

## DEBT VALUATION AND INTEREST

### Chapter 9

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### Principles Applied in This Chapter

- ☐ Principle 1: Money Has a Time Value.
- ☐ Principle 2: There is a Risk-Return Tradeoff.
- ☐ Principle 3: Cash Flows Are the Source of Value

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### Corporate Borrowings

- ☐ There are two main sources of borrowing for a corporation:
  1. Loan from a financial institution (known as **private debt** since it involves only two parties)
  2. Bonds (known as **public debt** since they can be traded in the public financial markets)

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## Borrowing Money in the Private Financial Market

- **Financial Institutions** provide loans
  - ▣ **Working capital loans** to finance firm's day-to-day operations
  - ▣ **Transaction loans** for the purchase of equipment or property
  - ▣ Loans may or may not be secured by a **collateral**.

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Table 9-1 Types of Bank Debt

(Panel A) Types of Bank Loans—Classified by Intended Use	
Working capital loans	Typically, these loans set up a line of credit based on an open-ended credit agreement whereby the firm has prior approval to borrow up to a set limit. This type of credit agreement is similar to that of a personal credit card that provides a line of credit up to an agreed-upon limit. The credit is then used to provide cash needed to support the firm's day-to-day business needs.
Transaction loans	Firms use this type of loan to finance a specific asset. These loans typically call for installment payments designed to repay the principal amount of the loan, plus interest, with fixed monthly or annual payments. Home mortgage and automobile loans are examples of transaction loans that require installment payments.
(Panel B) Types of Bank Loans—Classified by the Collateral Used to Secure the Loan	
Secured debt	This type of debt acts as a promise to pay that is backed by granting the lender an interest in a specific piece of property, known as collateral. The property used to secure the loan can include virtually any tangible business asset and could include accounts receivable, inventory, plant and equipment, and real estate.
Unsecured debt	A promise to pay that is not supported by collateral so that the lender relies upon the creditworthiness and reputation of the borrower to repay the debt when due.

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## Floating-Rate Loans

- In the private financial market, loans are typically **floating rate loans**
  - The interest rate is adjusted based on a specific benchmark rate.
  - The most popular benchmark rate is the **London Interbank Offered Rate (LIBOR)**, rate at which banks offer to lend in the London wholesale or interbank market

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## Floating-Rate Loans

For example, a corporation may get a 1-year loan with a rate of 300 basis points (or 3%) over LIBOR with a ceiling of 11% and a floor of 4%.

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## CHECKPOINT 9.1: CHECK YOURSELF

### Calculating the Rate of Interest on a Floating-Rate Loan

Consider a 1 year loan period

Spread over LIBOR is 75 basis points (0.75%).

Ceiling = 2.50%, floor = 1.75%

Is the ceiling rate or floor rate violated during the loan period?

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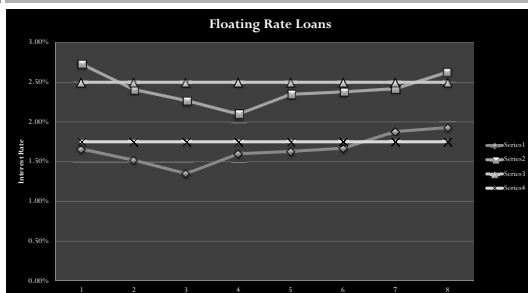
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## Step 1: Picture the Problem



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## Step 2: Decide on a Solution Strategy

- We have to determine the floating rate for every week and see if it exceeds the ceiling or falls below the floor.

- ▣ Floating rate on Loan

= LIBOR for the previous week + spread of .75%

The floating rate on loan cannot exceed the ceiling rate of 2.5% or drop below the floor rate of 1.75%.

