



Part II

Bond Valuation

Woraphon Wattanatorn, Ph.D.

Key Concepts and Skills

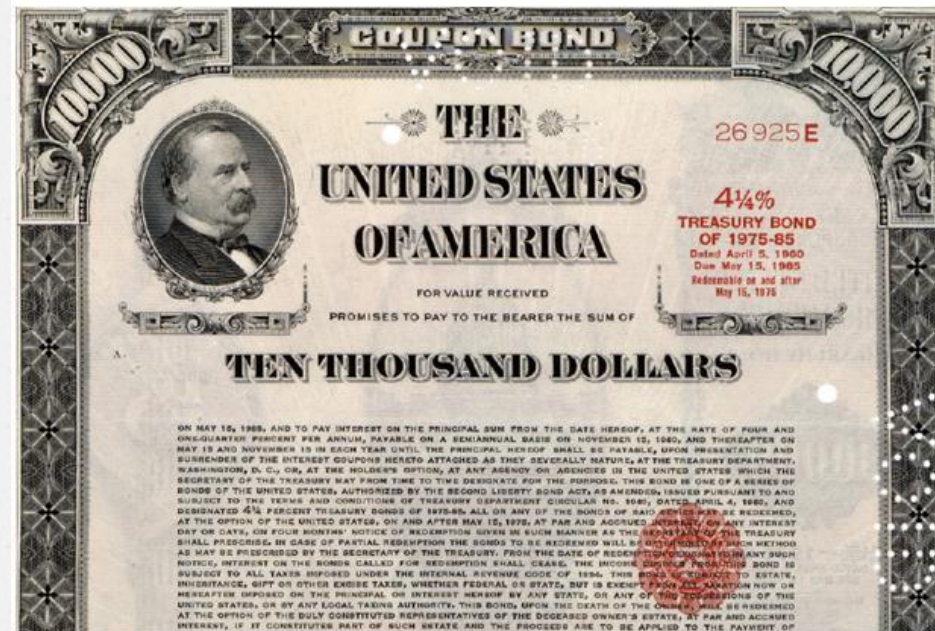
- o Know the important bond features and bond types
- o Understand bond values and why they fluctuate
- o Understand bond ratings and what they mean
- o Understand the impact of inflation on interest rates
- o Understand the term structure of interest rates and the determinants of bond yields

Chapter Outline

- o Bonds and Bond Valuation
- o More about Bond Features
- o Bond Ratings
- o Some Different Types of Bonds
- o Bond Markets
- o Inflation and Interest Rates
- o Determinants of Bond Yields

Bond Definitions

- o Bond
- o Par value (face value)
- o Coupon rate
- o Coupon payment
- o Maturity date
- o Yield or Yield to maturity



Present Value of Cash Flows as Rates Change

$$P = \frac{\sum_{t=1}^n CF_t}{(1+r)^t}$$

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

- Bond Value = PV of coupons + PV of par
- Bond Value = PV of annuity + PV of lump sum
- As interest rates increase, present values decrease
- So, as interest rates increase, bond prices decrease and vice versa

Valuing a Discount Bond with Annual Coupons

- o Consider a bond with a coupon rate of 10% and annual coupons.
- o The par value is \$1,000, and the bond has 5 years to maturity.
- o The yield to maturity is 11%. What is the value of the bond?
 - Using the formula:
 - o $B = \text{PV of annuity} + \text{PV of lump sum}$
 - o $B = 100[1 - 1/(1.11)^5] / .11 + 1,000 / (1.11)^5$
 - o $B = 369.59 + 593.45 = 963.04$
 - Using the calculator:
 - o $N = 5; I/Y = 11; PMT = 100; FV = 1,000$
 - o $\text{CPT PV} = -963.04$

