经济管理学院
The college of Economics and Management

Lecture 7

Interest Rates and Bond Valuation

Corporate Finance – Fall 2019

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Prelude

- Bond is a major source of financing for corporations. This chapter introduces bond features and how bonds are bought and sold.
- Apply DCF model (Chapter 6) to bond valuation
  - Remember, as with any asset, the value of a bond is simply the present value of its future cash flows
  - bond values largely depend on interest rates

Learning Objectives

- LO1: Important bond features and types of bonds
- LO2: Bond values and yields and why they fluctuate
- LO3: Bond ratings and what they mean
- LO4: The impact of inflation on interest rates
- LO5: The term structure of interest rates and the determinants of bond yields

Chapter Outline

7.1 Bonds and Bond Valuation

7.2 More about Bond Features

7.3 Bond Ratings

7.4 Some Different Types of Bonds

7.5 Bond Markets

7.6 Inflation and Interest Rates

7.7 Determinants of Bond Yields

7.1.1 Bond features and prices

- a bond is normally an interest-only loan
  - COUPON: the stated interest payment made on a loan
    - We are describing level coupon bonds – the coupon is constant and paid ever year
  - FACE (PAR) VALUE: the principle amount of a bond that is repaid at the end of the term.
    - A bond that sells for its par value -> par value bond
    - Government bonds frequently have much larger face values
  - COUPON RATE: the annual coupon divided by the face value of a bond
  - MATURITY: the specified date on which the principle amount of a bond is paid
    - usually 30 years for a corporate bond

7.1.2 Bond values and yields

- The value of the bond will fluctuate
  - The cash flows stay the same, but the interest rate changes
    - The coupon rate and the face value are fixed by the bond indenture when the bond is issued (except for floating-rate bonds)
    - Therefore, the expected cash flows don’t change during the life of the bond
    - However, the bond price will change as interest rates change and as the bond approaches maturity
  - Bond prices and interest rates move in opposite directions

- Determinants of bond value in particular time (DCF model)
  - The number of periods until maturity
  - The face value
  - The coupon
  - Yield to maturity (YTM, or yield)
    - The rate required in the market on a bond
    - The market interest rate for bonds with similar features

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

$$\text{Bond value} = \begin{matrix}\text{Present value} \\ \text{of the coupons}\end{matrix} + \begin{matrix}\text{Present value} \\ \text{of the face amount}\end{matrix}$$

- If coupon rate = YTM, then bond price = par value
  - See textbook example around Figure 7.1
- If coupon rate < YTM, then bond price < par value
  - Why? The discount provides such yield above coupon rate
  - Price below par value -> called a discount bond
- If coupon rate > YTM, then bond price > par value
  - Why? Higher coupon rate causes value above par
  - Price above par value -> called a premium bond

Example: Valuing a discount bond

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 = PV of the coupons + PV of the face amount
  - $B = 100[1 - 1/(1.11)^5] / .11 + 1{,}000 / (1.11)^5$
  - B = 369.59 + 593.45 = 963.04
- Using a spreadsheet or a financial calculator

Example: Valuing a Premium Bond

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?

