Chapter 11
Introduction to Risk, Return, and the Opportunity Cost of Capital

Financial Management (MGCM10018)

Preview

- Previous chapters skirted the issue of project risk
  - Now it's time to confront it.
  - We need to know how to measure risk.
  - We need to understand the relation between risk and the cost of capital.
- This chapter focuses on risk and return and their relationship to the opportunity cost of capital.
  - How are risk and return related?

Outline

- Rates of Return: A Review
- A Century of Capital Market History
- Measuring Risk
- Risk and Diversification
- Thinking about Risk

Rate of Return: A Review (11.1)

- When investors buy a stock or a bond, their return comes in two forms:
  - A dividend or interest payment
  - A capital gain or capital loss
- The percentage return on the investment is:

$$\text{Percentage Return} = \frac{\text{Capital Gain} + \text{Dividend}}{\text{Initial Share Price}}$$

Rate of Return: A Review (continued)

- The percentage return can be expressed as the sum of the dividend yield and percentage capital gain.

$$\text{Dividend Yield} = \frac{\text{Dividend}}{\text{Initial Share Price}}$$

$$\text{Capital Gain Yield} = \frac{\text{Capital Gain}}{\text{Initial Share Price}}$$

Rates of Return: Example

We purchase shares of GE stock at $15.13 on December 31, 2009. We sell them exactly one year later for $18.29. During this time GE paid $.46 in dividends per share. Ignoring transaction costs, what is your rate of return, dividend yield and capital gain yield?

Rate of Return: A Review (continued)

- Recall the relationship between real rates and nominal rates:

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

  - The nominal rate of return measures how much more money we will have at the end of the year if we invest today.
  - The real rate of return tells us how much more we'll be able to buy with the money at the end of year.

Rates of Return: Example

We purchase shares of GE stock at $15.13 on December 31, 2009. We sell them exactly one year later for $18.29. During this time GE paid $.46 in dividends per share. The nominal rate of return is:

Suppose inflation from December 2009 to December 2010 was 1.5%. What was GE stock's real rate of return?

A Century of Capital Market History (11.2)

- By looking at the history of security returns, we can get some idea of the return that investors might reasonably expect.
- We could then look at the risks and returns that investors have experienced in the past.
  - This could help us to know more about the returns of investments in different types of securities and of the risks that we face.

Market Indexes

- Market index is a measure of the investment performance of the overall market.
- The most well known market index in the U.S. is the Dow Jones Industrial Average (The Dow).
  - It was first computed in 1896.
  - It tracks the performance of a portfolio that holds one share in each of 30 large firms (blue-chip).
  - It is far from the best measure of the overall performance of stock market.

The Dow Jones Index Component Stocks

3M	Conglomerate	Johnson & Johnson	Pharmaceuticals
American Express	Consumer finance	JPMorgan Chase	Banking
AT&T	Telecommunication	McDonald's	Fast food
Boeing	Aerospace and defense	Merck	Pharmaceuticals
Caterpillar	Construction and mining equipment	Microsoft	Software
Chevron	Oil & gas	Nike	Apparel
Cisco Systems	Computer networking	Pfizer	Pharmaceuticals
Coca-Cola	Beverages	Procter & Gamble	Consumer goods
DuPont	Chemical industry	Travelers	Insurance
ExxonMobil	Oil & gas	UnitedHealth Group	Managed health care
General Electric	Conglomerate	United Technologies	Conglomerate
Goldman Sachs	Banking, Financial services	Verizon	Telecommunication
The Home Depot	Home improvement retailer	Visa	Consumer banking
Intel	Semiconductors	Wal-Mart	Retail
IBM	Computers and technology	Walt Disney	Broadcasting and entertainment

Market Indexes

- Another popular market index in the U.S. is the Standard & Poor's Composite Index (S&P500).
  - It includes the stocks of 500 major companies, and is a more comprehensive index than the Dow.
  - It measures the performance of a portfolio that holds shares in each firm in proportion to the number of shares issued to investors.
  - Thus, the S&P500 shows the average performance of investment in the 500 firms.

