

## **Learning Module 10: Interest Rate Risk and Return**

Q.90 The coupon reinvestment risk dominates the market price risk when:

- A. The Macaulay duration is lower than the investment horizon.
- B. The Macaulay duration is higher than the investment horizon.
- C. The Macaulay duration is the same as the investment horizon.

The correct answer is **A**.

When the Macaulay duration of a bond is lower than the investment horizon, it implies that the weighted average time until the bond's cash flows are received is shorter than the period over which the investor plans to hold the bond. In such scenarios, the investor will have to reinvest the coupon payments received before the investment horizon is reached. The risk associated with this reinvestment is known as coupon reinvestment risk. This risk arises because the future interest rates at which these coupons can be reinvested may be lower than the original yield of the bond, potentially leading to a lower overall return than expected.

**B is incorrect.** If the Macaulay duration is higher than the investment horizon, it indicates that the investor is more exposed to market price risk. Market price risk is the risk that the bond's market price will decline due to rising interest rates. In such cases, if the investor needs to sell the bond before the investment horizon, they may face losses due to a decrease in the bond's market value. This scenario emphasizes the dominance of market price risk over coupon reinvestment risk when the Macaulay duration exceeds the investment horizon.

**C is incorrect.** When the Macaulay duration and the investment horizon are equal, it ideally balances the exposure to both coupon reinvestment risk and market price risk. This balance means that the effects of interest rate changes on the bond's price and the reinvestment rates tend to offset each other to some extent.

Note: Coupon reinvestment risk is the risk that an investor will be unable to reinvest cash flows at a rate equal to their current return (the investor may be forced to reinvest at a lower rate), whereas market price risk is the risk of lower bond prices due to lower market interest rates.

***CFA Level I, Fixed Income, Learning Module 10: Interest Rate Risk and Return. LOS (b): describe the relationships among a bond's holding period return, its Macaulay duration, and the investment horizon***

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Q.91 A bond investor has an investment horizon of 9 years. He recently calculated that the Macaulay duration of his portfolio is 11 years. The duration gap is *closest to*?

- A. -2.
- B. 0.8182.
- C. 2.

The correct answer is C.

The duration gap is the difference between the Macaulay duration of a bond and the investment horizon.

$$\begin{aligned}\text{Duration gap} &= \text{Macaulay duration} - \text{Investment horizon} \\ &= 11 - 9 = 2\end{aligned}$$

**CFA Level I, Fixed Income, Learning Module 10: Interest Rate Risk and Return. LOS (b) Describe the relationships among a bond's holding period return, its Macaulay duration, and the investment horizon; LOS (c): define, calculate, and interpret Macaulay duration**

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Q.968 Which of the following statements is *most likely* accurate for premium and par bonds?

- A. Macaulay Duration is always equal to  $\frac{(1+r)}{r}$ , where r is the yield to maturity.
- B. Macaulay Duration is always less than  $\frac{(1+r)}{r}$ , where r is the yield to maturity.
- C. Macaulay Duration is always greater than  $\frac{(1+r)}{r}$ , where r is the yield to maturity.

The correct answer is **B**.

For premium and par bonds, the Macaulay Duration is always less than  $\frac{(1+r)}{r}$ .

Macaulay duration is given by:

$$\text{MacDur} = \left[ \frac{1+r}{r} - \frac{1+r + [N \times (c-r)]}{c \times [(1+r)^N - 1] + r} - \frac{t}{T} \right]$$

Where:

r=yield to maturity

c=coupon rate

$\frac{t}{T}$  = the fraction of the coupon period that has gone by since the last payment

When the coupon rate is greater than the market discount rate, the bond is priced at a premium above par value. When the coupon rate is equal to the market discount rate, the bond is priced at par value. This means that for premium and par bonds, the coupon rate is greater than or equal to yield-to-maturity (r).

The numerator of the second expression in braces is always positive because c-r is positive. The denominator of the second expression in braces is always positive. Second expression as a whole is always positive.

Therefore, macaulay duration is less than  $\frac{(1+r)}{r}$  because the second expression in braces is positive. MacDuration approaches  $\frac{(1+r)}{r}$  as time passes.