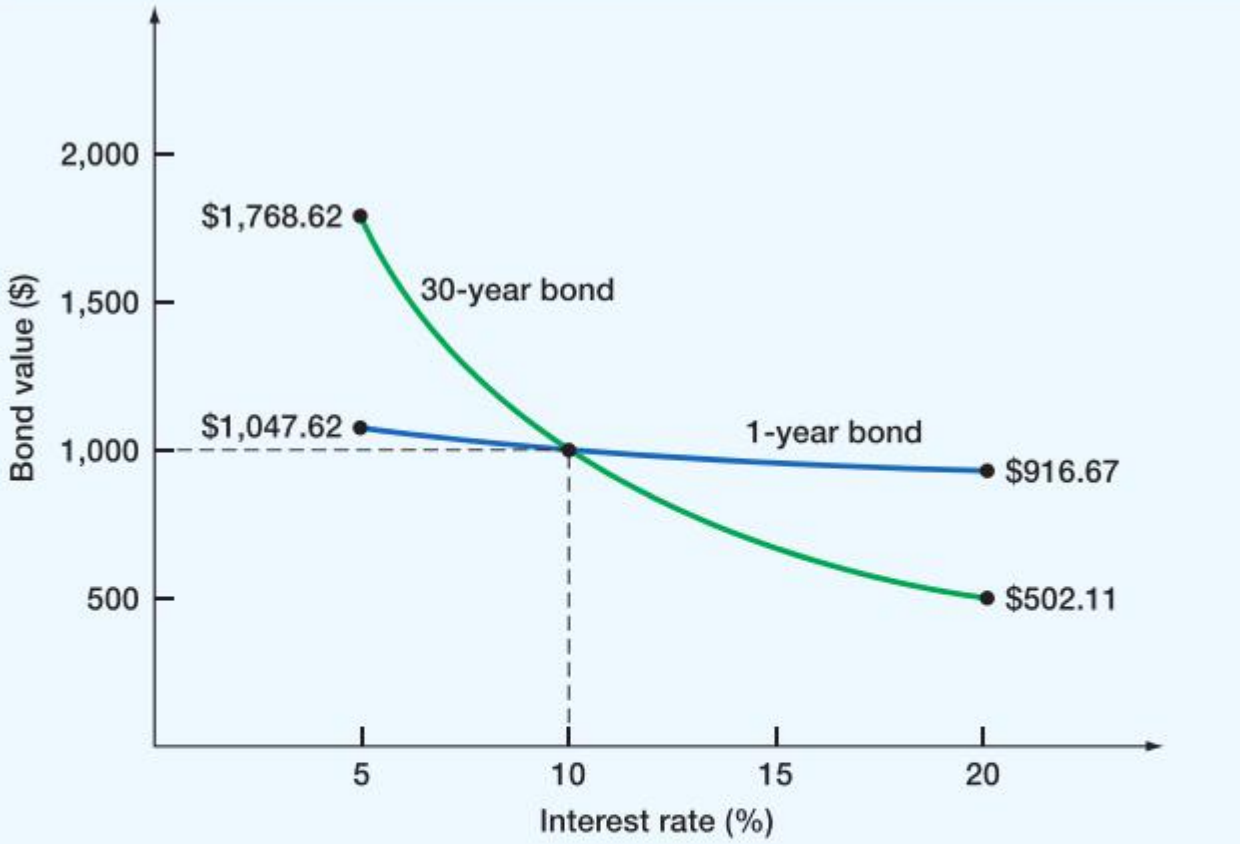
- B = PV of the coupons + PV of the face amount
- $B = 100[1 - 1/(1.08)^{20}] / .08 + 1000 / (1.08)^{20}$
- B = 981.81 + 214.55 = 1196.36

- Semiannual coupons (textbook example 7.1)
  - In practice, bonds issued in US usually pay coupons twice a year
    - bond yield and coupon rate are quoted like APRs
  - In our textbook, most examples consider annual coupons

7.1.3 Interest rate risk

- INTEREST RATE RISK: the risk that arises for bond owners from fluctuating interest rates
- More sensitive a bond's price is to interest rate changes -> greater interest rate risk.
- Specifically, as long as all other things being equal:
  - longer time to maturity -> greater interest rate risk
    - a large portion of the value comes from the face amount
  - lower coupon rate -> greater interest rate risk
    - all other things being equal
    - the value is more dependent on the face amount to be received at maturity
  - interest risk increases at a decreasing rate

Interest rate, bond value, & time to maturity



Value of a Bond with a 10 Percent Coupon Rate for Different Interest Rates and Maturities

	Time to Maturity	
Interest Rate	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

7.1.4 Find the yield to maturity: more trial and error

- Yield to maturity is implied by the current bond price
  - Excel spreadsheet (YIELD function), financial calculator, OR trial and error
- Current yield = annual coupon / price
  - YTM considers both current yield and capital gains yield
    - see Question 2
  - for discount bond, current yield < YTM
    - not consider built-in gain from the price discount
  - for premium bond, current yield > YTM
    - see textbook example 7.2
    - not consider built-in loss from the price premium

7.2 More about bond features

- equity securities vs. debt securities

- 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

7.2.1 Is it debt or equity?

- Sometimes the answer is not clear
  - Some bonds are very much similar to equities
  - Courts and taxing authorities would have the final say
- Corporations are adept at creating bonds that have equity features
  - Tax benefits of debt
  - Bankruptcy benefits of equity

