Chapter 6
Valuing Bonds

Financial Management (MGCM10018)

Preview

- Firms need money for investment in new plant and equipment.
- When previous earnings are not enough, firms need to raise cash from investors.
  - If the firms need money for just a short while, they may borrow from a bank.
  - If they need the money to make long-term investments, they generally issue bonds.
- This chapter discusses bond valuing.

Outline

- The Bond Market
- Interest Rates and Bond Prices
- Yield to Maturity
- Bond Rates of Return
- The Yield Curve
- Corporate Bonds and the Risk of Default

The Bond Market (6.1)

(Notes . Bills . Papers, Debentures) → 無擔保証券

- A bond is a debt instrument issued by governments or corporations to raise money.
  - It is a security that obligates the issuer to make specified payments to the bondholder. (1年一次)
  - It is the major type of fixed income security.
- The successful investor must be able to:
  - Understand bond structure.
  - Calculate bond rates of return.
  - Understand interest rate risk.
  - Differentiate between real and nominal returns.

Bond Characteristics

- When governments or companies issue bonds, they promise to make a series of interest payments and then repay the debt.
- Face Value (also called principal or par values)
  - Payment at the maturity of the bond.
- Coupon
  - The interest payments paid to the bondholder.
  - Zero coupon bonds do not pay coupon.
  - Coupon Rate: Annual interest payment as a percentage of face value.

(不考)

Bond Example

- Treasury bond prices are used to be quoted in 32nds rather than in decimals.
  - For a $1,000 face value bond with a bid price of 103:05 and an asked price of 103:06, how much would an investor pay for the bond?

103% + (06/32) = 103.1875% of face value

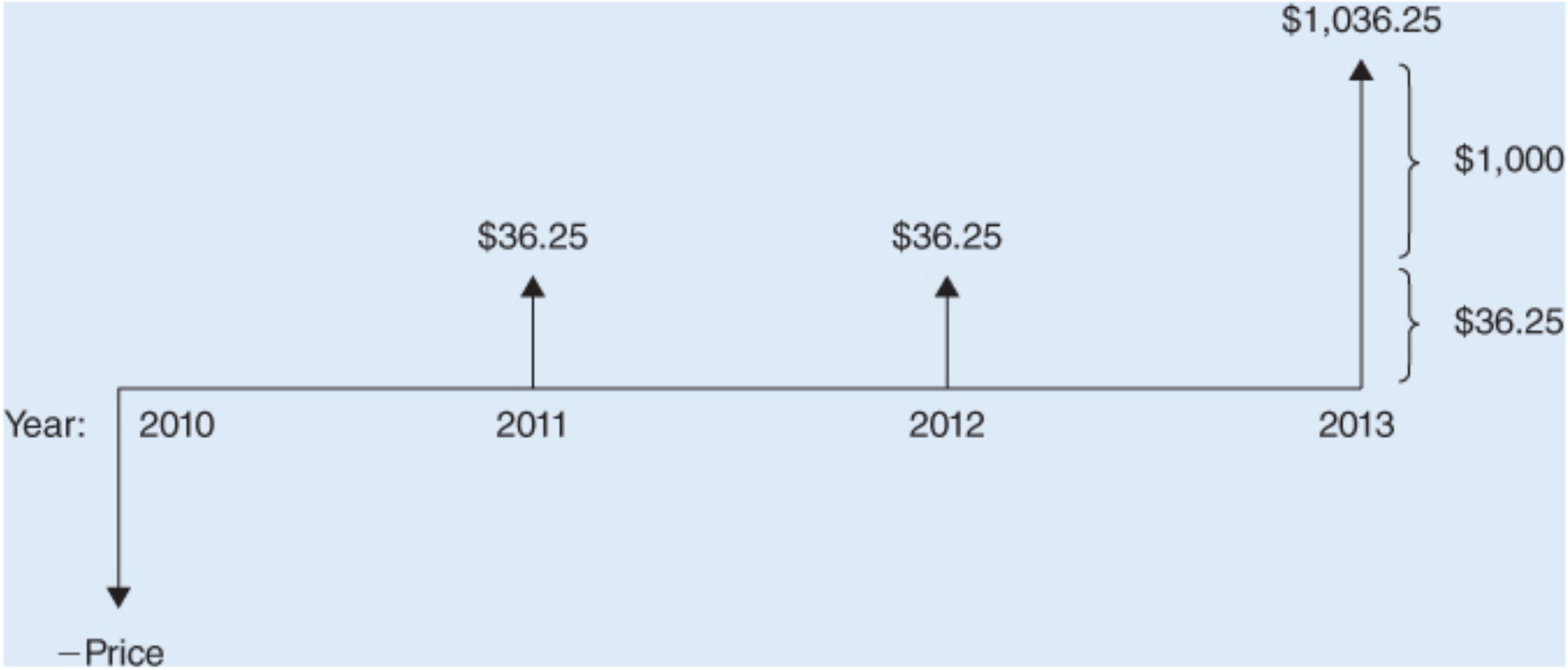
(1.031875) * ($1,000) = **$1,031.875**

Sample Treasury Bond Quotes

Maturity	Coupon	Bid Price	Asked Price	Asked Yield, %
2012 May 15	1.375	101:05	101:06	0.78
2013 May 15	**3.625**	**106:31**	**107:01**	**1.23**
2014 May 15	4.75	111:22	111:23	1.70
2020 May 15	8.75	144:17	144:19	3.44
2025 Aug 15	6.875	133:07	133:11	3.94
2030 May 15	6.25	128:25	128:27	4.12
2040 May 15	4.375	100:28	100:29	4.32

Source: The Wall Street Journal Web site, **www.wsj.com**.

