Fundamentals of Corporate Finance, 2/e

ROBERT PARRINO, PH.D.
DAVID S. KIDWELL, PH.D.
THOMAS W. BATES, PH.D.

Bond Valuation and the Structure of Interest Rates

Learning Objectives

1. DESCRIBE THE MARKET FOR CORPORATE BONDS AND THREE TYPES OF CORPORATE BONDS.
2. EXPLAIN HOW TO CALCULATE THE VALUE OF A BOND AND WHY BOND PRICES VARY NEGATIVELY WITH INTEREST RATE MOVEMENTS.
3. DISTINGUISH BETWEEN A BOND'S COUPON RATE, YIELD TO MATURITY, AND EFFECTIVE ANNUAL YIELD.

Learning Objectives

4. EXPLAIN WHY INVESTORS IN BONDS ARE SUBJECT TO INTEREST RATE RISK AND WHY IT IS IMPORTANT TO UNDERSTAND THE BOND THEOREMS.
5. DISCUSS THE CONCEPT OF DEFAULT RISK AND KNOW HOW TO COMPUTE A DEFAULT RISK PREMIUM.
6. DESCRIBE THE FACTORS THAT DETERMINE THE LEVEL AND SHAPE OF THE YIELD CURVE.

Corporate Bonds

- MARKET FOR CORPORATE BONDS
  - **Life insurance companies and pension funds buy most corporate bonds**

    Transactions tend to be in very large dollar amounts.
  - **Less than 1% of all corporate bonds are traded on organized exchanges**

    Most transactions take place through dealers in the over-the-counter (OTC) market.

Corporate Bonds

- MARKET FOR CORPORATE BONDS
  - **At the end of 2007, the amount of corporate and foreign debt outstanding was $10.1 trillion, ranking the debt market second behind the market for corporate equity ($20.8 trillion).**

Corporate Bonds

- MARKET FOR CORPORATE BONDS
  - **Only a small fraction of the bonds outstanding are traded each day.**
    - The market is thin compared to markets for money-market securities and stocks.
    - Corporate bonds are less marketable than securities with large daily trading volumes.
    - Prices in the market tend to be more volatile than those of securities with greater trading volumes.

Corporate Bonds

- BOND PRICE INFORMATION
  - **Corporate bond pricing is not considered transparent.**

    It is difficult for investors to obtain important information on prices and volume.

    Many transactions are negotiated directly between buyer and seller with little centralized reporting of transaction details.

Corporate Bonds

- FEATURES OF CORPORATE BONDS
  - long-term claims against company assets
  - face (par) value is $1,000
  - coupon rate is the annual coupon payment (C) divided by a bond's face value (F)
  - fixed amounts paid to lenders for the life of the contract

Vanilla Bonds

- TYPES OF CORPORATE BONDS
  - **Vanilla bond**

    coupon payments fixed for the life of the bond

    repay principal and retire the bonds at maturity

    contracts have the features and provisions found in most bond covenants.

    annual or semiannual coupon payments

Zero Coupon Bonds

- TYPES OF CORPORATE BONDS
  - **Zero coupon bond**

    no coupon payments

    pays face value at maturity.

    sell at deep discount

Convertible Bonds

- TYPES OF CORPORATE BONDS
  - **Convertible bonds**
    - may be exchanged for shares of the firm's stock
    - sells for a higher price than a comparable non-convertible bond
    - bondholders benefit if the market value of the company's stock gets high enough

Bond Valuation

- BOND PRICE
  - **In an efficient market, the price of an asset equals the present value of its future cash flows.**
  - **To calculate a bond's price, follow the same process used to value any financial asset.**

Bond Valuation

CALCULATE BOND PRICE

- **Determine the required rate-of-return**
- **Determine expected future cash flows – the coupon payments and par value**
- **Compute the current market value, or price (P_B) by calculating the present value of the expected cash flows**

$$P_B = PV_{\text{Coupon Payments}} + PV_{\text{Par Value}}$$

Bond Valuation

- GENERAL EQUATION FOR THE PRICE OF A BOND

$$P_B = \frac{C_1}{(1+i)^1} + \frac{C_2}{(1+i)^2} + \ldots + \frac{C_n + F_n}{(1+i)^n} \qquad (8.1)$$