7.2.2 Long-term debt: the basics

- Short-term vs. long-term
  - Short-term debt: with maturities of one year or less
  - Long-term debt: with maturities or more than one year
  - Our textbook uses debt to refer to long-term debt
- Bonds and notes
  - Issues with an original maturity more than one year and less than 10 years are often called notes
  - Longer-term issues are called bonds
- Two major forms of long-term debt
  - Public-issue (the main focus of this chapter)
  - Privately placed (directly placed by a lender and not offered to the public)

7.2.3 The indenture

- A 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)
  - The repayment arrangements
  - The call provisions
  - Details of protective covenants
- Bond Classifications
  - identification of owners: registered vs. bearer form
  - security: collateral, mortgage, and debenture
  - seniority: senior debts -> junior debts -> subordinated debts -> equity
- Repayment: at or before maturity
  - early repayment is often handled through a sinking fund

Example: 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
- Answers
  - Debenture: secured debt is less risky because the income from the security is used to pay it off first
  - Subordinated debenture: will be paid after the senior debt
  - Bond without sinking fund: company has to come up with substantial cash at maturity to retire debt, and this is riskier than systematic retirement of debt through time
  - Callable – bondholders bear the risk of the bond being called early, usually when rates are lower. They don't receive all of the expected coupons and they have to reinvest at lower rates.

7.3 Bond ratings

- Two leading bond-rating firms: Standard & Poor's (S&P), Moody's
- The debt ratings are an assessment of the creditworthiness of the corporate issuer
  - how likely the firm is to default
  - the protection creditors have in the event of default
  - concerned only with default, not with interest risk
- Ratings
  - AAA or Aaa: extremely good quality, not very often
  - AA or Aa: very good quality
  - BBB or Baa: the least investment grade
  - crossover or 5B (BBB and Ba, or BB and Baa): rate agencies don't agree
  - fallen angels: bonds that drop into junk status

	Investment-Quality Bond Ratings				Low-Quality, Speculative, and/or "Junk" Bond Ratings					
	High Grade		Medium Grade		Low Grade		Very Low Grade			
Standard & Poor's	**AAA**	**AA**	**A**	**BBB**	**BB**	**B**	**CCC**	**CC**	**C**	**D**
Moody's	**Aaa**	**Aa**	**A**	**Baa**	**Ba**	**B**	**Caa**	**Ca**	**C**	

Moody's	S&P	
Aaa	AAA	Debt rated Aaa and AAA has the highest rating. Capacity to pay interest and principal is extremely strong.
Aa	AA	Debt rated Aa and AA has a very strong capacity to pay interest and repay principal. Together with the highest rating, this group comprises the high-grade bond class.
A	A	Debt rated A has a strong capacity to pay interest and repay principal, although it is somewhat more susceptible to the adverse effects of changes in circumstances and economic conditions than debt in high-rated categories.
Baa	BBB	Debt rated Baa and BBB is regarded as having an adequate capacity to pay interest and repay principal. Whereas it normally exhibits adequate protection parameters, adverse economic conditions or changing circumstances are more likely to lead to a weakened capacity to pay interest and repay principal for debt in this category than in higher-rated categories. These bonds are medium-grade obligations.
Ba; B Caa Ca C	BB; B CCC CC C	Debt rated in these categories is regarded, on balance, as predominantly speculative with respect to capacity to pay interest and repay principal in accordance with the terms of the obligation. BB and Ba indicate the lowest degree of speculation, and Ca, CC, and C the highest degree of speculation. Although such debt is likely to have some quality and protective characteristics, these are outweighed by large uncertainties or major risk exposures to adverse conditions. Issues rated C by Moody's are typically in default.
	D	Debt rated D is in default, and payment of interest and/or repayment of principal is in arrears.

NOTE: At times, both Moody's and S&P use adjustments (called notches) to these ratings. S&P uses plus and minus signs: A+ is the strongest A rating and A− the weakest. Moody's uses a 1, 2, or 3 designation, with 1 being the highest.

