CHAPTER

8

Interest Rates and Bond Valuation

McGraw-Hill/Irwin

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 measure
- Understand the impact of inflation on interest rates
- Understand the term structure of interest rates and the determinants of bond yields

Chapter Outline

8.1 Bonds and Bond Valuation

8.2 Government and Corporate Bonds (SELF-STUDY)

8.3 Bond Markets (Partial Self-Study)

8.4 Inflation and Interest Rates

8.5 Determinants of Bond Yields

8.1 Bonds and Bond Valuation

- A bond is a legally binding agreement between a borrower and a lender that
  - specifies the principal amount, i.e., par value, face value, or maturity value of the bond
  - Specifies the size and timing of cash flows:
    - Coupon rate ➔ Coupon payment;
      - in dollar terms (fixed-rate borrowing)
      - as a formula (adjustable-rate borrowing)
    - and Maturity Date
- The yield to maturity (YTM) or bond yield is the REQUIRED interest rate on the bond, and hence *the discount rate in valuation*!

Bond Valuation

- Primary Principle:
  - Value of financial securities = PV of expected future cash flows
- Bond value is, therefore, determined by the present value of the coupon payments and par value.
- Interest rates (YTMs) are inversely related to present (i.e., bond) values.
  - Recall from Chapter 4 that PV and discount rate are inversely related!

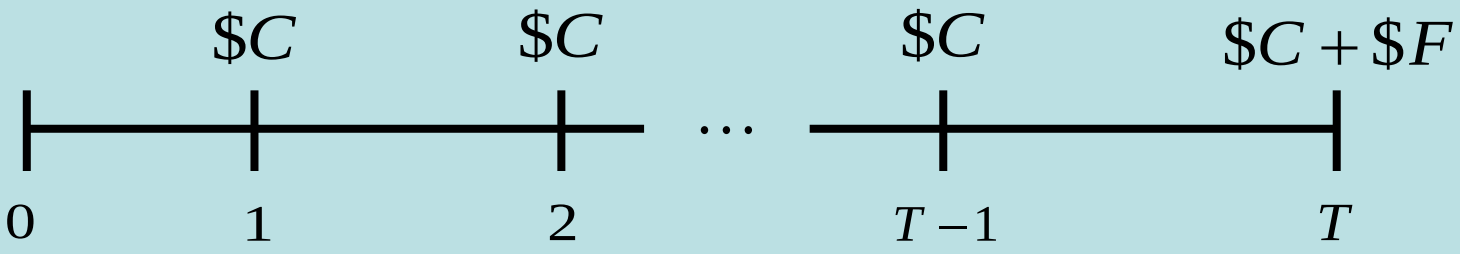
Bond Valuation

- Identify the size and timing of cash flows, i.e., coupon payments and principal repayment.
- Discount cash flows at the appropriate discount rate, which is a function of the riskiness of the bond.
  - If you know the price of a bond and the size and timing of cash flows, the *yield to maturity* is the discount rate.
  - If you want to determine the intrinsic value of a bond, use the yield to maturity on similar bonds, in terms of risk (bond rating) and maturity, as the appropriate discount rate in your calculation.

Level-Coupon Bonds

Information needed to value level-coupon bonds:

- Coupon payment dates and time to maturity (T)
- Coupon payment (C) per period and Face value (F)
- Discount rate (R)



Value of a Level-coupon bond

= PV of coupon payment annuity + PV of face value

$$PV = \frac{C}{r}\left[1 - \frac{1}{(1+r)^T}\right] + \frac{F}{(1+r)^T}$$

The Bond Pricing Equation

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

Pure Discount 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.

Pure Discount Bonds

Information needed for valuing pure discount bonds:

- Time to maturity (T) = Maturity date - today's date
- Face value (F)
- Discount rate (R)

Present value of a pure discount bond at time 0:

$$PV = \frac{FV}{(1+R)^T}$$

Pure Discount Bond: Example

Find the value of a 30-year zero-coupon bond with a $1,000 par value and a YTM of 6%.

$$PV = \frac{FV}{(1+R)^T} = \frac{\$1{,}000}{(1.06)^{30}} = \$174.11$$

Pure Discount Bonds: Example

Find the value of a 30-year zero-coupon bond with a $1,000 par value and a YTM of 6%.