Cash Flows for a Three-Year Bond

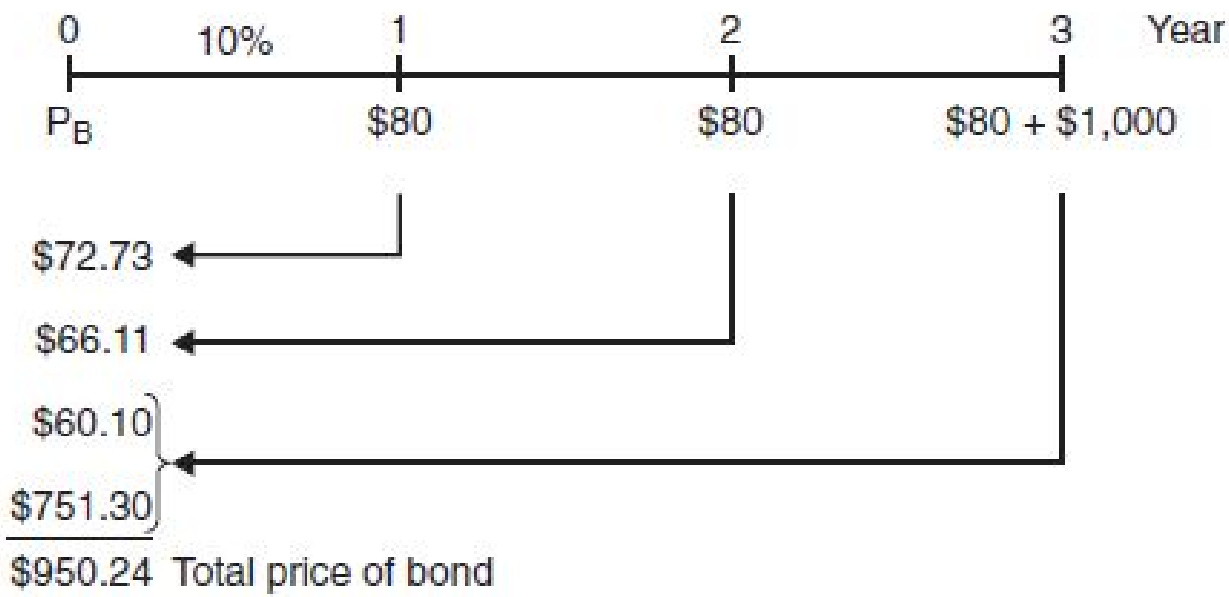


EXHIBIT 8.1
Cash Flows for a Three-Year Bond

The exhibit shows a time line for a three-year bond that pays an 8 percent coupon rate and has a face value of $1,000. How much should we pay for such a bond if the market rate of interest is 10 percent? To solve this problem, we discount the expected cash flows to the present and then add them up.

Bond Valuation

- BOND VALUATION EXAMPLE
  - **Calculator solution**

    Determine the price of the bond in Exhibit 8.1 with a financial calculator

Enter	3	10		80	1,000
	N	i	PV	PMT	FV
Answer			-950.26		

Using Excel – Calculate Bond Price

USING EXCEL

BOND PRICES AND YIELDS

Calculating bond prices and yields using a spreadsheet may seem daunting at first. However, understanding the terminology used in the formulas will make the calculations a matter of common sense:

Settlement date—the date a buyer purchases the bond.

Maturity date—the date the bond expires. If you know only the "*n*" (number of years remaining) of the bond, use a date that is *n* years in the future in this field.

Redemption—the security's redemption value per $10 face value. In other words, if the bond has a par value of $1,000, you enter 100 in this field.

Frequency—the number of coupon payments per year.

Here is a spreadsheet showing the setup for calculating the price of the discount bond described in Learning by Doing Application 8.1.

We first use the =PRICE(settlement, maturity, rate, yield, redemption, frequency) formula in Excel to calculate the bond price as a percentage of par. We then multiply this percentage (77.18 percent in the above example) by $1,000 to obtain the bond price in dollars. A bond yield, which is discussed in the next section, is calculated in a similar manner, using the "=YIELD (settlement, maturity, rate, price, redemption, frequency)" formula.