7.4 Some different types of bonds

7.4.1 government bonds

- 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
  - these bonds are just ordinary coupon bonds, except for
    - no default risk
    - exemption from state income taxes (although with federal income taxes)
- Municipal Securities
  - Debt of state and local governments
  - Varying degrees of default risk, rated similar to corporate debt
  - exempt from federal income taxes (not necessarily state income taxes)
  - see textbook example 7.4

7.4.2 zero coupon bonds

- ZERO COUPON BONDS: a bond that makes no coupon payments and is thus initially priced at a deep discount
  - e.g. Treasury Bills, principal-only Treasury strips
- Calculate using semiannual periods (consistent with coupon bond calculations)
- the implicit interest is determined by amortizing the loan (Table 7.2)
  - the issuer deducts interest every year
  - the owner must pay taxes on interest accrued every year
    - even though no interest is actually paid or received
- some bonds are zero coupon bonds for only part of their lives

7.4.3 floating-rate bonds

- The coupon payments are adjustable
  - The adjustments are tied to an interest rate index
    - e.g. Treasury bill interest rate, 30-year treasury bond rate
  - The coupon adjusts with a lag to the base rate
- The value of a "floater" depends on exactly how the coupon payment adjustments are defined
- The holder has the right to redeem the note at par on the coupon payment date after some time
- The coupon rate has a floor and ceiling (called collar)
- TIPS (Treasury inflation-protected securities)
  - coupons are adjusted according to the rate of inflation
  - the principle amount may be adjusted as well

7.5 Bond markets

- The daily trading volume in bonds is many times larger than the trading volume in stocks
  - in terms of trading volume, U.S. treasury market is the largest securities market

7.5.1 How bonds are bought and sold

- Most trading in bonds takes place over the counter (OTC)
  - no particular place
  - dealers around the world are connected electronically
- The number of bond issues far exceeds the number of stock issues
  - a corporation would typically have only one common stock issue, but it could easily have a dozen or more note and bond issues
  - federal, state, and local borrowing is enormous

- The bond market has historically had little or no transparency due to OTC
  - not possible to observe prices and volumes
  - transactions are privately negotiated between parties
    - little or no centralized reporting of transactions
  - The reported volume of bonds traded is not indicative of total activity due to off exchange transactions

7.5.2 Bond price reporting

- Under the regulation in 2002, corporate bond dealers are required to report trade information through the Trade Reporting and Compliance Engine (TRACE)
  - available at finra-markets.morningstar.com

- The U.S. treasury market is also an OTC market
  - 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
  - However, trading in Treasury issues is very heavy
    - representative prices for outstanding treasury issues are report each day
    - see Figure 7.4
  - Terminology
    - BID PRICE: the price a dealer is willing to pay for a security
    - ASK PRICE: the price a dealer is willing to take for a security
    - BID-ASK SPREAD: the difference between the bid price and the asked price
    - Bellwether bond: the last ordinary bond listed (with longest time to maturity), often referred to as "long-term interest rate“
  - Yields of Treasury issues vary by maturity (section 7.7)

7.5.3 A note about bond price quotes

- The bond market is to quote prices net of accrued interest
- CLEAN PRICE: the price a bond net of accrued interest -> this is the price that is typically quoted
- DIRTY PRICE: the price of a bond including accrued interest, also known as the full or invoice price -> this is the price the buyer actually paid

- *Example: Clean vs. Dirty Prices*
  - dirty price = quoted price + accrued interest
  - Consider a T-bond with a 4% semiannual rate 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*1000) = $13.26
    - Dirty price = $1,282.50 + $13.26 = $1,295.76
  - So, you would actually pay $ 1,295.76 for the bond

7.6 Inflation and interest rates

7.6.1 Real versus nominal rates

- NOMINAL RATES: interest rates or rates or return that have not been adjusted for inflation
  - The percentage change in the number of dollars you have
- REAL RATES: interest rates or rates of return that have been adjusted for inflation
  - The percentage change in how much you can buy with your dollars, or the percentage change in your buying power
  - e.g. textbook example: nominal return vs. pizza rate of return

7.6.2 The fisher effect

- the relationship between nominal returns, real returns, and inflation
- $1 + R = (1 + r) \times (1 + h)$
  - R is nominal rate, r is real rate, h is inflation rate
- $R = r + h + r \times h$
  - real rate, r
  - compensation for the decrease in the value of original money because of inflation, h
  - compensation for the decrease in dollar earned on the investment because of inflation, r*h
- Approximation: $R \approx r + h$
  - the third term is normally small

