Principles of Corporate Finance

Seventh Edition

Richard A. Brealey

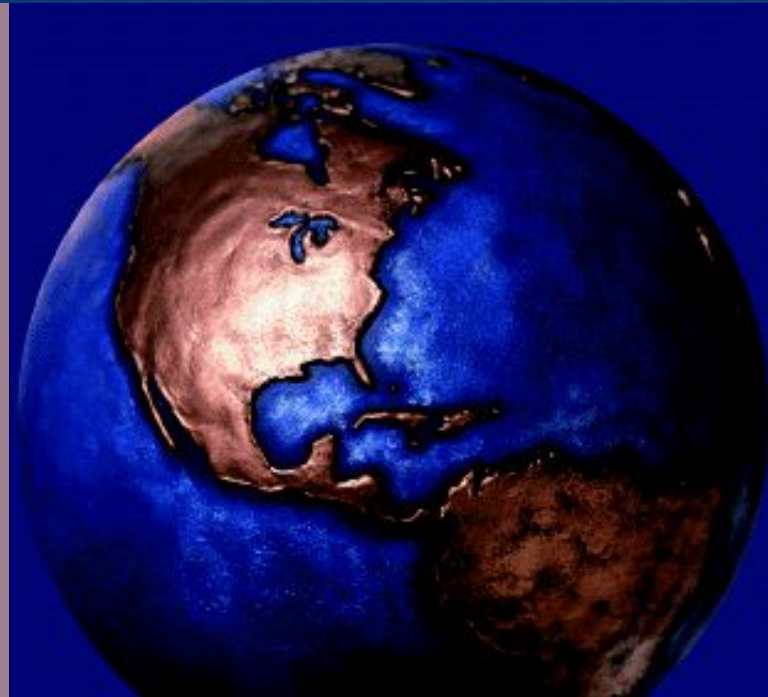**Stewart C. Myers**

Slides by

Matthew Will

Chapter 7
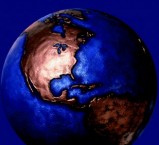
Introduction to Risk, Return, and the Opportunity Cost of Capital
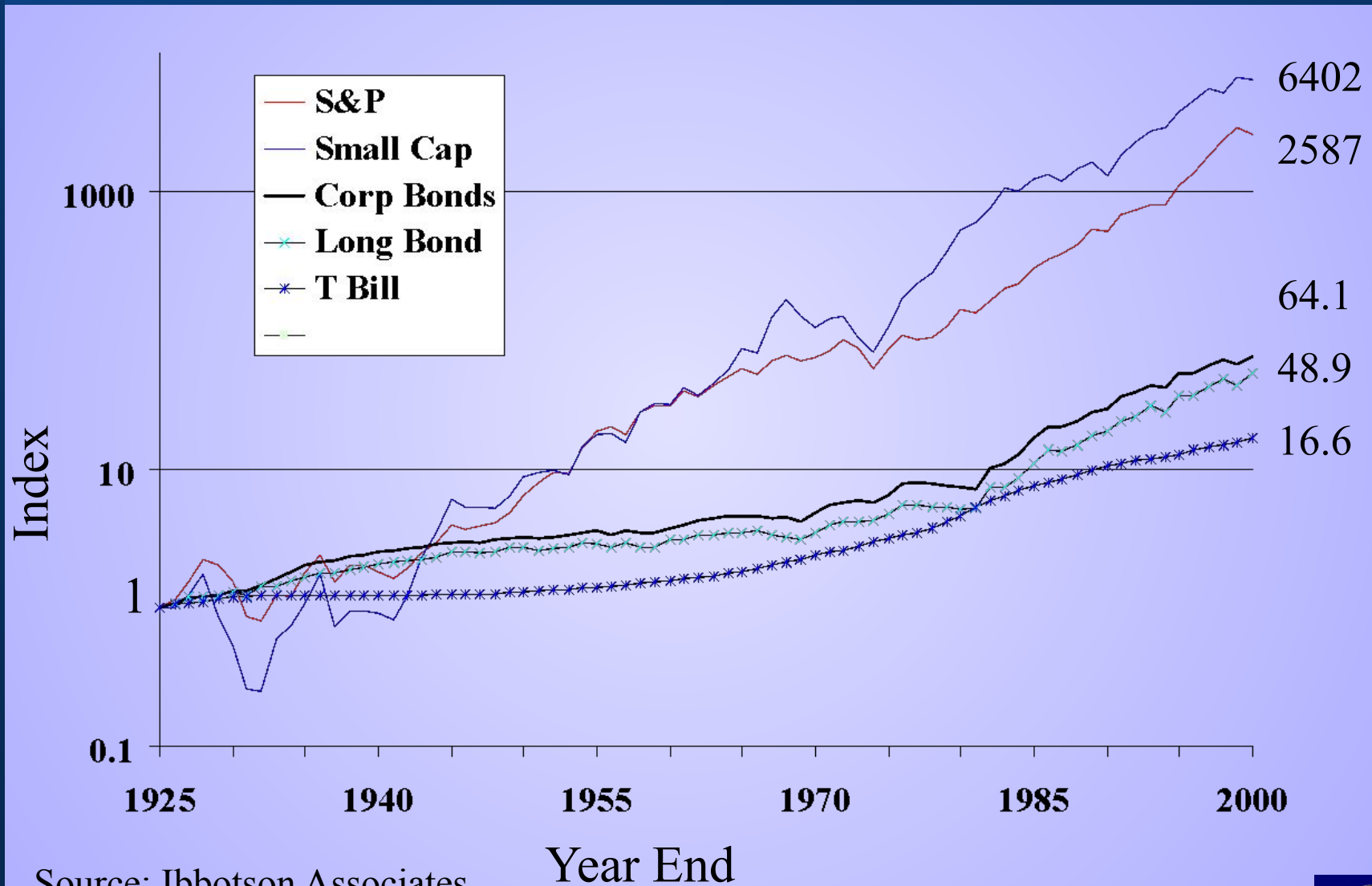
Topics Covered
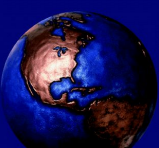
- 75 Years of Capital Market History

