**Bonds**

* Basics
  + Security that obligates the issuer to make specified payments to the holder over a period of time
  + Bond indenture
    - Contract between issuer and bondholder
    - Sets forth all obligations of the issuer
  + Cash flows
    - Principal: amount the issuer agrees to pay at maturity date
      * Also known as face or par value
    - Coupon payments
      * Coupon rate: interest rate issuer agrees to pay each period
      * Fixed, floating, zero
* Characteristics
  + Term to maturity
    - Number of years over which issuer has promised to meet conditions
    - Maturity: date at which issuer redeems the bond by paying outstanding principal
  + Price
    - Reflects current market rates
    - Quoted as a % of face value
    - If bond trades at face value, then it “trades at par”
  + Yield
    - Current interest rates determine the yield (and therefore price)
* Corporate bonds
  + Financial obligations of a corporation that have priority over common and preferred stock in case of bankruptcy
    - Legal default: failure to pay either principal or interest
  + Security for bonds
    - Mortgage bonds: secured by mortgage property
    - Collateral trust bonds: secured by stocks, notes, bonds, etc.
    - Debenture bonds: not backed by specific property
    - Subordinated debenture bonds: rank after debentures in claims
* Corporate bond—other provisions
  + May have a special repayment provision. Two major types:
    - Sinking fund: firm agrees to make early principal payments on a set schedule
      * Doesn’t have to be uniform or even payments, but it has to be pre-planned
    - Serial bonds: firm issues bonds with staggered maturities, so that portions of the issue mature sooner than others
  + Bond may also include certain restrictions on the firm’s ability to pay dividends
    - Can be a limit on the amount of the dividend or an outright prohibition
* Corporate Bond Options
  + Indenture may include provision that gives either bondholder and/or issuer an option to take some action against the other party
  + Call: grants issuer right to retire bonds before maturity date
    - Good for firm (refinances at a lower rate), bad for investor
  + Convertible: gives holder the right to exchange for shares of stock
    - Good for the investor
  + Put: allows bondholder to sell issue back at par value
    - Good for investor🡪allows you to cash out
* Major Bond Investing Risks
  + Interest rate risk: if rates rise, sell below purchase price
    - Higher rate, lower price
  + Reinvestment risk: market rate at which you invest cash flows falls
  + Any movement in interest rates is potentially bad for the bond investor
    - Rates rise, value of your position falls
    - Rates fall, you have to reinvest at a lower rate
* Other Significant Investing Risks
  + Call risk: issuer may call (retire) bond before maturity date
    - Will only call if rates have dropped, allowing firm to refinance at a lower rate
    - Hurts the bond investor, as they now have to reinvest their full principal at a lower rate
  + Credit (Default) risk: issuer fails to fulfill payment obligations
    - The bond investor’s upside is limited to the contracted amount, but if the firm is unable to pay, they might receive less
* Corporate Bond Credit Analysis
  + Estimating the ability of the issuer to meet obligations
    - Provide guidance for the likelihood of default and recovery given default
    - Investment grade (BBB or higher) vs. junk bonds
  + Determinants of financial risk:
    - Coverage ratio (pre-tax earnings to fixed costs)
    - Leverage (D/E)
    - Liquidity (current)
    - Profitability (ROA, ROE)
    - Cash flow to debt
* Danger: Relying on Ratings Alone
  + Keep 2 things in mind:
    - Specific ratings formulas may be proprietary and private, but we know a great deal about what goes into them
    - Ratings agencies are ultimately paid by the same firms they are rating
  + Firms have strong incentives to figure out the bare minimum they would need to do to get “bumped up” to the next rating
* Typical Bond Pricing
  + Bond contract specifies coupon rate
    - This is the rate of interest paid as coupons, but it doesn’t necessarily relate to an investor’s return on the bond
  + Often we assume one interest rate holds for the entire life of the bond
    - In these cases, we can make our calculations much simpler, as the coupon payments form an annuity
    - This rate is the YTM
  + However, most bonds pay semi-annual coupons
    - Generally, most interest rates are in APR terms
    - Double the number of periods and half the interest rate in calculations
* Example: Pricing