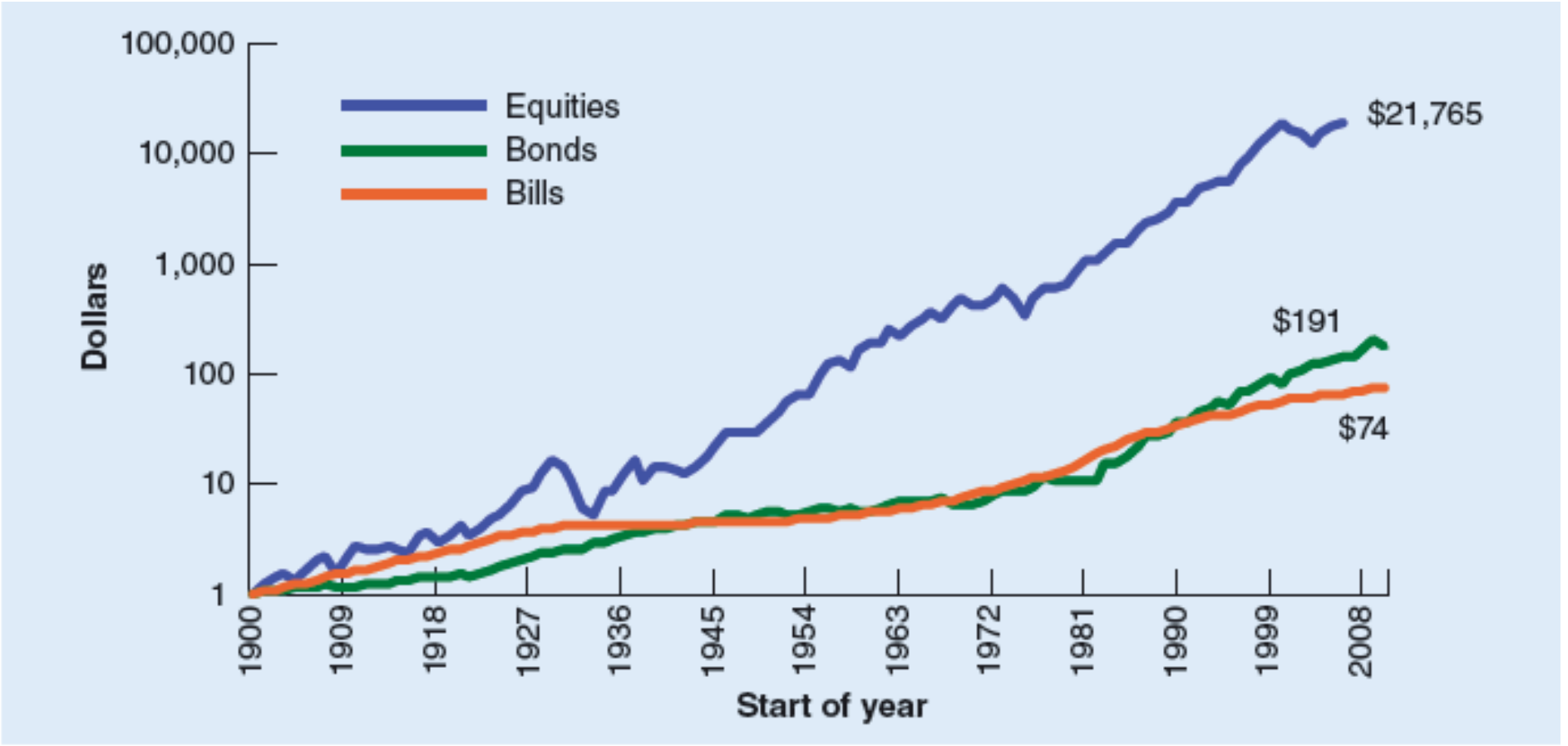
Market Indexes

- Other market indexes in the U.S. include an even large number of stocks.
  - NASDAQ Composite index; Russell 2000/3000; The Dow Jones Wilshire 5000
- Worldwide stock indexes
  - FTSE100 (UK); Nikkei225 (Japan); DAX (German); CAC40 (French); Hang Seng (Hong Kong); Taiwan Weighted (Taiwan); STI (Singapore); Shanghai (China)

Historical Record

- The historical returns of stock or bond market indexes can give us an idea of the typical performance of different investments.
  - For example, three scholars have compiled measures of the investment performance of 3 portfolios of securities since 1900:
    - A portfolio of 3-month loans issued each week by the U.S. government (Treasury bills).
    - A portfolio of 10-year Treasury bonds of U.S.
    - A diversified portfolio of common stocks.

The Value of an Investment of $1 in 1900



What Drives the Difference in Total Returns?

Portfolio	Average Annual Rate of Return	Average Premium (Extra Return versus Treasury Bills)
Treasury bills	4.0	
Treasury bonds	5.2	1.2
Common stocks	11.4	7.4

- Maturity Premium: Extra average return from investing in long- versus short-term Treasury securities.
- Risk Premium: Expected return in excess of risk-free return as compensation for risk.

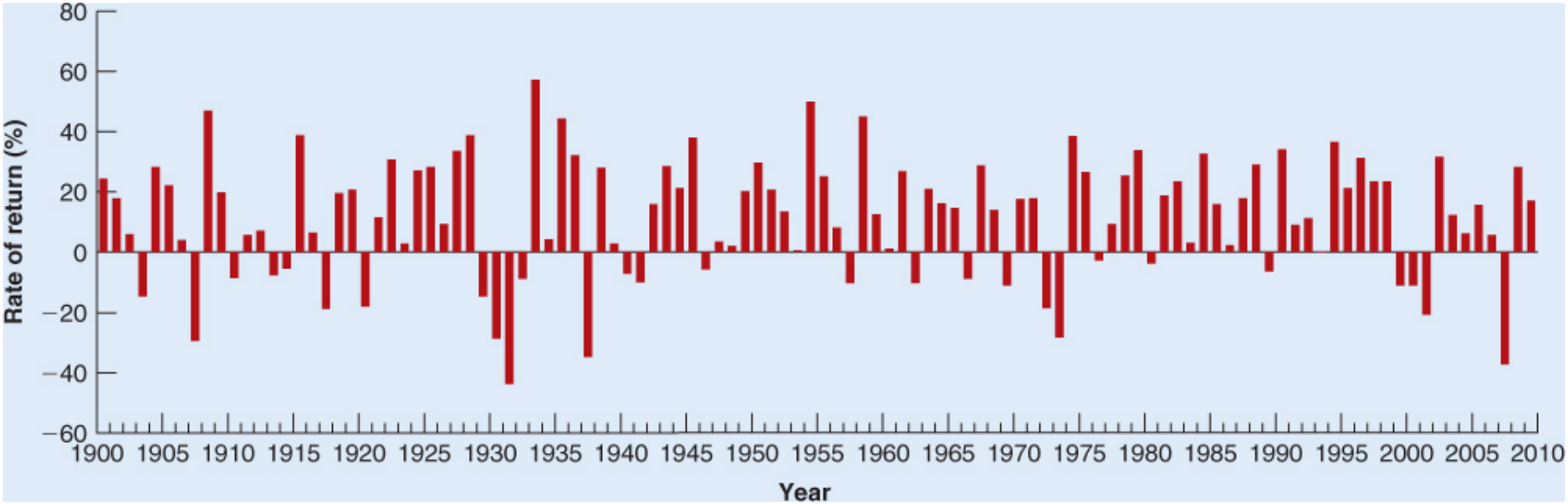
Risk Premium: Example

Expected Market Return	=	Interest Rate on Treasury Bills	+	Normal Risk Premium
1981: 21.6%	=	14%	+	7.6%
2008: 9.8%	=	2.2%	+	7.6%

Historical Record

- The historical record shows that investors have received a risk premium for holding risky assets.
  - Average returns on high-risk assets are higher than those low-risk assets.
- Thus, how are the expected returns and the risk of a security related?
  - The two variables exhibit a positive relationship.
  - High risk → High return.

