# Institutional Finance

## Financial Crises, Risk Management and Liquidity

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# Lending/Insuring vs. Trading

- Lending/Borrowing + Insuring
- = trading assets/securities
  - Bond
  - Stock
  - Derivatives, e.g. CDS
- At what price/rate?
  - How are different asset prices linked?
  - How do institutional investors constraint affect asset prices?
    (not only utility function of representative agent matters)

# Pricing Principal I

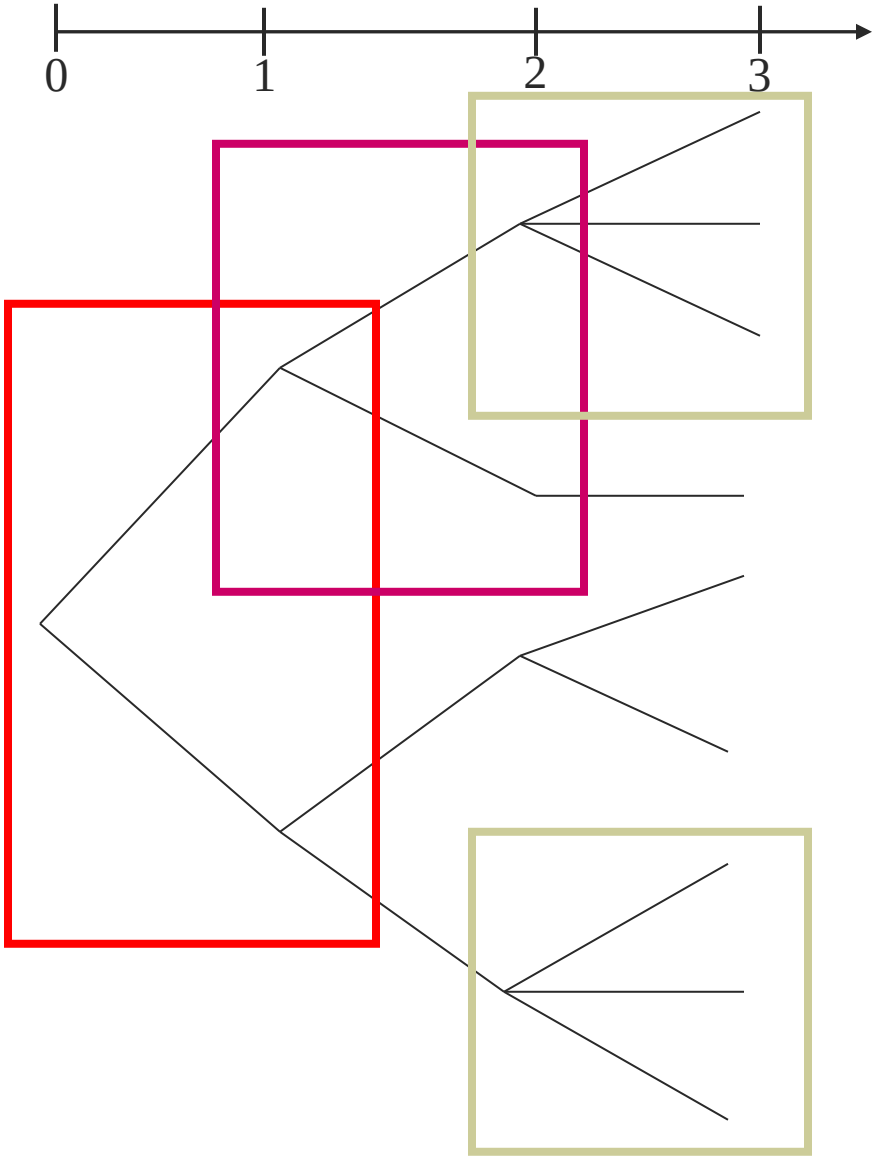
- No risk-free Arbitrage
- Relative vs. Absolute Asset Pricing

# How to deal with complexity?

- Subtasks
- Independence/separation results
- Simplify
  - form models - simplified pictures of reality
- Standardize

See Brunnermeier & Oehmke
“Complexity in Financial Markets”

