CHARTA LEARNING · LESSON NOTES

Applying Duration, Convexity and DV01

FRM Part I

1 A story: one rate moves the whole market

- Bond prices fall when interest rates rise
- Rates of different maturities tend to move together
- So one number may describe the day's rate scenario
- Risk work asks: how much per unit?

IN THE LESSON

- Imagine you run a small bond fund.
- On Monday morning the news says that rates went up.
- You do not need to check every bond one at a time to know the direction: nearly all your prices fell.
- That gut feeling is the seed of a very useful idea.
- Rates for different maturities are not independent.
- They tend to rise and fall together, like boats lifted by one tide.
- If a single tide explains most of what happens, then one number can describe the day, and the whole book can be repriced from it.
- That is where we begin.

2 The one-factor interest rate model

- One random factor drives all rates and bond prices
- Parallel shift: every yield moves by the same amount
- Yield beta: each yield moves by a fixed multiple of the factor
- Knowing the factor means knowing how every bond reprices

IN THE LESSON

- A one-factor interest rate model assumes that a single random variable drives every rate and every bond price.
- Once you know how that factor moves, you know how each security reprices.
- There are two ways to turn the factor into moves.
- The first is a parallel shift: every yield changes by the same amount.
- The second gives each yield its own sensitivity to the factor, a fixed multiple called a yield beta.
- A ten year yield might move one point two basis points for each basis point of the factor, a short yield only zero point eight.
- One scenario number then does all the work.

3 Which things can be the factor?

A factor is a market risk driver, not a term of the contract

Candidate	Factor?
Short-term rate	Yes
Yield on the 10-year par bond	Yes
One spot rate	Yes
Coupon of a bond	No: contract term
Maturity date	No: contract term

IN THE LESSON

- The factor has to be a risk driver, something in the market that moves unpredictably.
- The usual choices are the short term interest rate, the yield on a benchmark par bond such as the ten year, or a single spot rate.
- A contractual term can never be the factor.
- A coupon or a maturity date is written into the bond and does not wander at random.
- Notice the trade off.
- The appeal of a one-factor model is simplicity, and hedging becomes easy.
- The weakness is that it ignores changes in the slope and the curvature of the yield curve, so a book hedged against the factor can still lose when the curve twists.

4 DV01: the dollar value of one basis point

- Basis point = 0.01 percent of yield
- DV01 = price change when yield moves one basis point
- Quoted as a positive number for ordinary bonds
- In currency, so it grows with position size

IN THE LESSON

- A basis point is one hundredth of one per cent.
- D V zero one is the change in a security's price when its yield moves by one basis point, measured in money.
- The name says it: dollar value of an oh one.
- For an ordinary bond the price falls when yield rises, but D V zero one is quoted as a positive number, as a size and not a direction.
- It is a dollar figure, so it depends on how much you hold.
- A hundred million dollar position has a hundred times the D V zero one of a one million dollar position in the same bond.

5 Computing DV01 from a scenario

DV01 = absolute price change ÷ yield change in bp
DV01 = (P↓ − P↑) ÷ (2 × yield move in bp)

DV01, dollars	Dollar change per basis point
Price change	Absolute change in position value
Yield change, bp	Percent move times one hundred

IN THE LESSON

- To compute it from a scenario, take the absolute price change and divide by the yield change measured in basis points.
- Watch the units, because this is where mistakes happen.
- A yield move quoted in per cent must be multiplied by one hundred to give basis points.
- A price quoted per one hundred of face must be scaled up to the face amount you actually hold.
- And since the price yield curve bends, a better estimate averages an upward shift and a downward shift.
- You take the price after the fall in yield, subtract the price after the rise, and divide by twice the move.

