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Bond Yields, Duration and Convexity

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Yield Measures

FI.3.a · Contrast current yield with yield to maturity

How is current yield calculated, and what does it ignore?	Annual coupon ÷ price. It ignores the pull to par, reinvestment and time value.
What is yield to maturity?	The single discount rate that makes the present value of all the bond's cash flows equal its price.
How do yield to maturity and current yield compare for discount and premium bonds?	Discount: yield to maturity exceeds current yield. Premium: the order reverses.
Which assumption of yield to maturity is most often violated?	That coupons are reinvested at the yield itself.
Current yield	current yield = annual coupon ÷ flat price where annual coupon = the coupon in money for a year, not the coupon rate; flat price = the quoted price, excluding accrued interest It counts the coupon and nothing else. Because it ignores the pull to par it overstates the return on a premium bond and understates it on a discount bond, and it says nothing at all about a zero.

FI.3.b · Set out what yield to maturity implicitly assumes

What three conditions must hold for an investor to realise the yield to maturity?	Hold to maturity, receive every payment in full and on time, and reinvest every coupon at the yield to maturity.
Which assumption is most often forgotten and least likely to be true?	Reinvestment of coupons at the yield to maturity itself.
Why is yield to maturity a promised rather than an expected return?	A bond bought at 6% with coupons reinvested at 2% delivers materially less than 6%.

FI.3.c · Work out both yield to worst and yield to call

How is a yield to call computed?	For each call date, using the call price as the redemption amount and the call date as the horizon.
What is yield to worst?	The lowest of the yield to maturity and all the yields to call.
Why is yield to worst used when comparing callable bonds?	It is the conservative figure, since yield to maturity describes only one of several possible outcomes.
Which yield is usually the worst when a callable bond trades above its call price?	The yield to the first call date, as an economically rational issuer will choose that outcome.

FI.3.d · Tell a floating-rate note's quoted margin apart from its discount margin

What is the quoted margin of a floating-rate note?	The fixed spread added to the reference rate to set the coupon, set at issuance.
What is the discount margin?	Also the required margin: the spread over the reference rate the market currently demands, reflecting credit risk and liquidity.
How do the quoted and required margins determine whether the note trades at, below or above par?	Equal: par. Required above quoted (credit worse or less liquid): below par. Credit improves: above par.
What risk does a floating-rate note carry?	Almost no interest rate risk but full exposure to its required spread, mostly credit.
Coupon on a floating-rate note	coupon rate = reference rate + quoted margin where reference rate = the market rate the note resets to, such as a policy or interbank rate; quoted margin = the fixed spread set at issue, in basis points Reset each period, so the coupon follows the market and the price stays near par. The price drifts from par only when the issuer's credit moves: the quoted margin is fixed at issue and the discount margin the market now demands is not.

FI.3.e · Explain money market yield measures and the conventions they follow

Why does a discount-basis quote understate the true return on a short-term bill?	It expresses the discount as a percentage of face value rather than of the price paid, so the base is too large.
What is an add-on rate and why is it the economically meaningful measure?	Interest expressed as a percentage of the amount invested, which is what the investor actually puts up and earns on.
Name three day count conventions used for money market rates.	Actual over 360, actual over 365 and thirty over 360.
When can a rate quoted on a 360-day year be compared with one on a 365-day year?	Only after it has been restated onto the same day count basis; until then the two are not comparable.
Bond equivalent yield of a money market instrument	BEY = HPY × (365 ÷ t) where HPY = the holding period yield, the gain ÷ the price actually paid; t = days held Money market instruments are quoted on a discount or add-on basis and on 360 or 365 days, and none of those are comparable until they are on one basis. A discount rate is struck on face value rather than the price paid, so it always understates the return.

FI.3.f · Restate a yield at a different compounding frequency

What is a yield's periodicity and why must you know it?	The number of compounding periods a year it assumes. Two yields can only be compared once their periodicities are known.
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What are the steps to restate a yield at a different compounding frequency?	Convert to a per-period rate, compound it to the new period length, then annualise.
Is a 6% semiannual yield the same as a 6% annual yield?	No. The semiannual figure compounds to 6.09% effective, so it is higher than 6% annual.
Why restate before comparing a semiannual-pay bond market with an annual-pay one?	Conventions differ, so a bond-equivalent restatement is needed or any spread between the markets means nothing.
Converting a yield between periodicities	$(1 + \text{APR}_2 \div 2)^2 = (1 + \text{APR}_4 \div 4)^4$ where APR_2 = the annual rate quoted with semiannual compounding; APR_4 = the same yield quoted with quarterly compounding Same bond, same cash flows, two quoting conventions. Equate the annual growth factors and solve for the one you want; the more frequent the compounding, the lower the quoted number for the same return.

