

Introduction to Financing

Prepared by Dr. Sara Ahmed

Lecture 3





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Interest Rates and Bond Valuation

Lecture 3

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Topic
03

OUTLINE

- 1 Bonds and Bond Valuation
- 2 More on Bond Features
- 3 Bond Ratings
- 4 Some Different Types of Bonds
- 5 Bond Markets
- 6 Inflation and Interest Rates
- 7 Determinants of Bond Yields

Topic
03

Key Concepts and Skills

- Know the important bond features and bond types
- Understand:
 - Bond values and why they fluctuate
 - Bond ratings and what they mean
 - The impact of inflation on interest rates
 - The term structure of interest rates and the determinants of bond yields

Bond Definitions

- Bond
 - Debt contract
 - Interest-only loan
- Par value (face value) ~ \$1,000
- Coupon rate
- Coupon payment
- Maturity date
- Yield to maturity

Key Features of a Bond

- Par value:
 - Face amount
 - Re-paid at maturity
 - Assume \$1,000 for corporate bonds
- Coupon interest rate:
 - Stated interest rate
 - Usually = YTM at issue
 - Multiply by par value to get coupon payment

Key Features of a Bond

- Maturity:
 - Years until bond must be repaid
- Yield to maturity (YTM):
 - The market required rate of return for bonds of similar risk and maturity
 - The discount rate used to value a bond
 - Return if bond held to maturity
 - Usually = coupon rate at issue
 - Quoted as an APR (Annual Percentage Rate)

Bond Value

- Bond Value = $PV(\text{coupons}) + PV(\text{par})$
- Bond Value = $PV(\text{annuity}) + PV(\text{lump sum})$
- Remember:
 - As interest rates increase present values decrease ($r \uparrow \rightarrow PV \downarrow$)
 - As interest rates increase, bond prices decrease and vice versa

The Bond-Pricing Equation

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

PV(Annuity) PV(lump sum)

C = Coupon payment; F = Face value

Texas Instruments BA-II Plus

- , = number of periods to maturity
- - = period interest rate = YTM
- . = present value = bond value
- / = coupon payment
- 0 = future value = face value = par value

n, - . / 0



Spreadsheet Formulas

=FV(Rate,Nper,Pmt,PV,0/1)

=PV(Rate,Nper,Pmt,FV,0/1)

=RATE(Nper,Pmt,PV,FV,0/1)

=NPER(Rate,Pmt,PV,FV,0/1)

=PMT(Rate,Nper,PV,FV,0/1)

- Inside parens: (RATE,NPER,PMT,PV,FV,0/1)
- “0/1” Ordinary annuity = 0 (default)
Annuity Due = 1 (must be entered)

Valuing a Discount Bond with Annual Coupons

- Coupon rate = 10%
- Annual coupons
- Par = \$1,000
- Maturity = 5 years
- YTM = 11%

Using the calculator:

5 ,
11 -
100 /
1000 0
%. -963.04

Using the formula:

$$B = PV(\text{annuity}) + PV(\text{lump sum})$$

$$B = 369.59 + 593.45 = 963.04$$

$$B = 100 \left[\frac{1 - \frac{1}{(1.11)^5}}{0.11} \right] + \frac{1000}{(1.11)^5}$$

Using Excel: =PV(0.11, 5, 100, 1000, 0)

Note: When YTM > Coupon rate → Price < Par = “Discount Bond”

Valuing a Premium Bond with Annual Coupons

- Coupon rate = 10%
- Annual coupons
- Par = \$1,000
- Maturity = 20 years
- YTM = 8%

Using the calculator:

