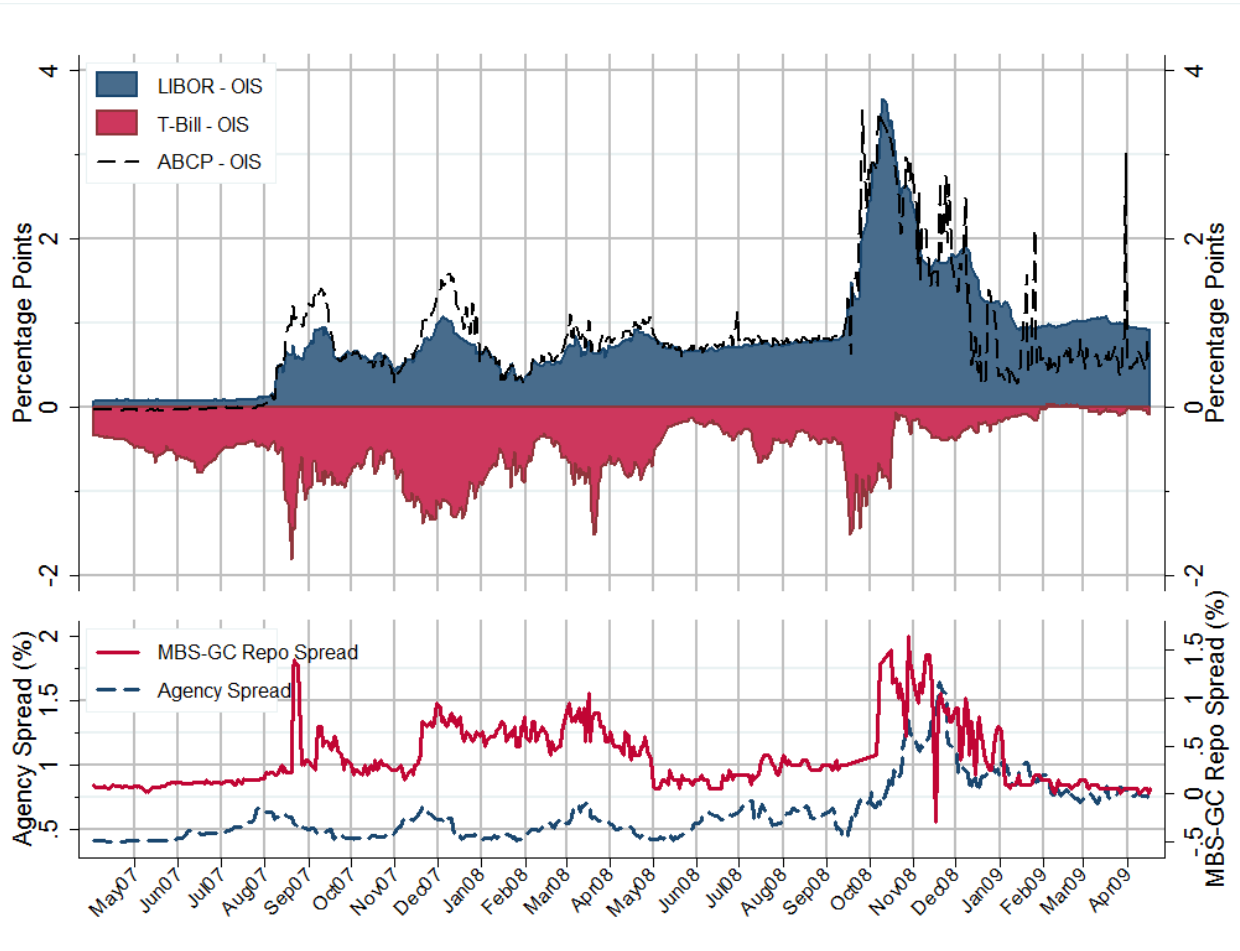
ABX 7-1 Prices

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3. RUN ON FINANCIAL INSTITUTIONS

- *Run before others run* – racing b/c it's better to be among first
  first mover advantage - dynamic co-opetition
  - Balance sheet worsens
  - Other lenders face adverse shock
- Financial Institutions
  - On C-Banks: Classic bank-run by demand depositors
  - On I-Banks: "Client run" by margin account holders
                       Bear Stearns' case
  - On HFs: "Margin run" by prime brokers
                       Redemption run by investors
  - On SIVs: Rollover stop by money market investors

- Note: "Liquidation policy" of SIVs favors early withdrawals!
- (Aside: Similar problem for mutual due to tax-treatment
                 Mutual funds' NAV should take hidden taxes into account.)

