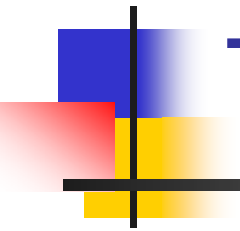
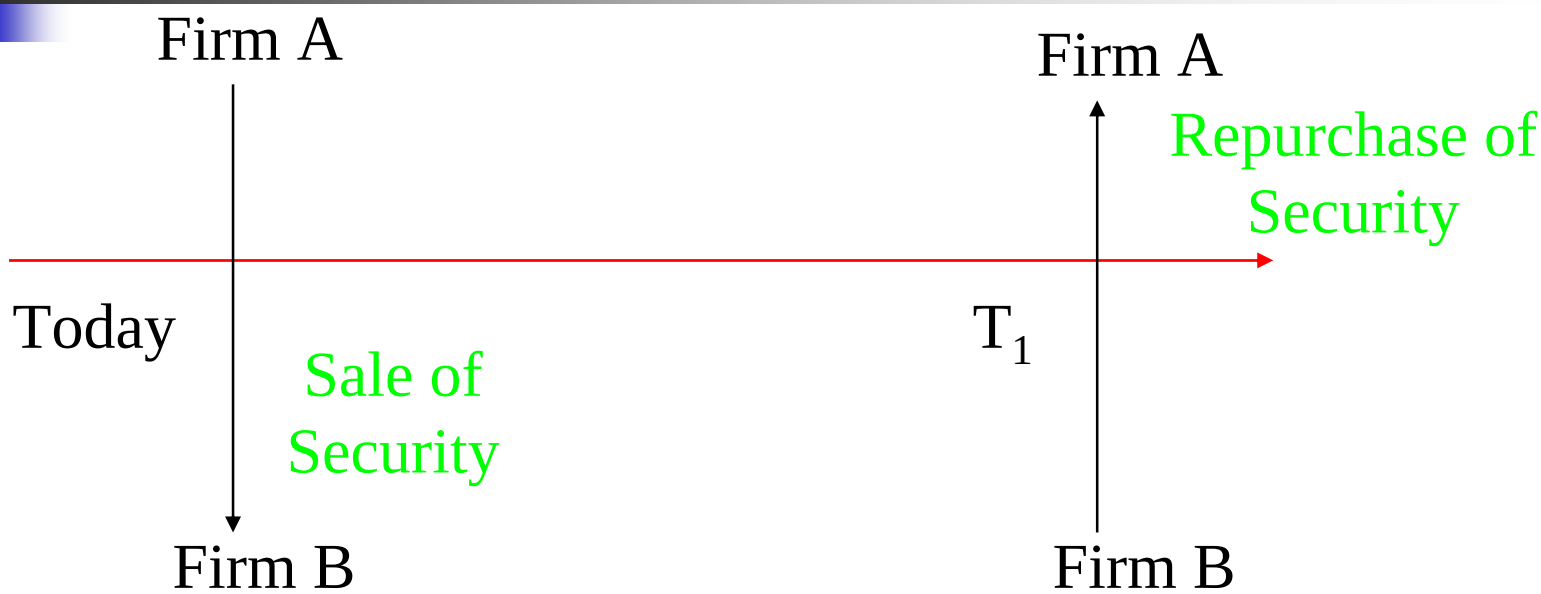


Trading the Yield Curve

Trading the Yield Curve

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

Repos



- 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 x 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

