Chapter 7
Interest Rates and Bond Valuation

Chapter Organization

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T7.2 Bond Features

- Bond - evidence of debt issued by a corporation or a governmental body. A bond represents a *loan* made by investors to the *issuer.* In return for his/her money, the investor receives a legal claim on future cash flows of the borrower. The issuer promises to:

  Make regular coupon payments every period until the bond matures, and

  Pay the face/par/maturity value of the bond when it matures.

- Default - since the above mentioned promises are *contractual obligations*, an issuer who fails to keep them is subject to legal action on behalf of the lenders (bondholders).

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T7.2 Bond Features (concluded)

- If a bond has five years to maturity, an $80 annual coupon, and a $1000 face value, its cash flows would look like this:

Time	0	1	2	3	4	5
Coupons		$80	$80	$80	$80	$80
Face Value						$ 1000
Market Price $____						

- How much is this bond worth? It depends on the level of current market interest rates. If the going rate on bonds like this one is 10%, then this bond has a market value of $924.18. Why? Stay tuned!

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T7.3 Bond Rates and Yields

- Consider again our example bond. It sells for $924.18, pays an annual coupon of $80, and it matures in 5 years. It has a face value of $1000. What are its coupon rate, current yield, and yield to maturity (YTM)?

  - 1. The *coupon rate* (or just "coupon") is the annual dollar coupon as a percentage of the face value:

    Coupon rate = $80 /$_____ = _____ %

  - 2. The *current yield* is the annual coupon divided by the current market price of the bond:

    Current yield = $ _____ /_____ = 8.66%

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T7.3 Bond Rates and Yields

- Consider again our example bond. It sells for $924.18, pays an annual coupon of $80, and it matures in 5 years. It has a face value of $1000. What are its coupon rate, current yield, and yield to maturity (YTM)?

  - 1. The *coupon rate* (or just "coupon") is the annual dollar coupon as a percentage of the face value:

    Coupon rate = $80 /$1000 = 8%

  - 2. The *current yield* is the annual coupon divided by the current market price of the bond:

    Current yield = $80 / 924.18 = 8.66%

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T7.3 Bond Rates and Yields (concluded)

- 3. The *yield to maturity* (or "YTM") is the rate that makes the market price of the bond equal to the present value of its future cash flows. It is the unknown r in the equation below:

$$\$924.18 = \$80 \times [1 - 1/(1 + r)^5]/r + \$1000/(1 + r)^5$$

The only way to find the YTM is by trial and error:

a. Try 8%: $\$80 \times [1 - 1/(1.08)^5]/.08 + \$1000/(1.08)^5 = \$1000$

b. Try 9%: $\$80 \times [1 - 1/(1.09)^5]/.09 + \$1000/(1.09)^5 = \$961.10$

c. Try 10%: $\$80 \times [(1 - 1/(1.10)^5]/.10 + \$1000/(1.10)^5 = \$924.18$

$\therefore$ So, the yield to maturity is 10%.

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T7.4 Valuing a Bond

- Let's do another one. Assume you have the following information.

  Seagrams bonds have a $1000 face value.
  The promised annual coupon is $100.
  The bonds mature in 20 years.
  The market's required return on similar bonds is 10%

  What is the bond's value?

  - 1. Calculate the present value of the face value

    $= \$1000 \times [1/1.10^{20}] = \$1000 \times .14864 = \$148.64$

  - 2. Calculate the present value of the coupon payments

    $= \$100 \times [1 - (1/1.10^{20})]/.10 = \$100 \times 8.5136 = \$851.36$

  - 3. The value of each bond = $148.64 + 851.36 = $1000

T7.5 Example: A Discount Bond

- How about another one? Assume you have the following information.

  Seagrams bonds have a $1000 face value

  The promised annual coupon is $100

  The bonds mature in 20 years

  The market's required return on similar bonds is 12%

  - 1. Calculate the present value of the face value

    $= \$1000 \times [1/1.12^{20}] = \$1000 \times .10366 = \$103.66$

  - 2. Calculate the present value of the coupon payments

    $= \$100 \times [1 - (1/1.10^{20})]/.10 = \$100 \times 7.4694 = \$746.94$

  - 3. The value of each bond = $103.66 + 746.94 = $850.60

  Why is this bond selling at a discount to its face value?

T7.6 Example: A Premium Bond

- One more. Now you have the following information.