◇	A	B	C	D
1				
2		**Bond Price Calculations**		
3	**Inputs**			
4	Settlement date	1/1/00		
5	Maturity date	1/1/15		
6	Rate	0.07		
7	Yield	0.10		
8	Redemption (% of par)	100		
9	Frequency	1		
10				
11	**Bond Price**			**Formulas Used**
12	Bond price as % of par	77.18		=PRICE(B4,B5,B6,B7,B8,B9)
13	Par value	$1,000.00		
14	Bond price	$771.82		=B12%*B13
15				

Bond Valuation

- PAR, PREMIUM, AND DISCOUNT BONDS
  - **If a bond's coupon rate is equal to the its yield, its price equals its face value; it is a par bond**
  - **If a bond's coupon rate is less than its yield, its price is less than its face value; it is a discount bond**
  - **If a bond's coupon rate is greater than its yield, its price is greater than its face value; it is a premium bond**

Bond Valuation

- SEMIANNUAL COMPOUNDING
  - **Most bonds issued in Europe pay annual coupons, most issued in the U.S. pay semiannual coupons**
  - **Eq. 8.2 shows how to value bonds that pay semi-annual coupons**

$$P_B = \frac{C/m}{(1+i/m)^1} + \frac{C/m}{(1+i/m)^2} + \frac{C/m}{(1+i/m)^3} + \ldots + \frac{C/m + F_{mn}}{(1+i/m)^{mn}} \qquad (8.2)$$

Bond Valuation

- SEMIANNUAL COMPOUNDING EXAMPLE
  - **What is the price of a three-year, 5% coupon bond with a market yield of 8% and semi-annual coupon payments?**

    Semi-annual market yield = 8%/2 = 4%

    Semi-annual coupon payment = $50/2 = $25

$$P_B = \frac{\$25}{(1.04)^1} + \frac{\$25}{(1.04)^2} + \frac{\$25}{(1.04)^3} + \frac{\$25}{(1.04)^4} + \frac{\$25}{(1.04)^5} + \frac{\$25 + \$1000}{(1.04)^6}$$

$$= \$24.04 + \$23.11 + \$22.22 + \$21.37 + \$20.55 + \$810.07$$

$$= \$921.36$$

Bond Valuation

- CALCULATOR SOLUTION
  - Semiannual Compounding Example

Enter	6	4		25	1,000
	N	i	PV	PMT	FV
Answer			-921.37		

Bond Valuation

- ZERO COUPON BONDS
  - **Zero coupon bonds do not make coupon payments but pay their face value at maturity**
  - **The price (or yield) of a zero coupon bond is a special case of Equation 8.2, where all coupon payments equal zero**

Bond Valuation

- ZERO COUPON BONDS
  - **Pricing equation for a zero coupon bond**

$$P_B = \frac{F_{mn}}{(1 + i/m)^{mn}} \qquad (8.3)$$

  - **Zero coupon bonds pay cash only at maturity and must sell for less than similar bonds which make periodic interest payments**

Bond Valuation

- ZERO COUPON BOND PRICE EXAMPLE
  - **What is the price of a zero coupon bond with a $1,000 face value, 10-year maturity, and semiannual compounding? The market rate on similar bonds is 12%.**

$$P_B = \frac{\$1000}{(1+0.12/2)^{20}} = \frac{\$1000}{(1+0.06)^{20}} = \$311.80$$

Bond Yields

- YIELD TO MATURITY (YTM)
  - **YTM**

    the rate that makes the present value of the bond's cash flows equal the price of bond

    the rate a bondholder earns if the bond is held to maturity and all coupon and principal payments are made as promised

    – *changes daily as interest rates change*

Bond Yields

- EFFECTIVE ANNUAL YIELD
  - **In bond trading, the EAR is called the effective annual yield (EAY). The way to annualize a bond yield**

$$EAY = (1 + \text{Quoted rate}/m)^m - 1$$

  - **Simple annual yield is yield per period multiplied by the number of compounding periods; for bonds with annual compounding, simple annual yield = semiannual yield × 2**

Bond Yields

- YIELD TO MATURITY AND EFFECTIVE ANNUAL YIELD EXAMPLE
  - **An investor buys a 30-year bond with a $1,000 face value for $800. The bond's coupon rate is 8% and interest payments are made semi-annually. What are the bond's yield to maturity and effective annual yield?**