# Abstraction – Event tree



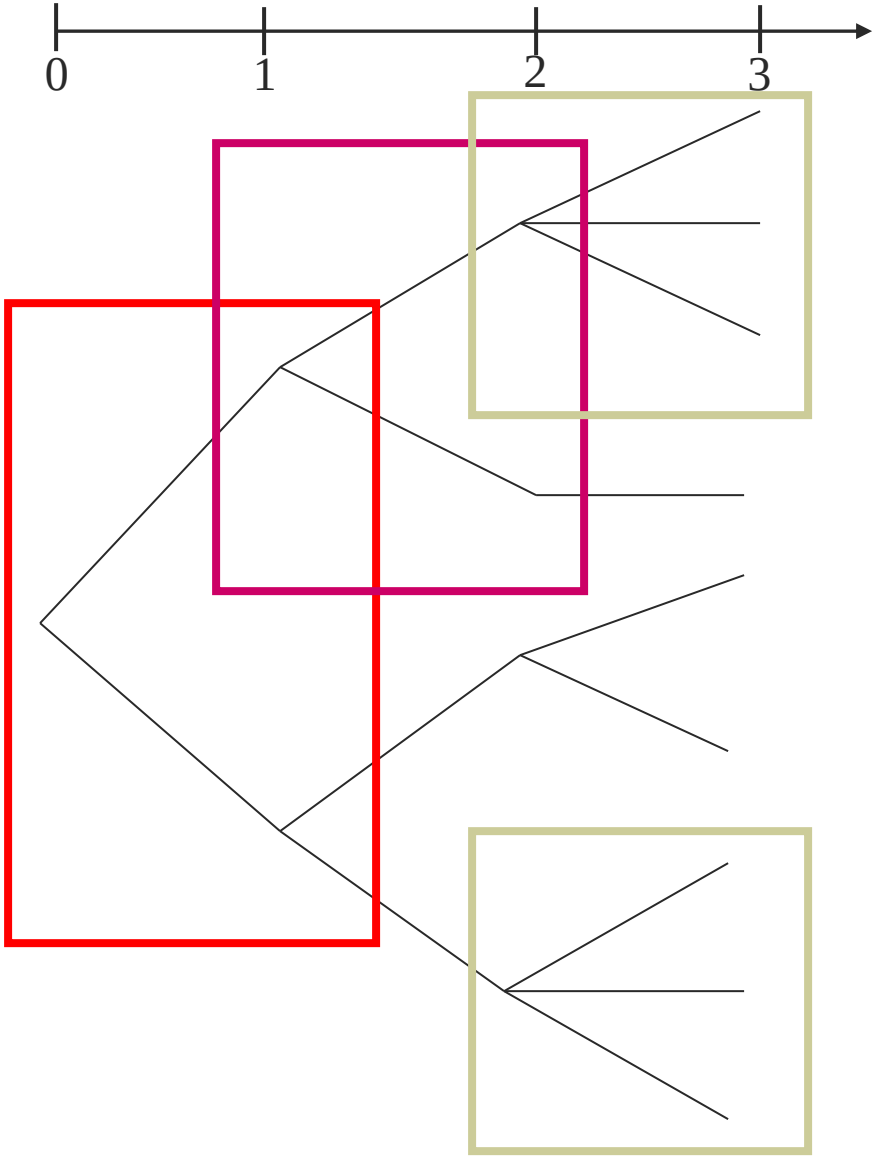
# Law of one Price,No risk-free Arbitrage

- Law of one price (LOOP)
  - Securities (strategies) with the same payoff in the future must have the same price today.
  - Price of actual security = price of synthetic security
- No (risk-free) Arbitrage
  - There does not exists an arbitrage strategy that costs nothing today, but yields non-negative and a strictly positive future payoff in at least one future state/event AND
  - There does not exist an arbitrage strategy that yields some strictly positive amount today and has non-negative payoffs at later point in time.
- No Arbitrage ⟹ LOOP

# Arbitrage Strategy

- **Static:**
  - Acquire all positions at time *t*
  - No retrades necessary
- **Dynamic:**
  - Future retrades are necessary for an arbitrage strategy
  - Retrades depend on price movements