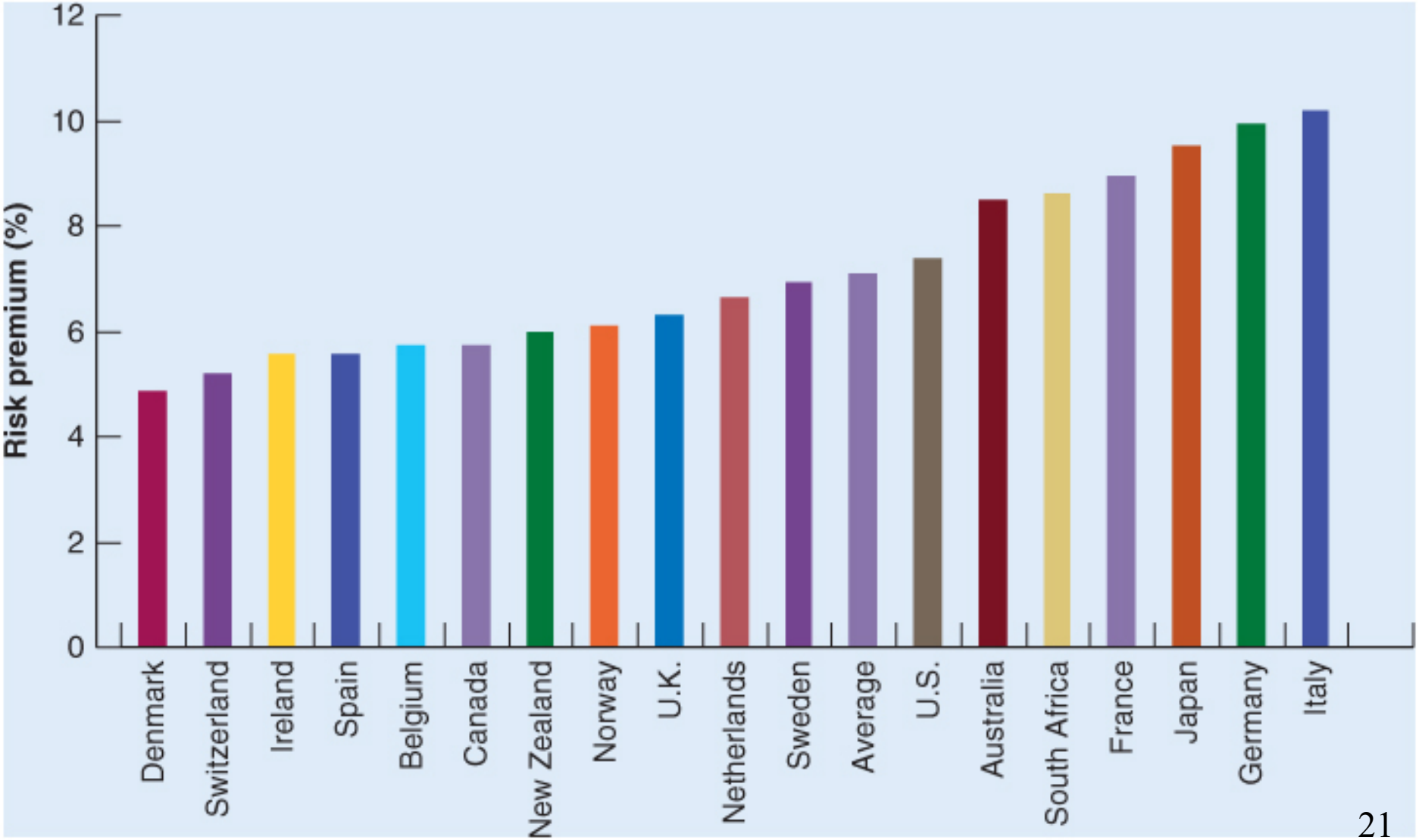
Rates of return on common stocks, 1900-2010



Using Historical Record

- Suppose there is an investment project has the same risk as a diversified portfolio of U.S. stocks.
  - Thus, the opportunity cost of capital for the project is the expected return from a market portfolio.
    - One could use previous formula to find such return.
    - Note that risk premium change through time.
    - They also vary across industries and countries.

