Chapter 6

Interest Rates and Bond Valuation

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

Chapter Outline

- Bonds and Bond Valuation
- More on Bond Features
- Bond Ratings
- Some Different Types of Bonds
- Bond Markets
- Inflation and Interest Rates
- Determinants of Bond Yields

Bond Definitions

- Bond
- Par value (face value)
- Coupon rate
- Coupon payment
- Maturity date
- Yield or Yield to maturity

PV of Cash Flows as Rates Change

- Bond Value = PV of coupons + PV of par
- Bond Value = PV annuity + PV of lump sum
- Remember, as interest rates increase, the PVs decrease
- So, as interest rates increase, bond prices decrease, and vice versa

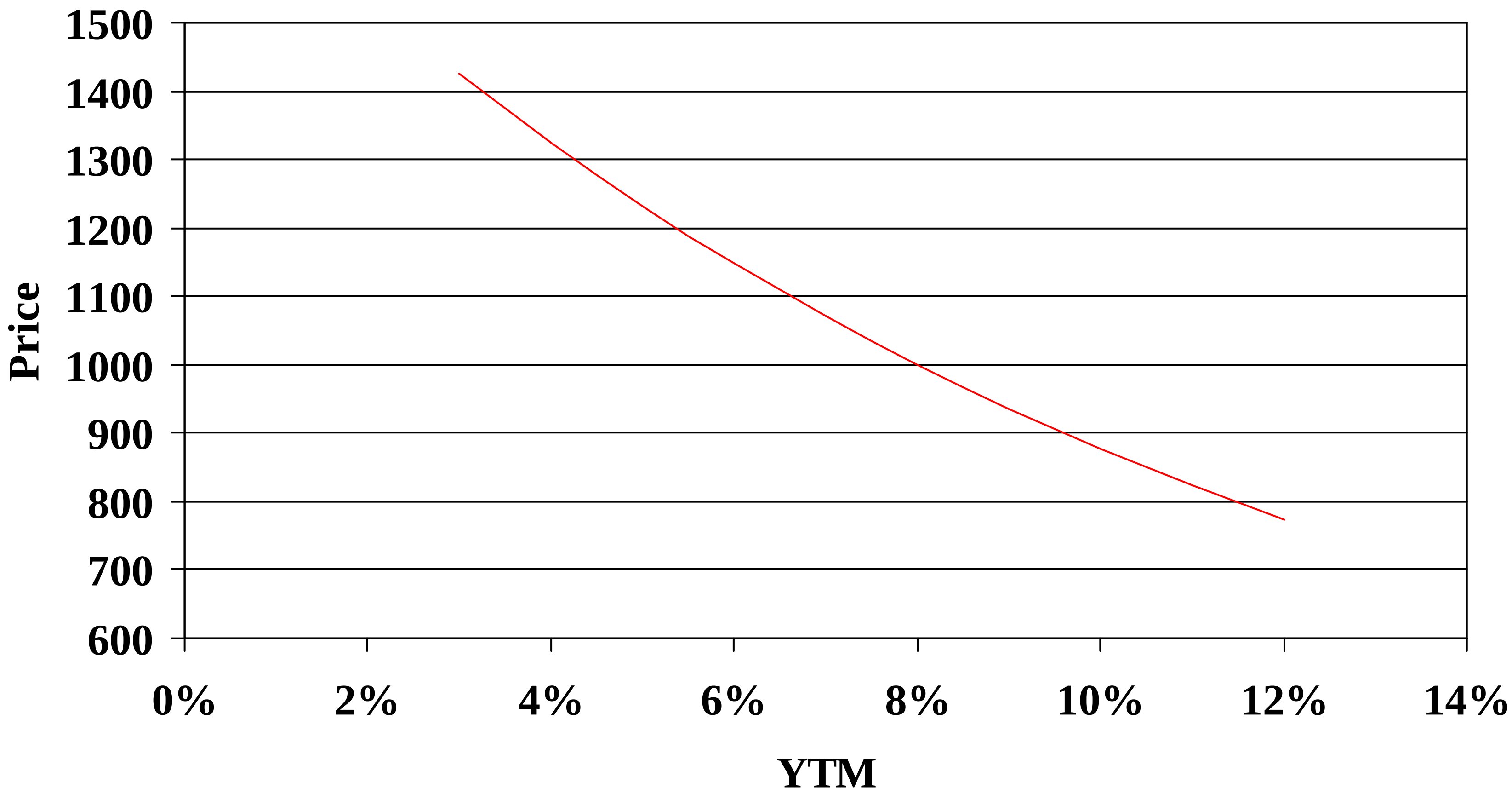
Valuing a Discount Bond with Annual Coupons