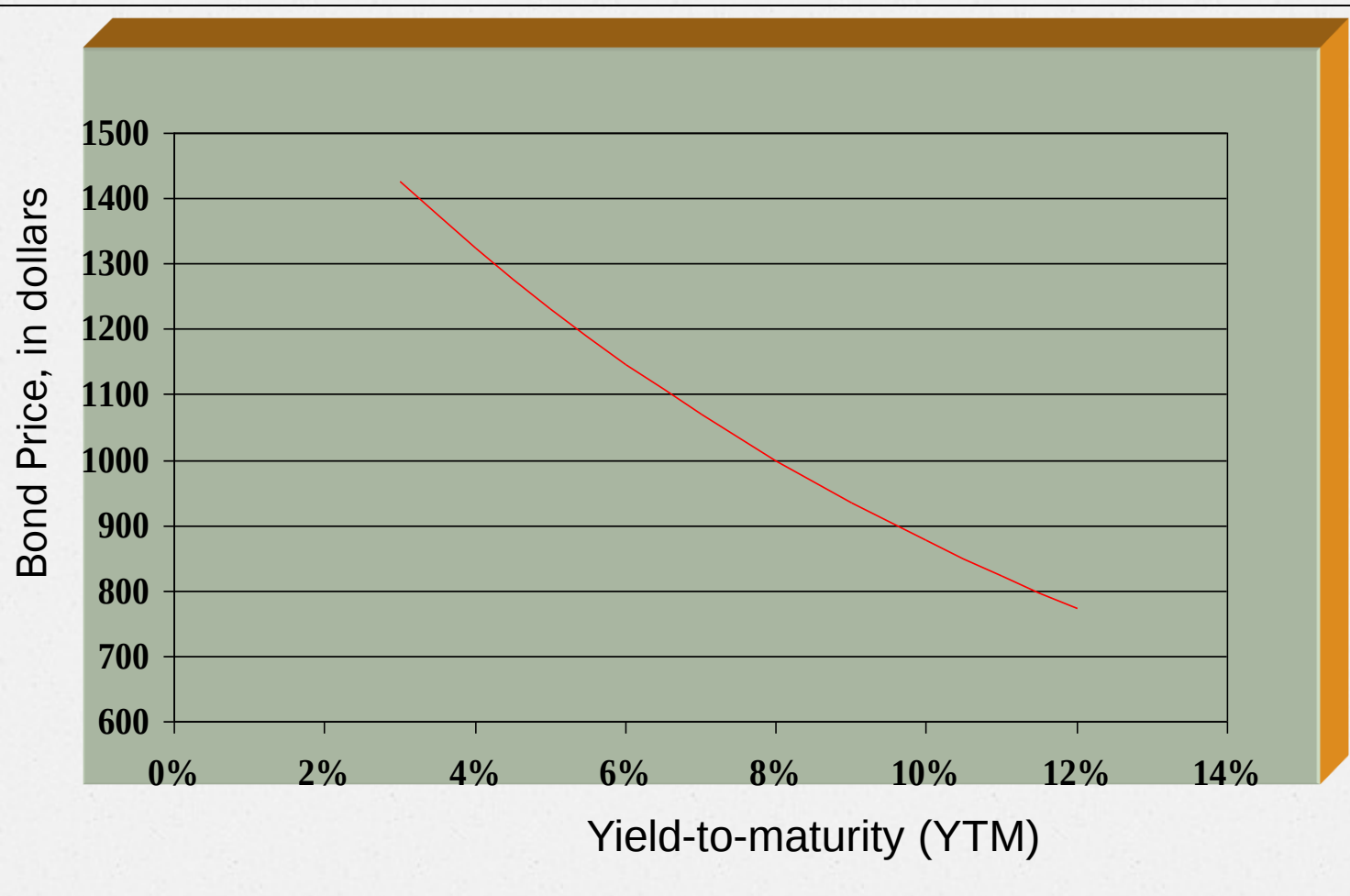
Valuing a Premium Bond with Annual Coupons

- o Suppose you are reviewing a bond that has a 10% annual coupon
- o Face value of \$1000.
- o There are 20 years to maturity, and the yield to maturity is 8%.
- o What is the price of this bond?
 - Using the formula:
 - o $B = \text{PV of annuity} + \text{PV of lump sum}$
 - o $B = 100[1 - 1/(1.08)^{20}] / .08 + 1000 / (1.08)^{20}$
 - o $B = 981.81 + 214.55 = 1196.36$
 - Using the calculator:
 - o $N = 20; I/Y = 8; PMT = 100; FV = 1000$
 - o $CPT PV = -1,196.36$

Practice Question

- Microhard has issued a bond with the following characteristics: Par: \$1,000 Time to maturity: 25 years Coupon rate: 7 percent Semiannual payments
- Calculate the price of this bond if the YTM is:
 - 1) 7 percent
 - 2) 9 percent
 - 3) 5 percent

Graphical Relationship Between Price and Yield-to-maturity (YTM)



Bond characteristics:

10 year maturity, 8% coupon rate, \$1,000 par value

Bond Prices: Relationship Between Coupon and Yield

- If $\text{YTM} = \text{coupon rate}$, then $\text{par value} = \text{bond price}$
- If $\text{YTM} > \text{coupon rate}$, then $\text{par value} > \text{bond price}$
 - Why? The discount provides yield above coupon rate
 - Price below par value, called a discount bond
- If $\text{YTM} < \text{coupon rate}$, then $\text{par value} < \text{bond price}$
 - Why? Higher coupon rate causes value above par
 - Price above par value, called a premium bond

The Bond Pricing Equation

$$\text{Bond Value} = C \left[\frac{1 - \frac{1}{(1+r)^t}}{r} \right] + \frac{FV}{(1+r)^t}$$

Practice Question

- Watters Umbrella Corp. issued 12-year bonds 2 years ago at a coupon rate of 7.8 percent. The bonds make semiannual payments. If these bonds currently sell for 105 percent of par value, what is the YTM?

Practice Question

- G-Corporation issued 20-year, noncallable, 7.5% annual coupon bonds at their par value of \$1,000 one year ago.
- Today, the market interest rate on these bonds is 5.5%.
- What is the current price of the bonds, given that they now have 19 years to maturity?

Challenging Question

- The Morgan Corporation has two different bonds currently outstanding.
 - Bond M has a face value of \$20,000 and matures in 20 years. The bond makes no payments for the first six years, then pays \$800 every six months over the subsequent eight years, and finally pays \$1,000 every six months over the last six years.
 - Bond N also has a face value of \$20,000 and a maturity of 20 years; it makes no coupon payments over the life of the bond.
- If the required return on both these bonds is 8 percent compounded semiannually what is the current price of Bond M?
Of Bond N?

Valuation Practice Set

Morin Company's bonds mature in 8 years, have a par value of \$1,000, and make an annual coupon interest payment of \$65. The market requires an interest rate of 8.2% on these bonds. What is the bond's price?

Ryngaert Inc. recently issued noncallable bonds that mature in 15 years. They have a par value of \$1,000 and an annual coupon of 5.7%. If the current market interest rate is 7.0%, at what price should the bonds sell?

Adams Enterprises' noncallable bonds currently sell for \$1,120. They have a 15-year maturity, an annual coupon of \$85, and a par value of \$1,000. What is their yield to maturity?

Dyl Inc.'s bonds currently sell for \$1,040 and have a par value of \$1,000. They pay a \$65 annual coupon and have a 15-year maturity, but they can be called in 5 years at \$1,100. What is their yield to maturity (YTM)?

Radoski Corporation's bonds make an annual coupon interest payment of 7.35%. The bonds have a par value of \$1,000, a current price of \$1,130, and mature in 12 years. What is the yield to maturity on these bonds?

Assume that you are considering the purchase of a 20-year, noncallable bond with an annual coupon rate of 9.5%. The bond has a face value of \$1,000, and it makes semiannual interest payments. If you require an 8.4% nominal yield to maturity on this investment, what is the maximum price you should be willing to pay for the bond?

Example 7.1

- If an ordinary bond has a coupon rate of 14 percent
- Then the owner will get a total of \$140 per year, but this \$140 will come in two payments of \$70 each.
- The yield to maturity is quoted at 16 percent.
- The bond matures in seven years.
- Note: Bond yields are quoted like APRs; the quoted rate is equal to the actual rate per period multiplied by the number of periods.

Example 7.1

- How many coupon payments are there?
- What is the semiannual coupon payment?
- What is the semiannual yield?
- What is the bond price?
- $B = 70[1 - 1/(1.08)^{14}] / .08 + 1,000 / (1.08)^{14} = 917.56$
- Or PMT = 70; N = 14; I/Y = 8; FV = 1,000; CPT PV = -917.56