**CFA Level I, Fixed Income, Learning Module 10: Interest Rate Risk and Return. LOS (b)**  
**Describe the relationships among a bond's holding period return, its Macaulay duration, and the investment horizon; LOS (c): define, calculate, and interpret Macaulay duration**

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Q.2137 An investor purchases a fixed-rate bond at a discount. The bond does not default, and the reinvestment rate is equal to the bond's yield to maturity (YTM). If the investor holds the bond until maturity, which of the following statements is *most accurate*?

- A. The investor will earn a rate of return equal to the YTM at purchase only if the bond is purchased at a discount.
- B. The investor will earn a return higher than the YTM at purchase if the bond is held until maturity.
- C. The investor will earn a return equal to the YTM at purchase, regardless of whether the bond is purchased at a premium or a discount.

The correct answer is **C**.

The YTM is the internal rate of return earned on the bond if the bond is held until maturity and all coupon payments are reinvested at the YTM, regardless of whether the bond is purchased at a premium, discount, or at par.

**A is incorrect.** The YTM represents the return that an investor will earn if the bond is held until maturity and all coupons are reinvested at the YTM, regardless of whether the bond is purchased at a discount, premium, or par.

**B is incorrect.** It suggests that the investor will earn a return higher than the YTM, which contradicts the definition of YTM. The YTM is the expected rate of return, assuming the bond is held until maturity, and all coupons are reinvested at the YTM.

**CFA Level I, Fixed Income, Learning Module 10: Interest Rate Risk and Return. LOS (a): calculate and interpret the sources of return from investing in a fixed-rate bond**

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Q.2138 For a bond that was purchased at a premium, the YTM of the bond is *most likely*:

- A. Equal to the coupon rate.
- B. Less than the coupon rate.
- C. More than the coupon rate.

The correct answer is **B**.

For a bond purchased at a premium, the YTM is less than the coupon rate because both the amortization of the premium and the reduction in interest earned on reinvestment of its cash flows decrease the bond's return.

We can also consider the yield-price relationship of bonds to answer this question. The price of a bond is inversely related to its yield. Therefore, a bond with a higher price will have a lower yield and vice versa. Since bonds issued at a premium have been issued at a higher price (price above par), then it follows that such bonds will have a lower yield.

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Q.2140 Michael holds a bond whose YTM is 6%. However, the YTM of the bond increases to 6.5% before the first coupon date. The rate of return for the new investors on the bond will *most likely*:

- A. Remain unaffected at 6%.
- B. Decrease to less than 6%.
- C. Increase to more than 6%.

The correct answer is **C**.

When the yield to maturity (YTM) of a bond increases from 6% to 6.5% before the first coupon date, it means that the market interest rates have risen, causing the bond's price to fall. For new investors who purchase the bond at this lower price, the YTM of 6.5% reflects their rate of return if they hold the bond until maturity, assuming all coupons are reinvested at the same rate.

Since the YTM for new investors is 6.5%, which is higher than the original YTM of 6%, their rate of return will be more than 6%.

***CFA Level I, Fixed Income, Learning Module 10: Interest Rate Risk and Return. LOS (a): calculate and interpret the sources of return from investing in a fixed-rate bond***

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Q.2141 Investor X has an investment horizon of 3 years and has invested in a 4% coupon-paying bond with a YTM of 6%. Investor Y has an investment horizon of 10 years and has invested in a 5% coupon-paying bond with a YTM of 5%.

Which investor *most likely* faces higher market price risk compared to reinvestment risk?

- A. Investor X.
- B. Investor Y.
- C. Both investors have the same market and reinvestment risks.

The correct answer is **A**.

For investor X, since the bond's coupon rate is below its YTM, Investor X is exposed to **market price risk**. If interest rates rise, the bond's price will fall, leading to capital losses. With a shorter investment horizon, reinvestment risk is less relevant for Investor X.

For investment Y, the bond's coupon rate aligns with its YTM, reducing market price risk. If interest rates change, the bond's price impact will be less severe. With a longer investment horizon, reinvestment risk becomes more significant for Investor Y. The coupons received over 10 years need to be reinvested, and if rates decline, reinvesting at lower rates could lead to lower returns.

**CFA Level I, Fixed Income, Learning Module 10: Interest Rate Risk and Return. LOS (a): calculate and interpret the sources of return from investing in a fixed-rate bond**

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Q.2142 Which of the following statements about reinvestment risk is *least likely* accurate?