- Measuring Risk

- Portfolio Risk

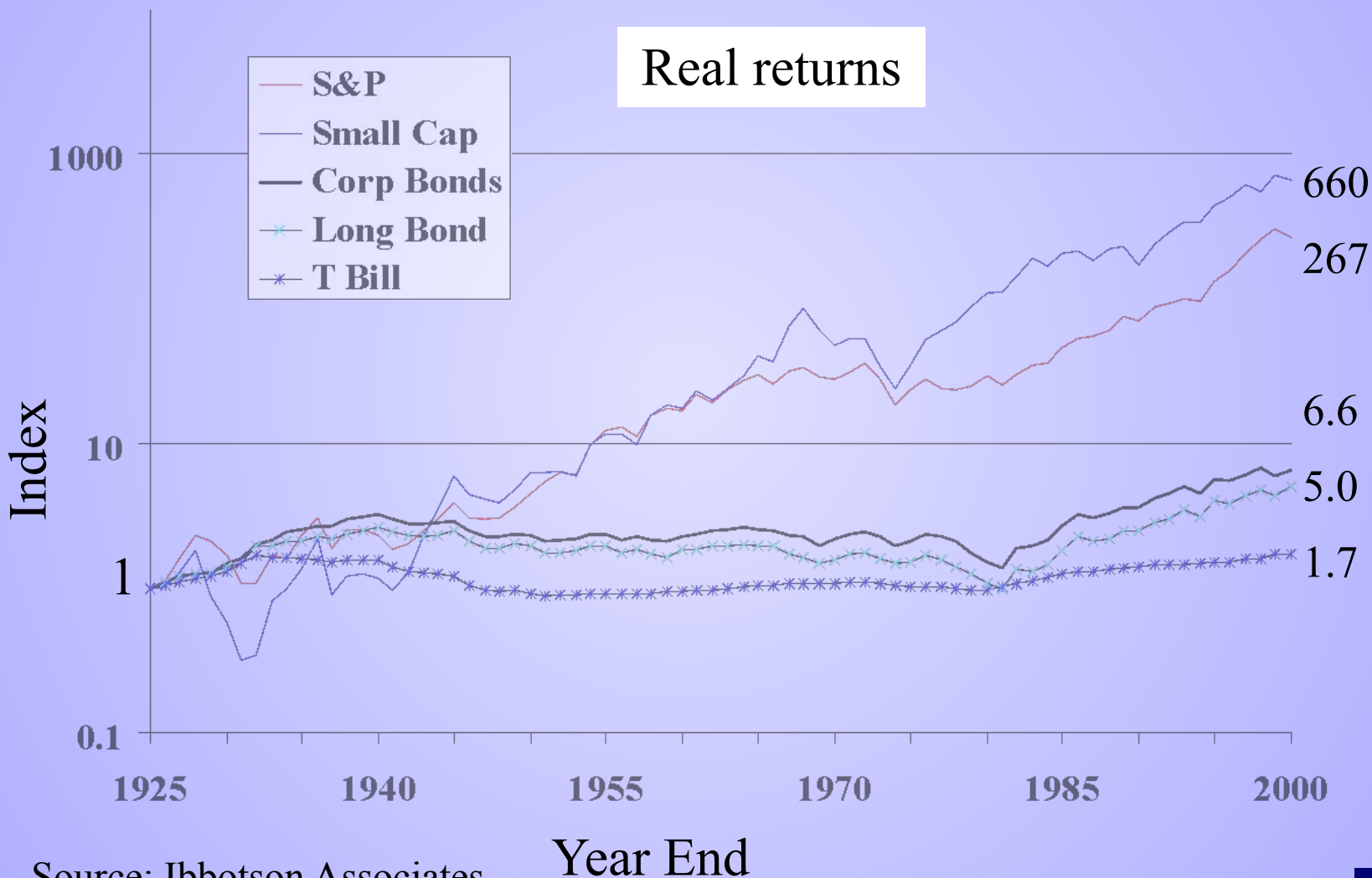- Beta and Unique Risk

- Diversification

The Value of an Investment of $1 in 1926

Source: Ibbotson Associates

The Value of an Investment of $1 in 1926

Real returns

Index

Source: Ibbotson Associates

Year End
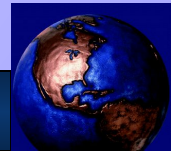
Rates of Return 1926-2000

Legend:
- Common Stocks (red)
- Long T-Bonds (green)
- T-Bills (blue)