Interest Rate Risk

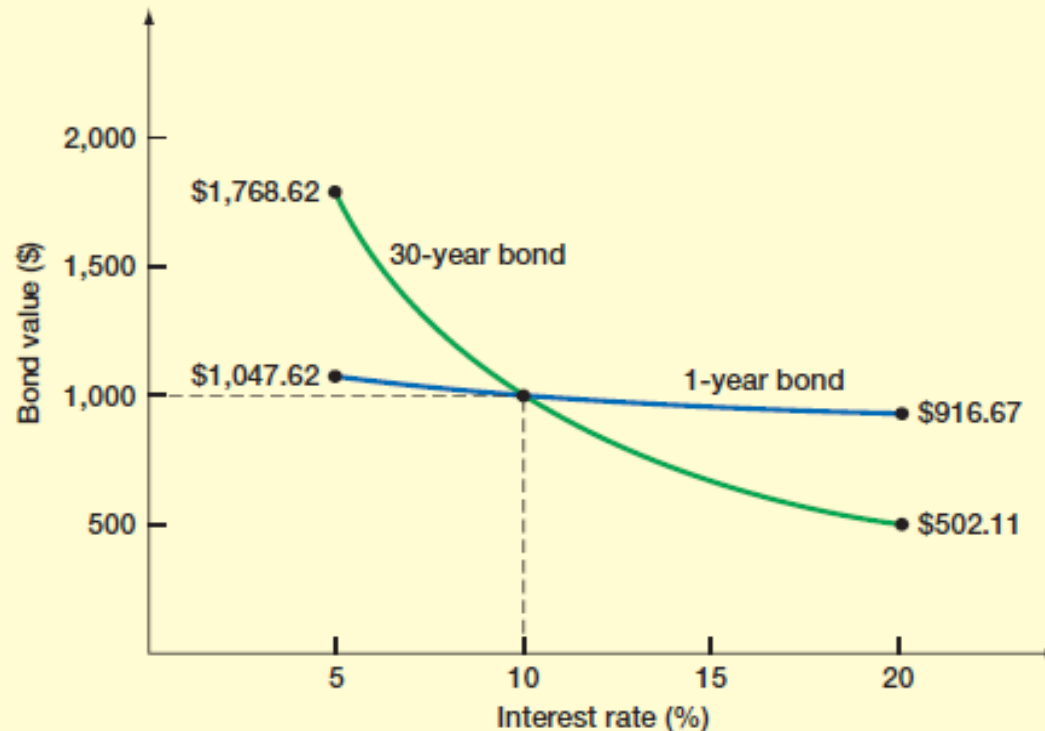
◌ Price Risk

- Change in price due to changes in interest rates
- Long-term bonds have more price risk than short-term bonds
- Low coupon rate bonds have more price risk than high coupon rate bonds

◌ Reinvestment Rate Risk

- Uncertainty concerning rates at which cash flows can be reinvested
- Short-term bonds have more reinvestment rate risk than long-term bonds
- High coupon rate bonds have more reinvestment rate risk than low coupon rate bonds

Figure 7.2



Value of a Bond with a 10 Percent Coupon Rate for Different Interest Rates and Maturities

Interest Rate	Time to Maturity	
	1 Year	30 Years
5%	\$1,047.62	\$1,768.62
10	1,000.00	1,000.00
15	956.52	671.70
20	916.67	502.11

Computing Yield to Maturity

- Yield to Maturity (YTM) is the rate implied by the current bond price
- Finding the YTM requires trial and error if you do not have a financial calculator and is similar to the process for finding r with an annuity
- If you have a financial calculator, enter N , PV , PMT , and FV , remembering the sign convention (PMT and FV need to have the same sign, PV the opposite sign)

YTM with Annual Coupons

- Consider a bond with a 10% annual coupon rate, 15 years to maturity and a par value of \$1,000. The current price is \$928.09.
 - Will the yield be more or less than 10%?
 - $N = 15$; $PV = -928.09$; $FV = 1,000$; $PMT = 100$; CPT I/Y = 11%

YTM with Semiannual Coupons

- o Suppose a bond with a 10% coupon rate and semiannual coupons, has a face value of \$1,000, 20 years to maturity and is selling for \$1,197.93.
 - Is the YTM more or less than 10%?
 - What is the semiannual coupon payment?
 - How many periods are there?
 - $N = 40$; $PV = -1,197.93$; $PMT = 50$; $FV = 1,000$; CPT $I/Y = 4\%$ (Is this the YTM?)
 - $YTM = 4\% * 2 = 8\%$

Current Yield vs. Yield to Maturity

- Current Yield = annual coupon / price
- Yield to maturity = current yield + capital gains yield
- Example: 10% coupon bond, with semiannual coupons, face value of 1,000, 20 years to maturity, \$1,197.93 price
 - Current yield = $100 / 1,197.93 = .0835 = 8.35\%$
 - Price in one year, assuming no change in YTM = 1,193.68
 - Capital gain yield = $(1,193.68 - 1,197.93) / 1,197.93 = -.0035 = -.35\%$
 - YTM = $8.35 - .35 = 8\%$, which is the same YTM computed earlier