Duration

FI.4.a · Use modified duration to estimate how a bond's price will change

What is the approximate price change formula using modified duration?	Percentage price change $\approx$ - modified duration $\times$ change in yield.
How does modified duration vary with maturity and coupon, and why?	It rises with maturity and falls with coupon, because a bond returning more value sooner is less exposed to the rate on distant cash flows.
Why is the duration estimate accurate only for small yield moves?	It is a straight line drawn against a curved price-yield relationship.
How does convexity help an option-free bond holder?	Prices rise more than duration predicts and fall less.
Price change estimated from modified duration	$\% \Delta \text{price} \approx -\text{ModDur} \times \Delta \text{yield}$ where $\% \Delta \text{price}$ = the percentage change in the bond's full price; ModDur = modified duration; Δyield = the change in yield, as a decimal - 25 bps is 0.0025 A straight-line estimate of a curved relationship, so it is close for small moves and increasingly wrong for large ones. It understates the price both ways: the true curve lies above the line, so prices rise more than this predicts and fall less.

FI.4.b · Tell apart Macaulay duration, modified duration and money duration

What is Macaulay duration and in what units is it measured?	The weighted average time to receipt of a bond's cash flows, each weighted by its present value as a share of price. It is in years.
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How is modified duration obtained and what does it show?	Macaulay duration divided by one plus the yield per period. It is the percentage price change for a one percentage point change in yield.
What is money duration and how does it differ from modified duration?	Modified duration multiplied by the full price, so it gives the price change in money terms rather than as a percentage.
What is the price value of a basis point and who uses it?	Money duration scaled to a single basis point. It is what a trader hedges with.
Modified duration from Macaulay duration	$\text{ModDur} = \text{MacDur} \div (1 + r)$ where MacDur = Macaulay duration, the weighted average time to the bond's cash flows; r = the yield per period Macaulay duration is a time, in years. Modified duration is a percentage price change per 1% of yield. Dividing by one plus the periodic yield is the whole of the difference between them.
Money duration	$\text{MoneyDur} = \text{ModDur} \times \text{PV}$ where ModDur = modified duration; PV = the full price of the position, in money Duration in currency rather than percent, so the estimate comes out in money: the price change is $-\text{MoneyDur} \times \Delta\text{yield}$. Taken per basis point on 100 of par it is the price value of a basis point.

FI.4.c · Set out how a bond's duration behaves and what drives it

What three rules describe how duration behaves?	It rises with maturity, falls as the coupon rises, and falls as the yield rises.
Why do coupon, yield and maturity change duration?	Each shifts the weight of the present value of cash flows earlier or later in the bond's life.
What is the duration of a zero-coupon bond, and what is the upper limit for coupon bonds?	A zero's Macaulay duration equals its maturity. No coupon bond can have a duration longer than its maturity.
When does the maturity rule fail?	For deep-discount long bonds, where duration can peak before maturity, so the relationship is not strictly monotonic.

FI.4.d · Work out convexity and explain what it means

Why does duration alone give an imperfect price estimate?	It predicts a linear price response, but the true price-yield relationship curves.
What convexity term corrects the duration estimate?	Add one half $\times$ convexity $\times$ (yield change) ² to the duration-based estimate.
For an option-free bond, in which direction does the convexity correction work?	Always upward: the bond gains more from a yield fall than it loses from an equal rise.
How does convexity affect yield, and when does it matter most?	Higher convexity is valuable, so it commands a lower yield among bonds of equal duration. It matters mainly for large yield moves.

Price change with the convexity adjustment	$\% \Delta \text{price} \approx -\text{ModDur} \times \Delta \text{yield} + \frac{1}{2} \times \text{Convexity} \times (\Delta \text{yield})^2$ where %Δprice = the percentage change in the full price; ModDur = modified duration; Convexity = the curvature of the price-yield relationship; Δyield = the change in yield, as a decimal The squared term is positive whichever way yields move, which is what it means to say convexity is worth having. Add it for large yield moves; for a few basis points it changes almost nothing.
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FI.4.e · Work out the duration of a portfolio and explain where the measure falls short

How is portfolio duration commonly calculated?	As the market-value-weighted average of the constituent bonds' durations.
What assumption underlies the weighted-average portfolio duration?	That all yields move by the same amount, a parallel shift of the curve.
Why can two portfolios with identical duration perform differently?	Curves steepen, flatten and twist rather than shifting in parallel, so identical duration does not mean identical exposure.
What is the theoretically correct alternative and why is it rarely used?	Compute the cash flow yield of the whole portfolio and its duration directly. It is rarely used because the inputs move constantly.
Portfolio duration	$\text{portfolio duration} = \sum w_i \times D_i$ where w_i = the share of the portfolio's market value held in bond i; D_i = the duration of bond i The weights are market values, not par amounts or holdings. It assumes every yield in the portfolio moves by the same amount on the same day, which is its limitation: one number says nothing about a curve that steepens.