Y-axis: Percentage Return (60, 40, 20, 0, -20, -40, -60)

X-axis: Year (26, 30, 35, 40, 45, 75, 80, 85, 90, 95, 2000)
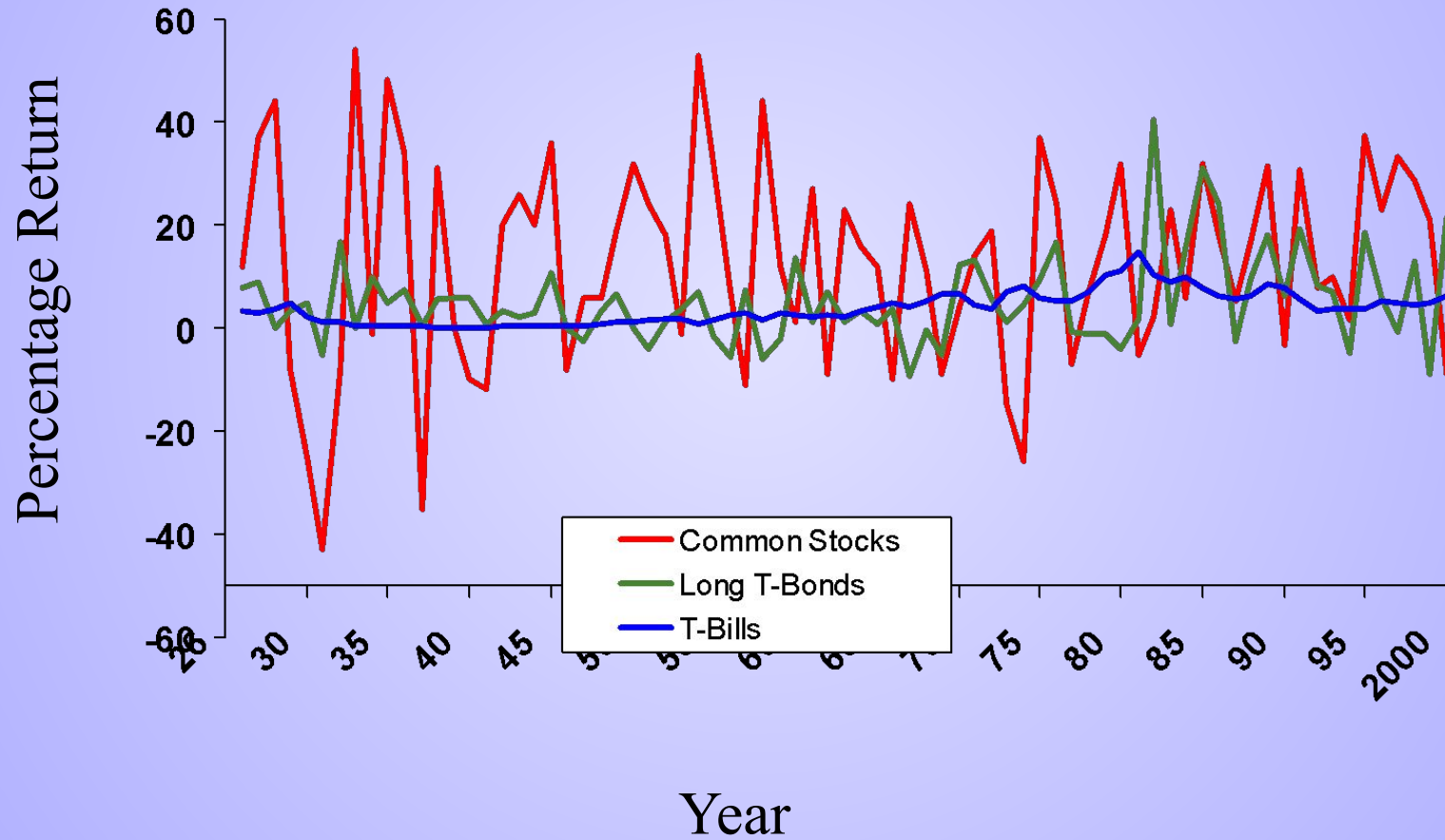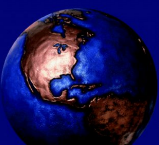
Average Market Risk Premia (1999-2000)

Risk premium, %

Country

Measuring Risk

Variance - Average value of squared deviations from mean. A measure of volatility.

