Vietnamese-German University

# Investments

## Finance 2 - BFIN

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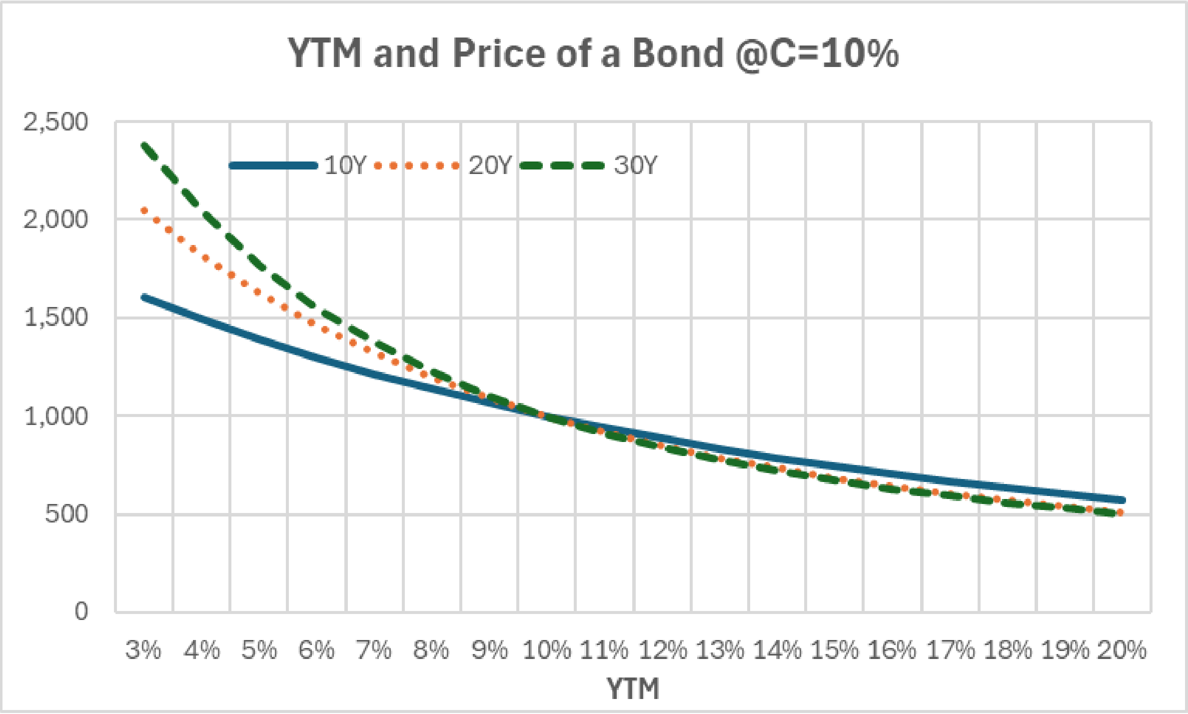
**Lecture 3**

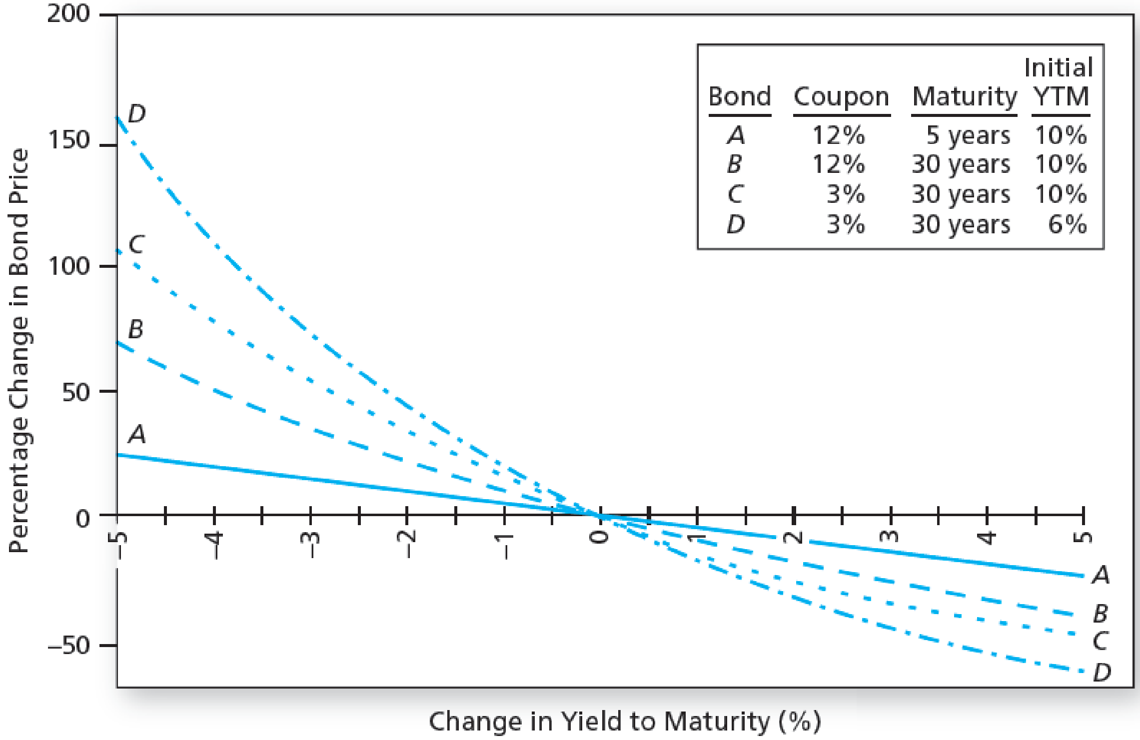
# Outline

- Fixed-Income Securities II
  - Managing Bond Portfolios
    - Interest rate risk
      - Interest rate sensitivity of bond prices
      - Duration and its determinants
    - Convexity
    - Passive and active management strategies

# Interest Rate Risk

- Bond prices and yields are inversely related
- An increase in a bond's yield to maturity causes smaller price change than a decrease of equal magnitude
- Long-term bonds tend to be more price sensitive than short-term bonds



# Interest Rate Risk

❖ Prices of 8% Coupon Bond (Coupons Paid Semiannually)

| Yield to Maturity (APR) | *T* = 1 Year | *T* = 10 Years | *T* = 20 Years |
| --- | --- | --- | --- |
| 8% | 1,000.00 | 1,000.00 | 1,000.00 |
| 9% | 990.64 | 934.96 | 907.99 |
| Fall in price (%)* | 0.94% | 6.50% | 9.20% |

*Equals value of bond at a 9% yield to maturity divided by value of bond at (the original) 8% yield, minus 1.

❖ Prices of Zero-Coupon Bond(Semiannual Compounding)

| Yield to Maturity (APR) | *T* = 1 Year | *T* = 10 Years | *T* = 20 Years |
| --- | --- | --- | --- |
| 8% | 924.56 | 456.39 | 208.29 |
| 9% | 915.73 | 414.64 | 171.93 |
| Fall in price (%)* | 0.96% | 9.15% | 17.46% |

*Equals value of bond at a 9% yield to maturity divided by value of bond at (the original) 8% yield, minus 1.

# Interest Rate Risk

- Duration
  - A measure of the effective maturity of a bond
  - The weighted average of the times until each payment is received
  - The weights are proportional to the present value of the payment
    - ✓ Duration = Maturity for zero coupon bonds
    - ✓ Duration < Maturity for coupon bonds

$$D = \sum_{t=1}^{T} t \times w_t$$

$$w_t = \frac{CF_t \big/ ((1+y))^t}{P}$$

$CF_t$ : Cash flow at time $t$
$P$ : Price of the bond
$y$ : Yield to maturity

- Duration is a key concept in fixed-income portfolio management.
  - A simple summary statistic of the effective average maturity of the portfolio.
  - An essential tool in immunizing portfolios from interest rate risk.
  - A measure of the interest rate sensitivity of a portfolio.