6 Example 1: DV01 from one scenario

Illustration: yield up 12bp, position falls USD 4,740

Price change	loss of the position	**USD 4,740**
Yield change	given	**12 bp**
DV01	4,740 ÷ 12	**USD 395**
Check: 0.25% move	0.25 × 100 = 25 bp	**25 bp**
Expected change	25 × 395	**USD 9,875**

IN THE LESSON

- Here is a first example.
- A position loses four thousand seven hundred forty dollars when its yield rises twelve basis points.
- To get the D V zero one, divide the loss by the number of basis points.
- Four thousand seven hundred forty divided by twelve is three hundred ninety five.
- So this position gains or loses about three hundred ninety five dollars for each basis point of yield.
- As a check, if the yield had moved by a quarter of one per cent, the first step is to convert to twenty five basis points, and the expected change is then about nine thousand eight hundred seventy five dollars.

7 Example 2: averaging up and down shifts

10-year 4% bond at 100. Yield 3.90%: 100.82. Yield 4.10%: 99.19. Face 5 million

Up shift only	(100 − 99.19) ÷ 10	**0.0810**
Down shift only	(100.82 − 100) ÷ 10	**0.0820**
Average of both	(100.82 − 99.19) ÷ 20	**0.0815**
Scale: 5m ÷ 100	0.0815 × 50,000	**USD 4,075**

IN THE LESSON

- Now a bond with real prices.
- Take a ten year bond with a four per cent coupon, priced at one hundred when its yield is four per cent.
- Push the yield down ten basis points and the price per hundred of face becomes one hundred point eight two.
- Push it up ten basis points and it becomes ninety nine point one nine.
- The up shift alone gives zero point zero eight one per basis point, the down shift alone zero point zero eight two.
- Averaging, we take the gap of one point six three over twenty basis points, giving zero point zero eight one five per hundred.
- On five million of face, scale by fifty thousand: four thousand seventy five dollars.

8 Why hedge with DV01?

- Hedge DV01 = position DV01, opposite sign
- Long the position: sell the hedge. Short: buy the hedge
- Then a small parallel move cancels out
- Question left: how much face amount?

IN THE LESSON

- Suppose you own a position that loses money when rates rise, and you want to take that worry away.
- The simplest tool is another position that gains the same dollars when rates rise.
- If the two have equal and opposite D V zero ones, a small parallel move in yields cancels out between them.
- So the rule for a D V zero one hedge is to pick a position whose total D V zero one equals yours, with the opposite sign.
- If you are long the original position, you sell the hedge instrument.
- If you are short, you buy it.
- The remaining job is to work out how much face amount that takes.

9 The face amount of the hedge

Face of hedge = Face of position × DV01 per 100 of position ÷ DV01 per 100 of hedge

Face of hedge	Face amount to trade
Face of position	Face you already hold
DV01 per 100, position	Sensitivity of your bond
DV01 per 100, hedge	Sensitivity of the hedge bond

IN THE LESSON

- When D V zero ones are quoted per one hundred of face, the face amount of the hedge comes from a ratio.
- Multiply the face of your position by its D V zero one per hundred, and divide by the D V zero one per hundred of the hedge bond.
- The position goes on top.
- This makes sense: a bond with a small D V zero one per hundred is not very sensitive, so you need more face of it to offset the same dollars.
- The usual mistake is to match face amounts, or even market values.
- Bonds with different maturities or coupons have different D V zero ones per unit of face, so equal face does not mean equal risk.

10 Example 3: hedging a long position

Long 20m face. Position DV01 per 100: 0.072. Hedge bond DV01 per 100: 0.045

Position DV01	20m ÷ 100 × 0.072	**USD 14,400**
Hedge face	20m × 0.072 ÷ 0.045	**32m, sell**
Hedge DV01 check	32m ÷ 100 × 0.045	**USD 14,400**
Mistake: sell 20m face	20m ÷ 100 × 0.045	**USD 9,000 only**

IN THE LESSON

- Here is a worked hedge.
- You are long twenty million of face of a ten year bond whose D V zero one per hundred is zero point zero seven two.
- You want to hedge with a five year bond whose D V zero one per hundred is zero point zero four five.
- The position's total D V zero one is twenty million divided by a hundred, times zero point zero seven two, which is fourteen thousand four hundred dollars.
- The hedge face is twenty million times zero point zero seven two over zero point zero four five, thirty two million.
- You sell it.
- Matching face at twenty million would have offset only nine thousand dollars of the fourteen thousand four hundred.