- Consider a bond with a coupon rate of 10% and coupons paid annually. 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 annuity + PV of lump sum
    - $B = \$100[1 – 1/(1.11)^5] / .11 + \$1,000 / (1.11)^5$
    - B = $369.59 + 593.45 = $963.04

Valuing a Premium Bond with Annual Coupons

- Suppose you are looking at a bond that has a 10% annual coupon and a face value of $1,000. There are 20 years to maturity and the yield to maturity is 8%. What is the price of this bond?
  - Using the formula:
    - B = PV of annuity + PV of lump sum
    - B = $100[1 – 1/(1.08)^{20}] / .08 + $1,000 / (1.08)^{20}
    - B = $981.81 + 214.55 = $1,196.36

Graphical Relationship Between Price and YTM



Bond Prices: Relationship Between Coupon and Yield

- If YTM = coupon rate, then par value = bond price
- If YTM > coupon rate, then par value > bond price
  - Why?
  - Price below par = “discount” bond
- If YTM < coupon rate, then par value < bond price
  - Why?
  - Price above par = “premium” bond

The Bond-Pricing Equation

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

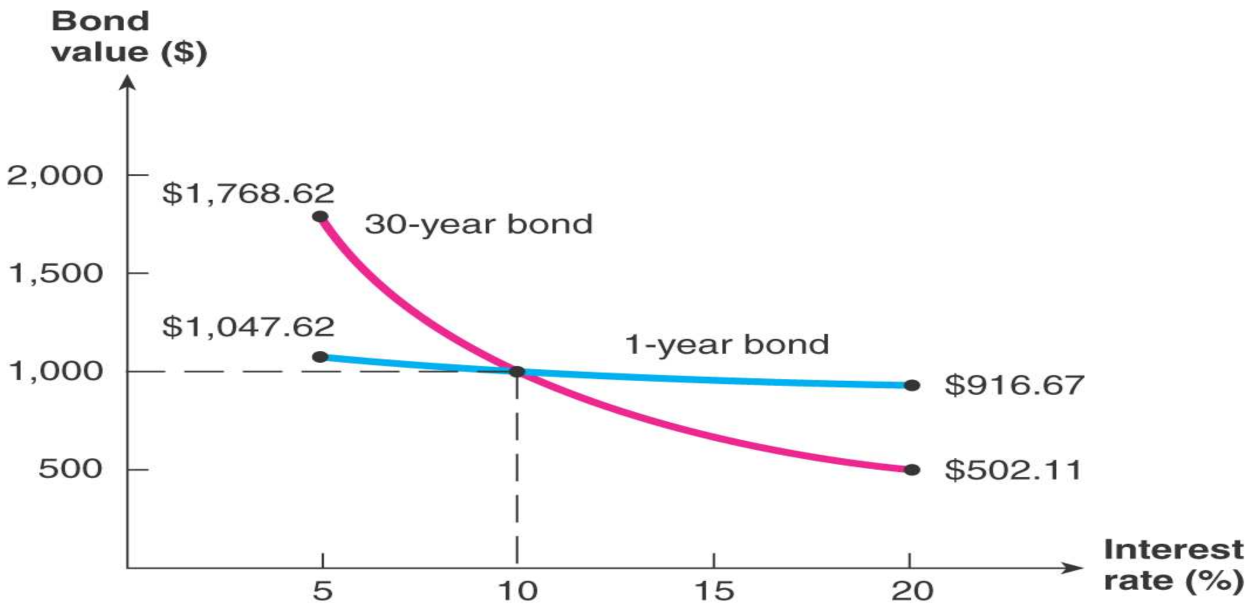
Example 6.1

- Find present values based on the payment period
  - How many coupon payments are there?
  - What is the semiannual coupon payment?
  - What is the semiannual yield?
  - $B = \$70[1 – 1/(1.08)^{14}] / .08 + \$1,000 / (1.08)^{14} = \$917.56$

Interest Rate Risk

- Change in price due to changes in interest rates
  - – Interest rates up, bond price down!
  - – Long-term bonds have more interest rate risk than short-term bonds
    - More-distant cash flows are more adversely affected by an increase in interest rates
  - – Lower coupon rate bonds have more interest rate risk than higher coupon rate bonds
    - More of the bond’s value is deferred to maturity (thus, for a longer time) if the coupons are small

Figure 6.2



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

Computing YTM

- 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 or spreadsheet, 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%?
  - CPT YTM = 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?
  - Solve for r by trial-and-error, starting with a semiannual rate below 5%. Will this r be the YTM?
  - YTM = 4%*2 = 8%

Table 6.1

I. Finding the value of a bond

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.