- Financial rates (interest rates ,discount rates, return...) are almost always quoted in nominal terms

7.6.3 Inflation and present values

- Principle: either discount nominal cash flows at a nominal rate or discount real cash flow at a real rate
- consistency leads to the same answer
- Textbook example of withdrawals

7.7 Determinants of bond yields

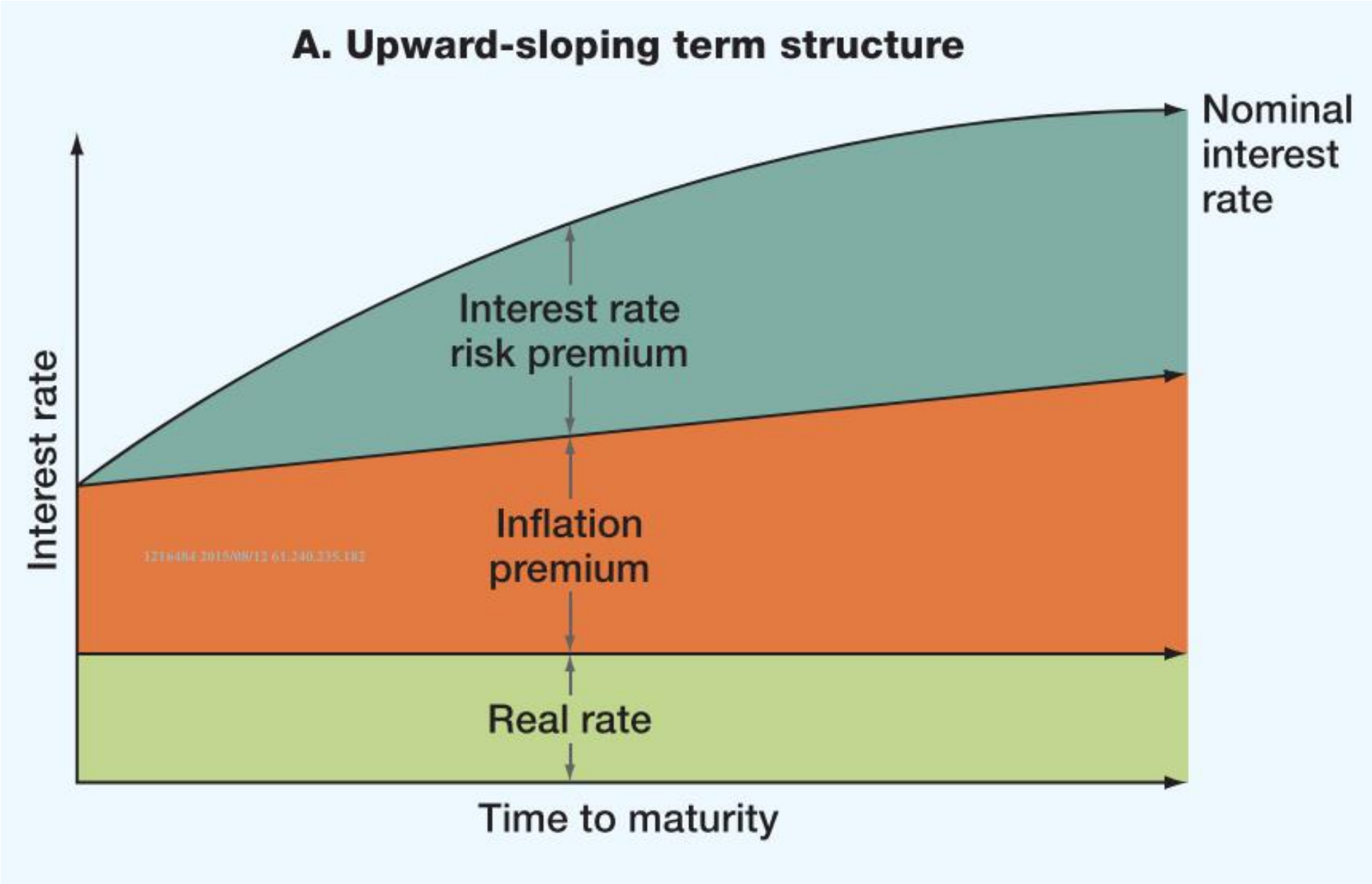
7.7.1 The term structure of interest rates