11 Limits of a DV01 hedge

- Works for small parallel moves only
- A twist in the curve can break the match
- DV01s drift with time and yield, so rebalance
- Matching face or market value is the classic error

IN THE LESSON

- A D V zero one hedge is a good first line of defence, and it is not a guarantee.
- It works for small parallel moves only.
- If the curve twists, the two bonds can move by different amounts, and the hedge leaks.
- It also decays with time.
- As yields change and the weeks pass, each bond's D V zero one drifts, and the two drift at different speeds.
- So the hedge has to be rebalanced from time to time, by resizing the face amounts to restore the match.
- A trader who hedges once and forgets is carrying a growing hidden position.
- We will meet a further leak, convexity, after we build the two measures we still need.

12 Effective duration: sensitivity as a percentage

- Percent change in price per unit change in yield
- Duration 6.5: price falls about 6.5% if yield rises 1 point
- Measured by repricing after a shift down and a shift up
- Full repricing handles bonds with embedded options

IN THE LESSON

- D V zero one is a dollar number.
- Often we would rather ask a size free question: by what percentage does the price change for a given move in yield?
- That is effective duration.
- It is the percentage change in price per unit change in yield.
- A duration of six point five says the price falls by about six point five per cent when yield rises by one percentage point.
- It is called effective because it is measured by repricing.
- You shift the yield down and up by the same small amount, recompute the price each time with the full valuation model, and read the sensitivity from the results.
- That works even for bonds with embedded options.

13 The effective duration formula

Duration = (P↓ − P↑) ÷ (2 × P₀ × Δy)

Effective duration	Percent move per unit of yield
Price, yield down	Price after yield falls
Price, yield up	Price after yield rises
Starting price	Starting price
Yield change, decimal	Shift as a decimal, 25bp = 0.0025

IN THE LESSON

- Here is the formula.
- Take the price after yields fall, subtract the price after yields rise, and divide by twice the starting price times the yield change.
- The yield change is a decimal: twenty five basis points is zero point zero zero two five.
- Two slips are very common.
- One is forgetting the factor of two, which appears because the two shifts together span twice the distance.
- The other is putting basis points in where decimals belong.
- If you have only one shift, you can divide the percentage price change by the yield change and sign the answer to make it positive.

14 Example 4: duration from two prices

Price at 4.00% is 100. At 3.75%: 102.05. At 4.25%: 98.00

Price gap	102.05 − 98.00	**4.05**
Denominator	2 × 100 × 0.0025	**0.5**
Effective duration	4.05 ÷ 0.5	**8.1**
Meaning	+1 point of yield	**−8.1% price**

IN THE LESSON

- Use our ten year four per cent bond again, priced at one hundred.
- Lower the yield twenty five basis points, to three point seven five per cent, and the price rises to one hundred two point oh five.
- Raise it to four point two five per cent and the price falls to ninety eight.
- The difference between the two prices is four point oh five.
- The denominator is two, times one hundred, times zero point zero zero two five, which is zero point five.
- Dividing, the duration is eight point one.
- So a one point rise in yield cuts the price by about eight point one per cent, roughly eight dollars ten on a hundred.

15 DV01 and duration compared

Same first-order idea, two different units

Feature	Duration | DV01
Unit	Years | Currency
Depends on position size?	No | Yes
Can positions be added?	Only weighted | Yes
Best for	Comparing | Sizing and limits
Convexity included?	No | No

IN THE LESSON

- So we now have two measures, and they are close relatives.
- Both give the first order effect of a small move in yield, and both ignore convexity, which we will meet soon.
- They are tied together by a simple link: D V zero one equals effective duration times the full market value of the position times zero point zero zero zero one.
- The difference is the unit.
- Duration is a percentage, quoted in years, so it does not care how big the position is and lets you compare a cheap bond with an expensive one.
- D V zero one is money, so it grows with size, and the D V zero ones of different positions can simply be added.