# Interest Rate Risk

- Duration-Price Relationship
  - Price change is proportional to duration.
  - The percentage change in bond price is the product of modified duration and the change in the bond's yield to maturity.

$$\frac{\Delta P}{P} = -D \times \left[\frac{\Delta(1+y)}{1+y}\right]$$

$$\frac{\Delta P}{P} = -D_M \, \Delta y$$

$$D_M = \frac{D}{(1+y)}$$

$D_M$ : Modified duration

**12% annual coupon, 5y bond**

| t | PV(CF) | $w_t$ | $t^*w_t$ |
|---|---|---|---|
| 0.0 | | | |
| 1.0 | 1,071.43 | 0.11 | 0.1071 |
| 2.0 | 956.63 | 0.10 | 0.1913 |
| 3.0 | 854.14 | 0.09 | 0.2562 |
| 4.0 | 762.62 | 0.08 | 0.3050 |
| 5.0 | 6,355.18 | 0.64 | 3.1776 |
| Price | 10,000.00 | 1.00 | |
| | | D | 4.0373 |
| | | $D_M$ | 3.6048 |

| t | PV(CF) | $w_t$ | $t^*w_t$ |
|---|---|---|---|
| 0.0 | | | |
| 0.5 | 566.04 | 0.06 | 0.0283 |
| 1.0 | 534.00 | 0.05 | 0.0534 |
| 1.5 | 503.77 | 0.05 | 0.0756 |
| 2.0 | 475.26 | 0.05 | 0.0951 |
| 2.5 | 448.35 | 0.04 | 0.1121 |
| 3.0 | 422.98 | 0.04 | 0.1269 |
| 3.5 | 399.03 | 0.04 | 0.1397 |
| 4.0 | 376.45 | 0.04 | 0.1506 |
| 4.5 | 355.14 | 0.04 | 0.1598 |
| 5.0 | 5,918.98 | 0.59 | 2.9595 |
| Price | 10,000.00 | 1.00 | |
| | | D | 3.9008 |
| | | $D_M$ | 3.6800 |

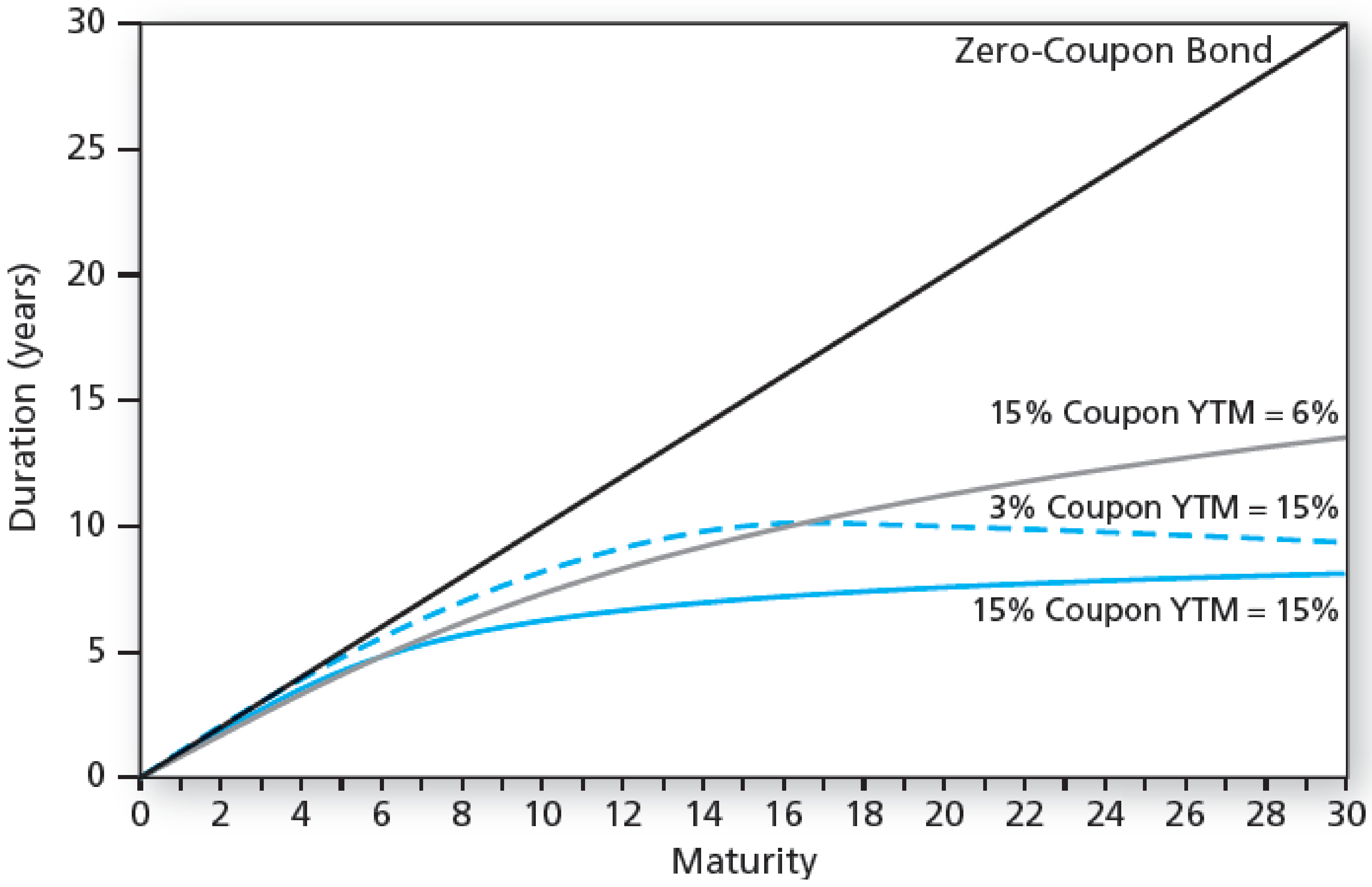
# Interest Rate Risk

- Rule 1: The duration of a zero-coupon bond equals its time to maturity.
- Rule 2: Holding maturity constant, a bond's duration is higher when the coupon rate is lower.
- Rule 3: Holding the coupon rate constant, a bond's duration generally increases with its time to maturity.
- Rule 4: Holding other factors constant, the duration of a coupon bond is higher when the bond's yield to maturity is lower.
- Rule 5: The duration of a level perpetuity is equal to: $\frac{1+y}{y}$

| | Coupon Rates (per Year) | | | | |
|---|---|---|---|---|---|
| Maturity (years) | 2% | 4% | 6% | 8% | 10% |
| 1 | 0.995 | 0.990 | 0.985 | 0.981 | 0.976 |
| 5 | 4.742 | 4.533 | 4.361 | 4.218 | 4.095 |
| 10 | 8.762 | 7.986 | 7.454 | 7.067 | 6.772 |
| 20 | 14.026 | 11.966 | 10.922 | 10.292 | 9.870 |
| Infinite (perpetuity) | 13.000 | 13.000 | 13.000 | 13.000 | 13.000 |

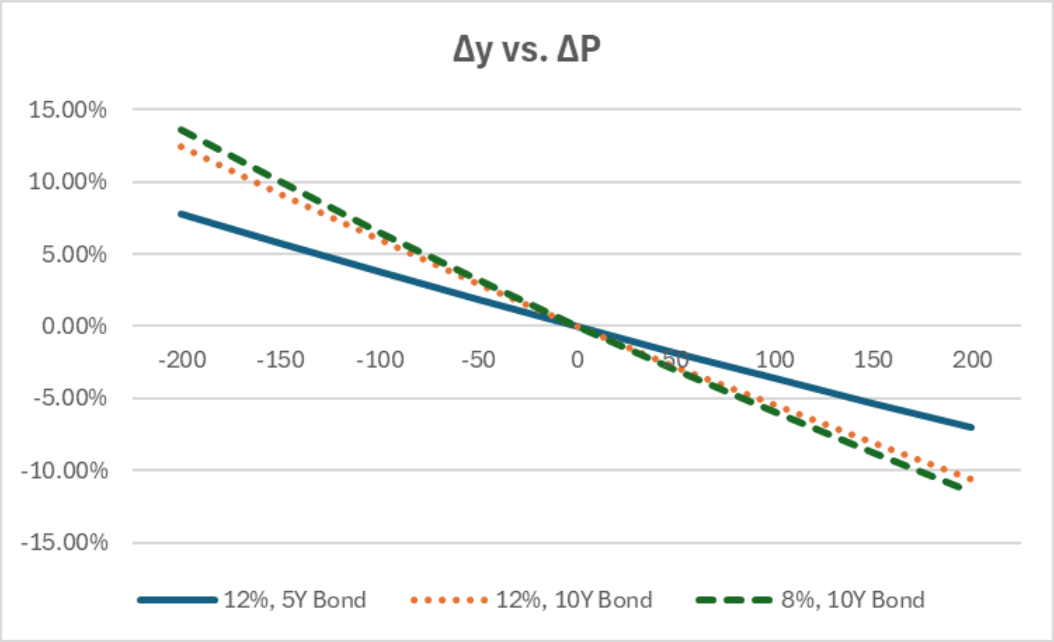
**Bond durations**
(YTM = 8% BEY; semiannual coupons)