FI.4.f · Explain effective duration and the cases that require it

Why does modified duration fail for callable, putable or mortgage-backed securities?	It is computed from fixed cash flows, but for these securities the cash flows depend on the level of rates.
How is effective duration measured?	Revalue the price with a model under a small upward and downward shift of the benchmark curve, then measure sensitivity from the two prices.
Why can effective duration be far below modified duration?	Because the embedded option changes the cash flows as rates move.
When can the effective duration of a mortgage security turn negative?	When prepayments accelerate.

Effective duration	$\text{EffDur} = (\text{PVdown} - \text{PVup}) \div (2 \times \Delta\text{curve} \times \text{PV}_0)$ where PVdown = the price after the benchmark curve is shifted down; PVup = the price after it is shifted up by the same amount; Δcurve = the size of that shift, as a decimal; PV_0 = the price before either shift For bonds whose cash flows change with yields - callable, putable, mortgage-backed - where modified duration does not apply because there is no one yield to maturity to differentiate. It shifts the whole curve and reprices instead.
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FI.4.g · Explain key rate duration and what it is used for

What does key rate duration measure?	Sensitivity of a bond or portfolio to a change in the benchmark yield at one specific maturity, holding the others constant.
How do key rate durations relate to effective duration?	They sum approximately to effective duration, decomposing that single figure by where on the curve the exposure sits.
Why does key rate duration make non-parallel shifts manageable?	A manager can see exposure at each maturity, for example large at ten years and none at two, and hedge a steepening directly.
Why does equal duration not mean equal risk?	Portfolios with the same overall duration can have exposure at different points on the curve and so react differently to non-parallel shifts.

FI.4.h · Explain empirical duration and why it may diverge from analytical duration

How is empirical duration estimated?	By regressing observed bond price changes on observed benchmark yield changes, rather than computing it from a model.
Why do empirical and analytical duration diverge for lower-quality credit?	In a flight to quality government yields fall while credit spreads usually widen, so the bond's price rises less than analytical duration predicts.
What does analytical duration assume that empirical duration does not?	It holds the spread constant, assuming away the correlation between the benchmark yield and the spread.
What can happen to a high-yield bond's price when government yields fall?	It may rise less than its analytical duration predicts, and sometimes it falls.

FI.4.i · Explain the investment horizon and the gap in duration relative to it

What two offsetting risks does a coupon bond investor face when rates change?	Price risk and reinvestment risk: rising rates cut the price but raise coupon reinvestment returns, and falling rates do the reverse.
When do price and reinvestment effects cancel, and what is the result?	At a horizon equal to Macaulay duration, after a single parallel yield shift, the realised return equals the original yield to maturity (immunisation).

How is the duration gap defined?	Macaulay duration less the investment horizon.
What does a positive duration gap expose the investor to, and a negative one?	A positive gap exposes to rising rates through price risk; a negative gap exposes to falling rates through reinvestment risk.
Duration gap	duration gap = MacDur – investment horizon where MacDur = the bond's Macaulay duration, in years; investment horizon = how long the money is to stay invested, in years At zero the two risks cancel: a rise in yields costs price and repays it in reinvestment income. A positive gap leaves price risk dominant, a negative gap leaves reinvestment risk dominant.

Yield-Based Bond Duration Measures and Properties

FI.4.j · Work out a bond's PVBP (value change per basis point) and explain it

What is the PVBP of a bond?	The change in a bond's price for a one basis point change in yield, stated as a money amount rather than a percentage.
How is PVBP estimated by repricing?	$PVBP = (\text{price at the lower yield} - \text{price at the higher yield}) \div 2$, repricing one basis point either side.
What is the approximation of PVBP using duration?	Modified duration $\times$ full price $\times$ 0.0001. It is one ten-thousandth of money duration.
Why is PVBP the working measure for hedging?	It is in currency, so it scales with position size and adds across a portfolio. The hedge par amount is set so its PVBP offsets the portfolio's.
How does PVBP behave as yields rise for an option-free bond?	It falls, since both price and duration decline.

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