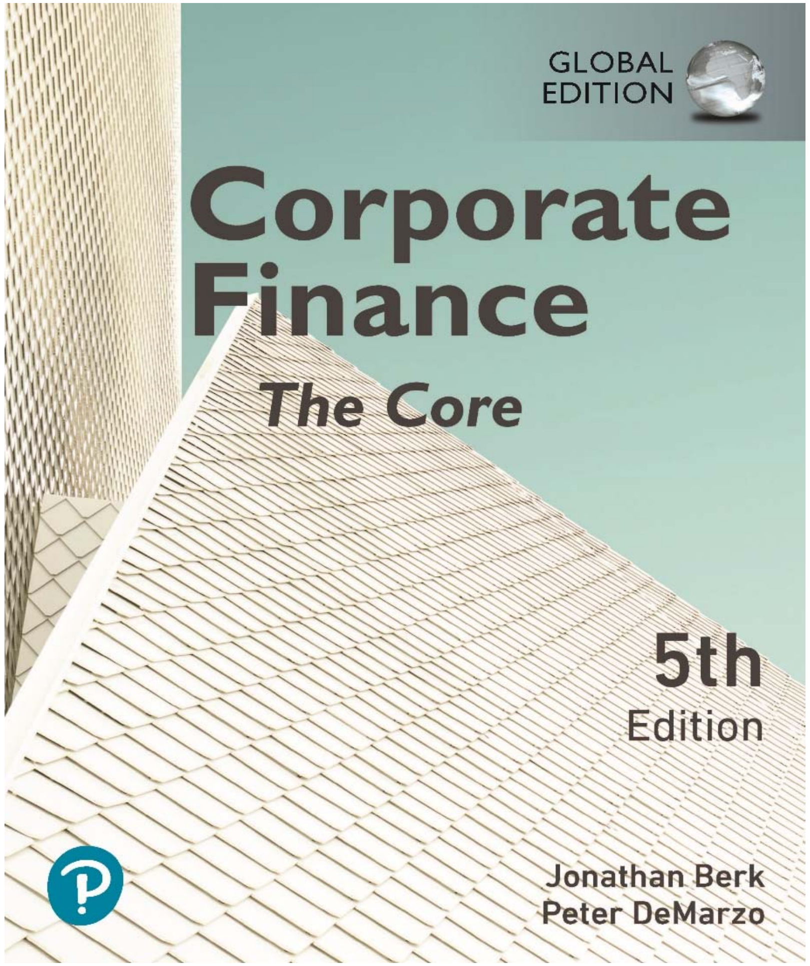
Corporate Finance: The Core

Fifth Edition, Global Edition



Chapter 10

Capital Markets and the Pricing of Risk

Chapter Outline

Learning Objectives (1 of 4)

- Define a probability distribution, the mean, the variance, the standard deviation, and the volatility.
- Compute the realized or total return for an investment.
- Using the empirical distribution of realized returns, estimate expected return, variance, and standard deviation (or volatility) of returns.

Learning Objectives (2 of 4)

- Use the standard error of the estimate to gauge the amount of estimation error in the average.
- Discuss the volatility and return characteristics of large stocks versus large stocks and bonds.
- Describe the relationship between volatility and return of individual stocks.

Learning Objectives (3 of 4)

- Define and contrast idiosyncratic and systematic risk and the risk premium required for taking each on.
- Define an efficient portfolio and a market portfolio.
- Discuss how beta can be used to measure the systematic risk of a security.

Learning Objectives (4 of 4)

- Use the Capital Asset Pricing Model to calculate the expected return for a risky security.
- Use the Capital Asset Pricing Model to calculate the cost of capital for a particular project.
- Explain why in an efficient capital market the cost of capital depends on systematic risk rather than diversifiable risk.