# Interest Rate Risk

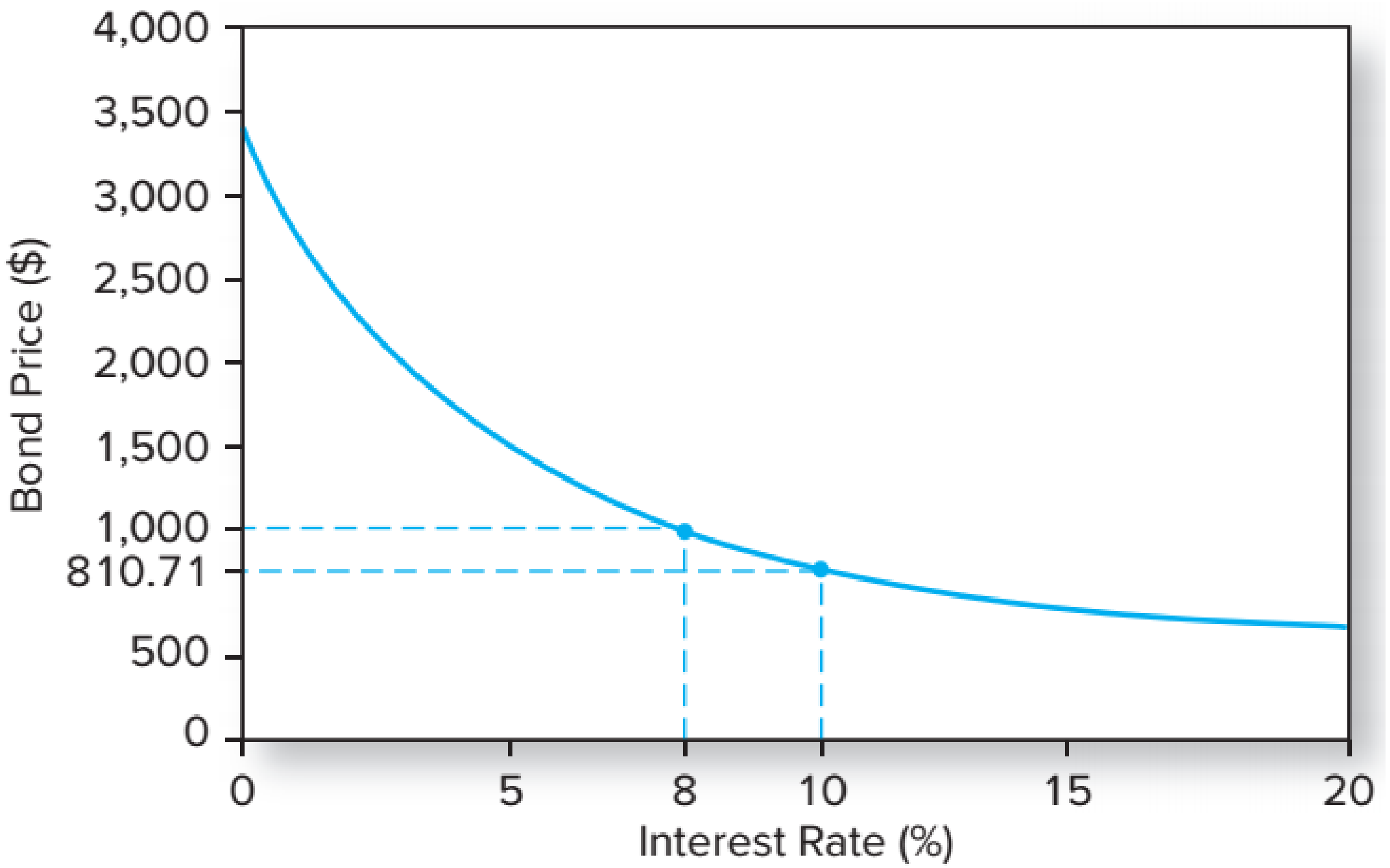


# Interest Rate Risk

| | | 12%, 5Y Bond | | | | 12%, 10Y Bond | | | | 8%, 10Y Bond | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| y' | Δy | P' | Δ Price | D | $D_M$ | P' | Δ Price | D | $D_M$ | P' | Δ Price | D | $D_M$ |
| 10.00% | -200 | 10,772.17 | 7.72% | 3.95 | 3.76 | 11,246.22 | 12.46% | 6.31 | 6.01 | 8,753.78 | 13.60% | 6.84 | 6.51 |
| 10.50% | -150 | 10,572.16 | 5.72% | 3.93 | 3.74 | 10,915.17 | 9.15% | 6.25 | 5.94 | 8,474.72 | 9.98% | 6.78 | 6.44 |
| 11.00% | -100 | 10,376.88 | 3.77% | 3.92 | 3.72 | 10,597.52 | 5.98% | 6.20 | 5.87 | 8,207.44 | 6.51% | 6.72 | 6.37 |
| 11.50% | -50 | 10,186.20 | 1.86% | 3.91 | 3.70 | 10,292.66 | 2.93% | 6.14 | 5.80 | 7,951.38 | 3.18% | 6.67 | 6.30 |
| 12.00% | 0 | 10,000.00 | 0.00% | 3.90 | 3.68 | 10,000.00 | 0.00% | 6.08 | 5.73 | 7,706.02 | 0.00% | 6.61 | 6.23 |
| 12.50% | 50 | 9,818.16 | -1.82% | 3.89 | 3.66 | 9,718.98 | -2.81% | 6.02 | 5.67 | 7,470.84 | -3.05% | 6.55 | 6.16 |
| 13.00% | 100 | 9,640.56 | -3.59% | 3.88 | 3.64 | 9,449.07 | -5.51% | 5.96 | 5.60 | 7,245.37 | -5.98% | 6.49 | 6.09 |
| 13.50% | 150 | 9,467.09 | -5.33% | 3.87 | 3.62 | 9,189.77 | -8.10% | 5.90 | 5.53 | 7,029.17 | -8.78% | 6.43 | 6.02 |
| 14.00% | 200 | 9,297.64 | -7.02% | 3.85 | 3.60 | 8,940.60 | -10.59% | 5.85 | 5.46 | 6,821.80 | -11.47% | 6.37 | 5.95 |



# Interest Rate Risk




- Modified duration is proportional to the derivative of the bond's price with respect to changes in the bond's yield.
- For small changes in yield,

$$D_M = -\frac{1}{P}\frac{dP}{dy}$$

$$P = \sum_{t=1}^{T} \frac{CF_t}{(1+y)^t}$$

$$Money\ Duration = D_M * (-P) = \frac{dP}{dy}$$

- Money (dollar) duration is the negative of the first derivative of a bond's price with respect to its yield.
- The money duration of a portfolio is just the sum of the dollar duration of the various instruments in the portfolio.
- DV01 is the dollar value of a basis point.