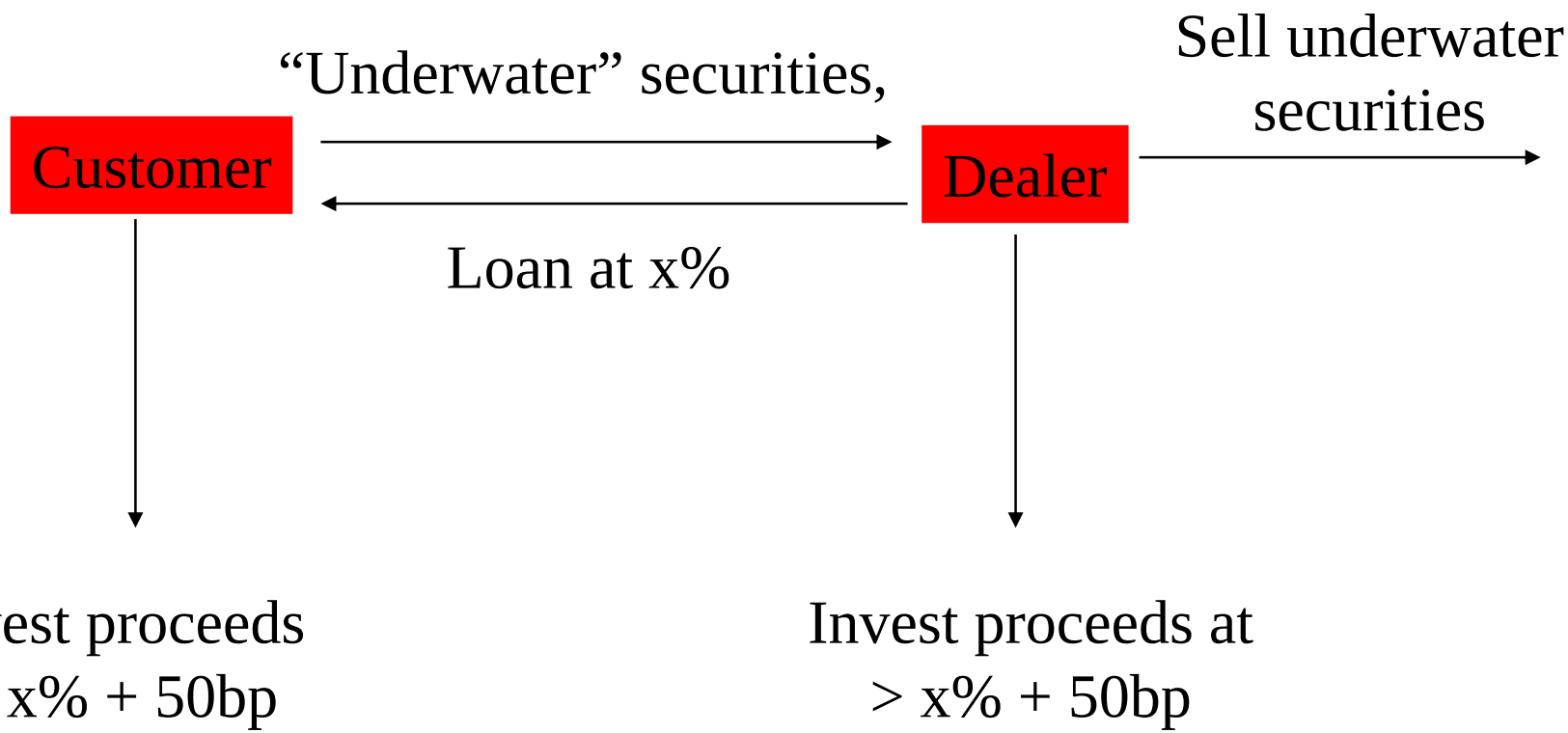
Customer Arbs

- 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

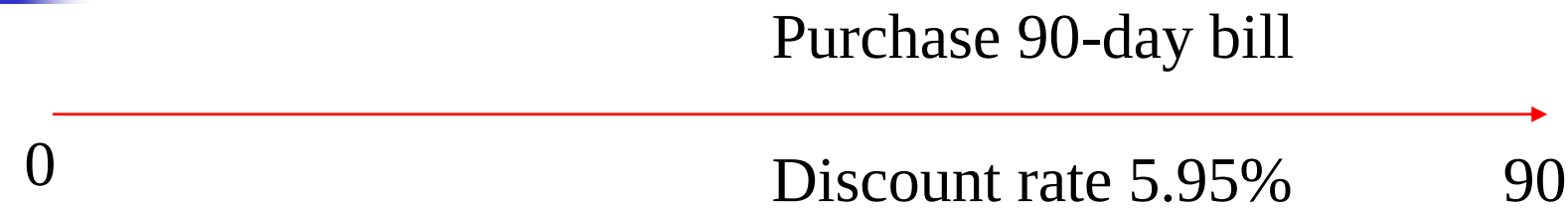
Reverses to Maturity

- 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)

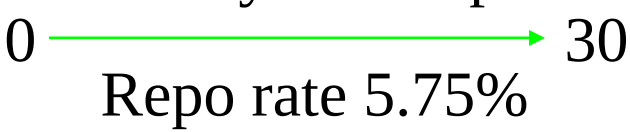
Reverse to Maturity



Tails



Finance purchase with
30-day term repo



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

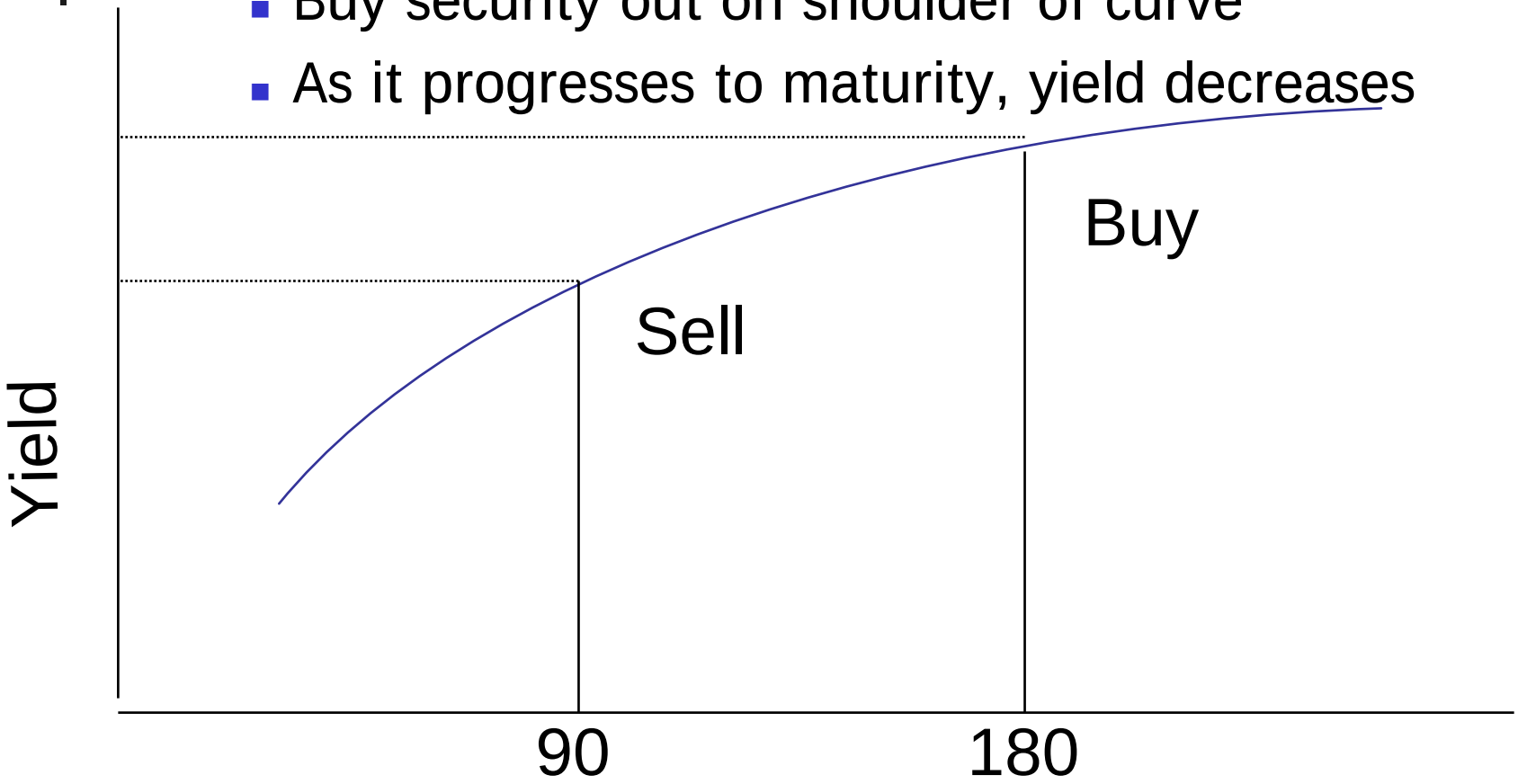
- Purchase 147-day bill at $979,869
- Sell Dec futures contract at $987,589
- Implied repo rate:
  - (979,869 - 987,589) x 360/56 = 5.06%
- Profit on C&C Trade:
  - (5.06% - 4.83%) x $1MM x 56/360 = $357

