Fixed Income Portfolio Management Techniques

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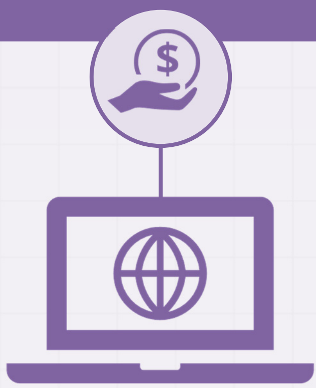

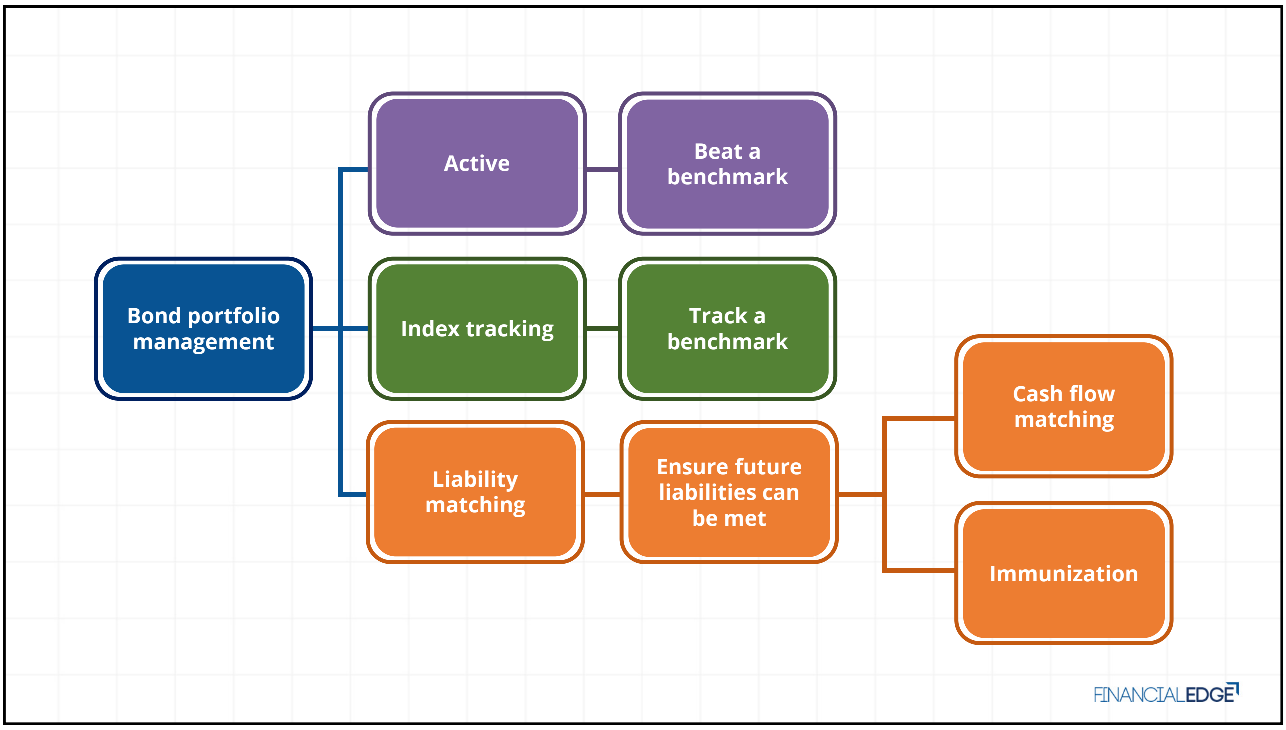
Bond portfolio management
Active
Beat a benchmark
Index tracking
Track a benchmark
Liability matching
Ensure future liabilities can be met
Cash flow matching
Immunization
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Bond Portfolio Risk
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Interest rate risk	Risk of reduction in portfolio value if interest rates increase
Reinvestment risk	Risk of reduction in returns on reinvested cash flows if interest rates decrease
Credit risk	Risk of borrower not making scheduled interest or capital repayments, or reduction in bond value if risk of default increases
Inflation risk	Risk of reduction of real returns on fixed income products if inflation is higher than expected
FX risk	Risk of depreciation of FX rate in country where overseas bonds are held

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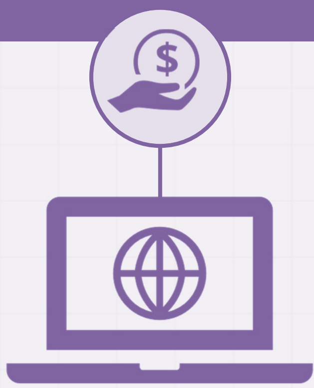
Interest Rate Risk



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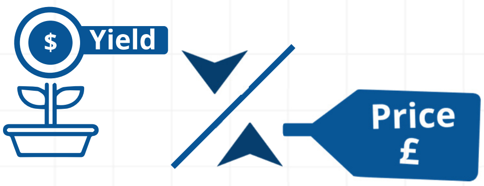
Interest Rate Risk

Bond prices and yields are inversely related

Interest rate risk often defined as the risk of a fall in bond prices when yields rise

Interest rate sensitivity describes the magnitude of the price move

Interest Rate Sensitivity



The prices of bonds with longer terms are more sensitive to changes in yield

The prices of bonds with low coupons are more sensitive to changes in yield

Bond 1	Bond 2
Term: 6 years Coupon: 15.0%	Term: 5 years Coupon: 1.0%

Investors require ratios to be able to **compare the interest rate sensitivity** between bonds

Duration

Measuring Interest Rate Sensitivity

Macaulay Duration

Weighted average maturity of the bond's cash flows

$$D = \frac{\sum_{t=1}^{n} t * CF_t * (1+YTM)^{-t}}{\sum_{t=1}^{n} CF_t * (1+YTM)^{-t}} = \frac{\sum_{t=1}^{n} t * CF_t * (1+YTM)^{-t}}{P_0}$$

The higher the Macaulay Duration of a bond, the higher the bond's sensitivity

Macaulay Duration Example

5Y bond
Annual coupon: 2%
YTM: 2%

Year (t)	Cash flow	PV	PV*t
1	2%	1.96%	1.96%
2	2%	1.92%	3.84%
3	2%	1.88%	5.65%
4	2%	1.85%	7.39%
5	102%	92.38%	461.92%
	Total:	**100.00%**	**480.77%**

Macaulay Duration
= 480.77%/100.00%
= 4.81

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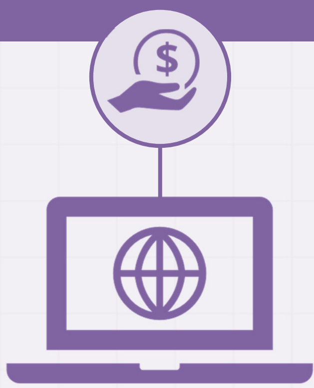
Modified Duration



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Measuring Interest Rate Sensitivity

Modified Duration

→ Estimate of the relative change in bond price due to a change in YTM

→ Often expressed in %

$$MD = \frac{D}{(1+YTM/k)}$$

D = Macaulay duration

k = number of payments per year

YTM = yield to maturity

The absolute change in bond price (sometimes referred to as "risk") is given by the product of MD and the dirty price of the bond.