# Interest Rate Risk

- A bond with a par value of €10,000, a maturity of 4 years, semiannual coupon payments, has a price of €9,326.72 and a yield to maturity of 8%.
  - What is the annual coupon rate?
  - What is the duration of the bond at the current price?
  - What is the modified duration?
  - Estimate the price of the bond given a 50 basis points decline in the YTM.
  - What is the actual price of the bond when the YTM declines to 7.5%?

$$€9{,}326.72 = \sum_{t=1}^{8} \frac{C_t}{(1+4\%)^t} + \frac{Par\ Value}{(1+4\%)^8}$$

$$C = €300$$

$$Annual\ coupon\ rate = \frac{€300 * 2}{€10{,}000} = 6\%$$

| t | PV(CF) | $w_t$ | $t^*w_t$ | PV(CF) | $w_t$ | $t^*w_t$ |
|---|---|---|---|---|---|---|
| 0.0 | | | | | | |
| 0.5 | 288.46 | 0.03 | 0.0155 | 289.16 | 0.03 | 0.0152 |
| 1.0 | 277.37 | 0.03 | 0.0297 | 278.71 | 0.03 | 0.0294 |
| 1.5 | 266.70 | 0.03 | 0.0429 | 268.63 | 0.03 | 0.0425 |
| 2.0 | 256.44 | 0.03 | 0.0550 | 258.92 | 0.03 | 0.0546 |
| 2.5 | 246.58 | 0.03 | 0.0661 | 249.56 | 0.03 | 0.0657 |
| 3.0 | 237.09 | 0.03 | 0.0763 | 240.54 | 0.03 | 0.0760 |
| 3.5 | 227.98 | 0.02 | 0.0856 | 231.85 | 0.02 | 0.0855 |
| 4.0 | 7,526.11 | 0.81 | 3.2278 | 7,672.42 | 0.81 | 3.2340 |
| | **9,326.73** | **1.00** | **3.60** | **9,489.79** | **1.00** | **3.60** |

$$D_M = \frac{D}{(1+y/2)} = \frac{3.60}{(1+0.04)} = 3.4615$$

$$\frac{\Delta P}{P} = -D_M\,\Delta y = -3.4615 * -0.5\% = 1.73\%$$

$$P' = \sum_{t=1}^{8} \frac{300}{(1+3.75\%)^t} + \frac{10{,}000}{(1+3.75\%)^8} = €9{,}489.79$$

$$\frac{\Delta P}{P} = \frac{9{,}489.79}{9{,}326.72} - 1 = 1.75\%$$

# Interest Rate Risk

- A bond with a par value of ₺10,000, a maturity of 7 years, coupon payments twice a year, an annual coupon of 10%, and a yield to maturity of 8%.
  - What is the current price of the bond?
  - What is the duration of the bond at the current price?
  - What is the modified duration?
  - Estimate the bond price given a 50 basis points increase in the YTM.
  - What is the actual price of the bond when the YTM increases to 8.5%?

| t | PV(CF) | $w_t$ | $t^*w_t$ | PV(CF) | $w_t$ | $t^*w_t$ |
|---|---|---|---|---|---|---|
| 0.0 | | | | | | |
| 0.5 | 480.77 | 0.04 | 0.0217 | 479.62 | 0.04 | 0.0222 |
| 1.0 | 462.28 | 0.04 | 0.0418 | 460.06 | 0.04 | 0.0427 |
| 1.5 | 444.50 | 0.04 | 0.0603 | 441.31 | 0.04 | 0.0614 |
| 2.0 | 427.40 | 0.04 | 0.0773 | 423.32 | 0.04 | 0.0785 |
| 2.5 | 410.96 | 0.04 | 0.0929 | 406.06 | 0.04 | 0.0942 |
| 3.0 | 395.16 | 0.04 | 0.1072 | 389.51 | 0.04 | 0.1084 |
| 3.5 | 379.96 | 0.03 | 0.1203 | 373.63 | 0.03 | 0.1213 |
| 4.0 | 365.35 | 0.03 | 0.1322 | 358.39 | 0.03 | 0.1330 |
| 4.5 | 351.29 | 0.03 | 0.1430 | 343.78 | 0.03 | 0.1435 |
| 5.0 | 337.78 | 0.03 | 0.1528 | 329.77 | 0.03 | 0.1530 |
| 5.5 | 324.79 | 0.03 | 0.1616 | 316.32 | 0.03 | 0.1614 |
| 6.0 | 312.30 | 0.03 | 0.1695 | 303.43 | 0.03 | 0.1689 |
| 6.5 | 300.29 | 0.03 | 0.1765 | 291.06 | 0.03 | 0.1755 |
| 7.0 | 6,063.49 | 0.55 | 3.8389 | 5,863.06 | 0.54 | 3.8074 |
| | **11,056.31** | **1.00** | **5.30** | **10,779.32** | **1.00** | **5.27** |

$$P_0 = \sum_{t=1}^{14} \frac{500}{(1+4\%)^t} + \frac{10,000}{(1+4\%)^{14}} \qquad P_0 = €11,056.30$$

$$D_M = \frac{D}{(1+y/2)} = \frac{5.30}{(1+0.04)} = 5.10$$

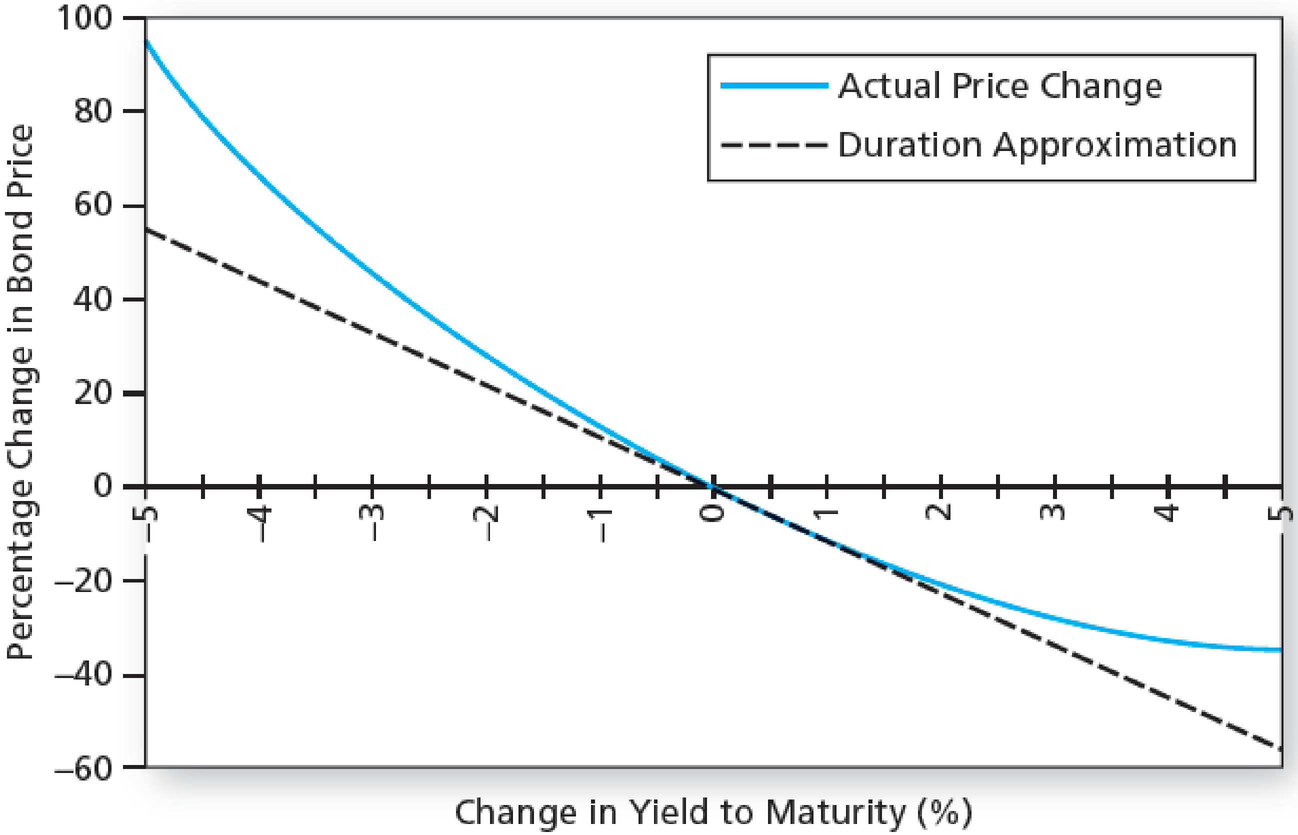
$$\frac{\Delta P}{P} = -D_M\,\Delta y = -5.10 * 0.5\% = -2.55\%$$

$$P' = \sum_{t=1}^{14} \frac{500}{(1+4.25\%)^t} + \frac{10,000}{(1+4.25\%)^{14}} = €10,779.30$$

$$\frac{\Delta P}{P} = \frac{10,779.30}{11,056.30} - 1 = -2.51\%$$

# Interest Rate Risk

- Convexity
  - Duration rule for the impact of interest rates on bond prices is only an approximation.
  - A good approximation for small changes in bond yield, but it is less accurate for larger changes.
  - Duration approximation always understates the value of the bond;
    - ✓ Underestimates the increase in bond price when the yield falls,
    - ✓ Overestimates the decline in price when the yield rises.
  - The curvature of the price-yield curve is called the convexity of the bond.
    - ✓ Convexity is measured as the rate of change of the slope of the price-yield curve, expressed as a fraction of the bond price.