Cash Flows to an investor in the 3.625% coupon bond maturing in the year of 2013



The Bond Market (continued)

protect bond issuer

- Most corporate bonds contain a call provision, which gives the issuing corporation the right to call the bonds for redemption.
  - The call provision generally states that the company must pay the bondholders an amount greater than the par value if they are called. The additional sum, which is termed a call premium.
  - Bonds are often not callable until several years (generally 5 to 10) after they are issued. This is known as a deferred call with call protection.

→ 條款

protect bond holder

The Bond Market (continued)

償債基金

- Some bonds include a sinking fund provision that facilitates the orderly retirement of the bond issue.
- Owners of convertible bonds have the option to convert the bonds into a fixed number of shares of common stock.
- Corporate bonds are traded primarily in electronic/telephone markets rather than in organized exchanges.

on-the-run bond 一個用來發行的債券 (剛發行 Bond Price = Par value)
(同時 r = coupon rate)

Interest Rates and Bond Prices (6.2)

- Rationally, the bondholder must expected to earn a return from bonds where alternative instrument can provide.
  - The interest rate offered by the alternative instrument is the opportunity cost.
  - Thus, the current price (present value) of bonds must be

(Bond Price)

$$PV = \frac{coupon}{(1+r)^1} + \frac{coupon}{(1+r)^2} + \ldots + \frac{(coupon + par)}{(1+r)^t}$$

(1000)

r↑, PV↓ r↓, PV↑

Bond Pricing: Example

$\frac{a(1-r^n)}{1-r}$

What is the price of a 9% annual coupon bond with a par value of $1,000 that matures in 3 years? Assume a required rate of return of 4%.

Coupon payment = $1000 \times 9\% = 90$

$$PV = \frac{90}{1.04} + \frac{90}{1.04^2} + \frac{(90+1000)}{1.04^3}$$

$$= \frac{\frac{90}{1.04}\left(1-\frac{1}{1.04^3}\right)}{1-\frac{1}{1.04}} + \frac{1000}{1.04^3} = \frac{90\left(1-\frac{1}{1.04^3}\right)}{1.04-1} + \frac{1000}{1.04^3}$$

$$= 1,138.75$$

Bond Pricing

- A bond is a package of two investments: an annuity + a final repayment.

$$PV_{Bond} = PV_{Coupons} + PV_{Par\,Value}$$

$$PV_{Bond} = coupon \times (Annuity\ Factor) + par\ value \times (Discount\ Factor)$$

$$\text{where } Annuity\ Factor = \frac{1-(1+r)^{-t}}{r}$$

$$\text{and } Discount\ Factor = \frac{1}{(1+r)^{t}}$$

Bond Pricing: Example

- What is the value of a 3-year annuity that pays $90 each year and an additional $1,000 at the date of the final repayment? Assume a discount rate of 4%.

$$PV_{bond} = (coupon \times annuity\ factor) + (par\ value \times discount\ factor)$$

Bond Prices vs. Interest Rates

What is the present value of a 4% coupon bond with face value $1,000 that matures in 3 years? Assume a discount rate of 5%.

$$PV_{bond} = \frac{\$40}{(1.05)^1} + \frac{\$40}{(1.05)^2} + \frac{(\$1{,}040)}{(1.05)^3} = \mathbf{\$972.77}$$

discount bond

What is the present value of this same bond at a discount rate of 2%?

