Trading the Yield Curve

- Repos
- Riding the Curve
- Yield Spread Trades
- Coupon Rolls
- Yield Curve Steepeners & Flatteners
- Butterfly Trading
Repos

Firm A

Today

Sale of Security

Firm B

Firm A

Repurchase of Security

T₁

Firm B

Firm A funds itself by doing a *repo*

- Pays interest to the buyer at the *repo rate*

Firm B lends money by doing a *reverse repo*

- Regarded as a collateralized loan
Repo Trades

- Repo Master Agreement
- Term
  - Mainly short term: overnight (70%) to 1 week (20%)
  - Long term up to one year (‘Term repos’)
- Repo Rate
  - Can be paid as interest or by setting repurchase price above sale price
  - Simple add-on interest, 360 day year: \((1 + r \times n/360)\)
  - Overnight repo rate typically spread below Fed Funds
Repo Trades

- Securities ("Collateral")
  - Mainly Treasuries & Agency securities, but also CD’s BA’s, CP, MBS
- Credit risk: applies to both parties
- Margin ("Haircut")
  - Good faith deposit paid by borrower to lender
  - Sells securities worth $100, borrows $98
- Right of substitution
  - Borrow may pay extra 2-3 bp for right to offer lender other collateral
Repo Markets

- Borrowers of collateral (reverses)
  - Mainly dealers wanting to short specific issues
  - The “specials” market
- Lenders of collateral (repos)
  - Banks, S&L’s Munis
- Brokers
  - Garvin, Prebon, Tullet
Trading Applications

- Customer Arbs
  - Reverses to maturity
- Tails
Customer Arbs

- Reverses to maturity
  - Yields have risen, customer portfolios are underwater
  - Portfolio managers can’t take a loss
  - Carrying securities at book value, rather than current lower market value

- Choice:
  - Sell securities, book loss, & reinvest proceeds at higher yields
  - Hang onto underwater securities, avoid booking a loss, earn a lower yield
Reverses to Maturity

- Dealer offers to reverse in underwater securities for remaining term
  - Sells securities in market
  - Invests proceeds in securities of equal maturity at yield spread above break-even reverse rate
- Customer gets funds at repo rate, re-invests in higher yield securities at e.g. X% + 50bp
- At maturity dealer offsets amount lent to customer (plus interest) against face value of securities he has reversed in (plus final coupon)
Reverse to Maturity

“Weekwater” securities,

Customer

Dealer

Loan at x%

Sell underwater securities

Invest proceeds at x% + 50bp

Invest proceeds at > x% + 50bp
Tails

Purchase 90-day bill

Discount rate 5.95%

Finance purchase with 30-day term repo

Repo rate 5.75%

60-day forward bill

Effective discount rate ??
(current 60-day bill yield is 5.80%)
Lab: Figuring the Tail

- Current 90-day bill yield is 5.95%
- 30-day term repo rate is 5.75%
- Earn 20bp carry by repo-ing the 90-day bill
- Effectively creates a 60-day bill in 30-days time
- What is the effective discount rate on this forward bill?
  - Current 60-day bill yield is 5.80%
Figuring the Tail

Effective yield on future security =

Yield on cash security purchased +

(Carry x Days carried / Days left to maturity)

Yield = 5.95% + (0.20% x 30 / 60) = 6.09%
Profit = 6.09% - 5.80% = 0.29%
Will do trade if Fed doesn’t tighten or spreads don’t change unfavorably
Cash and Carry Trade

- Create the tail as before
  - Buy cash bill
  - Finance with term repo
- Sell the tail forward using *bill futures*
- Break-even repo rate is called the *implied repo rate*
- Trade is profitable when current repo rate is less than the implied repo rate.
Cash & Carry Trade - Example

- March ‘98 T-Bill
  - 147 days to maturity
  - Discount rate is 4.93%
- Dec ‘97 T-Bill futures contract
  - Expiry in 56 days
  - Futures price 95.09
- What is the implied repo rate?
- If the 56-day repo rate is 4.83%, calculate the $ profit per $1MM on the cash and carry trade
Cash & Carry Trade - Solution