$$Convexity = \frac{1}{P \times (1+y)^2} \sum_{t=1}^{T} \left[ \frac{CF_t}{(1+y)^t} (t^2 + t) \right]$$

$$\frac{\Delta P}{P} = -D_M * \Delta y + \frac{1}{2} [\text{Convexity} \times (\Delta y)^2]$$

# Interest Rate Risk

- A bond with a par value of €10,000, a maturity of 8 years, annual coupon payments, an annual coupon rate of 6%, and a yield to maturity of 8%.
  - Duration of the bond is 6.48. What is the modified duration?
  - Estimate the bond price given a 50 basis points decline in the YTM.
  - What is the actual price of the bond when the YTM declines to 7.5%?
  - What is the convexity of the bond at the current price?

$$Convexity = \frac{1}{P \times (1+y)^2} \sum_{t=1}^{T} \left[ \frac{CF_t}{(1+y)^t} (t^2 + t) \right]$$

$$P = \sum_{t=1}^{8} \frac{600}{(1+8.0\%)^t} + \frac{10{,}000}{(1+8.0\%)^8} = €8{,}850.67$$

$$D_M = \frac{D}{(1+y)} = \frac{6.48}{(1+0.08/1)} = 6.00$$

$$\frac{\Delta P}{P} = -D_M\, \Delta y = -6.00 * -0.5\% = 3.00\%$$

$$P' = \sum_{t=1}^{8} \frac{600}{(1+7.5\%)^t} + \frac{10{,}000}{(1+7.5\%)^8} = €9{,}121.40$$

$$\frac{\Delta P}{P} = \frac{9{,}121.40}{8{,}850.67} - 1 = 3.06\%$$

| t | PV(CF@8.0%) | $w_t$ | $t^*w_t$ | Convexity | PV(CF@7.5%) |
|---|---|---|---|---|---|
| 0.0 | | | | | |
| 1.0 | 555.56 | 0.06 | 0.0628 | 0.11 | 558.14 |
| 2.0 | 514.40 | 0.06 | 0.1162 | 0.30 | 519.20 |
| 3.0 | 476.30 | 0.05 | 0.1614 | 0.55 | 482.98 |
| 4.0 | 441.02 | 0.05 | 0.1993 | 0.85 | 449.28 |
| 5.0 | 408.35 | 0.05 | 0.2307 | 1.19 | 417.94 |
| 6.0 | 378.10 | 0.04 | 0.2563 | 1.54 | 388.78 |
| 7.0 | 350.09 | 0.04 | 0.2769 | 1.90 | 361.65 |
| 8.0 | 5,726.85 | 0.65 | 5.1764 | 39.94 | 5,943.44 |
| | **8,850.67** | **1.00** | **6.48** | **46.38** | **9,121.40** |
| | | **$D_M$** | **6.00** | | |

| | | |
|---|---|---|
| **Initial Price** | **8,850.67** | |
| **Duration Estimate** | **3.00%** | **9,116.20** |
| **Convexity Adjustment** | **0.06%** | **9,121.33** |

# Interest Rate Risk

- A bond with a par value of €10,000, a maturity of 8 years, semiannual coupon payments, an annual coupon rate of 6%, and a yield to maturity of 8%.
  - Estimate the bond price given a 50 basis points decline in the YTM.
  - What is the actual price of the bond when the YTM declines to 7.5%?

$$P = \sum_{t=1}^{16} \frac{300}{(1+4.0\%)^t} + \frac{10{,}000}{(1+4.0\%)^{16}} = €8{,}834.77$$

$$P' = \sum_{t=1}^{16} \frac{300}{(1+3.75\%)^t} + \frac{10{,}000}{(1+3.75\%)^{16}} = €9{,}109.74$$

$$\frac{\Delta P}{P} = \frac{9{,}109.74}{8{,}834.77} - 1 = 3.112\%$$

$$D_M = \frac{D}{(1+y)} = \frac{6.35}{(1+0.08/2)} = 6.11$$

$$\frac{\Delta P}{P} = -D_M\,\Delta y = -6.11 * -0.5\% = 3.055\%$$

$$\frac{\Delta P}{P} = -D_M * \Delta y + \frac{1}{2}[\text{Convexity} \times (\Delta y)^2] = 3.055\% + \frac{1}{2}[45.98 \times (0.005)^2]$$
$$= \mathbf{3.055\% + 0.575\% = 3.112\%}$$

| | |
|---|---|
| **Par Value** | **10,000.00** |
| **C (Annual)** | **6.00%** |
| **Frequency** | **2** |
| **YTM_0** | **8.00%** |
| **YTM_1** | **7.50%** |

| t | PV(CF@8.0%) | $w_t$ | $t^*w_t$ | Convexity | PV(CF@7.5%) |
|---|---|---|---|---|---|
| 0.0 | | | | | |
| 1.0 | 288.46 | 0.03 | 0.0327 | 0.03 | 289.16 |
| 2.0 | 277.37 | 0.03 | 0.0628 | 0.09 | 278.71 |
| 3.0 | 266.70 | 0.03 | 0.0906 | 0.17 | 268.63 |
| 4.0 | 256.44 | 0.03 | 0.1161 | 0.27 | 258.92 |
| 5.0 | 246.58 | 0.03 | 0.1395 | 0.39 | 249.56 |
| 6.0 | 237.09 | 0.03 | 0.1610 | 0.52 | 240.54 |
| 7.0 | 227.98 | 0.03 | 0.1806 | 0.67 | 231.85 |
| 8.0 | 219.21 | 0.02 | 0.1985 | 0.83 | 223.47 |
| 9.0 | 210.78 | 0.02 | 0.2147 | 0.99 | 215.39 |
| 10.0 | 202.67 | 0.02 | 0.2294 | 1.17 | 207.61 |
| 11.0 | 194.87 | 0.02 | 0.2426 | 1.35 | 200.10 |
| 12.0 | 187.38 | 0.02 | 0.2545 | 1.53 | 192.87 |
| 13.0 | 180.17 | 0.02 | 0.2651 | 1.72 | 185.90 |
| 14.0 | 173.24 | 0.02 | 0.2745 | 1.90 | 179.18 |
| 15.0 | 166.58 | 0.02 | 0.2828 | 2.09 | 172.70 |
| 16.0 | 5,499.25 | 0.62 | 9.9593 | 78.27 | 5,715.15 |
| | **8,834.77** | **1.00** | **6.35** | **45.98** | **9,109.74** |
| | | **$D_M$** | **6.11** | | |

| | | |
|---|---|---|
| **Initial Price** | **8,834.77** | |
| **Duration Estimate** | **3.05%** | **9,104.59** |
| **Convexity Adjustment** | **0.06%** | **9,109.67** |

# Interest Rate Risk

$$Bond\ Convexity\ Approximation = \frac{P_{up} + P_{Down} - 2 * P}{P * (\Delta y)^2}$$

- A bond with a par value of €10,000, a maturity of 8 years, semiannual coupon payments, an annual coupon rate of 6%, and a yield to maturity of 8%.
  - Estimate current bond price and the bond prices given a 50 basis points decline and increase in the YTM.
  - Calculate the approximate convexity of the bond.

