

If Two Portfolios Have The Same Duration, The Change In Their Value When Interest Rates Change Will Be

Introduction

If two portfolios have the same duration, the change in their value when interest rates change will be approximately equal in magnitude, but the direction depends on whether interest rates rise or fall. This concept of duration is fundamental in bond and portfolio management, serving as a key measure of interest rate risk. Understanding how duration influences the sensitivity of portfolios to interest rate movements is crucial for investors and fund managers aiming to mitigate risk or capitalize on interest rate changes.

Understanding Duration: The Foundation of Interest Rate Risk

What Is Duration?

Duration is a measure of the sensitivity of a bond or a portfolio's price to changes in interest rates. It estimates how much the price of a bond will change in response to a 1% change in interest rates. The most common type is Macaulay duration, which is a weighted average time until cash flows are received. Modified duration adjusts Macaulay duration to directly relate to price sensitivity.

Why Is Duration Important?

- It provides a single figure that summarizes interest rate risk.
- It helps in immunizing portfolios against interest rate fluctuations.
- It allows investors to compare different bonds or portfolios on the basis of interest rate risk.

Equal Duration, Equal Sensitivity: The Relationship Between Two Portfolios

The Implication of Same Duration

When two portfolios have the same duration, they are equally sensitive to interest rate movements, assuming all other factors are constant. This means that a 1% increase in interest rates will cause approximately the same percentage decrease in the value of each portfolio, and vice versa.

Approximate Change in Portfolio Value

The change in value (ΔV) of a portfolio due to a change in interest rates (Δi) can be approximated as:

- $\Delta V \approx - (\text{Duration}) \times (\text{Portfolio Value}) \times \Delta i$

Because both portfolios have the same duration, the magnitude of the change will be similar, scaled by their respective portfolio values.

Factors Influencing the Change in Portfolio Values

Portfolio Size and Composition

- Larger portfolios will experience a greater absolute change in value, although the percentage change remains similar if durations are equal.
- The composition of the portfolios (e.g., bond types, maturities, coupon rates) affects their overall duration.

Interest Rate Changes (Δi)

- The magnitude of the interest rate change directly impacts the change in portfolio value.
- Small interest rate movements produce proportionally small changes, while larger shifts have more significant effects.

Convexity and Non-Linear Effects

While duration provides a linear approximation, actual bond prices exhibit convexity, meaning that the relationship between interest rate changes and price movements is slightly curved. For small interest rate changes, duration approximation is adequate, but for larger changes, convexity adjustments are necessary.

Scenario Analysis: What Happens When Interest Rates Change?

Interest Rates Rise

- Both portfolios with the same duration will decline in value approximately equally in percentage terms.
- The actual dollar decline depends on the initial values of the portfolios.

Interest Rates Fall

- Both portfolios will increase in value similarly, again proportionally to their sizes and the duration.

Illustrative Example

Suppose two portfolios, A and B, each valued at \$1,000,000 and both with a duration of 5 years.

- If interest rates increase by 1% ($\Delta i = 0.01$), the approximate change in each portfolio's value is:

$$\Delta V \approx -5 \times \$1,000,000 \times 0.01 = -\$50,000$$

- Conversely, if interest rates decrease by 1%, the portfolios' values increase by approximately \$50,000.

This example highlights that the percentage change is about 5%, consistent for both portfolios due to identical durations.

Limitations of Duration as a Risk Measure

Assumption of Small Rate Changes

Duration provides an accurate approximation only for small interest rate movements (typically less than 100 basis points). Larger changes introduce non-linear effects that duration does not capture.

Ignoring Convexity

The convexity of bonds causes the actual price change to be slightly greater than predicted by duration when interest rates fall, and slightly less when rates rise. Incorporating convexity leads to

more accurate estimations.

Impact of Other Risk Factors

- Credit risk, liquidity risk, and changes in spread can also affect portfolio values independently of interest rate movements.
- Duration only measures interest rate sensitivity, assuming all else remains constant.

Practical Implications for Portfolio Management

Hedging Interest Rate Risk

- Portfolios with the same duration can be hedged against interest rate changes by using interest rate derivatives such as interest rate swaps or futures.
- Maintaining equal durations across portfolios can simplify risk management strategies.

Constructing Immunized Portfolios

- Investors aim to match the duration of assets and liabilities to immunize against interest rate fluctuations.
- When portfolios share the same duration, they tend to react similarly to interest rate shifts, aiding in risk mitigation.

Balancing Risk and Return

- While matching durations reduces interest rate risk, it may also limit potential returns.
- Portfolio managers must consider the trade-off between risk exposure and yield objectives.