20 ,
8 -
100 /
1000 0
%. -1,196.36

Using the formula:

$$B = PV(\text{annuity}) + PV(\text{lump sum})$$

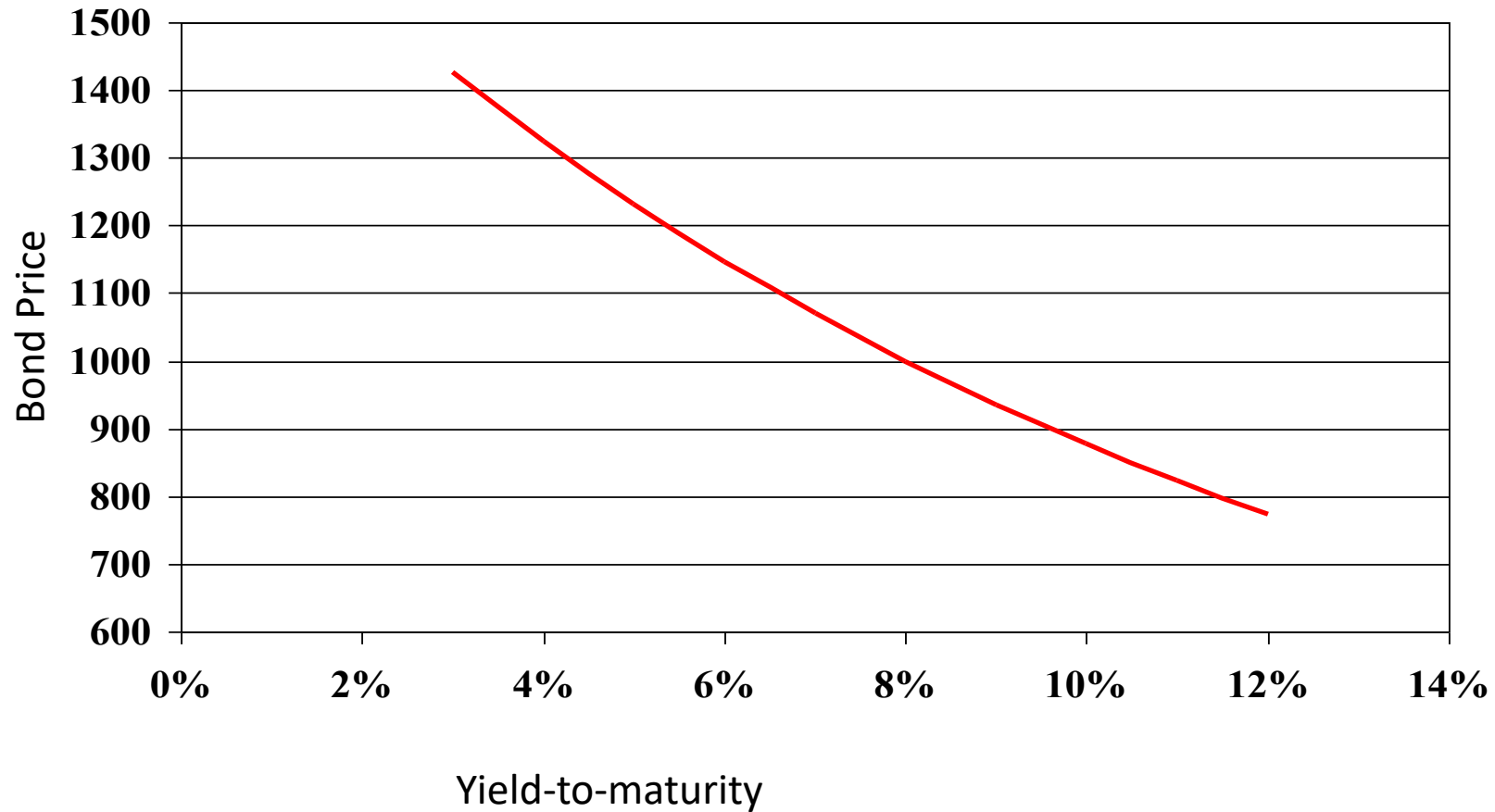
$$B = 981.81 + 214.55 = 1196.36$$

$$B = 100 \left[\frac{1 - \frac{1}{(1.08)^{20}}}{0.08} \right] + \frac{1000}{(1.08)^{20}}$$

Using Excel: =PV(0.08, 20, 100, 1000, 0)

Note: When YTM < Coupon rate → Price > Par = “Premium Bond”