N	30
I/Y	6
PV	174.11
PMT	
FV	1,000

Level Coupon Bonds

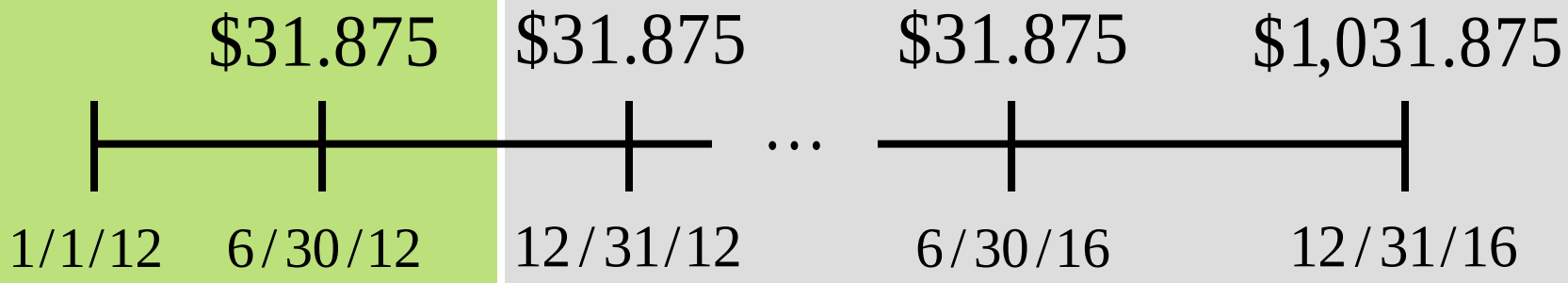
- Make periodic coupon payments in addition to the maturity value
- The payments are equal each period. Therefore, the bond is just a combination of an annuity and a terminal (maturity) value.
- Coupon payments are typically semiannual.

- Effective annual rate (EAR) =

$$(1 + R/m)^m - 1$$

Level Coupon Bond: Example

- Consider a U.S. government bond with a 6 3/8% coupon that expires in December 2016.
  - The *Par Value* of the bond is $1,000.
  - *Coupon payments* are made semi-annually (June 30 and December 31 for this particular bond).
  - Since the *coupon rate* is 6 3/8%, the payment is $31.875.
  - On January 1, 2012 the size and timing of cash flows are:



Level Coupon Bond: Example

- On January 1, 2012, the required annual yield is 5%.

$$PV = \frac{\$31.875}{.05/2}\left[1 - \frac{1}{(1.025)^{10}}\right] + \frac{\$1{,}000}{(1.025)^{10}} = \$1{,}060.17$$

Bond Example: Calculator

Find the present value (as of January 1, 2012), of a 6 3/8% coupon bond with semi-annual payments, and a maturity date of December 2016 if the YTM is 5%.

N	10
I/Y	2.5
PV	– 1,060.17
PMT	$31.875 = \frac{1{,}000 \times 0.06375}{2}$
FV	1,000

Bond Pricing with a Spreadsheet

- There are specific formulas for finding bond prices and yields 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 given as % of par value
- Click on the Excel icon for an example.

Consols

- Not all bonds have a final maturity.
- British consols pay a set amount (i.e., coupon) every period forever.
- These are examples of a perpetuity.

$$PV = \frac{C}{R}$$

Bond Concepts

1. Bond prices and interest rates (bond yields or YTMs) move in opposite directions.

2. When coupon rate = YTM, price = par value.
   When coupon rate > YTM, price > par value (premium bond)
   When coupon rate < YTM, price < par value (discount bond)