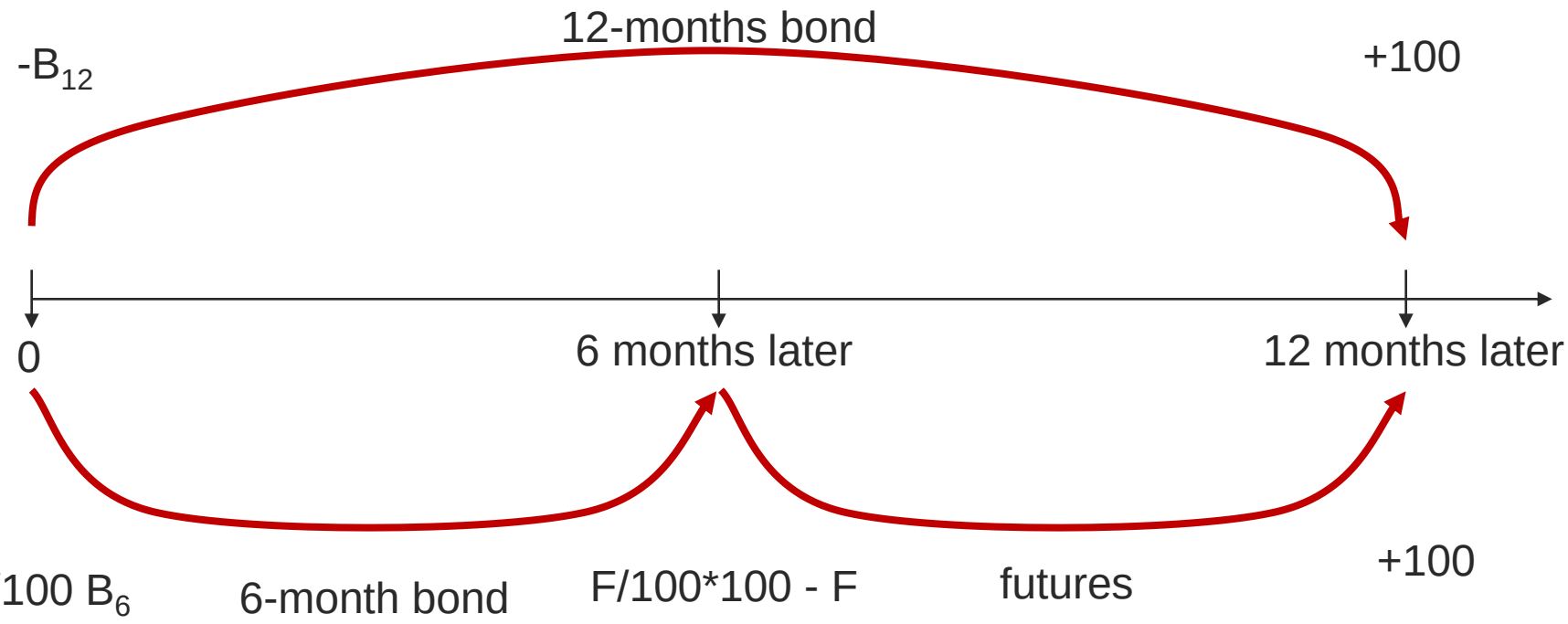
# Abstraction – Event tree, again



# Bond - Simplest Event Tree

- A zero-coupon bond pays $100 at maturity with no intermediate cashflows
- The future value (FV=$100) and the present value (PV=bond price, B) are related by the following equation: PV x (1+r) = FV, where R is the periodic interest rate
- Equivalently, PV = FV / (1+r)
- The bond price is: B = $100 / (1+r)

# Bond Pricing Example




$$1+r_{0,12} = (1+r_{0,6})(1+ r_{6,12})$$

# Law of One Price

**Payoffs to purchasing the securities**

| | 0 | 0.5 | 1 |
|---|---|---|---|
| Long Bond | $-B_{Long}$ | 0 | 100 |
| Short Bond | $-B_{Short}$ | 100 | |
| Futures | 0 | -F | 100 |

**Suppose you want $100 in one year**

| | 0 | 0.5 | 1 |
|---|---|---|---|
| Long Bond | $-B_{Long}$ | 0 | 100 |

*Buy 1 long-term bond*

**Alternatively**

| | 0 | 0.5 | 1 |
|---|---|---|---|
| Short Bond | $-B_{Short}$ x F/100 | F | |
| Futures | 0 | -F | 100 |
| Net | $-B_{Short}$ x F/100 | 0 | 100 |

2 ways of getting the same payoffs should have the same price:

$$B_{Short} \times F/100 = B_{Long}$$

# Synthetic Long-term Bond

- The pricing relation: $B_{12} = B_6 \times F/100$, can be rearranged to solve for any of the securities
  - The RHS represents a **"synthetic" long-term bond** (1 futures contract and F/100 short-term bonds)
- For example, $F = B_{12} / B_6 \times 100$
- If this pricing relation does not hold, then there is a risk-free profit opportunity
  – a risk-free arbitrage

# Bond Pricing Example

- What if you observe the following prices:
  - Long Bond = $94.50
  - Short Bond = $95.00
  - Futures = $98.00
- Synthetic LBond = BShort x F/100 = $93.10

**Arbitrage Trade**

| | 0 | 0.5 | 1 |
|---|---|---|---|
| Sell 1 Long Bond | 94.50 | 0.00 | -100.00 |
| Buy 0.98 Short Bonds | -93.10 | 98.00 | 0.00 |
| Buy 1 Futures | 0.00 | -98.00 | 100.00 |
| Net | 1.40 | 0.00 | 0.00 |

# Example in International Setting

- Any one of the following four securities:
  - Domestic bond
  - Foreign bond
  - Spot currency contract
  - Currency futures contract

  can be replicated with the other three.
- Create a synthetic $/£ futures contract using:
  - US bond = $95
  - UK bond = £96
  - Pounds spot = $1.50/£

# Bid-Ask Spread limits arbitrage

- What is the market price for a security?
  - Ask: the market price to buy
  - Bid or offer: the market price to sell
  - prices at which **market orders** are executed
- If we view the midpoint as the "fair value", then
  ½ x (Ask-Bid) = transaction cost per unit traded
  - A round-trip market order transaction will pay the full spread
- If the transaction size exceeds quantity being offered at the best bid or ask?
  - Transaction cost is an increasing function of order size
- UpTick records the difference between a trade's average transaction price and mid-price prevailing immediately prior to the trade as the trade's transaction cost.