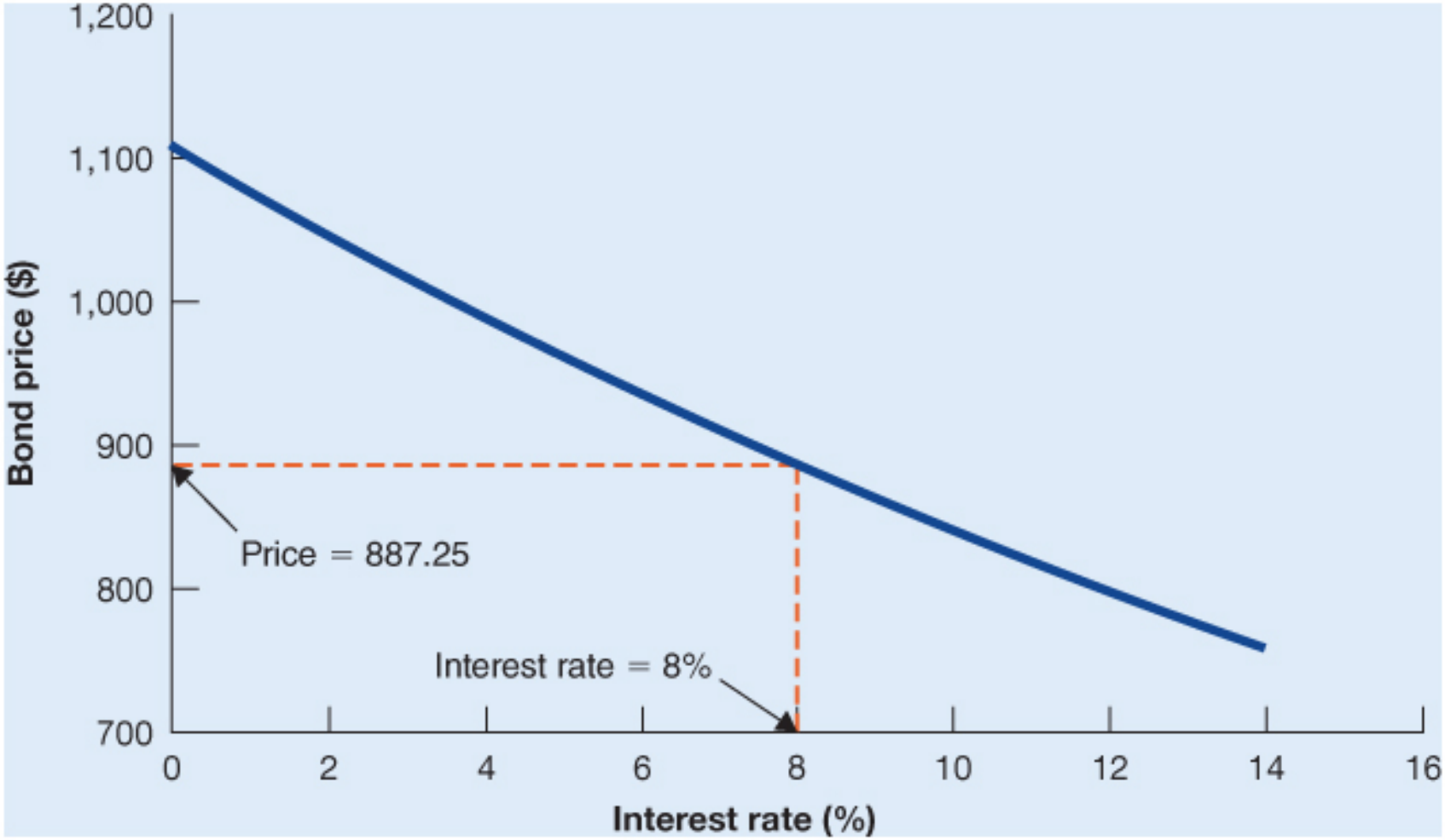
$$PV_{bond} = \frac{\$40}{(1.02)^1} + \frac{\$40}{(1.02)^2} + \frac{\$1{,}040}{(1.02)^3} = \mathbf{\$1{,}057.68}$$