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## Step 3: Solve

	LIBOR	LIBOR + Spread (.75%)	Loan Rate
2/29/2008	1.98%		
3/7/2008	1.66%	2.73%	2.50%
3/14/2008	1.52%	2.44%	2.41%
3/21/2008	1.35%	2.27%	2.27%
3/28/2008	1.60%	2.10%	2.10%
4/4/2008	1.63%	2.35%	2.35%
4/11/2008	1.67%	2.38%	2.38%
4/18/2008	1.88%	2.42%	2.42%
4/25/2008	1.93%	2.63%	2.50%
5/2/2008		2.68%	2.50%

→ Ceiling Violated

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## Step 4: Analyze

- If there were no ceiling, the loan rate would have been 2.73% during the first week of the loan, and 2.63% and 2.68% during the last two weeks of the loan.
- ▣ The rate was set to the ceiling of 2.50% for those three weeks.

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## Corporate Bonds

- **Corporate bond** is a debt security issued by corporation that has promised future payments and a maturity date.
- If the firm fails to pay the promised future payments of interest and principal, the bond trustee can classify the firm as insolvent and force the firm into bankruptcy.

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## Basic Bond Features

- The basic features of a bond include the following:
  - Bond indenture
  - Claims on assets and income
  - Par or face value
  - Coupon interest rate
  - Maturity and repayment of principal
  - Call provision and conversion features

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## Bond Terminology

<b>Indenture</b>	The legal agreement between the firm issuing the bonds and the bond trustee who represents the bondholders. It lists the specific terms of the loan agreement, including a description of the bonds, the rights of the bondholders, the rights of the issuing firm, and the responsibilities of the trustee.
<b>Priority of claim on assets and income</b>	In the case of insolvency, claims of debt in general, including bonds, are honored before those of both common stock and preferred stock. In addition, interest payments hold priority over dividend payments for common and preferred stock.
<b>Par value</b>	The par value of a bond, also known as its face value, is the principal that must be repaid to the bondholder at maturity. In general, corporate bonds are issued with par values in increments of \$1,000. Also, when bond prices are quoted in the financial press, prices are generally expressed as a percentage of the bond's par value.
<b>Maturity and repayment of principal</b>	The maturity date refers to the date on which the bond issuer must repay the principal or par value to the bondholder.
<b>Coupon interest rate</b>	The coupon rate on a bond indicates the percentage of the par value of the bond that will be paid out annually in the form of interest.
<b>Current yield</b>	The current yield on a bond refers to the ratio of the annual interest payment to the bond's current market price. If, for example, we have a bond with an 8% coupon interest rate, a par value of \$1,000, and a market price of \$700, it would have a current yield of 11.4%, calculated as follows: $\text{Current Yield} = \frac{\text{Annual Interest Payment}}{\text{Current Market Price of the Bond}} = \frac{0.08 \times \$1,000}{\$700} = \frac{\$80}{\$700} = 0.114 \text{ or } 11.4\%$ <span style="float: right;">(9-1)</span>
<b>Call provision</b>	The call provision provides the issuer of the bond with the right to redeem or retire a bond before it matures.
<b>Conversion feature</b>	In addition, some bonds have a conversion feature that allows bondholders to convert their bonds into a set number of shares of common stock.