Bond Yields

- YIELD TO MATURITY AND EFFECTIVE ANNUAL YIELD EXAMPLE
  - **Step 1:**

Enter	60		-800	40	1,000
	N	i	PV	PMT	FV
Answer		5.07			

Bond Yields

- YIELD TO MATURITY AND EFFECTIVE ANNUAL YIELD EXAMPLE
  - **Step 2:**

    Calculate YTM

Enter	**.0507**	**2**	
	x	**=**	
Answer			**.1014**

Bond Yields

- YIELD TO MATURITY AND EFFECTIVE ANNUAL YIELD EXAMPLE
  - **Step 3:**

    Calculate EAY

Enter	1.0507	-	=
	X^2	1	
Answer			.1040

Bond Yields

- REALIZED YIELD
  - **The return earned on a bond given the cash flows actually received by investor**
  - **The interest rate at which the present value of actual cash flows generated by the investment equals bond's price**
  - **The realized yield is important because it allows investors to see what they actually earned on their investments.**

Interest Rate Risk

- BOND THEOREMS
  - **Bond theorems are statements about the math used in bond pricing.**

    Bond prices are inversely related to interest rate movements.

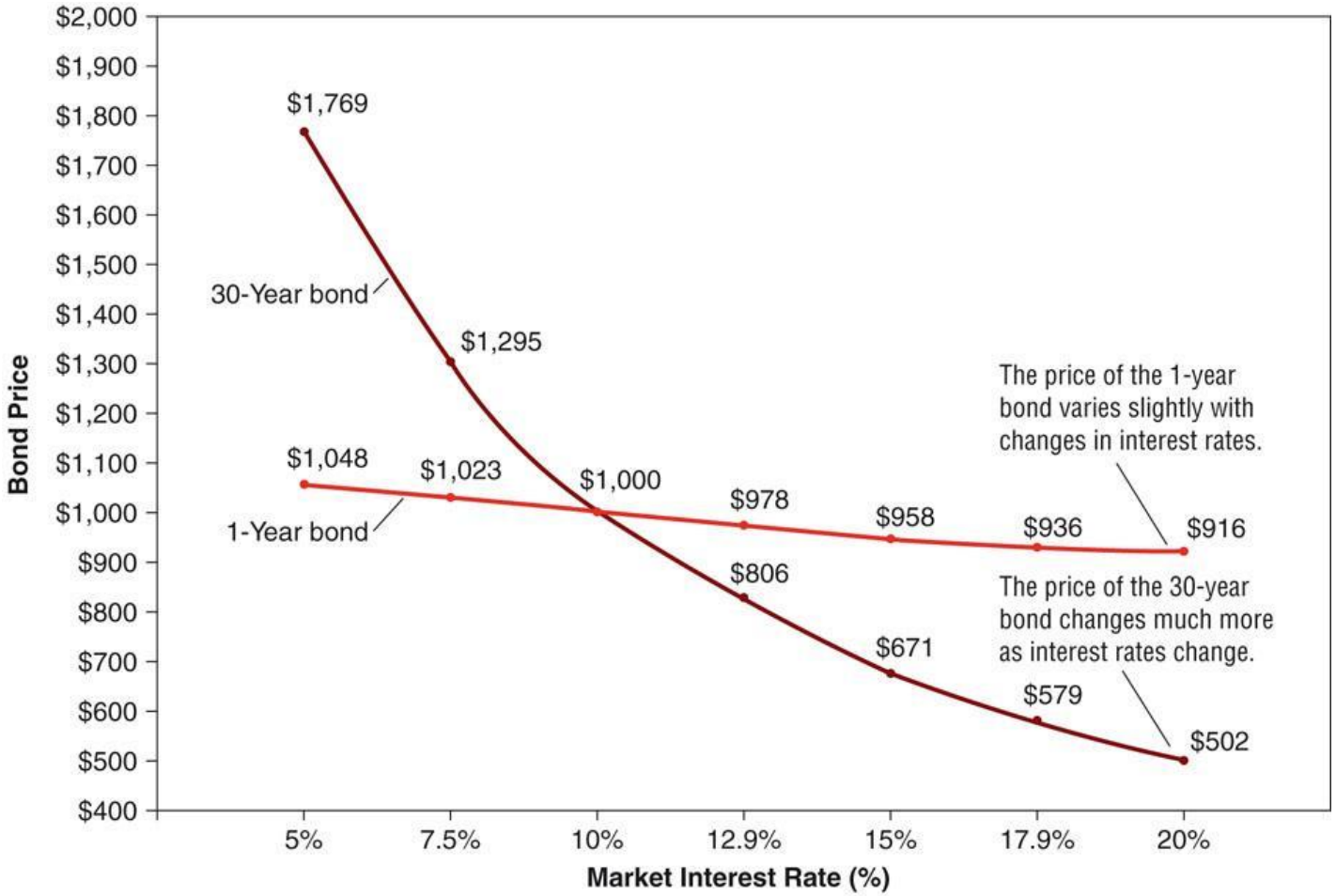
    As interest rates decline, prices of bonds rise; as interest rates rise, prices of bonds decline.