- A. A bond investor can eliminate reinvestment risk by holding a coupon bond until maturity.
- B. An investor concerned about reinvestment risk is most concerned about a decrease in interest rates.
- C. A bond's yield calculation assumes that the coupons and the investment cash flows can be reinvested at the yield to maturity.

The correct answer is **A**.

Even if a bond investor holds a coupon bond until maturity, they still face reinvestment risk. This is because the coupons received before maturity need to be reinvested, and there is uncertainty about the interest rate at which these coupons can be reinvested.

**B is accurate.** An investor concerned about reinvestment risk is indeed most concerned about a decrease in interest rates because lower interest rates would result in lower returns on reinvested coupon payments.

**C is accurate.** The yield to maturity (YTM) calculation does assume that the coupons and the investment cash flows can be reinvested at the YTM rate. If the actual reinvestment rate is lower than the YTM, the realized yield will be lower than the YTM.

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Q.2145 Which of the following statements about the Macaulay duration of a coupon bond is *most accurate*?

- A. Between coupon payment dates, the Macaulay duration of a coupon bond decreases over time and then increases sharply on the coupon payment date.
- B. Between coupon payment dates, the Macaulay duration of a coupon bond increases over time and then decreases sharply on the coupon payment date.
- C. Between coupon payment dates, the Macaulay duration of a coupon bond remains constant and does not change until the coupon payment date.

The correct answer is **B**.

For Macaulay duration, it typically follows an increasing trend followed by a sudden drop on each coupon payment date. In that:

**Between coupon payments:** As time passes, the Macaulay duration gradually increases. This is because the bond's remaining cash flows (coupons and principal) are weighted more heavily toward the distant future.

**On the coupon payment date:** The Macaulay duration experiences a sharp decrease. Why? Because the bondholder receives a coupon payment, which reduces the remaining time until the next coupon payment. Consequently, the weighted average time decreases.

**A is incorrect.** Macaulay duration does not exhibit such behavior. It remains relatively stable between coupon payment dates.

**C is incorrect.** Macaulay duration does change between coupon payment dates due to the evolving time-to-maturity and cash flow patterns.

**CFA Level I, Fixed Income, Learning Module 10: Interest Rate Risk and Return. LOS (b): describe the relationships among a bond's holding period return, its Macaulay duration, and the investment horizon**

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Q.2162 If an investor's investment horizon equals the bond's Macaulay duration, how will a parallel yield curve shift impact the investor's return before the first coupon payment?

- A. It will increase the investor's return.
- B. It will decrease the investor's return.
- C. It will have little effect on the investor's horizon return.

The correct answer is C.

When the investment horizon and the bond's Macaulay duration are matched, a parallel shift in the yield curve before the first coupon payment will not (or minimally) affect the investor's horizon return. When the investment horizon directly matches the Macaulay duration, the effect of a change in YTM on the sale price of a bond and the reinvestment income offset each other.

**A is incorrect.** This is because when the investment horizon matches the bond's Macaulay duration, a parallel shift in the yield curve does not typically result in an increased return.

**B is incorrect.** This is because when the holding period equals the bond's Macaulay duration, a parallel shift in the yield curve does not generally lead to a decreased return.

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***CFA Level I, Fixed Income, Learning Module 10: Interest Rate Risk and Return. LOS (b): describe the relationships among a bond's holding period return, its Macaulay duration, and the investment horizon***

Q.2163 The duration gap is *best* defined as:

- A. The difference between a bond's Macaulay duration and the bondholder's investment horizon.
- B. The difference between a bond's effective duration and the bondholder's investment horizon.
- C. The difference between a bond's modified duration and the bondholder's investment horizon.

The correct answer is **A**.

The difference between a bond's Macaulay duration and the bondholder's investment horizon is referred to as the duration gap. This measurement helps assess the sensitivity of the bond's price to interest rate changes in relation to the investor's holding period.

**B is incorrect.** The duration gap is not the difference between a bond's effective duration and the bondholder's investment horizon. Effective duration is used to measure interest rate sensitivity considering embedded options, but it does not define the duration gap.