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## Types of Corporate Bonds

<b>Debentures</b>	Any form of unsecured long-term debt. Because they are unsecured, the earning ability of the issuing corporation is of great concern to the bondholder. They are riskier than secured bonds and as a result must provide investors with a higher yield than secured bonds provide. Often, the issuing firm attempts to provide some protection to the holder of the bond by prohibiting the firm from issuing more secured long-term debt that would further tie up the firm's assets and leave the bondholders less protected. To the issuing firm, the major advantage of debentures is that no property has to be secured by them. This allows the firm to issue debt and still preserve some future borrowing power.
<b>Subordinated debentures</b>	The claims of the subordinated debentures are honored only after the claims of secured debt and unsubordinated debentures have been satisfied.
<b>Mortgage bonds</b>	Bonds secured by a lien on real property. Typically, the value of the real property is greater than the amount of the bonds issued. This provides the mortgage bondholders with a margin of safety in the event the market value of the secured property declines. In the case of foreclosure, the bondholders get the proceeds from the sale of the secured property. If the proceeds from this sale do not cover the bonds, the bondholders become general creditors, similar to debenture bondholders, for the unpaid portion of the debt.
<b>Eurobonds</b>	Bonds issued in a country different from the one in whose currency the bond is denominated. For example, a bond that is issued in Europe or in Asia by an American company and that pays interest and principal to the holder in U.S. dollars would be considered a Eurobond. Thus, even if the bond is not issued in Europe, it merely needs to be sold in a country different from the one in whose currency it is denominated to be considered a Eurobond.
<b>Zero-coupon and very-low-coupon bonds</b>	These bonds require either no coupon interest payments (these are called <i>zeros</i> ) or very low interest payments. Consequently, the bondholder receives all or most of their return at maturity. Because these bonds pay little or no interest they must sell at a deep discount. For the investor, a zero-coupon bond is like a U.S. savings bond. The obvious appeal of zero-coupon bonds is to those investors who need a lump sum of money at some future date but don't want to be concerned about reinvesting interest payments. Today, zero-coupon bonds are infrequently issued by corporations. The dominant player in this market is the U.S. government, with the government's zero-coupon bonds called <i>STRIPS</i> .
<b>Junk (high-yield) bonds</b>	High-risk debt that has a below-investment grade bond rating (see the earlier discussion of bond ratings). Junk bonds are also called high-yield bonds because they pay interest rates that are 3 to 5% higher than those of the highest rated bonds.
<b>Floating-rate bonds</b>	A floating- or variable-rate bond is simply one whose coupon rate fluctuates according to the level of current market interest rates. These bonds are quite popular with municipalities and foreign governments, but are far less common among corporations.
<b>Convertible bonds</b>	Convertible bonds are debt securities that can be converted into a firm's stock at a pre-specified price.

## Borrowing Money in the Public Financial Market

Corporations engage the services of an **investment banker** while raising long-term funds in the public financial market. The investment banker performs three basic functions:

- ❑ **Underwriting:** assuming risk of selling a security issued. The client is given the money before the securities are sold to the public.
- ❑ **Distributing**
- ❑ **Advising**

## Interpreting Bond Ratings

Bond Rating Category	Standard & Poor's	Moody's	Description
<b>Investment Grade:</b>			
Prime or highest strong	AAA	Aaa	Highest quality; extremely strong capacity to pay
High quality	AA	Aa	Very strong capacity to pay
Upper medium	A	A-1, A	Upper medium quality; strong capacity to pay
Medium	BBB	Baa-1, Baa	Lower medium quality; changing circumstances could impact the firm's ability to pay
<b>Not Investment Grade:</b>			
Speculative	BB	Ba	Speculative elements; faces uncertainties
Highly speculative	B, CCC, CC	B, Caa, Ca	Extremely speculative and highly vulnerable to nonpayment
Default	D	C	Income bond; doesn't pay interest

## Valuing Corporate Debt

The value of corporate debt is equal to the present value of the contractually promised principal and interest payments (the cash flows) discounted back to the present using the market's required yield to maturity on similar risk.

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## Valuing Corporate Debt

Step 1: Determine bondholder cash flows, which are the the amount and timing of the bond's promised interest and principal payments to the bondholders.

□ Annual Interest = Par value × coupon rate

□ Example 9.1: The annual interest for a 10-year bond with coupon interest rate of 7% and a par value of \$1,000 is equal to \$70, ( $.07 \times \$1,000 = \$70$ ). This bond will pay \$70 every year and \$1,000 at the end of 10-years.

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## Valuing Corporate Debt

Step 2: Estimate the appropriate discount rate on a bond of similar risk.

Discount rate is the return the bond will yield if it is held to maturity and all bond payments are made.

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## Valuing Corporate Debt

**Step 3:** Calculate the present value of the bond's interest and principal payments from Step 1 using the discount rate in step 2.

$$\text{Bond Value} = \left( \frac{\text{Present Value of the Bond's Coupon Interest Payments}}{\right) + \left( \frac{\text{Present Value of the Principal Amount (par Value) of the Bond Issue}}{\right)$$

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## Calculating a Bond's Yield to Maturity (YTM)

We can think of YTM as the discount rate that makes the present value of the bond's promised interest and principal equal to the bond's observed market price.

$$\text{Bond Price} = \frac{\text{Interest}_{\text{year 1}}}{(1 + \text{YTM})^1} + \frac{\text{Interest}_{\text{year 2}}}{(1 + \text{YTM})^2} + \frac{\text{Interest}_{\text{year 3}}}{(1 + \text{YTM})^3} + \dots + \frac{\text{Interest}_{\text{year } n}}{(1 + \text{YTM})^n} + \frac{\text{Principal}}{(1 + \text{YTM})^n}$$

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## CHECKPOINT 9.2: CHECK YOURSELF

### Calculating the Yield to Maturity on a Corporate Bond

Calculate the YTM on the Ford bond where the bond price rises to \$900 (holding all other things equal).