3. RUNS

- New elements – other lenders' decisions affect optimal choice

- Coordination effect – higher order beliefs matter

- More later in Lecture 10 on banking.

4. NETWORK – CPCR+GRIDLOCK RISK

- Network:
  - Interweaved network of financial obligations
  - Lender and borrower at the same time
- Balance sheet and lending channel simultaneously at work

- Investors take on position that might partially cancel each other at some later point
  - Go long a swap with one party and short the swap a week later with some other party – asset need not be totally identical
  - Also explains why CDS US$ ≈45tr while corporate debt ≈US$ 5tr

- Counterparty Credit Risk & Gridlock Risk

4. NETWORK EFFECTS

- Example: Interest rate swap
  - Hedge fund can "step out" (by netting/novating)
  - March 11ᵗʰ evening, Goldman sent an e-mail to hedge fund: netting that directly exposes Goldman to Bear Stearns can only approved next morning
  - **Question:** Did **misinterpretation** led to hedge fund clients run?

- Let's extend the example

Bear Stearns

fixed

floating
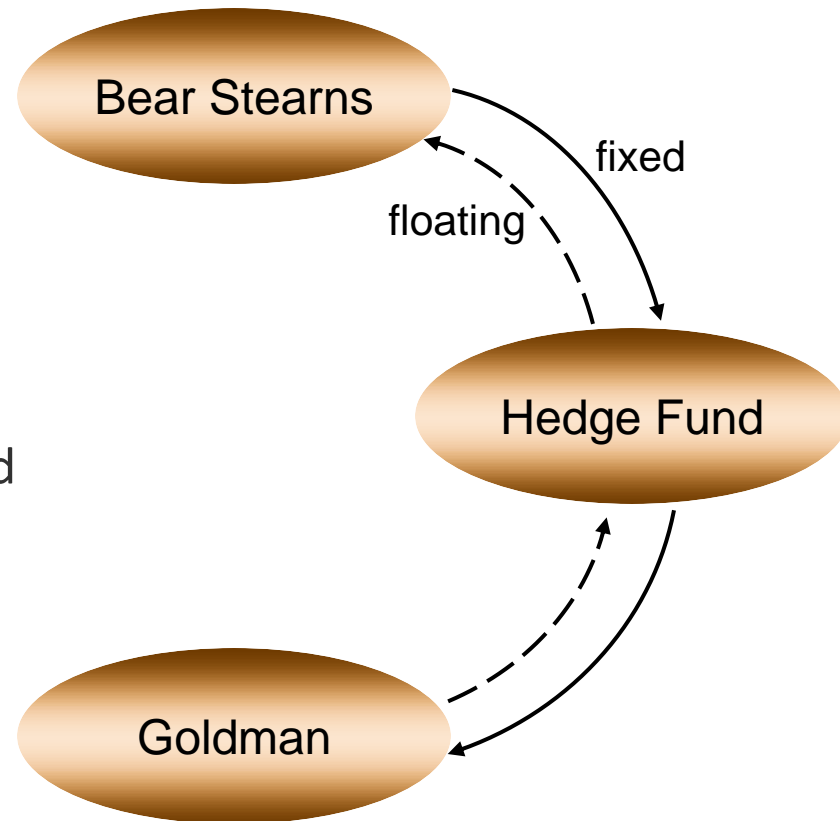
Hedge Fund

Goldman

4. NETWORK EFFECTS

- Extended example:
  - Everything can be netted out
  - But each party only knows his obligations

  - After Goldman's call, hedge fund and private equity fund can't step out
  - More "funding liquidity" is necessary
  - Hedge funds might go under as well