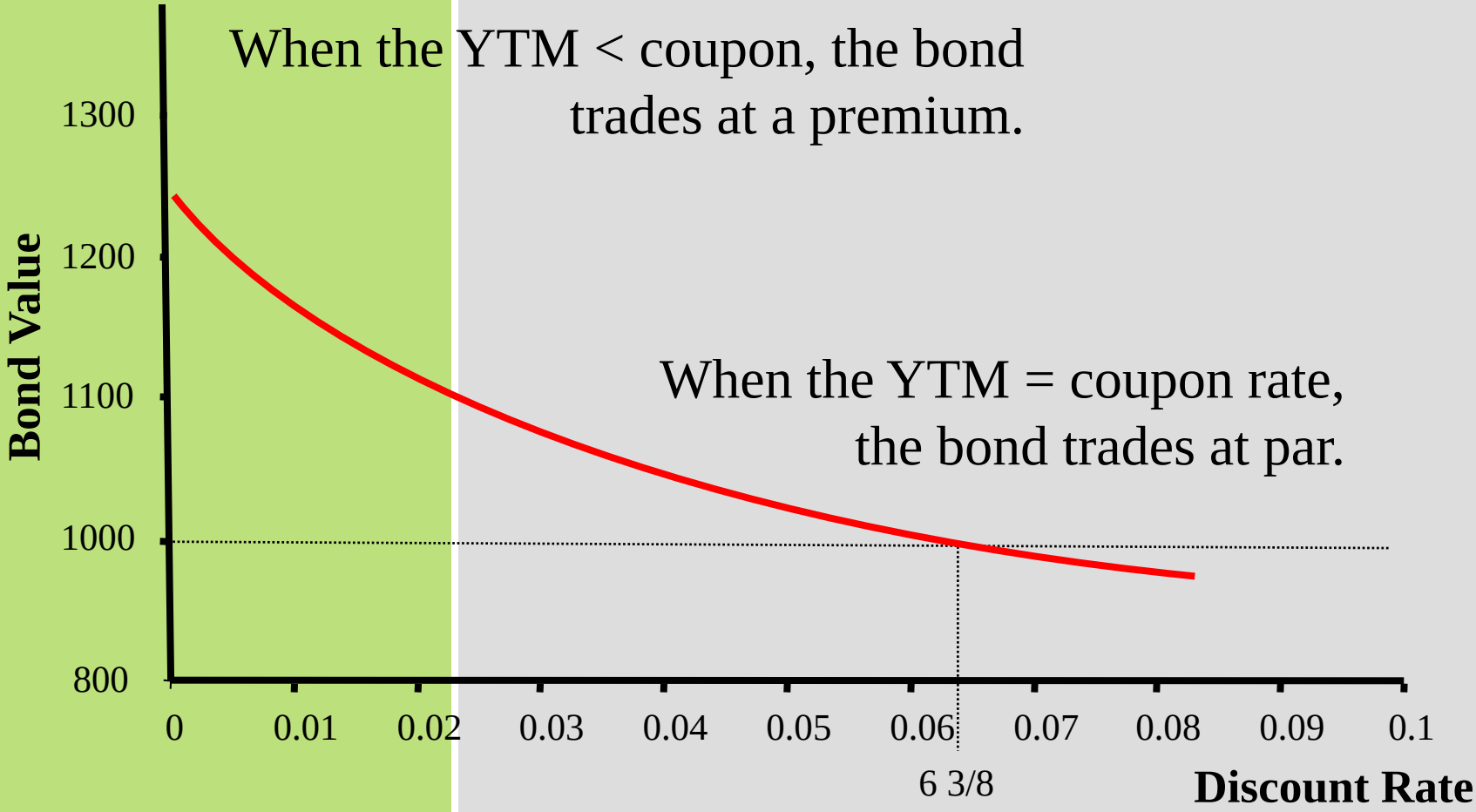
3. A bond with longer maturity has higher relative (%) price change than one with shorter maturity when interest rate (YTM) changes. All other features are identical.

4. A lower coupon bond has a higher relative price change than a higher coupon bond when YTM changes. All other features are identical.

YTM and Bond Value

When the YTM < coupon, the bond trades at a premium.

When the YTM = coupon rate, the bond trades at par.



When the YTM > coupon, the bond trades at a discount.