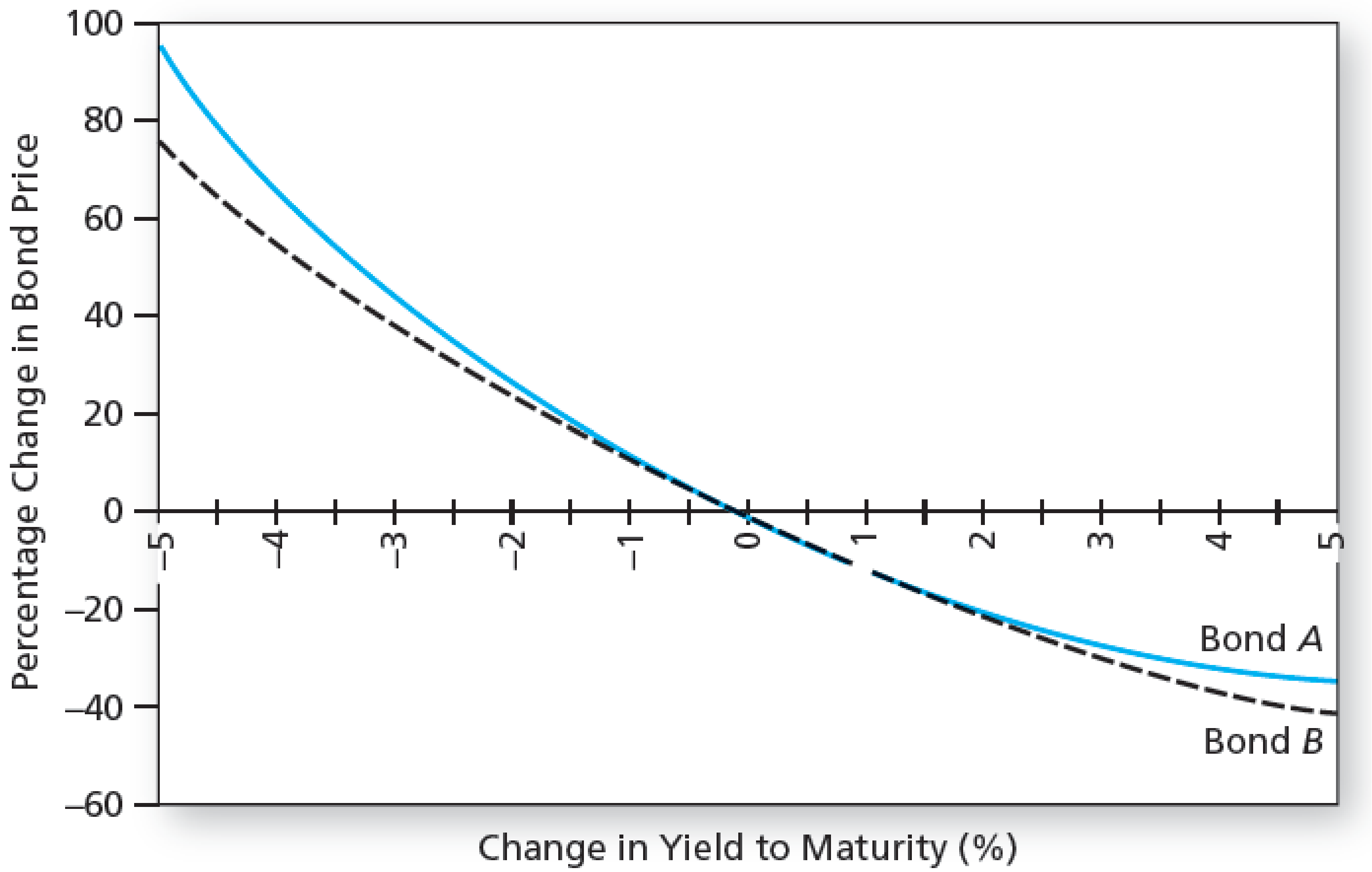
$$P = \sum_{t=1}^{16} \frac{300}{(1 + 4.0\%)^t} + \frac{10{,}000}{(1 + 4.0\%)^{16}} = €8{,}834.77$$

$$P_{Up} = \sum_{t=1}^{16} \frac{300}{(1 + 3.75\%)^t} + \frac{10{,}000}{(1 + 3.75\%)^{16}} = €9{,}109.74$$

$$P_{Down} = \sum_{t=1}^{16} \frac{300}{(1 + 4.25\%)^t} + \frac{10{,}000}{(1 + 4.25\%)^{16}} = €8{,}569.96$$

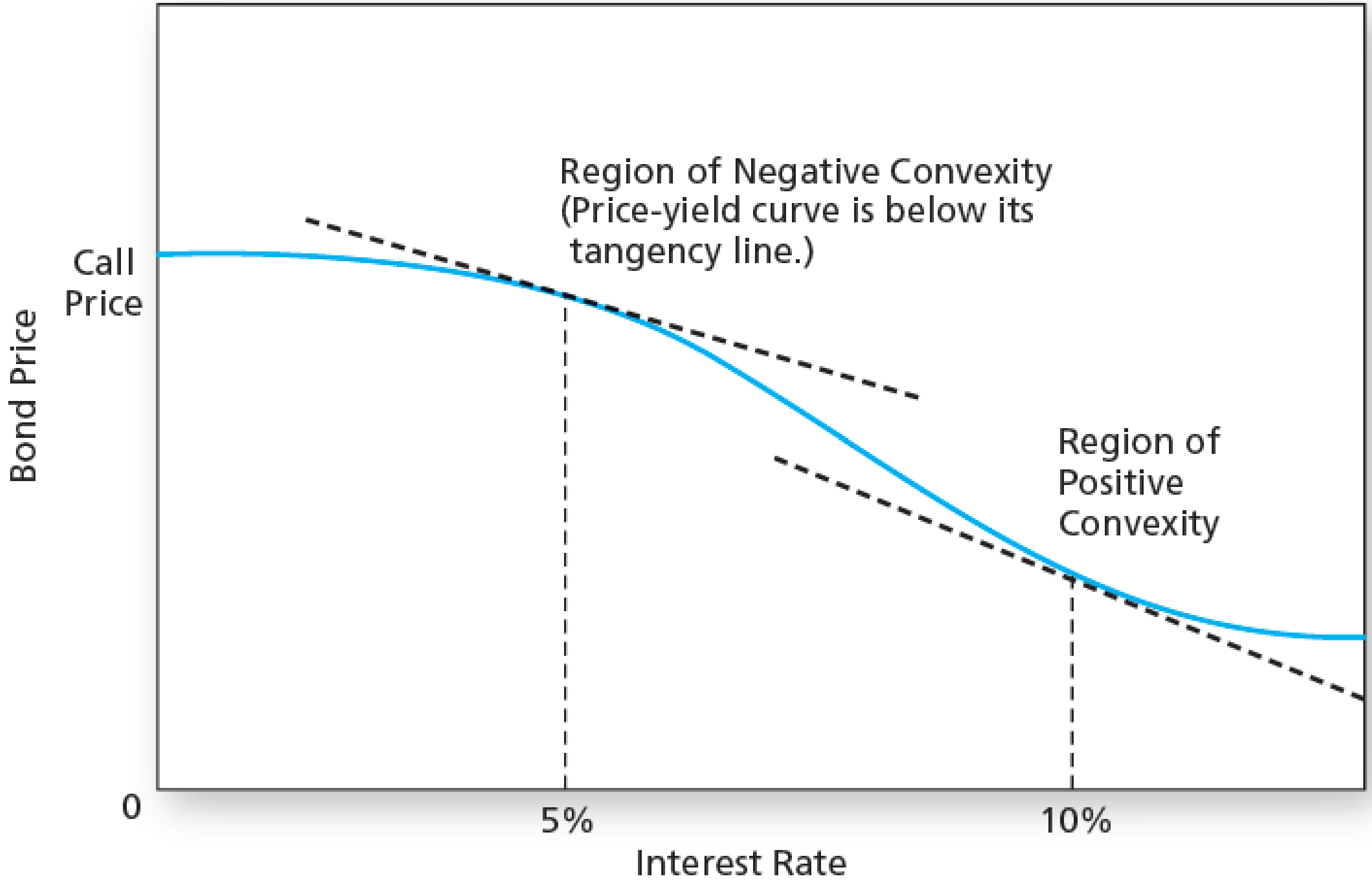
$$Bond\ Convexity\ Approximation = \frac{9{,}109.74 + 8{,}569.96 - 2 * 8{,}834.77}{8{,}834.77 * (0.005)^2} = \frac{9{,}109.74 + 8{,}569.96 - 2 * 8{,}834.77}{0.220869} = 46.00$$

# Interest Rate Risk




- ❖ Higher Convexity → Bigger price increases when yields fall than the price declines when yields rise.
- ❖ The more volatile interest rates, the more attractive this asymmetry.
- ❖ Bonds with greater convexity → higher prices and/or lower yields, all else equal.