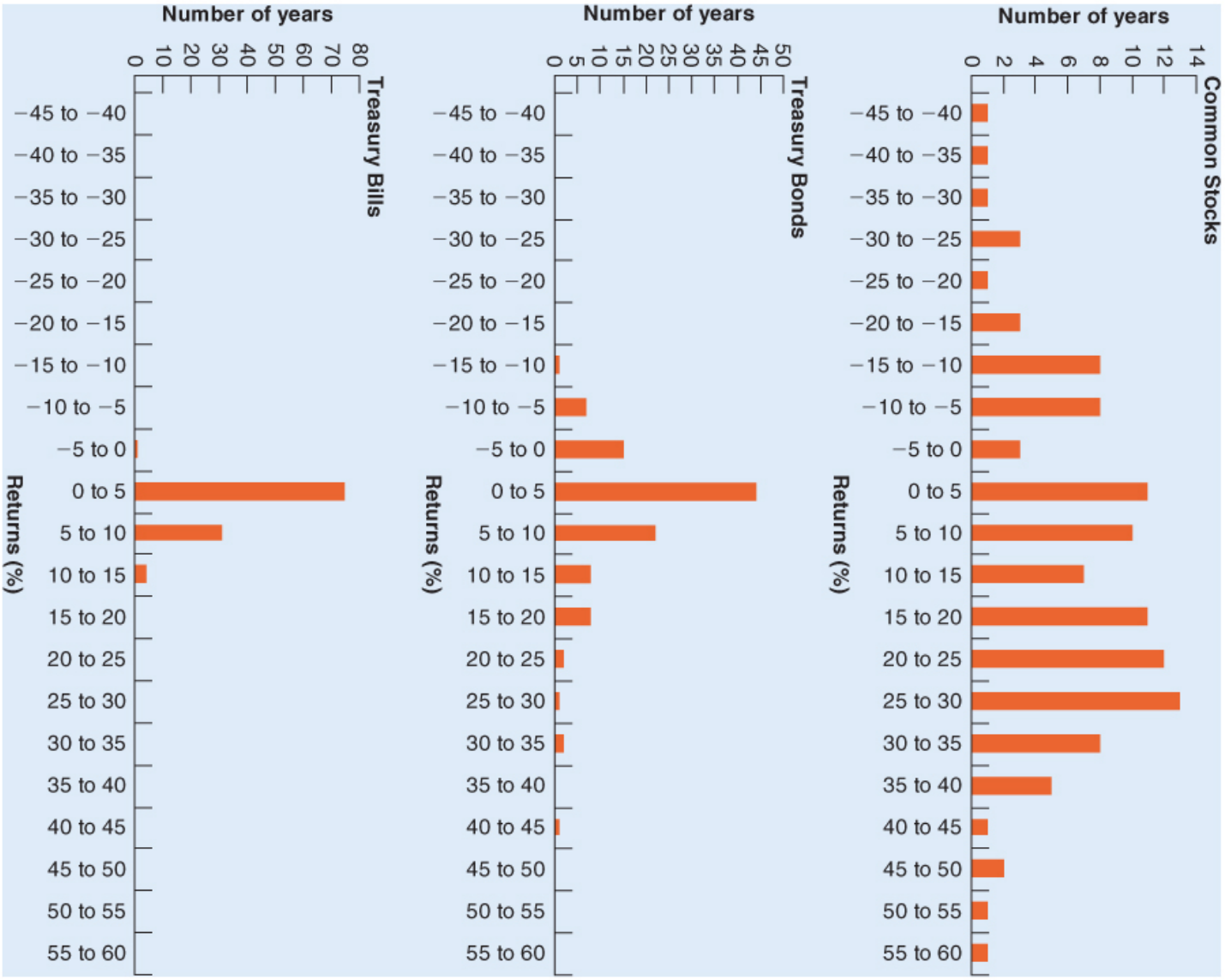
Risk premium in 18 countries, 1900-2000



Measuring Risk (11.3)

- What is risk?
  - Chance of losses in investment from uncertainty of price movement in financial assets.
- How can it be measured?
  - One way to present the spread of possible investment returns is by using histograms.
    - Based on figure in next slide, we observe wide spread of outcomes for performance of common stocks.
    - We see +55-60% and also -40-45% annual returns.

Historical returns on major asset classes, 1900-2000



Measuring Risk (continued)

- Thus, investment risk depends on the dispersion of possible outcomes.
- Financial managers need numerical measurement of dispersion.
  - Variance: Average value of squared deviations from mean. A measure of volatility.
  - Standard Deviation: Square root of variance. Also a measure of volatility.

Historical Risk by Standard Deviation
(1900-2010)

Portfolio	Standard Deviation, %
Treasury bills	2.8
Long-term government bonds	8.6
Common stocks	20.0

Variance and Standard Deviation: Coin Toss Game Example

- Suppose that you are offered the opportunity to play a game. You invest $100, and then two coins are flipped.
  - For each head that comes up, the balance will be increased by 20%.
  - For each tail that comes up, the balance will be reduced by 10%.
  - Four possible outcomes: HH 40%, HT 10%, TH 10%, and TT -20%.

Variance and Standard Deviation: Example

Coin Toss Game: calculating variance and standard deviation
(assume a mean of 10)

(1) Percent Rate of Return	(2) Deviation from Mean	(3) 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 the Variation in Stock Returns

- Financial analysts often assume that the spread of returns in the past is a reasonable indication of what will happen in the future.
  - They thus calculate the standard deviation of past returns.
  - This is often referred as the volatility of stock returns.

The average return and standard deviation of stock market returns (2005-2010)

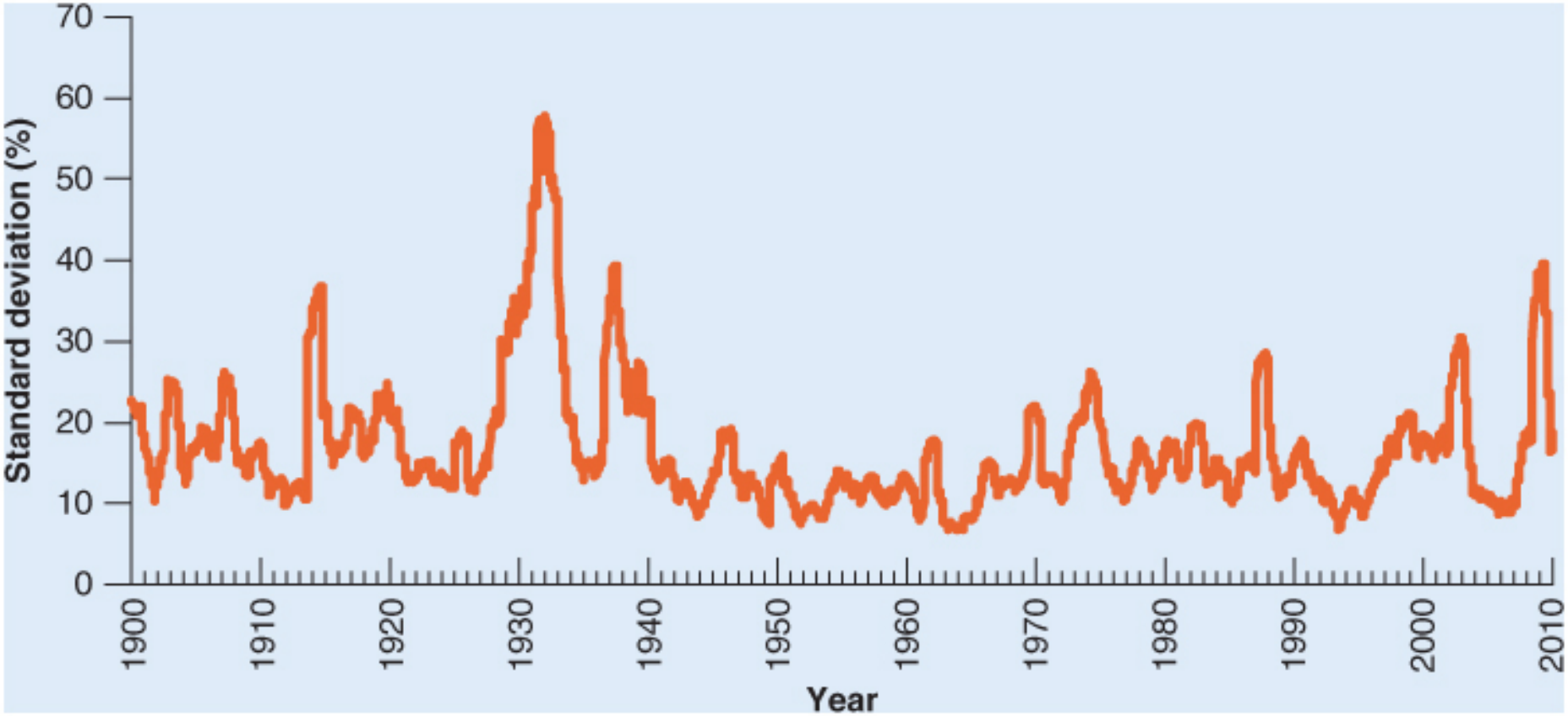
Year	Rate of Return, %	Deviation from Average Return, %	Squared Deviation
2005	6.38	0.38	0.14
2006	15.77	9.77	95.52
2007	5.62	−0.38	0.15
2008	−37.23	−43.23	1,869.23
2009	28.30	22.30	497.48
2010	17.16	11.16	124.65
Total	36.00		2,587.17
Average return = 36.00/6 = 6.00%			
Variance = average of squared deviations = 2,587.17/6 = 431.19			
Standard deviation = square root of variance = 20.77%			