# Arbitrage with Bid-Ask Spread

- The law of one price holds exactly only for transactable prices (i.e. within the bounds)
- Pricing relation: BLong = BShort x F/100

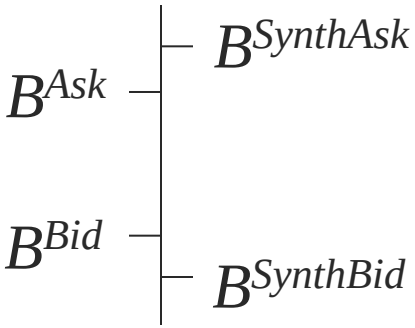
$$B_{1-yr}^{Synthetic} = \frac{F}{100} \cdot B_{6-mo}$$

- Total cost of buying the Long Bond synthetically:

$$B_{1-yr}^{SyntheticASK} = \frac{F^{ASK}}{100} \cdot B_{6-mo}^{ASK}$$

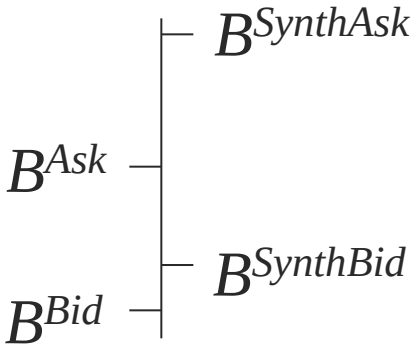
# Arbitrage with Bid-Ask Spread

Case 1



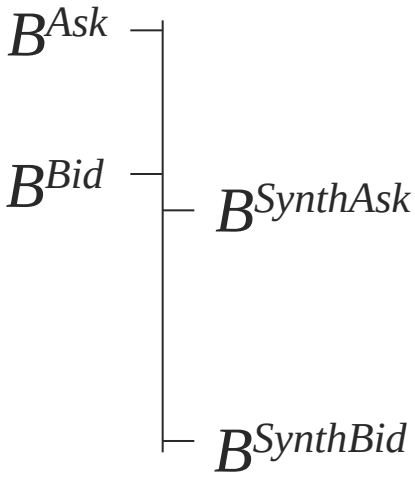

- Buy and sell direct
- No arbitrage

Case 2




- Buy direct; Sell synthetic
- No arbitrage

Case 3




- Buy synthetic; sell direct
- Arbitrage

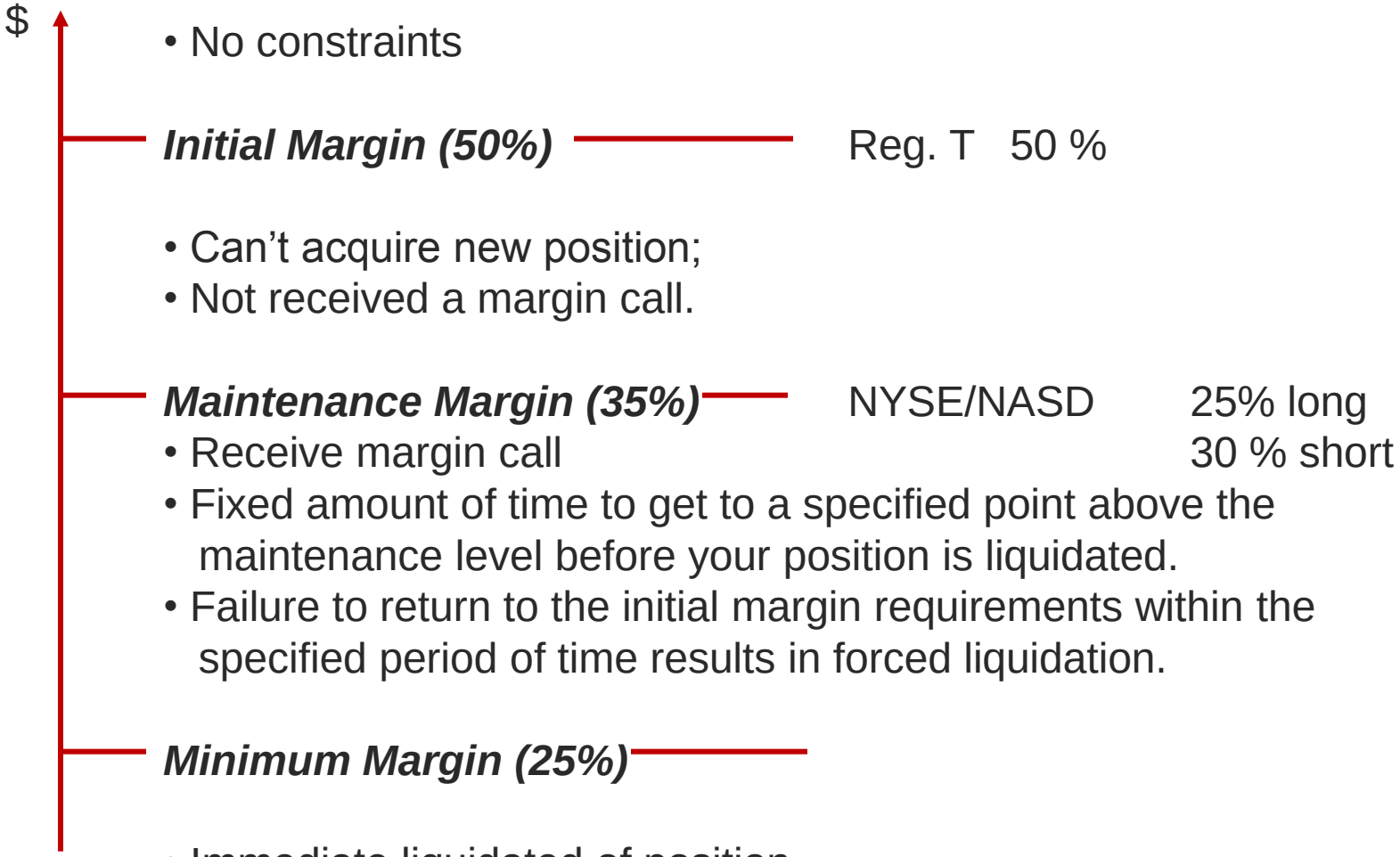
# Margins limit arbitrage

- Positive size is limited
  - Long an asset
    - m% * p * x $\leq$ marked-to-market wealth
  - Short an asset
    - Sell asset, receive p = $100
    - Put p + m%*p in margin account
    - Use up m%*p of your own financial wealth
- Cross-Margining