# Interest Rate Risk



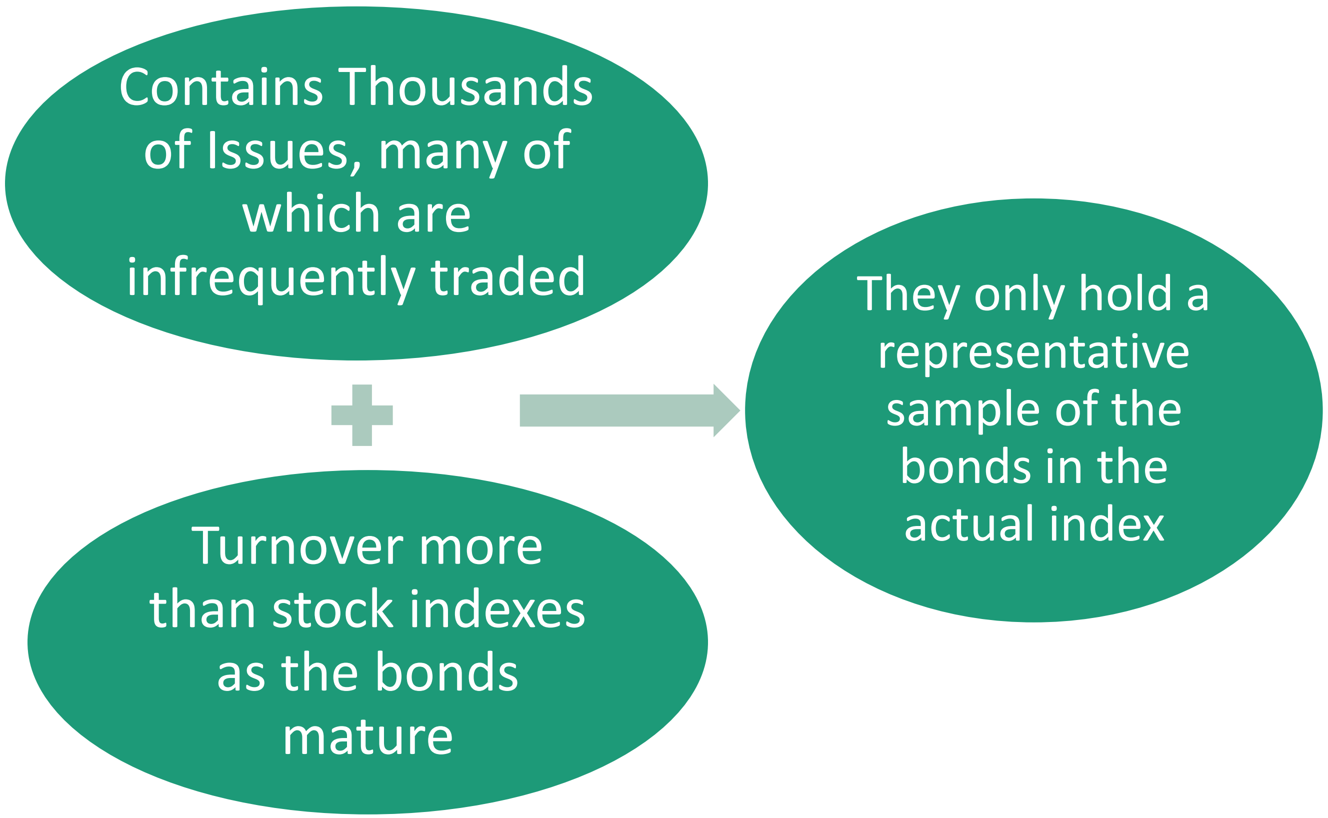

- Price–Yield Curve for a Callable Bond
  - As rates fall, there is a ceiling on the bond's market price, which cannot rise above the call price.
  - Negative convexity

# Passive Management

- Two passive bond portfolio strategies:
  - Indexing
    - ✓ Attempts to replicate the performance of a given bond index.
  - Immunization
    - ✓ Used widely by financial institutions such as insurance companies and pension funds to shield overall financial status from exposure to interest rate fluctuations.
- Both see market prices as being correct
- Differ greatly in terms of risk
  - A bond-index portfolio will have the same risk-reward profile as the bond market index to which it is tied.
  - Immunization strategies seek to establish a virtually zero-risk profile
    - ✓ Interest rate movements have no impact on the value of the portfolio.

# Passive Management: Indexing

## Bond Index Funds

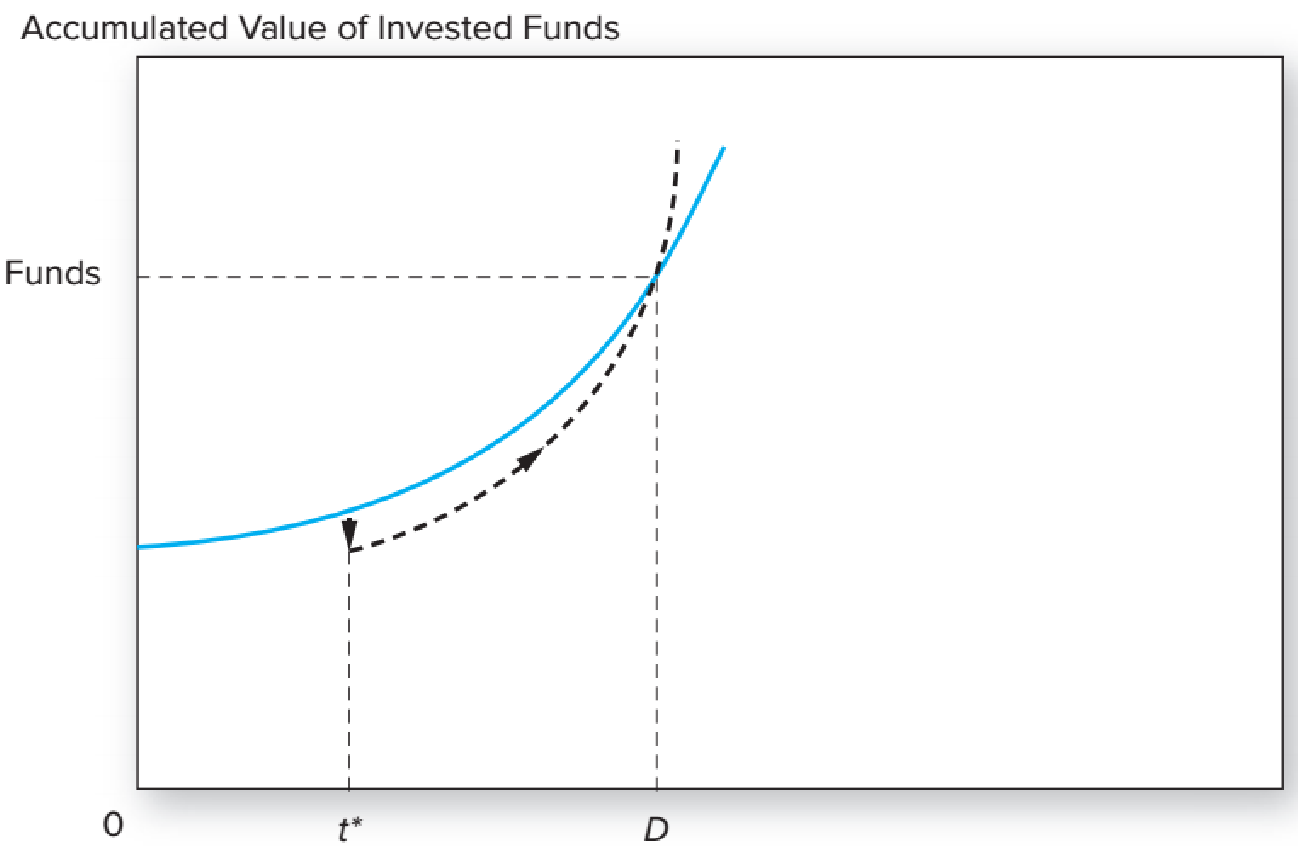



- ❖ The idea is to create a portfolio that mirrors the composition of an index that measures the broad market.
  - ➢ Broad market indexes
  - ➢ Government, Agencies, Supras
  - ➢ Corporate,
  - ➢ Mortgage-backed securities
  - ➢ Yankee bonds
- ❖ Challenges in constructing an indexed bond portfolio
  - ➢ Indexes include thousands of securities
  - ➢ Many bonds are very thinly traded
  - ➢ Rebalancing problems
    - ✓ Bonds are continually dropped from the index as they approach maturity.
    - ✓ New bonds are added to the index as they are issued.
  - ➢ Bonds generate considerable interest income that must be reinvested.