Source: Elroy Dimson, Paul Marsh, and Mike Staunton, *Triumph of the Optimists: 101 Years of Global Investment Returns* (Princeton, NJ: Princeton University Press, 2002). Updates courtesy of *Triumph*'s authors.

Measuring the Variation in Stock Returns (continued)

- There is no reason to believe that the market's variability should stay the same over many years.
- Many people believe that in recent years the stock market has become more volatile due to irresponsible speculation.

Annualized standard deviation of weekly percent changes in the DJIA (1900-2010)



Risk and Diversification (11.4)

- The stock return volatilities of individual stocks can vary a lot across different types of firms.
- The table in next slide provides few examples.
- The market portfolio during the same time period has standard deviation about 16.3%.
- Most of the stocks in the table have volatilities higher than the market volatility.
- Selling umbrellas and ice cream are both risky business.
  - How about we sell both?

Standard deviations for selected common stocks May 2005 ~ April 2010

Ford Motor	77.4%
Dow Chemical	55.5
Amazon.com	49.0
Newmont	38.5
Starbucks	35.8
Dell	35.7
Boeing	30.0
Microsoft	25.5
Disney	23.7
Pfizer	22.0
IBM	20.5
McDonald's	17.7
ExxonMobil	17.6
Campbell Soup	16.9
Walmart	16.6
S&P	16.3
Consolidated Edison	15.9

Risk and Diversification (continued)

- Diversification: strategy designed to reduce risk by spreading a portfolio across many investments.
- Unique Risk: risk factors affecting only that firm.
  - Also called firm-specific risk or diversifiable risk.
- Market Risk: economy-wide sources of risk that affect the overall stock market.
  - Also called systematic risk.

Risk and Diversification (continued)

- Portfolio diversification works because prices of different stocks do not move exactly together.
  - In another word, stock price changes are less than perfectly correlated.
- Thus, diversification works best when the returns are negatively correlated.
  - Unfortunately, stocks that are negatively correlated are very rare.

Asset versus Portfolio Risk

- The history of returns on different asset classes provides compelling evidence of a risk-return trade-off.
  - It suggests that the volatility on each asset class is a useful measure of risk.
- Suppose there are three equally likely outcomes:
  - A recession, normal growth, and a boom.
  - Auto firms are cyclical, and gold firms are often said to be countercyclical.

Rate of return assumptions for two stocks

Scenario	Probability	Rate of Return, %	
		Auto Stock	Gold Stock
Recession	1/3	−8	+20
Normal	1/3	+5	+3
Boom	1/3	+18	−20

Asset vs. Portfolio Risk (continued)

- It appears that gold is the more volatile investment.
  - Its difference in return across the boom and bust scenarios is 40%.
    - Compared to a spread of only 26% for the auto stock.
- In fact, we can confirm the higher volatility by measuring the standard deviation of returns of the two assets.

Expected returns and volatilities for the two stocks

Scenario	Auto Stock			Gold Stock		
	Rate of Return, %	Deviation from Expected Return, %	Squared Deviation	Rate of Return, %	Deviation from Expected Return, %	Squared Deviation
Recession	−8	−13	169	+20	+19	361
Normal	+5	0	0	+3	+2	4
Boom	+18	+13	169	−20	−21	441
Expected return	$\frac{1}{3}(-8 + 5 + 18) = 5\%$			$\frac{1}{3}(+20 + 3 - 20) = 1\%$		
Variance*	$\frac{1}{3}(169 + 0 + 169) = 112.7$			$\frac{1}{3}(361 + 4 + 441) = 268.7$		
Standard deviation ($=\sqrt{\text{variance}}$)	$\sqrt{112.7} = 10.6\%$			$\sqrt{268.7} = 16.4\%$		

Asset vs. Portfolio Risk (continued)

- The gold stock offers a lower expected rate of return than auto stock but more volatility.
  - Would anyone be willing to hold gold stocks in an investment portfolio?
  - Suppose we only invest in auto stock, we will then have expected return of 5% and standard deviation of 10.6%
  - What if we invest 75% in autos and 25% in gold?

Diversification: Building a Portfolio

A portfolio's rate of return is the weighted sum of each asset's rate of return.

$$\text{Portfolio Rate of Return} = \begin{pmatrix}\text{fraction of portfolio}\\ \text{in first asset}\end{pmatrix} \text{ x } \begin{pmatrix}\text{rate of return}\\ \text{on first asset}\end{pmatrix} + \begin{pmatrix}\text{fraction of portfolio}\\ \text{in second asset}\end{pmatrix} \text{ x } \begin{pmatrix}\text{rate of return}\\ \text{on second asset}\end{pmatrix}$$

Building a Portfolio: Example

Consider the following portfolio:

Stock	Weight	Rate of Return
IBM	$w_{IBM} = 50\%$	$r_{IBM} = 8.3\%$
Starbucks	$w_{SBUX} = 25\%$	$r_{SBUX} = 12.5\%$
Walmart	$w_{W} = 25\%$	$r_{W} = 4.7\%$

What is the portfolio rate of return?

Asset vs. Portfolio Risk (continued)

- Thus, for the auto and gold stocks example
  - Portfolio return in recession =

    $0.75 \times -8\% + 0.25 \times 20\% = -1\%$

Scenario	Probability	Rate of Return, %		Portfolio Return, %*
		Auto Stock	Gold Stock	
Recession	1/3	−8	+20	−1.0
Normal	1/3	+5	+3	+4.5
Boom	1/3	+18	−20	+8.5
Expected return		5	1	4
Variance		112.7	268.7	15.2
Standard deviation		10.6	16.4	3.9

Asset vs. Portfolio Risk (continued)

- We see that volatility of the auto-plus-gold portfolio is considerably less than the volatility of either stock separately.
  - This is the payoff to diversification.
  - This due to the inverse relationship between the returns on the two stocks across boom and recession.
  - That is, the incremental risk of the gold stock adding to auto stock is actually negative.