    For a given change in interest rates, prices of longer-term bonds change more than prices of shorter-term bonds.

    Interest rate risk increases as maturity increases, but at a decreasing rate.

Relation Between Bond Price Volatility and Maturity

Exhibit 8.2 Relation Between Bond Price Volatility and Maturity



Note: Plots are for a 1-year bond and a 30-year bond with a 10 percent coupon rate and annual payment

Interest Rate Risk

- BOND THEOREMS
  - **For a given change in interest rates, prices of lower-coupon bonds change more than prices of higher-coupon bonds.**

Relation Between Bond Price Volatility and the Coupon Rate

EXHIBIT 8.3 **Relation between Bond Price Volatility and the Coupon Rate**

The exhibit shows the prices of three 10-year bonds: a zero coupon bond, a 5 percent coupon bond, and a 10 percent coupon bond. Initially, the bonds are priced at a 5 percent yield (column 2). The bonds are then priced at yields of 6 and 4 percent (columns 3 and 6). The price changes shown are consistent with the third bond theorem: the smaller the coupon rate, the greater the percentage price change for a given change in interest rates.

		Price Change if Yield Increases from 5% to 6%			Price Change if Yield Decreases from 5% to 4%		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Coupon Rate	Bond Price at 5% Yield	Bond Price at 6%	Loss from Increase in Yield	% Price Change	Bond Price at 4%	Gain from Decrease in Yield	% Price Change
0%	$613.91	$588.39	$25.52	−9.04%	$675.56	$61.65	10.04%
5%	$1,000.00	$926.40	$73.60	−7.36%	$1,081.11	$81.11	8.11%
10%	$1,386.09	$1,294.40	$91.69	−6.62%	$1,486.65	$100.56	7.25%

Note: Calculations are based on a bond with a $1,000 face value and a 10-year maturity and assume annual compounding.

Interest Rate Risk

- BOND THEOREM APPLICATIONS
  - **If interest rates are expected to increase, avoid long-term bonds – they will experience the largest price declines.**
  - **If interest rates are expected to decline, buy zero-coupon bonds. Their prices will increase more than those of coupon-paying bonds.**

The Structure of Interest Rates

- RISK CHARACTERISTICS OF BONDS
  - **Four features of debt instruments are responsible for most of the differences in corporate borrowing costs and determine the level and structure of interest rates:**
    - Marketability
    - Call feature
    - Default risk
    - Term-to-maturity

The Structure of Interest Rates

- MARKETABILITY
  - **How quickly and easily a security can be sold at at low transaction cost and at fair market value**

    The selling price varies directly with the degree of marketability.

    The transaction cost varies inversely with the degree of marketability.

    The yield-to-maturity varies inversely with the degree of marketability.

The Structure of Interest Rates

- MARKETABILITY
  - **The difference in yields between a highly marketable security ($i_{high\ mkt}$) and a less marketable security ($_{ilow\ mkt}$) is the marketability risk premium (MRP)**

$$MRP = i_{high\ mkt} - i_{low\ mkt} > 0$$

  - **U.S. Treasury bills are considered the most marketable of all securities**

The Structure of Interest Rates

- CALL PROVISION
  - **Bond issuer's option to purchase a bond from the bondholder at a predetermined price before maturity.**

    When bonds are called, bondholders suffer financial loss because they must surrender higher-yield bonds and replace them with lower-yield bonds.