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Modified Duration Example

5Y Bond Annual coupon: 2% YTM: 2%	(Macaulay) Duration = 4.81 Current price = 100.00	Modified Duration = 4.81/1.02 = 4.71

Inverse relationship between price and yield

Estimated change in bond price = - Modified duration X Change in yield X Current bond price

If yields rises by 0.5%

Estimated change in bond price = - 4.71 X 0.005 X 100.00 = - 2.36

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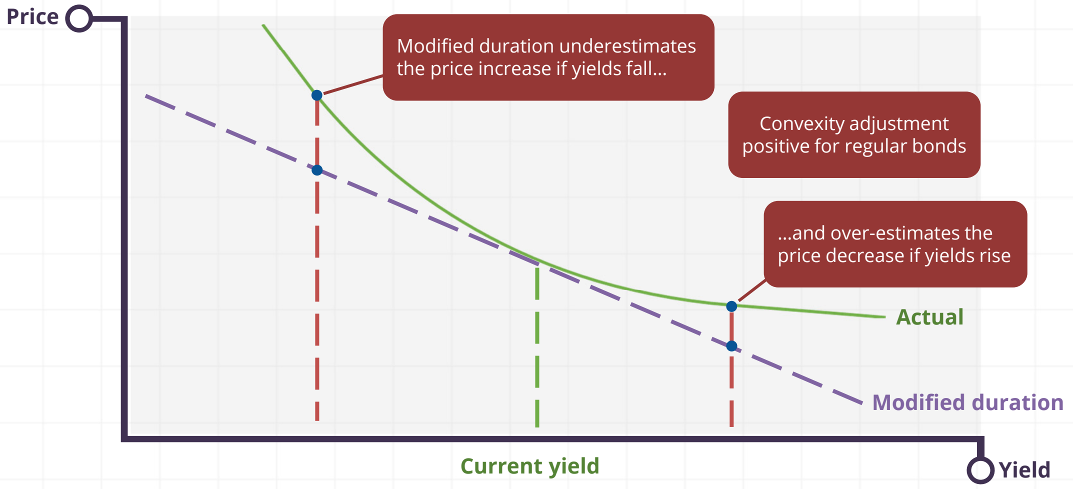
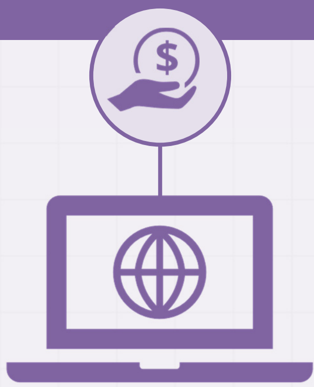
Convexity

- MD provides a linear estimate of bond prices for certain scenarios
- However, the bond's price/yield function is convex



Convexity Adjustment Calculation



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Convexity

$$= \frac{P_+ + P_- - 2P_0}{2 \times P_0 \times \Delta y^2}$$

Convexity adjustment (%)

$$= \text{Convexity} \times 100 \times \Delta y^2$$

Estimated bond price with convexity adjustment

$$= P_0 - MD \times P_0 \times \Delta y + \text{Convexity} \times P_0 \times \Delta y^2$$

P_0 : Current bond price
P_+ : New price if rates increase
P_- : New price if rates decrease

5Y bond, annual coupon: 2%, YTM: 2%
MD : 4.71

Based on 1% Δy:
P_0: 100
P_+: 95.42
P_-: 104.85

$$\text{Convexity} = \frac{95.42 + 104.85 - 2 \times 100}{2 \times 100 \times 0.01^2} = 13.68$$

$$\text{Convexity adjustment (\%)} = 13.68 \times 100 \times 0.01^2 = 0.14$$

If rates fall by 1%:

New price
$$= 100 - 4.71 \times 100 \times -0.01 + 13.68 \times 100 \times 0.01^2$$
$$= 100 + 4.71 + 0.14$$
$$= 104.85$$

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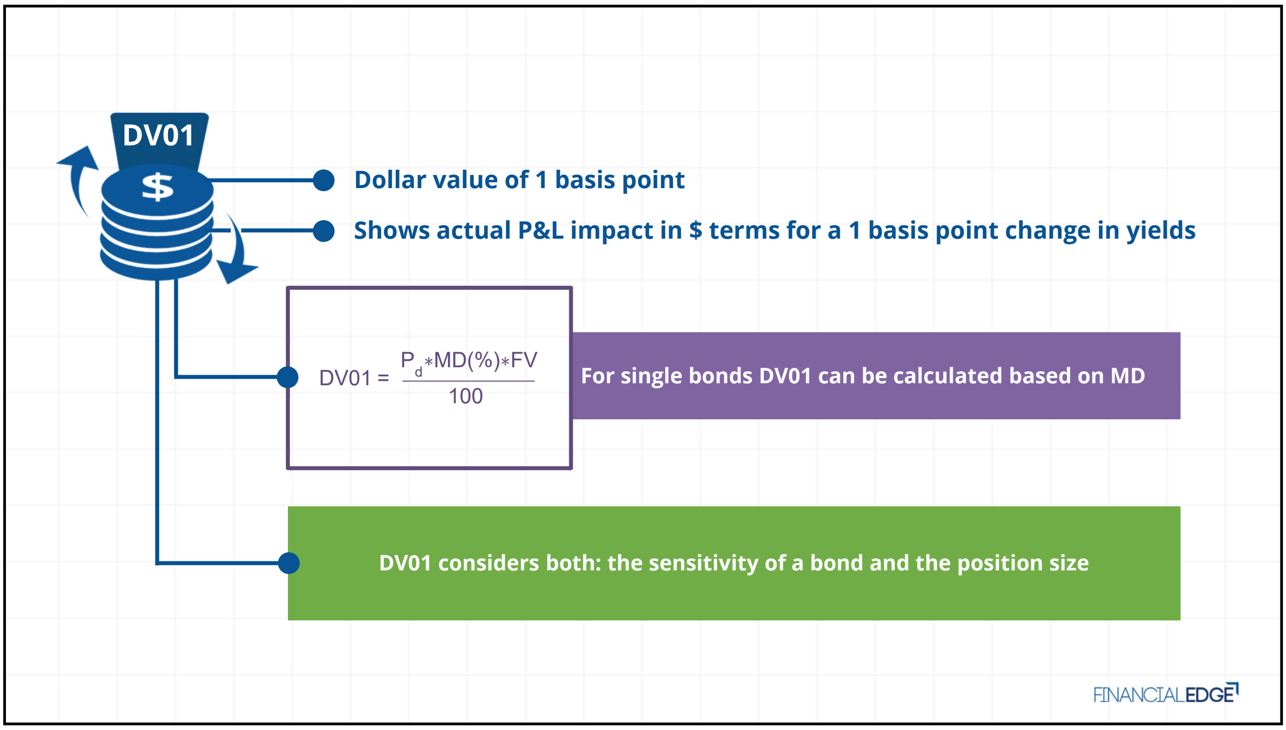
DV01