16 The link between them

DV01 = Duration × Market value × 0.0001

DV01, dollars	Dollars per basis point
Effective duration	Percent sensitivity, in years
Market value	Full value of the position

IN THE LESSON

- Here is that link written out.
- The price in the formula is the whole market value of what you hold, not the price per hundred of face.
- Multiply the duration, which is a fraction per unit of yield, by the market value, and you get dollars per unit of yield.
- Multiplying by zero point zero zero zero one then turns one unit into one basis point.
- Run it backwards and you can recover duration from a D V zero one by dividing by the market value and by zero point zero zero zero one.
- The link holds for the first order measure alone, which is why both numbers share the same blind spot.

17 Example 5: lower duration, bigger DV01

Bond X: duration 6, value USD 2m. Bond Y: duration 4, value USD 5m

DV01 of X	6 × 2,000,000 × 0.0001	**USD 1,200**
DV01 of Y	4 × 5,000,000 × 0.0001	**USD 2,000**
Higher duration		**X**
Higher DV01		**Y**

IN THE LESSON

- Which of two bonds is riskier?
- Bond X has a duration of six and a market value of two million dollars.
- Bond Y has a duration of four and a market value of five million.
- By duration alone, X looks more sensitive.
- Now convert to dollars.
- For X, six times two million times zero point zero zero zero one is twelve hundred dollars per basis point.
- For Y, four times five million times zero point zero zero zero one is two thousand dollars.
- So the bond with the lower duration carries more D V zero one, because it is a much larger position.
- Use duration to compare instruments, and D V zero one to size hedges and set limits.

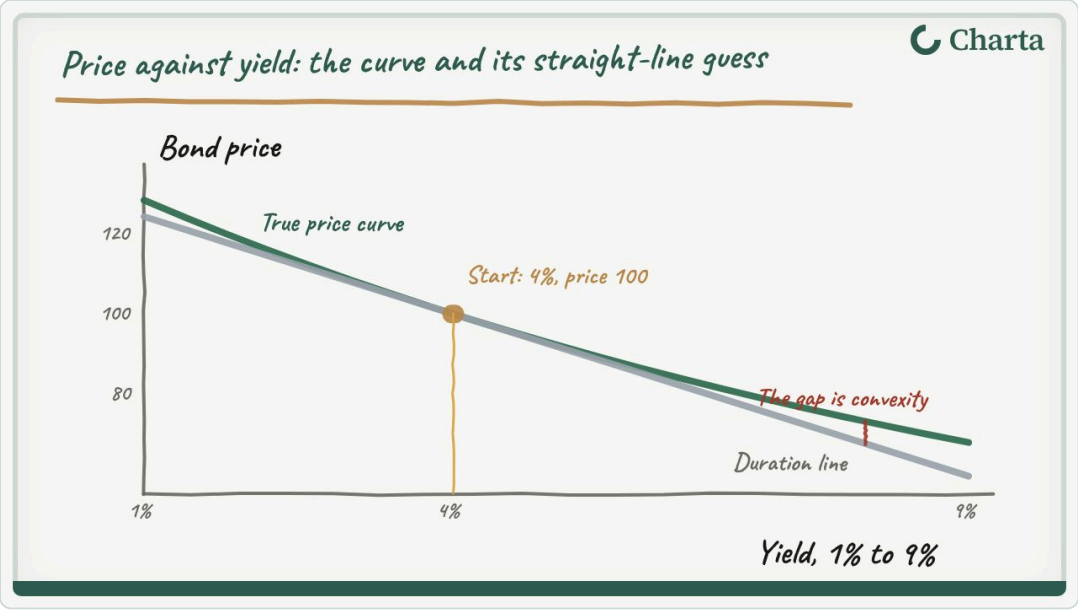
18 Convexity: the curve in the price line

- Convexity = how much the price-yield line bends
- It is how fast duration or DV01 changes as yield changes
- Positive: gains from a fall exceed losses from an equal rise
- Callable bonds can have negative convexity