  - Netting: Only perfectly negatively correlated assets
  - Portfolio margin constrained
    - If better hedge one can take larger positions

# More on Margins

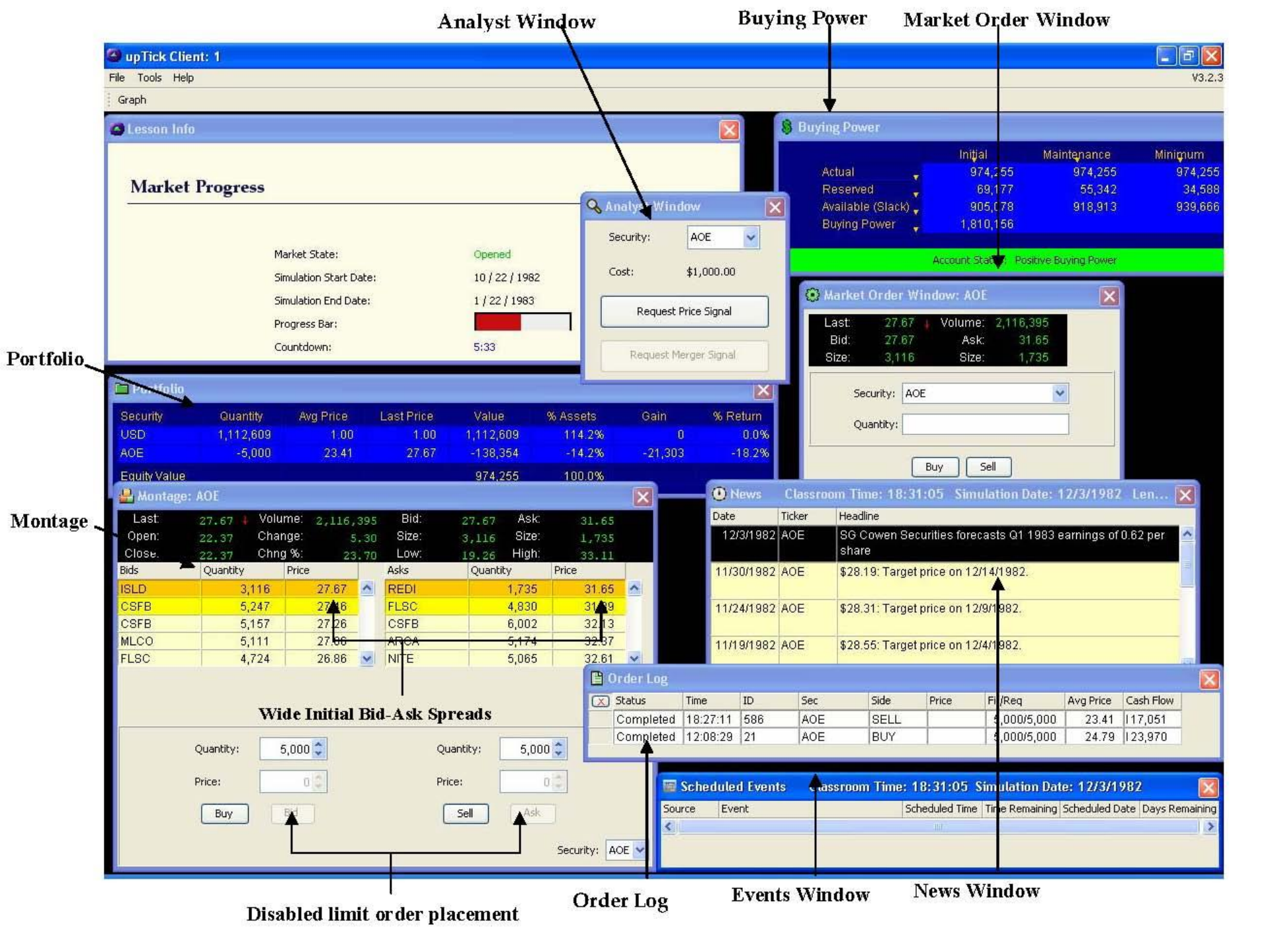
- How much leverage should your broker allow you?
  - Depends on interest they charge  risk they are willing to bear
- Most brokers charge an interest rate that is close to the Federal Funds rate (riskfree rate)
- Hence, from broker's perspective the loan must be close to riskfree (very small probability of you defaulting)
  - Broker requires **equity cushion** sufficient to keep the loan close to riskfree, subject to constraints imposed by the Federal Reserve and exchanges
  - **Cross-margining/Netting:** Most brokers give preferred margin terms to clients with low total portfolio risk
  - upTick requires 50% margin to initiate most equity and bond positions
  - upTick evaluates the overall risk of portfolios
    rebates some of the reserved equity for perfectly offsetting positions