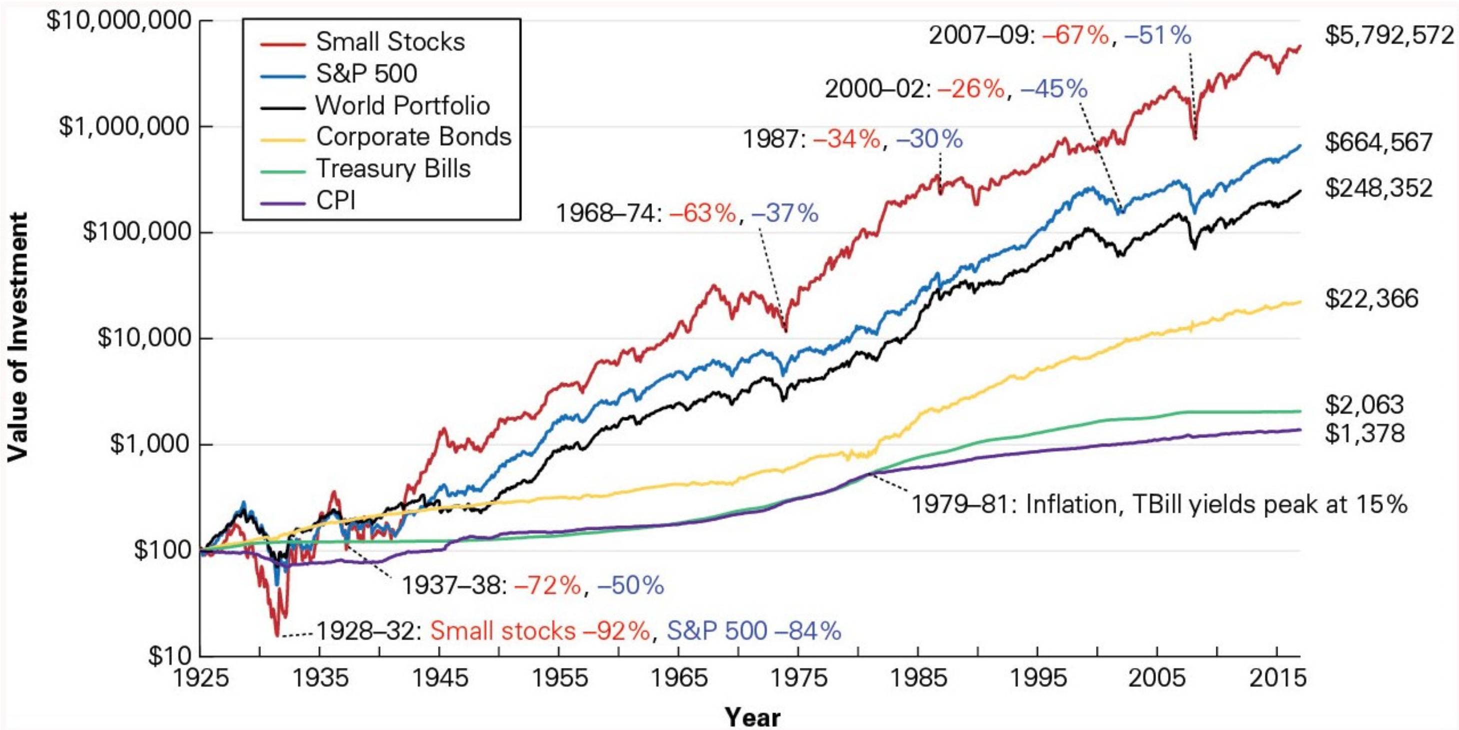
10.1 Risk and Return: Insights from 92 Years of Investor History (1 of 4)

- How would $100 have grown if it were placed in one of the following investments?
  - Standard & Poor's 500: 90 U.S. stocks up to 1957 and 500 after that. Leaders in their industries and among the largest firms traded on U.S. Markets
  - Small stocks: Securities traded on the NYSE with market capitalizations in the bottom 20%

10.1 Risk and Return: Insights from 92 Years of Investor History (2 of 4)

- How would $100 have grown if it were placed in one of the following investments?
  - World Portfolio: International stocks from all the world's major stock markets in North America, Europe, and Asia
  - Corporate Bonds: Long-term, AAA -rated U.S. corporate bonds with maturities of approximately 20 years
  - Treasury Bills: An investment in three-month Treasury bills

Figure 10.1 Value of $100 Invested at the End of 1925



Source: Chicago Center for Research in Security Prices, Standard and Poor's, MSCI, and Global Financial Data.

