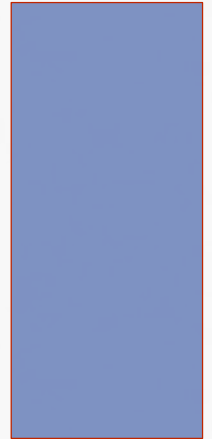




# CHAPTER 7

## INTEREST RATES AND BOND VALUATION





# KEY CONCEPTS AND SKILLS

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



# CHAPTER OUTLINE

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



# BOND DEFINITIONS

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



# PRESENT VALUE OF CASH FLOWS AS RATES CHANGE

- 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

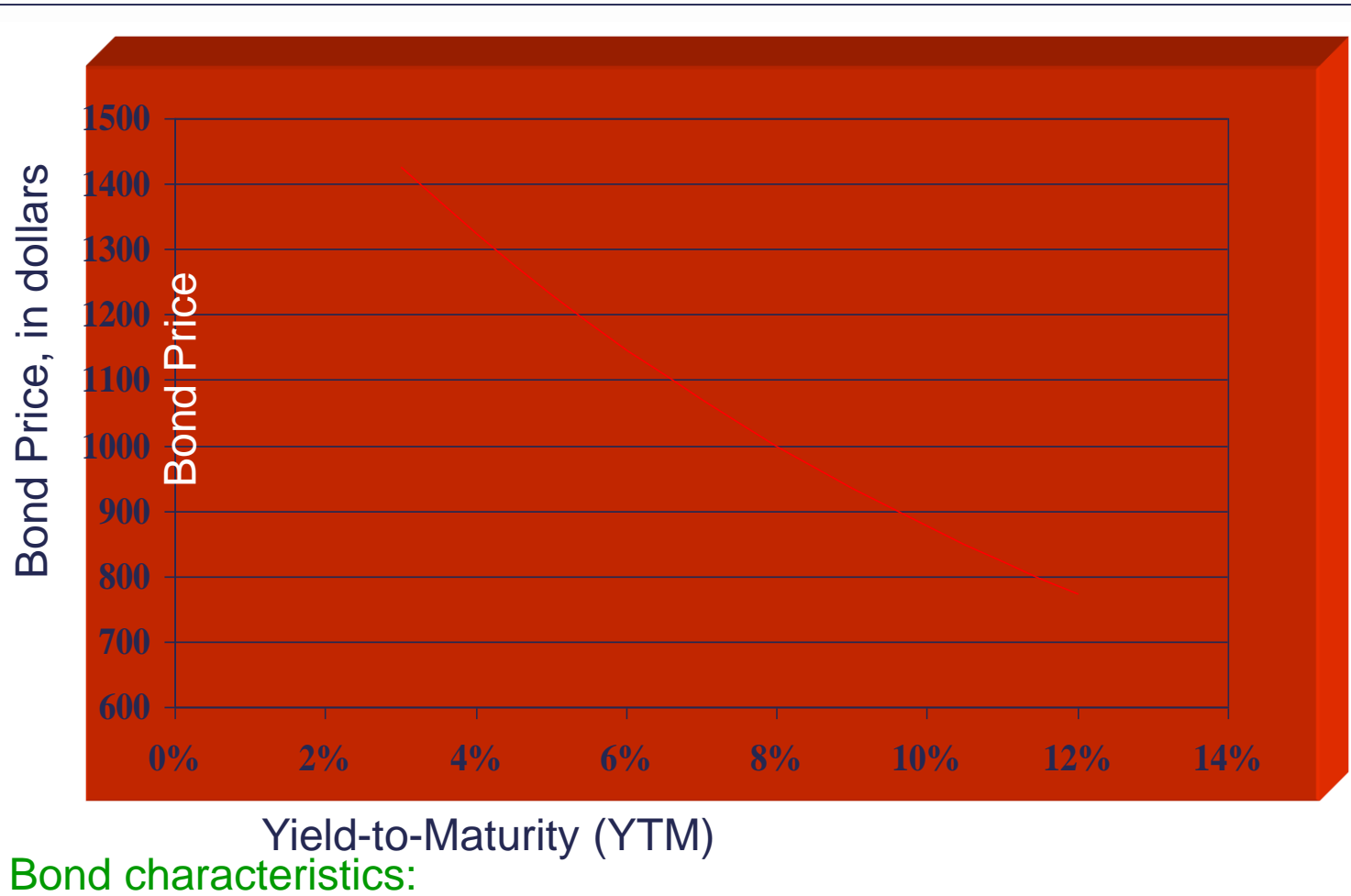
- Consider a bond with a coupon rate of 10% and annual coupons. The par value is \$1,000, and the bond has 5 years to maturity. The yield to maturity is 11%. What is the value of the bond?
  - Using the formula:
    - $B = \text{PV of annuity} + \text{PV of lump sum}$
    - $B = 100[1 - 1/(1.11)^5] /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