IN THE LESSON

- Duration treats the price as if it fell along a straight line as yield rises.
- But the real price yield relationship is a curve.
- Convexity measures how bent that curve is.
- Technically it is the second derivative of price with respect to yield, divided by the price.
- An easier way to see it: convexity tells you how fast the duration or the D V zero one changes as yield changes.
- For an ordinary bond, duration is larger when yields are low, and smaller when they are high.
- So with positive convexity, a fall in yield raises the price by more than an equal rise in yield lowers it.
- That asymmetry is a gift to the holder.

19 Price against yield: the curve and its straight-line guess



IN THE LESSON

- Look at the picture.
- The curved line is the true price of our ten year bond for yields from one to nine per cent.
- The straight line touches the curve at four per cent, where the price is one hundred, and its slope is the duration.
- Away from that point the curve always sits above the line.
- If yield falls to one per cent the true price is higher than the line says, and if yield rises to nine per cent the true price is higher than the line says too.
- The gap between curve and line is what convexity measures.
- The straight line understates the price on both sides.

20 Convexity and the price estimate

Convexity = (P↑ + P↓ − 2P₀) ÷ (P₀ × Δy²)
% change = −Duration × Δy + ½ × Convexity × Δy²

Convexity	Curvature of price against yield
Percent price change	Estimated percent price change
Effective duration	Straight-line part
Yield change, decimal	Decimal shift, squared

IN THE LESSON

- From prices, convexity is estimated with the same two shifted prices.
- Add the price after the fall and the price after the rise, subtract twice the starting price, and divide by the starting price times the squared yield change.
- Then combine it with duration to estimate the percentage price change: minus duration times the yield change, plus one half of convexity times the yield change squared.
- The convexity term is positive whichever way yield moves, because a square is never negative.
- Two frequent mistakes: forgetting the one half, and squaring basis points instead of decimals.

21 Example 6: convexity and a one-point rise

Same bond: $P_{\downarrow}$ 102.05, $P_{\uparrow}$ 98.00, P_0 100, Δy 0.0025, duration 8.1

Numerator	98 + 102.05 − 200	**0.05**
Convexity	0.05 ÷ (100 × 0.0025²)	**80**
Estimate, +1 point	−0.081 + 0.5 × 80 × 0.01²	**−7.7%**
Price near	100 × (1 − 0.077)	**92.30**

IN THE LESSON

- Back to our bond.
- The sum of the two shifted prices, ninety eight and one hundred two point oh five, is two hundred point oh five.
- Subtract twice the starting price, two hundred, and you are left with zero point oh five.
- The denominator is one hundred times zero point zero zero zero zero six two five, which is zero point zero zero zero six two five.
- The convexity is eighty.
- Now estimate a one point rise in yield.
- Duration alone gives minus eight point one per cent.
- The convexity term adds back plus zero point four.
- The estimate is minus seven point seven per cent, a price near ninety two point three.
- The true price is ninety two point two eight.

22 Portfolios: adding up the risk

- DV01: add the position DV01s; shorts count as negative
- Duration: market-value-weighted average
- Convexity: weighted the same way, by market value
- Never add durations, or average them without weights

IN THE LESSON

- Now move from a single bond to a portfolio.
- The three measures aggregate differently, and mixing them up is a classic exam error.
- D V zero one is additive.
- The portfolio's D V zero one is the sum of the position D V zero ones, and a short position enters as a negative number.
- Effective duration and convexity are different.
- They are weighted averages, with weights set by market value.
- You multiply each position's duration by its market value, add them up, and divide by the portfolio value.
- Weights come from market values, never from face amounts, and never from a plain average of the numbers.