Graphical Relationship Between Price and Yield-to-maturity

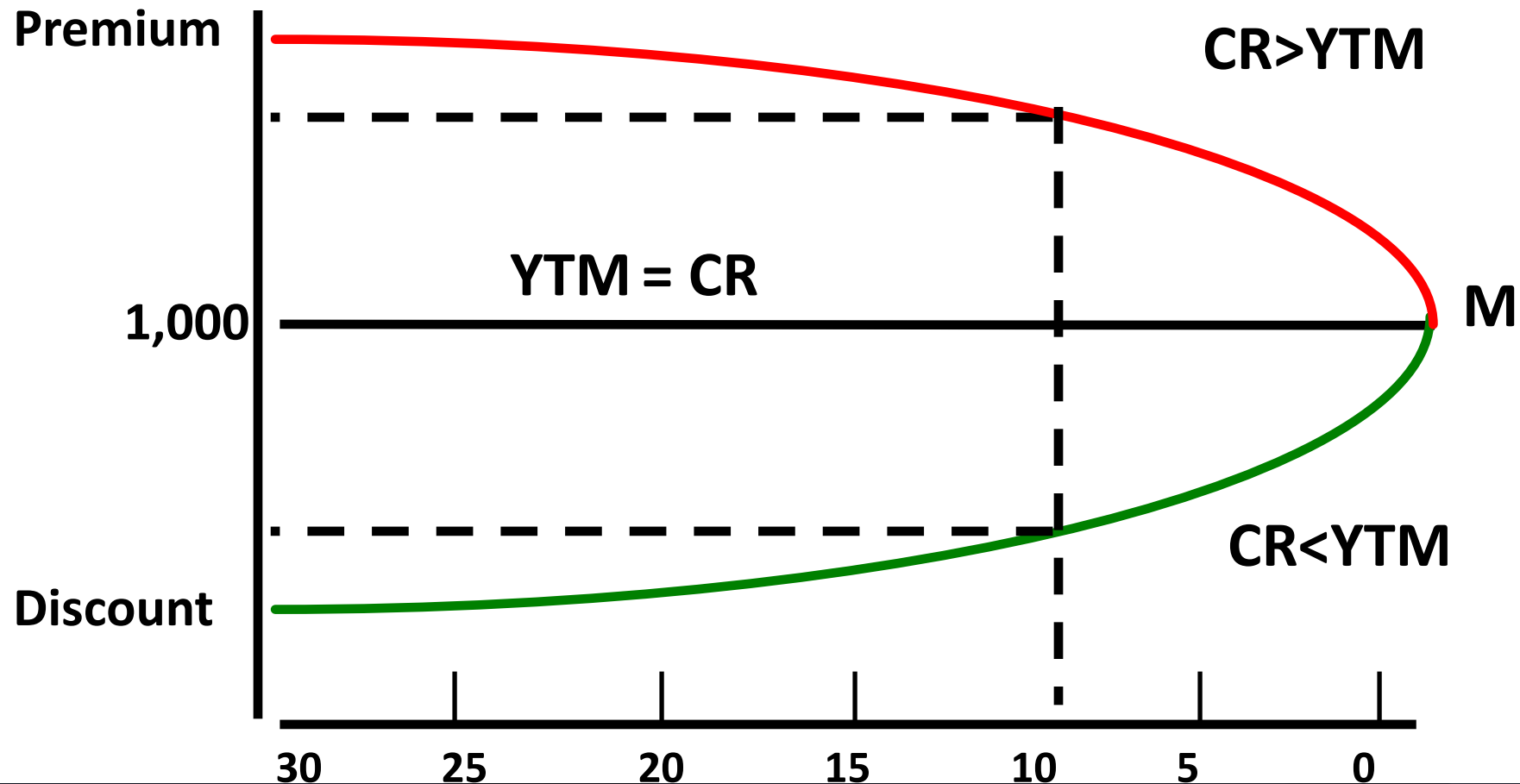


Bond Prices:

Relationship Between Coupon and Yield

- Coupon rate = YTM ➡ Price = Par
- Coupon rate < YTM ➡ Price < Par
 - “Discount bond” ... Why?
- Coupon rate > YTM ➡ Price > Par
 - “Premium bond” ... Why?