# VALUING A PREMIUM BOND WITH ANNUAL COUPONS

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



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

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

## 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

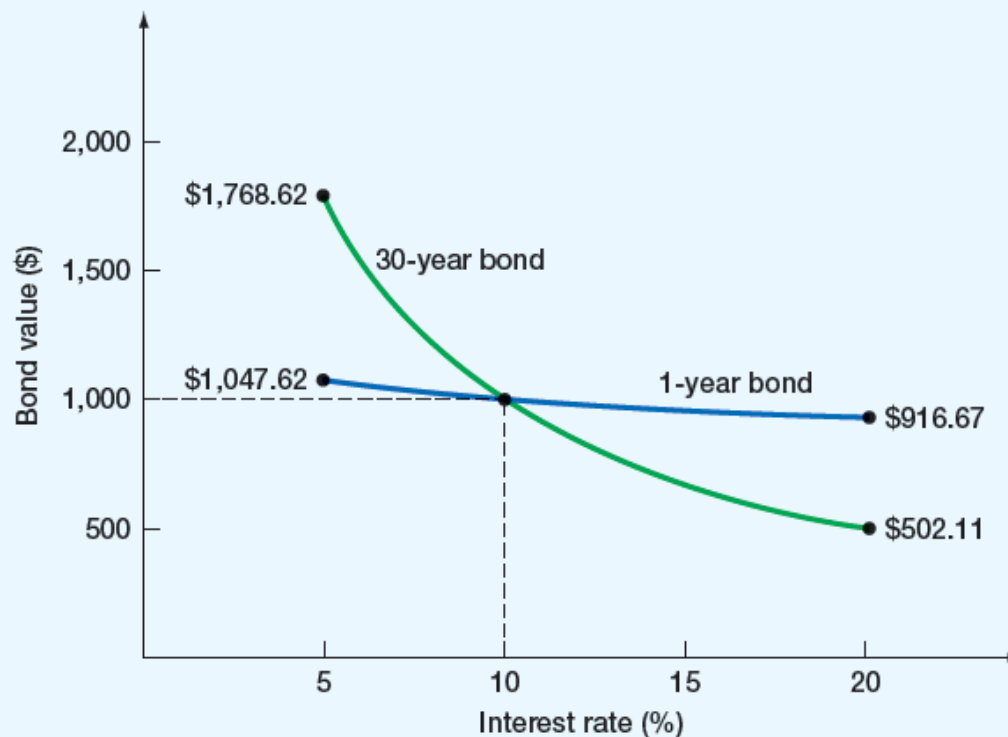
- How many coupon payments are there?
- What is the semiannual coupon payment?
- What is the semiannual yield?
- What is the bond price?
- $B = 70[1 - 1/(1.08)^{14}] / .08 + 1,000 / (1.08)^{14} = 917.56$
- Or PMT = 70; N = 14; I/Y = 8; FV = 1,000; CPT  
PV = -917.56



# 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

- 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?)
  - $YTM = 4\% * 2 = 8\%$

# TABLE 7.1

## I. Finding the Value of a Bond

$$\text{Bond value} = C \times [1 - 1/(1 + r)^t]/r + F/(1 + r)^t$$

where:

$C$  = Coupon paid each period

$r$  = Rate per period

$t$  = Number of periods

$F$  = Bond's face value

## II. Finding the Yield on a Bond

Given a bond value, coupon, time to maturity, and face value, it is possible to find the implicit discount rate, or yield to maturity, by trial and error only. To do this, try different discount rates until the calculated bond value equals the given value (or let a financial calculator do it for you). Remember that increasing the rate *decreases* the bond value.