  Seagrams bonds have a $1000 face value

  The promised annual coupon is $100

  The bonds mature in 20 years

  The market's required return on similar bonds is 8%

  - 1. Calculate the present value of the face value

    $= \$1000 \times [1/1.08^{20}] = \$1000 \times .21455 = \$214.55$

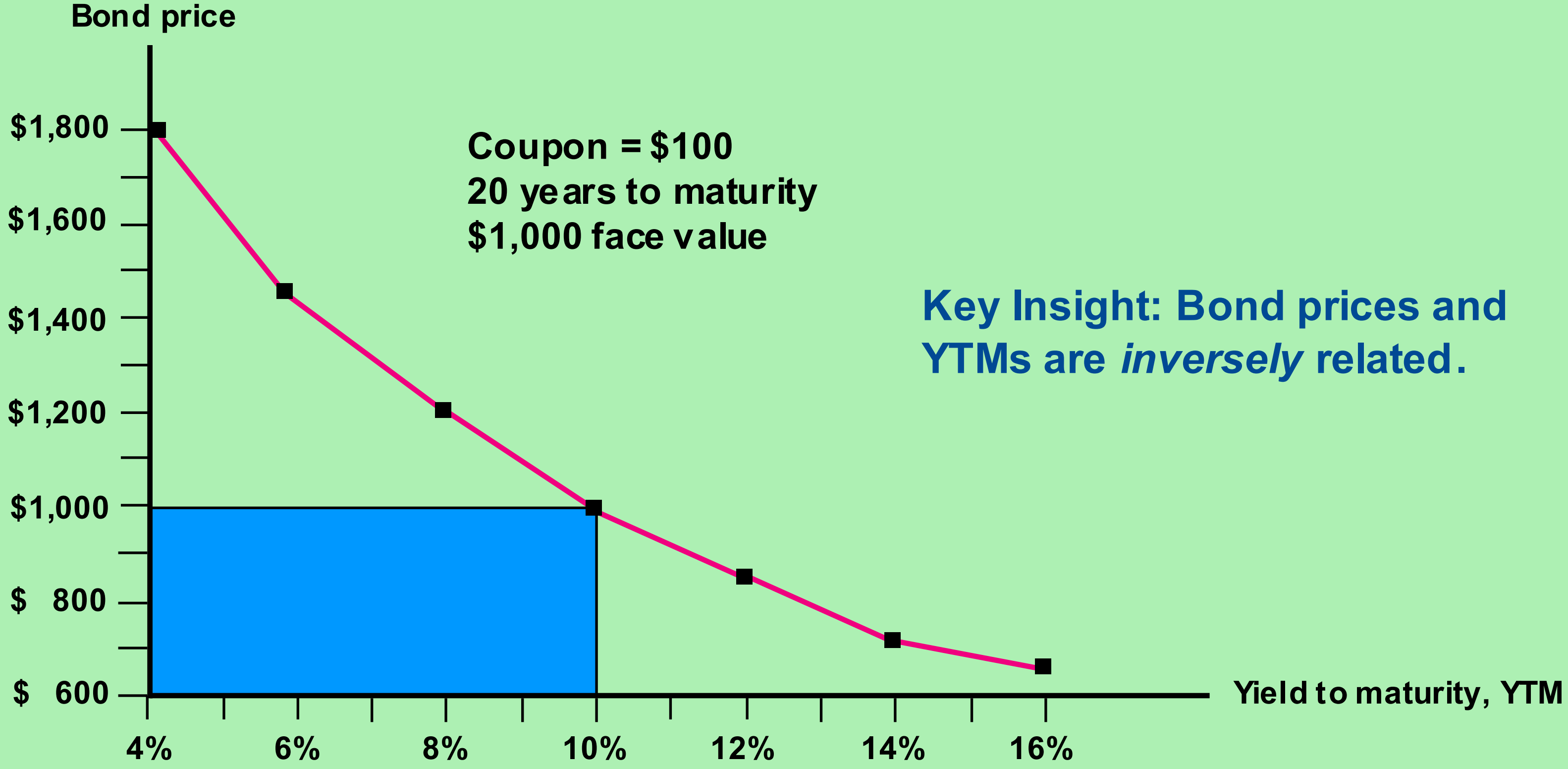
  - 2. Calculate the present value of the coupon payments

    $= \$100 \times [1 - (1/1.08^{20})]/.08 = \$100 \times 9.8181 = \$981.81$

  - 3. The value of each bond = $214.55 + 981.81 = $1,196.36

    Why is this bond selling at a premium to par?