- Purchase 147-day bill at $979,869
- Sell Dec futures contract at $987,589
- Implied repo rate:
  - \[(979,869 - 987,589) \times 360/56 = 5.06\%\]
- Profit on C&C Trade:
  - \[(5.06\% - 4.83\%) \times $1\text{MM} \times 56/360 = $357\]
Riding the Yield Curve

- A strategy to increase return
- Works for positively sloped yield curves
- Assumes stable yield curve
Riding Yield Curve Method

- Buy security out on shoulder of curve
- As it progresses to maturity, yield decreases
Example: Riding Yield Curve

- 6m (180 day) T-Bill Trading at 6.90
- 3m (90 day) T-Bill Trading at 6.50

Alternatives:
- Buy 3m T-Bill and mature it
- Buy 6m T-Bill and sell after 3 months

Perform break-even analysis
Lab: Riding Yield Curve

- Worksheet: Riding Yield Curve
- Use Bond Tutor: Treasury Calculator
- Work out Returns:
  - Strategy I (buy 90 day bill)
  - Strategy II (buy 180 days bill & sell after 90 days)

What is the extra profit from the yield curve play?

What is the Break-Even Discount Rate?
- Rate at which 180-day bill is sold, after 90 days
- Rate at which return from Strategy II = return from Strategy
- Use Goal Seek to find rate
## Break Even Analysis

### I. Buy $1MM of 90 day bills @ 6.5% and hold to maturity

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face Value</td>
<td>$1,000,000</td>
</tr>
<tr>
<td>Less: Purchase Price</td>
<td>($983,750)</td>
</tr>
<tr>
<td><strong>Return</strong></td>
<td><strong>$16,250</strong></td>
</tr>
</tbody>
</table>

### II. Buy $1MM of 180 day bills @ 6.9% and sell at 6.5% after 90 days

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sale Price</td>
<td>$983,750</td>
</tr>
<tr>
<td>Less: Purchase Price</td>
<td>($965,500)</td>
</tr>
<tr>
<td><strong>Return</strong></td>
<td><strong>$18,250</strong></td>
</tr>
</tbody>
</table>

### Profit From Yield Curve Play

<table>
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<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return from Strategy I</td>
<td>$16,250</td>
</tr>
<tr>
<td>Return from Strategy II</td>
<td>$18,250</td>
</tr>
<tr>
<td><strong>Profit from Yield Curve Play</strong></td>
<td><strong>$2,000</strong></td>
</tr>
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</table>

### Break-even Yield 7.3%

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV. Buy $1MM of 180 day bills @ 6.9% and sell at break-even yield</td>
<td></td>
</tr>
<tr>
<td>Sale Price</td>
<td>$981,750</td>
</tr>
<tr>
<td>Less: Purchase Price</td>
<td>($965,500)</td>
</tr>
<tr>
<td><strong>Break-even Return</strong></td>
<td><strong>$16,250</strong></td>
</tr>
</tbody>
</table>
Riding Yield Curve: Risk/Reward

- B/e yield is 7.3%
- Yield on 3m bill will be 6.5%, if yields are unchanged
- So, strategy has 80bp protection
- How likely is Fed to tighten 80bp in next 3 months?
- Exposure of riding yield curve strategies:
  - Upward shift across yield curve
  - Yield curve might invert at short end
Yield Spread Trades

- Short End
  - T-Bills vs. Short-dated Bonds
  - Treasury coupons vs. Eurodollar Strips

- Long End
  - Curve Steepeners & Flatteners
  - Bond Basis Trading
Trading T-Bills vs. Coupon Issues

- Yield on Treasury Notes vs. T-Bills
- Yield on Notes > Bills (usually):
  - Bills have greater liquidity
  - Bills have greater convexity
  - Coupon issues have reinvestment risk, Bills do not
Coupons-Bills Spread - Typical