# 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

# BOND PRICES WITH A SPREADSHEET

- There is a specific formula for finding bond prices on a spreadsheet
  - PRICE(Settlement,Maturity,Rate,Yld,Redemption,Frequency,Basis)
  - YIELD(Settlement,Maturity,Rate,Pr,Redemption,Frequency,Basis)
  - Settlement and maturity need to be actual dates
  - The redemption and Pr need to be input as % of par value
- Click on the Excel icon for an example





# DIFFERENCES BETWEEN DEBT AND EQUITY

- 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
- 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 CHARACTERISTICS AND REQUIRED RETURNS

- The coupon rate depends on the risk characteristics of the bond when issued
- Which bonds will have the higher coupon, all else equal?
  - Secured debt versus a debenture
  - Subordinated debenture versus senior debt
  - A bond with a sinking fund versus one without
  - A callable bond versus a non-callable bond



# BOND RATINGS – INVESTMENT QUALITY

- High Grade
  - Moody's Aaa and S&P AAA – capacity to pay is extremely strong
  - Moody's Aa and S&P AA – capacity to pay is very strong
- Medium Grade
  - Moody's A and S&P A – capacity to pay is strong, but more susceptible to changes in circumstances
  - Moody's Baa and S&P 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 BB and B
  - Considered possible that the capacity to pay will degenerate.
- Very Low Grade
  - Moody's C (and below) and S&P C (and below)
    - income bonds with no interest being paid, or
    - in default with principal and interest in arrears



# GOVERNMENT BONDS

- 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
- 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

- 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?
    - $8\%(1 - .4) = 4.8\%$
    - 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?
    - $8\%(1 - T) = 6\%$
    - $T = 25\%$





# 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



# FLOATING-RATE BONDS

- Coupon rate floats depending on some index value
- Examples – adjustable rate mortgages and inflation-linked Treasuries
- There is less price risk with floating rate bonds
  - The coupon floats, so it is less likely to differ substantially from the yield-to-maturity
- Coupons may have a “collar” – the rate cannot go above a specified “ceiling” or below a specified “floor”



# OTHER BOND TYPES

- Disaster bonds
- Income bonds
- Convertible bonds
- Put bonds
- 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



# SUKUK

- Sukuk are bonds have been created to meet a demand for assets that comply with Shariah, or Islamic law
- Shariah does not permit the charging or paying of interest
- Sukuk are typically bought and held to maturity, and are extremely illiquid



# 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

# WORK THE WEB EXAMPLE

- Bond quotes are available online
- One good site is FINRA's Market Data Center
- Click on the web surfer to go to the site
  - Choose a company, enter it in the Issuer Name bar, choose Corporate, and see what you can find!



# TREASURY QUOTATIONS

- Highlighted quote in Figure 7.4

Maturity yield	Coupon	Bid	Asked	Chg	Asked
5/15/2030	6.250	136.8359	136.9141	-0.7813	3.289

- What is the coupon rate on the bond?
- When does the bond mature?
- What is the bid price? What does this mean?
- What is the ask price? What does this mean?
- How much did the price change from the previous day?
- What is the yield based on the ask price?



# CLEAN VS. DIRTY PRICES

- Clean price: quoted price
- Dirty price: price actually paid = quoted price *plus* accrued interest
- Example: Consider a T-bond with a 4% semiannual yield and a clean price of \$1,282.50:
  - Number of days since last coupon = 61
  - Number of days in the coupon period = 184
  - Accrued interest =  $(61/184)(.04 \times 1000) = \$13.26$
  - Dirty price =  $\$1,282.50 + \$13.26 = \$1,295.76$
- So, you would actually pay \$ 1,295.76 for the bond