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	
Face Value	$1,000,000
Less: Purchase Price	($983,750)
Return	$16,250

II. Buy $1MM of 180 day bills @ 6.9% and sell at 6.5% after 90 days	
Sale Price	$983,750
Less: Purchase Price	($965,500)
Return	$18,250

Profit From Yield Curve Play	
Return from Strategy I	$16,250
Return from Strategy II	$18,250
Profit from Yield Curve Play	$2,000

Break-Even Yield	7.3%

IV. Buy $1MM of 180 day bills @ 6.9% and sell at break-even yield	
Sale Price	$981,750
Less: Purchase Price	($965,500)
Break-Even Return	$16,250

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

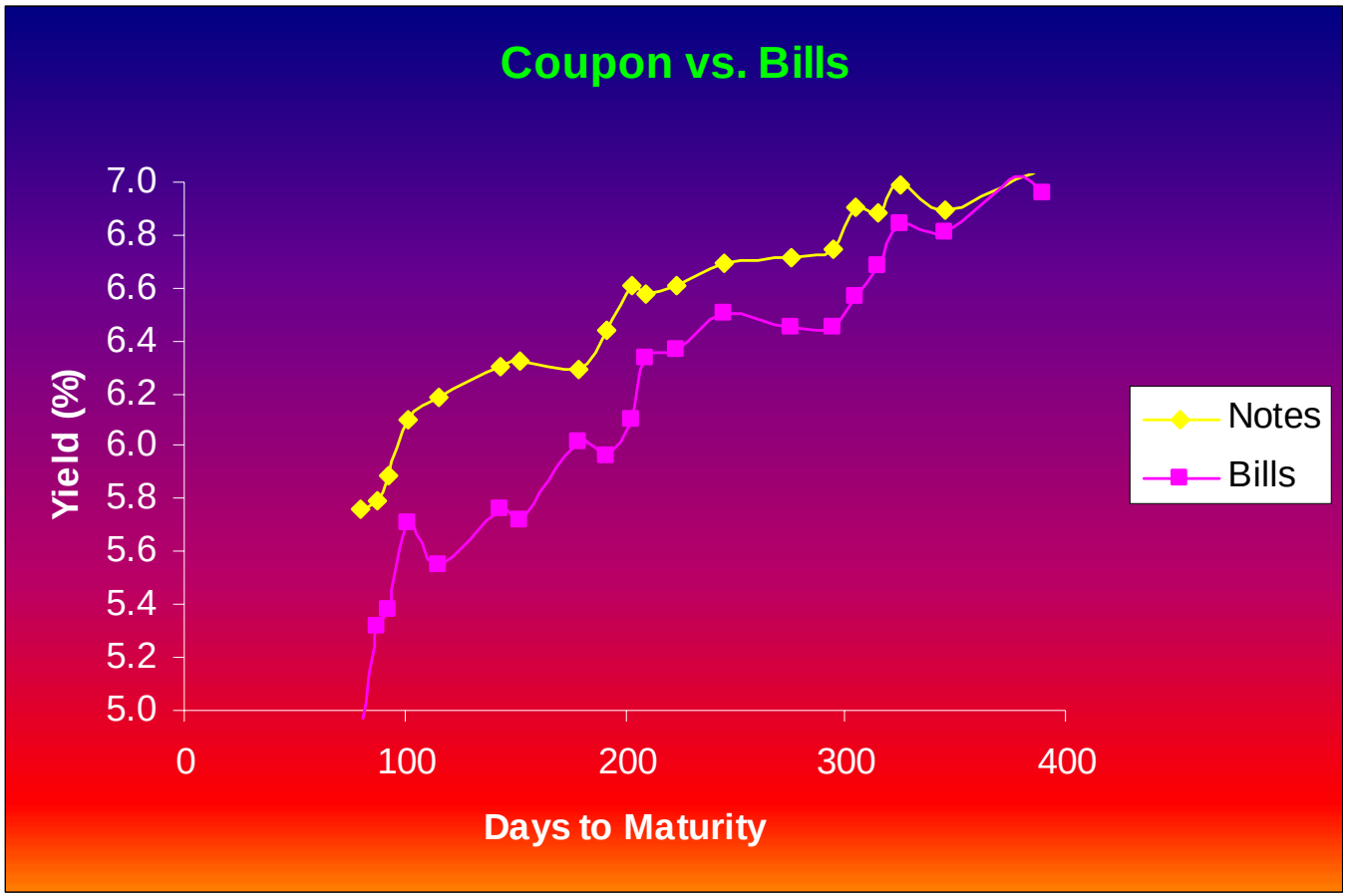
Yield Spread Trades

- Short End
  - T-Bills vs. Short-dated Bonds
  - Treasury coupons vs. Eurodollar Strips
- Long End
  - Curve Steepeners & Flatteners
  - Bond Basis Trading