T7.7 Bond Price Sensitivity to YTM



Key Insight: Bond prices and YTMs are *inversely* related.

T7.8 The Bond Pricing Equation

- Bond Value = Present Value of the Coupons

  + Present Value of the Face Value

$$= C \times [1 - 1/(1 + r)^t]/r + F \times 1/(1 + r)^t$$

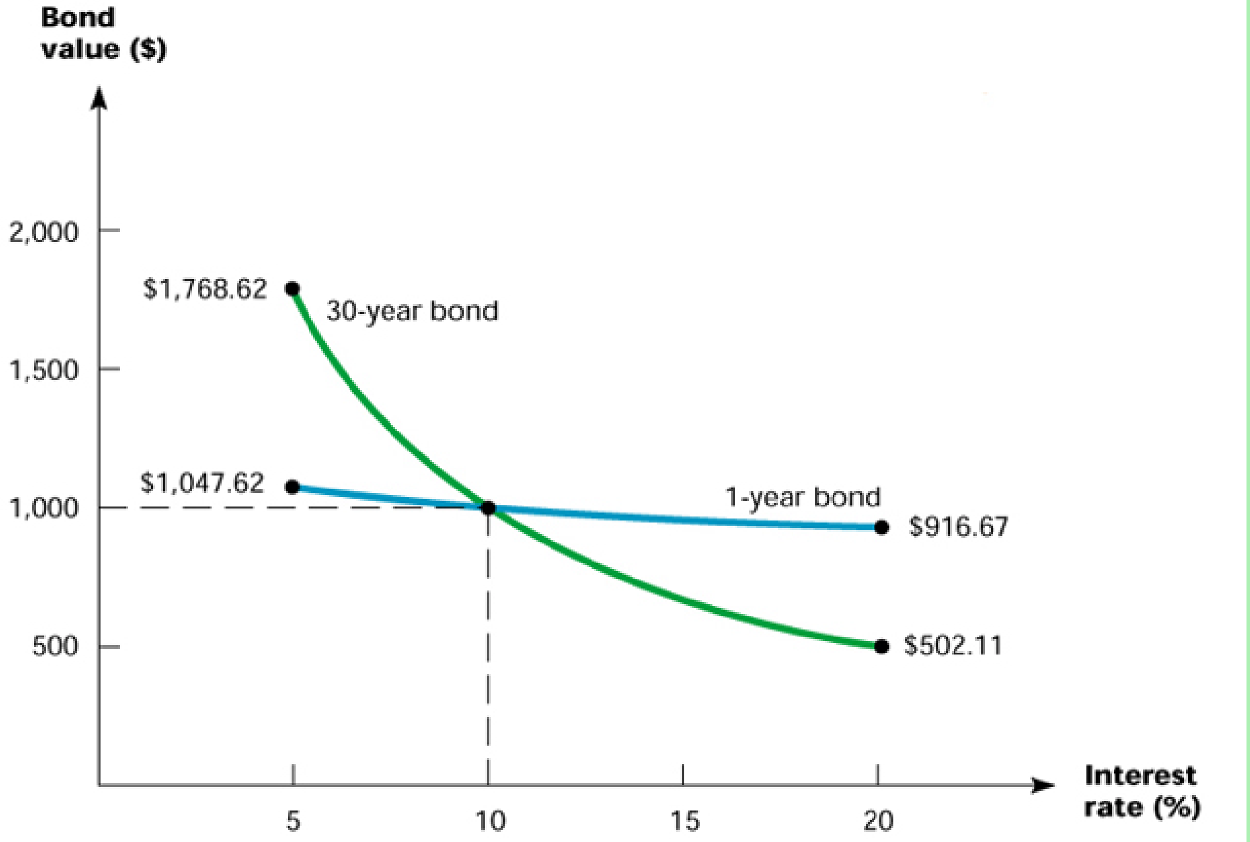
where: C = Coupon paid each period

r = Rate per period

t = Number of periods

F = Bond's face value

T7.9 Interest Rate Risk and Time to Maturity (Figure 7.2)



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

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T7.10 Summary of Bond Valuation (Table 7.1)

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

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T7.11 Bond Pricing Theorems

- The following statements about bond pricing are *always* true.
  - 1. Bond prices and market interest rates move in opposite directions.
  - 2. When a bond's coupon rate is (greater than / equal to / less than) the market's required return, the bond's market value will be (greater than / equal to / less than) its par value.
  - 3. Given two bonds identical but for maturity, the price of the longer-term bond will change more (in percentage terms) than that of the shorter-term bond, for a given change in market interest rates.
  - 4. Given two bonds identical but for coupon, the price of the lower-coupon bond will change more (in percentage terms) than that of the higher-coupon bond, for a given change in market interest rates.