DV01
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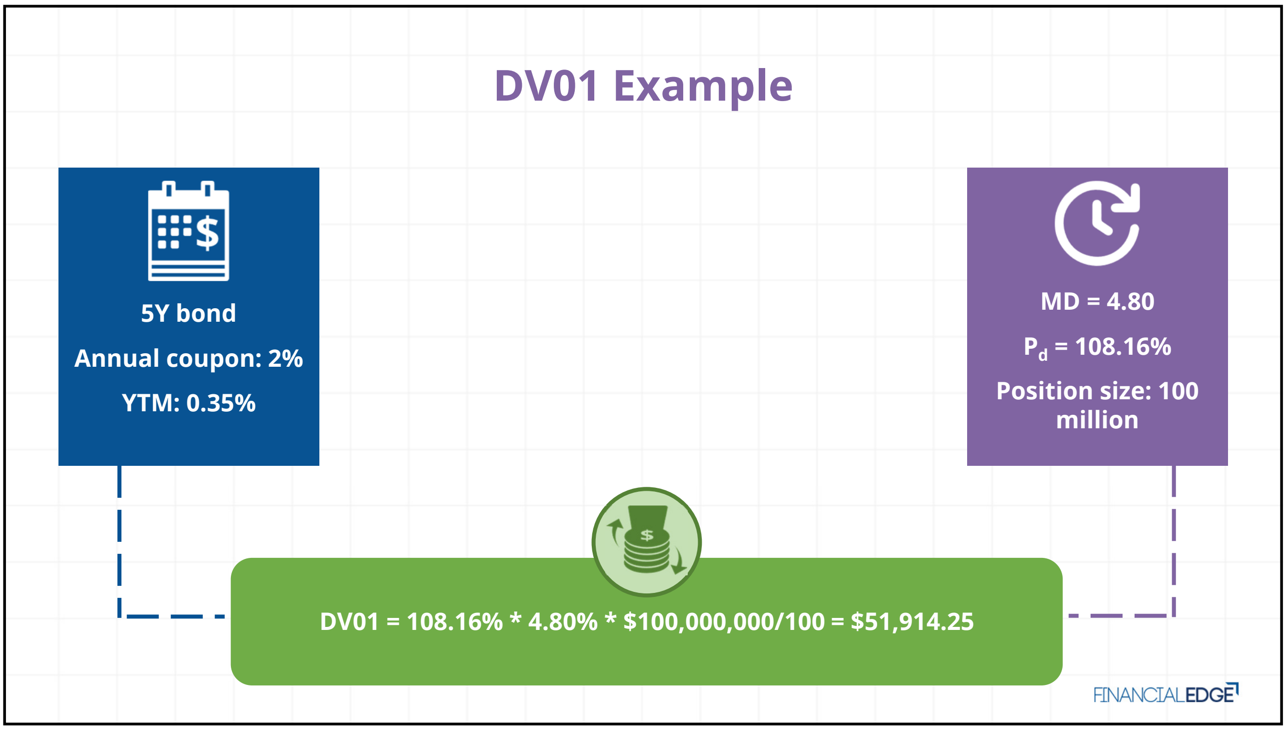
Dollar value of 1 basis point
Shows actual P&L impact in $ terms for a 1 basis point change in yields
DV01 = $\frac{P_d * MD(\%) * FV}{100}$
For single bonds DV01 can be calculated based on MD
DV01 considers both: the sensitivity of a bond and the position size


DV01 Example
5Y bond
Annual coupon: 2%
YTM: 0.35%
MD = 4.80
P_d = 108.16%
Position size: 100 million
DV01 = 108.16% * 4.80% * $100,000,000/100 = $51,914.25
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Approaches to Liability Matching
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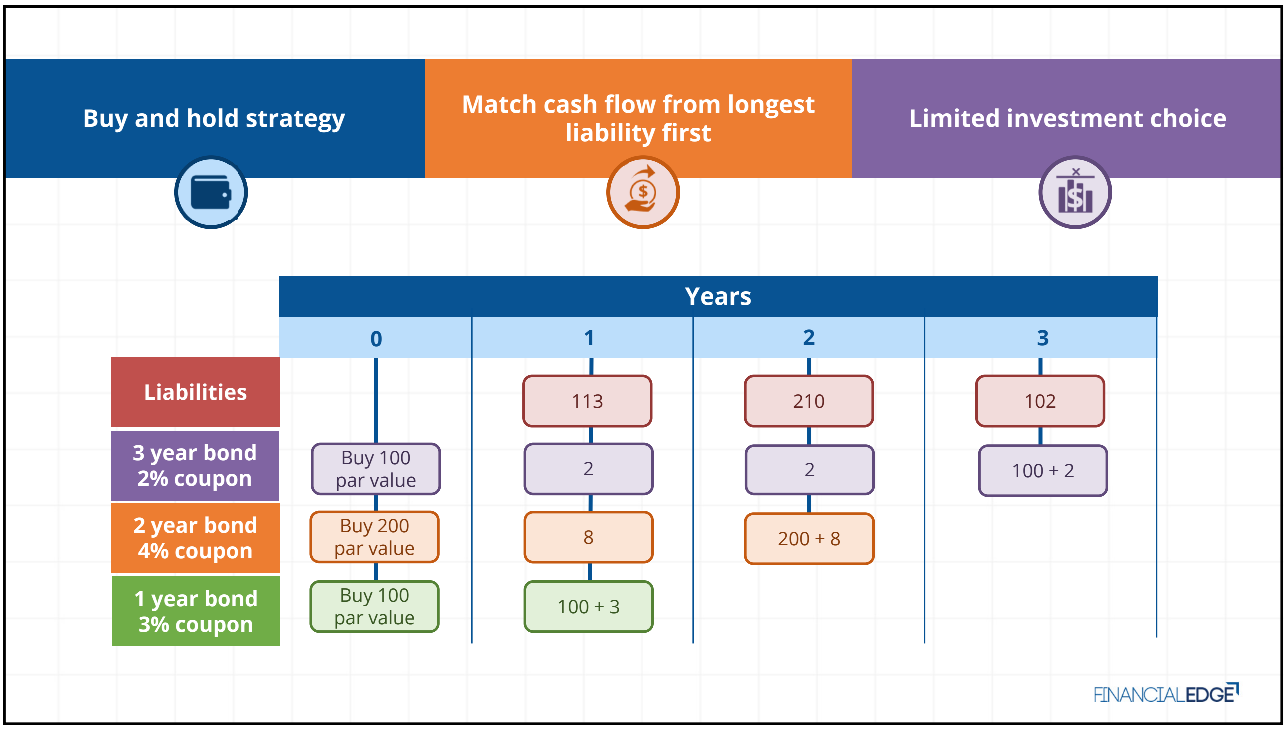
	Cash Flow Matching	Duration Matching (Immunization)
Description	Construct a portfolio of bonds whose future cash flows will meet future liabilities	Construct a portfolio of bonds whose duration matches the duration of the liability
Advantages	Simple buy and hold strategy removes exposure to interest rate risk	Wide variety of bonds can be used
Disadvantages	Bonds may not be available to match timings of liabilities precisely	Requires monitoring and rebalancing

Cash Flow Matching


Buy and hold strategy
Match cash flow from longest liability first
Limited investment choice
Years
0
1
2
3
Liabilities
113
210
102
3 year bond 2% coupon
Buy 100 par value
2
2
100 + 2
2 year bond 4% coupon
Buy 200 par value
8
200 + 8
1 year bond 3% coupon
Buy 100 par value
100 + 3
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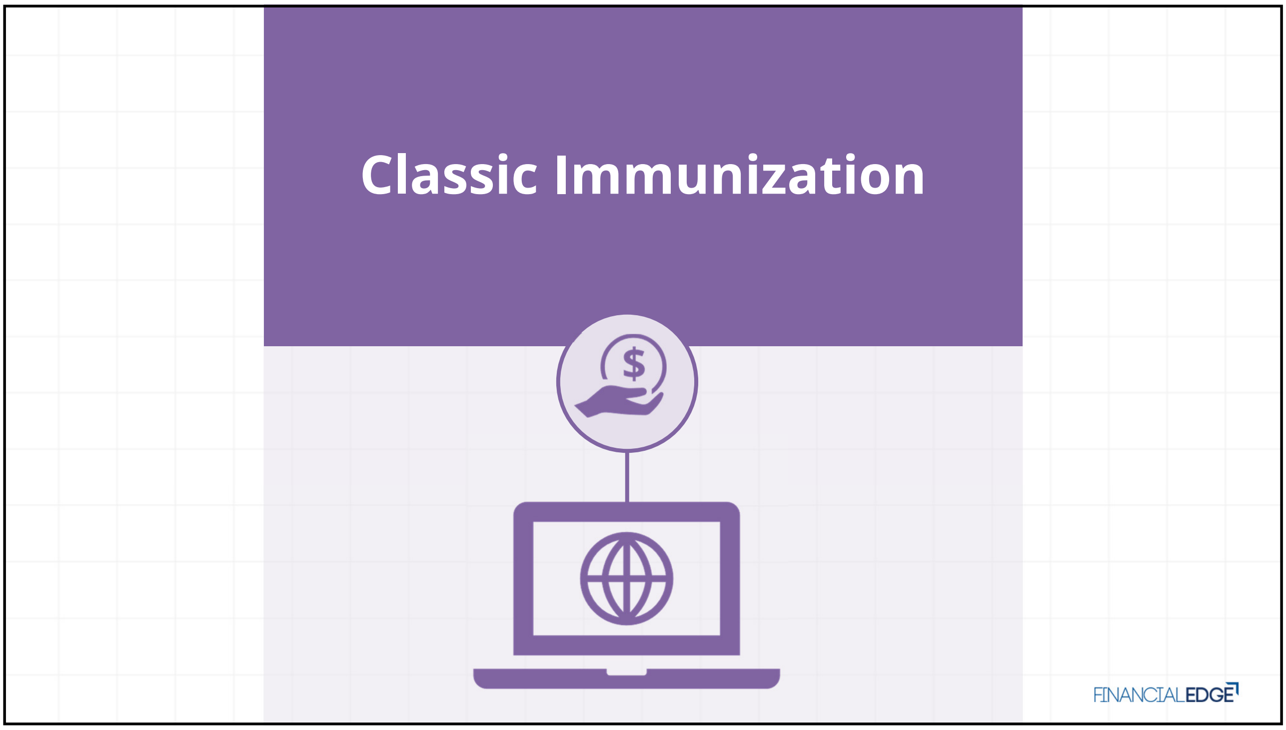
Classic Immunization
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The interest rate risk of a portfolio used to meet a single future liability can be almost eliminated by holding a bond, or portfolio of bonds for which the duration of the bond(s) matches the duration of the liability