23 Portfolio duration and convexity

Duration_p = Σ(value × duration) ÷ portfolio value
Convexity_p = Σ(value × convexity) ÷ portfolio value
DV01_p = Σ DV01 of each position, shorts negative

Market value weight	Each position's value share
Effective duration	Position or portfolio duration
Convexity	Weighted the same way
DV01, dollars	Simply added

IN THE LESSON

- Written as formulas, the portfolio duration is the sum of each value times its duration, divided by the portfolio value, and the convexity follows the same pattern.
- Once you have a portfolio duration and a portfolio convexity, the percentage change estimate is the same one we used for a single bond.
- One caution for long short books.
- The dollar duration is the long value times its duration minus the short value times its duration.
- Dividing that by a small net value can give a very large duration, so many managers prefer to quote D V zero one for such a book instead.

24 Example 7: a three position book

Long 5m (D 8, C 80). Long 3m (D 3, C 12). Short 2m (D 5, C 26). Net 6m

Portfolio duration	(40 + 9 − 10) ÷ 6	**6.5**
Portfolio DV01	39m × 0.0001	**USD 3,900**
Portfolio convexity	(400 + 36 − 52) ÷ 6	**64**
+50bp: percent	$-6.5 \times 0.005 + 0.5 \times 64 \times 0.005^2$	**−3.17%**
In dollars	3.17% × 6m	**about −190,200**

IN THE LESSON

- Here is a small book.
- A long position of five million with duration eight and convexity eighty.
- A long position of three million, duration three, convexity twelve.
- And a short position of two million, duration five, convexity twenty six.
- Net value is six million.
- Dollar duration is forty plus nine minus ten, thirty nine million, so portfolio duration is six point five, and D V zero one is thirty nine million times zero point zero zero zero one, thirty nine hundred dollars.
- Convexity is four hundred plus thirty six minus fifty two, over six: sixty four.
- A fifty basis point rise gives minus three point one seven per cent of net value, about a hundred ninety thousand dollars.

25 Hedging with duration and convexity

- Match dollar duration = duration × market value
- Hedge value Vh = V × D ÷ Dh, opposite direction
- Face = market value ÷ price per unit of face
- Only first-order exposure is removed

IN THE LESSON

- Duration gives us a second way to hedge.
- A duration hedge matches dollar duration, which is duration times market value, and this is the same thing as matching D V zero one.
- If the position has value V and duration D, and the hedge instrument has duration D h, the market value to hold in the opposite direction is V times D divided by D h.
- To turn market value into face amount, divide by the price per unit of face.
- This removes first order exposure to a small parallel shift.
- It does not remove everything, because the position and the hedge almost never have the same convexity.

26 Example 8: a duration hedge, and what is left

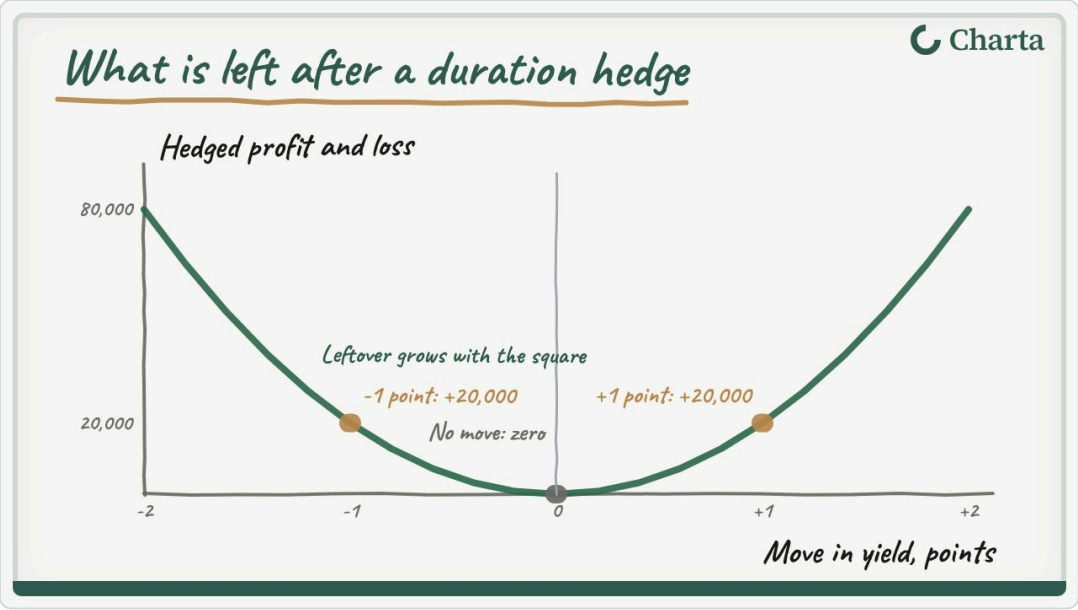
Long 10m, D 7, C 70. Hedge: D 3.5, C 15, price 80 per 100