Standard Deviation - Average value of squared deviations from mean. A measure of volatility.
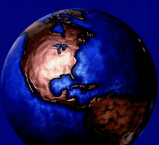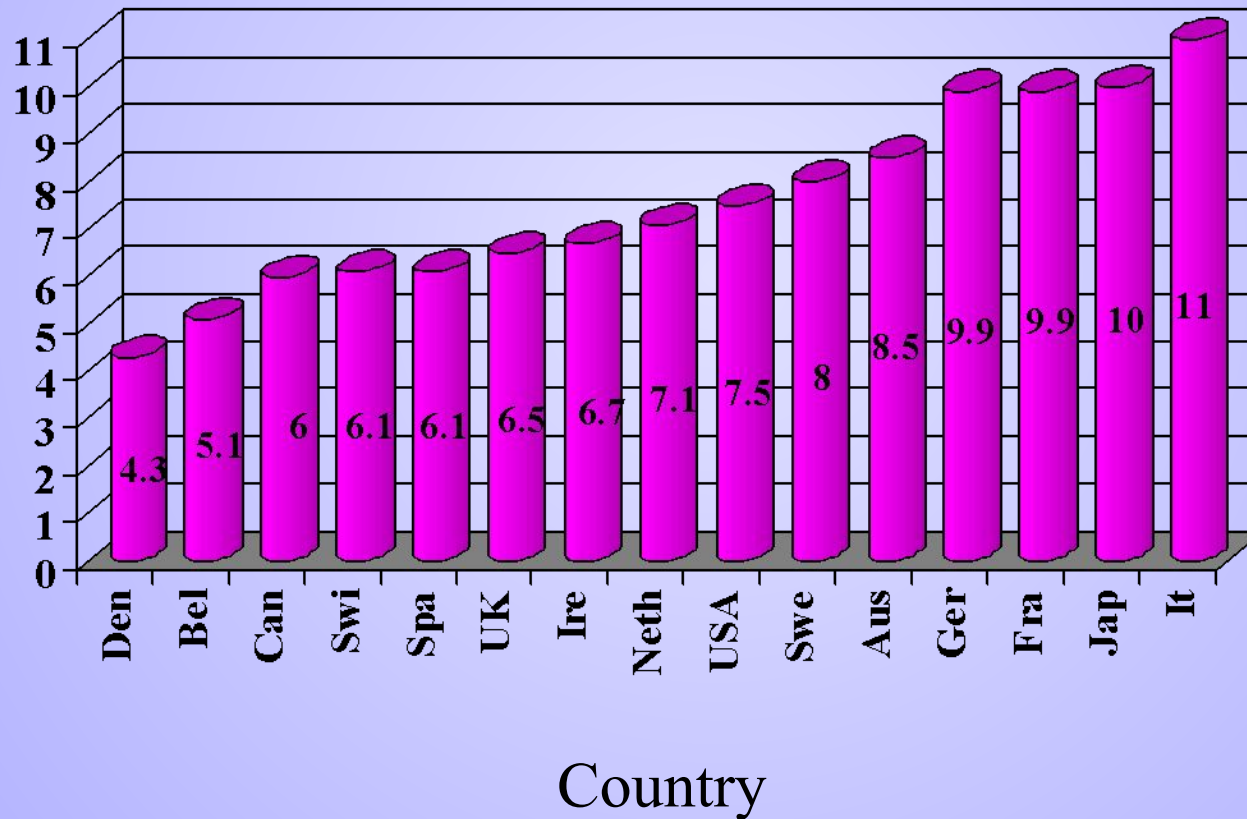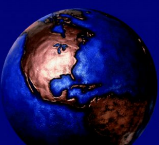
Measuring Risk

Coin Toss Game-calculating variance and standard deviation

(1)	(2)	(3)
Percent Rate of Return	Deviation from Mean	Squared Deviation
+ 40	+ 30	900
+ 10	0	0
+ 10	0	0
- 20	- 30	900

Variance = average of squared deviations = 1800 / 4 = 450

Standard deviation = square of root variance = $\sqrt{450}$ = 21.2%
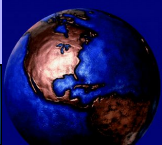
Measuring Risk