Bond Value (\$) vs Years remaining to Maturity



The Bond-Pricing Equation Adjusted for Semi-annual Coupons

$$\text{Bond Value} = \frac{C}{2} \left[\frac{1 - \frac{1}{(1 + \text{YTM}/2)^{2t}}}{\text{YTM}/2} \right] + \frac{F}{(1 + \text{YTM}/2)^{2t}}$$

C = Annual coupon payment

⇒ C/2 = Semi-annual coupon

YTM = Annual YTM (as an APR) ⇒ YTM/2 = Semi-annual YTM

t = Years to maturity

⇒ 2t = Number of 6-month
periods to maturity

Semiannual Bonds

Example 6.1

- Coupon rate = 14% - Semiannual
- YTM = 16% (APR)
- Maturity = 7 years
 - Number of coupon payments? (t or ,)
 - $14 = 2 \times 7 \text{ years}$
 - Semiannual coupon payment? (C or /)
 - $\$70 = (14\% \times \text{Face Value})/2$
 - Semiannual yield? (YTM or -)
 - $8\% = 16\%/2$

Example 6.1

- Semiannual coupon = \$70
- Semiannual YTM = 8%
- Periods to maturity = 14
- Bond value =
- $70[1 - 1/(1.08)^{14}] / .08 + 1000 / (1.08)^{14} = \mathbf{917.56}$

$$B = 70 \left[\frac{1 - \frac{1}{(1.08)^{14}}}{0.08} \right] + \frac{1000}{(1.08)^{14}}$$

Using Excel: =PV(0.08, 14, 70, 1000, 0)

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

Using the calculator:

14	,
8	-
70	/
1000	0
%. -	917.56

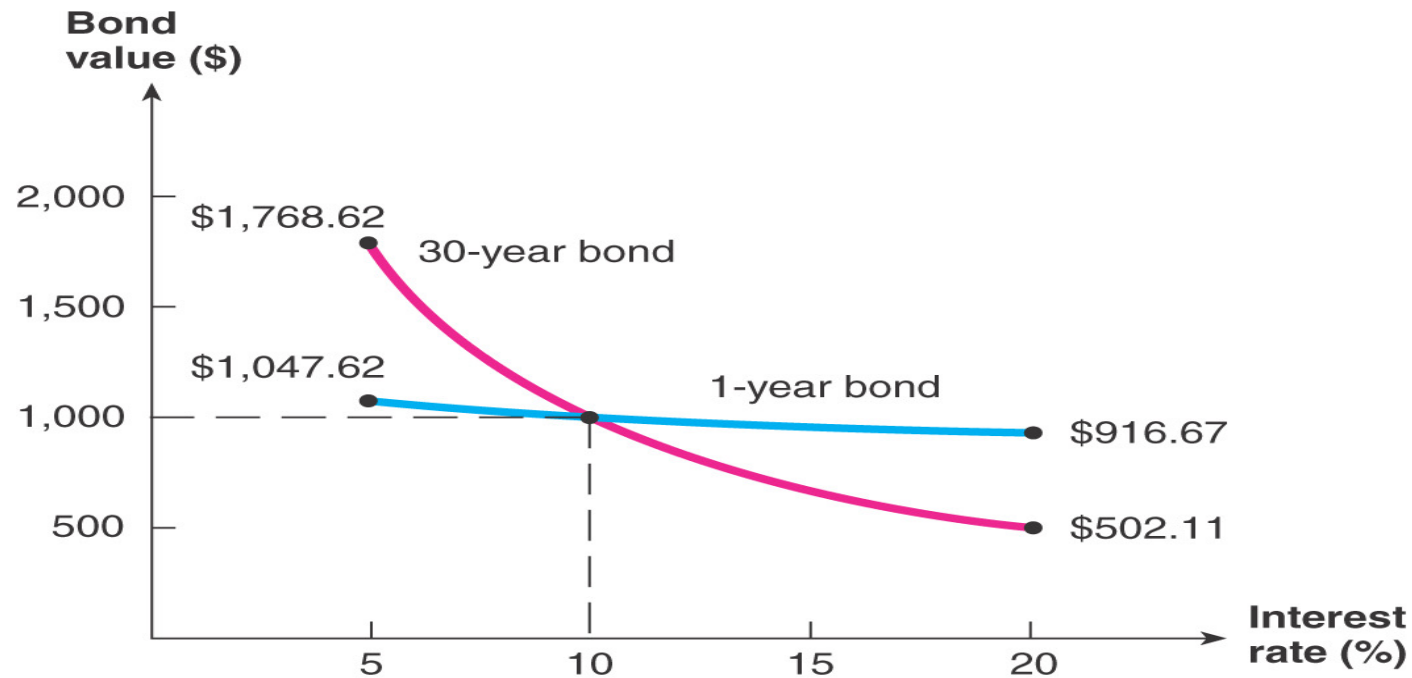
Interest Rate Risk

- 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

Interest Rate Risk

- 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

Figure 6.2



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

Interest Rate	Time to Maturity	
	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

Computing Yield-to-Maturity YTM

- Yield-to-maturity (YTM) = the market required rate of return implied by the current bond price
- With a financial calculator,
 - Enter PV , FV , N , and PMT
 - **Remember the sign convention**
 - PV and FV need to have the same sign (+)
 - PMT the opposite sign (-)
 - YTM

YTM with Annual Coupons

Consider a bond with a 10% annual coupon rate, 15 years to maturity and a par value of \$1000. The current price is \$928.09.

- Will the yield be more or less than 10%?

$$\begin{array}{rcl} 15 & , & \\ 928.09 \$ & & \\ 1000 & 0 & \\ 100 & / & \\ \%- & = 11\% & \leftarrow \text{Result} = \text{YTM} \end{array}$$

Using Excel: `=RATE(15, 100, -928.09, 1000, 0)`

YTM with Semiannual Coupons

Suppose a bond with a 10% coupon rate and semiannual coupons, has a face value of \$1000, 20 years to maturity and is selling for \$1197.93.

- Is the YTM more or less than 10%?
- What is the semiannual coupon payment?
- How many periods are there?

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.

40	,
1197.93	\$.
1000	0
50	/
%- 4%	

$$\text{YTM} = 4\% \times 2 = 8\%$$

↑ Result = $\frac{1}{2}$ YTM

NOTE: Solving a semi-annual payer for YTM results in a 6-month YTM.

The calculator & Excel solve what you enter.

Using Excel: `=RATE(40, 50, -1197.93, 1000, 0) = 4%`

Table 6.1

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

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 in the formula above until the calculated bond value equals the given bond value. Remember that increasing the rate *decreases* the bond value.

Debt versus Equity

- Debt

- Not an ownership interest
- No voting rights
- Interest 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 to elect the board of directors and on other issues
- Dividends are not tax deductible
- Dividends are not a liability of the firm until declared. Stockholders have no legal recourse if dividends are not declared
- An all-equity firm cannot go bankrupt

The Bond Indenture

“Deed of Trust”

Contract between issuing company and bondholders includes:

- Basic terms of the bonds
- Total amount of bonds issued
- Secured versus Unsecured
- Sinking fund provisions
- Call provisions
 - Deferred call
 - Call premium
- Details of protective covenants



Bond Classifications

- Registered vs. Bearer Bonds
- Security
 - Collateral – secured by financial securities
 - Mortgage – secured by real property, normally land or buildings
 - Debentures – unsecured
 - Notes – unsecured debt with original maturity less than 10 years
- Seniority
 - Senior versus Junior, Subordinated

Bond Characteristics and Required Returns

- Coupon rate
 - ☐ (risk characteristics of the bond when issued)
 - Usually $\approx$ yield at issue
- 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

Government Bonds

- 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
 - Interest usually exempt from state tax in issuing state

Government Bonds

- Treasury Securities = Federal government debt
 - Treasury Bills (T-bills)
 - Pure discount bonds
 - Original maturity of one year or less
 - Treasury notes
 - Coupon debt
 - Original maturity between one and ten years
 - Treasury bonds
 - Coupon debt
 - Original maturity greater than ten years

Example 6.4

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

Zero Coupon Bonds

- Make no periodic interest payments (coupon rate = 0%)
- Entire yield-to-maturity comes from the difference between the purchase price and the par value (capital gains)
- Cannot sell for more than par value
- Sometimes called zeroes, or deep discount bonds
- Treasury Bills and U.S. Savings bonds are good examples of zeroes

Floating Rate Bonds

- Coupon rate floats depending on some index value
- Examples – adjustable rate mortgages and inflation-linked Treasuries
- Less price risk with floating rate bonds
 - Coupon floats, so 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
- Many types of provisions can be added to a bond
 - Important to recognize how these provisions affect required returns
 - Who does the provision benefit?