# More on Margins



# Introduction

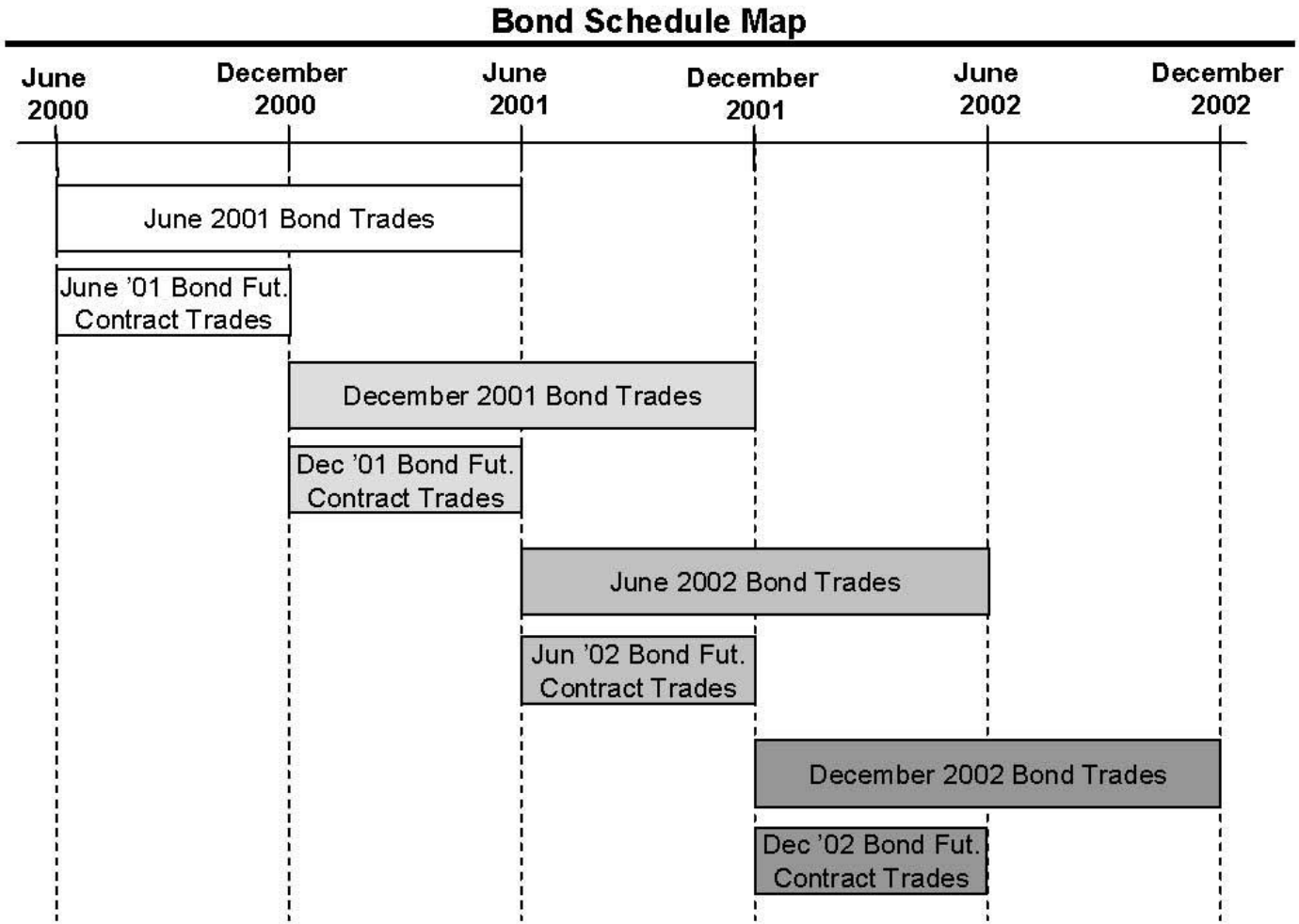
- Main Principles of Finance
  - One principle per lesson – see syllabus
  - Focus on institutional features (frictions matter)
- "UpTick" Trading software developed by
  - Joshua Coval (HBS)
  - Eric Stafford (HBS)
  - If software breaks down, we will switch to a standard lecture
- Student presentation (Masters students)