Differences Between Debt and 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 to elect the board of directors and on other issues
  - Dividends are not considered a cost of doing business and 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

- Contract between the company and the bondholders and 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

Bond Classifications

- Registered vs. Bearer Forms
- 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

Bond Characteristics and Required Returns

- The coupon rate is usually set close to the yield, which depends on the risk characteristics of the bond when issued
- Which bonds will have the higher yield, 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 – 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, B, Caa, and Ca
  - S&P BB, B, CCC, CC
  - Considered speculative with respect to capacity to pay. The “B” ratings are the lowest degree of speculation.
- Very Low Grade
  - Moody’s C and S&P C – income bonds with no interest being paid
  - Moody’s D and S&P D – in default with principal and interest in arrears

Government Bonds

- Treasury Securities
  - 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
- 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

Example 6.3

- 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, or deep discount bonds
- Treasury Bills and principal-only Treasury strips are good examples of zeroes

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

- Disaster bonds
- Income bonds
- Convertible bonds
- Put bond
- 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 small company or municipal issues
- Treasury securities are an exception

Bond Quotations

- Consider the following bond quotation:
  - GM 8.375 Jul 15, 2033 100.641 8.316 362 30 763,528
  - Interpret the information above
- Consider the last Treasury quotation in Figure 6.3:
  - 4½ Feb 36 92:21 92:22 -8 4.98
  - What was the previous day's asked price?

Inflation and Interest Rates

- Real rate of interest – change in purchasing power
- Nominal rate of interest - quoted rate of interest; Reflects 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
- $(1 + R) = (1 + r)(1 + h)$, where
  - R = nominal 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 a significant difference between the actual Fisher Effect and the approximation.