- 11 year maturity
- 6.5% coupon rate
- \$1000 face value

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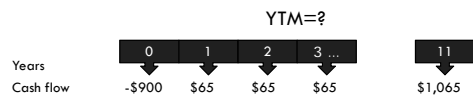
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## Step 1: Picture the Problem



- Purchase price = \$900
- Interest payments = \$65 per year for years 1-11
- Final payment = \$1,000 in year 11 of principal.

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## Step 2: Decide on a Solution Strategy

YTM is the solution to

$$\text{Bond Price} = \frac{\text{Interest}_{\text{year 1}}}{(1 + YTM)^1} + \frac{\text{Interest}_{\text{year 2}}}{(1 + YTM)^2} + \frac{\text{Interest}_{\text{year 3}}}{(1 + YTM)^3} + \dots + \frac{\text{Interest}_{\text{year } n}}{(1 + YTM)^n} + \frac{\text{Principal}}{(1 + YTM)^n}$$

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## Step 3: Solve

Using a Financial Calculator

Need to find interest rate

N = 11

PV = -90

PMT = 65

FV = 1,000

□ I/Y = **7.89**

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## Step 4: Analyze

- The yield to maturity on the bond is 7.89%.
  - The yield is higher than the coupon rate of interest of 6.5%.
  - Since the coupon rate is lower than the yield to maturity, the bond is trading at a price below \$1,000.
  - We call this a *discount bond*.

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## Corporate Bond Credit Spread Tables

Rating	Maturity						
	1 yr	2 yr	3 yr	5 yr	7 yr	10 yr	30 yr
Aaa/AAA	5	7	12	19	31	49	78
Aa1/AA+	10	22	31	43	55	70	103
Aa2/AA-	13	36	50	67	79	91	128
Aa3/AA-	16	40	54	72	84	96	134
A1/A+	17	42	58	76	88	101	140
A2/A	44	66	79	96	107	118	152
A3/A2-	53	84	103	127	143	160	210
Baa1/BBB+	78	113	132	157	174	191	245
Baa2/BBB-	98	137	160	188	208	227	289
Baa3/BBB-	157	194	215	242	259	278	336
Ba1/BB+	251	287	310	337	358	379	433
Ba2/BB-	343	379	403	433	455	479	532
Ba3/BB-	437	472	498	528	553	580	629
B1/B+	530	564	592	623	650	680	727
B2/B	624	656	686	719	749	781	824
B3/B-	716	749	780	814	847	881	923
Caa/CCC+	810	841	875	908	944	982	1020
U.S. Treasury Yield	0.18%	0.25%	0.32%	0.60%	1.00%	1.59%	2.76%

YTM<sub>coupon</sub> = 6.5%  
 Spread + YTM<sub>coupon</sub> = 1.28% + 6.5% = 7.78%

YTM<sub>coupon</sub> = 6.5%  
 Spread + YTM<sub>coupon</sub> = 1.39% + 6.5% = 7.89%

[http://www.bondsource.com/Today\\_Market/Corporate\\_Bond\\_Spreads.php](http://www.bondsource.com/Today_Market/Corporate_Bond_Spreads.php)

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## Promised versus Expected Yield to Maturity

The yield to maturity calculation *assumes* that the bond performs according to the terms of the bond contract or indenture.

Since corporate bonds are subject to risk of default, the promised yield to maturity may not be equal to expected yield to maturity.

That is, we need to take account of the default risk in our YTM calculation

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### Promised versus Expected Yield to Maturity

- **Example** Consider a one-year bond that promises a coupon rate of 8% and has a principal (par value) of \$1,000. Further assume the bond is currently trading for \$850.