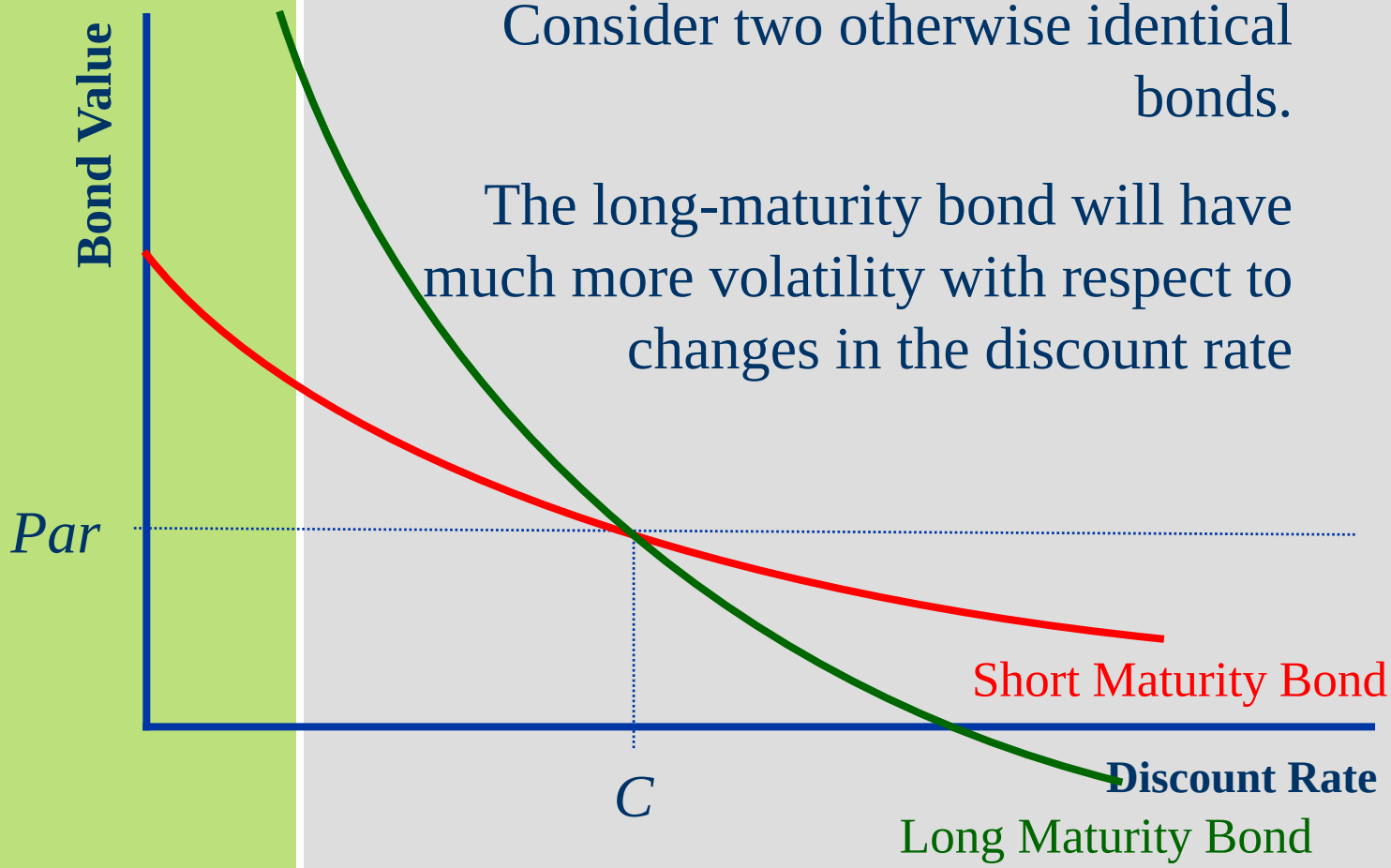
Interest Rate Risk

- 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.