# Passive Management: Immunization

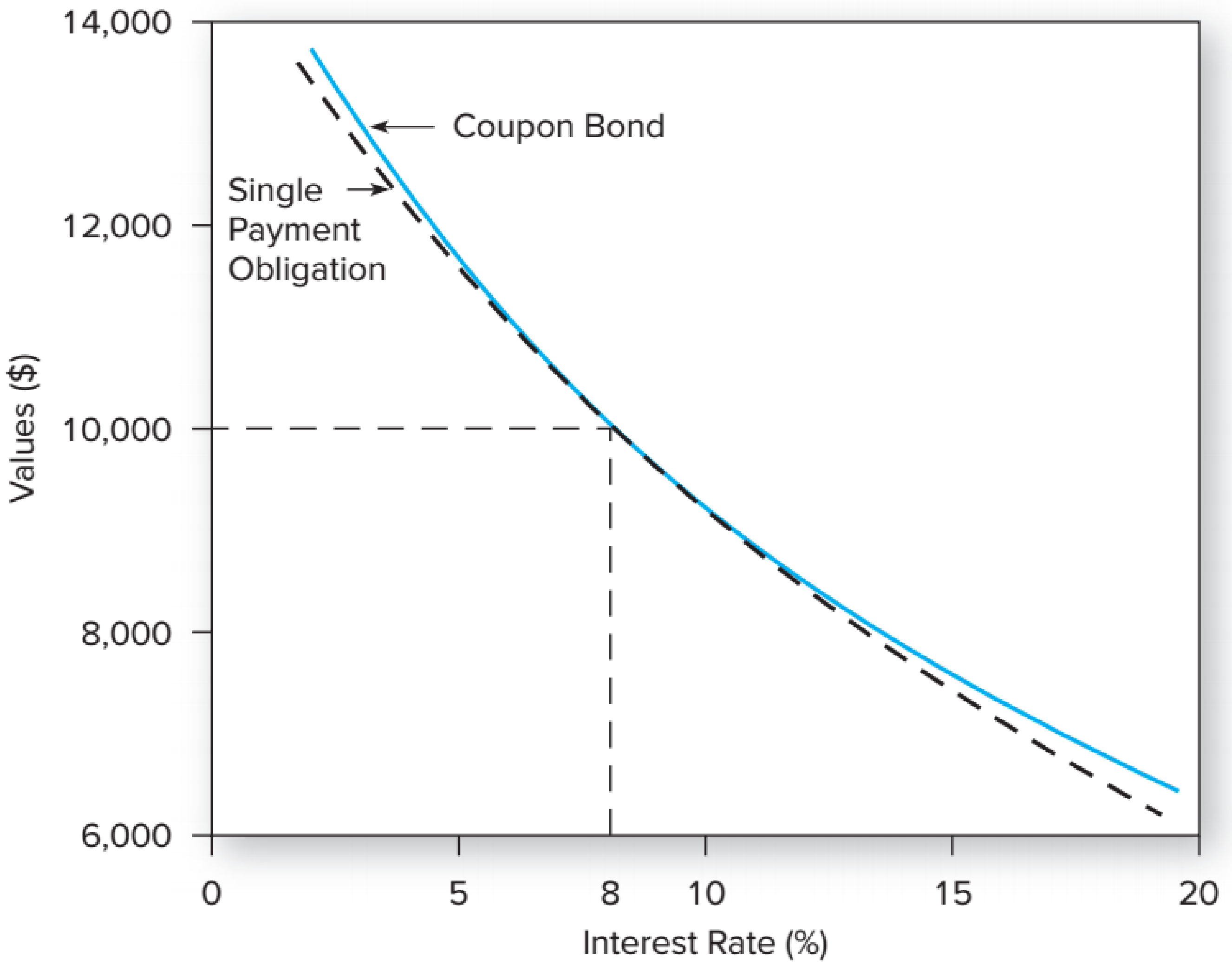
- Control interest rate risk
- Widely used by pension funds, insurance companies, and banks
- A natural mismatch between asset and liability maturity structures.
  - Bank liabilities are primarily the deposits owed to customers, most of which are short-term and, consequently, have low duration.
  - Bank assets by contrast are composed largely of outstanding commercial and consumer loans or mortgages, which have longer duration.
  - **What happens when interest rates rise unexpectedly?**
  - **What about the risks pension funds are exposed to?**
- The interest rate exposure of assets and liabilities is matched in the portfolio.
  - Match the duration of the assets and liabilities.
  - Price risk and reinvestment rate risk exactly cancel out.
    - ✓ When the portfolio duration equals the investor's horizon date, the accumulated value of the investment fund at the horizon date will be unaffected by interest rate fluctuations.
  - Value of assets match liabilities whether rates rise/fall.
  - Duration-matched assets and liabilities let the asset portfolio meet the firm's obligations despite interest rate movements.

# Passive Management: Immunization




- ❖ Duration matching balances the difference between the accumulated value of the coupon payments (reinvestment rate risk) and the sale value of the bond (price risk).
  - ➢ When interest rates fall, the coupons grow less than in the base case, but the higher value of the bond offsets this.
  - ➢ When interest rates rise, the value of the bond falls, but the coupons more than make up for this loss because they are reinvested at the higher rate.

# Passive Management: Immunization




- Coupon paying bond and single-payment obligation.
  - For small changes in interest rates, the change in value of both the asset and the obligation is equal, so the obligation remains fully funded.
  - For greater changes in the interest rate, the present value curves diverge.
  - Convexity
  - Rebalancing
    - ✓ Interest rate changes cause mismatch.
    - ✓ Asset durations will change with time.
    - ✓ Without rebalancing, durations will become unmatched.

# Passive Management: Cash Flow Matching and Dedication

- Cash Flow Matching
  - Buy a zero-coupon bond with a face value equal to the projected cash outlay.
  - The cash flow from the bond and the obligation exactly offset each other, no interest rate risk.
- Dedication strategy
  - Cash flow matching on a multiperiod basis.
  - Either zero-coupon or coupon bonds with total cash flows in each period that match a series of obligations.
  - There is no need for rebalancing once the cash flows are matched.
- Some Issues
  - Cash flow matching imposes constraints on bond selection.
  - Immunization or dedication strategies are appealing to firms/investors that do not wish to bet on general movements in interest rates.
  - Sometimes, cash flow matching is simply not possible b/c of the availability of assets with required maturities.
- Other Problems
  - Duration is calculated using YTM. The implicit assumption is a flat yield curve.
  - What if the yield curve is not flat as is the case most of the time in the real world?
    - Discount using the appropriate spot interest rate from the zero-coupon yield curve corresponding to the date of the particular cash flow.
    - Even with this modification, duration matching will immunize portfolios only for parallel shifts in the yield curve.

# What is next?

- Portfolio Theory and Practice I
  - Risk, Return, and the Historical Record
  - Capital Allocation to Risky Assets
    - ✓ Readings: Ch. 5 & 6
  - Suggested Problems
    - ✓ **Ch. 16:** 4, 5, 9, 11, 12, 16, 21, 23
    - ✓ **Ch 16 – CFA Problems:** 7, 12

# Investments
## Finance 2 - BFIN

Vietnamese-German University

**Dr. Omer CAYIRLI**

**Lecture 3**