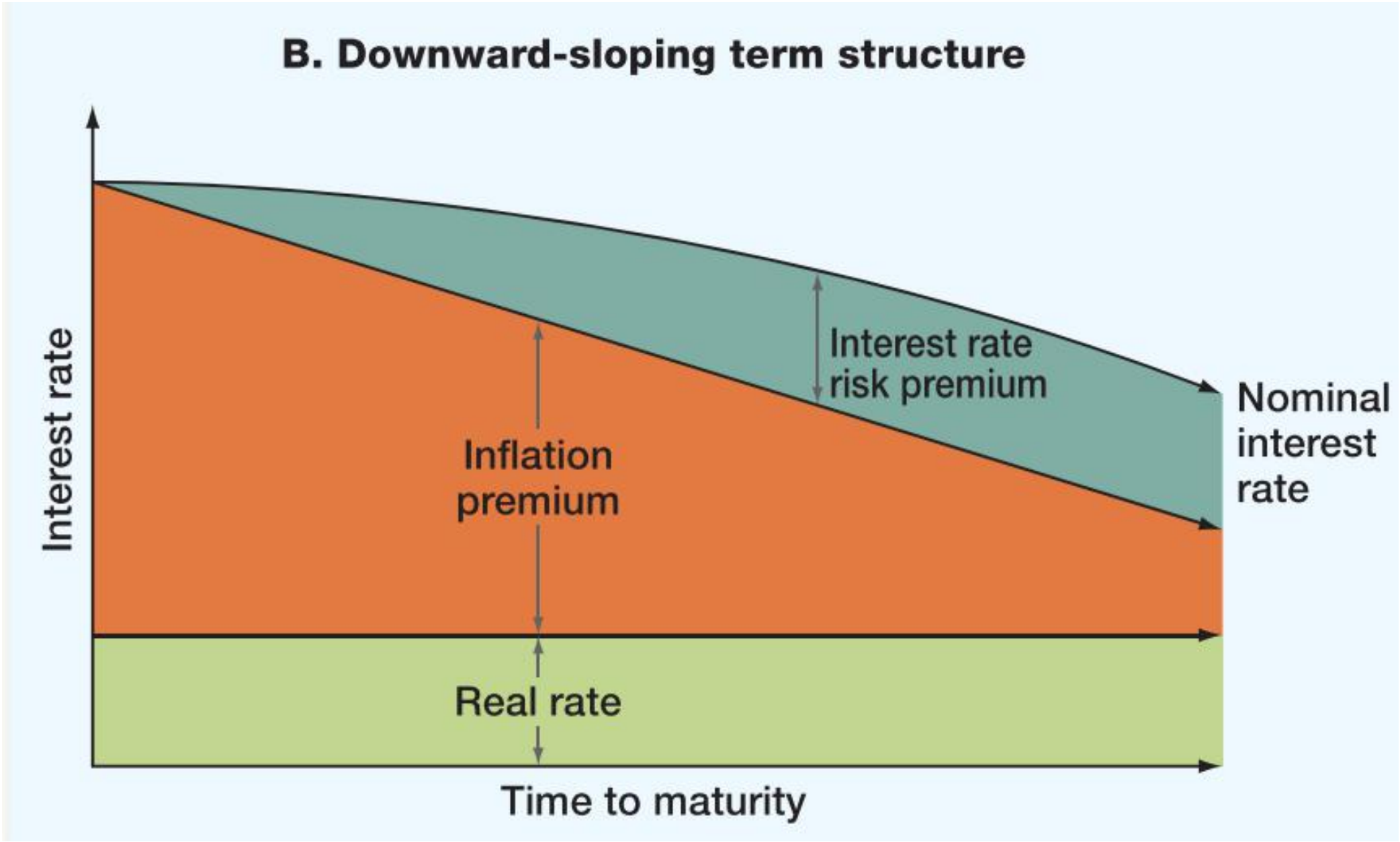
- TERM STRUCTURE OF INTEREST RATES: the relationship between nominal interest rates on default-free, pure discount securities and time to maturity
  - That is, the pure time value of money for different length of time
  - No risk of default involved
- Upward sloping
  - Long-term rates > short-term rates
  - Most common shape in modern times
    - However, the degree of steepness has varied a lot