**Coupon vs. Bills**

- **Yield (%)**
- **Days to Maturity**

- **Notes**
- **Bills**
Coupons-Bills Spread - Nov 94

![Graph showing the comparison between Coupon and Bill yields over days to maturity.]
Coupons-Bills Spread

- Shape of curves not atypical
- But spread has narrowed by 30 bp or so.
- Betting on spread widening would have been very profitable
  - Sell Notes, buy Bills
- NB must take rolldown effects into consideration
TED Spread

- Spread of LIBOR over Treasury spot curve
  - Compare:
    - Eurodollar futures yields
    - Yields on Treasury coupons
    - Typical spread 30-120 bp, historically

- Spreads widen:
  - Financial crises
  - Weakness in banking sector

- NB can trade with basis swaps
Coupon Rolls

- Simultaneous purchase & sale
  - E.g. Buy current 5-year
  - Sell new 5-year (WI)
  - Spread between securities’ yields is what dealer “gives” to do the roll

- Used by customers to “roll” investment from the outstanding note to the new note
  - Enables customer to lock in yield on new issue
    - No risk of being shut out of auction and having to pay more for bonds later
Economic Significance of Coupon Rolls

- Used to position dealers for Treasury auctions
  - Dealer usually shorts outstanding issue prior to announcement of new issue
    - In anticipation of market decline

- By doing the roll, the dealer:
  - Closes out short position in outstanding issue
    - Eliminates cost of borrowing bond to cover short
  - Creates a short position in new security
    - So he will be an active bidder in the auction
    - i.e. coupon rolls assist distribution process
Pricing a Coupon Roll

4 Factors

- **Maturity**
  - Investor usually gains yield pickup by extending maturity

- **Coupon rates**
  - May be some yield pickup from rolling into the new issue, if the coupon is higher

- **Return on funds between settlement dates**
  - E.g. investor sells outstanding note, settlement Apr 3, purchases new note, settlement Apr 15
  - Invests funds at 12-day term repo rate

- **Scarcity of outstanding issue**
  - Dealers may give more to cover short position
Pricing a Coupon Roll - Example

- Coupon roll on 10-year note
  - Existing Note
    - Settlement April 3rd
    - Maturity November 15, 2007
    - Trading at 100 27/32
    - Coupon 5 3/4%

- Treasury announces auction
  - Reopens existing 5 3/4% of Nov 15, 2007
  - Auction April 8, settlement April 15th

- Price the 10-year coupon roll
Pricing a Coupon Roll - Steps

- Compute dirty price of note for regular settlement
  - Accrued interest since November

- Calculate financing cost
  - Dirty price of note financed for 12 days
    - \[ \text{Cost} = P \times (1 + r \times 12/360) \]
  - This must be equivalent to dirty price of forward note

- Calculate clean price of forward note
  - Subtract accrued interest from dirty price

- Compute fair price of coupon role
  - Difference in yields on cash vs. forward note
## Pricing a Coupon Roll - Solution

### Outstanding 10-Year

<table>
<thead>
<tr>
<th>Settlement Date</th>
<th>3-Feb-98</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quoted Price</td>
<td>100 27/32</td>
</tr>
<tr>
<td>Accrued Interest</td>
<td>2.2079</td>
</tr>
<tr>
<td>Dirty Price</td>
<td>103.0517</td>
</tr>
</tbody>
</table>

### New 10-Year

<table>
<thead>
<tr>
<th>Settlement Date</th>
<th>15-Feb-98</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value for Settlement</td>
<td>103 7/32</td>
</tr>
<tr>
<td>Accrued Interest</td>
<td>2.3985</td>
</tr>
<tr>
<td>Derived Price Quote</td>
<td>100.8249</td>
</tr>
</tbody>
</table>