Bear Stearns

fixed

floating

Private Equity Fund

Hedge Fund
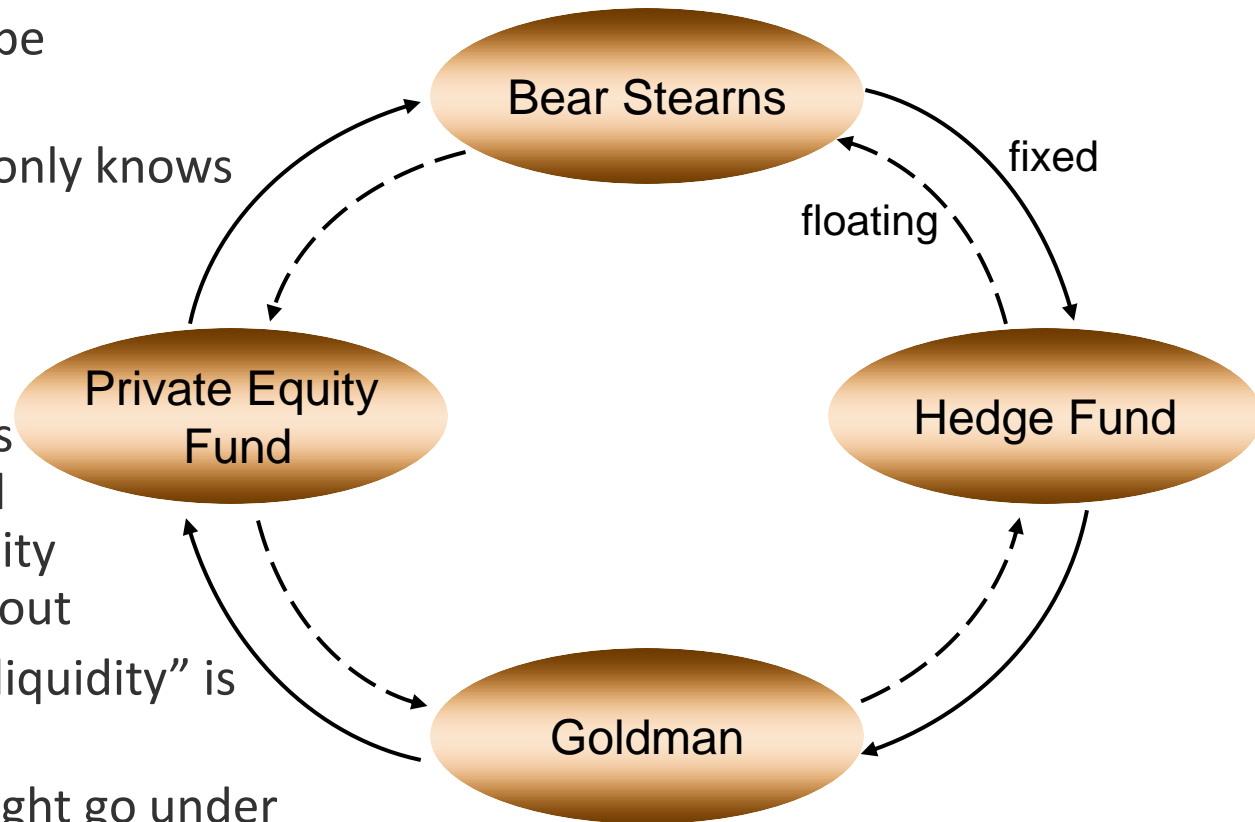
Goldman

- What's a Credit Default Swap?
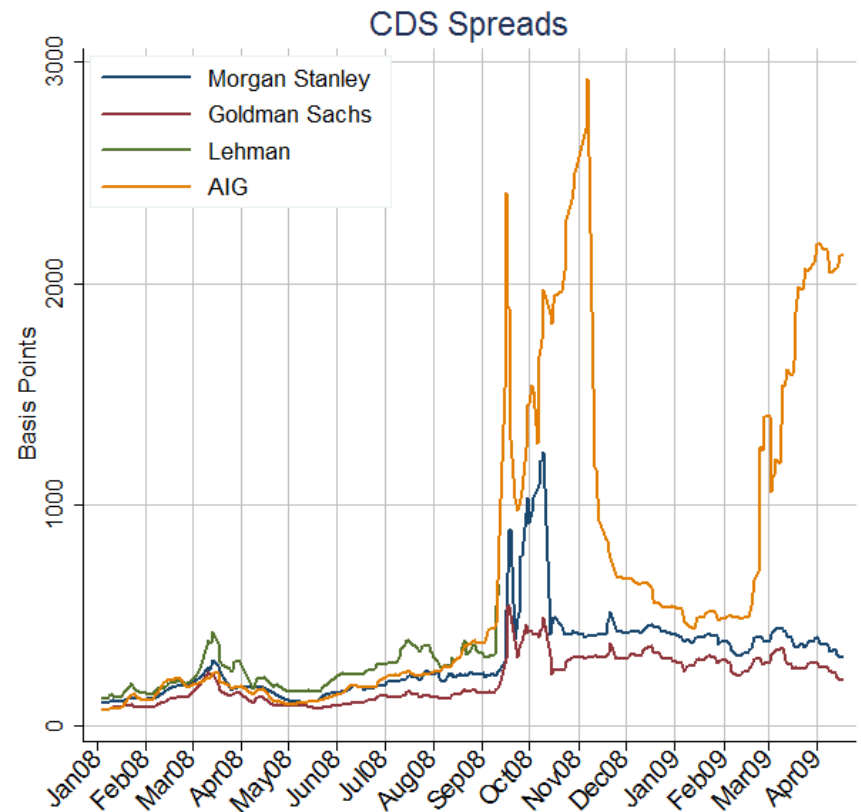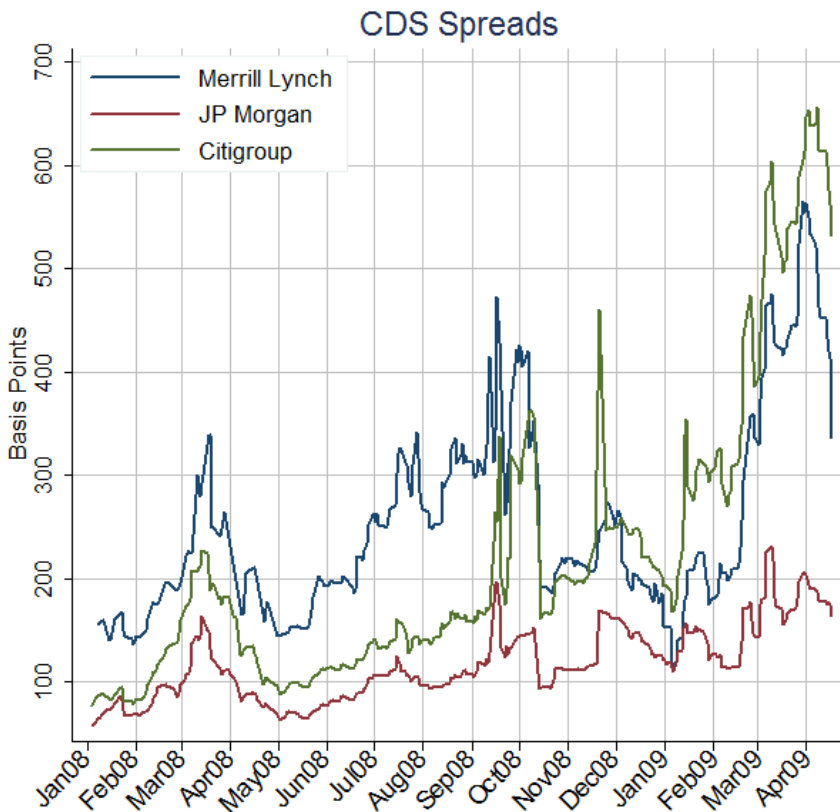
LIMITS OF ARBITRAGE - ILLIQUIDITY

- Market liquidity provision =
  = (risky arbitrage) trading to exploit
    temporary mispricing…

- Very similar – just different language

- Why does temporary "mispricing" persist?

  - Illiquidity refers "more" to high frequency mispricing (daily, weekly)

  - Limits to arbitrage literature refers more to long-run mispricings phenomena

EMH AND LIMITS TO ARBITRAGE

- Keynes (1936)   ↻ bubble can emerge

  - "It might have been supposed that *competition between expert professionals*, possessing judgment and knowledge beyond that of the average private investor, would correct the vagaries of the ignorant individual left to himself."

- Friedman (1953), Fama (1965)
  Efficient Market Hypothesis ↻ no bubbles emerge

  - "If there are many sophisticated traders in the market, they may cause these "bubbles" to burst before they really get under way."

EXTRA SLIDES FOLLOW