T7.12 Features of a May Department Stores Bond

Term		Explanation
Amount of issue	$200 million	The company issued $200 million worth of bonds.
Date of issue	8/4/94	The bonds were sold on 8/4/94.
Maturity	8/1/24	The principal will be paid 30 years after the issue date.
Face Value	$1,000	The denomination of the bonds is $1,000.
Annual coupon	8.375	Each bondholder will receive $83.75 per bond per year (8.375% of the face value).
Offer price	100	The offer price will be 100% of the $1,000 face value per bond.

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T7.12 Features of a May Department Stores Bond (concluded)

Term		Explanation
Coupon payment dates	2/1, 8/1	Coupons of $83.75/2 = $41.875 will be paid on these dates.
Security	None	The bonds are debentures.
Sinking fund	Annual beginning 8/1/05	The firm will make annual payments toward the sinking fund.
Call provision	Not callable before 8/1/04	The bonds have a deferred call feature. (See Appendix 7C on Canada plus calls.)
Call price	104.188 initially, declining to 100	After 8/1/04, the company can buy back the bonds for $1,041.88 per bond, declining to $1,000 on 8/1/14.
Rating	Moody's A2	This is one of Moody's higher ratings. The bonds have a low probability of default.

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The Bond Indenture

- The bond indenture is a *three-party contract* between the bond issuer, the bondholders, and the trustee. The trustee is hired by the issuer to protect the bondholders' interests. (What do you think would happen if an issuer refused to hire a trustee?)
- The indenture includes
  - The basic terms of the bond issue
  - The total amount of bonds issued
  - A description of the security
  - The repayment arrangements
  - The call provisions
  - Details of the protective covenants

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T7.14 Bond Ratings

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

Moody's	DBRS	
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.

T7.14 Bond Ratings (concluded)

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	BB, B CC, C	Debt rated in these categories is regarded, on balance, as Ca, C 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 CC and Ca the highest degree of speculation. Although such debt will likely have some quality and protective characteristics, these are out-weighed by large uncertainties or major risk exposures to adverse conditions. Some issues may be in default.
D	D	Debt rated D is in default, and payment of interest and/or repayment of principal is in arrears

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T7.15 Sample *National Post* Bond Quotation (Figure 7.3)

Insert Figure 7.3

T7.16 Inflation and Returns

- Key issues:
  - What is the difference between a *real* return and a *nominal* return?
  - How can we convert from one to the other?

- Example:

  Suppose we have $1000, and Diet Coke costs $2.00 per six pack. We can buy 500 six packs. Now suppose the rate of inflation is 5%, so that the price rises to $2.10 in one year. We invest the $1000 and it grows to $1100 in one year. What's our return in *dollars*? In *six packs*?

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T7.16 Inflation and Returns (continued)

- A. *Dollars.* Our return is

  ($1,100 - $1,000)/$1,000 = $100/$1,000 = .10.

  The percentage increase in the amount of green stuff is 10%; our return is 10%.

- B. *Six packs*. We can buy $1,100/$2.10 = 523.81 six packs, so our return is

  (523.81 - 500)/500 = 23.81/500 = 4.76%

  The percentage increase in the amount of brown stuff is 4.76%; our return is 4.76%.

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T7.16 Inflation and Returns (continued)

- Real versus nominal returns:

Your *nominal* return is the percentage change in the amount of money you have.

Your *real* return is the percentage change in the amount of stuff you can actually buy.