Hedge market value	10m × 7 ÷ 3.5	**20m**
Hedge face	20m ÷ 0.80	**25m**
Dollar convexity gap	700m − 300m	**400m**
Net gain, ±1 point	$0.5 \times 400\text{m} \times 0.01^2$	**USD 20,000**

IN THE LESSON

- Take a ten million dollar position with duration seven and convexity seventy.
- The hedge instrument has duration three point five, convexity fifteen, and trades at eighty per hundred.
- The hedge market value is ten million times seven over three point five, twenty million, and the face is twenty million divided by zero point eight, twenty five million.
- Now the leftover.
- Dollar convexity of the position is ten million times seventy, seven hundred million.
- The hedge has twenty million times fifteen, three hundred million.
- The difference of four hundred million, times one half, times a one point move squared, leaves a gain of about twenty thousand dollars, whichever way yields move.

27 What is left after a duration hedge



IN THE LESSON

- This chart shows the result for example eight.
- Along the bottom is the move in yield, from minus two points to plus two points.
- Up the side is the profit and loss of the hedged book.
- In the middle, for a tiny move, the line is almost flat: the duration hedge has worked.
- As the move gets bigger, the line curves upward on both sides, because the position is more convex than the hedge and wins from big moves either way.
- Had the position been less convex than its hedge, the shape would flip into a hill, and large moves of either sign would cost money.
- The leftover grows with the square of the move.

28 Hedging both duration and convexity

- One instrument fixes duration only
- Two instruments: solve two equations at once
- Equation 1: dollar duration adds to zero
- Equation 2: dollar convexity adds to zero

IN THE LESSON

- What if you want to remove the convexity exposure as well?
- Then one hedge instrument is not enough.
- You use two, and you solve two equations together.
- The first says the dollar duration of the two hedges, added to that of the position, must be zero.
- The second says the same for dollar convexity.
- Two unknown amounts, two equations, one solution.
- In practice the second instrument is chosen for being quite different, perhaps a long bond with a lot of convexity, so the system has a sensible answer.
- And even then, every hedge drifts as rates move and time passes, so it needs rebalancing.

29 Bullet and barbell

- Bullet: cash flows concentrated around one maturity
- Barbell: a short bond and a long bond, nothing between
- Match cost and duration, so first-order risk is the same
- Differences then come from convexity and curve shape

IN THE LESSON

- Duration also helps with a choice about how to arrange a portfolio.
- A bullet concentrates its cash flows around one maturity, say a single bond with duration five.
- A barbell splits the same money between a short bond and a long bond and holds nothing in the middle, like a bar with weights at both ends.
- We can build a barbell that costs the same and has the same duration as the bullet.
- That makes the first order risk identical.
- Any difference in behaviour must then come from something else, and the something else turns out to be convexity and the shape of the curve.

30 Building the barbell

w_long = (D_bullet − D_short) ÷ (D_long − D_short)
w_short = 1 − w_long

Weight in long bond	Share of money in the long bond
Bullet duration	Duration to match
Short bond duration	Duration of the short bond
Long bond duration	Duration of the long bond

IN THE LESSON

- To match the bullet, two conditions must hold.
- The two weights must sum to one, so the cost is the same.
- And the weighted average of the two durations must equal the bullet's duration.
- Solve the pair and the weight in the long bond is the bullet's duration minus the short bond's duration, divided by the gap between long and short.
- Whatever remains goes to the short bond.
- A sanity check helps.
- If the bullet's duration sits closer to the short bond's, the weight in the long bond should be small.
- The common error is to reverse the two weights.