Term Structure of Interest Rates

- 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

Figure 6.5 – Upward-Sloping Yield Curve

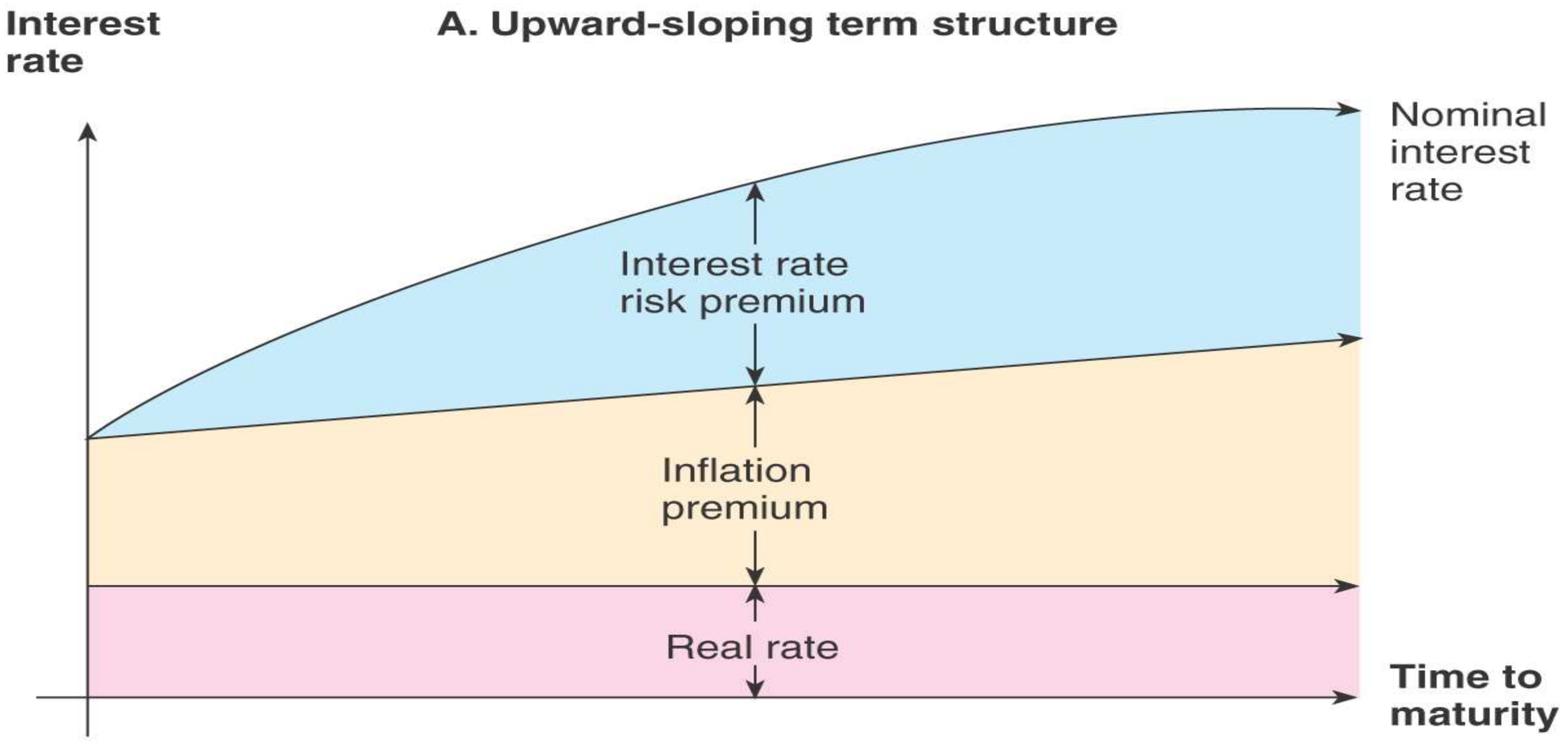


Figure 6.5 – Downward-Sloping Yield Curve

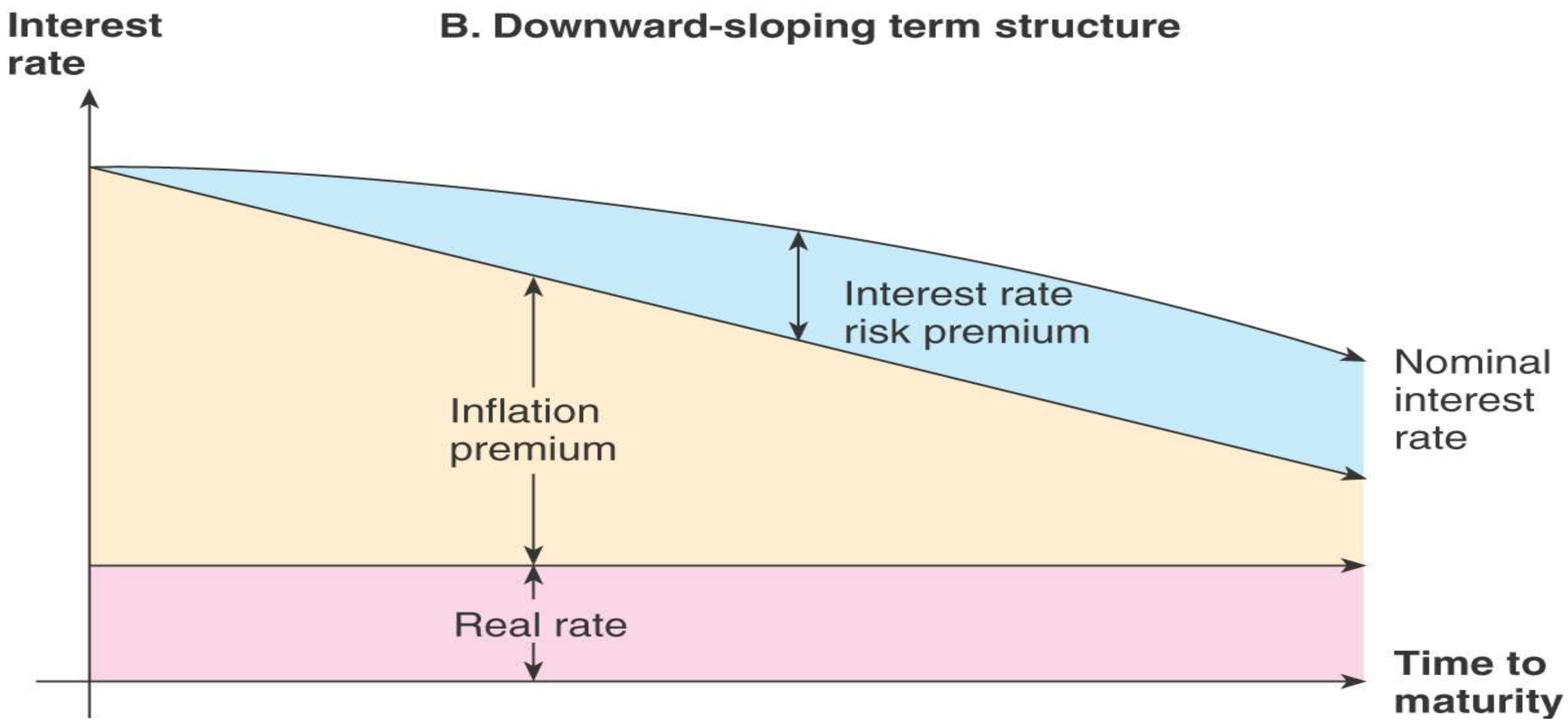
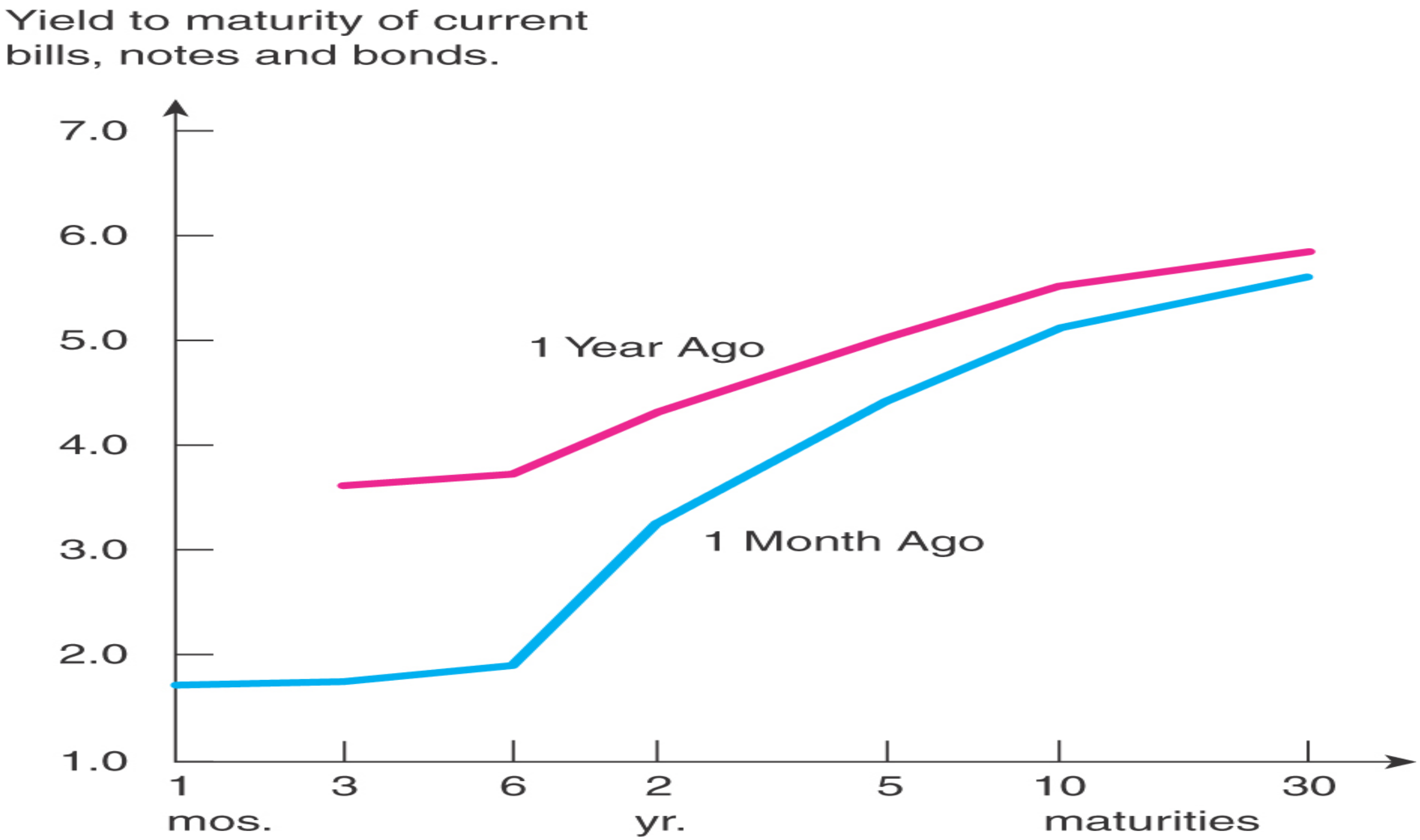


Figure 6.6 – Treasury Yield Curve



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
- 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?

Comprehensive Problem

- What is the price of a $1,000 par value bond with a 6% coupon rate paid semiannually, if the bond is priced to yield 5% YTM, and it has 9 years to maturity?
- What would be the price of the bond if the yield rose to 7%.
- What is the current yield on the bond if the YTM is 7%?