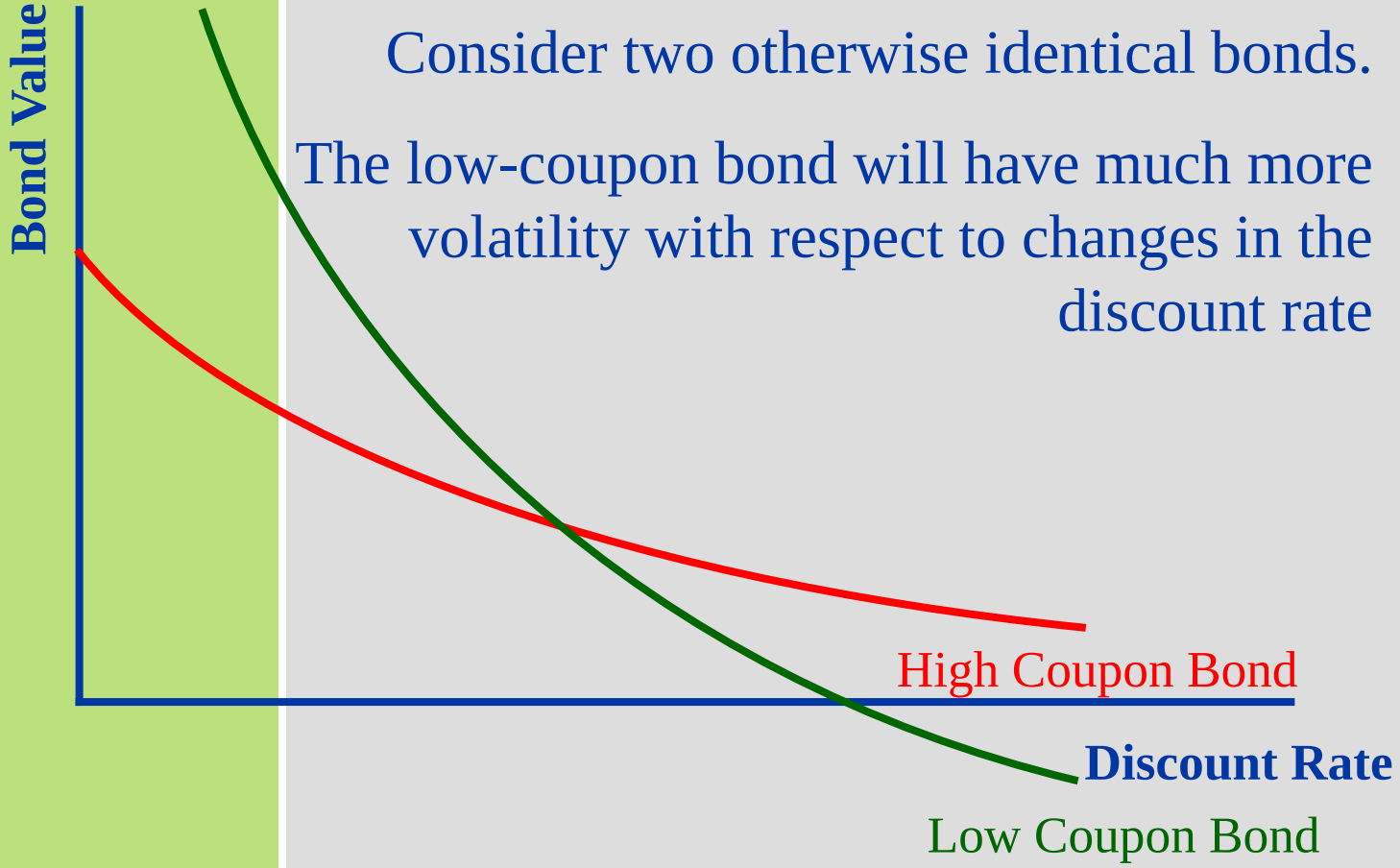
Maturity and Bond Price Volatility

Consider two otherwise identical bonds.

The long-maturity bond will have much more volatility with respect to changes in the discount rate



Coupon Rate and Bond Price Volatility

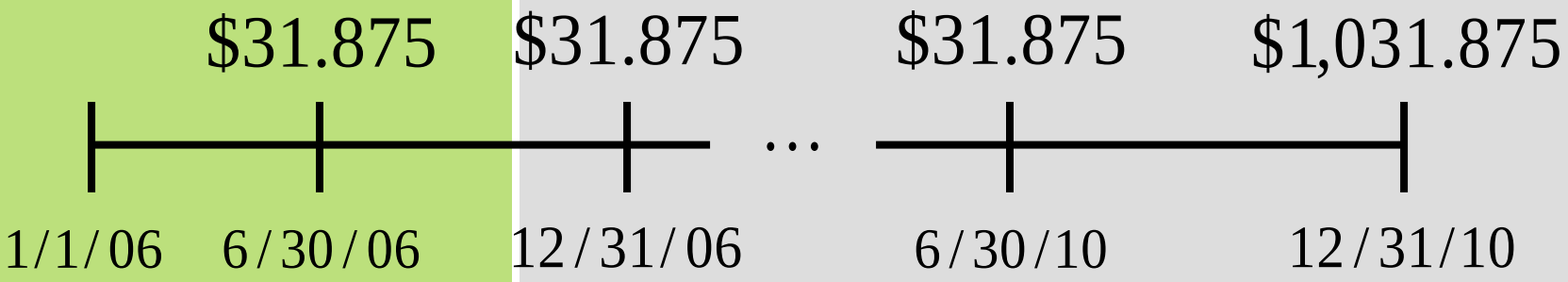


Consider two otherwise identical bonds.

