Chapter 5

Interest Rates and Bond Valuation

Key Concepts and Skills

- Know the important bond features and bond types
- Compute bond values and comprehend why they fluctuate
- Appreciate bond ratings, their meaning, and relationship to bond terms and value
- Understand the impact of inflation on interest rates
- Grasp the term structure of interest rates and the determinants of bond yields
Bonds and Bond Valuation

- A bond is a legally binding agreement between a borrower and a lender that specifies the:
  - Par (face) value
  - Coupon rate
  - Coupon payment
  - Maturity Date
- The yield to maturity is the required market interest rate on the bond.
- Do not confuse the coupon rate with the required market interest rate

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 are inversely related to present (i.e., bond) values.
The Bond–Pricing Equation

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

Frequency of Coupon Payments

- Bond terms dictate the frequency of coupon payments
- The coupon rate is expressed in annual terms
- If the rate is expressed annually and the payments are more frequent, calculation of bond value requires:
  - Dividing the annual coupon payment by the number of compounding periods per year to arrive at the value of each coupon payment (C);
  - Dividing the annual required rate of return by the number of compounding periods per year to arrive at the desired periodic yield (r);
  - Multiplying the remaining years of the bond’s life by the number of compounding periods per year to arrive at the remaining number of coupon payments (T).
Consider a U.S. government bond with a 6 3/8% coupon that expires in December 2012.
- 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, 2008 the size and timing of cash flows are:

$31.875 $31.875 $31.875 $1,031.875

1/1/08 6/30/08 12/31/08 6/30/08 12/31/08

On January 1, 2008, the required yield is 5%.
The size and timing of the cash flows are:

$31.875 $31.875 $31.875 $1,031.875

1/1/08 6/30/08 12/31/08 6/30/08 12/31/08

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

Find the present value (as of January 1, 2008), of a 6 3/8% coupon bond with semi-annual payments, and a maturity date of December 2012 if the YTM is 5%.

\[
\begin{align*}
N &= 10 \\
I/Y &= 2.5 \\
PV &= 1,000 - 1,060.17 \\
PMT &= \frac{1,000 \times 0.06375}{2} = 31.875 \\
FV &= 1,000
\end{align*}
\]

Bond Example

› Now assume that the required yield is 11%.
› How does this change the bond’s price?

\[
PV = \frac{31.875}{0.11/2} \left[ 1 - \frac{1}{(1.055)^{10}} \right] + \frac{1,000}{(1.055)^{10}} = 825.69
\]

\[
\begin{align*}
\text{1/1/08} & \quad \text{6/30/08} & \quad \text{12/31/08} & \quad \text{6/30/12} & \quad \text{12/31/12} \\
\$31.875 & \quad \$31.875 & \quad \ldots & \quad \$31.875 & \quad \$1,031.875
\end{align*}
\]
When the YTM < coupon, the bond trades at a premium.

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

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

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**Bond Concepts**

- Bond prices and market interest rates move in opposite directions.
- 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)
**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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**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.
Consider two otherwise identical bonds. The low-coupon bond will have much more volatility with respect to changes in the discount rate.

**Coupon Rates and Bond Prices**

![Graph showing bond value vs. discount rate for high and low coupon bonds.]

**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 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 semi-annual 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 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 = 1193.68
  - Capital gain yield = (1193.68 – 1197.93) / 1197.93 = -.0035 = -.35%
  - YTM = 8.35 - .35 = 8%, which is the same YTM computed earlier

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 given as % of par value
- Click on the Excel icon for an example.
Debt versus 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 cannot go bankrupt

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
Required Yields

- 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

- 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
- Low Grade
  - Moody’s B 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.
Government Bonds

- **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
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

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%.

\[
PV = \frac{F}{(1 + r)^T} = \frac{1,000}{(1.06)^{30}} = $174.11
\]
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

- 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.
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

Bond Quotations
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 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
Factors Affecting Required Return

- Default risk premium – remember bond ratings
- Taxability premium – remember municipal versus taxable
- Liquidity premium – bonds that have more frequent trading will generally have lower required returns (remember bid-ask spreads)
- Anything else that affects the risk of the cash flows to the bondholders will affect the required returns.