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
- Getting up-to-date prices difficult, particularly on small company or municipal issues
- Treasury securities are an exception

Work the Web Example

- Bond information is available online
- One good site:
<http://cxa.marketwatch.com/finra/BondCenter>
- Click on the web surfer to go to the site
 - Use “Quick Bond Search” to observe the yields for various bond types, and the shape of the yield curve.

Quoted Price vs. Invoice Price

- Quoted bond prices = “clean” price
 - Net of accrued interest
- Invoice Price = “dirty” or “full” price
 - Price actually paid
 - Includes accrued interest
- Accrued Interest
 - Interest earned since last coupon payment is owed to bond seller at time of sale

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

The Fisher Effect

The Fisher Effect defines the relationship between real rates, nominal rates and inflation

$$(1 + R) = (1 + r)(1 + h)$$

R = nominal rate (Quoted rate)

r = real rate

h = *expected* inflation rate

Approximation: $R = r + h$

Example 6.6

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.

Term Structure of Interest Rates

- Term structure: The relationship between time to maturity and yields, all else equal
 - The effect of default risk, different coupons, etc. has been removed.
- Yield curve: Graphical representation of the term structure
 - Normal = upward-sloping ➡ $L/T > S/T$
 - Inverted = downward-sloping ➡ $L/T < S/T$