Histogram of Annual Stock Market Returns

of Years

Return %
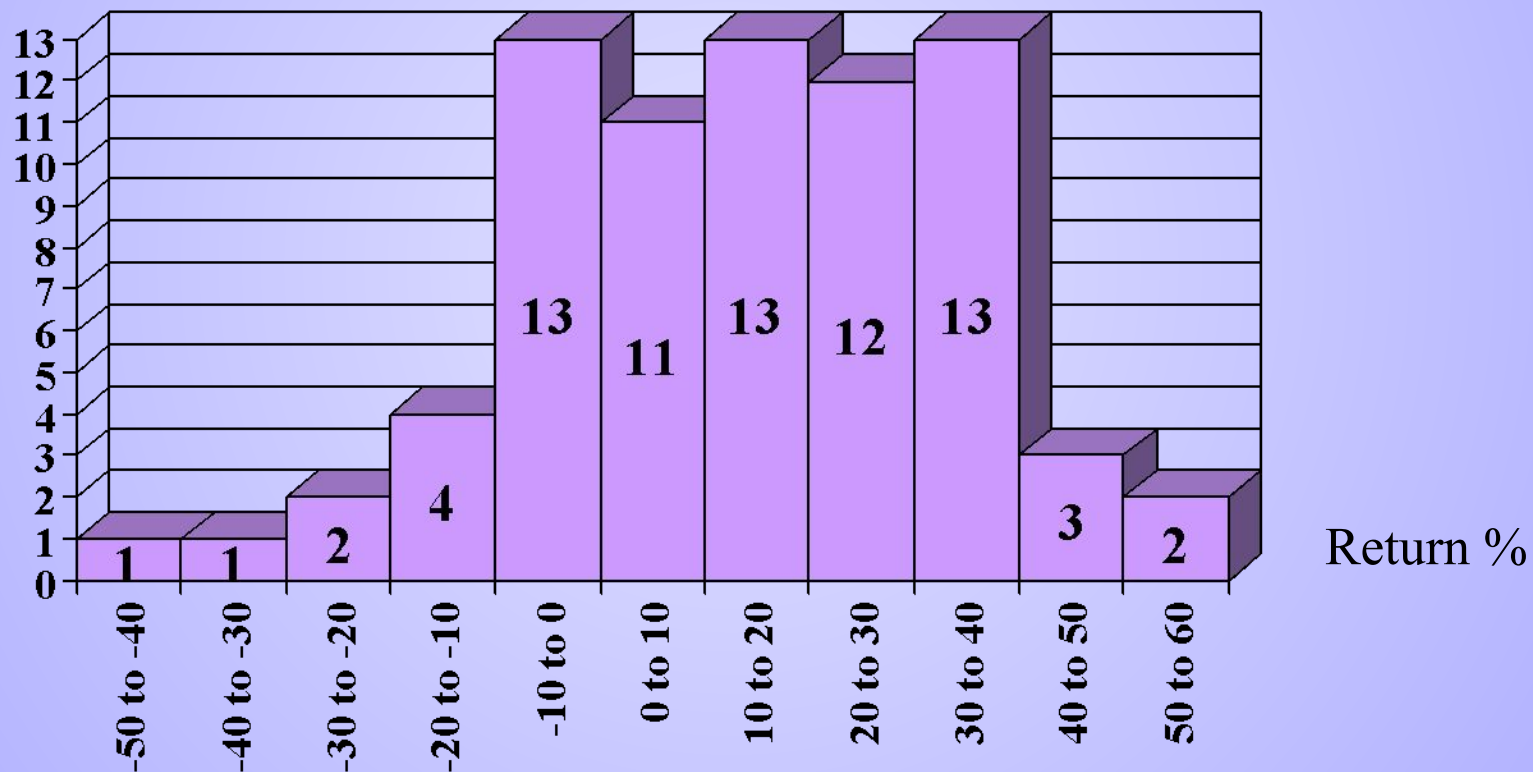
Measuring Risk

Diversification - Strategy designed to reduce risk by spreading the portfolio across many investments.
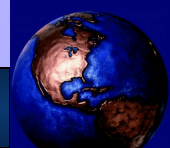
Unique Risk - Risk factors affecting only that firm. Also called "diversifiable risk."

Market Risk - Economy-wide sources of risk that affect the overall stock market. Also called "systematic risk."

Measuring Risk

$$
\begin{array}{l}
\text{Portfolio rate} \\
\text{of return}
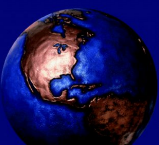\end{array}
=
\left\{
\begin{array}{l}
\text{fraction of portfolio} \\
\text{in first asset}
\end{array}
\right\}
\text{x}
\left\{
\begin{array}{l}
\text{rate of return} \\
\text{on first asset}
\end{array}
\right\}
$$

$$
+
\left\{
\begin{array}{l}
\text{fraction of portfolio} \\
\text{in second asset}
\end{array}
\right\}
\text{x}
\left\{
\begin{array}{l}
\text{rate of return} \\
\text{on second asset}
\end{array}
\right\}
$$