The Structure of Interest Rates

- CALL PROVISION
  - **The difference in interest rates between a callable bond and a non-callable bond is the call premium (CIP)**

$$CIP = i_{call} - i_{no\ call} > 0$$

  - **Callable bonds sell for lower prices and higher yields than non-callable bonds**
  - **Bonds paying high yields are more likely to be called when interest rates decline; these bonds have a high CIP**

The Structure of Interest Rates

- DEFAULT RISK
  - **Risk that a borrower may not make payments as promised**
  - **Lenders are paid a default risk premium for purchasing securities with default risk**
  - **The default risk premium (DRP) is the difference between the yield on a security with default risk, i_{dr}, and the risk-free rate, i_{rf}**
  - **Yield on T-bills is a proxy for the risk-free rate.**

The Structure of Interest Rates

- BOND RATINGS
  - **Individuals and small businesses rely on outside agencies for information on the default potential of bonds.**

    The two most prominent credit rating agencies are Moody's Investors Service (Moody's) and Standard & Poor's (S&P).

    – *Both services rank bonds in order of probability of default and publish ratings as letter grades.*

The Structure of Interest Rates

- BOND RATINGS
  - **The highest grade bonds have the lowest default risk and are rated Aaa or AAA.**

    Investment grade bonds are rated Aaa to Baa.

    State and federal laws typically require commercial banks, insurance companies, pension funds, certain other financial institutions, and government agencies to purchase only investment-grade securities.

Corporate Bond Rating Systems

EXHIBIT 8.4 **Corporate Bond Rating Systems**

Moody's has a slightly different notation in their ratings of corporate bonds than do Standard & Poor's and Fitch, but the interpretation is the same. Bonds with the highest credit standing are rated Aaa (or AAA) and have the lowest default risk. The credit rating declines as the default risk of the bonds increases.

Explanation	Moody's	Standard & Poor's/Fitch	Default Risk Premium	Regulatory Designation
Best quality, smallest degree of risk	Aaa	AAA	Lowest	Investment Grade
High quality, slightly more long-term risk than top rating	Aa	AA		
Upper-medium grade, possible impairment in the future	A	A		
Medium grade, lacks outstanding investment characteristics	Baa	BBB		
Speculative, protection may be very moderate	Ba	BB		Noninvestment Grade
Very speculative, may have small assurance of interest and principal payments	B	B		
Issues in poor standing, may be in default	Caa	CCC		
Speculative to a high degree, with marked shortcomings	Ca	CC		
Lowest quality, poor prospects of attaining real investment standing	C	C	Highest	

Default Risk Premiums for Selected Bond Ratings

Exhibit 8.5 Default Risk Premiums for Selected Bond Ratings

Security: Moody's Credit Rating	Security Yield (%) (1)	Risk-Free Rate[a] (%) (2)	Default Risk: Premium (%) (1) − (2)
Aaa	5.26	4.45	0.81
Aa	5.49	4.45	1.04
A	5.72	4.45	1.27
Baa	6.14	4.45	1.69

The Structure of Interest Rates

- TERM STRUCTURE OF INTEREST RATES
  - **The term structure of interest rates**

    the relationship between yield to maturity and term-to-maturity on a bond

    the graph of the term structure of interest rates is a yield curve

    - *The shape and position of the yield curve are not constant.*
    - *As the overall level of interest rates changes, the yield curve shifts up and down and changes its shape and slope.*

The Structure of Interest Rates

- BASIC SHAPES (SLOPES) OF YIELD CURVES
  1. **Ascending or normal yield curves slope upward from left to right and imply higher interest rates are likely**
  2. **Descending or inverted yield curves slope downward from left to right and imply lower interest rates are likely**
  3. **Flat yield curves imply interest rates unlikely to change**

The Structure of Interest Rates

- SHAPE OF THE YIELD CURVE
  - **Three factors that influence the shape of the yield curve**
    1) Real rate of interest
    2) Expected rate of inflation
    3) Interest rate risk

The Structure of Interest Rates

- THE REAL RATE OF INTEREST
  - **The real rate of interest changes with the business cycle.**
    - Highest rates occur at the end of an economic expansion.
    - Lowest rates occur at the end of an economic contraction.
    - Changes in the expected future real rate of interest can affect the slope of the yield curve.