  + US Treasury has a 20 year bond outstanding with coupon of 4%. This bond was originally issues 4 years ago. What price does it sell for today if YTM is 6%? Assume semi-annual coupons.
* YTM
  + Discount rate that makes price = present value
  + Return if you hold the bond to maturity and reinvest coupons
  + Reported as a bond equivalent yield (APR)
* Current Yield
  + Measures cash income as a % of price
  + Ignores capital gains
  + Useful if you need to consider the cash flow of the bond investment
* Yield to Call
  + Yield that sets the current price equal to the present value until the bond is called
  + Assumes that the bond is called as early as possible
  + N is the number of periods until the bond can be called (usually have a waiting period)
  + BA II Plus
    - FV = may need to replace with the call price
    - n = # of periods until bond is callable
* Example: Bond Yields
  + Consider a 20 year bond with a 6% coupon rate that makes semiannual payments. The bond is priced at $1,095. The bond is callable at a price of $1,050 in 5 years. What is the bond’s YTM?
  + What is the current yield?
  + What is the yield to call?
* Relationship Between Yield Measures
  + YTM assumes that you hold the bond to maturity (best case)
  + YTC assumes bond is called as soon as possible (worst case)
    - Bond will only be called if interest rates have fallen
    - YTC only matters if the bond is trading at a premium
    - May be equal to or greater than the YTM otherwise
  + Current yield disregards capital gains
    - If you purchase the bond at a discount, the current yield will be lower than the YTM
    - If you purchase the bond at a premium, the current yield will be higher than the YTM
* Realized Compound Yield
  + Recall that we receive cash from a bond in 2 ways:
    - Selling the bond/the bond maturing
    - Coupon payments
  + Another way: reinvest coupon payments
  + YTM makes a huge assumption about this reinvestment:
    - Assumes we reinvest at YTM
    - What if we don’t get that rate?
  + Illustrated
  + Will allow us to account for differing reinvestment rates
  + Rate of return realized over the life of the bond, accounting for the reinvestment rate of coupons
  + Where:
  + Note: set up to be used historically, would have to forecast future rates in order to use it as a future model
* Using BA II Plus for Yr
  + Inputs
    - PV = -Price
    - FV = Total Future Dollars
    - N = T
    - PMT = 0
* Example: Realized Compound Yield
  + Consider a 3 year bond that you originally purchased for $960 that paid a 7% coupon annually. Over the next 3 years, interest rates fluctuated, affecting the reinvestment rate of the coupons. The one year interest rates were actually 4%, 9%, and 6%. What was your actual return over these 3 years?
* Issues in Bond Pricing
  + 2 big assumptions we have made to this point:
    - We are always buying and selling the bond exactly on a coupon date
    - There is a single YTM that covers the bond’s entire life
  + What if these aren’t true?
    - If we don’t buy or sell on a coupon date, we would need to divide the interest between buyer and seller
    - If there isn’t a single yield, we would need to discount each cash flow separately
* Bond Pricing Between Coupon Payments
  + Our pricing formula assumes next coupon payment is one period away
  + Interest accrues to the bondholder between payment periods
    - Bondholder must be compensated at time of sale
  + Then the actual price of the bond is:
* Example: Pricing Between Coupon Dates
  + A coupon bond paying semi-annual interest is reported as having an ask price of 110% of its $1,000 par value. If the last interest payment was made 2 months ago and the coupon rate is 8%, what is the invoice price of the bond?
* Generalized Bond Pricing
  + Remember the law of one price:
    - Coupon payment = coupon rate x FV
    - Rt is the discount rate for CFs at time t
    - T is maturity date
* Example: Generalized Bond Pricing
  + The one period spot rate is 1.5%, the two period spot rate is 2%, and the three period spot rate is 2.5%. What price does a 3 period bond with a coupon rate of 3% and a face value of $1,000 sell for?
* Bond Prices and Yields
* Yield Curve
  + Graphical representation of the relationship between the yields on bonds of the same credit quality but different maturities
    - Term structure of interest rates
* Zero Coupon Yield Curve
  + Bonds are packages of zero-coupon instruments
  + Each zero-coupon instrument has maturity equal to its coupon date
    - Or maturity date for the principal payment
  + Value of the bond equals the value of all the component zero-coupon bonds
  + Spot yield: the YTM on a zero-coupon bond (starting today)
* Using BA II Plus for Zero Coupon Bonds