31 Example 9: a barbell for a bullet

Bullet: D 5, C 35, cost 10m. Short bond: D 2, C 5. Long bond: D 10, C 120

Long weight	(5 − 2) ÷ (10 − 2)	**37.5%**
Short weight	1 − 37.5%	**62.5%**
Duration check	0.375×10 + 0.625×2	**5.0**
Barbell convexity	0.375×120 + 0.625×5	**48.125**

IN THE LESSON

- Build a barbell for ten million dollars.
- The bullet has duration five.
- The short bond has duration two and the long bond duration ten.
- The long weight is five minus two over ten minus two, three eighths, or thirty seven point five per cent.
- The short weight is sixty two point five per cent.
- That puts three million seven hundred fifty thousand in the long bond and six million two hundred fifty thousand in the short bond.
- Check the duration: zero point three seven five times ten plus zero point six two five times two is five.
- With convexities of one hundred twenty and five, the barbell has forty eight point one two five against the bullet's thirty five.

32 What each structure does well and badly

Same cost, same duration, different shape

	Bullet | Barbell
Cash flows	Concentrated | Spread out
Convexity	Lower | Higher
Large parallel move	Does worse | Does better
Yield, convexity priced in	Higher | Usually lower
Curve twist	Results can differ

IN THE LESSON

- So what does each structure do?
- The barbell, with its spread out cash flows, has the higher convexity.
- It does better when yields make a large parallel move in either direction.
- The price of that benefit is usually a lower yield, in a market that charges for convexity.
- The bullet tends to give up that protection and in return typically earns more income.
- A twist in the curve can make the two perform very differently, because their exposure sits at different points on the curve, even though their durations match.
- So neither is better on its face.
- Each is a bet on how rates will behave.

33 Recap: the main ideas

- One factor: simple, but blind to slope and curvature
- DV01 = price change ÷ bp. Hedge face uses DV01 ratios
- Duration from two prices; DV01 = D × value × 0.0001
- Convexity adds ½CΔy². Portfolio: add DV01, weight D, C
- Barbell long weight from the three durations

IN THE LESSON

- Let us gather the main ideas.
- A one factor model uses a single market driver to describe how every rate moves, and it is silent on slope and curvature.
- D V zero one is the dollar change for one basis point, found as price change over basis points.
- A hedge matches D V zero ones, using the ratio of per hundred figures.
- Effective duration is the percentage sensitivity, with the factor of two and decimals.
- Convexity adds the one half term.
- Portfolios add D V zero ones but weight durations and convexities by value.
- Barbells carry more convexity than the bullets they match.

34 Try three quick questions

1. A yield rise of 8bp cuts a position by USD 2,400. DV01?
   Answer: 2,400 ÷ 8 = USD 300 per basis point.
2. Long 30m face, DV01 per 100 of 0.06. Hedge: 0.04. Face to sell?
   Answer: 30m × 0.06 ÷ 0.04 = 45m.
3. Duration 5, value USD 8m. DV01?
   Answer: 5 × 8,000,000 × 0.0001 = USD 4,000.

IN THE LESSON

- Time to test yourself.
- Pause the video, think each one through, then listen to the answer.
- Question one.
- A yield rise of eight basis points cuts a position by two thousand four hundred dollars.
- What is the D V zero one?
- Two thousand four hundred over eight is three hundred dollars per basis point.
- Question two.
- You are long thirty million face, the position has a D V zero one per hundred of zero point zero six, and the hedge has zero point zero four.
- What face amount do you sell?
- Thirty million times zero point zero six over zero point zero four is forty five million.
- Question three.
- A position has a duration of five and a value of eight million dollars.
- What is its D V zero one?
- Five times eight million times zero point zero zero zero one is four thousand dollars.