Measuring Risk
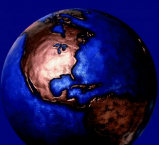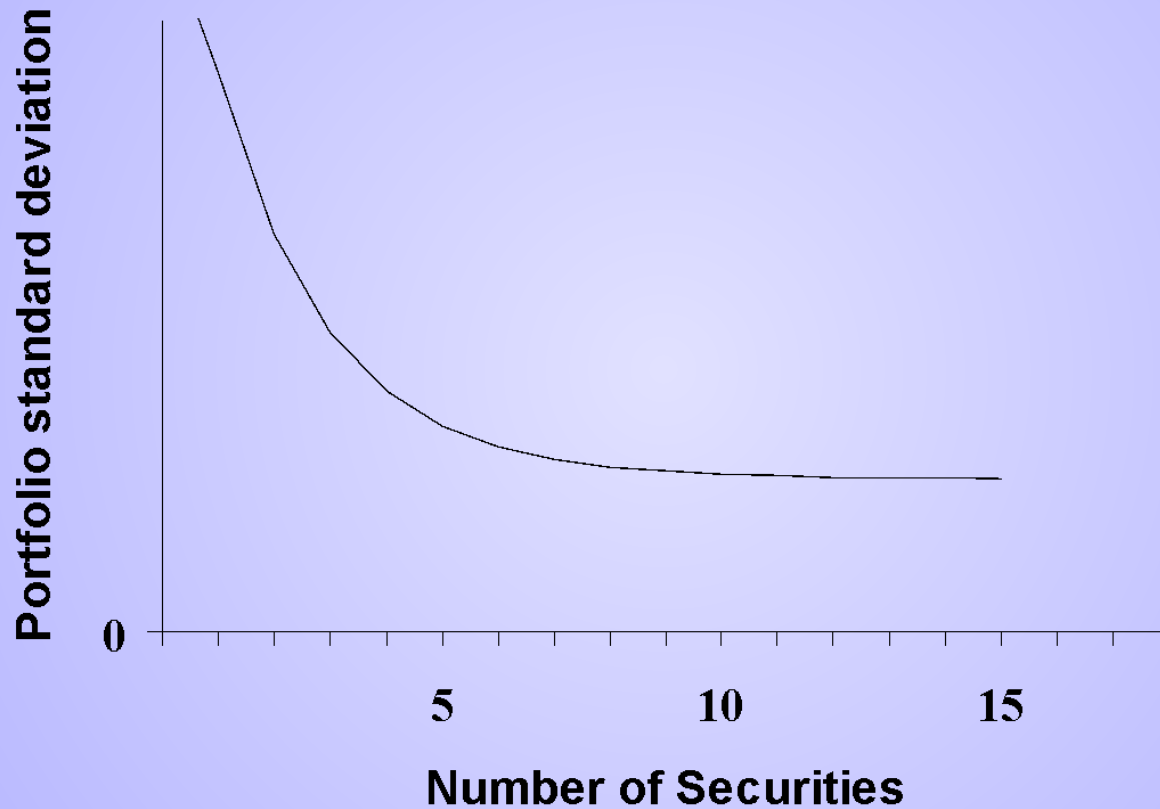
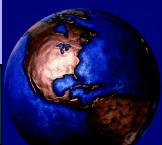# Measuring Risk
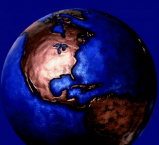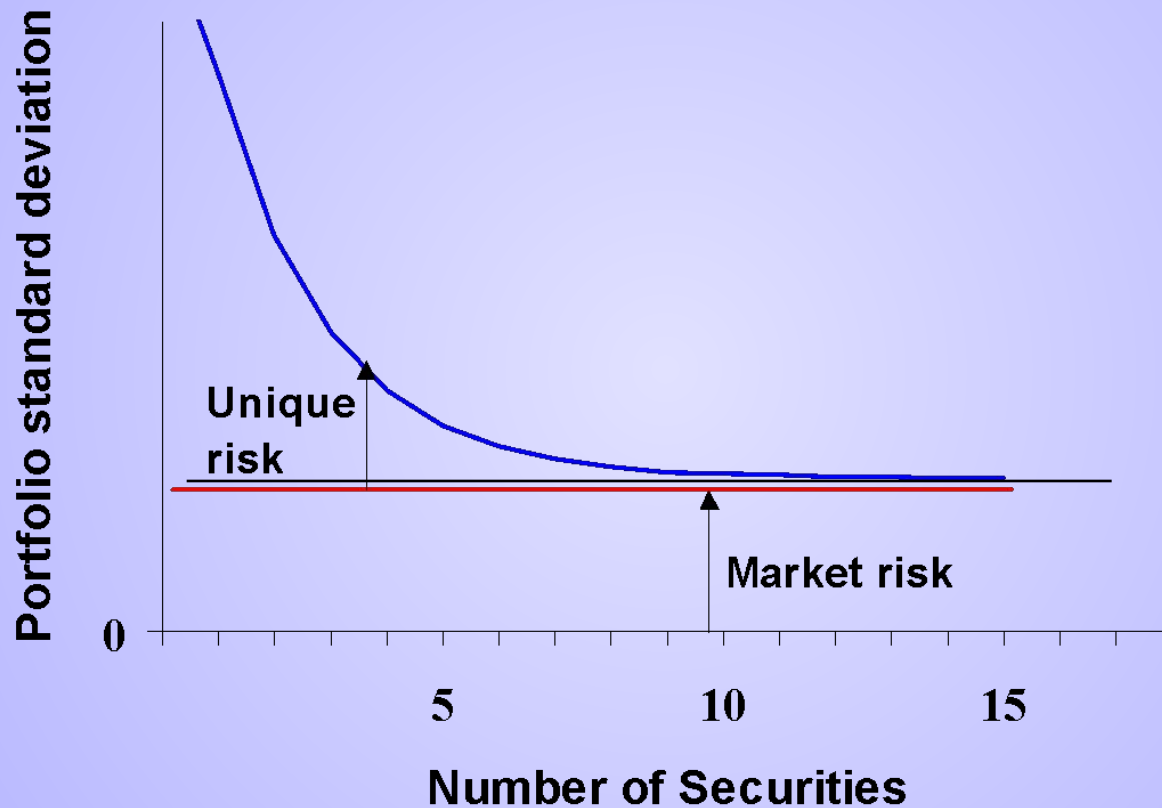
Portfolio Risk

The variance of a two stock portfolio is the sum of these four boxes

	Stock 1	Stock 2
Stock 1	$x_1^2 \sigma_1^2$	$x_1 x_2 \sigma_{12} =$ $x_1 x_2 \rho_{12} \sigma_1 \sigma_2$
Stock 2	$x_1 x_2 \sigma_{12} =$ $x_1 x_2 \rho_{12} \sigma_1 \sigma_2$	$x_2^2 \sigma_2^2$

Portfolio Risk

Example

Suppose you invest 65% of your portfolio in Coca-Cola and 35% in Reebok. The expected dollar return on your CC is 10% x 65% = 6.5% and on Reebok it is 20% x 35% = 7.0%. The expected return on your portfolio is 6.5 + 7.0 = 13.50%. Assume a correlation coefficient of 1.