Liability (years)	4.5
Bond:	
Maturity	5.0
Coupon rate	5.86%
Par value	100.0
Duration (years)	4.5

		Value at time 4.5, if rates are:		
Year	**Cash flows**	**3.0%**	**4.0%**	**5.0%**
1.0	5.86	6.49	6.72	6.95
2.0	5.86	6.31	6.46	6.62
3.0	5.86	6.12	6.21	6.30
4.0	5.86	5.94	5.98	6.00
5.0	105.86	104.30	103.80	103.31
		129.17	**129.17**	**129.17**

Coupons reinvested until time 4.5 earning interest

Sale proceeds at time 4.5 are the present value of remaining cash flows

Duration of bond matches time until liability is due

If rates fall, lower interest on coupons but higher sale proceeds

If rates fall, lower interest on coupons but higher sale proceeds

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Problems with Immunization

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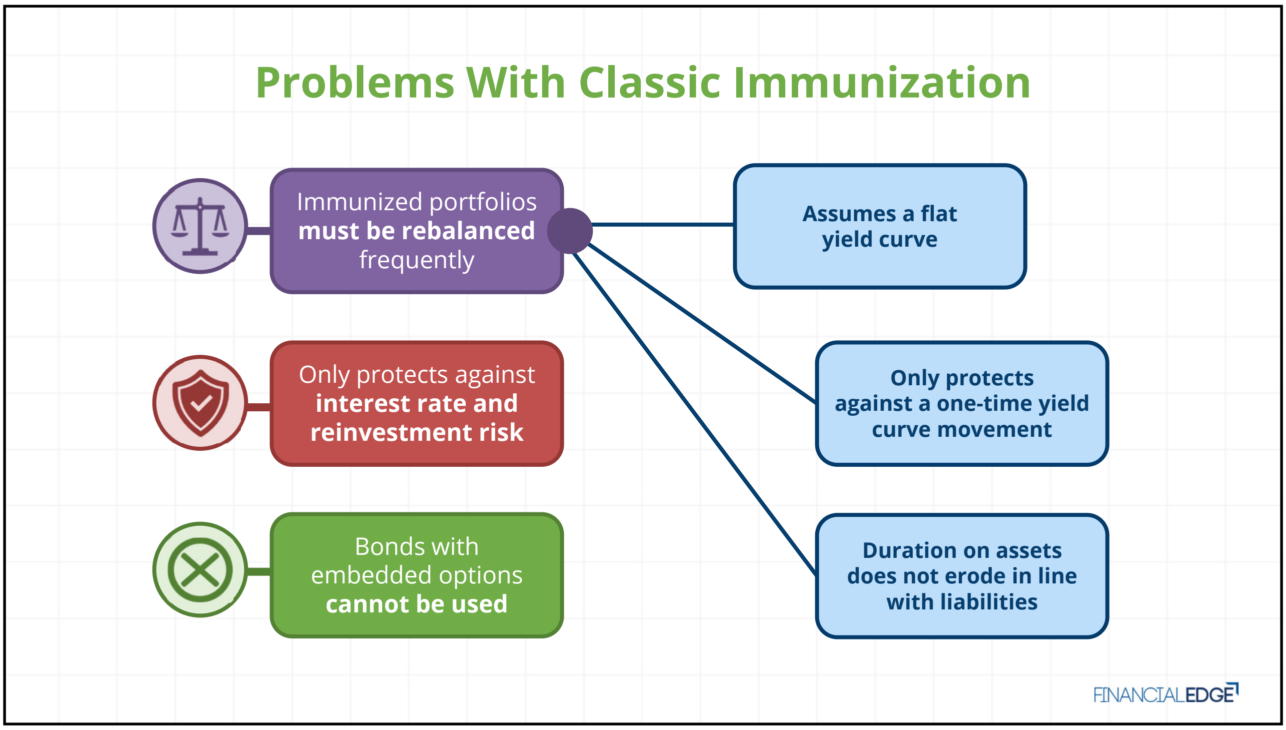
Problems With Classic Immunization
Immunized portfolios must be rebalanced frequently
Only protects against interest rate and reinvestment risk
Bonds with embedded options cannot be used
Assumes a flat yield curve
Only protects against a one-time yield curve movement
Duration on assets does not erode in line with liabilities
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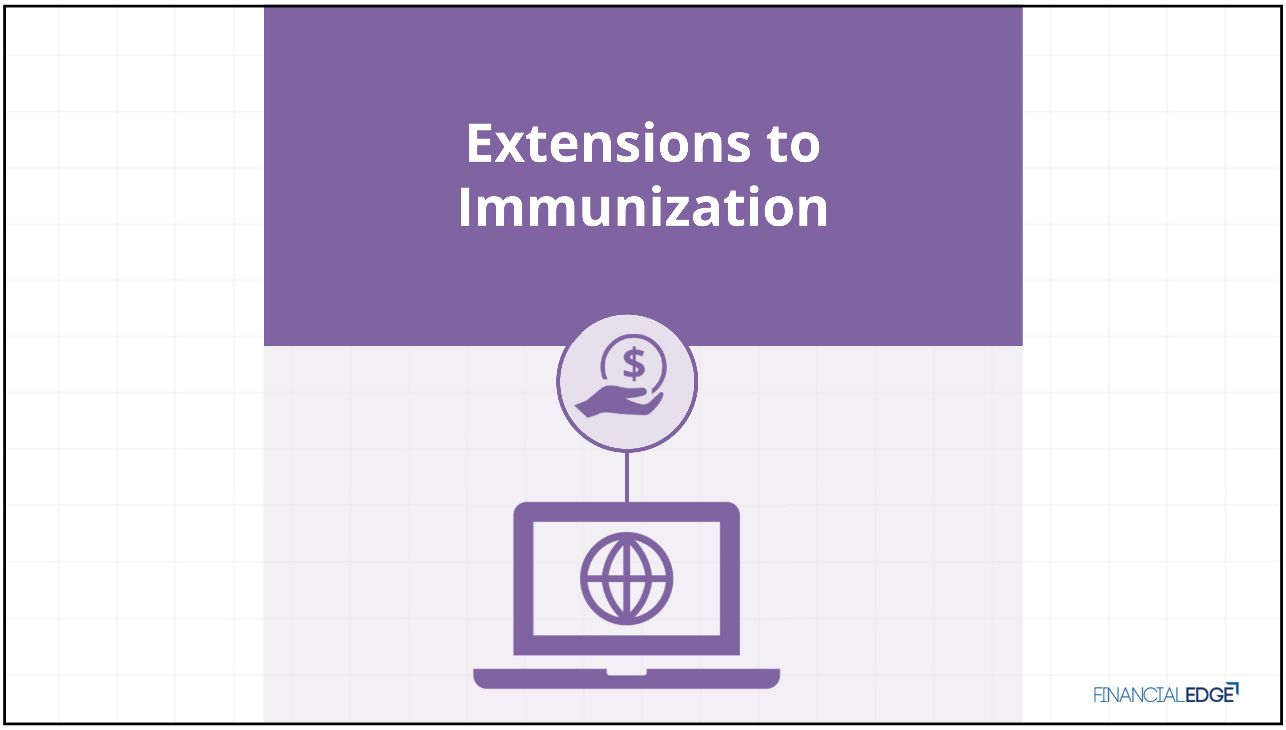
Extensions to Immunization
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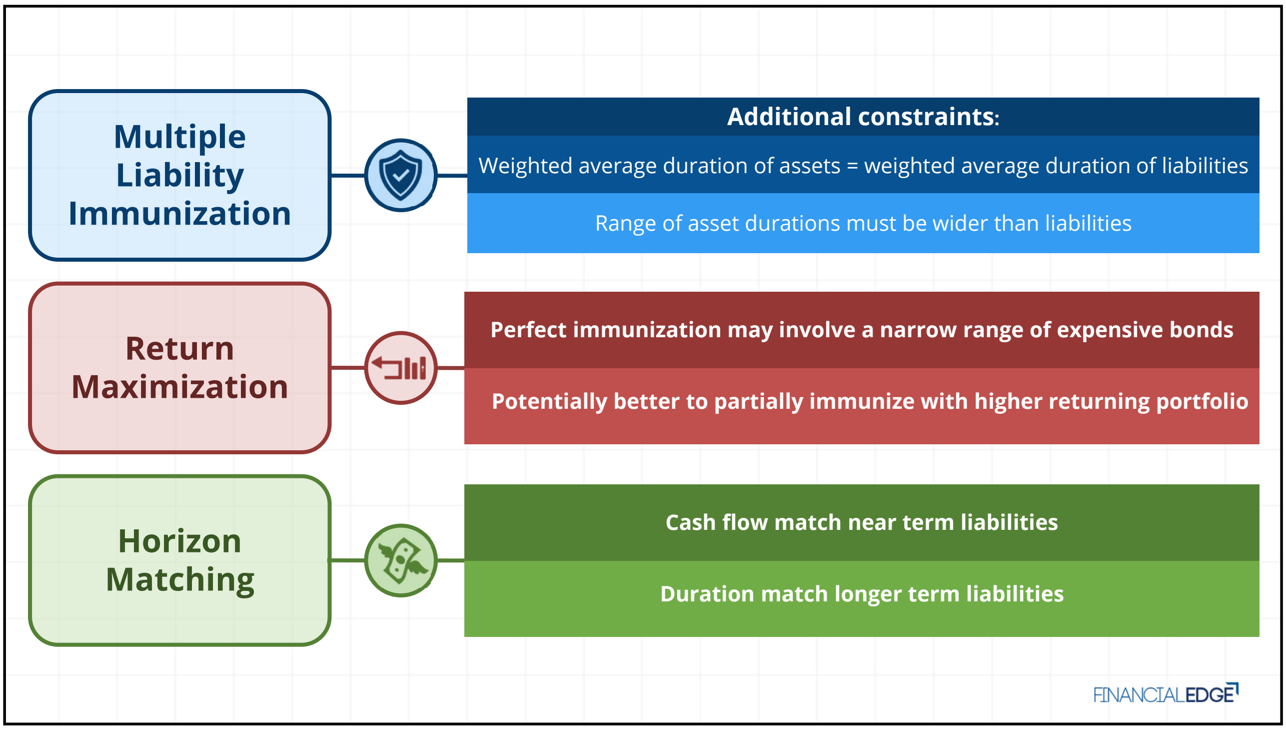