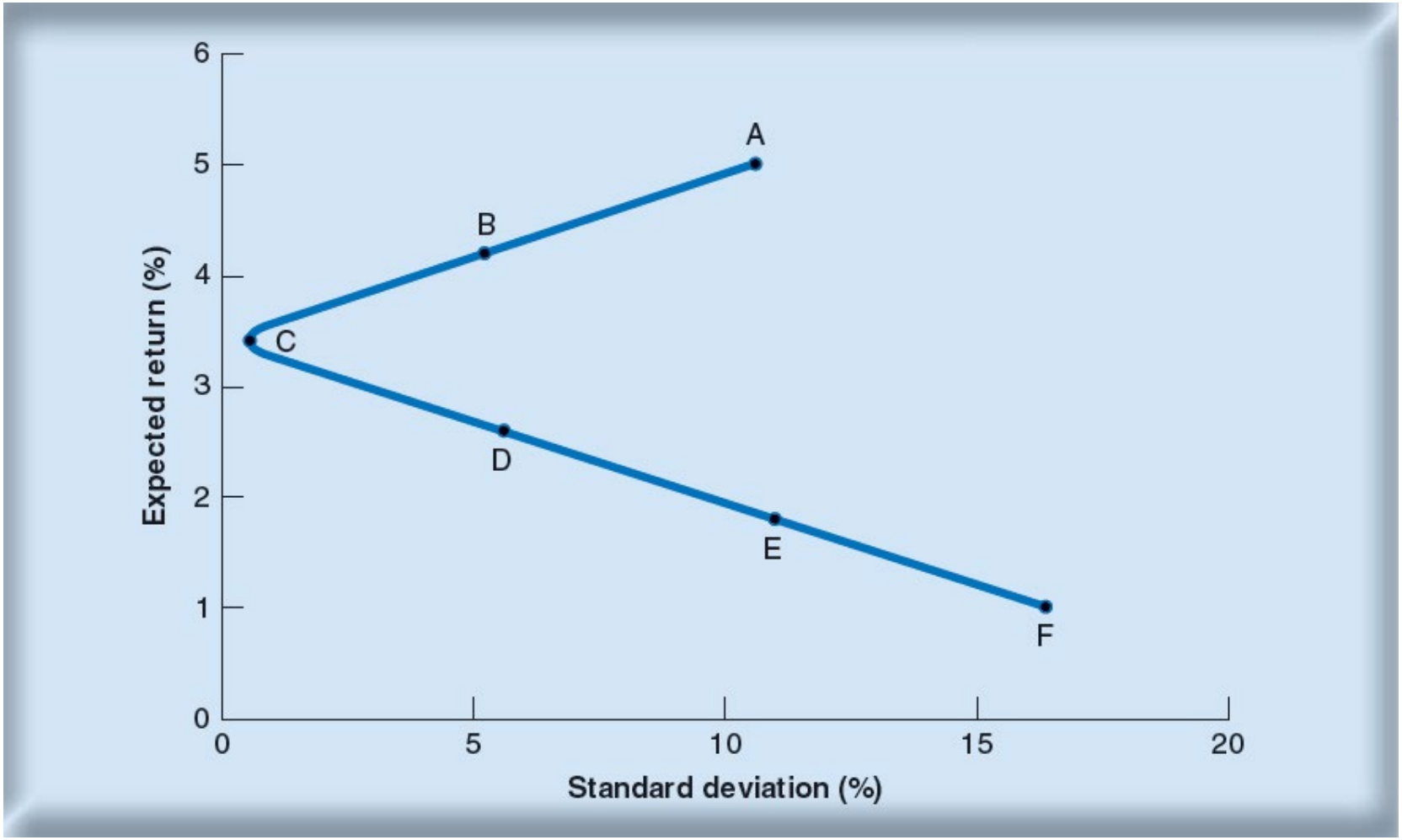
Asset vs. Portfolio Risk (continued)

- How much more can we reduce risk?
- Next slide considers several other potential portfolios b/w auto and gold stocks.
  - Portfolio A is invested fully in the auto stock, and portfolio F invested fully in the gold stock.