- Downward sloping
  - short-term rates > long-term rates
- Other shapes (e.g. "humped")
- Determinants of term structure
  - I. the real rate of interest
    - Compensates investors for forgoing the use of money
    - Basic component underlying every interest rate, regardless of the time to maturity
    - Doesn't really determine the shape, but influences the level

- II. The rate of inflation
  - INFLATION PREMIUM: the portion of a nominal interest rate that represents compensation for expected future inflation
  - Strongly influences the shape
  - Investors expect higher inflation in the future -> upward-sloping term structure may reflect the increases in inflation
  - Investors expect lower inflation in the future -> downward-sloping term structure probably reflects that falling in inflation

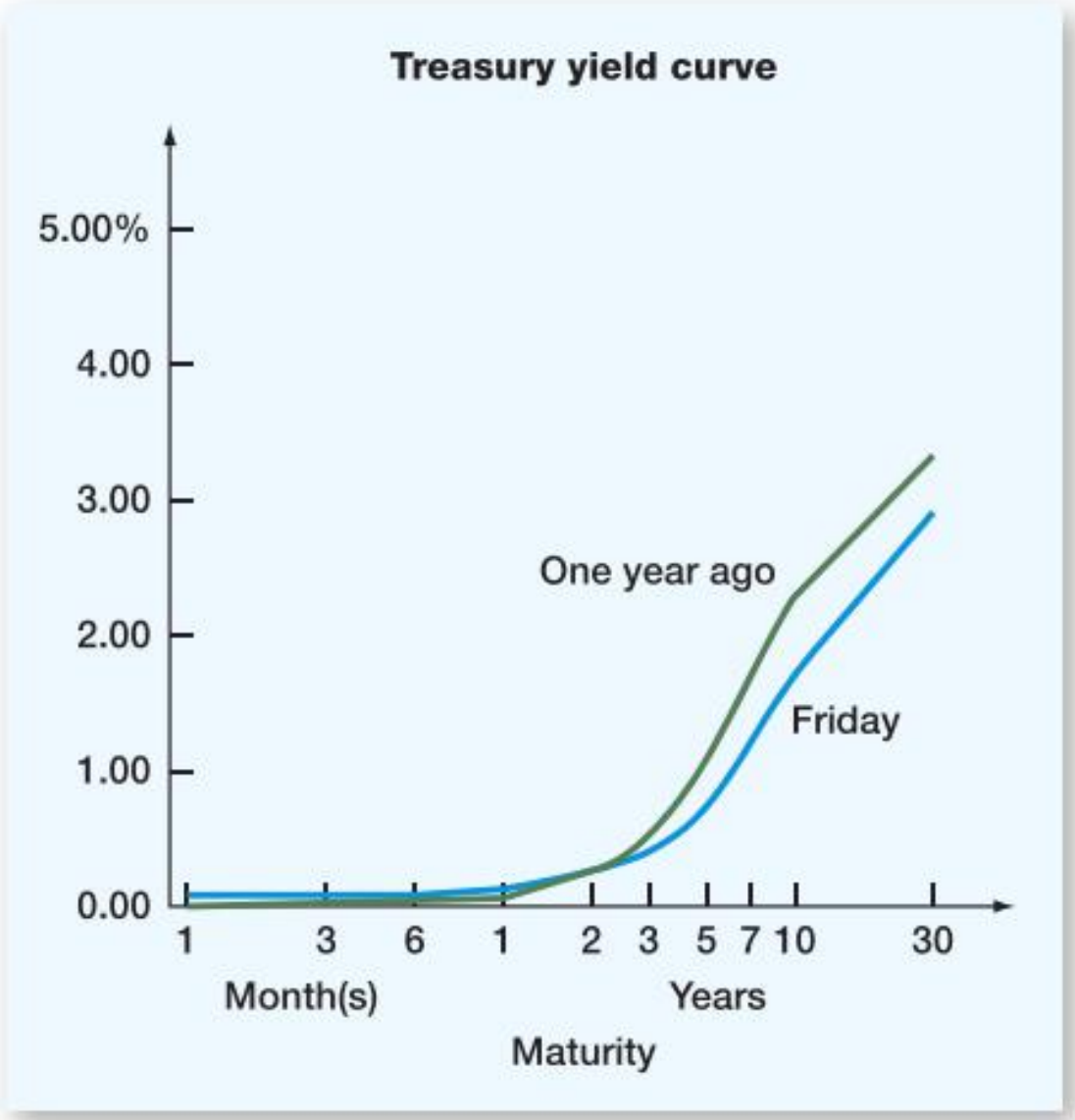
- III. Interest risk
  - longer time to maturity -> greater interest rate risk
  - long-term bonds have much greater of loss resulting from changes in interest rates than do short-term bonds
  - The risk increases at a decreasing rate
  - INTEREST RATE RISK PREMIUM: the compensation investors demand for bearing interest rate risk