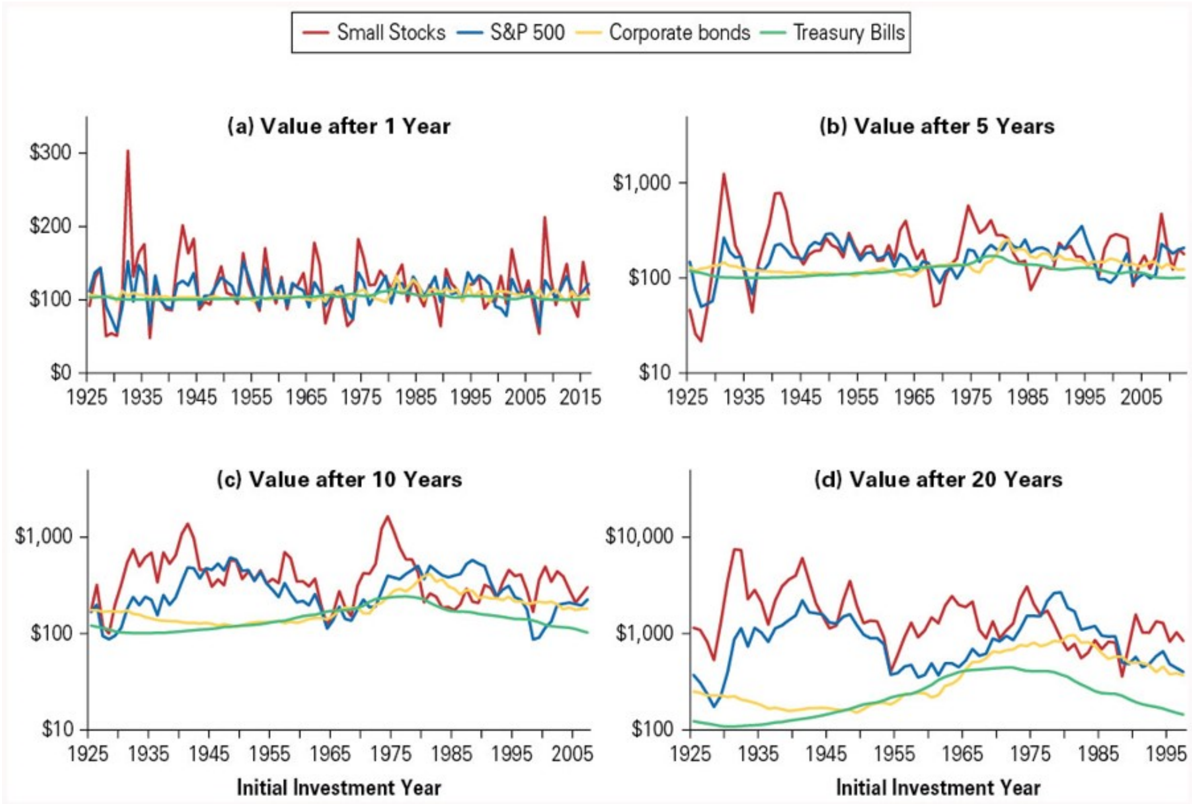
10.1 Risk and Return: Insights from 92 Years of Investor History (3 of 4)

- Small stocks had the highest long-term returns, while T-Bills had the lowest long-term returns
- Small stocks had the largest fluctuations in price, while T-Bills had the lowest
  - Higher risk requires a higher return

10.1 Risk and Return: Insights from 92 Years of Investor History (4 of 4)

- Few people ever make an investment for 92 years
- More realistic investment horizons and different initial investment dates can greatly influence each investment's risk and return

Figure 10.2 Value of $100 Invested in Alternative Investment for Differing Horizons



Source: Chicago Center for Research in Security Prices, Standard and Poor's, MSCI, and Global Financial Data.