**C is incorrect.** The duration gap is not the difference between a bond's modified duration and the bondholder's investment horizon. Modified duration measures price sensitivity to interest rate changes, but the duration gap specifically involves Macaulay duration in comparison to the investment horizon.

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**CFA Level I, Fixed Income, Learning Module 10: Interest Rate Risk and Return. LOS (b): describe the relationships among a bond's holding period return, its Macaulay duration, and the investment horizon**

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Q.2164 A positive duration gap exposes the investor to:

- A. Market price risk from increasing interest rates.
- B. Reinvestment risk from decreasing interest rates.
- C. Both reinvestment risk and market price risk equally.

The correct answer is **A**.

A positive duration gap means the bond's Macaulay duration is greater than the investor's holding period. This situation exposes the investor primarily to market price risk from increasing interest rates, as the bond's price would decline more than the reinvestment income would offset.

**B is incorrect.** A positive duration gap does not primarily expose investors to reinvestment risk from decreasing interest rates. Reinvestment risk is more relevant when the investment horizon is longer than the bond's duration, i.e., an investor is exposed to reinvestment risk from decreasing interest rates when the Macaulay duration is less than the investment horizon.

**C is incorrect.** A positive duration gap does not expose the investor to both reinvestment risk and market price risk equally. The primary concern with a positive duration gap is market price risk due to rising interest rates.

***CFA Level I, Fixed Income, Learning Module 10: Interest Rate Risk and Return. LOS (b): describe the relationships among a bond's holding period return, its Macaulay duration, and the investment horizon***

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Q.3881 A bond investor has an investment horizon of 6 years. He recently calculated that the Macaulay duration of his portfolio is 9. The duration gap is *closest* to?

- A. 0.67.
- B. 1.5.
- C. 3.

The correct answer is C.

The difference between the Macaulay duration of a bond and investment horizon is called the duration gap.

$$\begin{aligned}\text{Duration gap} &= \text{Macaulay duration} - \text{Investment horizon} \\ &= 9 \text{ Years} - 6 \text{ Years} \\ &= 3 \text{ Years}\end{aligned}$$

**CFA Level I, Fixed Income, Learning Module 10: Interest Rate Risk and Return. LOS (c): define, calculate, and interpret Macaulay duration**

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Q.4873 Three investors, Redwood Investors, Spruce Capital, and Pinecone Funds, each purchase a 6.25%, 20-year Argentine Eurobond at par value. The bond's Macaulay duration is 11.8 years. Redwood's investment horizon is 5 years, while Spruce and Pinecone have investment horizons of 11 and 20 years, respectively. Which of the following has the *least* sensitivity to interest rate changes?

- A. Redwood Investors.
- B. Spruce Capital.
- C. Pinecone Funds.

The correct answer is **B**.

Spruce Capital's investment horizon (11 years) is close to the bond's Macaulay duration (11.8 years). This alignment minimizes the duration gap, reducing sensitivity to interest rate changes. When the horizon matches or nearly matches the bond's duration, price changes due to rate shifts are offset by changes in reinvestment income, resulting in a more stable return profile.

**A is incorrect:** Redwood Investors' short investment horizon (5 years) creates a positive duration gap. Their bond's Macaulay duration (11.8 years) exceeds their holding period. As a result, they face market price risk. When interest rates rise, the bond's price falls more than the reinvestment income increases, leading to net losses. Conversely, when rates fall, the bond's price rises, but this effect is less significant than for an investor with a matching duration.

**C is incorrect.** Pinecone Funds' long investment horizon (20 years) creates a negative duration gap. Their bond's Macaulay duration (11.8 years) falls short of their holding period. This creates a duration gap that exposes them to reinvestment risk, making their returns more susceptible to changes in interest rates.

**CFA Level I, Fixed Income, Learning Module 10: Interest Rate Risk and Return. LOS (b): Describe the relationships among a bond's holding period return, its Macaulay duration, and the investment horizon.**

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Q.4874 Alex, an investor, purchases a bond with a remaining maturity of 20 years and plans to hold it for 20 years. The bond's Macaulay duration is 12 years. Alex is primarily exposed to:

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

The correct answer is **B**.

Reinvestment risk is the risk that the coupons received over the investment horizon will be reinvested at lower interest rates. Given that Alex's holding period (20 years) exceeds the bond's Macaulay duration (12 years), Alex is primarily exposed to reinvestment risk.