# 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

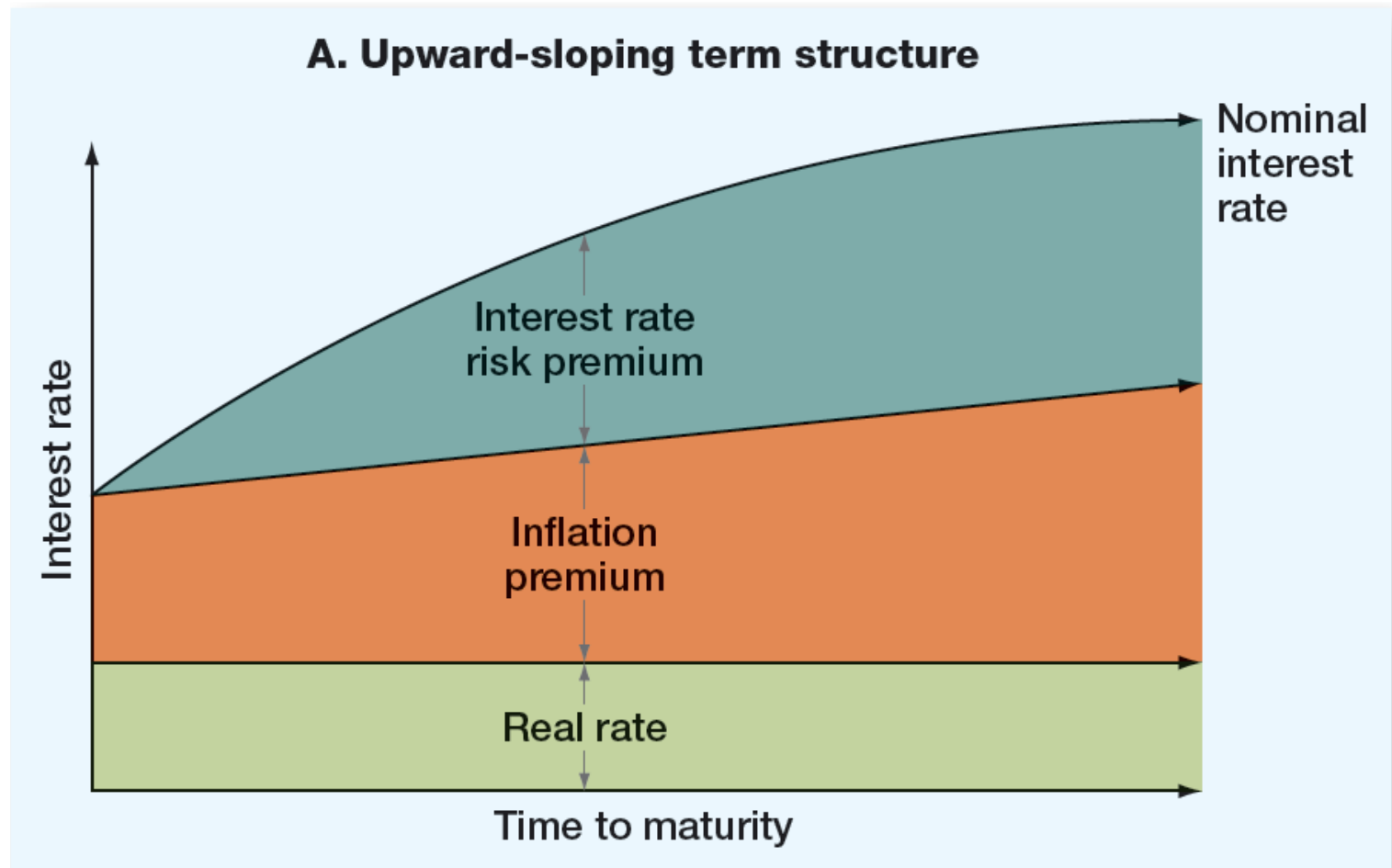
- If we require a 10% real return and we expect inflation to be 8%, what is the nominal rate?
- $R = (1.1)(1.08) - 1 = .188 = 18.8\%$
- Approximation:  $R = 10\% + 8\% = 18\%$
- Because the real return and expected inflation are relatively high, there is significant difference between the actual Fisher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