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T7.16 Inflation and Returns (concluded)

- The relationship between real and nominal returns is described by the Fisher Effect. Let:

R	=	the nominal return
r	=	the real return
h	=	the inflation rate

- According to the Fisher Effect:

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

- From the example, the real return is 4.76%; the nominal return is 10%, and the inflation rate is 5%:

$$(1 + R) = 1.10$$

$$(1 + r) \times (1 + h) = 1.0476 \text{ x } 1.05 = 1.10$$

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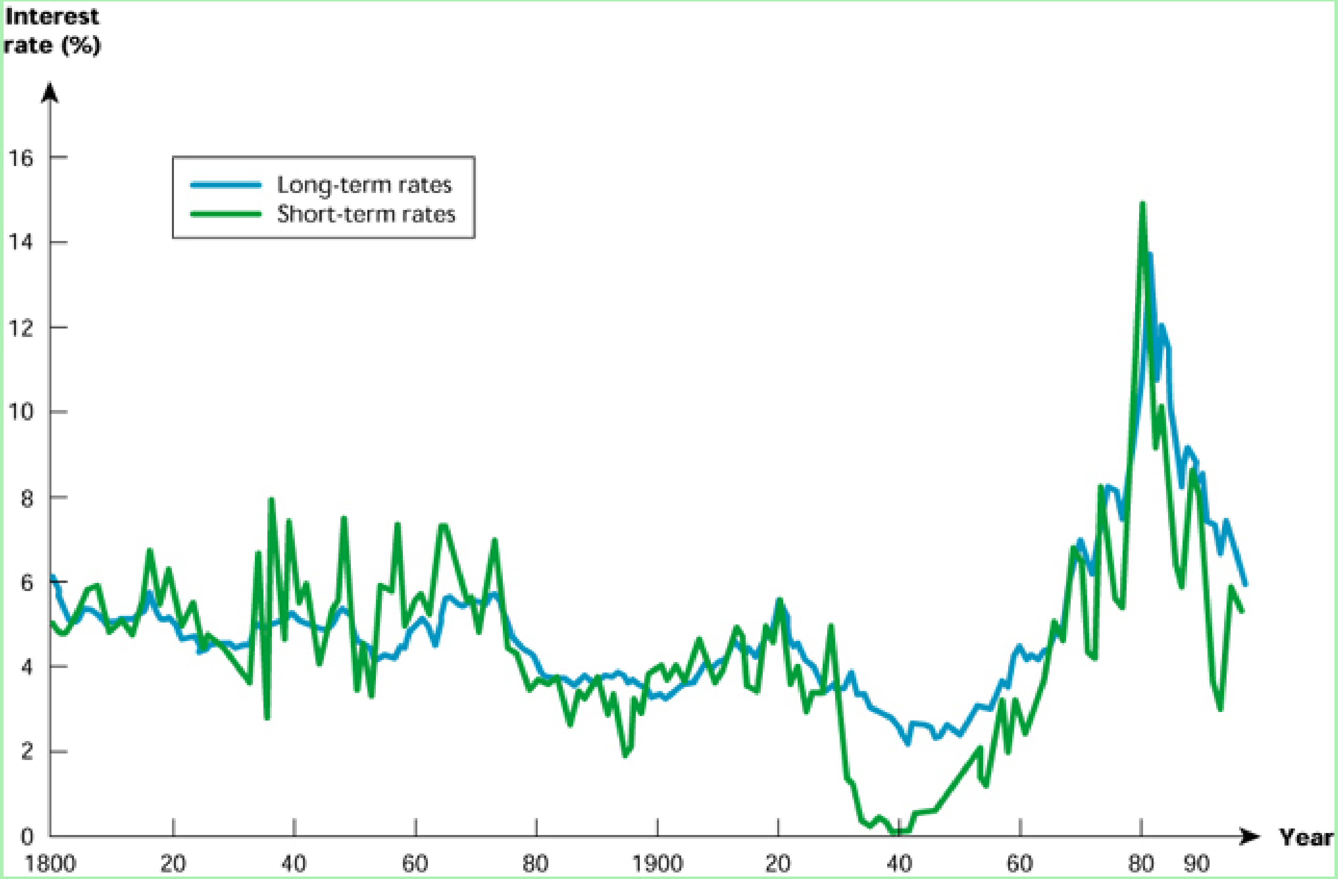
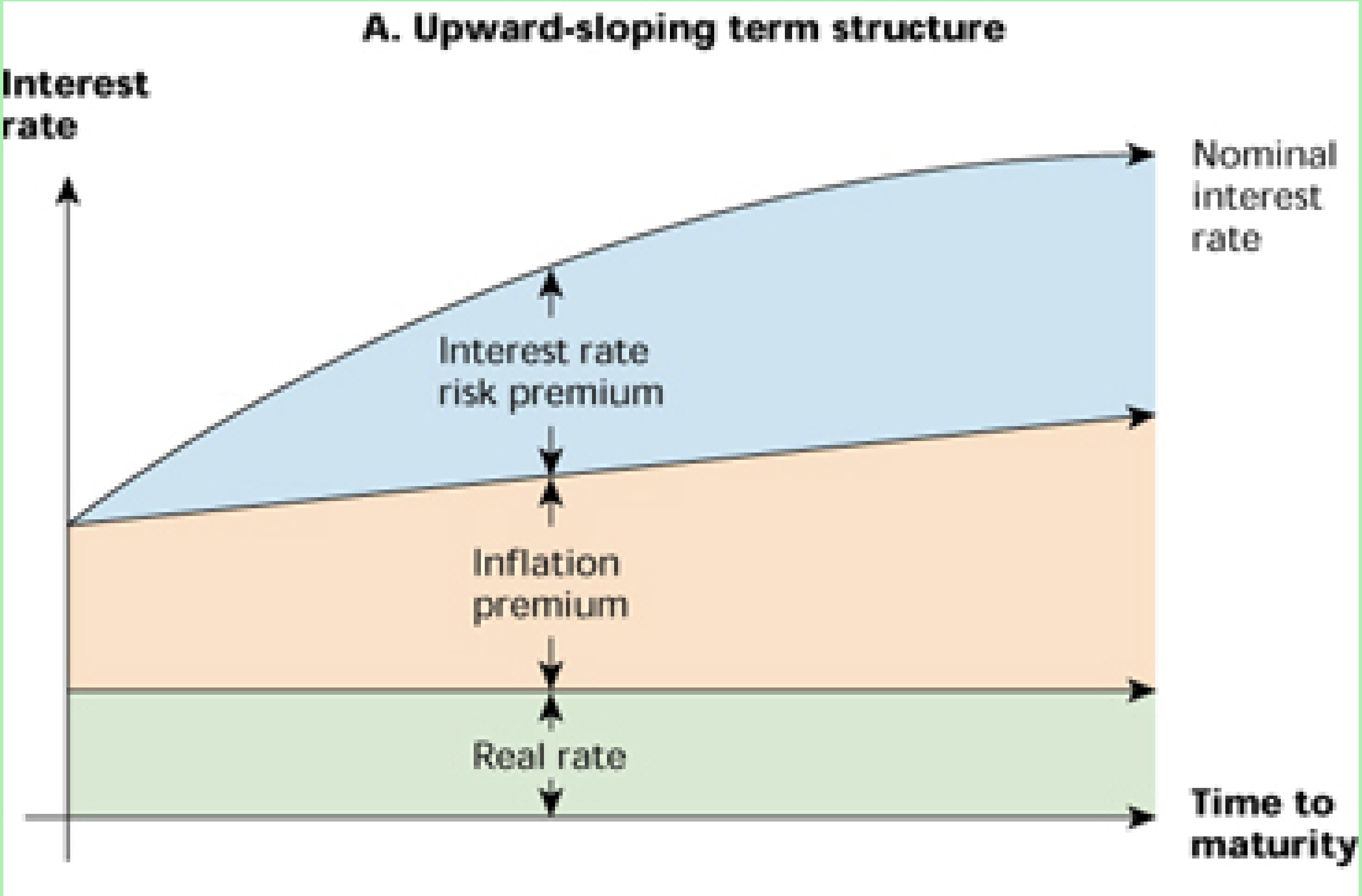
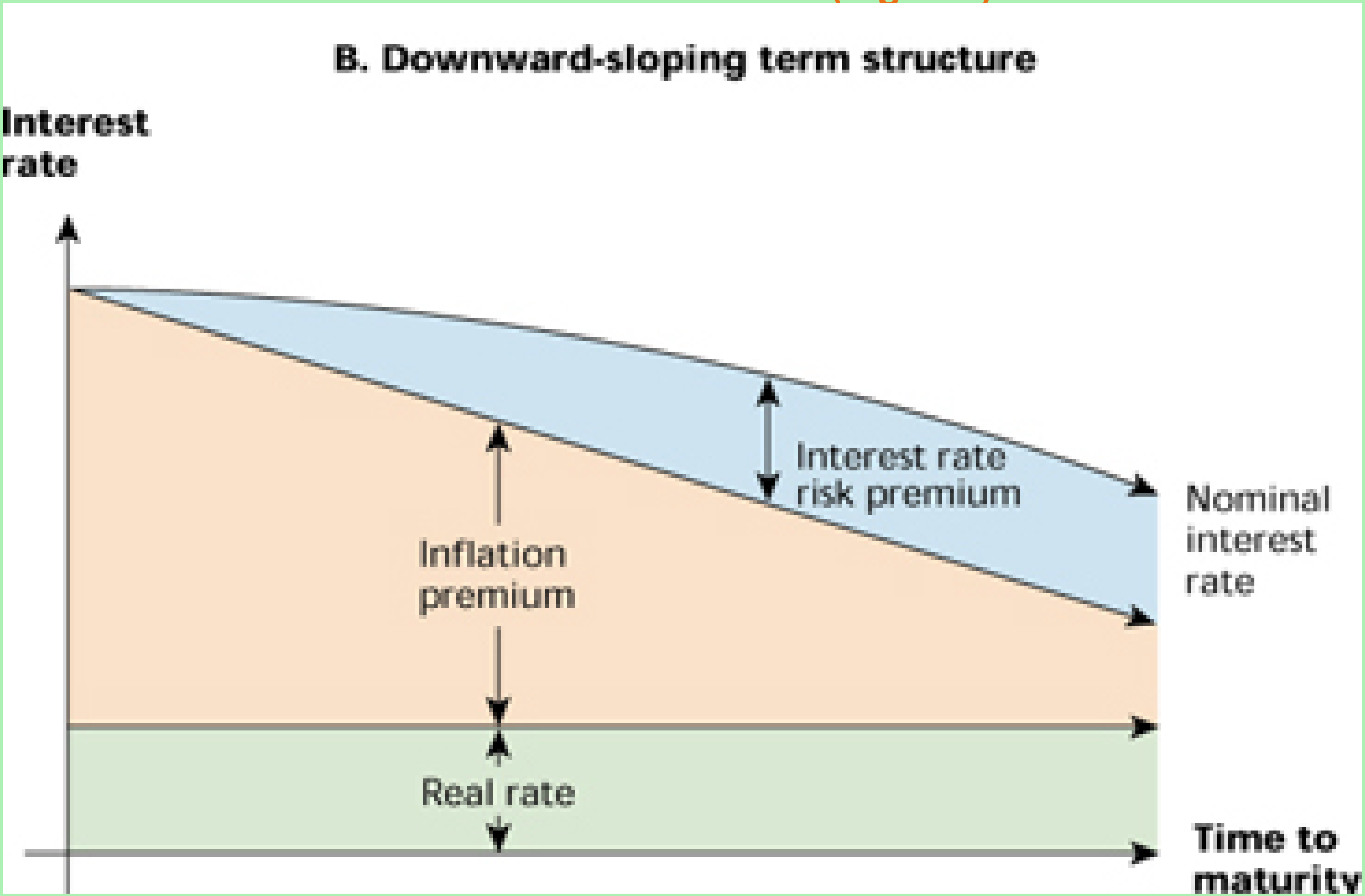
T7.17 U.S. Interest Rates: 1800-1997