### Financing

<table>
<thead>
<tr>
<th>Term (days)</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repo Rate</td>
<td>5.00%</td>
</tr>
<tr>
<td>Funds Borrowed</td>
<td>103.0517</td>
</tr>
<tr>
<td>Funds Owed</td>
<td>103.2234</td>
</tr>
</tbody>
</table>

### Break-even Roll

<table>
<thead>
<tr>
<th>Yield on New Issue</th>
<th>5.637%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield on Outstanding Issue</td>
<td>5.634%</td>
</tr>
<tr>
<td>Break-even Roll</td>
<td>0.003%</td>
</tr>
</tbody>
</table>
Yield Curve Plays

‘STEEEPENERS’
- Bet that the yield curve will steepen
- Buy the short end, Sell the long end

‘FLATTENERS’
- Bet that the yield curve will flatten
- Sell the short end, Buy the long end

*Duration-Weight* the trade to hedge parallel-shifts in the curve

Popular choices:
- Two’s-Bonds
- NoB Spread (10y Notes over Bonds)
Example: 2’s-Bonds Trade

- Upcoming numbers:
  - Expect good news on inflation

- Question 1: what trade should you put on?
  - Steepener of flattener?

- Question 2:
  - Assume you want to hedge against parallel moves in the yield curve
  - What hedging action do you need to take?
Lab: 2’s-Bonds Trade

- Use Bond Tutor
  - Subject: Bond Values & Yield Curve

- Bond & Yield Curve details
  - Yield curve: Flat at 7% out to 30 years
  - 30 year Bond 7% coupon
  - 2 year Notes, 7% coupon

- Work out Hedge Ratio
  - Based on duration
  - Assume 1 bp parallel shift up or down
  - Work out change in value of both bond & note
  - Compute hedge ratio
Lab: 2’s-Bond Trade

- Assume you put on a duration-weighted trade.
- Start with yield curve flat at 7%.
- What is your P/L if:
  - Curve flattens or steepens by 10 bp?
  - There is a parallel shift of 10 bp?
  - A parallel shift of 50bp?
  - A flattening (2 yr down 10bp, 30 yr down 20bp)?
- Repeat, but now with curve flat at 14%.
- Conclusions:
  - How effective is duration-hedge?
  - What difference does level of yield curve make?
Solution: 2’s-Bond Flattener

Sell 7% 2Y Notes (Duration = 1.84)

Buy 7% Bonds (Duration=12.47)

Hedge Ratio = 12.47/1.84 = 6.79

Short $6.79MM 2Y for each $1MM Long Bond
## Solution: Flattener Trade P&L

<table>
<thead>
<tr>
<th>Yield Curve Move</th>
<th>Bond P/L</th>
<th>2-Yr P/L</th>
<th>Position P/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>30yr down 10bp</td>
<td>8.26</td>
<td>0</td>
<td>8.26</td>
</tr>
<tr>
<td>30yr up 10bp</td>
<td>-8.09</td>
<td>0</td>
<td>-8.09</td>
</tr>
<tr>
<td>Parallel up 10bp</td>
<td>-12.35</td>
<td>1.83</td>
<td>0.09</td>
</tr>
<tr>
<td>Parallel down 10bp</td>
<td>12.60</td>
<td>-1.84</td>
<td>0.13</td>
</tr>
<tr>
<td>Parallel up 50bp</td>
<td>-59.34</td>
<td>9.12</td>
<td>2.57</td>
</tr>
<tr>
<td>Parallel down 50bp</td>
<td>65.63</td>
<td>-9.23</td>
<td>2.98</td>
</tr>
<tr>
<td>Flattening</td>
<td>21.07</td>
<td>-6.79</td>
<td>8.56</td>
</tr>
</tbody>
</table>
Questions on the Lab

1. Why isn’t the P/L exactly zero for a 10 bp parallel move?
2. Why is the gain on a 10bp steepening not exactly equal to the loss on a 10bp flattening?
3. Why is there such a large P/L for a 50bp parallel move?
4. Why is there a gain from a parallel move up or down?
5. Can you guess what the P/L characteristics of an equivalent steepener trade would be?
Flattener P&L as F^n of Yield