Multiple Liability Immunization
Additional constraints:
Weighted average duration of assets = weighted average duration of liabilities
Range of asset durations must be wider than liabilities
Return Maximization
Perfect immunization may involve a narrow range of expensive bonds
Potentially better to partially immunize with higher returning portfolio
Horizon Matching
Cash flow match near term liabilities
Duration match longer term liabilities
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Active Bond Portfolio Management
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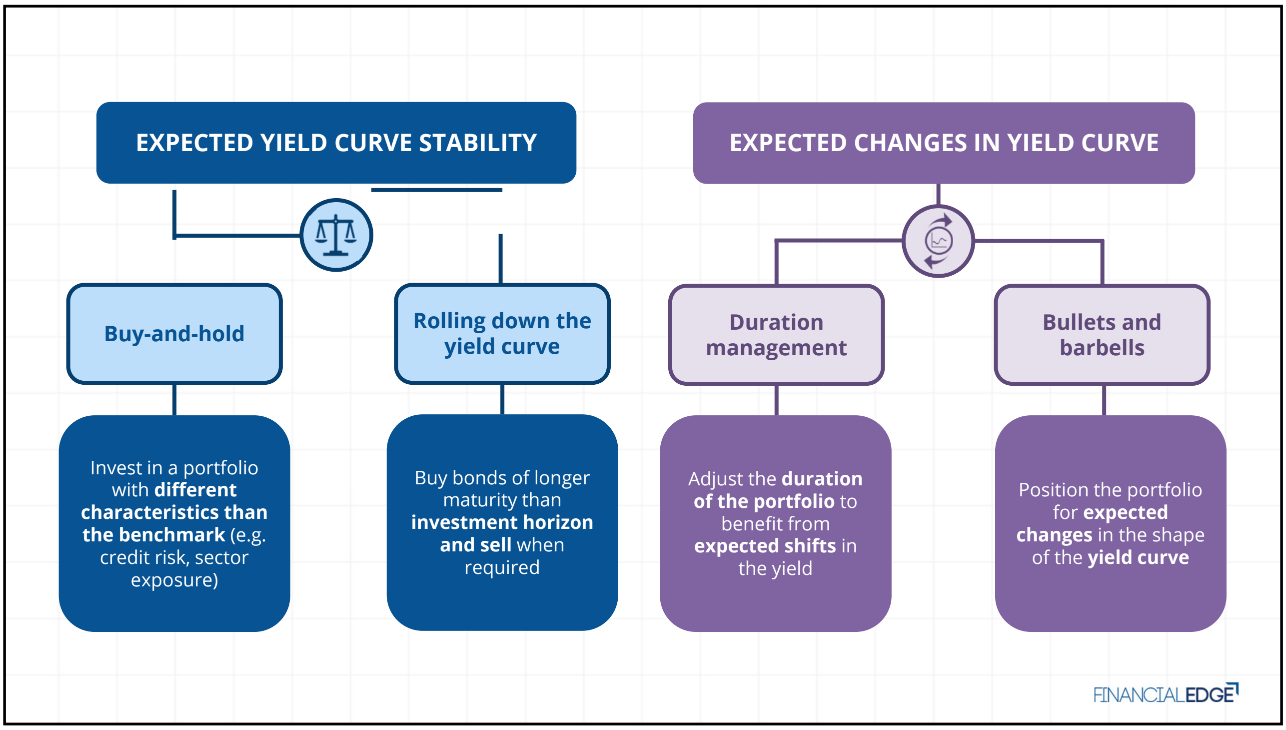
EXPECTED YIELD CURVE STABILITY
EXPECTED CHANGES IN YIELD CURVE
Buy-and-hold
Rolling down the yield curve
Duration management
Bullets and barbells
Invest in a portfolio with different characteristics than the benchmark (e.g. credit risk, sector exposure)
Buy bonds of longer maturity than investment horizon and sell when required
Adjust the duration of the portfolio to benefit from expected shifts in the yield
Position the portfolio for expected changes in the shape of the yield curve