T7.18 The Term Structure of Interest Rates (Fig. 7.6)



T7.18 The Term Structure of Interest Rates (Fig. 7.6)



T7.19 Government of Canada Yield Curve (Fig. 7.5)

Insert Figure 7.5

T7.20 Factors Affecting Bond Yields

Key Issue:

What factors affect observed bond yields?

- The real rate of interest
- Expected future inflation
- Interest rate risk
- Default risk premium
- Taxability premium
- Liquidity premium

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T7.21 Chapter 7 Quick Quiz

1. Under what conditions will the coupon rate, current yield, and yield to maturity be the same?

   A bond's coupon rate, current yield, and yield-to-maturity be the same if and only if the bond is selling at par.

2. What does it mean when someone says a bond is selling "at par"? At "a discount"? At "a premium"?

   A par bond is selling for its face value (typically $1000 for corporate bonds); the price of a discount bond is less than par, and the price of a premium bond is greater than par.

3. What is a "transparent" market?

   A market is transparent if it is possible to easily observe its prices and trading volumes.

T7.21 Chapter 7 Quick Quiz

4. What is the "Fisher Effect"?

The Fisher Effect is the name for the relationship between nominal returns, real returns, and inflation.

5. What is meant by the "term structure" of interest rates? How is the term structure of interest rates related to the yield curve?

The term structure of interest rates is the relationship between nominal interest rates on default-free, pure discount securities and time to maturity. The yield curve is a picture of the term structure existing at a point in time.

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T7.22 Solution to Problem 7.8

- Joe Kernan Corporation has bonds on the market with 10.5 years to maturity, a yield-to-maturity of 8 percent, and a current price of $850. The bonds make semiannual payments. What must the coupon rate be on the bonds?

Total number of coupon payments = $10.5 \times 2 = 21$

Yield to maturity per period = 8% / 2 = 4%

Maturity value = F = $1000

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T7.22 Solution to Problem 7.8 (concluded)

- Substituting the values into the bond pricing equation:

Bond Value $= C/2 \times [1 - 1/(1 + r)^t] / r + F / (1 + r)^t$

$\$850 = C/2 \times [1 - 1/(1 + .04)^{21}] / .04 + \$1000/(1.04)^{21}$

$\$850 = C/2 \times 14.0291 + \$438.83$

$C/2 = \$29.31$

So the annual coupon must be $29.31 × 2 = $58.62

and the coupon rate is $58.62 / $1,000 = .0586 = 5.86%.

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T7.23 Solution to Problem 7.13

- This problem refers to the bond quotes in Figure 7.3. Calculate the price of the Canada 10.25, 1 Feb 04 to prove that it is 113.68 as shown.
- What is its coupon rate?

Insert Figure 7.3

- What is its bid price?
- What is the yield to maturity?
- Confirm the price.

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T7.23 Solution to Problem 7.13

- This problem refers to the bond quotes in Figure 7.3. Calculate the price of the Canada 10.25, 1 Feb 04 to prove that it is 113.68 as shown.
- What is its coupon rate?

  The coupon rate is 10.25%.
- What is its bid price?

  The bid price is 113.68, or $1,136.80
- What is the yield to maturity?

The yield calculated on this bond is 6.12%

- Price...Bond Value = $C/2 \times [1 - 1/(1 + r)^t] / r + F / (1 + r)^t$

$$1136.80 = 102.5/2 \times [1 - 1/(1 + 3.06\%)^{7.56}] / 3.06\% + 1000 / (1 + 3.06\%)^{7.56}$$

where 7.56 is the remaining semiannual periods for the bond. - Note these are approximately equal

T7.24 Solution to Problem 7.17

- Bond J is a 4% coupon bond. Bond K is a 10% coupon bond. Both bonds have 8 years to maturity, make semiannual payments, and have a YTM of 9%. If interest rates suddenly rise by 2%, what is the percentage price change of these bonds? What if rates suddenly fall by 2% instead? What does this problem tell you about the interest rate risk of lower-coupon bonds?

Current Prices:

Bond J:

PV = $\$20 \times [1 - 1/(1.045)^{16}]/.045 + \$1000/(1.045)^{16} = \$719.15$

Bond K:

PV = $\$50 \times [1 - 1/(1.045)^{16}]/.045 + \$1000/(1.045)^{16} = \$1056.17$

T7.24 Solution to Problem 7.17 (continued)

Prices if market rates rise by 2% to 11%:

Bond J:

PV = $\$20 \times [1 - 1/(1.055)^{16}]/.055 + \$1000/(1.055)^{16} = \$633.82$

Bond K:

PV = $\$50 \times [1 - 1/(1.055)^{16}]/.055 + \$1000/(1.055)^{16} = \$947.69$

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T7.24 Solution to Problem 7.17 (continued)

Prices if market rates fall by 2% to 7%:

Bond J:

PV = $\$20 \times [1 - 1/(1.035)^{16}]/.035 + \$1,000/(1.035)^{16} = \$818.59$

Bond K:

PV = $\$50 \times [1 - 1/(1.035)^{16}]/.035 + \$1,000/(1.035)^{16} = \$1181.41$

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T7.24 Solution to Problem 7.17 (concluded)

- Percentage Changes in Bond Prices

Bond Prices and Market Rates

	7%	9%	11%
Bond J	$818.59	$719.15	$633.82
% **chg.**	(+13.83%)		(–11.87%)
Bond K	$1181.41	$1056.17	$947.69
% **chg.**	(+11.86%)		(–10.27%)

All else equal, the price of the lower-coupon bond changes more (in percentage terms) than the price of the higher-coupon bond when market rates change.