Portfolio Risk

Example

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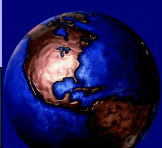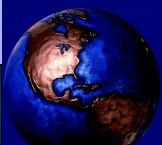|	Coca - Cola	Reebok
Coca - Cola	$x_1^2 \sigma_1^2 = (.65)^2 \times (31.5)^2$	$x_1 x_2 \rho_{12} \sigma_1 \sigma_2 = .65 \times .35$ $\times 1 \times 31.5 \times 58.5$
Reebok	$x_1 x_2 \rho_{12} \sigma_1 \sigma_2 = .65 \times .35$ $\times 1 \times 31.5 \times 58.5$	$x_2^2 \sigma_2^2 = (.35)^2 \times (58.5)^2$

Portfolio Risk

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$$\text{Portfolio Valriance} = [(.65)^2 \, x(31.5)^2]$$
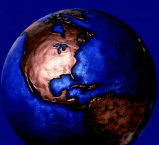$$+ [(.35)^2 \, x(58.5)^2]$$
$$+ 2(.65x.35x1x31.5x58.5) = 1,006.1$$

$$\text{Standard Deviation} = \sqrt{1,006.1} = 31.7\%$$

Portfolio Risk
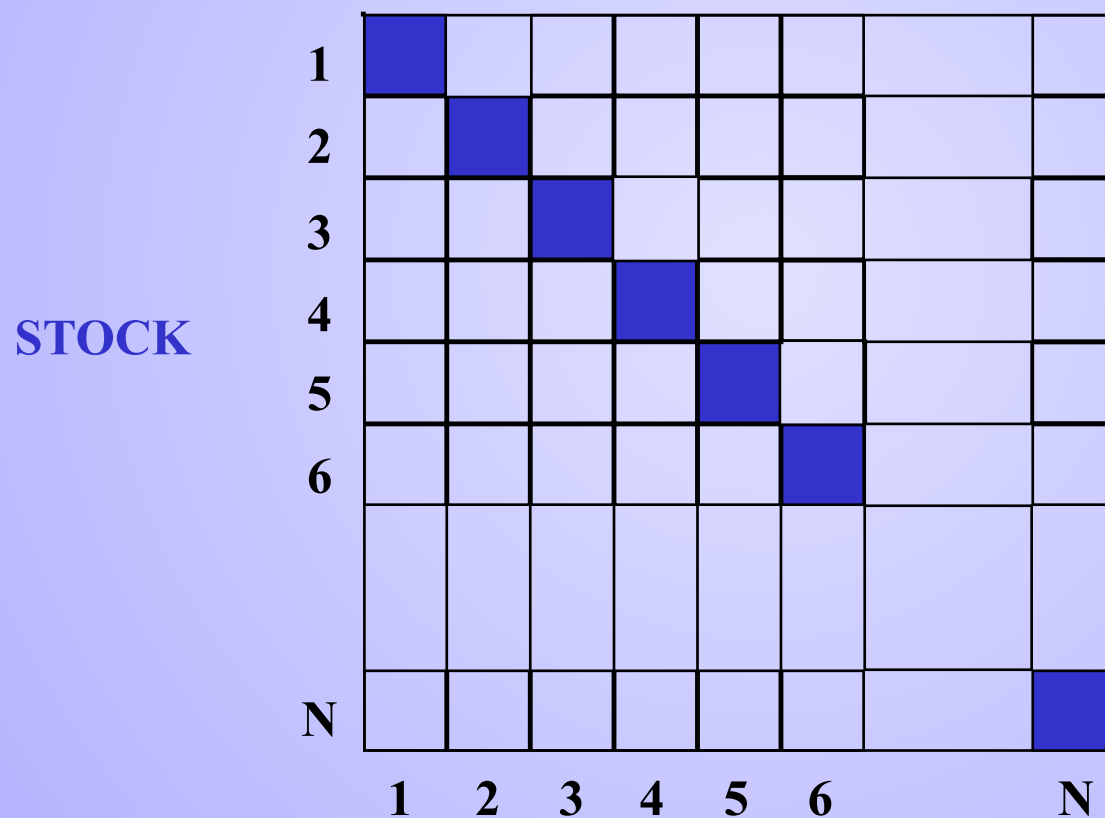
Expected Portfolio Return $= (x_1 r_1) + (x_2 r_2)$

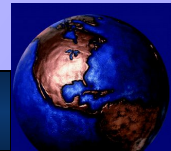Portfolio Variance $= x_1^2 \sigma_1^2 + x_2^2 \sigma_2^2 + 2(x_1 x_2 \rho_{12} \sigma_1 \sigma_2)$

Portfolio Risk

The shaded boxes contain variance terms; the remainder contain covariance terms.