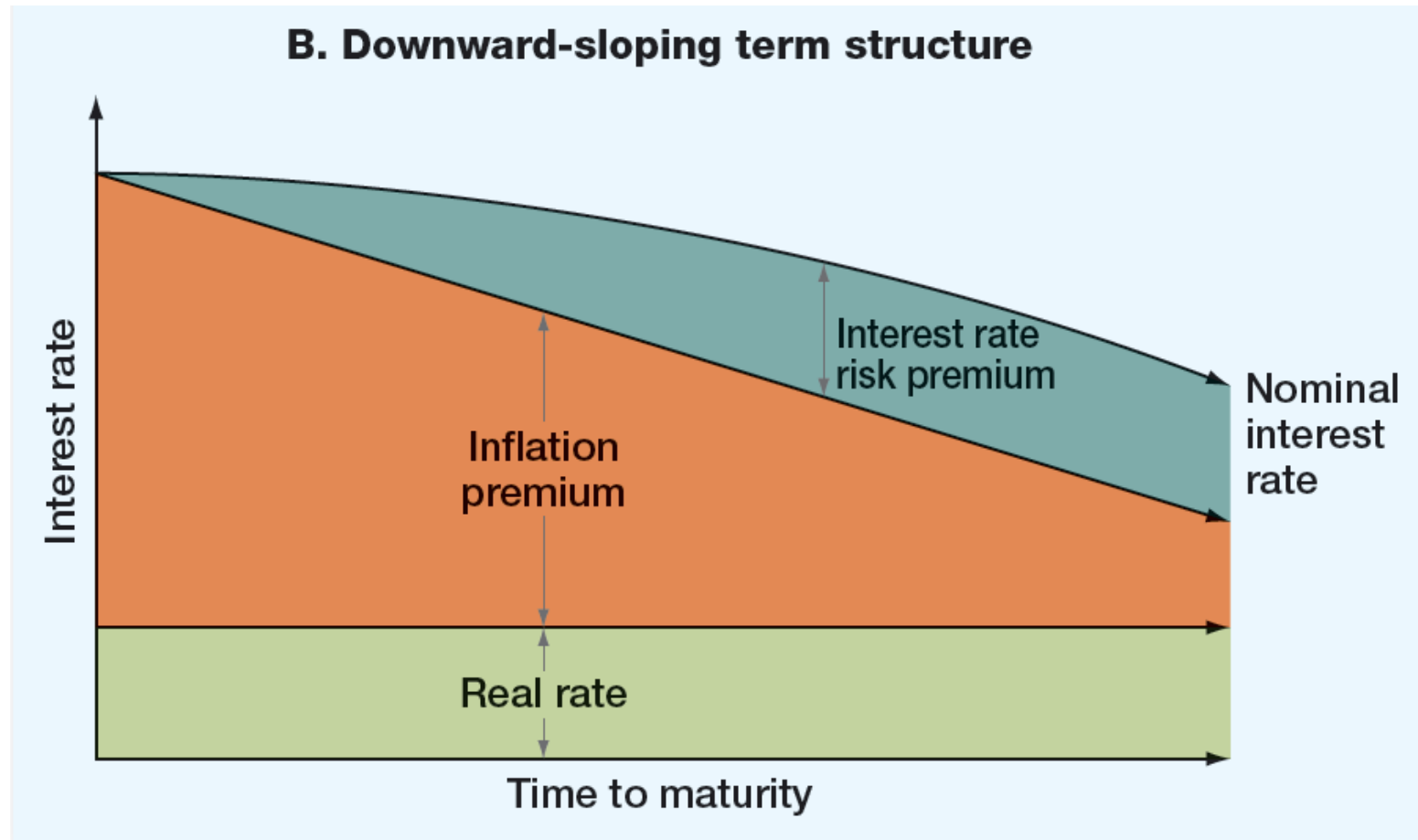
# TERM STRUCTURE OF INTEREST RATES

- Term structure is the relationship between time to maturity and yields, all else equal
- It is important to recognize that we pull out the effect of default risk, different coupons, etc.
- Yield curve – graphical representation of the term structure
  - Normal – upward-sloping; long-term yields are higher than short-term yields
  - Inverted – downward-sloping; long-term yields are lower than short-term yields

