

SESSION 15

46. Fixed-Income Securities

47. Fixed-Income Markets

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46. Fixed-Income Risk and Return

47. Fundamentals of Credit Analysis

1. Sources of Return

2. Duration

3. Convexity

4. Interest Rate Risk

Duration

Duration

- The sensitivity of bond's full price to changes in the bond's YTM or in benchmark interest rates.
 - ✓ Assuming that variables other than YTM or benchmark rates are held constant.
 - ✓ Measures the instantaneous change in bond price when YTM or benchmark rates change.

Duration

Duration

- **Yield duration:** sensitivity of bond price to the bond's own YTM.
 - ✓ Macaulay duration , modified duration, money duration, price value of a basis point (PVBP).
- **Curve duration:** sensitivity of bond price to a benchmark yield curve.
 - ✓ In practice, the government par curve is often used.
 - ✓ Effective duration is a curve duration statistic.

Duration

Yield duration

- **Macaulay duration:** weighted average time to receipt of the bond's promised payments, where the weights are the shares of the full price that correspond to each of the bond's promised future payments.

$$\text{MacDur} = \frac{\sum_{t=1}^n t \times \text{PVCF}_t}{\sum \text{PVCF}_t}$$

- ✓ MacDur is measured in terms of time periods.
- ✓ For perpetuity bond, $\text{MacDur} = (1 + r)/r$.

Duration

Yield duration (Cont.)

- **Modified duration:** requires a simple adjustment to Macaulay duration.

$$\text{ModDur} = \frac{\text{MacDur}}{1 + r}$$

- ✓ r: yield per **period**.
- Modified duration provides an **linear** estimate of the percentage price change for a bond given a change in its YTM.

$$\% \Delta \text{Price} \approx -\text{ModDur} \times \Delta \text{Yield}$$

Duration

Example:

- If the annual yield on a 6% semiannual coupon payment bond that matures on 14 February 2022 jumps by 100 bps, from 6.00% to 7.00%, and the bond's modified duration is 6.12, what should be the bond's percentage price change?

➤ **Answer:**

$$\% \Delta P \approx -6.12 \times 0.01 = -0.0612 = -6.12\%$$

Duration

Yield duration (Cont.)

- **Approximate modified duration:** an alternative approach to calculate modified duration.

$$\text{ApproxModDur} = \frac{P_- - P_+}{2 \times (\Delta \text{Yield}) \times P_0}$$

- **Approximate Macaulay duration**

$$\text{ApproxMacDur} = \text{ApproxModDur} \times (1 + r)$$

Yield duration (Cont.)

- **Money duration/dollar duration:** a measure of the price change **in units of currency** given a change in its YTM.
- ✓ $\text{MoneyDur} = \text{ModDur} \times \text{Price (full)}$
 - MoneyDur per 100 units of par value = $\text{ModDur} \times \text{Price (full)}$ of bond per 100 of par value.

Yield duration (Cont.)

➤ $\Delta P^{\text{Full}} \approx -\text{MoneyDur} \times \Delta \text{Yield}$

- ✓ **Price value of a basis point (PVBP, DV01):** the money change in full price of a bond when its YTM changes by one basis point (0.01%).

$$\text{PVBP} = \frac{P_- - P_+}{2}$$

- ✓ P_- and P_+ are the full prices calculated by decreasing and increasing the YTM by 1 basis point.

Example:

- Suppose a 10-year, 8% annual-pay straight bond priced at 105. Calculate the PVBP if it has a par value of 10,000.
- ✓ Step 1: $N=10$, $PV=-105$, $PMT=8$, $FV=100$; CPT: $I/Y=7.28$
- ✓ Step 2: calculate bond price with YTM of 7.27 and 7.29
 - $N=10$, $PMT=800$, $FV=10,000$, $I/Y=7.27$, CPT: $PV=-10506.3$
 - $N=10$, $PMT=800$, $FV=10,000$, $I/Y=7.29$, CPT: $PV=-10492.1$
- ✓ Step 3: $PVBP=(10506.3-10492.1)/2=7.1$

Duration

Curve duration

- Effective duration: the sensitivity of bond's price to a change in a benchmark yield curve.

$$\text{EffDur} = \frac{P_- - P_+}{2 \times (\Delta\text{Curve}) \times P_0}$$

- ✓ Measures interest rate risk in terms of a **parallel shift** in the benchmark yield curve (ΔCurve).
- ✓ Used for bonds with **embedded option due to uncertain future cash flow and absence of well-defined IRR (YTM)**.

Duration

Example:

- Suppose a callable bond is priced at 101.060489, and when the government par curve is raised and lowered by 25 bps, the new full prices for the callable bond are 99.05012 and 102.890738, respectively. Calculate the effective duration of the callable bond.

➤ **Answer:**

$$\text{Effective duration} = (102.890738 - 99.05012) / (2 \times 0.0025 \times 101.060489) = 7.6006$$

Key rate duration/partial duration

- A measure of a bond's sensitivity to a change in the benchmark yield curve at a specific maturity segment.
- ✓ Useful to identify "**shaping risk**" for a bond (e.g., the yield curve becoming steeper or flatter).
- ✓ Useful to measure bond's sensitivity to **nonparallel shift** of the benchmark yield curve.

Summary of duration application:

➤ Yield duration (Price sensitivity to YTM)

- ✓ Uncertain future cash flow
- ✓ No well-defined IRR (YTM)

- ✓ Macaulay duration
- ✓ Modified duration
- ✓ Money duration
 - PVBP (DV01)

➤ Curve duration (Price sensitivity to benchmark yield curve)

- ✓ Non-parallel shift

- ✓ Effective duration

➤ Key rate duration (Sensitivity to yield at specific maturity)