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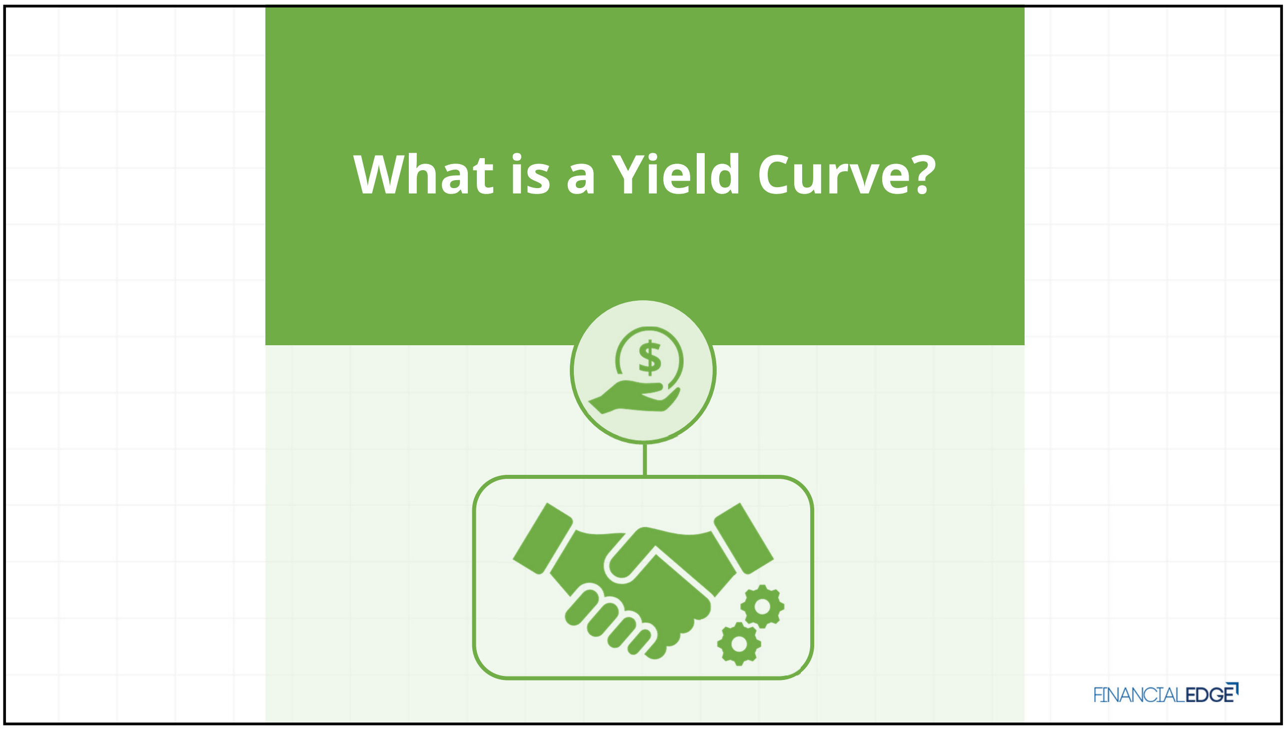
What is a Yield Curve?
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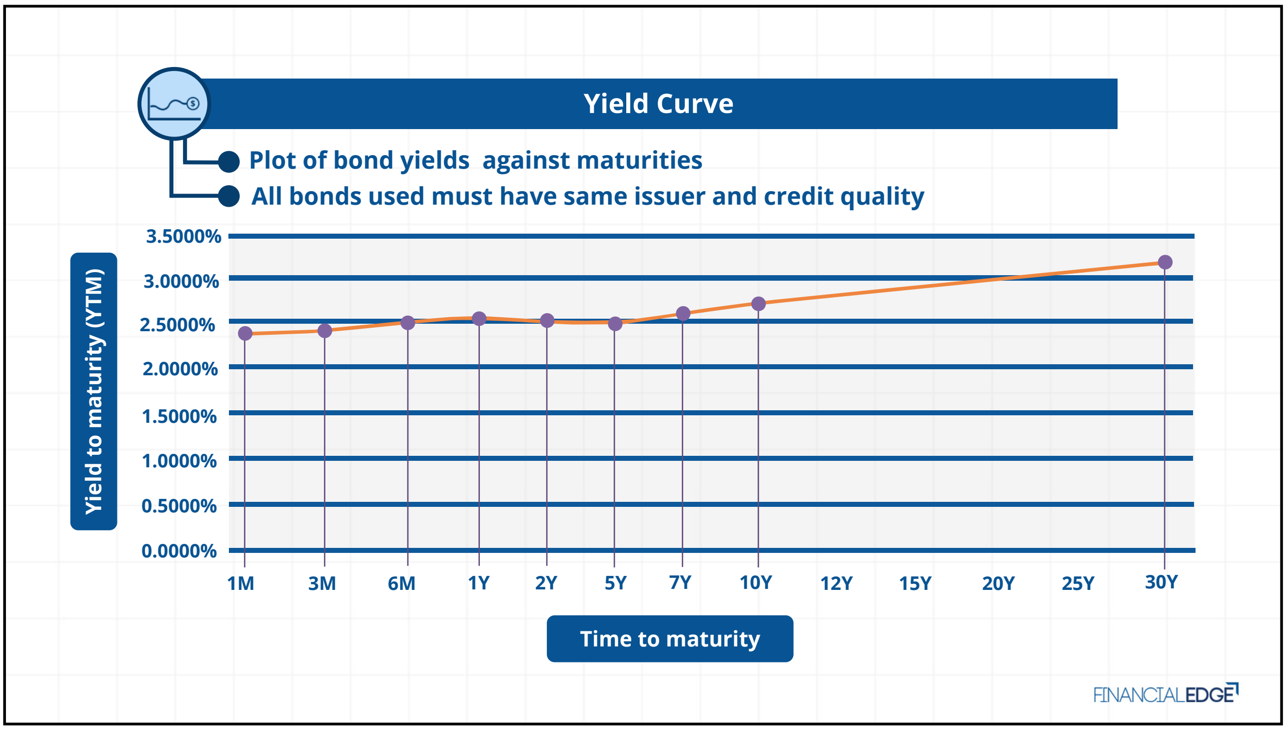
Yield Curve
Plot of bond yields against maturities
All bonds used must have same issuer and credit quality
Yield to maturity (YTM)
3.5000%
3.0000%
2.5000%
2.0000%
1.5000%
1.0000%
0.5000%
0.0000%
1M
3M
6M
1Y
2Y
5Y
7Y
10Y
12Y
15Y
20Y
25Y
30Y
Time to maturity
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Components of Return
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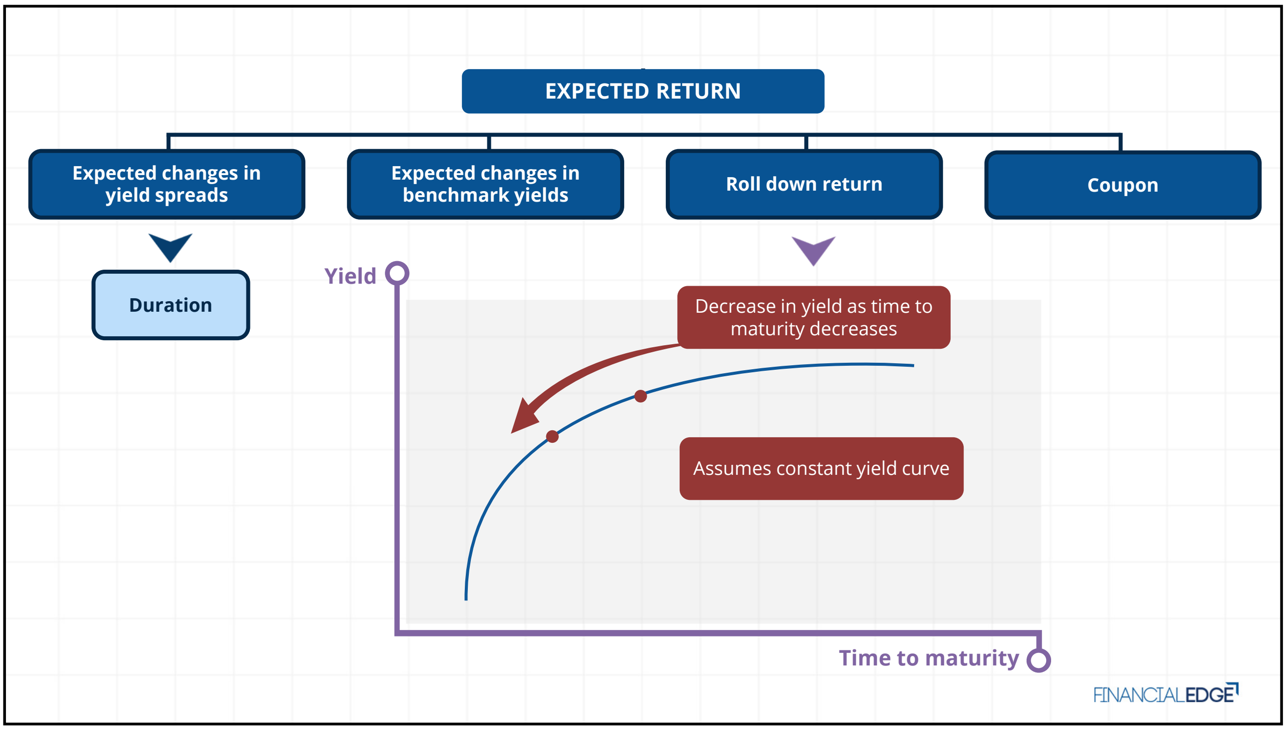
EXPECTED RETURN
Expected changes in yield spreads
Expected changes in benchmark yields
Roll down return
Coupon
Duration
Yield
Decrease in yield as time to maturity decreases
Assumes constant yield curve
Time to maturity
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Rolling Down the Yield Curve
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Buy Longer Dated Bond That Investment Horizon and Sell Bond as Needed