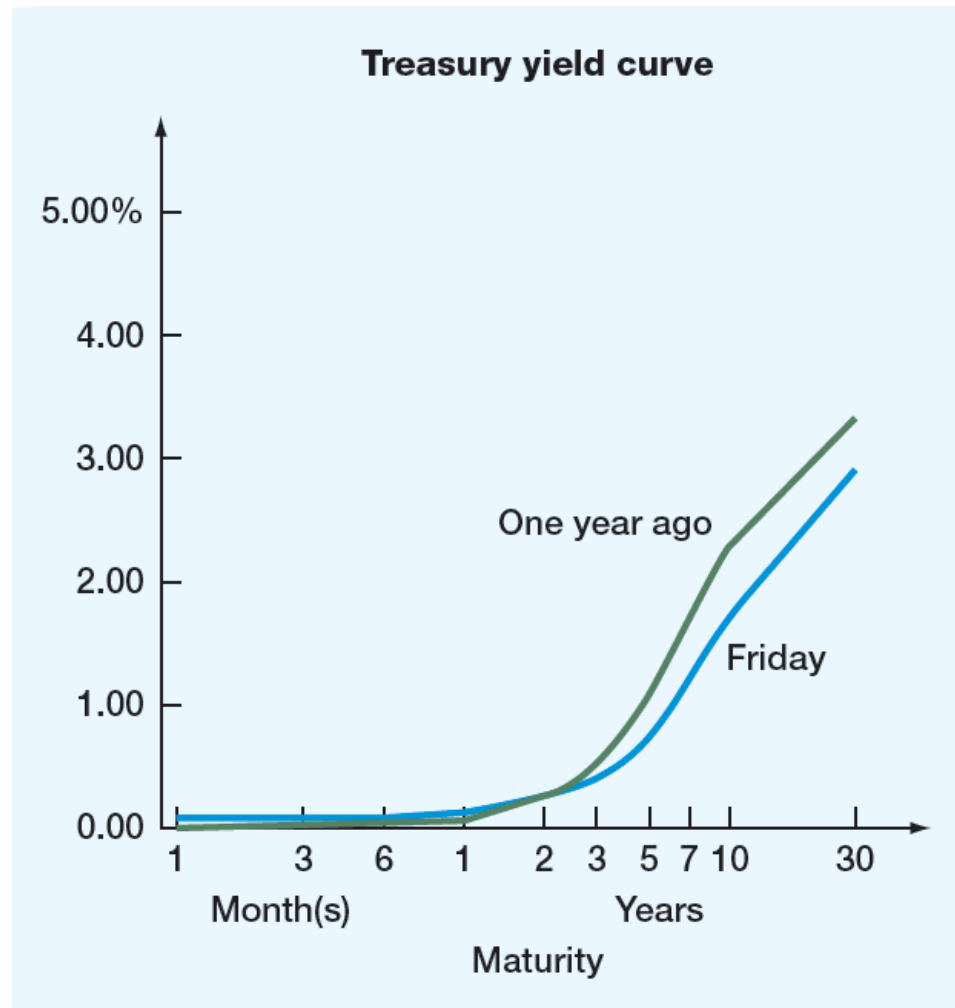
# FIGURE 7.6 – UPWARD-SLOPING YIELD CURVE



# FIGURE 7.6 – DOWNWARD-SLOPING YIELD CURVE



# FIGURE 7.7







# FACTORS AFFECTING BOND YIELDS

- Real rate of interest
- Expected future inflation premium
- Interest rate risk premium
- Default risk premium
- Taxability premium
- Liquidity premium



# QUICK QUIZ

- How do you find the value of a bond, and why do bond prices change?
- What is a bond indenture, and what are some of the important features?
- What are bond ratings, and why are they important?
- How does inflation affect interest rates?
- What is the term structure of interest rates?
- What factors determine the required return on bonds?



# ETHICS ISSUES

- In 1996, allegations were made against Moody's that it was issuing ratings on bonds it had not been hired to rate, in order to pressure issuers to pay for their service.
- The government conducted an inquiry, but charges of antitrust violations were dropped. Even though no legal action was taken, does an ethical issue exist?



# 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%?

# CHAPTER 7

END OF CHAPTER