premium bond 溢价债券

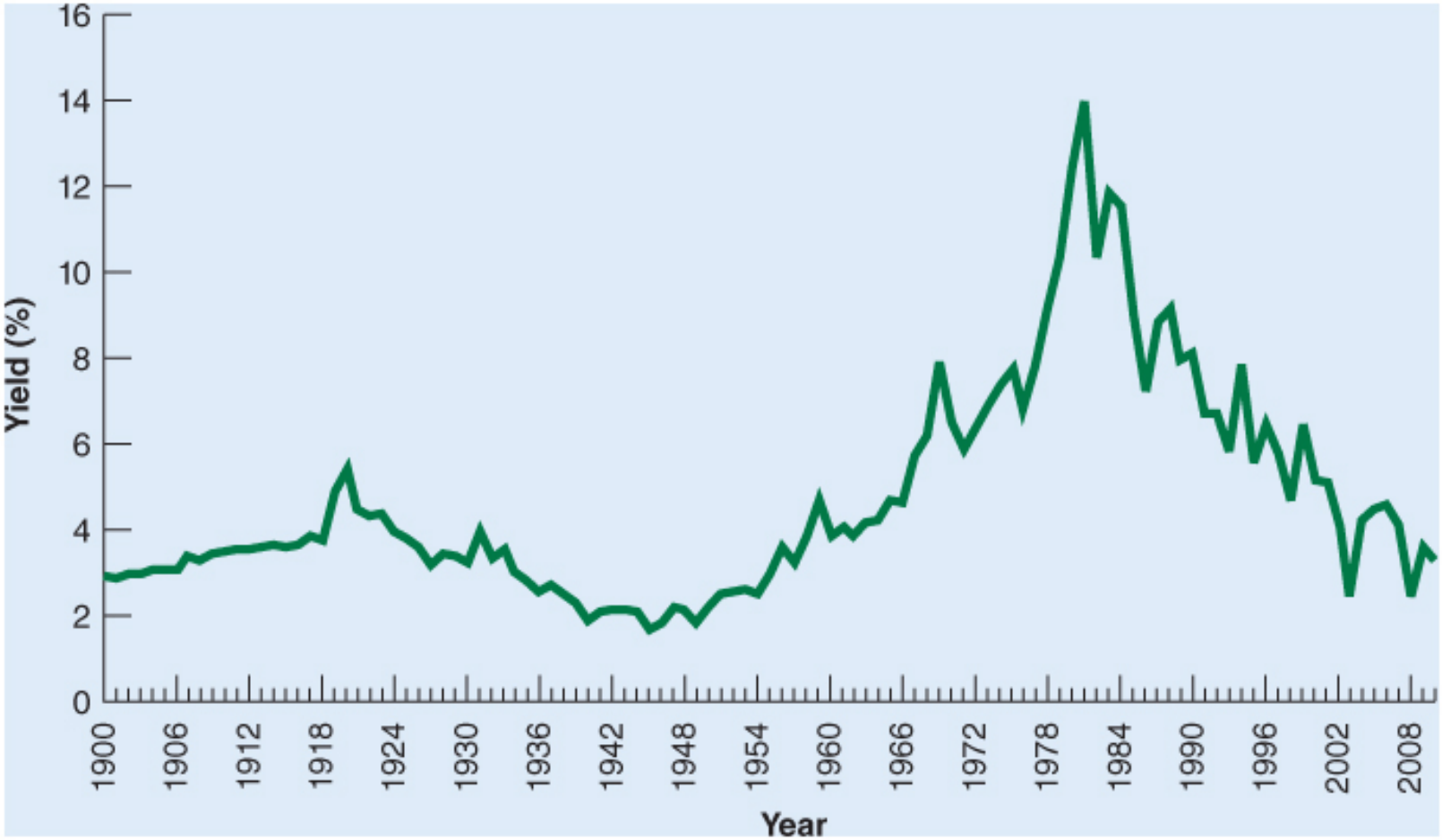
Bond Prices vs. Interest Rates

- When the interest rate *rises*, the PV of the payment to be received by the bondholders *falls*.
  - A *decline* in the interest rate increases the PV of those payments and results in a *higher* bond price.
- Interest rate risk is the risk in bond prices due to fluctuations in interest rate.
  - This risk is higher for distant cash flows than for near-term cash flows.

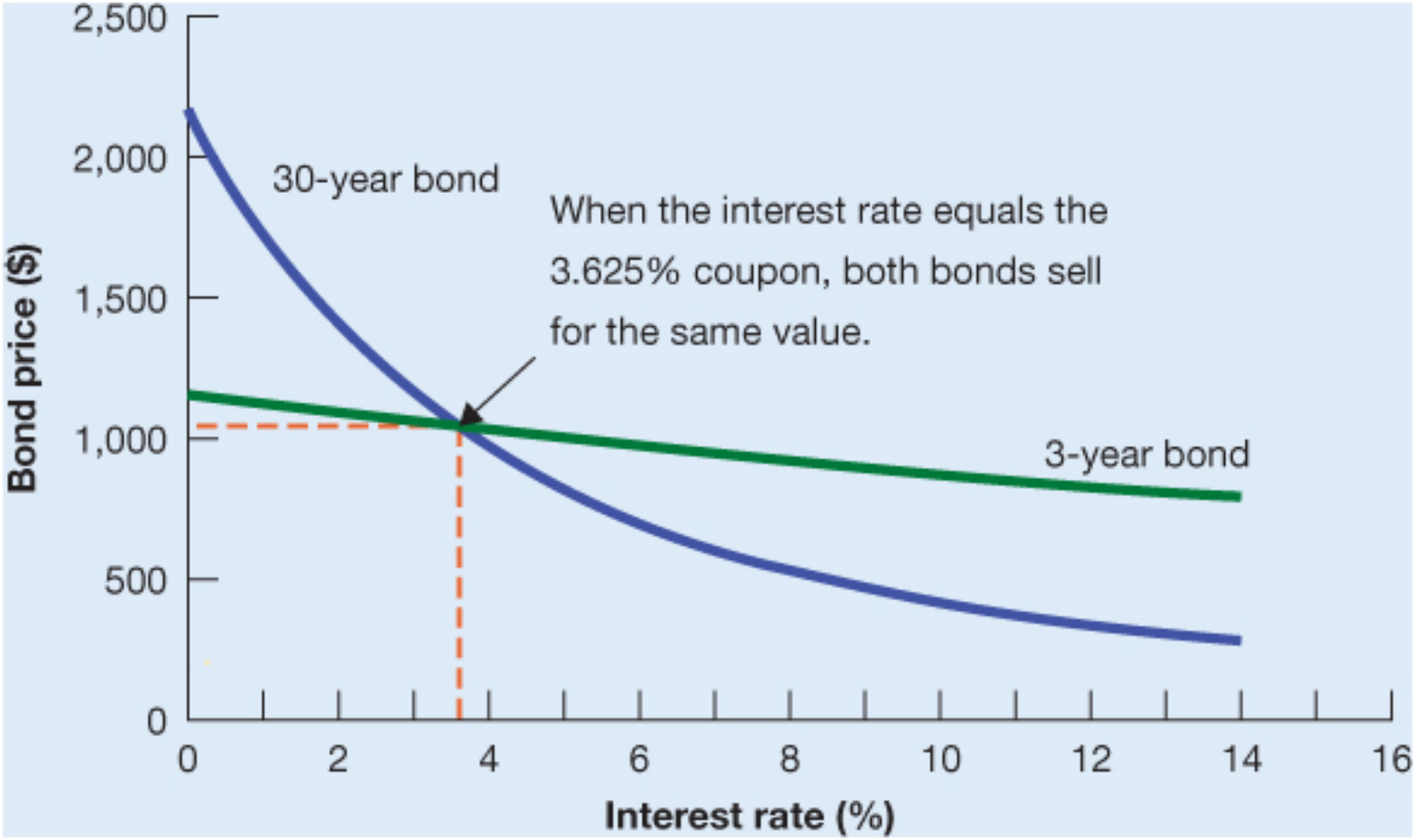
The value of the 3.625% bond falls as interest rates rise