|  |  |
| --- | --- |
| Knowing the YTM | Knowing the Bond Price |
| **Calculating the Bond Price** | **Calculating the YTM** |
| FV = -Face Value | FV = +Face Value |
| I/Y = YTM | PV = -Bond Price |
| PMT = 0 | PMT = 0 |
| N = T | N = T |

* Consequence: Bond Arbitrage
  + We should be able to deconstruct any bond and reproduce it has a series of zero coupon bonds
  + The two investments should be the same price, whether we purchase one coupon-paying bond or multiple zero coupon bonds
    - **If they are different, then there is an arbitrage opportunity**
  + We can buy the cheaper investment and short the more expensive investment. Since the cash flows are the same, we would make a riskless profit
* Example: Arbitrage
  + You observe the following prices for default free, zero coupon bonds:

|  |  |  |  |
| --- | --- | --- | --- |
| Maturity (Years) | 1 | 2 | 3 |
| Price (FV = $1000) | $975 | $930 | $880 |

* + At the same time, suppose that a 3-year, default free, 8% coupon bond is trading at $1,095. Is there an arbitrage opportunity?
* Consequence of Example
  + We were given that the 3 year coupon-paying bond costs $1,095 while we found that replacing it using a set of zero coupon bonds would cost $1,102.80
  + We would make a riskless $7.80 profit by implementing the following strategy:
    - Buy the 3 year coupon paying bond for $1,095
    - Short an $80 face value 1 year zero coupon bond
    - Short an $80 face value 2 year zero coupon bond
    - Short an $1,080 face value 3 year zero coupon bond
* Yield Curve and Pricing—Nominal Spread
  + Would like to use the Treasury Yield Curve to price other issues
  + Nominal spread: we can simply add a risk premium to the relevant Treasury Yield
  + For example, suppose that the YTM on a 10-year Treasury bond was 3%. Then a 10-year Baa corporate bond would be priced to yield 3% plus the Baa credit spread
    - Problem: ignores differences in cash flow patterns
* Yield Curve and Pricing—Z Spread
  + Instead of taking the treasury rate at a single point, we could calculate a more comprehensive measure
  + Zero Volatility Spread (Z-Spread): the spread the investor would capture over the entire treasury yield curve if the bond is held to maturity
    - Problem: no way to solve for this, can use Solver in Excel
* Yield Curve and Pricing—Bond Options
  + We can go one step further and take the effects of embedded options into account with our calculations
  + Option-Adjusted Spread (OAS): the spread the investor captures above the entire treasury yield curve adjusted for the effects of the embedded option
  + For a bond with a call provision: OAS < Z-Spread
  + For a bond with a put provision: OAS > Z-Spread
  + For an option-free bond: OAS = Z-Spread
* Deriving the Yield Curve
  + Term structure of interest rates
    - Pattern of spot rates over a range of maturities
  + Problem:
    - T-bills are the only zero coupon treasuries, and they only have maturities up to one year
  + Any coupon-paying bond is “contaminated”: we can’t use it to determine a given yield, since it will have cash flows at different times
    - Impossible to isolate a given length of time
* Bootstrapping the Yield Curve
  + Bootstrapping: fill in the missing values using available data
    - Derive the theoretical term structure of interest rates
  + We will start with a short-term zero coupon bond (usually a T-bill)
    - Once we know its yield, we can use it to figure out the value of the coupon for a longer-term coupon-paying bond
    - We discount the coupon and then subtract it from the price of the bond
    - This leaves a “zero coupon” bond, so we can calculate a “pure” interest rate
  + Illustrated
* Example: Bootstrapping
  + Suppose you observe the following:
    - A 6 month T-bill trading at $9,800
    - A 12 month T-bill trading at $9,200
    - An 18 month T-note trading at par with a 9% coupon rate
  + Find the theoretical spot rate curve
  + Now find the 18 month spot rate
* Rethinking the Yield Curve
  + When thinking about bootstrapping, we have focused on a rate that starts today and runs through a particular period of time
  + How do we get from the shorter term rate to the longer term rate?
  + We have a one period rate and a two period rate
  + What would I get in period two if I invested in the one period rate now?
* Forward Rates
  + Spot rates
    - Rate at which you agree today for an investment
    - Denoted Yn (or rn)
  + Forward rates
    - Rate at which we would agree today for an investment that will take place in the future
    - Depend on spot rates from the yield curve
* Using BA II Plus for the Forward Rate
  + Can use to calculate the forward rate and skip needing the annualized spot yields
    - Note: not faster if we actually need the spot rates
  + Inputs
    - PV = -
    - FV =
    - N = t
    - PMT = 0
    - CPT I/Y
  + Example: Spot Rates
    - Given the following prices and maturities of a set of zero coupon bonds:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Maturity (Years) | 1 | 2 | 3 | 4 |
| Price (FV = $1000) | $940 | $870 | $790 | $680 |

* + - What are the spot rates implied by the 1 and 2 year maturity bonds?
    - The 3 and 4 year bonds?
* Example: Forward Rates
  + Prices and maturities of a set of zero coupon bonds:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Maturity (Years) | 1 | 2 | 3 | 4 |
| Price (FV = $1000) | $940 | $870 | $790 | $680 |

* + What is the 1 year forward rate starting at year 1? The 2 year forward rate? 3 year forward rate?
  + What is the 1 year forward rate starting at year 2? The 2 year forward rate?
  + What is the 1 year forward rate starting at year 3?
* Yield Curve Determinants
  + Expectations Theory
    - Long term rates are a function of expected future short term rates
    - Upward slope means that the market is expecting higher future short term rates
    - Downward slope means that the market is expecting lower future short term rates
  + Liquidity Preference
    - Upward bias over expectations
    - The observed long term rate includes a risk premium