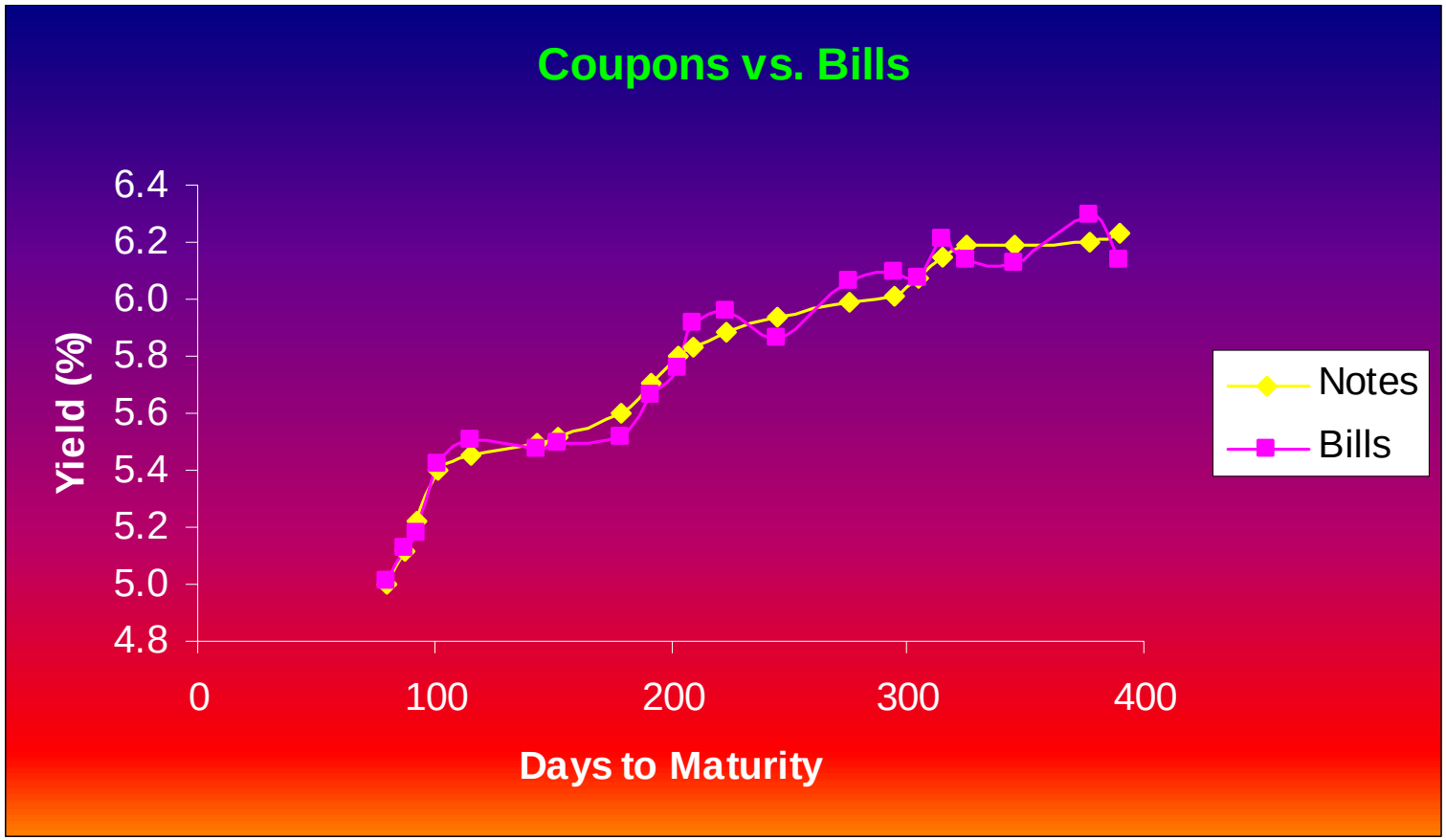
Trading T-Bills vs. Coupon Issues

- 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



Coupons-Bills Spread - Nov 94



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
    - Cost = P x (1 + r x 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	
Settlement Date	3-Feb-98
Quoted Price	100 27/32
Accrued Interest	2.2079
Dirty Price	103.0517

New 10-Year	
Settlement Date	15-Feb-98
Value for Settlement	103 7/32
Accrued Interest	2.3985
Derived Price Quote	100.8249

Financing	
Term (days)	12
Repo Rate	5.00%
Funds Borrowed	103.0517
Funds Owed	103.2234

Break-even Roll	
Yield on New Issue	5.637%
Yield on Outstanding Issue	5.634%
Break-even Roll	0.003%

Yield Curve Plays

- ‘STEEPENERS’
  - 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?