Analyst Window
Buying Power
Market Order Window
upTick Client: 1
File Tools Help
V3.2.3
Graph
Lesson Info
Market Progress
Market State: Opened
Simulation Start Date: 10 / 22 / 1982
Simulation End Date: 1 / 22 / 1983
Progress Bar:
Countdown: 5:33
Analyst Window
Security: AOE
Cost: $1,000.00
Request Price Signal
Request Merger Signal
Buying Power
Initial Maintenance Minimum
Actual 974,255 974,255 974,255
Reserved 69,177 55,342 34,588
Available (Slack) 905,078 918,913 939,666
Buying Power 1,810,156
Account Status: Positive Buying Power
Market Order Window: AOE
Last: 27.67 Volume: 2,116,395
Bid: 27.67 Ask: 31.65
Size: 3,116 Size: 1,735
Security: AOE
Quantity:
Buy
Sell
Portfolio
Security Quantity Avg Price Last Price Value % Assets Gain % Return
USD 1,112,609 1.00 1.00 1,112,609 114.2% 0 0.0%
AOE -5,000 23.41 27.67 -138,354 -14.2% -21,303 -18.2%
Equity Value 974,255 100.0%
Montage
Montage: AOE
Last: 27.67 Volume: 2,116,395 Bid: 27.67 Ask: 31.65
Open: 22.37 Change: 5.30 Size: 3,116 Size: 1,735
Close: 22.37 Chng %: 23.70 Low: 19.26 High: 33.11
Bids Quantity Price
ISLD 3,116 27.67
CSFB 5,247
CSFB 5,157
MLCO 5,111 27.66
FLSC 4,724 26.86
Asks Quantity Price
REDI 1,735 31.65
FLSC 4,830
CSFB 6,002
ARCA 5,174
NITE 5,065 32.61
Wide Initial Bid-Ask Spreads
Quantity: 5,000
Price:
Buy
Bid
Quantity: 5,000
Price:
Sell
Ask
Security: AOE
Disabled limit order placement
News Classroom Time: 18:31:05 Simulation Date: 12/3/1982
Date Ticker Headline
12/3/1982 AOE SG Cowen Securities forecasts Q1 1983 earnings of 0.62 per share
11/30/1982 AOE $28.19: Target price on 12/14/1982.
11/24/1982 AOE $28.31: Target price on 12/9/1982.
11/19/1982 AOE $28.55: Target price on 12/4/1982.
Order Log
Status Time ID Sec Side Price Fl/Req Avg Price Cash Flow
Completed 18:27:11 586 AOE SELL 5,000/5,000 23.41 117,051
Completed 12:08:29 21 AOE BUY 5,000/5,000 24.79 123,970
Order Log
Scheduled Events Classroom Time: 18:31:05 Simulation Date: 12/3/1982
Source Event Scheduled Time Time Remaining Scheduled Date Days Remaining
Events Window
News Window

# Philosophy of UpTick

- Price is affected by
  - historical real price data
  - trading of students
- Price is loosely anchored around real historical price data
  1. Computer traders/market makers find it more and more profitable to trade towards historical price the further price deviates from historical time series
  2. Signals reveal historical price x periods ahead
  3. Final liquidity value equals historical price
- Realistic trading screen
  - Montage - limit order book (shows bid-ask spread + market depth)
  - Event window
- Personal Calculator (Excel)