**A is incorrect.** Price risk involves the potential for the bond's price to decrease if interest rates rise. Since Alex's holding period (20 years) is longer than the bond's Macaulay duration (12 years), price risk is not the primary concern.

**C is incorrect.** Alex is not free from interest rate risks. The difference between the bond's Macaulay duration and the holding period makes Alex primarily exposed to reinvestment risk.

***CFA Level I, Fixed Income, Learning Module 10: Interest Rate Risk and Return. LOS (a): calculate and interpret the sources of return from investing in a fixed-rate bond.***

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Q.4875 Given the following scenarios with their associated interest rate risks.

Scenarios	Interest Rate Risks
Scenario 1 : Macaulay duration < investment horizon	Risk A : Price risk from rising interest rates
Scenario 2 : Macaulay duration > investment horizon	Risk B : Reinvestment risk from falling interest rates

Which of the following matches are *most likely* correct?

- A. Scenario 1, Risk A.
- B. Scenario 1, Risk B.
- C. Scenario 2, Both Risk A and B.

The correct answer is **B**.

When the Macaulay duration is less than the investment horizon, the investor is exposed to reinvestment risk from falling interest rates. When the Macaulay duration is greater than the investment horizon, the investor is exposed to price risk from rising interest rates.

**A is incorrect:** It incorrectly matches the scenarios to the risks. Macaulay duration less than the investment horizon corresponds to reinvestment risk from falling interest rates, not price risk from rising interest rates.

**C is incorrect:** It incorrectly matches the scenarios to the risks by attributing both scenarios to reinvestment risk from falling interest rates, which is incorrect.

**CFA Level I, Fixed Income, Learning Module 10: Interest Rate Risk and Return. LOS (b): describe the relationships among a bond's holding period return, its Macaulay duration, and the investment horizon.**

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Q.4876 A buy-and-hold fixed-income investor, ignoring credit risk, is *primarily* exposed to which source of risk?

- A. Changes in bond prices before maturity.
- B. Variability in the reinvestment rate of coupon payments.
- C. Both changes in bond prices before maturity and variability in the reinvestment rate of coupon payments.

The correct answer is **B**.

The primary source of risk for a buy-and-hold investor is the variability in the reinvestment rate of coupon payments. Changes in interest rates affect the returns earned from reinvesting these coupon payments, leading to reinvestment risk.

**A is incorrect:** A buy-and-hold investor is not affected by changes in bond prices before maturity because they hold the bond until maturity and receive the par value.

**C is incorrect:** While reinvestment risk is a concern, changes in bond prices before maturity do not affect a buy-and-hold investor, as they do not plan to sell the bond before maturity. Thus, this option incorrectly includes an irrelevant source of risk.

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***CFA Level I, Fixed Income, Learning Module 10: Interest Rate Risk and Return. LOS (a): calculate and interpret the sources of return from investing in a fixed-rate bond.***

Q.4877 James buys a bond with a face value of \$100 and plans to hold it for four years. The bond pays an annual coupon of \$5 and is currently priced at \$95. James expects to reinvest the coupons at an annual rate of 4%. James's annualized holding period return is *closest to*:

- A. 5.22%
- B. 5.47%
- C. 6.25%

The correct answer is **C**.

To calculate the holding period return (horizon yield), we use the formula:

$$r = \left( \frac{FV + F}{PV} \right)^{\frac{1}{T}} - 1$$

Where:

$r$  = Realized rate of return or Horizon Yield.

$FV$  = Future value of the reinvested coupons.

$F$  = Face value of the bond (\$1,00).

$PV$  = Present value or the bond's current price (\$95).

$T$  = Investment horizon (4 years).

**Step 1:** Let's calculate the future value of the reinvested coupons. The future value of an annuity (reinvested coupons) can be calculated using the future value of annuity formula:

$$FV = C \left( \frac{(1 + r)^n - 1}{r} \right)$$

Where:

- $C$  is the annual coupon payment (\$5).
- $r$  is the reinvestment rate (0.04).
- $n$  is the number of years (4).