Promised YTM

$$= \{(\text{Interest}_{\text{year 1}} + \text{Principal}) \div (\text{Bond Value})\} - 1$$

$$= \{(\$80 + \$1,000) \div (\$850)\} - 1 = \mathbf{27.06\%}$$

### Promised versus Expected Yield to Maturity

- Assume there is a 40% probability of default on this bond
- If the bond defaults, the bondholders will receive only 60% of the principal and interest owed.
- What is the expected YTM on this bond?

$YTM_{\text{default}}$

$$= \{(\text{Interest}_{\text{year 1}} + \text{Principal})\} \div (\text{Bond Value}) - 1$$

$$= \{(\$80 + \$1,000) \times .60\} \div (\$850) - 1 = \mathbf{-23.76\%}$$

### Promised versus Expected Yield to Maturity

□  $E(YTM)$

$$= YTM_{\text{NoDefault}} \times (1 - \text{Prob}(\text{Default})) \\ + YTM_{\text{Default}} \times \text{Prob}(\text{Default})$$

$$= (27.06 \times .60) + (-23.76 \times .40)$$

$$= \mathbf{6.73\%}$$

## Ratings and Default Risk

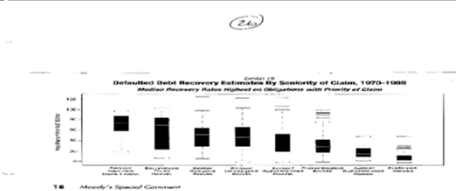
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### Historical Default Experience of Bonds Rated by Fitch

Investment-grade Bonds										
10-yr Default Prob.	0.19%	0.57%	0.89%	1.15%	1.63%	1.85%	2.44%	3.13%	3.74%	7.26%
Default Rate (ann.)	0.02%	0.06%	0.09%	0.12%	0.17%	0.19%	0.25%	0.32%	0.38%	0.75%
Rating	AAA	AA+	AA	AA-	A+	A	A-	BBB+	BBB	BBB-
Speculative-grade Bonds										
Rating	BB+	BB	BB-	B+	B	B-	CCC+	CCC	CC	C
10-yr Default Prob.	10.18%	13.53%	18.46%	22.84%	27.67%	34.98%	43.36%	48.52%	77.00%	95.00%
Default Rate (ann.)	1.07%	1.45%	2.04%	2.59%	3.24%	4.30%	5.68%	6.64%	14.70%	29.96%

Source: Koval, Jurek and Stafford 2008

## Recovery Rates on Defaulted Bonds



## CHECKPOINT 9.3: CHECK YOURSELF

### Valuing a Bond Issue

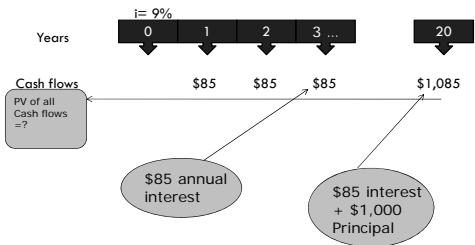
Calculate the value of the AT&T bond should the yield to maturity for comparable risk bonds rise to 9% (holding all other things equal).

20 year bond

8.5% coupon rate

\$1000 par value

## Step 1: Picture the Problem



## Step 2: Decide on a Solution Strategy

- Here we know the following:
  - ▣ Annual interest payments = \$85
  - ▣ Principal amount or par value = \$1,000
  - ▣ Time = 20 years
  - ▣ YTM or discount rate = 9%
- We can use the above information to determine the value of the bond by discounting future interest and principal payment to the present.