The Structure of Interest Rates

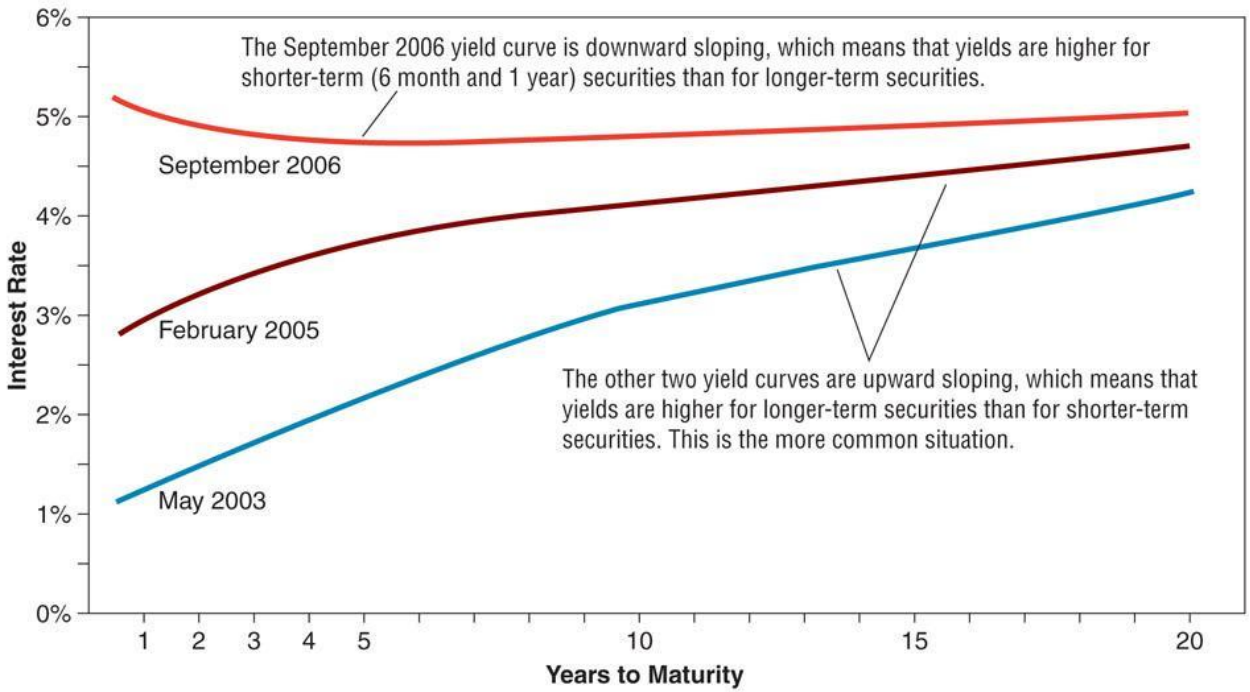
- THE EXPECTED RATE OF INFLATION
  - **If higher inflation is forecast, the yield curve will slope upward because longer-term yields will contain a larger inflation premium than shorter-term yields**
  - **If investors believe inflation will subside, the yield curve will slope downward**

The Structure of Interest Rates

- INTEREST RATE RISK
  - **The longer the maturity of a security, the greater its interest rate risk – the risk of selling the security at a lower price - and the higher its yield-to-maturity**
  - **The interest rate risk premium adds upward bias to the slope of the yield curve**

Yield Curves for Treasury Securities at Three Different Points in Time

Exhibit 8.6



	Interest Rate (%)		
Terms to Maturity	September 2006	February 2005	May 2003
6 months	5.10	2.86	1.08
1 year	4.99	3.05	1.14
5 year	4.68	3.78	2.33
10 years	4.73	4.16	3.34
20 years	4.95	4.60	4.28

The Structure of Interest Rates

- CUMULATIVE EFFECT OF FACTORS
  - **In an economic expansion, the real rate of interest and the inflation premium increase monotonically . Interest rate risk increases.**
  - **In an economic contraction, the real rate of interest and inflation premium decrease monotonically. Interest rate risk decreases.**