Therefore,

$$FV = 5 \left( \frac{(1 + 0.04)^4 - 1}{0.04} \right) = 21.33$$

### Using the BA II Plus calculator:

- Press [2nd] [CLR TVM] to clear previous entries.
- Enter  $N=4$ : Press [4] [N]
- Enter  $I/Y=4$ : Press [4] [I/Y]
- Enter  $PMT=5$ : Press [5] [PMT]
- Compute  $FV$ : Press [CPT] [FV]

**Step 2:** Calculate the total future value of the bond and reinvested coupons.

$$\text{Total future value} = FV + F = 21.33 + 100 = \$121.33$$

**Step 3:** Apply the formula to find the annualized holding period return.

$$r = \left( \frac{121.33}{95} \right)^{\frac{1}{4}} - 1 = 0.062849 \approx 6.29\%$$

**Using the BA II Plus calculator:**

- Press [2nd] [CLR TVM] to clear previous entries.
- Enter N=4: Press [4] [N]
- Enter PV=−95: Press [95] [+/-] [PV] (negative because it's an outflow)
- Enter PMT=0: Press [0] [PMT]
- Enter FV =121.23: Press [121.23] [FV]
- Compute I/Y: Press [CPT] [I/Y]

**CFA Level I, Fixed Income, Learning Module 10: Interest Rate Risk and Return. LOS (b): describe the relationships among a bond's holding period return, its Macaulay duration, and the investment horizon; LOS (c): define, calculate, and interpret Macaulay duration.**

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Q.4878 Leoning Corp issues a bond with four years remaining to maturity, a coupon of 1.5% paid annually, and a yield-to-maturity of 0.5%. The bond's face value is \$100. The bond's annualized Macaulay duration is *closest to*:

- A. 3.91 years.
- B. 4.85 years.
- C. 5.75 years.

The correct answer is A.

To calculate the annualized Macaulay duration, we use the given formula:

$$\text{MacDur} = \frac{\sum_{i=1}^N \left( \frac{t \times CF_t}{(1+r)^t} \right)}{\sum_{i=1}^N \left( \frac{CF_t}{(1+r)^t} \right)}$$

**Step 1:** Let's first calculate the annual coupon payment:

$$\text{Annual Coupon} = 1.5\% \times 100 = \$1.50$$

**Step 2:** Calculate the present value of each cash flow using the YTM of 0.5% (0.005 as a decimal):

$$PV(CF_t) = \frac{CF_t}{(1 + YTM)^t}$$

$$\text{Year 1: } PV (\$1.50) = \frac{1.50}{(1.005)^1} = \frac{1.50}{1.005} \approx 1.4925$$

$$\text{Year 2: } PV (\$1.50) = \frac{1.50}{(1.005)^2} = \frac{1.50}{1.010025} \approx 1.4851$$

$$\text{Year 3: } PV (\$1.50) = \frac{1.50}{(1.005)^3} = \frac{1.50}{1.015075} \approx 1.4778$$

**Year 4 (including the face value of \$100):**

$$PV(\$101.50) = \frac{101.50}{(1.005)^4} = \frac{101.50}{1.0202} = 99.49$$

**Step 3:** Calculate the total present value of all cash flows (which should approximate the bond price).

$$\begin{aligned}\text{Bond Price} &\approx 1.4925 + 1.4851 + 1.4778 + 99.4951 \\ &\approx 103.9505\end{aligned}$$

**Step 4:** Calculate the numerator of the Macaulay duration:

$$\begin{aligned}\text{Numerator} &= \sum_{i=1}^N \frac{t \times CF_t}{(1+r)^t} = \frac{1 \times 1.50}{1.005} + \frac{2 \times 1.50}{1.010} + \frac{3 \times 1.50}{1.015} + \frac{4 \times 101.50}{1.0201} \\ &= 1 \times 1.4925 + 2 \times 1.4851 + 3 \times 1.4778 + 4 \times 99.4951 \\ &\approx \$406.8765\end{aligned}$$

**Step 5:** Calculate the denominator of the Macaulay duration:

$$\begin{aligned}\text{Denominator} &= \sum_{i=1}^N \frac{CF_t}{(1+r)^t} = 1.4925 + 1.4851 + 1.4778 + 99.4951 \\ &\approx 103.9505\end{aligned}$$