A. Upward-sloping term structure
Nominal interest rate
Interest rate risk premium
Interest rate
Inflation premium
Real rate
Time to maturity


B. Downward-sloping term structure
Interest rate
Interest rate risk premium
Nominal interest rate
Inflation premium
Real rate
Time to maturity

7.7.2 Bond yields and the yield curve: putting it all together

- TREASURY YIELD CURVE: a plot of the yields on Treasury notes and bonds relative to maturity
- The shape of the yield curve reflects the term structure of interest rates
  - They are almost the same thing, except that the term structure is based on pure discount bonds, and the yield curve is based on coupon bond yields
- Determinants for Treasury yields
  - the real rate, expected future inflation, and the interest rate risk premium
  - Note that Treasury securities are default free, taxable, and highly liquid


Treasury yield curve
5.00%
4.00
3.00
2.00
1.00
0.00
One year ago
Friday
1
3
6
1
2
3
5
7
10
30
Month(s)
Years
Maturity

- Additional determinants for corporate or municipal bonds
  - Credit risk
    - DEFAULT RISK PREMIUM: the portion of a nominal interest rate or bond yield that represents compensation for the possibility of default
    - Lower-rated bonds have higher yields
    - These yields are calculated assuming that all the promised payments will be made
    - So-called "high yield" bonds are effectively "high promised yield" bonds
  - Taxes
    - TAXABILITY PREMIUM: the portion of a nominal interest rate or bond yield that represents compensation for unfavorable tax status
    - Municipal bonds are free from most taxes -> much lower yields
  - liquidity
    - LIQUIDITY PREMIUM: the portion of a nominal interest rate or bond yield that represents compensation for lack of liquidity
    - Ceteris paribus, less liquid bonds will have higher yields than more liquid bonds

Epilogue

This chapter has explored bonds, bond yields, and interest rates:

- Determining bond prices and yields is an application of basic discounted cash flow principles
- Bond values move in the direction opposite that of interest rates, leading to potential gains or losses for bond investors
- Bonds have a variety of features spelled out in a document called the indenture
- Bonds are rated based on their default risk. Some bonds, such as Treasury bonds, have no risk of default, whereas so-called junk bonds have substantial default risk.
- A wide variety of bonds exist, many of which contain exotic or unusual features

- Almost all bond trading is OTC, with little or no market transparency in many cases. As a result, bond price and volume information can be difficult to find for some types of bonds.
- Careful analysis of no fewer than six things regarding bond yields
    1. The real rate of interest
    2. Expected future inflation
    3. Interest rate risk
    4. Default risk
    5. Taxability
    6. Lack of liquidity

Bonds are a vital source of financing to government and corporations of all types. This chapter touches only the most important concepts and ideas.

CH7 Assignments (Due at 11 a.m. 2019/10/16)

1. **Compulsory:** QUESTIONS AND PROBLEMS: 1,4,5,6,9,18
2. **Optional:** 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.
   - Firstly, is the YTM more or less than 10%? Then calculate the YTM.
   - what is the current yield?
   - verify "yield to maturity = current yield + capital gains yield" by calculation in the first year

   Hint: capital gains in the first year = Price(19 years to maturity) – Price(20 years to maturity), assuming no change in YTM