## Step 3: Solve

### Using a Mathematical Formula

$$\text{Bond Value} = \text{Interest} \left[ \frac{1 - \frac{1}{(1 + YTM_{\text{Market}})^n}}{YTM_{\text{Market}}} \right] + \text{Principal} \left[ \frac{1}{(1 + YTM_{\text{Market}})^n} \right]$$

$$\begin{aligned}
 &= \$85 \left[ \frac{1 - (1/(1.09)^{20})}{.09} \right] + 1,000/(1.09)^{20} \\
 &= \$85 (9.128) + \$178.43 \\
 &= \mathbf{\$954.36}
 \end{aligned}$$

### Step 3: Solve

Using a Financial  
Calculator

- ▣ N = 20
- ▣ I/Y = 9.0
- ▣ PMT = 85
- ▣ FV = 1000
- ▣ PV = **954.36**

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### Step 4: Analyze

- ▣ The value of AT&T bond falls to \$954.36 when the yield to maturity rises to 9%. The bonds are now trading at a discount as the coupon rate on AT&T bonds is lower than the market yield.
- ▣ An investor who buys AT&T bonds at its current discounted price will earn a promised yield to maturity of 9%.

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### Semiannual Interest Payments

Corporate bonds typically pay interest to bondholders semiannually.

$$\text{Bond Value (semiannual payments)} = (\text{Interest}/2) \left[ \frac{1 - \left( \frac{1}{1 + \frac{YTM_{\text{Market}}}{2}} \right)^{2n}}{\frac{YTM_{\text{Market}}}{2}} \right] + \text{Principal} \left[ \frac{1}{\left( 1 + \frac{YTM_{\text{Market}}}{2} \right)^{2n}} \right]$$

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### CHECKPOINT 9.4: CHECK YOURSELF

#### Valuing a Bond Issue That Pays Semiannual Interest

Calculate the present value of the AT&T bond should the yield to maturity on comparable bonds rise to 9% (holding all other things equal).

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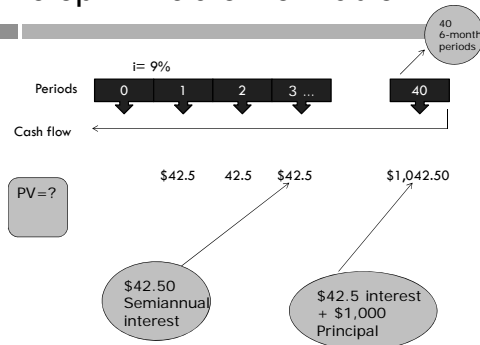
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#### Step 1: Picture the Problem



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#### Step 2: Decide on a Solution Strategy

- Here we know the following:
  - ▣ Semiannual interest payments = \$42.50
  - ▣ Principal amount or par value = \$1,000
  - ▣ Time = 20 years or 40 periods
  - ▣ YTM or discount rate = 9% or 4.5% for 6-months
- We can use the above information to determine the value of the bond by discounting future interest and principal payment to the present.

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### Step 3: Solve

#### Using a Mathematical Formula

$$\text{Bond Value (semiannual payments)} = (\text{Interest}/2) \left[ \frac{1 - \left( \frac{1}{1 + \frac{YTM_{\text{Market}}}{2}} \right)^{2n}}{\frac{YTM_{\text{Market}}}{2}} \right] + \text{Principal} \left[ \frac{1}{\left( 1 + \frac{YTM_{\text{Market}}}{2} \right)^{2n}} \right]$$

$$= \$42.5 \left\{ \left[ 1 - (1/(1.045)^{40}) \right] \div (.20) \right\} + \$1,000/(1.045)^{40}$$

$$= \$42.5 (18.40) + \$171.93$$

$$= \mathbf{\$953.996}$$

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### Step 3: Solve

#### Using a Financial Calculator

- ▣ N = 40
- ▣ 1/y = 4.50
- ▣ PMT = 42.50
- ▣ FV = 1000
- ▣ PV = **953.996**

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### Step 4: Analyze

Using semi-annual compounding we get a value of \$953.9960 for AT&T bonds. This is very close to the value of \$954.36 found using annual compounding.

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## Bond Valuation: Four Key Relationships

- **First Relationship:** The value of bond is inversely related to changes in the yield to maturity.

