

# CHAPTER 7

## INTEREST RATES AND BOND VALUATION

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### 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

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## 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:
    - $N = 5; I/Y = 11; PMT = 100; FV = 1,000$
    - $CPT PV = -963.04$

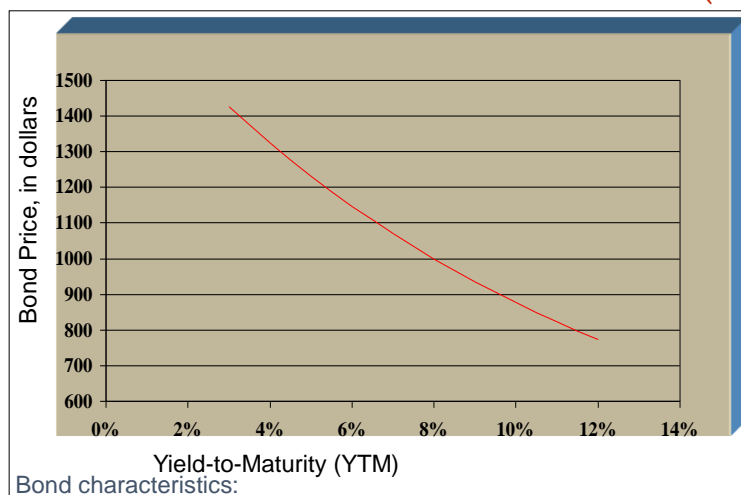
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## VALUING A PREMIUM BOND WITH ANNUAL COUPONS

- 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:
    - $N = 20$ ;  $I/Y = 8$ ;  $PMT = 100$ ;  $FV = 1000$
    - $\text{CPT PV} = -1,196.36$

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## GRAPHICAL RELATIONSHIP BETWEEN PRICE AND YIELD-TO-MATURITY (YTM)



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## BOND PRICES: RELATIONSHIP BETWEEN COUPON AND YIELD

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

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## THE BOND PRICING EQUATION

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

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## 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.

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## 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

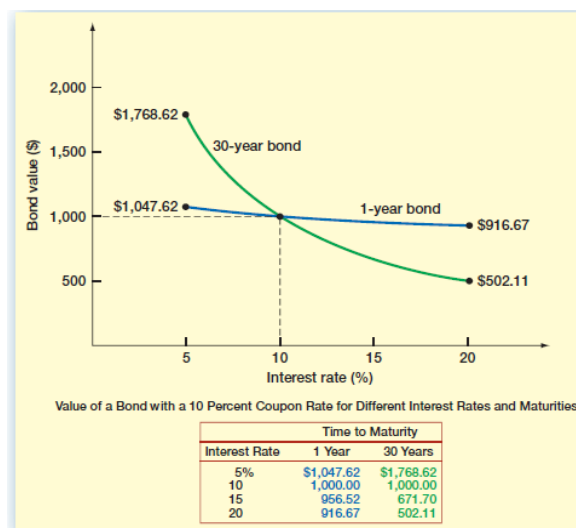
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# INTEREST RATE RISK

- 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

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## FIGURE 7.2



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## 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)

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## 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  $I/Y = 11\%$

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## 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?)
  - $YTM = 4\% \times 2 = 8\%$

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## 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	
<p>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 <i>decreases</i> the bond value.</p>	

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## 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

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## 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

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## 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

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## DIFFERENCES BETWEEN DEBT AND EQUITY

- |  |  |
|--|--|
| <ul style="list-style-type: none"><li>• Debt<ul style="list-style-type: none"><li>▪ Not an ownership interest</li><li>▪ Creditors do not have voting rights</li><li>▪ Interest is considered a cost of doing business and is tax deductible</li><li>▪ Creditors have legal recourse if interest or principal payments are missed</li><li>▪ Excess debt can lead to financial distress and bankruptcy</li></ul></li></ul> | <ul style="list-style-type: none"><li>• Equity<ul style="list-style-type: none"><li>▪ Ownership interest</li><li>▪ Common stockholders vote for the board of directors and other issues</li><li>▪ Dividends are not considered a cost of doing business and are not tax deductible</li><li>▪ Dividends are not a liability of the firm, and stockholders have no legal recourse if dividends are not paid</li><li>▪ An all equity firm can not go bankrupt merely due to debt since it has no debt</li></ul></li></ul> |
|--|--|

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## BOND CHARACTERISTICS AND REQUIRED RETURNS

- The coupon rate depends on the risk characteristics of the bond when issued

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## BOND RATINGS – INVESTMENT QUALITY

- 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
- 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

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## 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

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## 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

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## 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?
    - $8\%(1 - T) = 6\%$
    - $T = 25\%$

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## 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

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## 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

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## 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

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## 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!

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## 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

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## 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
  - $R = r + h$

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## 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.

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## 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

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