Figure 6.5 A – Upward-Sloping Yield Curve

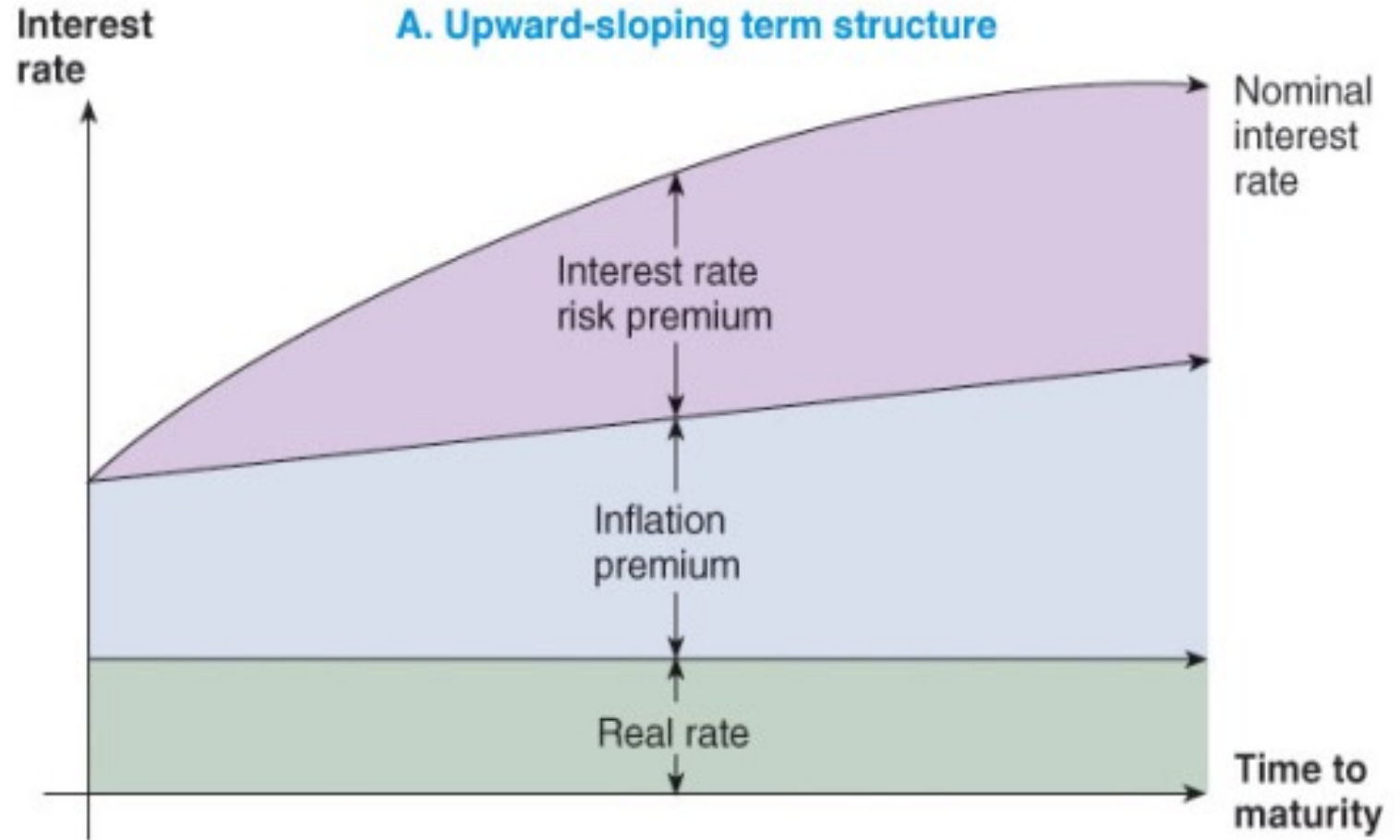


Figure 6.5 B – Downward-Sloping Yield Curve

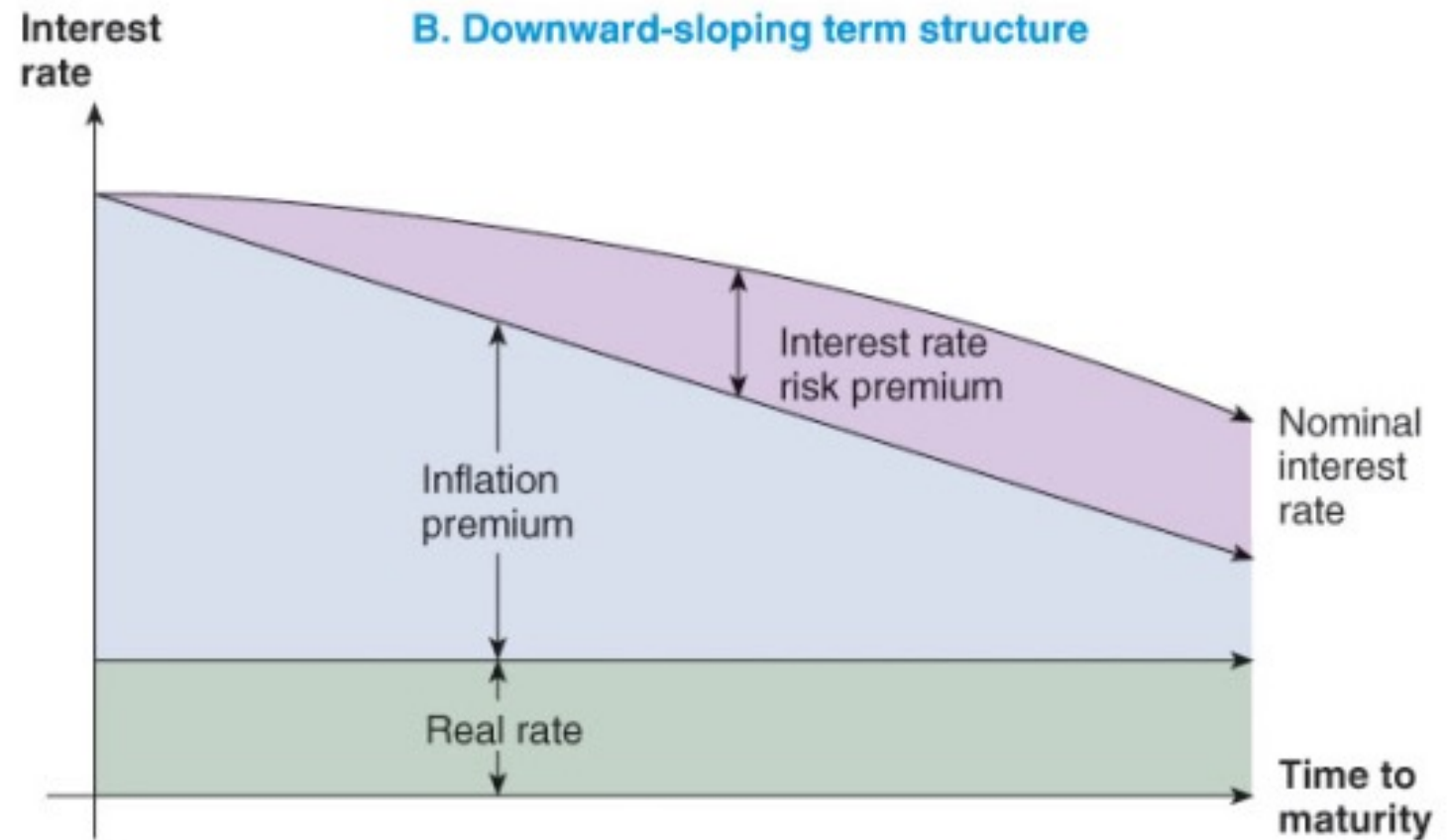


Figure 6.6 – Treasury Yield Curve

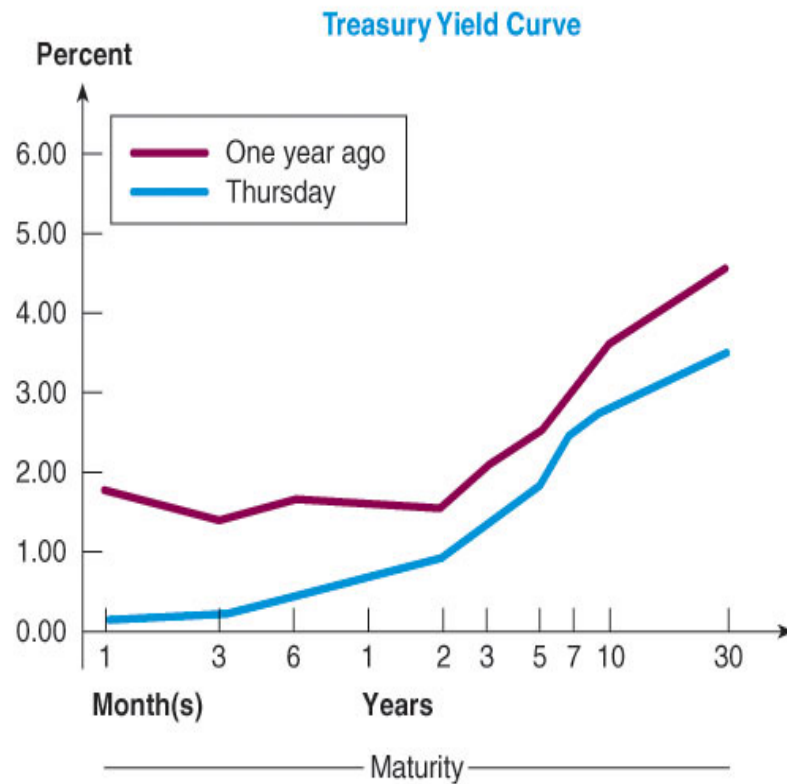


FIGURE 6.6

The Treasury yield curve

Treasury Yield Curve
March 5, 2009

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Factors Affecting Required Return

- Default risk premium – bond ratings
- Taxability premium – municipal versus taxable
- Liquidity premium – bonds that have more frequent trading will generally have lower required returns
- Maturity premium – longer term bonds will tend to have higher required returns.

Anything else that affects the risk of the cash flows to the bondholders will affect the required returns

Quick Quiz

- How do you find the value of a bond and why do bond prices change?
- What is a bond indenture and what are some of the important features?
- 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?



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Thank You