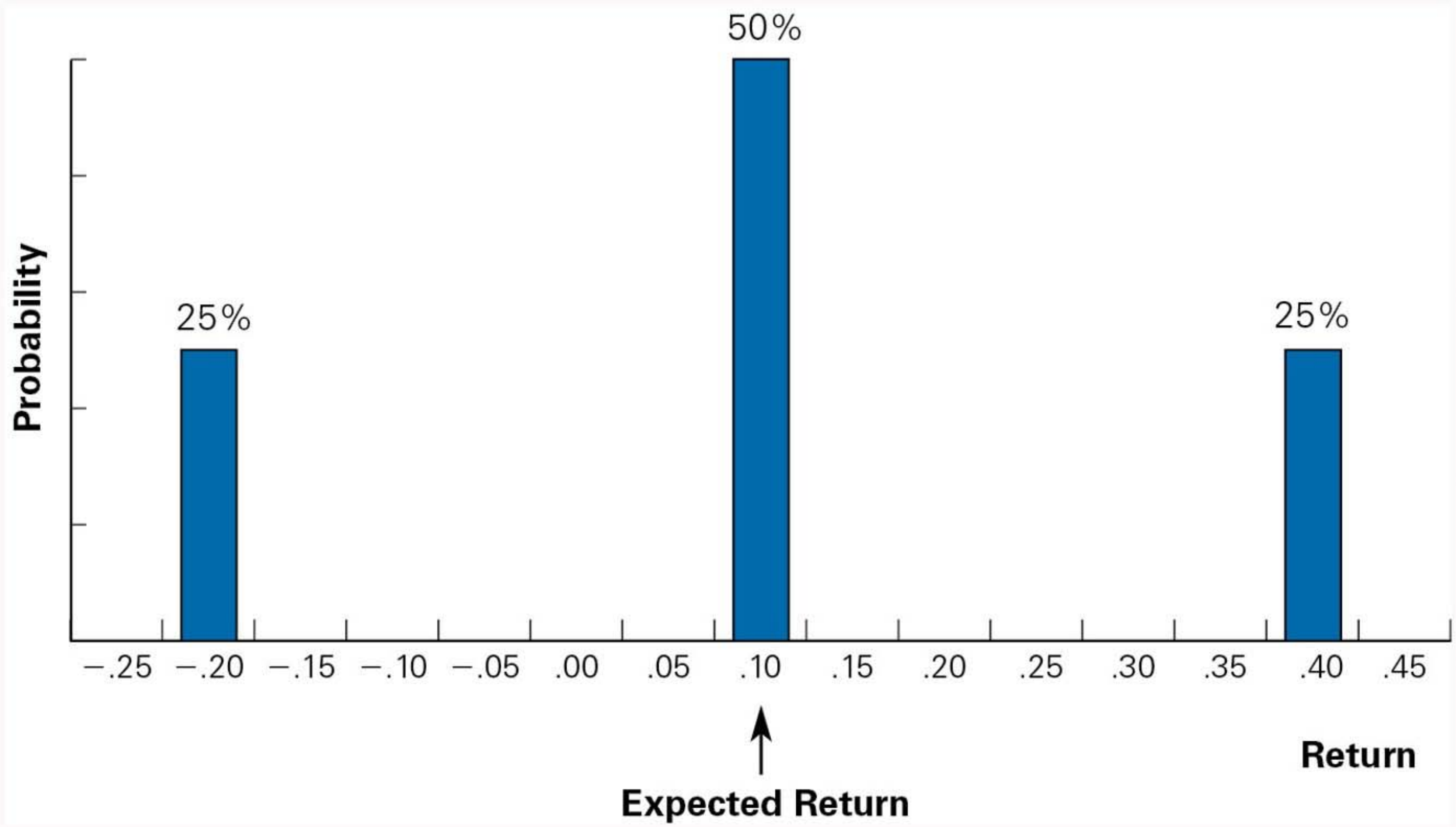
10.2 Common Measures of Risk and Return

- Probability Distributions
  - When an investment is risky, it may earn different returns
  - Each possible return has some likelihood of occurring
  - This information is summarized with a probability distribution, which assigns a probability, PR , that each possible return, R, will occur
    - Assume BFI stock currently trades for $100 per share
    - In one year, there is a 25% chance the share price will be $140, a 50% chance it will be $110, and a 25% chance it will be $80

Table 10.1 Probability Distribution of Returns for BFI

		Probability Distribution	
Current Stock Price ($)	Stock Price in One Year ($)	Return, R	Probability, p_R
	140	0.40	25%
100	110	0.10	50%
	80	−0.20	25%

Figure 10.3 Probability Distribution of Returns for BFI



Expected Return

- Expected (Mean) Return
  - Calculated as a weighted average of the possible returns, where the weights correspond to the probabilities.

$$\text{Expected Return} = E[R] = \sum_R P_R \times R$$

$$E[R_{BFI}] = 25\%(-0.20) + 50\%(0.10) + 25\%(0.40) = 10\%$$

Variance and Standard Deviation (1 of 2)

- Variance
  - The expected squared deviation from the mean