Interest rate of 10-year U.S. Treasury bonds, 1900-2010



Bond prices as a function of interest rate



Maturity Risk Premium

- Interest rate risk is part of maturity risk premium.
  - It shows that bond prices would drop when interest rates rise.
- Now suppose that interest rates decline. When the short-term bonds mature, they will have to be replaced with lower-yielding bonds.
  - In addition, many of the remaining long-term bonds may be called, and as calls occur, the investor will have to replace high coupon bonds with low coupon bonds.
  - The risk of an income decline due to a drop in interest rates is called reinvestment risk.

Yield to Maturity (6.3)

- To calculate how much we earn on a bond investment, we can calculate two types of bond yields.
  - Current yield
    - Annual coupon payments divided by bond price.
    - It focuses only on current income and ignores prospective changes in bond price.
  - Yield to maturity (YTM)
    - Interest rate for which the present value of the bond's payments equals the price.

Current Yield: Example

- Suppose you spend $1,150 for a $1,000 face value bond that pays a $60 annual coupon payment for 3 years. What is the bond's current yield?

$$CR = \frac{60}{1150} = 5.22\%$$

Yield to Maturity (continued)

- Note that current yield does not measure the bond's total rate of return.
  - Since it focuses only on current income and ignores prospective price increases or decreases.
  - Current yield overstates the return of premium bonds and understates that of discount bonds.
    - Premium (discount) bonds are the ones with current prices higher (lower) than par value.

Yield to Maturity (continued)

- Yield to maturity (YTM):
  - In addition to cash flow, we need to consider the par payment into return calculation.

$$PV = \frac{coupon}{(1+r)^1} + \frac{coupon}{(1+r)^2} + ... + \frac{(coupon + par)}{(1+r)^t}$$

Same Example

- Suppose you spend $1,150 for a $1,000 face value bond that pays a $60 annual coupon payment for 3 years. What is the bond's yield to maturity?

$$1150 = \frac{60}{1+r} + \frac{60}{(1+r)^2} + \frac{60+1000}{(1+r)^3} \qquad r = 0.91\%$$

计算机也按不出来！

$$YTM = \frac{\text{Coupon} + \frac{\text{Face} - PV}{t}}{\frac{\text{Face} + PV}{2}} = 0.93\%$$

Yield to Maturity (continued)

- Approximate formula of YTM:

$$YTM = \frac{Coupon + \frac{Face - PV}{t}}{\frac{Face + PV}{2}}$$

※: YTC (yield to call) 贖回殖利率

$$PV = \frac{coupon}{1+r} + \frac{coupon}{(1+r)^2} + \cdots + \frac{coupon + call\ price}{(1+r)^{time\ to\ call}}$$

call price = par + 補貼金

How bond prices change as they approach maturity, assuming constant yield

Rates of Return (6.4)

- The rate of return for bond is the total income per period per dollar invested.