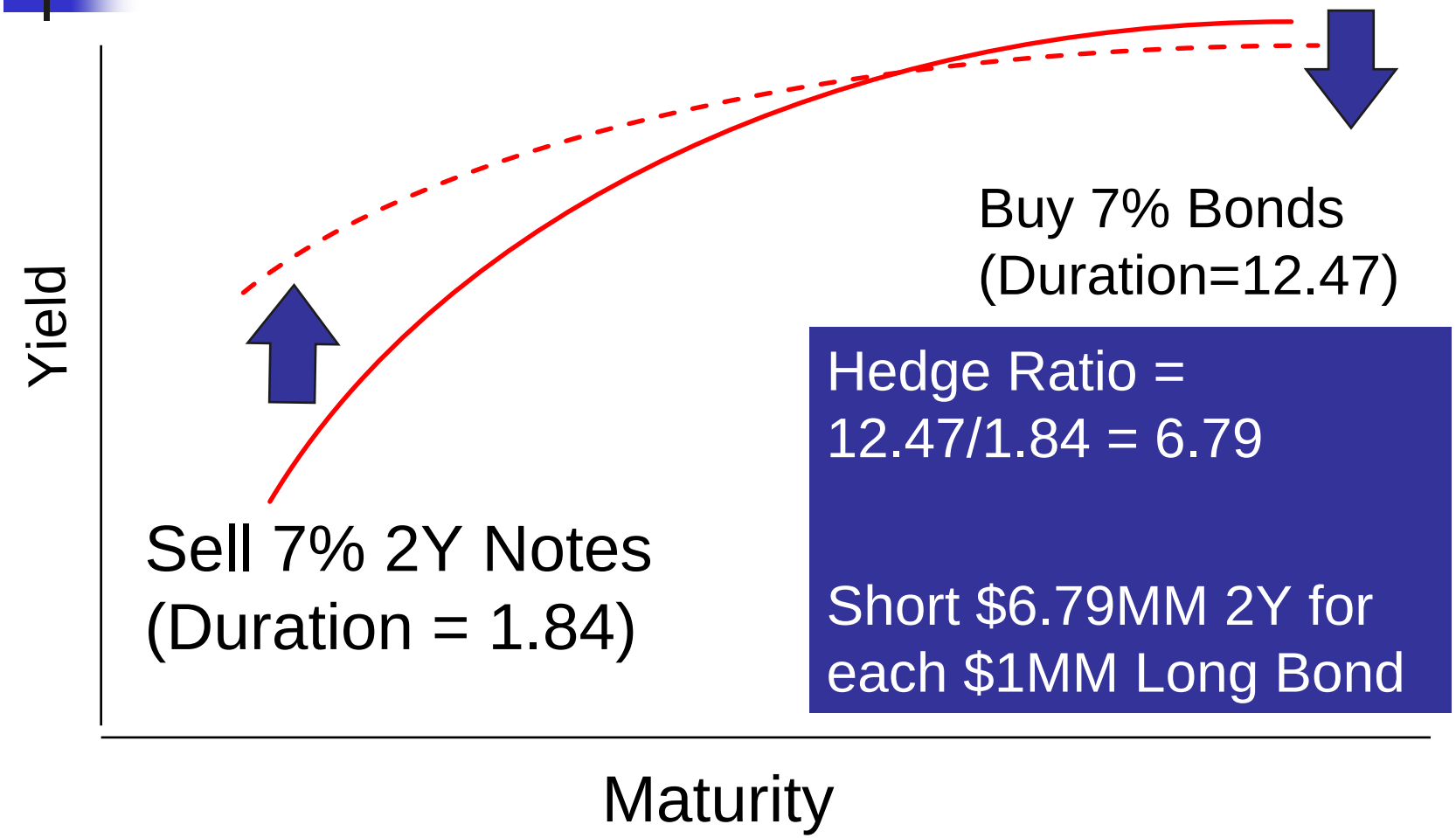
Lab: 2's-Bonds Trade

- 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



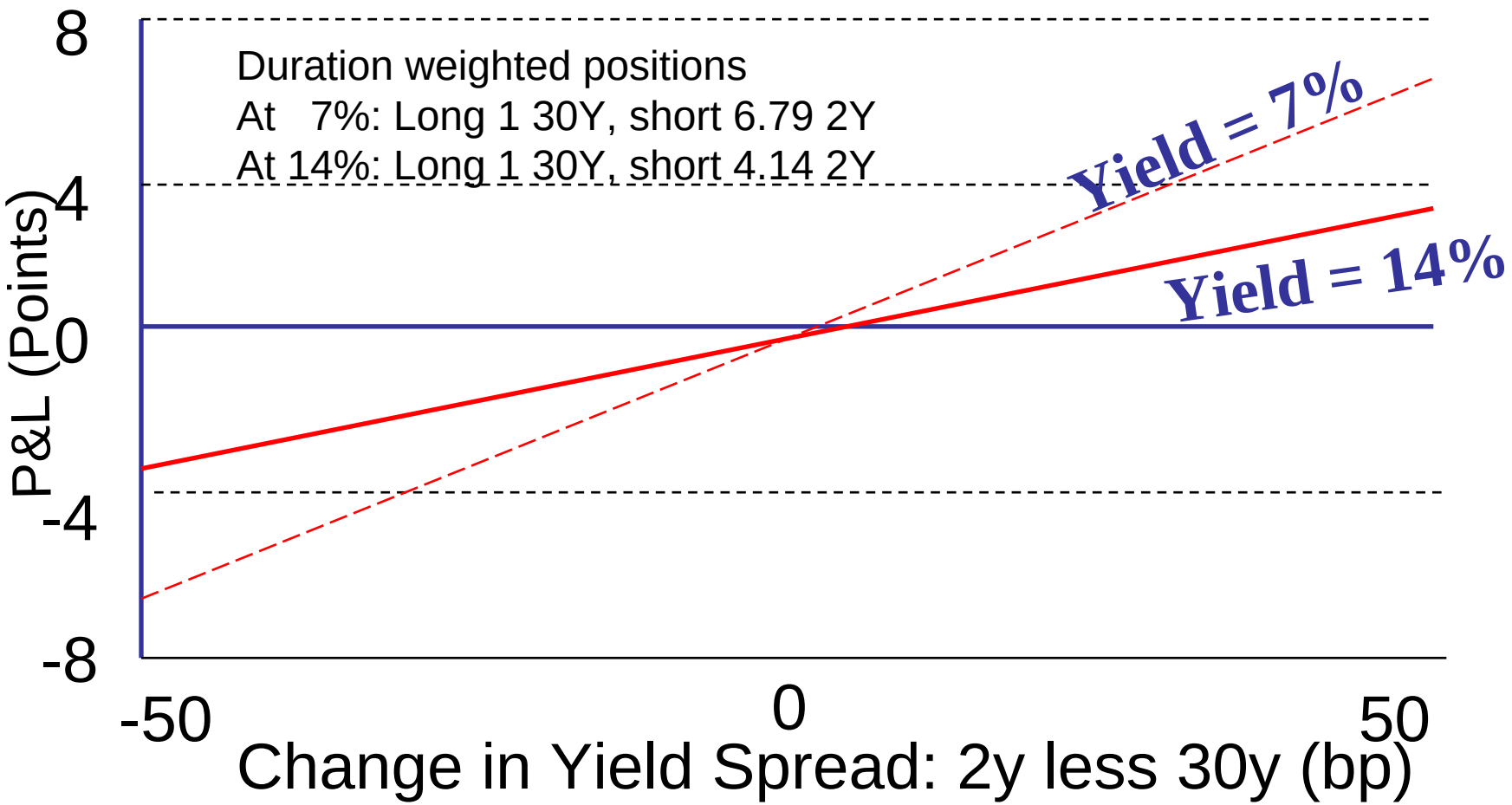
Solution: Flattener Trade P&L

Yield Curve Move	Bond P/L	2-Yr P/L	Position P/L
30yr down 10bp	8.26	0	8.26
30yr up 10bp	-8.09	0	-8.09
Parallel up 10bp	-12.35	1.83	0.09
Parallel down 10bp	12.60	-1.84	0.13
Parallel up 50bp	-59.34	9.12	2.57
Parallel down 50bp	65.63	-9.23	2.98
Flattening	21.07	-6.79	8.56

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?