$$Var(R) = E\left[\left(R - E[R]\right)^2\right] = \sum_R P_R \times \left(R - E[R]\right)^2$$

- Standard Deviation
  - The square root of the variance

$$SD(R) = \sqrt{Var(R)}$$

- Both are measures of the risk of a probability distribution

Variance and Standard Deviation (2 of 2)

- For BFI, the variance and standard deviation are

$$Var\left[R_{BFI}\right] = 25\% \times (-0.20 - 0.10)^2 + 50\% \times (0.10 - 0.10)^2 + 25\% \times (0.40 - 0.10)^2 = 0.045$$

$$SD(R) = \sqrt{Var(R)} = \sqrt{0.045} = 21.2\%$$

  - In finance, the standard deviation of a return is also referred to as its **volatility**
  - The standard deviation is easier to interpret because it is in the same units as the returns themselves

Textbook Example 10.1 (1 of 2)

Calculating the Expected Return and Volatility

- **Problem**
  - Suppose AMC stock is equally likely to have a 45% return or a –25% return. What are its expected return and volatility?

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Textbook Example 10.1 (2 of 2)

Solution

First, we calculate the expected return by taking the probability-weighted average of the possible returns:

$$E[R] = \sum_R p_R \times \mathrm{R} = 50\% \times 0.45 + 50\% \times (-0.25) = 10.0\%$$

