

A horizontal banner with a light blue background. On the left, there is a vertical teal stripe. The main area is a dark blue rectangle with a white double-lined chevron pointing to the right. The text "Fixed Income" is written in white.

Fixed Income

A horizontal banner with a light blue background. On the left, there is a vertical dark blue stripe. The main area is a teal rectangle with a white double-lined chevron pointing to the right. The text "Interest Rate Risk and Return" is written in white.

Interest Rate Risk and Return



Exam Focus

- Sources of return
- Macaulay duration

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Sources of Return: **Example**

An investor purchases a new 10-year, 6.2% annual coupon priced at par, holding it to maturity.

The return consists of:

1. Coupons and principal payments
2. Reinvestment income from any coupon payments
3. Any capital gain or loss if sold before maturity (n/a)

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Sources of Return: Example

An investor purchases a new 10-year, 6.2% annual coupon priced at par \$100, holding it to maturity.

1. Coupons and principal payments = $(\$6.20 \times 10) + \$100 = \$162$

2. Reinvestment income from any coupon payments =

Assume coupons are reinvested at YTM. As bond is priced at par, YTM = coupon = 6.2%. Find FV of coupons:

$N = 10$; $I/Y = 6.2$; $PV = 0$; $PMT = 6.2$; FV CPT =

\$82.49 represents of coupons plus of reinvestment income.

-4

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Sources of Return: Example

Total return across 10 years =

_____ =

Annual return = = (i.e., YTM)

-2

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Sources of Return

- Therefore, if interest rate declines after purchase (e.g., from 6.2% to 5.2%):
 - Coupon reinvestment income will be lower (reinvestment risk)
 - Price of the bond will increase (price risk)

Reinvestment risk + price risk = interest rate risk

- The two work in **opposite directions**

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Sources of Return: **Example**

An investor purchases a new 10-year, 6.2% annual coupon priced at par \$100, holding it to maturity. **Rates immediately decline after purchase to 5.2%.**

1. Coupons and principal payments = $(\$6.20 \times 10) + \$100 = \$162$

2. Reinvestment income from any coupon payments =

Coupons now reinvested at 5.2%. Find FV of coupons:

$N = 10; I/Y = 5.2; PV = 0; PMT = 6.2; FV \text{ CPT} =$

\$78.71 represents of coupons plus of reinvestment income.

-4

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Sources of Return: Example

Total return across 10 years =

_____ =

Annual return = _____ =

- Lower HPR as coupons were not able to be reinvested at 6.2% (reinvestment risk)
- No price risk here as held until maturity

-3

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Sources of Return: Example

An investor purchases a new 10-year, 6.2% annual coupon priced at par \$100, holding it for 4 years and then selling it for \$95.263. Interest rates immediately rose to 7.2% after purchase.

1. Coupons and principal payments = _____ =

2. Reinvestment income from any coupon payments =

Find FV of coupons:

N = 4; I/Y = 7.2; PV = 0; PMT = 6.2; FV CPT =

\$27.61 represents _____ of coupons plus _____ of reinvestment income.

-4

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Sources of Return: Example

Total return across 4 years =

_____ =

Annual return = _____ =

Higher interest rates meant the coupons were able to be reinvested at a higher rate, but this was more than offset by a lower sales price.

-3

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Sources of Return: Conclusions

An increase in interest rates after purchase will:

- increase HPR due to higher reinvestment income (assuming there are coupons)

but

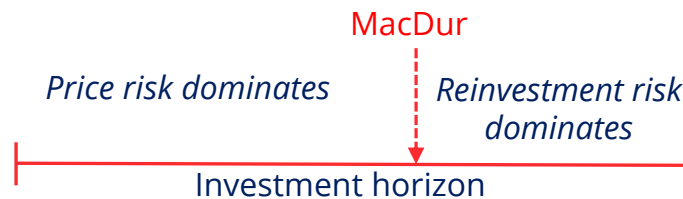
- decrease HPR due to lower sales price of bond (assuming sold before maturity)

So, which dominates?

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Macaulay Duration

The investment horizon where reinvestment risk exactly cancels out price risk = Macaulay duration:



If investment horizon > MacD, reinvestment risk will dominate (-ve duration gap)

If investment horizon < MacD, price risk will dominate (+ve duration gap)

Duration gap = MacDur – investment horizon

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Interest Rate Risks: **Example**

An investor intends to hold a bond with eight years remaining to maturity for eight years. The bond's Macaulay duration is 6.841. The investor is *primarily* exposed to which of the following interest rate risks:

- A. Price risk.
- B. Reinvestment risk.
- C. Neither price nor reinvestment risk.