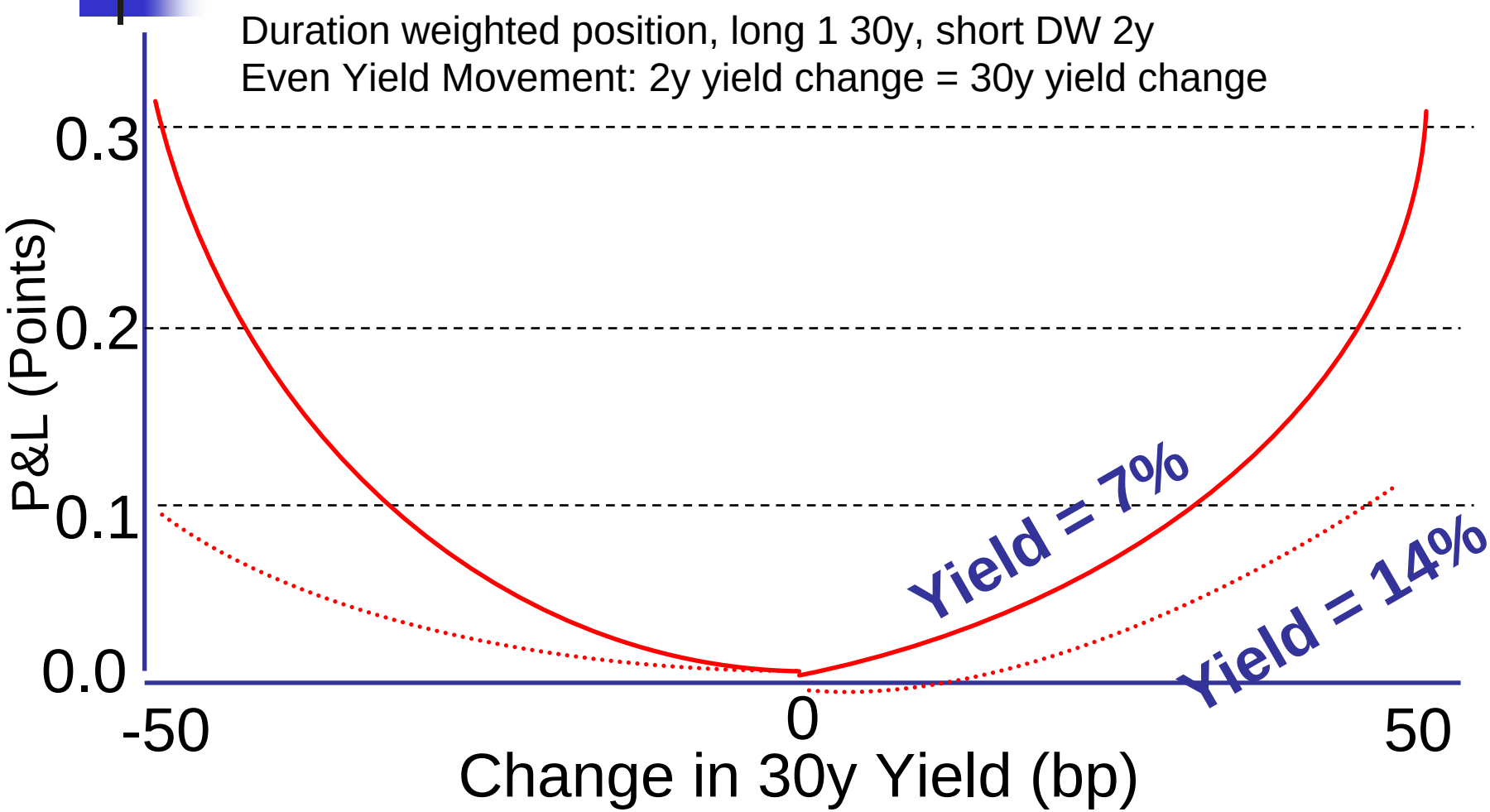
Flattener P&L as F^{n} of Yield



Risks of Curve Plays

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

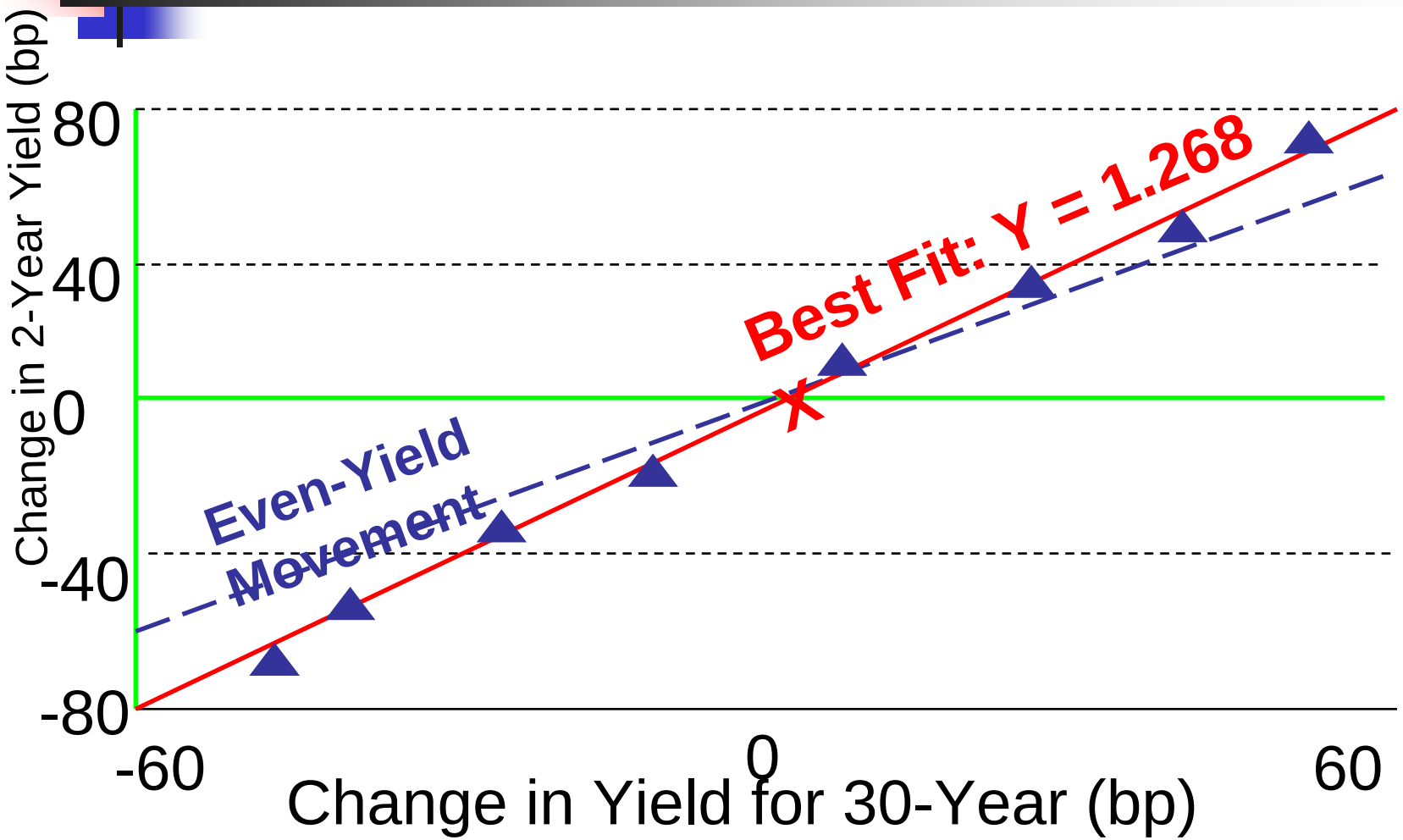
Convexity


Duration weighted position, long 1 30y, short DW 2y
Even Yield Movement: 2y yield change = 30y yield change
0.3
0.2
0.1
0.0
P&L (Points)
Yield = 7%
Yield = 14%
-50
0
50
Change in 30y Yield (bp)

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



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

- Woksheet: Barbell

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

- 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%

	YTM	Modified Duration	Qty	Weight (%)	Market Value	Dollar Duration	Dollar Convexity
A	6.8960%	3.9507	0.483	55.4%	49.4122	1.9521	
B	7.4255%	9.3628	0.389	44.6%	55.1311	5.1618	88.79
C	7.0724%	6.8048	-1.000	-100%	-104.5433	-7.1139	-66.39
	0.0600%				**0.0000**	**0.0000**	**22.40**

Yield Gain

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