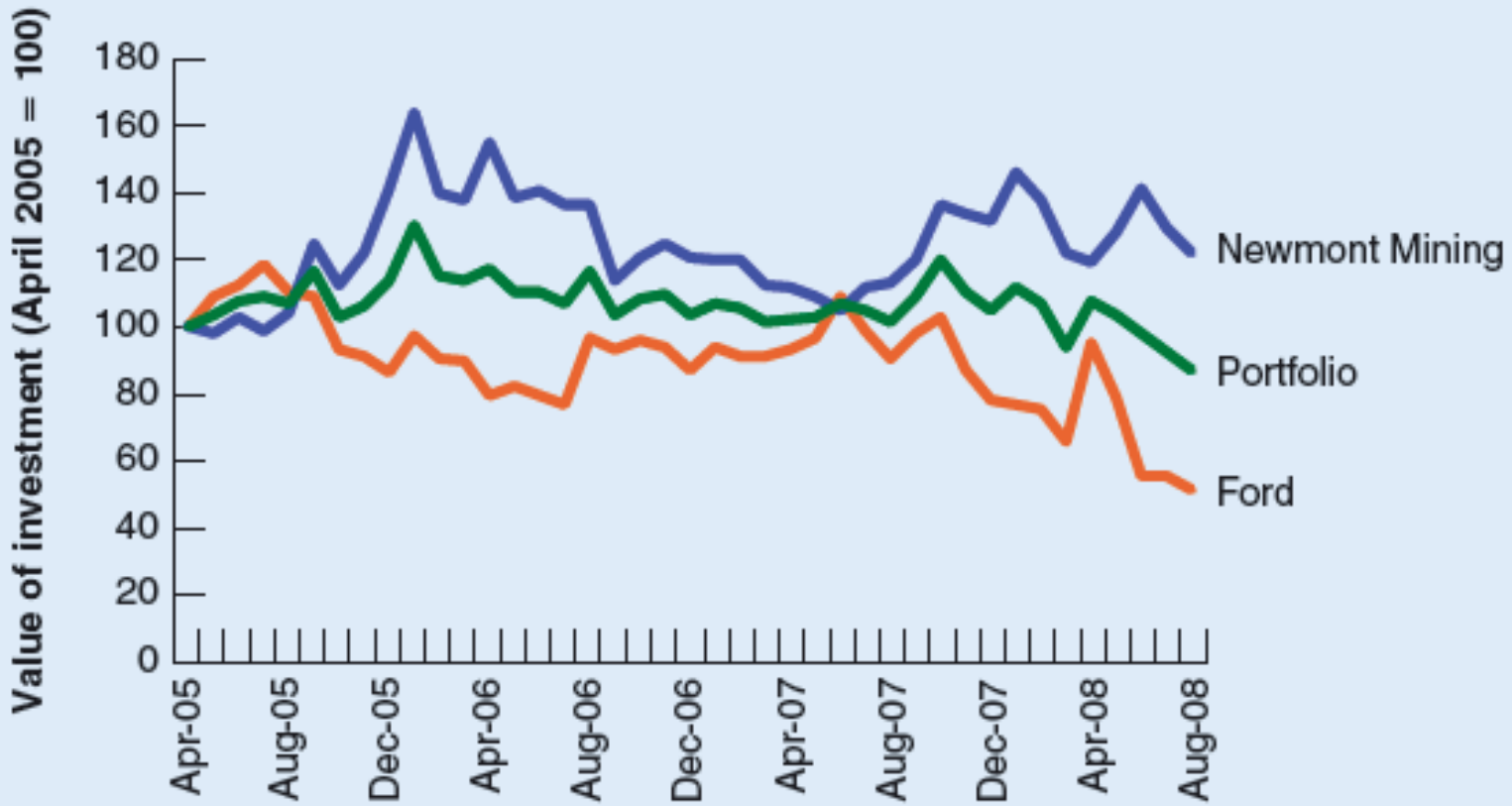
Asset vs. Portfolio Risk (continued)

	Portfolio Weights		Portfolio Rate of Return				
	Gold	Autos	Recession	Normal	Boom	Expected Return	Standard Deviation
A	0.0	1.0	−8.0	5.0	18.0	5.0	10.6
B	0.2	0.8	−2.4	4.6	10.4	4.2	5.2
C	0.4	0.6	3.2	4.2	2.8	3.4	0.6
D	0.6	0.4	8.8	3.8	−4.8	2.6	5.6
E	0.8	0.2	14.4	3.4	−12.4	1.8	11.0
F	1.0	0.0	20.0	3.0	−20.0	1.0	16.4

Investment Opportunity Frontier



Do stock prices move together?

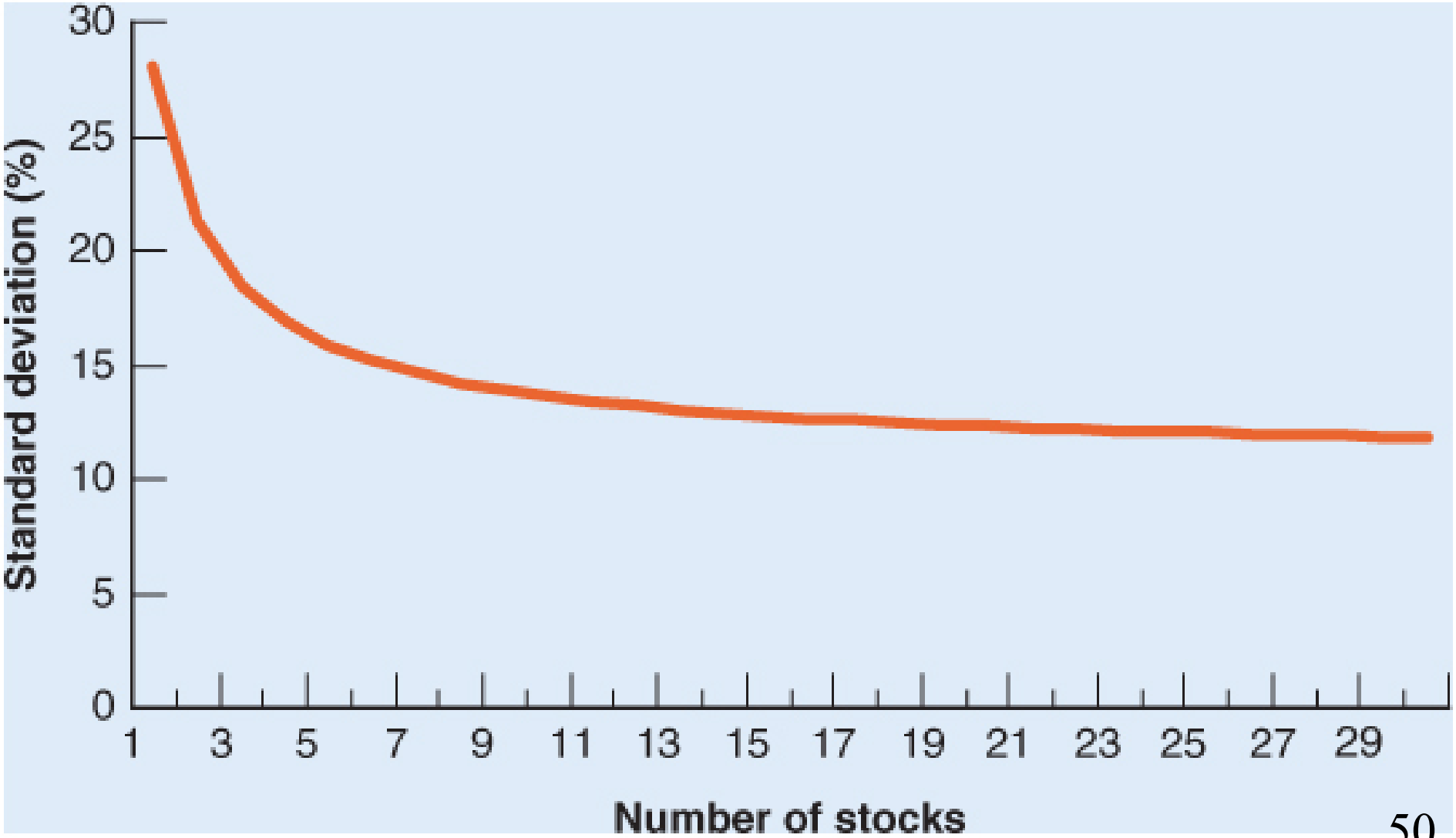


What effect does diversification have on a portfolio's total risk, unique risk and market risk?