**Step 6:** Calculate the Macaulay duration:

$$\text{MacDur} = \frac{406.8765}{103.9505} \approx 3.91 \text{ years}$$

**CFA Level I, Fixed Income, Learning Module 10: Interest Rate Risk and Return. LOS (b): describe the relationships among a bond's holding period return, its Macaulay duration, and the investment horizon; LOS (c): define, calculate, and interpret Macaulay duration.**

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Q.4879 Greenwood Corporation issued a bond with three years remaining to maturity, a coupon of 2% paid annually, and a yield-to-maturity of 1%. Assume it is 60 days into the first coupon period on a 30/360 basis. The bond's annualized Macaulay duration is closest to:

- A. 3.7421.

B. 3.7197.

C. 3.9337.

The correct answer is **B**.

First, let's determine the time to receipt for each cash flow:

$$\text{Time to first coupon} = \frac{360 - 60}{360} = \frac{300}{360} = 0.8333 \text{ years}$$

The subsequent coupon payments will be:

$$\text{Time to second coupon} = 1 + 0.8333 = 1.8333 \text{ years}$$

$$\text{Time to third coupon} = 2 + 0.8333 = 2.8333 \text{ years}$$

$$\text{Time to final payment} = 3 + 0.8333 = 3.8333 \text{ years}$$

Secondly, let's calculate the Present Value of each Cash flow. Given the yield-to-maturity (YTM) of 1% (0.01 as a decimal):

$$PV(\$2.00)_{t=0.8333} = \frac{2.00}{(1 + 0.01)^{0.8333}} = 1.9835$$

$$PV(\$2.00)_{t=1.8333} = \frac{2.00}{(1 + 0.01)^{1.8333}} = 1.9638$$

$$PV(\$2.00)_{t=2.8333} = \frac{2.00}{(1 + 0.01)^{2.8333}} = 1.9444$$

$$PV(\$102.00)_{t=3.8333} = \frac{102.00}{(1 + 0.01)^{3.8333}} = 98.1827$$

Therefore, the total present value of Cash Flows (Bond Price):

$$\text{Bond Price (PV)} \approx 1.9835 + 1.9638 + 1.9444 + 98.1827 = \$104.0744$$

Next, calculate the numerator of the Macaulay duration:

$$\begin{aligned}\text{Numerator} &= \sum_{i=1}^4 \frac{t \times CF_t}{(1 + r)^t} \\ &= (0.8333 \times 1.9835) + (1.8333 \times 1.9638) + (2.8333 \times 1.9444) + (3.8333 \times 98.1827) \\ &= \$387.1259\end{aligned}$$

The denominator of Macaulay duration is equal to the total present value of cash flows, which is equal to \$104.0744.

Therefore,

$$\text{Macaulay Duration} = \frac{387.1259}{104.0744} \approx 3.7197 \text{ years}$$

**CFA Level I, Fixed Income, Learning Module 10: Interest Rate Risk and Return. LOS (b): describe the relationships among a bond's holding period return, its Macaulay duration, and the investment horizon; LOS (c): define, calculate, and interpret Macaulay duration.**

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Q.4880 An investor purchases a bond with five years remaining until maturity, a 2% coupon paid semiannually, and a yield-to-maturity of 1.5%. The investor plans to hold the bond for four years. Regarding interest rate risk, what is the investor's primary concern?

- A. The bond's price declines if interest rates increase.
- B. The bond's price rises if interest rates decrease.
- C. Interest rate changes have a negligible effect on the bond's value.

The correct answer is **A**.

The investor is primarily concerned that the bond's price will decline if interest rates increase. The investor is exposed to price risk since the investment horizon (4 years) is shorter than the bond's maturity (5 years). An increase in interest rates would cause the bond's price to fall, negatively impacting the investor who plans to sell the bond before maturity.

**B is incorrect:** While a decrease in interest rates would cause the bond's price to rise, this scenario benefits the investor rather than posing a risk.

**C is incorrect:** Changes in interest rates will have a significant effect on the bond's value due to the mismatch between the investment horizon and the bond's maturity, so the concern is not negligible.