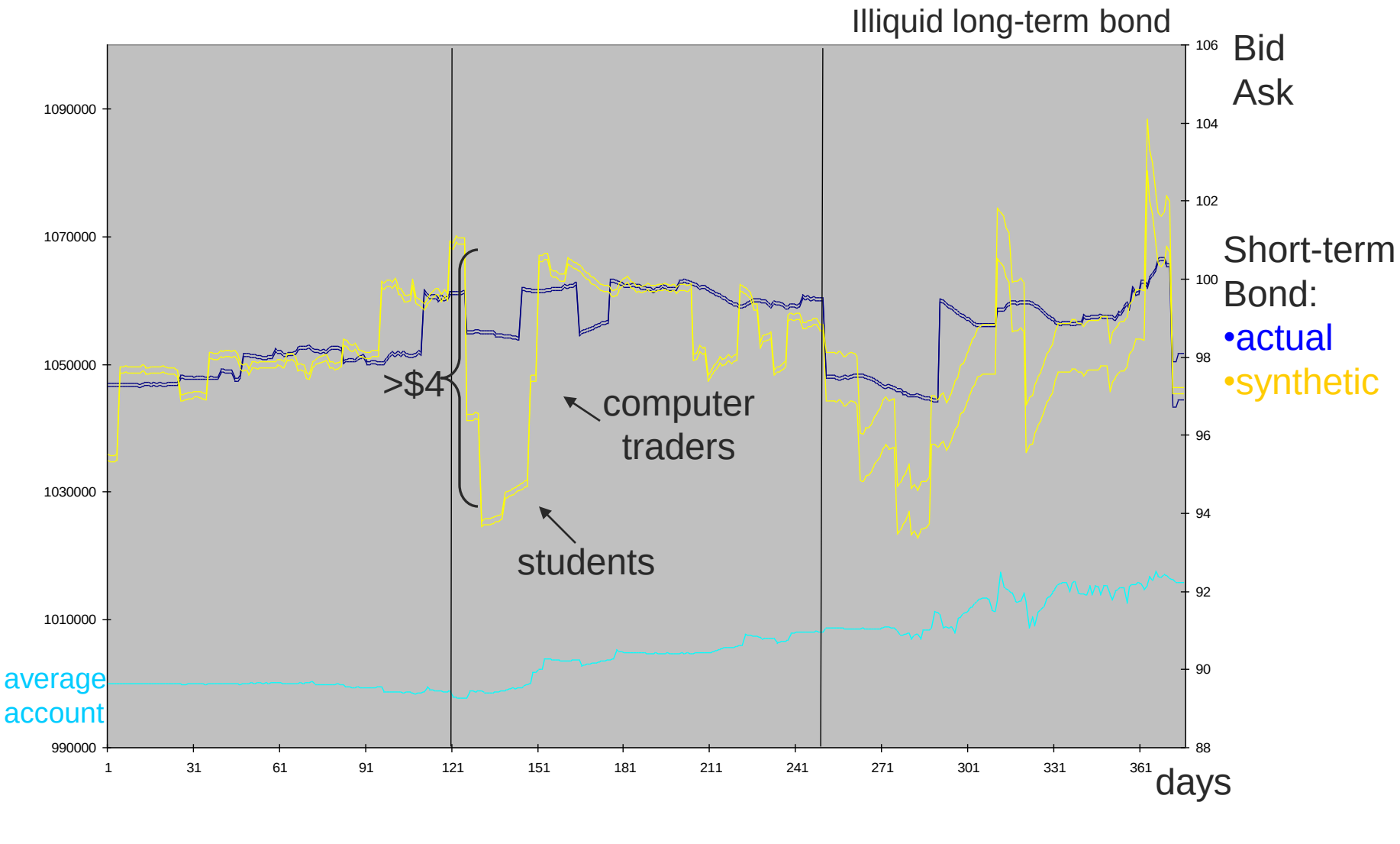
# Simulation – Law of One Price



# Three simulations

1. Equal liquidity for all three assets
   - 12-month bond
   - 6-month bond
   - Future
2. 12-month bond is less liquid
3. 6-month bond is less liquid
   + negative endowment in 6-month bond

# Actual vs. synthetic 6-month bond



# More about the simulations

- It's better to study synthetic short-term bond or futures contract (since every 6 months they converge to 100)
- *Big jumps* are created by *computer traders*.
  - Students should have noticed that short-term bond has to go to 100 after 6 months (expect a jump and trade very aggressively)
- Mispricing was sometimes up to $4 – be more aggressive.
- Quantity of trades
  - Average quantity for which the bid and ask was valid was 600 contracts
  - For roughly the next 200 contracts the price moved by 21 bp (.21 %)
  - Often there was significant mispricing (600 contracts make $1 and for another 1200 contracts make .8$ since price moves only .21%)
- Effect of Cross-margining:
  - Creates incentive to perfectly hedged because one can take larger positions
  - Simulation with illiquid short-term bond and large short position:
    **Idea** – get out of short-position by taking a long-position in synthetic short-term bond.

# Law of one Price – No (risk-free) Arbitrage

- Powerful argument - important principle
  - **Relative** asset prices – consistency check
  - Not absolute – what drives true price?
- Main Lessons
  - Transaction cost matter! (bid-ask spread)
  - Experiment to study depth of the market
  - Don’t get out of illiquid short position – hedge with synthetic bond!
    - Make sure to create perfectly hedged position!