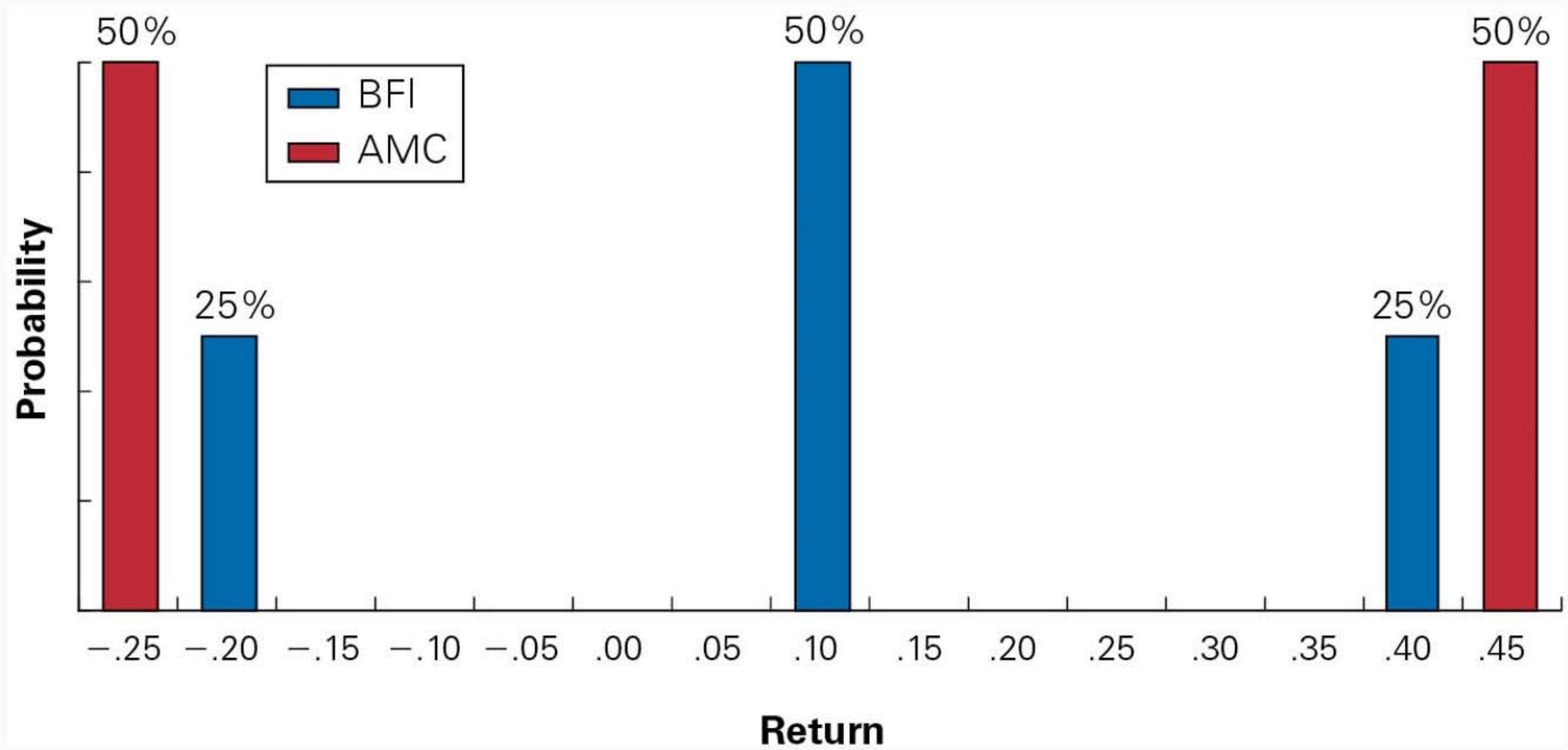
Then, the volatility or standard deviation is the square root of the variance:

$$\begin{aligned} Var(R) &= \sum_R p_R \times (R - E[R])^2 = 50\% \times (0.45 - 0.10)^2 + 50\% \times (-0.25 - 0.10)^2 \\ &= 0.1225 \end{aligned}$$

To compute the volatility, we first determine the variance:

$$SD(R) = \sqrt{Var(R)} = \sqrt{0.1225} = 35\%$$

Figure 10.4 Probability Distributions for BFI and AMC Returns



10.3 Historical Returns of Stocks and Bonds (1 of 4)

- Computing Historical Returns
  - Realized Return
    - The return that actually occurs over a particular time period

$$R_{t+1} = \frac{Div_{t+1} + P_{t+1}}{P_t} - 1 = \frac{Div_{t+1}}{P_t} + \frac{Div_{t+1} - P_t}{P_t}$$

$$= \text{Dividend Yield} + \text{Capital Gain Rate}$$

10.3 Historical Returns of Stocks and Bonds (2 of 4)

- Computing Historical Returns
  - If you hold the stock beyond the date of the first dividend, then to compute your return you must specify how you invest any dividends you receive in the interim
  - Let's assume that **all dividends are immediately reinvested and used to purchase additional shares of the same stock or security**