	YTM = 12%	YTM rises to 15%
Par value	\$1,000	\$1,000
Coupon rate	12%	12%
Maturity date	5 years	5 years
Bond Value	\$1,000	\$899.44

Bond Value Drops

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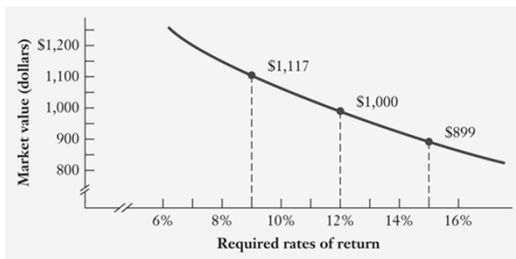
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Figure 9-1 Bond Value and the Market's Required Yield to Maturity (5-Year Bond, 12% Coupon Rate)



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## Bond Valuation: Four Key Relationships

- **Second Relationship:** The market value of a bond will be less than the par value (**discount bond**) if the market's required yield to maturity is above the coupon interest rate and will be valued above par value (**premium bond**) if the market's required yield to maturity is below the coupon interest rate.

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## Bond Valuation: Four Key Relationships

- **Third Relationship** As the maturity date approaches, the market value of a bond approaches its par value.
  - That's because at maturity the bond will be taken away and the investor will receive the par value of the bond.

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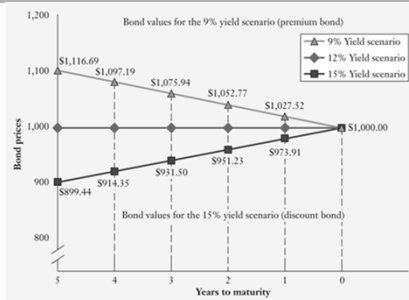
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## Value of a 12% Coupon Bond during the Life of the Bond



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## Bond Valuation: Four Key Relationships

**Fourth Relationship** Long term bonds have greater interest-rate risk than short-term bonds.

- While all bonds are affected by a change in interest rates, the prices of longer-term bonds fluctuate more when interest rates change than do the prices of shorter-term bonds (see Table 9.6)

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### Bond Valuation: Four Key Relationships

- **First Relationship** The value of bond is inversely related to changes in the yield to maturity.

	YTM = 12%	YTM rises to 15%	YTM rises to 15%
Par value	\$1,000	\$1,000	\$1,000
Coupon rate	12%	12%	12%
Maturity date	5 years	5 years	10 years
Bond Value	\$1,000	\$899.44	\$839.44

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### Determinants of Interest Rates

- As we observed earlier, bond prices vary inversely with interest rates.
- Therefore in order to understand how bond prices fluctuate, we need to know the determinants of interest rates.

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### Inflation and Real versus Nominal Interest Rates

- Quotes of interest rates in the financial press are commonly referred to as the **nominal (or quoted) interest rates**.
- **Real rate of interest** adjusts for the effects of inflation.

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## Fisher Effect: The Nominal and Real Rate of Interest

- The relationship between the nominal rate of interest,  $r_{\text{nominal}}$ , the anticipated rate of inflation,  $r_{\text{inflation}}$ , and the real rate of interest is known as the **Fisher effect**.
- $1 + r_{\text{nominal}} = (1 + r_{\text{real}})(1 + r_{\text{inflation}})$
- $= 1 + r_{\text{real}} + r_{\text{inflation}} + r_{\text{real}} * r_{\text{inflation}}$
- $\approx 1 + r_{\text{real}} + r_{\text{inflation}}$

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## Interest Rate Determinants

- We can think of the reported nominal = interest rate on a bond as having five components:
  - ▣ Real risk-free rate
  - ▣ The inflation premium
  - ▣ Default-risk premium
  - ▣ Maturity-risk premium
  - ▣ Liquidity-risk premium

$$\text{Nominal Rate of Interest, } r_{\text{nominal}} = \text{Real Risk-free Rate of Interest, } r_{\text{real risk-free}} + \text{Inflation Premium} + \text{Default-risk Premium} + \text{Maturity-risk Premium} + \text{Liquidity-risk Premium}$$

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## The Maturity-Risk Premium and the Term Structure of Interest Rates

- The relationship between interest rates and time to maturity with risk held constant is known as the **term structure of interest rates** or the **yield curve**.
- Figure 9-3 illustrates a hypothetical term structure of U.S. Treasury Bonds.