-1

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Macaulay Duration

How to calculate:

- Calculate the cash flow at each time period
- Find the PV of each cash flow, discounted at the bond's YTM
- Find the weight of each PV: PV of CF / total PV
- Multiply each weight by time to receipt (i.e., $\times 1$ for 1 year, $\times 2$ for 2 years)
- Sum of weighted receipts = Macaulay duration

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Macaulay Duration: **Example**

Find the MacD of a 5-year, 6.2% annual-pay bond, par value \$100.
Trading at par, so YTM = 6.2%.

| Time Period | Cash Flow | PV of Cash Flow | Weighting of CF | Weighting \times Time |
|---------------|-----------|-----------------|-----------------|-------------------------|
| 1 | \$6.20 | \$5.84 | 5.84% | 0.0584 |
| 2 | \$6.20 | \$5.50 | 5.50% | 0.1100 |
| 3 | \$6.20 | \$5.18 | 5.18% | 0.1554 |
| 4 | \$6.20 | \$4.87 | 4.87% | 0.1948 |
| 5 | \$106.20 | \$78.61 | 78.61% | 3.9305 |
| Totals | | \$100 | 100% | 4.45 years |

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Macaulay Duration: **Example**

Macaulay duration = 4.45 years. What does this mean?

Investment horizon where reinvestment risk exactly offsets price risk:

(i.e., the investor will earn the initial YTM of 6.2% regardless of interest rate movements)

If investment horizon > 4.45 years, reinvestment risk will dominate price risk:

Interest rates rise, overall HPR will increase; if interest rates fall, overall HPR will decrease

If investment horizon < 4.45 years, price risk will dominate:

Interest rates rise, overall HPR will decrease; if interest rates fall, overall HPR will increase

-4

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Solutions

Sources of Return: Example

An investor purchases a new 10-year, 6.2% annual coupon priced at par \$100, holding it to maturity.

1. Coupons and principal payments = $(\$6.20 \times 10) + \$100 = \$162$

2. Reinvestment income from any coupon payments =

Assume coupons are reinvested at YTM. As bond is priced at par, YTM = coupon = 6.2%. Find FV of coupons:

$N = 10$; $I/Y = 6.2$; $PV = 0$; $PMT = 6.2$; FV CPT = $\$82.49$

$\$82.49$ represents $\$62$ of coupons plus $\$20.49$ of reinvestment income.

-4

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Sources of Return: Example

Total return across 10 years =

$$\frac{\$62 + \$100 + \$20.49}{\$100} = 1.8249$$

Annual return = $1.8249^{1/10} - 1 = 6.2\%$ (i.e., YTM)

-2

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Sources of Return: Example

An investor purchases a new 10-year, 6.2% annual coupon priced at par \$100, holding it to maturity. **Rates immediately decline after purchase to 5.2%.**

1. Coupons and principal payments = $(\$6.20 \times 10) + \$100 = \$162$

2. Reinvestment income from any coupon payments =

Coupons now reinvested at 5.2%. Find FV of coupons:

$N = 10$; $I/Y = 5.2$; $PV = 0$; $PMT = 6.2$; $FV \text{ CPT} = \$78.71$

\$78.71 represents \$62 of coupons plus \$16.71 of reinvestment income.

-4

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Sources of Return: Example

Total return across 10 years =

$$\frac{\$62 + \$100 + \$16.71}{\$100} = 1.7871$$

$$\text{Annual return} = (1.7871)^{1/10} - 1 = 5.98\%$$

- Lower HPR as coupons were not able to be reinvested at 6.2% (reinvestment risk)
- No price risk here as held until maturity

-3

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Sources of Return: Example

An investor purchases a new 10-year, 6.2% annual coupon priced at par \$100, holding it for 4 years and then selling it for \$95.263. Interest rates immediately rose to 7.2% after purchase.

1. Coupons and principal payments = $(\$6.20 \times 4) + \$95.263 = \$120.06$

2. Reinvestment income from any coupon payments =

Find FV of coupons:

$N = 4; I/Y = 7.2; PV = 0; PMT = 6.2; FV \text{ CPT} = \27.61

\$27.61 represents \$24.80 of coupons plus \$2.81 of reinvestment income.

-4

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Sources of Return: Example

Total return across 4 years =

$$\frac{\$24.80 + \$95.263 + \$2.81}{\$100} = 1.22873$$

$$\text{Annual return} = (1.22873)^{1/4} - 1 = 5.28\%$$

Higher interest rates meant the coupons were able to be reinvested at a higher rate, but this was more than offset by a lower sales price.

-3

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Interest Rate Risks: **Example**

An investor intends to hold a bond with eight years remaining to maturity for eight years. The bond's Macaulay duration is 6.841. The investor is *primarily* exposed to which of the following interest rate risks:

- A. Price risk.
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- C. Neither price nor reinvestment risk.

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