**CFA Level I, Fixed Income, Learning Module 10: Interest Rate Risk and Return. LOS (a): calculate and interpret the sources of return from investing in a fixed-rate bond.**

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Q.4881 Bright Future Investments purchases a 12-year, 5.5% annual coupon bond with an investment horizon of 6 years. The Macaulay duration of the bond is 8.75 years. The duration gap at the time of purchase is *closest to*:

- A. 2.75
- B. 5.25
- C. 6.75

The correct answer is **A**.

The duration gap is calculated as the difference between the Macaulay duration of the bond and the investor's investment horizon.  $\text{Duration Gap} = \text{Macaulay Duration} - \text{Investment Horizon}$  Given:

- Macaulay Duration = 8.75 years
- Investment Horizon = 6 years

$$\text{Duration Gap} = 8.75 \text{ years} - 6 \text{ years} = 2.75 \text{ years}$$

**CFA Level I, Fixed Income, Learning Module 10: Interest Rate Risk and Return. LOS (b): describe the relationships among a bond's holding period return, its Macaulay duration, and the investment horizon.**

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Q.4882 Which of the following *best* describes the impact of interest rate changes on reinvestment income and bond prices?

- A. An increase in interest rates will lead to higher reinvestment income but lower bond prices if sold prior to maturity.
- B. A decrease in interest rates will result in lower reinvestment income and lower bond prices if sold prior to maturity.
- C. An increase in interest rates will have no impact on reinvestment income but will lead to higher bond prices if sold prior to maturity.

The correct answer is **A**.

When interest rates increase, the reinvestment of coupon payments can be done at higher rates, leading to higher reinvestment income. However, the market price of existing fixed-rate bonds will decrease because new bonds are issued with higher coupon rates, making the existing bonds less attractive.

**B is incorrect.** A decrease in interest rates indeed results in lower reinvestment income. However, it incorrectly suggests that bond prices will decrease, whereas bond prices actually increase when interest rates fall, as existing bonds with higher coupon rates become more attractive.

**C is incorrect.** An increase in interest rates does impact reinvestment income, typically increasing it. Additionally, higher interest rates result in lower bond prices, not higher.

**CFA Level I, Fixed Income, Learning Module 10: Interest Rate Risk and Return. LOS (a): calculate and interpret the sources of return from investing in a fixed-rate bond.**

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Q.4883 A pension fund purchases a four-year, 4.5% annual coupon corporate bond priced at par for settlement on 1 January 2025. The bond matures on 1 January 2029. Immediately after the purchase of the bond, interest rates rise to 5.2%. The pension fund sells the bond after two years. The pension fund's total annualized return on the investment was *closest to*:

- A. 3.89%
- B. 4.50%
- C. 5.20%

The correct answer is **A**.

**Step 1:** Let's calculate the bond's price after two years using the formula:

$$\text{Bond Price} = \sum_{t=1}^n \left( \frac{C}{(1+r)^t} \right) + \frac{F}{(1+r)^n}$$

Where:

C = annual coupon payment (4.5% of par value, which is 4.5) F = par value of the bond (100) r = new yield to maturity (5.2% or 0.052) n = number of remaining years (2)

Therefore,

$$\text{Bond Price} = \frac{4.5}{(1+0.052)^1} + \frac{4.5}{(1+0.052)^2} + \frac{100}{(1+0.052)^2} = \$98.7021$$

**Step 2:** We'll then calculate the Future Values of the Coupons.

The future value (FV) of each coupon payment, including reinvestment, is calculated using the formula:

$$FV = PV \times (1+r)^n$$

Therefore,

$$FV = (4.5 \times (1+0.052)^1) + 4.5 \approx \$9.234$$

Thus, the total proceeds is  $98.7021 + 9.234 \approx \$107.9361$ .

**Step 3:** Let's now calculate the annualized return given by the formula:

$$r = \left( \frac{FV}{PV} \right)^{\frac{1}{T}} - 1$$

Where:

- FV = Total proceeds (\$107.9361)
- PV = Initial investment (100)
- T = Holding period in years (2 years)

Therefore,

$$r = \left( \frac{107.9361}{100} \right)^{\frac{1}{2}} - 1 \approx 0.038923 \approx 3.89\%$$

**CFA Level I, Fixed Income, Learning Module 10: Interest Rate Risk and Return. LOS (a): calculate and interpret the sources of return from investing in a fixed-rate bond.**