$$\text{Rate of Return} = \frac{Coupon\ Income + P_1 - P_0}{P_0}$$

  - P_0: the price paid for the bond initially
  - P_1: the sell price of the bond

Rate of Return: Example

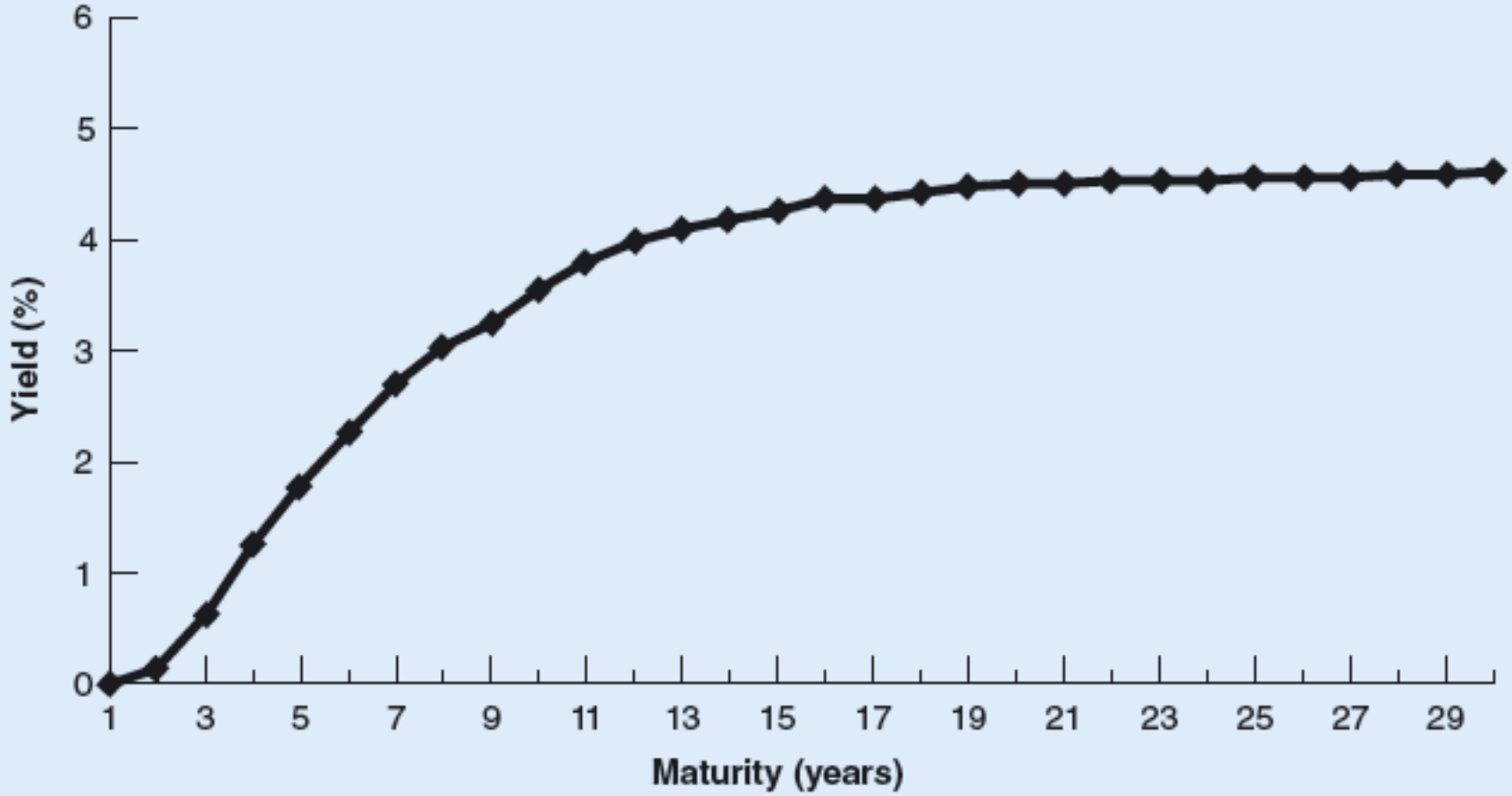
- Suppose you purchase a 5% coupon bond, par value $1,000, with 5 years until maturity, for $975.00 today. After one year you sell the bond for $965.00. What was the rate of return during the period?

$$RoR = \frac{1000 \times 5\% + 965 - 975}{975} = 4.1\%$$

The Yield Curve (6.5)

- The yield curve is a plot of relationship between bond yields to maturity and time to maturity.
- The U.S. Treasury can split its bond into a series of mini-bonds, each of which makes a single payment.
  - These single payment bonds are called strips.
  - They provide a convenient way to measure the yield curve.

The Yield Curve: Example, May 2010



The Yield Curve (continued)

- The above figure with the yield curve as upward sloping.
  - Such phenomenon is often called normal yield curve.
  - If it is downward sloping, it is an inverted yield curve.
    - This is when high inflation is expected in the short-run, so the inflation premium becomes larger for short-term bonds than for long-term bonds.

預期短期 ⇒ 經濟衰退前兆

Indexed Bond 指標債券

- From chapter 5, we know that in the presence of inflation, an investor's real interest rate is always less than the nominal interest rate.

$$1 + \text{real interest rate} = \frac{1+\text{nominal interest rate}}{1+\text{inflation rate}}$$

- We can nail down a real rate of interest by buying an index bond, whose payment are linked to inflation.

Indexed Bond (continued)

- The most appearing example of indexed bond is the Treasury Inflation-Protected Securities (TIPS). 確保購買力不変
  - It was first issued by the U.S. Treasury in 1997.
  - The real cash flows on TIPS are fixed, and its nominal cash flows increase when CPI increases.