Duration weighted positions
At 7%: Long 1 30Y, short 6.79 2Y
At 14%: Long 1 30Y, short 4.14 2Y

Yield = 7%
Yield = 14%

P&L (Points)

Change in Yield Spread: 2y less 30y (bp)
Risks of Curve Plays

- Convexity
- Spread Volatility
- Systematic effects in yield-curve motion
Convexity

Duration weighted position, long 1 30y, short DW 2y
Even Yield Movement: 2y yield change = 30y yield change

Yield = 7%
Yield = 14%
Volatility

- Sd. of daily changes in bond yield: -10bp
- Sd. of daily changes in 2-30 spread: -8bp
- Not much gain from ‘diversification’
- Can easily lose extra ticks legging into & out of trade
2Y Yield Change vs. 30Y Yield Change

Best Fit: $Y = 1.268 \times X$

Even-Yield Movement
Bias in Curve Trade

- Standard Duration Weighting produces:
  - Bullish bias to steepeners
  - Bearish bias to flatteners

- Need to adjust hedge ratio by Yield Change Multiplier

- Example (2Y v Bonds):
  - Adjusted Hedge Ratio = 6.79 / 1.268 = 5.35
  - Sell $5.35MM 2 Year Notes vs Buy S1MM 30 Year Bond
Bond Swaps

- Yield Enhancement Swap
- Quality Enhancement Swap
- Liquidity Enhancement Swap
- Convexity Enhancement Swap
- Interest Rate Anticipation Swap
Convexity Enhancement Swaps: Barbell-Bullet Trades

- **Barbell:**
  - Combination of short and long tenor bonds

- **Bullet**
  - Single bond of intermediate maturity

- **Barbell-Bullet trade:**
  - Arbitrage spread trade
  - Long one position, short the other
  - Equal duration risk and market values
Barbell-Bullet Example

Worksheet: Barbell

<table>
<thead>
<tr>
<th></th>
<th>Maturity</th>
<th>Coupon</th>
<th>Clean Price</th>
<th>Acrued Interest</th>
<th>Dirty Price</th>
<th>YTM</th>
<th>Modified Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>15-Feb-00</td>
<td>7 1/8</td>
<td>100 29/32</td>
<td>1.4959</td>
<td>102.4021</td>
<td>6.8960%</td>
<td>3.9507</td>
</tr>
<tr>
<td>B</td>
<td>15-Feb-15</td>
<td>11 1/4</td>
<td>139 10/32</td>
<td>2.3619</td>
<td>141.6744</td>
<td>7.4255%</td>
<td>9.3628</td>
</tr>
<tr>
<td>C</td>
<td>15-Feb-05</td>
<td>7 1/2</td>
<td>102 31/32</td>
<td>1.5746</td>
<td>104.5433</td>
<td>7.0724%</td>
<td>6.8048</td>
</tr>
</tbody>
</table>

- Barbell: purchase bonds A&B
- Bullet: sell bond C
- What weights to assign to bonds A&B?
Barbell-Bullet Trade Analysis

Yield gain is 0.06%

<table>
<thead>
<tr>
<th></th>
<th>YTM</th>
<th>Modified Duration</th>
<th>Qty</th>
<th>Weight (%)</th>
<th>Market Value</th>
<th>Dollar Duration</th>
<th>Dollar Convexity</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>6.8960%</td>
<td>3.9507</td>
<td>0.483</td>
<td>55.4%</td>
<td>49.4122</td>
<td>1.9521</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>7.4255%</td>
<td>9.3628</td>
<td>0.389</td>
<td>44.6%</td>
<td>55.1311</td>
<td>5.1618</td>
<td>88.79</td>
</tr>
<tr>
<td>C</td>
<td>7.0724%</td>
<td>6.8048</td>
<td>-1.000</td>
<td>-100%</td>
<td>-104.5433</td>
<td>-7.1139</td>
<td>-66.39</td>
</tr>
<tr>
<td></td>
<td>0.0600%</td>
<td>0.0000</td>
<td>-1.000</td>
<td>-100%</td>
<td>0.0000</td>
<td>0.0000</td>
<td>22.40</td>
</tr>
</tbody>
</table>