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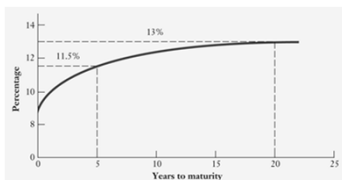
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**Figure 9-3 The Term Structure of Interest Rates or Yield Curve**




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### The Shape of the Yield Curve

By reviewing equation 9-5, we can gain insight into the shape of the yield curve for US Treasuries. Since there is no default risk or liquidity risk and the real-risk free rate of interest is unlikely to change, the shape of the yield curve is driven by inflation premium and maturity risk premium.

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### The Shape of the Yield Curve

During periods when inflation is expected to subside, the inflation premium should decrease over longer maturities, resulting in a downward sloping Treasury yield curve as shown in Figure 9.5. The reverse is also true as shown in Figure 9.4

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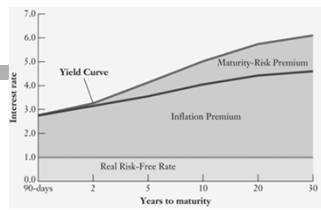
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**Figure 9.4**  
Treasury Yield  
Curve during  
Period of  
Increasing  
Inflation



Maturity	Real Risk-Free Rate	Inflation Premium	Maturity-Risk Premium	Yield
90 days	1.00%	1.75%	0.01%	2.76%
2 years	1.00%	2.15%	0.11%	3.26%
5 years	1.00%	2.56%	0.57%	4.13%
10 years	1.00%	3.05%	0.97%	5.02%
20 years	1.00%	3.42%	1.32%	5.74%
30 years	1.00%	3.60%	1.50%	6.10%

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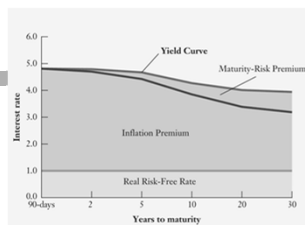
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**Figure 9.5**  
Treasury Yield  
Curve during  
Period of  
Decreasing  
Inflation



Maturity	Real Risk-Free Rate	Inflation Premium	Maturity-Risk Premium	Yield
90 days	1.00%	3.80%	0.01%	4.81%
2 years	1.00%	3.71%	0.08%	4.79%
5 years	1.00%	3.42%	0.25%	4.67%
10 years	1.00%	2.85%	0.42%	4.27%
20 years	1.00%	2.38%	0.63%	4.01%
30 years	1.00%	2.19%	0.75%	3.94%

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## Shifts in the Yield Curve

- The yield curve changes over time as expectations regarding each of the four factors that underlie interest rates change.
- Figure 9-6 shows the yield curve one day before 9/11 attack and again two weeks later. Investors shifted their funds to the safety of Treasuries, pushing up the prices and bringing down the yields.

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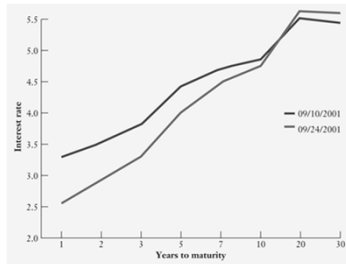
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Figure 9-6 Changes in the Term Structure of Interest Rates around September 11, 2001




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## Shifts in the Yield Curve

- The yield curve is generally **upward sloping** but it can assume different shapes i.e. downward sloping or flat.
- Figure 9-7 illustrates different shapes of yield curves at different dates, observed within a span of only 13 months.

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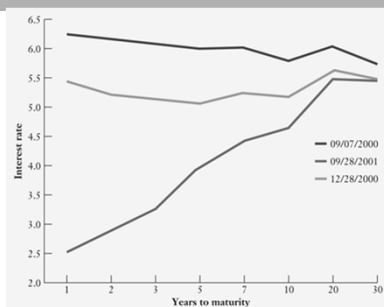
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Figure 9.7 Historical Term Structure of Interest Rates for Government Securities




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## US Treasury Yield Curve

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- <https://www.treasury.gov/resource-center/data-chart-center/Pages/index.aspx>

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## International Yield Curves

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- <https://www.bondsupermart.com/main/market-info/yield-curves-chart>

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