Bond Pricing Theorems

- Bonds of similar risk (and maturity) will be priced to yield about the same return, regardless of the coupon rate
- If you know the price of one bond, you can estimate its YTM and use that to find the price of the second bond
- This is a useful concept that can be transferred to valuing assets other than bonds

Differences Between Debt and Equity

o Debt

- Not an ownership interest
- Creditors do not have voting rights
- Interest is considered a cost of doing business and is tax deductible
- Creditors have legal recourse if interest or principal payments are missed
- Excess debt can lead to financial distress and bankruptcy

o Equity

- Ownership interest
- Common stockholders vote for the board of directors and other issues
- Dividends are not considered a cost of doing business and are not tax deductible
- Dividends are not a liability of the firm, and stockholders have no legal recourse if dividends are not paid
- An all equity firm can not go bankrupt merely due to debt since it has no debt

The Bond Indenture

- Contract between the company and the bondholders that includes
 - The basic terms of the bonds
 - The total amount of bonds issued
 - A description of property used as security, if applicable
 - Sinking fund provisions
 - Call provisions
 - Details of protective covenants

Bond Classifications

- Registered vs. Bearer Forms
- Security
 - Collateral – secured by financial securities
 - Mortgage – secured by real property, normally land or buildings
 - Debentures – unsecured
 - Notes – unsecured debt with original maturity less than 10 years
- Seniority

Bond Ratings – Investment Quality

o High Grade

- Moody's Aaa, S&P and Fitch AAA – capacity to pay is extremely strong
- Moody's Aa, S&P and Fitch AA – capacity to pay is very strong

o Medium Grade

- Moody's A, S&P and Fitch A – capacity to pay is strong, but more susceptible to changes in circumstances
- Moody's Baa, S&P and Fitch BBB – capacity to pay is adequate, adverse conditions will have more impact on the firm's ability to pay

Bond Ratings – Speculative Grade

○ Low Grade

- Moody's Ba and B
- S&P and Fitch BB and B
- Considered possible that the capacity to pay will degenerate.

○ Very Low Grade

- Moody's C (and below) and S&P and Fitch C (and below)
 - income bonds with no interest being paid, or
 - in default with principal and interest in arrears

Government Bonds

o Treasury Securities

- Federal government debt
- T-bills – pure discount bonds with original maturity of one year or less
- T-notes – coupon debt with original maturity between one and ten years
- T-bonds – coupon debt with original maturity greater than ten years

o Municipal Securities

- Debt of state and local governments
- Varying degrees of default risk, rated similar to corporate debt
- Interest received is tax-exempt at the federal level

Example 7.4

- o A taxable bond has a yield of 8%, and a municipal bond has a yield of 6%.
 - If you are in a 40% tax bracket, which bond do you prefer?
 - o $8\%(1 - .4) = 4.8\%$
 - o The after-tax return on the corporate bond is 4.8%, compared to a 6% return on the municipal
 - At what tax rate would you be indifferent between the two bonds?
 - o $8\%(1 - T) = 6\%$
 - o $T = 25\%$

Zero Coupon Bonds

- Make no periodic interest payments (coupon rate = 0%)
- The entire yield-to-maturity comes from the difference between the purchase price and the par value
- Cannot sell for more than par value
- Sometimes called zeroes, deep discount bonds, or original issue discount bonds (OIDs)
- Treasury Bills and principal-only Treasury strips are good examples of zeroes

Other Bond Types

- o Disaster bonds
- o Income bonds
- o Convertible bonds
- o Put bonds
- o There are many other types of provisions that can be added to a bond and many bonds have several provisions – it is important to recognize how these provisions affect required returns

Bond Markets

- Primarily over-the-counter transactions with dealers connected electronically
- Extremely large number of bond issues, but generally low daily volume in single issues
- Makes getting up-to-date prices difficult, particularly on small company or municipal issues
- Treasury securities are an exception

Inflation and Interest Rates

- Real rate of interest – change in purchasing power
- Nominal rate of interest – quoted rate of interest, change in actual number of dollars
- The *ex ante* nominal rate of interest includes our desired real rate of return plus an adjustment for expected inflation