Use Solver to find these weights $W_A$ and $W_B$

Net Duration = 0
Cash-Flow Yield

- Previous analysis is very approximate
  - Estimate’s Barbell’s YTM as weighted average of YTM of each bond
  - Approximate because bonds A and B have different maturities
- Better method:
  - Calculate Barbell YTM from actual cash flows
Calculating Barbell YTM

- Set out Barbell cash flows
  - \( w_A Fc_A + w_B Fc_B \)
  - Don’t forget face value on maturity of bond A

- Compute discount factors

\[
P V = \frac{1}{\left[1 + \frac{y}{2}\right]^{(\text{Periods} - 1 + \frac{\text{AccrualDays}}{\text{ActualDaysin Periods}})}}
\]

- Refinement: adjust for weekends

- Use Solver to find \( y \) so that:
  - Cash flow NPV = Market Value (104.5433%)
## Barbell-Bullet Solution

<table>
<thead>
<tr>
<th>Cash Flow</th>
<th>YTM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barbell</td>
<td>7.2812%</td>
</tr>
<tr>
<td>Bullet</td>
<td>7.0724%</td>
</tr>
<tr>
<td>Yield pick-up</td>
<td>0.2088%</td>
</tr>
</tbody>
</table>
Duration-Weighted Yield

Approximate the cash flow yield using **dollar-duration weighted average yield**:

\[
Y^* = \frac{Y_A D_A + Y_B D_B}{D_A + D_B}
\]

\[
Y^* = 6.8960\% \times 1.9251 + 7.4255\% \times \frac{5.1618}{1.9251 + 5.1618}
\]

\[
Y^* = 7.2802\% \quad \text{(actual 7.2812\%)}
\]
Barbell-Bullet Risk Analysis

- Barbell gains 21bp yield over bullet
- Is there any explanation for this?
  - Is the Barbell position more risky than the bullet?
- Risk
  - Duration risk of two positions is the same
  - Convexity?
- Convexity formula:

\[
Convexity = \frac{1}{[1 + y/2]^2} \times \sum_{t=1}^{n} \frac{tPV(t)[1+t]}{Dirty\ Price}
\]
Solution: Barbell-Bullet
Risk Analysis

- Yield gain: +21bp
- Convexity gain: +22.4
- Something doesn’t add up!

<table>
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<tr>
<th>YTM</th>
<th>Modified Duration</th>
<th>Qty</th>
<th>Weight (%)</th>
<th>Market Value</th>
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<tr>
<td>7.0724%</td>
<td>6.8048</td>
<td>-1.000</td>
<td>-100%</td>
<td>-104.5433</td>
<td>-7.1139</td>
<td>-66.39</td>
</tr>
<tr>
<td>0.2088%</td>
<td>0.0000</td>
<td>0.0000</td>
<td>22.40</td>
<td>0.0000</td>
<td>0.0000</td>
<td></td>
</tr>
</tbody>
</table>

Yield Gain
Convexity Gain
Horizon Value and Volatility

- Consider following example:
  - Assume yield curve is flat at 10%
  - Horizon yield is 10% over 5 years
  - Assume rates move, then hold for 5 years
    - How does Barbell perform relative to bullet?