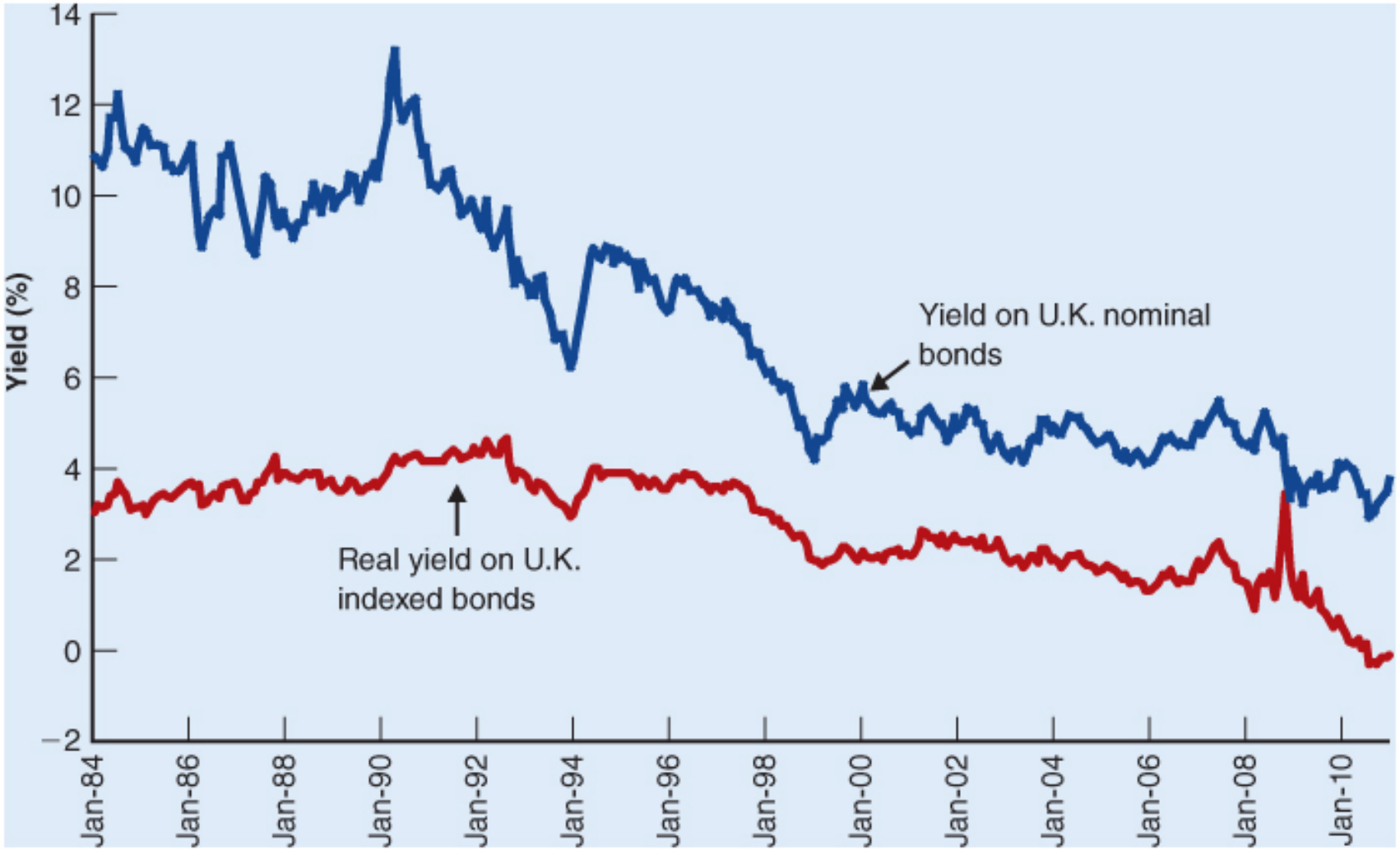
Indexed Bond (continued)

- A 3% coupon, 2-year TIPS (face of $1,000) would have nominal cash flows as follow:
  - Assuming inflations are 5% and 4% in year 1 and 2, respectively.

	Year 1	Year 2
Real cash flows	$30	$1,030

	Year 1	Year 2
Nominal cash flows	$30 × 1.05 = $31.5	$1,030 × 1.05 × 1.04 = $1,124.76

U.K. Indexed and Nominal Bonds



Risk of Default (6.6)

- When investing in bonds, there is always the risk that the issuer may default.
  - Default (or credit) risk is the risk that a bond issuer may default on its bond.
- Default premium is the additional yield on a bond that investors require for bearing credit risk.
  - Investment grade: bonds rated Baa or above by Moody's or BBB or above by Standard & Poor's.
  - Junk bond: non-investment grade bonds.

Credit Ratings by Credit Agencies

Moody's	Standard & Poor's	Percent of Bonds Defaulting within 10 Years of Issue	Safety
Investment Grade Bonds			
Aaa	AAA	0.6%	The strongest rating; ability to repay interest and principal is very strong.
Aa	AA	0.8	Very strong likelihood that interest and principal will be repaid.
A	A	1.9	Strong ability to repay, but some vulnerability to changes in circumstances.
Baa	BBB	5.2	Adequate capacity to repay; more vulnerability to changes in economic circumstances.
High-Yield Bonds			
Ba	BB	16.0	Considerable uncertainty about ability to repay.
B	B	28.4	Likelihood of interest and principal payments over sustained periods is questionable.
Caa Ca	CCC CC	50.3	Bonds that may already be in default or in danger of imminent default.
C	C	—	Little prospect for interest or principal on the debt ever to be repaid.

高息债券/垃圾债券/投机债券

Risk of Default (continued)

- Note that junk bonds are also called high yield bonds or speculative grade.
  - In the 1980s, large investors like T. Boone Pickens and Henry Kravis thought that certain old-line, established companies were run inefficiently and were financed too conservatively.
  - These corporate raiders were able to put in some of their own money, borrow the rest via junk bonds, and take over the target company.
  - Because these deal used lots of debt, they were called leveraged buyouts (LBOs).