STOCK

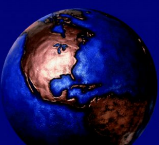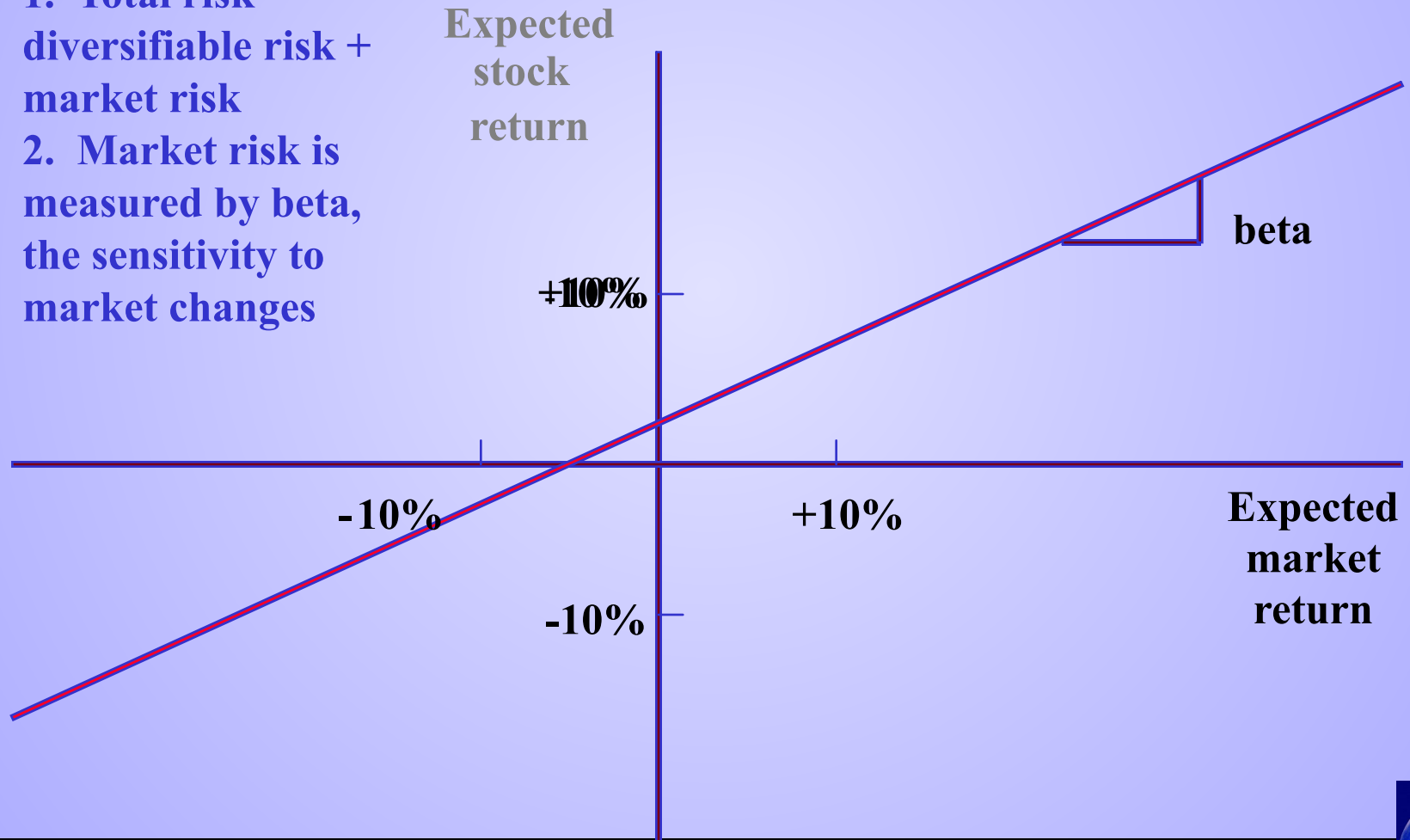|	1	2	3	4	5	6		N
1	■							
2		■						
3			■					
4				■				
5					■			
6						■		
N								■

1 2 3 4 5 6   N

STOCK

To calculate portfolio variance add up the boxes

Beta and Unique Risk

1. **Total risk = diversifiable risk + market risk**

2. **Market risk is measured by beta, the sensitivity to market changes**

Expected stock return

beta

+10%

-10%

+10%

Expected market return

-10%

Beta and Unique Risk

Market Portfolio - Portfolio of all assets in the economy. In practice a broad stock market index, such as the S&P Composite, is used to represent the market.

Beta - Sensitivity of a stock's return to the return on the market portfolio.
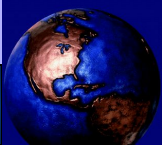
Beta and Unique Risk

$$B_i = \frac{\sigma_{im}}{\sigma_m^2}$$

Beta and Unique Risk

$$B_i = \frac{\sigma_{im}}{\sigma_m^2}$$

Covariance with the market

Variance of the market