The Fisher Effect

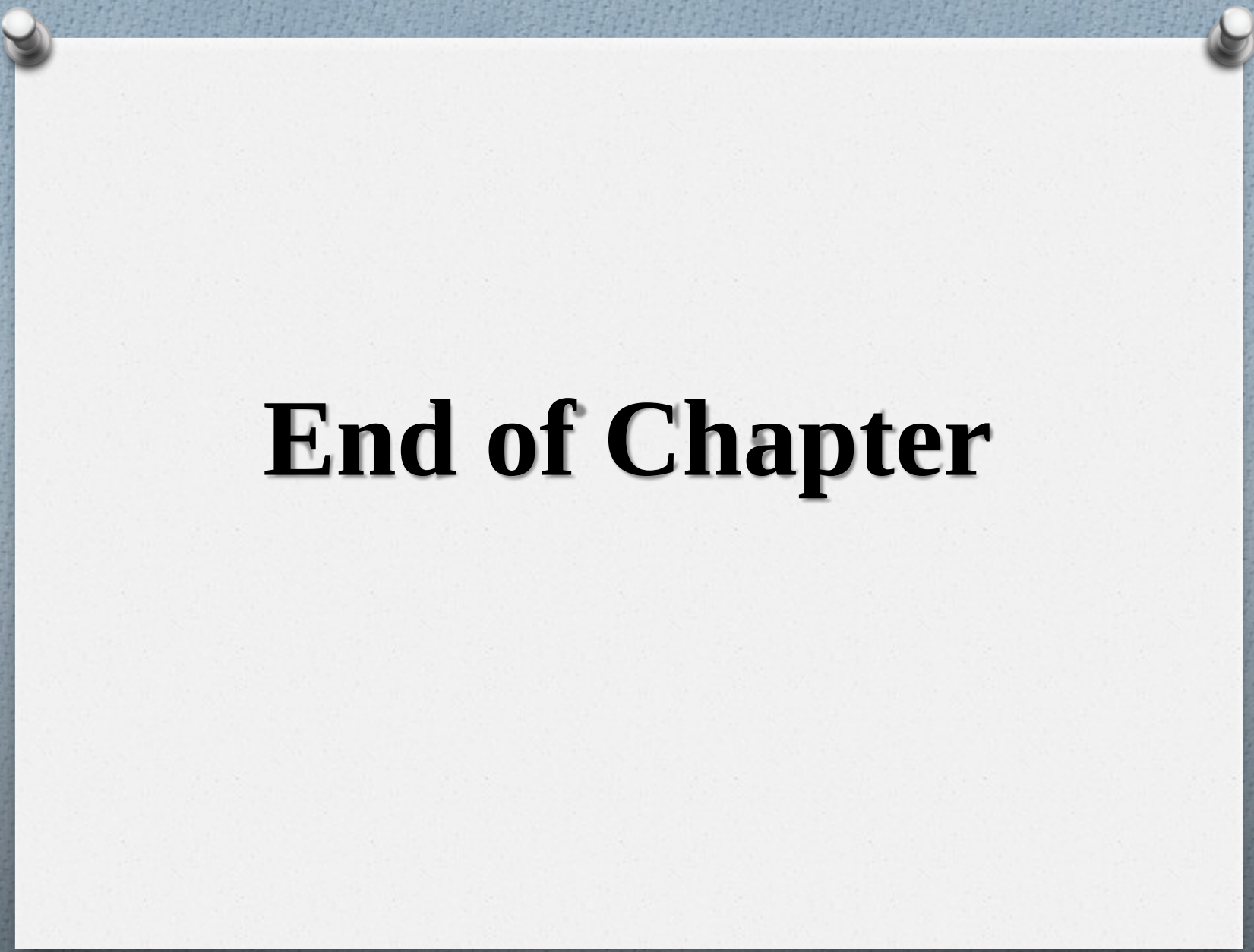
- The Fisher Effect defines the relationship between real rates, nominal rates, and inflation
- $(1 + R) = (1 + r)(1 + h)$, where
 - R = nominal rate
 - r = real rate
 - h = expected inflation rate
- Approximation
 - $R = r + h$

Example 7.5

- If we require a 10% real return and we expect inflation to be 8%, what is the nominal rate?
- $R = (1.1)(1.08) - 1 = .188 = 18.8\%$
- Approximation: $R = 10\% + 8\% = 18\%$
- Because the real return and expected inflation are relatively high, there is significant difference between the actual Fisher Effect and the approximation.

Comprehensive Problem

- What is the price of a \$1,000 par value bond with a 6% coupon rate paid semiannually, if the bond is priced to yield 5% and it has 9 years to maturity?
- What would be the price of the bond if the yield rose to 7%?
- What is the current yield on the bond if the YTM is 7%?



End of Chapter