Prices and yields of a sample of heavily traded corporate bonds, June 1, 2010

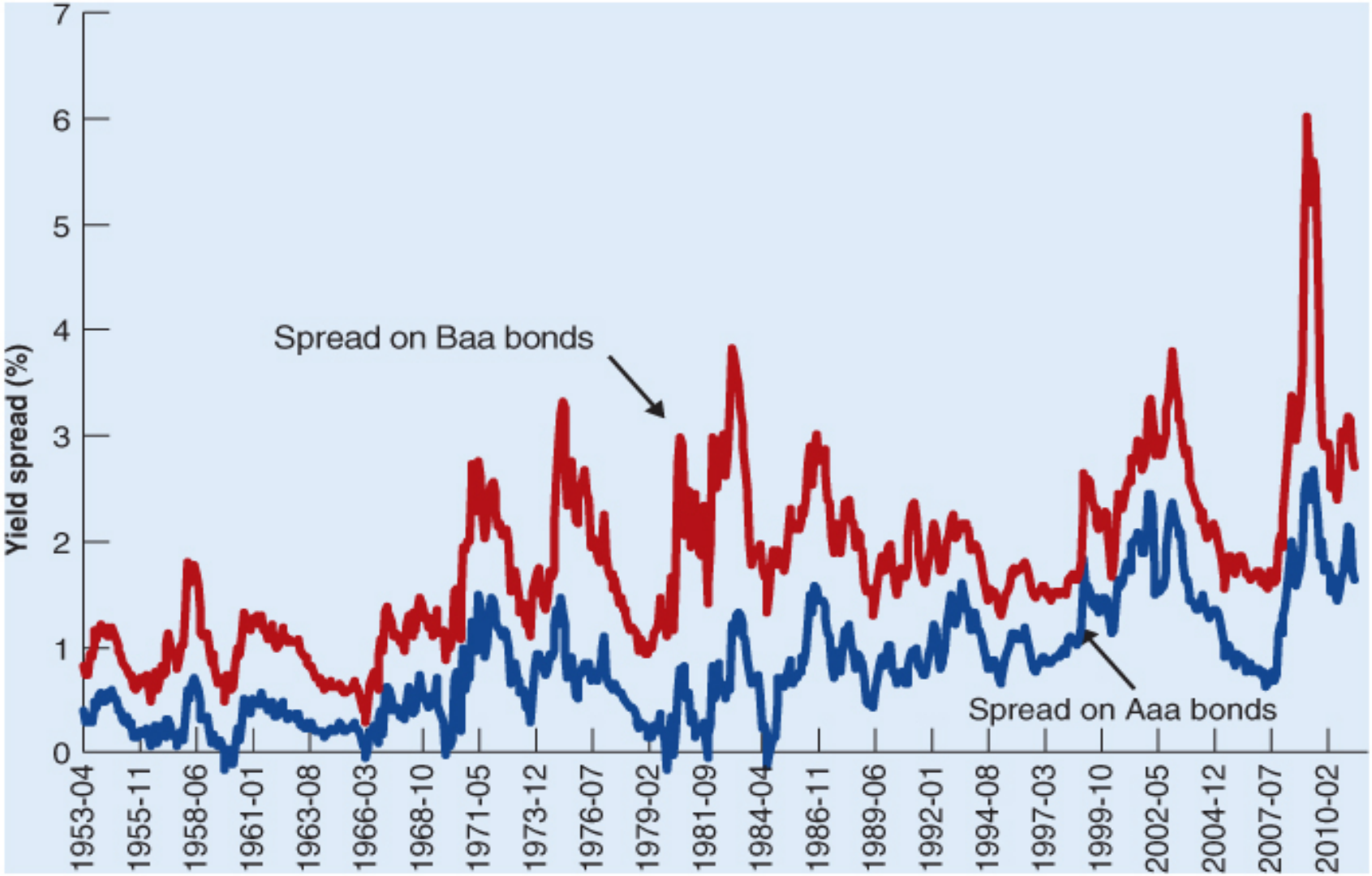
Issuer Name	Coupon, %	Maturity	Moody's Rating	Last Price	Yield, %
JPMorgan Chase	3.700	Jan 2015	Aa	101.512	3.344
Cisco Systems	5.900	Feb 2039	A	109.106	5.280
Goldman Sachs	5.375	Mar 2020	A	96.287	5.878
Time Warner	4.875	Mar 2020	Baa	100.650	4.790
NewPage Corp.	11.375	Dec 2014	B	93.000	13.460
First Data Corp.	9.875	Sep 2015	Caa	80.125	15.494

Source: **www.wsj.com**.

Risk of Default (continued)

- The difference between yields of corporate bonds and Treasuries is called yield spread.
- It measures the additional premium for the corporate bonds over the risk-free rate, which is proxied by the yields of Treasury bills, notes, or bonds.

Yield spread b/w corporate and 10-year Treasury bonds



Steps to minimize default risk

偿债顺序

- Seniority
  - Some bonds are subordinated.
- Security
  - Use of collateral, the assets that are set as security for the bonds.
  - Secured debt.
- Protective covenants
  - Conditions imposed on borrowers to protect lenders from unreasonable risks.

Variations in Corporate Bonds

- Zero-coupon bonds
  - These bonds do not pay coupon and are often issued at prices well below face value.
- Floating-rate bonds
  - The coupon rate changes over time and is often tied to some measure of current market rates.
- Convertible bonds
  - When the bonds mature, the bondholders can choose to exchange the bond for a specified number of common stocks.