Conclusion

In summary, when two portfolios have the same duration, their values will respond similarly to changes in interest rates, with the approximate magnitude of change proportional to their initial values and the size of interest rate shifts. Understanding the concept of duration allows investors to gauge and manage interest rate risk effectively. However, it is essential to recognize the limitations of duration as a linear approximation and incorporate convexity and other factors for more precise risk assessment. Proper application of these principles enables better portfolio construction, hedging, and risk management strategies in a fluctuating interest rate environment.

Frequently Asked Questions

If two portfolios have the same duration, how will their values change when interest rates increase?

Both portfolios will experience a similar percentage decline in value when interest rates rise, since their durations are equal, indicating comparable sensitivity to interest rate changes.

Does having the same duration guarantee identical price changes for two different portfolios?

No, while their price sensitivities to interest rate changes are similar, differences in their convexity or cash flow structures can lead to differing actual price changes.

How does equal duration influence the interest rate risk of two portfolios?

Equal duration implies both portfolios have the same level of interest rate risk, meaning their values will respond similarly to interest rate fluctuations.

If interest rates decrease, what is the expected change in value for two portfolios with the same duration?

Both portfolios are expected to increase in value by approximately the same percentage, proportional to their common duration, assuming other factors remain constant.

Can two portfolios with the same duration have different convexities, and how does this affect their value changes?

Yes, they can have different convexities; higher convexity portfolios will experience more favorable price increases when interest rates decline and less severe declines when rates rise.

Is duration alone sufficient to predict the exact change in portfolio value when interest rates change?

No, duration provides a linear approximation; actual changes also depend on convexity and other factors influencing bond price sensitivity.

In a rising interest rate environment, how do portfolios with the same duration compare in terms of risk?

They carry similar interest rate risk, meaning their values will decline similarly, though other factors like credit quality and cash flow structure can influence the exact impact.

Why is it important to consider both duration and convexity when assessing interest rate risk?

Because duration estimates the linear price change, while convexity accounts for curvature in the price-yield relationship, providing a more accurate measure of potential value changes.

Additional Resources

Interest Rate Sensitivity

Introduction

In the world of fixed income investing, understanding how changes in interest rates impact bond portfolios is fundamental for both individual investors and institutional fund managers. A key concept that aids this understanding is duration, a measure that indicates the sensitivity of a bond or portfolio's value to interest rate fluctuations. When two portfolios possess the same duration, a common question arises: how will their values change when interest rates change?

This article delves into this question, exploring the mechanics of duration, how it relates to portfolio valuation, and the factors that influence the degree of change in value when interest rates shift. We'll analyze the theoretical underpinnings, practical implications, and nuances that investors should consider when managing portfolios with similar durations.

Understanding Duration: The Fundamental Concept

What Is Duration?

Duration, in its simplest form, measures the approximate percentage change in a bond's price for a 1% change in interest rates. It is expressed in years and can be thought of as the weighted average time until cash flows are received.

Types of Duration:

- Macaulay Duration: The weighted average time until cash flows are received, calculated based on present values.
- Modified Duration: Derived from Macaulay Duration, it directly estimates the percentage change in price for a given change in yield.
- Effective Duration: Used for bonds with embedded options, considering changes in cash flows due to interest rate shifts.

For most practical purposes, Modified Duration is the primary measure used to estimate price sensitivity to interest rate changes.

Why Is Duration Important?

Duration provides a single, quantifiable measure of interest rate risk. It allows investors to:

- Estimate Price Changes: For small interest rate shifts, the change in bond or portfolio value can be approximated by multiplying the duration by the change in interest rates.
- Compare Risk Profiles: Portfolios with higher durations are more sensitive to rate changes.
- Implement Risk Management Strategies: Adjusting durations helps in hedging against anticipated rate movements.

The Relationship Between Duration and Portfolio Value Changes

The Duration Approximation Formula

The core relationship is expressed via the following approximation:

$$\frac{\Delta P}{P} \approx -D_{\text{mod}} \times \Delta y$$

Where:

- $\frac{\Delta P}{P}$ = Percentage change in the portfolio's value
- D_{mod} = Modified duration of the portfolio
- Δy = Change in yield (interest rate), expressed in decimal form

This indicates that, for small interest rate changes, two portfolios with the same duration will experience approximately the same percentage change in value when interest rates change by the same amount.

Key Assumptions Behind the Approximation

- Small Rate Changes: The linear approximation holds best for minor shifts (e.g., up to 100 basis points).
- Parallel Shift in Yield Curve: The model assumes that interest rates for all maturities change uniformly.
- Constant Duration: It assumes the duration remains unchanged, which may not hold for larger rate movements or over longer periods.

When Two Portfolios Have the Same Duration

Theoretical Implication

If Portfolio A and Portfolio B both have an identical duration, then:

- A 1% increase in interest rates results in roughly the same percentage decrease in the value of both portfolios.
- A 1% decrease in interest rates results in a similar percentage increase in their values.