Market Risk vs. Specific Risk

- The auto and gold example shows that even a little diversification can provide a substantial reduction in variability.
- Suppose we compare the standard deviations of one-stock, two-stock, and five-stock portfolios,
  - We will see that the diversification can cut the variability of returns by about half.
  - The improvement of lower risk is slight when the number of stocks increase beyond 20 or 30.

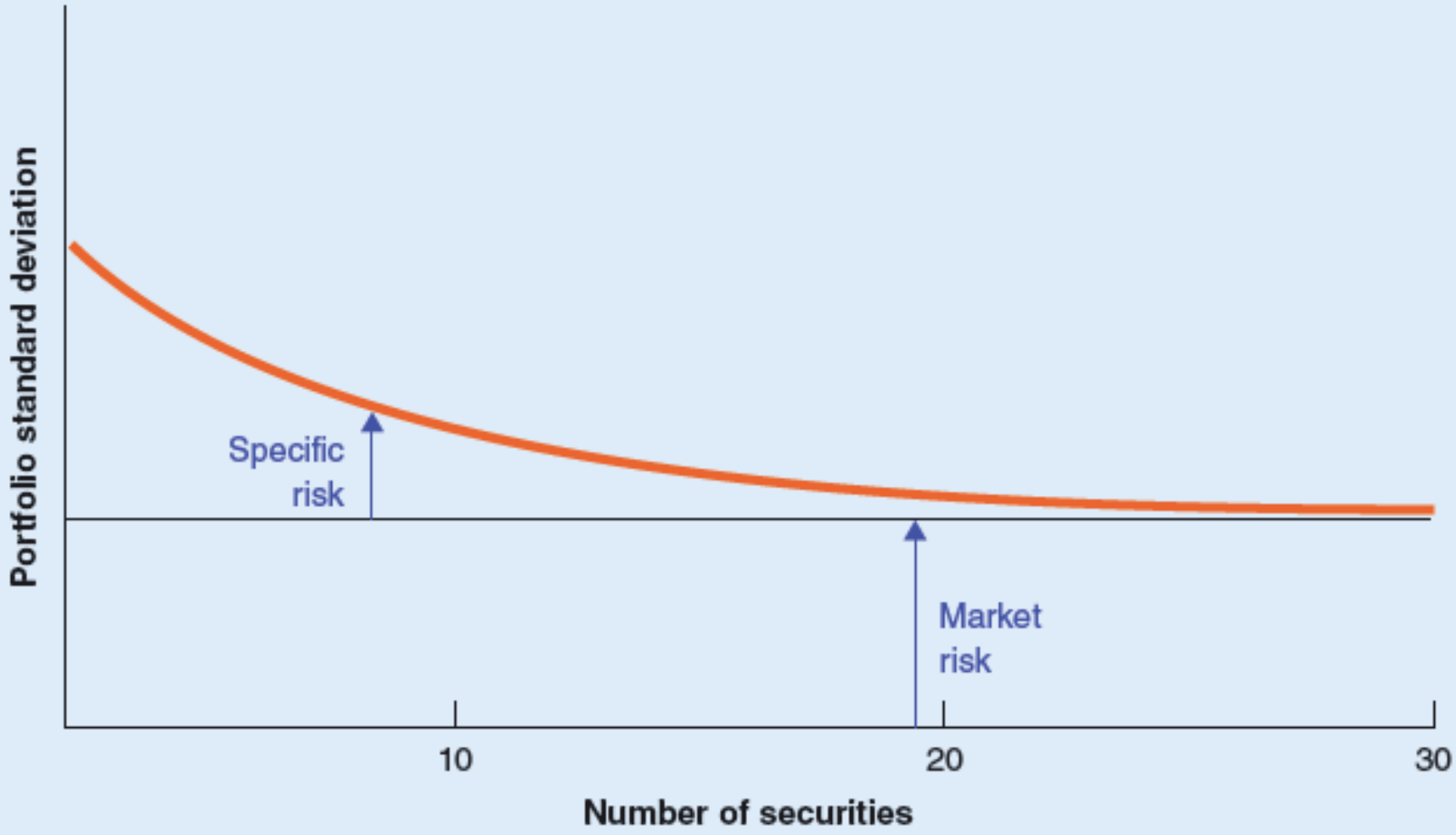
The risk of portfolios containing different numbers of randomly chosen NYSE stocks.



Market Risk vs. Specific Risk

- The risk that can be eliminated by diversification is called specific risk.
  - Specific risk arises because many of the perils that surround an individual company are peculiar to that company.
- The risk that we can't avoid regardless of how much we diversify is generally known as market risk (or systematic risk).
  - Market risk stems from economy-wide perils that threaten all business at the same time.
- For a reasonably well-diversified portfolio, only market risk matters!

Diversification eliminates specific risk



Thinking about Risk (11.5)

- Message 1
  - Some Risks Look Big and Dangerous but Really Are Diversifiable
    - An investment can have large volatility
    - But yet the same investment may not seem risky to an investor who can combine it in a diversified portfolio with many other assets.
    - Would you be willing to write a $100,000 fire insurance to your neighbor who will pay a $100 premium? The chance of fire is 1 in 1,000.
      - Risk in insurance protection can be diversified.

Thinking about Risk (continued)

- Message 2
  - Market Risks Are Macro Risks
    - Diversified portfolios are not exposed to the specific risks of individual stocks but are exposed to the uncertain events that affect the entire securities market and economy.
  - Some industries have substantial macro risks:
    - Airlines; Machine tool manufacturers
  - Some have less macro exposures:
    - Food companies; Electric utilities

Thinking about Risk (continued)

- Message 3
  - Risk Can Be Measured
    - Is IBM stock a riskier investment than ExxonMobil?
  - Note that diversified investors are concerned with market risks.
    - The performance of the market is barely affected by a firm-specific event.
    - We measure individual stock's sensitivity to the fluctuations of the overall stock market.