$$PV = \frac{1}{[1+y/2]^{\left(Periods-1+\frac{AccrualDays}{ActualDay\sin Periods}\right)}}$$

  - Refinement: adjust for weekends
- Use Solver to find y so that:
  - Cash flow NPV = Market Value (104.5433%)

Barbell-Bullet Solution

	Cash Flow YTM
Barbell	7.2812%
Bullet	7.0724%
Yield pick-up	0.2088%

Duration-Weighted Yield

- Approximate the cash flow yield using *dollar-duration weighted average yield:*
- $$Y^* = \frac{Y_A D_A + Y_B D_B}{D_A + D_B}$$
- $$Y^* = \frac{6.8960\% \times 1.9251 + 7.4255\% \times 5.1618}{1.9251 + 5.1618}$$
- $Y^* = 7.2802\%$ *(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:

$$Convexity = \frac{1}{[1+y/2]^2} \times \frac{\sum_{t=1}^{n} tPV(t)[1+t]}{Dirty\,\Pr ice}$$

Solution: Barbell-Bullet Risk Analysis

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

YTM	Modified Duration	Qty	Weight (%)	Market Value	Dollar Duration	Dollar Convexity
6.8960%	3.9507	0.483	55.4%	49.4122	1.9521	
7.4255%	9.3628	0.389	44.6%	55.1311	5.1618	88.79
7.0724%	6.8048	-1.000	-100%	-104.5433	-7.1139	-66.39
0.2088%				**0.0000**	**0.0000**	**22.40**