In essence, the change in their values is primarily dictated by their common duration, assuming all else remains equal.

Practical Considerations

While the theory suggests equivalence in sensitivity, several factors can cause actual results to differ:

- Convexity: This is a measure of how the duration changes as interest rates change. Portfolios with higher convexity tend to experience more favorable price increases when rates fall and less severe declines when rates rise.
- Cash Flow Timing: The distribution and timing of cash flows influence how a portfolio responds to interest rate shifts.
- Embedded Options: Bonds with options (callable, putable) have altered sensitivities, affecting effective duration.
- Yield Curve Shape: Non-parallel shifts mean different parts of the portfolio may be affected differently.

Factors Influencing the Change in Portfolio Value Beyond Duration

1. Convexity

While duration provides a linear approximation, convexity captures the curvature of the price-yield relationship. Portfolios with higher convexity benefit more from declining interest rates because their prices increase at an increasing rate as yields fall.

Implication: Two portfolios with the same duration but different convexities will not experience identical percentage changes if interest rates change significantly.

2. Cash Flow Structure and Maturity Distribution

Portfolios with different maturity profiles respond differently:

- Longer-term bonds tend to have higher durations and convexities, making them more sensitive.
- Shorter-term bonds are less sensitive and have lower convexity.

Example:

Portfolio	Average Maturity	Duration	Convexity
A	5 years	5	20
B	5 years	5	15

Despite equal durations, Portfolio A's higher convexity means it will generally perform better in a declining rate environment than Portfolio B.

3. Embedded Options and Call Features

Callable bonds or portfolios with callable components tend to have lower effective durations because the issuer may call the bond if interest rates fall, capping upside gains.

Impact: Portfolios with embedded options might not respond linearly to interest rate changes, making the simple duration approximation less accurate.

4. Market Conditions and Yield Curve Movements

The assumption of parallel shifts is often unrealistic. Changes in interest rates may be:

- Non-parallel: Different maturities shift differently.
- Steepening or flattening: Affect different parts of the yield curve differently.

Such shifts mean portfolios with similar durations could still experience divergent changes in value depending on their cash flow profiles.

Practical Example: Comparing Two Portfolios with Equal Duration

Suppose we have:

- Portfolio A: A bond fund with a duration of 7 years.
- Portfolio B: Another bond fund with the same duration of 7 years.

If interest rates increase by 0.50% (50 basis points):

$$\Delta P / P \approx -D_{\text{mod}} \times \Delta y = -7 \times 0.005 = -0.035$$

This indicates:

- Portfolio A: Approximately 3.5% decrease in value.
- Portfolio B: Approximately 3.5% decrease in value.

Similarly, a decrease of 0.50% in interest rates would result in roughly a 3.5% increase in both portfolios' values.

Note: These are approximate estimates; actual outcomes may vary slightly due to convexity, cash flow timing, and market conditions.

Limitations and Nuances

While the principle that portfolios with the same duration respond similarly to interest rate changes is foundational, it's crucial to recognize its limitations:

- Large Rate Changes: The linear approximation becomes less accurate with significant interest rate shifts.
- Non-parallel Shifts: Changes in the yield curve can cause different responses.
- Changing Market Conditions: Duration is a snapshot measure; market dynamics can alter sensitivities over time.

- Portfolio Composition: Variations in credit quality, sector, and embedded options influence actual sensitivities.

Strategic Implications for Investors

Risk Management

Investors aiming to hedge interest rate risk should focus on matching durations across portfolios. If two portfolios have the same duration, they can be expected to experience similar percentage changes in value for small, parallel interest rate shifts.

Portfolio Construction

- Use duration matching to control interest rate exposure.
- Incorporate convexity considerations for better risk-adjusted performance.
- Diversify across maturities and sectors to mitigate non-parallel shift risks.

Monitoring and Adjustment

- Continuously monitor effective durations as market conditions evolve.
- Adjust portfolio durations based on interest rate outlooks and risk appetite.

Conclusion

In summary, when two portfolios have the same duration, their percentage change in value when interest rates change—assuming small, parallel shifts—will be approximately equal. This fundamental principle underscores the importance of duration as a core risk management tool in fixed income investing.

However, it's essential to recognize that real-world complexities—such as convexity, embedded options, maturity profiles, and yield curve shape—can cause actual outcomes to deviate from simple estimates. Skilled investors and portfolio managers account for these factors, employing a comprehensive approach that goes beyond duration alone.

By understanding the mechanics and limitations of duration, investors can better anticipate how their portfolios will respond to interest rate movements and implement strategies to optimize returns while managing risk effectively.

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