Example 3-month investment horizon

	Buy and hold 3-month Treasury Bill	Buy 6-month Treasury Bill and sell after 3 months
Purchase price	99.50 (3m T-Bill)	98.80 (6m T-Bill)
Cash flow in 3 months	100 (Par value)	99.50 (now a 3m T-Bill)
3 month holding period return	= (100 – 99.50) / 99.50 = 0.50%	= (99.50 – 98.80) / 98.80 = 0.71%

0.21% more return than buy and hold

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Active Bond Portfolio Management – **Yield Curve Shifts**

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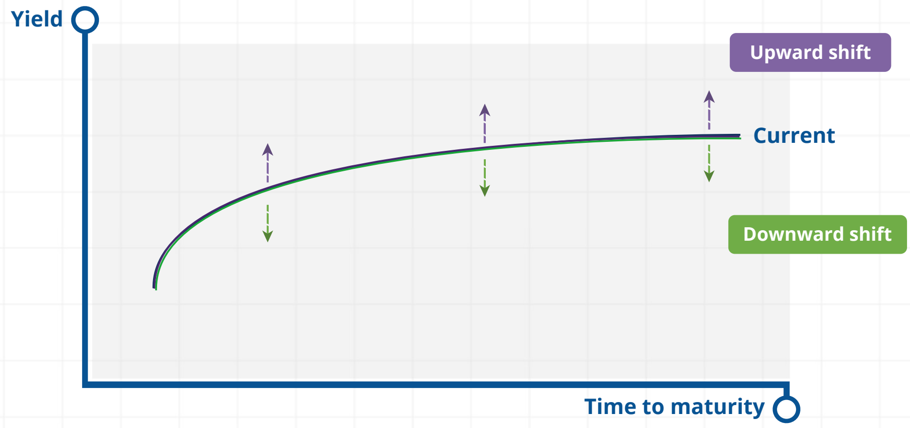
Bond portfolios can be constructed to take **advantage of expected changes** in the yield curve

A 'shift' in the yield curve assumes a **parallel change** in yields along the entire yield curve

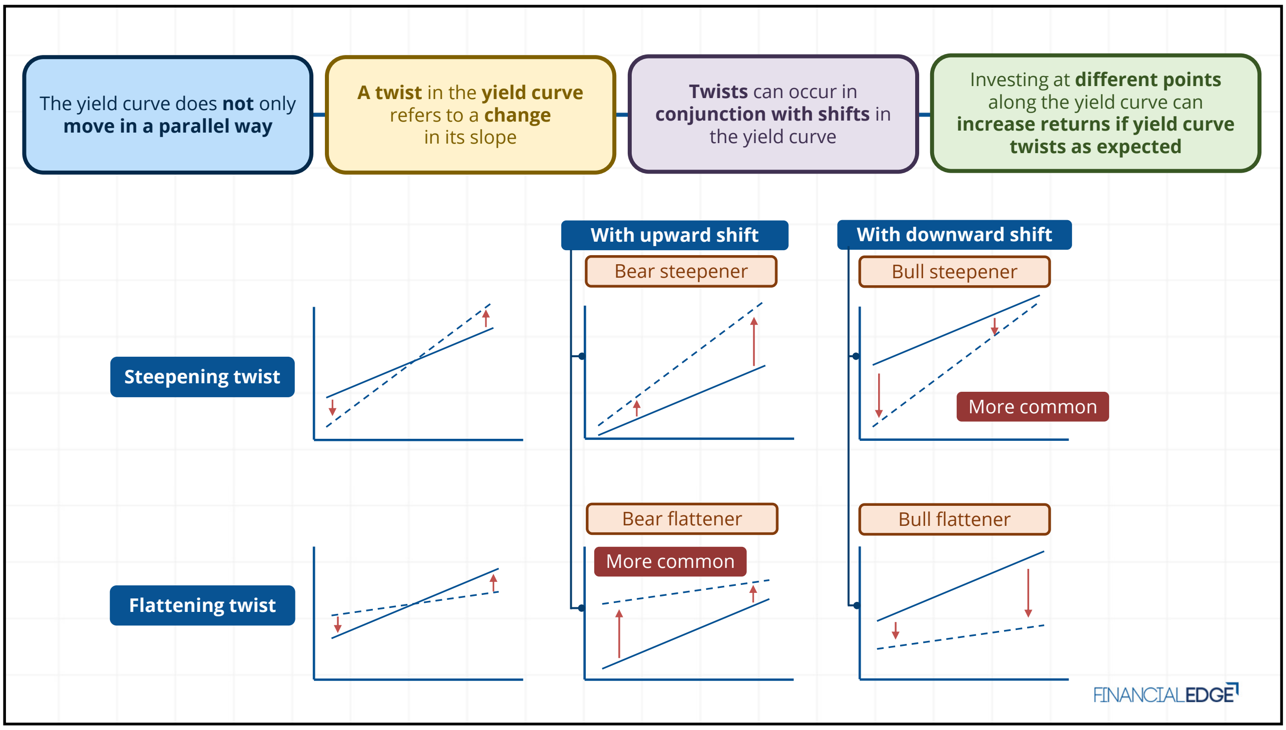
A bond portfolio's exposure to parallel changes in the yield curve can be **measured using duration**