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

BOND	Maturity	Coupon	Price	Weight	YTM	Duration	Convexity	Weighted Duration	Weighted Value
A	5/15/05	10.00%	100	27.37%	10.00%	6.231	133.810	1.706	27.37
B	5/15/25	10.00%	100	72.63%	10.00%	9.465		6.874	72.63
C	5/15/15	10.00%	100	-100.00%	10.00%	8.580	121.560	-8.580	-100.00
Net Position							**12.250**	**0.000**	**0**

Barbell vs. Bullet Analysis

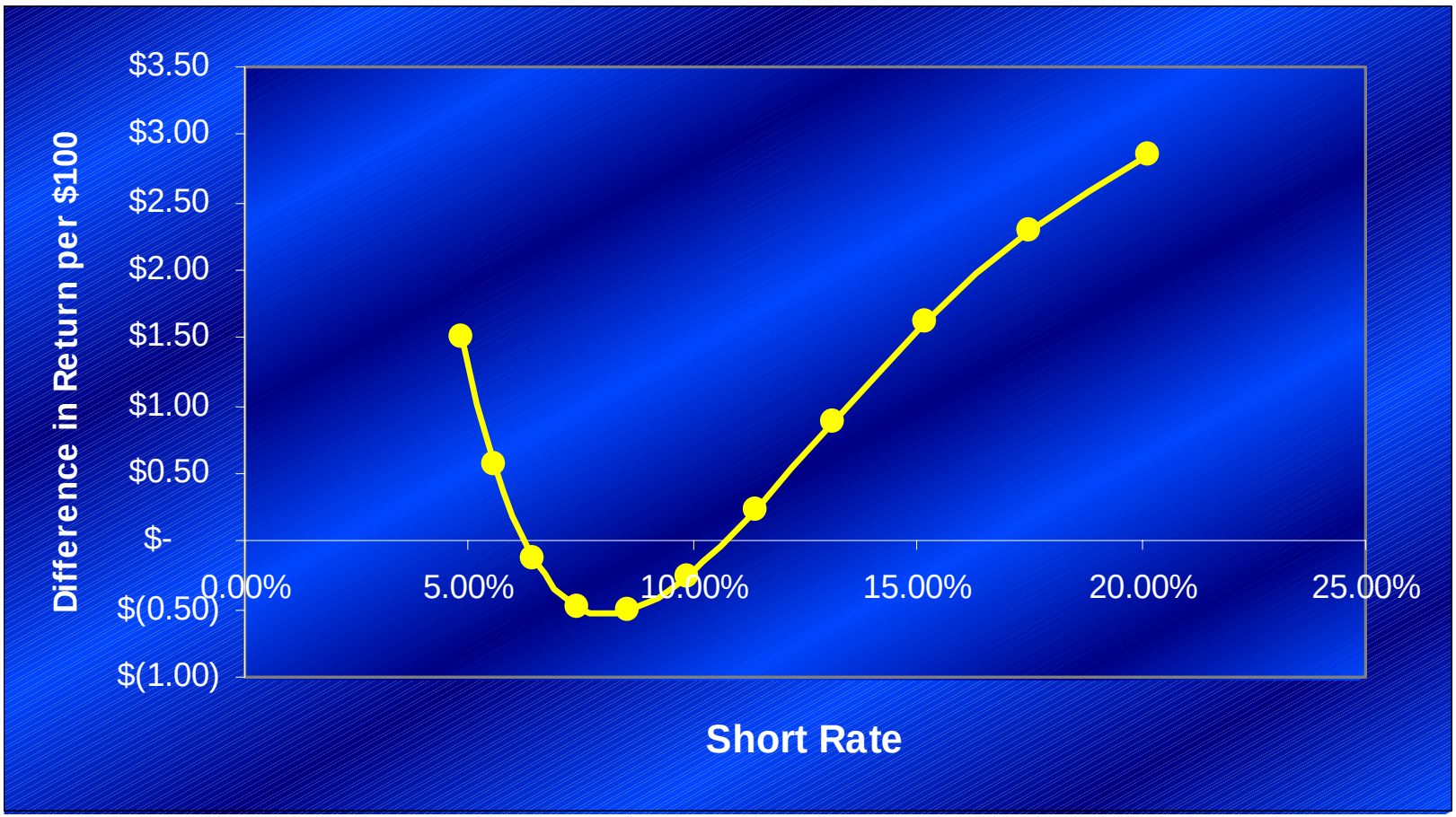
- Barbell apparently enjoys convexity advantage
- But, assumptions are unrealistic:
  - Rates do not move instantaneously and then hold for 5 years
  - Takes no account of how likely rates are to move by given amount
- Need an interest rate model
  - E.g Binomial short-rate tree
  - Takes account of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

Barbell vs. Bullet Interest Rate Model

Short Rate	Probability	Bullet FV	Dumbell FV	Difference
4.81%	0.1%	208.36	209.86	1.50
5.56%	1.0%	199.36	199.92	0.56
6.43%	4.4%	190.07	189.94	-0.13
7.42%	11.7%	180.6	180.12	-0.48
8.56%	20.5%	171.11	170.6	-0.51
9.88%	24.6%	161.79	161.54	-0.25
11.40%	20.5%	152.84	153.07	0.23
13.15%	11.7%	144.43	145.32	0.89
15.17%	4.4%	136.76	138.37	1.61
17.49%	1.0%	129.99	132.28	2.29
20.16%	0.1%	124.25	127.11	2.86
		162.25	**162.27**	**0.03**

Source: "Active Total Return Management of Fixed Income Portfolios", Dattatreya and Fabozzi, Probus Publishing, 1989

Barbell vs. Bullet Interest Rate Model



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