The low-coupon bond will have much more volatility with respect to changes in the discount rate

Bond Example Revisited

- Using our previous example, now assume that the required yield is 11%.
- How does this change the bond's price?



$$PV = \frac{\$31.875}{.11/2}\left[1 - \frac{1}{(1.055)^{10}}\right] + \frac{\$1{,}000}{(1.055)^{10}} = \$825.69$$

Computing Yield to Maturity

- Yield to maturity is the rate implied by the current bond price.
- Finding the YTM requires trial and error if you do not have a financial calculator.
- 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%

Current Yield vs. Yield to Maturity

- Current Yield = annual coupon / price
- Yield to maturity (YTM) = current yield (CY) + capital gain yield (CGY)
  - ➔ **CGY = YTM – CY**
- Example: 10% coupon bond, with semi-annual coupons, face value of 1,000, 20 years to maturity, $1,197.93 price
  - Current yield = 100 / 1197.93 = .0835 = 8.35%
  - Price in one year, assuming no change in YTM, = 1,193.68
  - Capital gain yield = (1193.68 – 1197.93) / 1197.93 = -.0035 = -.35%
  - YTM = 8.35 - .35 = 8%, which is the same YTM computed earlier
  - OR **CGY = 8% - 8.35% = -0.35%**

Bond Pricing Theorem

- 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 of same risk.
- This is a useful concept that can be transferred to valuing assets other than bonds.

8.2 Government and Corporate Bonds (SELF-STUDY)

- Treasury Securities
  - Federal government debt
  - T-bills – pure discount bonds with original maturity less than one year
  - 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, but the exemption does NOT apply to capital gain!

After-tax Yields

- 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 - .40) = 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%

Corporate Bonds

- Greater default risk relative to government bonds
- The promised yield (YTM) may be higher than the expected return due to this added default risk

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

- Low Grade
  - Moody's Ba and B
  - S&P BB and B
  - Considered speculative with respect to capacity to pay.
- Very Low Grade
  - Moody's C
  - S&P C & D
  - Highly uncertain repayment and, in many cases, already in default, with principal and interest in arrears.

8.3 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 a small company or municipal issues
- Treasury securities are an exception

Treasury Quotations

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- 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 versus Dirty Prices

- **Clean price**: quoted price
- **Dirty price**: price actually paid = quoted price plus accrued interest

- Example: Consider T-bond in previous slide, assume today is July 15, 2012
  - Number of days since last coupon = 61
  - Number of days in the coupon period = 184
  - Accrued interest = (61/184)(.08/2*1,000) = 13.26
- Prices (based on ask):
  - Clean price = 1,327.50
  - Dirty price = 1,327.50 + 13.26 = 1,340.76
- So, you would actually pay $1,340.76 for the bond.

8.4 Inflation and Interest Rates

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

Real versus Nominal Rates

- The Fisher Equation (Recall Chapter 6)

- (1 + R) = (1 + r)(1 + h), where
  - R = nominal rate
  - r = real rate
  - h = expected inflation rate

- Approximation
  - R = r + h

Inflation-Linked Bonds

- Most government bonds face inflation risk
- TIPS (Treasury Inflation-Protected Securities), however, eliminate this risk by providing promised payments specified in real, rather than nominal, terms
  - Adjustment for inflation rate via the Par value!

The Fisher Effect: Example

- 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 a significant difference between the actual Fisher Effect and the approximation.

8.5 Determinants of Bond Yields

- Term structure is the relationship between time to maturity and yields, all else equal.
- It is important to recognize that we control for 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

Factors Affecting Required Return

- Required Return = Real Interest Rate + Expected Inflation Rate + Risk Premiums
- Real interest rate – compensation for foregoing immediate gratification; f(real economic growth)
- Inflation premium – compensation for erosion of purchasing power; f(economic condition)
- Interest rate (or maturity) risk premium - compensation for price risk; more for longer-term bonds
- Default risk premium – compensation for default risk
- Taxability premium - compensation for risk of unfavorable tax law changes
- Liquidity premium – bonds that have more frequent trading will generally have lower required returns (remember bid-ask spreads)

Quick Quiz

- How do you find the value of a bond, and why do bond prices change?
- 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?