**Worksheet: Barbell convexity**

<table>
<thead>
<tr>
<th>BOND</th>
<th>Maturity</th>
<th>Coupon</th>
<th>Price</th>
<th>Weight</th>
<th>YTM</th>
<th>Duration</th>
<th>Convexity</th>
<th>Weighted Duration</th>
<th>Weighted Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>5/15/05</td>
<td>10.00%</td>
<td>100</td>
<td>27.37%</td>
<td>10.00%</td>
<td>6.231</td>
<td>133.810</td>
<td>1.706</td>
<td>27.37</td>
</tr>
<tr>
<td>B</td>
<td>5/15/25</td>
<td>10.00%</td>
<td>100</td>
<td>72.63%</td>
<td>10.00%</td>
<td>9.465</td>
<td></td>
<td>6.874</td>
<td>72.63</td>
</tr>
<tr>
<td>C</td>
<td>5/15/15</td>
<td>10.00%</td>
<td>100</td>
<td>-100.00%</td>
<td>10.00%</td>
<td>8.580</td>
<td>121.560</td>
<td>-8.580</td>
<td>-100.00</td>
</tr>
</tbody>
</table>

Net Position: 12.250 0.000 0
Barbell vs. Bullet Analysis

- Barbell apparently enjoys convexity advantage
- But, assumptions are unrealistic:
  - Rates do not move instantaneously and then hold for 5 years
  - Takes no account of how likely rates are to move by given amount
- Need an interest rate model
  - E.g Binomial short-rate tree
  - Takes account of interest rate volatility
  - Generate distribution function of like horizon values
## Barbell vs. Bullet Interest Rate Model

### Table: Short Rate Probability Bullet FV vs. Dumbell FV

<table>
<thead>
<tr>
<th>Short Rate</th>
<th>Probability</th>
<th>Bullet FV</th>
<th>Dumbell FV</th>
<th>FV Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.81%</td>
<td>0.1%</td>
<td>208.36</td>
<td>209.86</td>
<td>1.50</td>
</tr>
<tr>
<td>5.56%</td>
<td>1.0%</td>
<td>199.36</td>
<td>199.92</td>
<td>0.56</td>
</tr>
<tr>
<td>6.43%</td>
<td>4.4%</td>
<td>190.07</td>
<td>189.94</td>
<td>-0.13</td>
</tr>
<tr>
<td>7.42%</td>
<td>11.7%</td>
<td>180.6</td>
<td>180.12</td>
<td>-0.48</td>
</tr>
<tr>
<td>8.56%</td>
<td>20.5%</td>
<td>171.11</td>
<td>170.6</td>
<td>-0.51</td>
</tr>
<tr>
<td>9.88%</td>
<td>24.6%</td>
<td>161.79</td>
<td>161.54</td>
<td>-0.25</td>
</tr>
<tr>
<td>11.40%</td>
<td>20.5%</td>
<td>152.84</td>
<td>153.07</td>
<td>0.23</td>
</tr>
<tr>
<td>13.15%</td>
<td>11.7%</td>
<td>144.43</td>
<td>145.32</td>
<td>0.89</td>
</tr>
<tr>
<td>15.17%</td>
<td>4.4%</td>
<td>136.76</td>
<td>138.37</td>
<td>1.61</td>
</tr>
<tr>
<td>17.49%</td>
<td>1.0%</td>
<td>129.99</td>
<td>132.28</td>
<td>2.29</td>
</tr>
<tr>
<td>20.16%</td>
<td>0.1%</td>
<td>124.25</td>
<td>127.11</td>
<td>2.86</td>
</tr>
</tbody>
</table>

| Total      |            | 162.25    | 162.27     | 0.03          |

Barbell vs. Bullet Interest Rate Model

![Graph showing the difference in return per $100 against the short rate. The graph has a Y-axis labeled "Difference in Return per $100" ranging from $(1.00) to $3.50 and an X-axis labeled "Short Rate" ranging from 0.00% to 25.00%. The graph features a curve that peaks at 5.00% and 15.00%.]
Summary: Trading the Yield Curve

- Repo Trades
  - Figuring the tail
  - Cash & carry trades
- Riding the curve
- Yield spread trades
- Coupon rolls
- Steepeners & flatteners
- Butterfly trades