Active Bond Portfolio Management **– Duration Management**

Expectations of an upward shift in the yield curve	Expectations of a downward shift in the yield curve
Higher interest rates mean lower bond prices	Lower interest rates mean higher bond prices
Reduce portfolio duration to increase exposure to falling bond prices	Increase portfolio duration to increase exposure to increasing bond prices
Sell longer dates bonds, buy shorter dated bonds	Sell shorter dates bonds, buy longer dated bonds
Sell bond futures	Buy bond futures
Pay fixed on interest rate swaps	Receive fixed on interest rate swaps

Active Bond Portfolio Management **– Yield Curve Twists**



The yield curve does not only move in a parallel way
A twist in the yield curve refers to a change in its slope
Twists can occur in conjunction with shifts in the yield curve
Investing at different points along the yield curve can increase returns if yield curve twists as expected
With upward shift
With downward shift
Bear steepener
Bull steepener
More common
Steepening twist
Bear flattener
Bull flattener
More common
Flattening twist
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Active Bond Portfolio Management
– Bullets & Barbells
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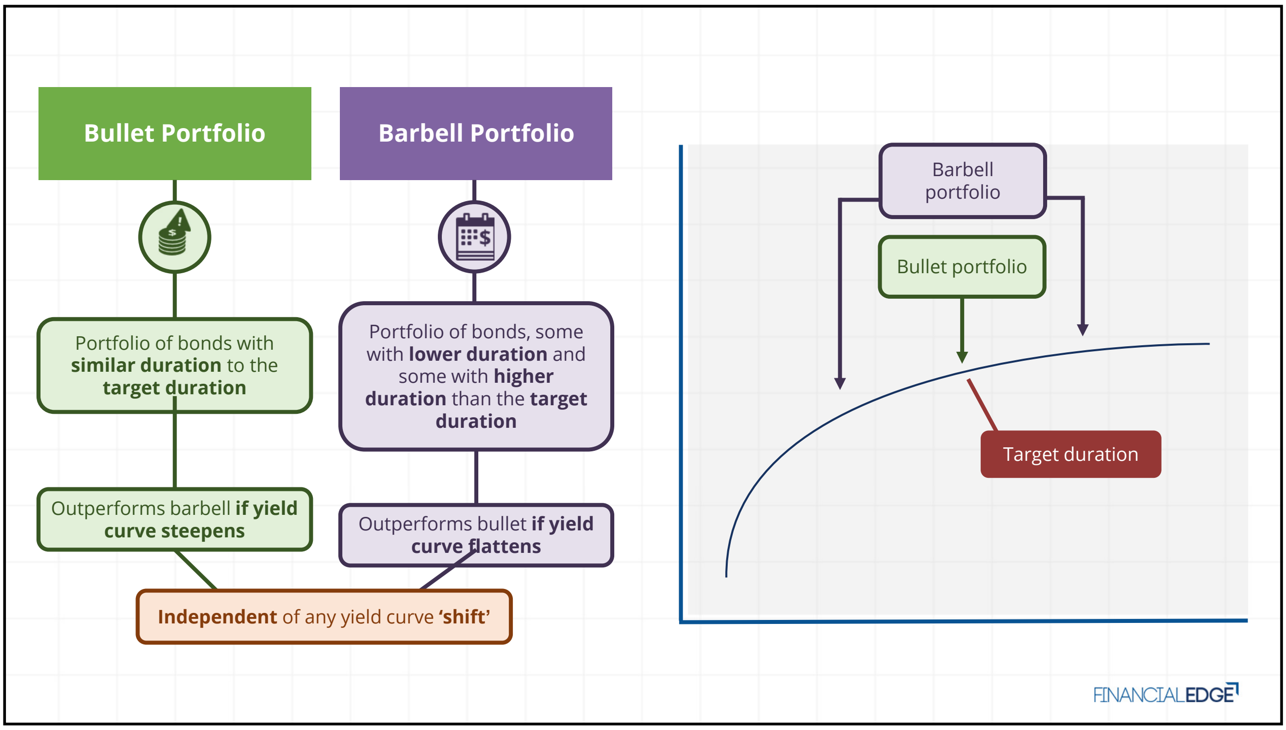
Bullet Portfolio
Barbell Portfolio
Portfolio of bonds with **similar duration** to the **target duration**
Portfolio of bonds, some with **lower duration** and some with **higher duration** than the **target duration**
Outperforms barbell **if yield curve steepens**
Outperforms bullet **if yield curve flattens**
Independent of any yield curve **'shift'**
Barbell portfolio
Bullet portfolio
Target duration
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Using Derivatives to Manage Interest Rate Risk
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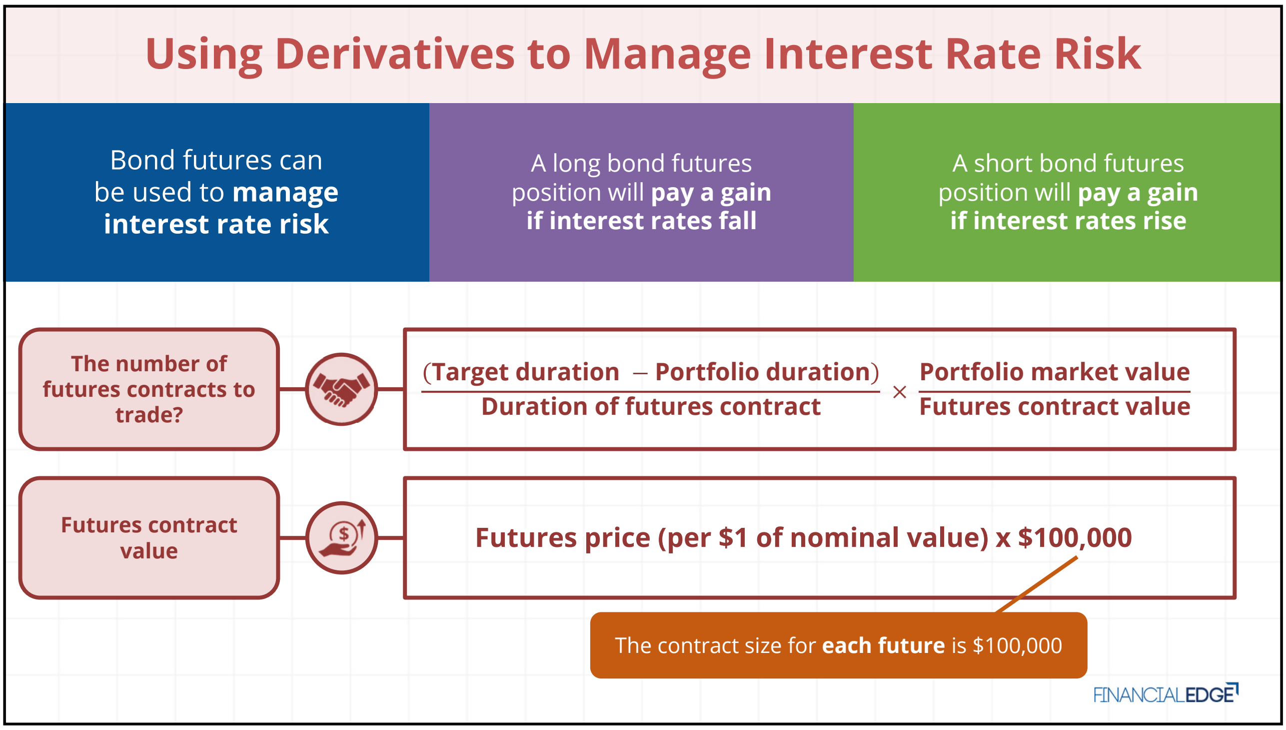
Using Derivatives to Manage Interest Rate Risk
Bond futures can be used to manage interest rate risk
A long bond futures position will pay a gain if interest rates fall
A short bond futures position will pay a gain if interest rates rise
The number of futures contracts to trade?
(Target duration − Portfolio duration) / Duration of futures contract × Portfolio market value / Futures contract value
Futures contract value
Futures price (per $1 of nominal value) x $100,000
The contract size for each future is $100,000
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