10.3 Historical Returns of Stocks and Bonds (3 of 4)

- Computing Historical Returns
  - If a stock pays dividends at the end of each quarter, with realized returns $R_{Q1}, \ldots, R_{Q4}$ each quarter, then its annual realized return, R_{annual} is computed as follows:

$$1 + R_{annual} = (1 + R_{Q1})(1 + R_{Q2})(1 + R_{Q3})(1 + R_{Q4})$$

Textbook Example 10.2 (1 of 4)

Realized Returns for Microsoft Stock

Problem

What were the realized annual returns for Microsoft stock in 2004 and 2008?

Textbook Example 10.2 (2 of 4)

Solution

When we compute Microsoft’s annual return, we assume that the proceeds from the dividend payment were immediately reinvested in Microsoft stock. That way, the return corresponds to remaining fully invested in Microsoft over the entire period. To do that we look up Microsoft stock price data at the start and end of the year, as well as at any dividend dates (Yahoo! Finance is a good source for such data; see also MyFinancelLab or berkdemarzo.com for additional sources). From these data, we can construct the following table (prices and dividends in $/share):

Textbook Example 10.2 (3 of 4)

Date	Price	Dividend	Return	Date	Price($)	Dividend	Return
12/31/03	27.37	-	-	12/31/07	35.06	-	-
8/23/04	27.24	0.08	-0.18%	2/19/08	28.17	0.11	–20.56%
11/15/04[6]	27.39	3.08	11.86%	5/31/08	27.32	0.11	6.11%
12/31/04	26.72	-	-2.45 %.	8/19/08	19.62	0.11	-7.89 %.
-	-	-	-	11/18/08	19.44	0.13	–27.71%
-	-	-	-	12/31/08	-	-	–0.92%

The return from December 31,2003,until August 23,2004,is equal to

$$\frac{0.08 + 27.24}{27.37} - 1 = -0.18\%$$

Textbook Example 10.2 (4 of 4)

The rest of the returns in the table are computed similarly. We then calculate the annual returns using Eq. 10.5:

$$R_{2004} = (0.9982)(1.1186)(0.9755) - 1 = 8.92\%$$

$$R_{2008} = (0.7944)(1.0611)(0.9211)(0.7229)(0.9908) - 1 = -43.39\%$$

Table 10.2 Realized Return for the S&P 500, Microsoft, and Treasury Bills, 2005–2017

Year End	S&P 500 Index	Dividends Paid*	S&P 500 Realized Returned	Microsoft Realized Return	1-Month T-Bill Return
2004	1211.92	-	-	-	-
2005	1248.29	23.15	4.9 %	–0.9 %	3 %
2006	1418.3	27.16	15.8 %	15.8 %	4.8 %
2007	1468.36	27.86	5.5 %	20.8 %	4.7 %
2008	903.25	21.85	–37%	–44.4%	1.5 %
2009	1115.1	27.19	26.5 %	60.5 %	0.1 %
2010	1257.64	25.44	15.1 %	–6.5 %	0.1 %
2011	1257.61	26.59	2.1 %	–4.5 %	0 %
2012	1426.19	32.67	16 %	5.8 %	0.1 %
2013	1848.36	39.75	32.4 %	44.3 %	0 %
2014	2058.9	42.47	13.7 %	27.6 %	0 %
2015	2043.94	43.45	1.4 %	22.7 %	0 %
2016	2238.83	49.56	12 %	15.1 %	0.2 %
2017	2673.61	53.99	21.8 %	40.7 %	0.8 %

Total dividends paid by the 500 stocks in the portfolio, based on the number of shares of each stock in the index, adjusted until the end the year, assuming they were reinvested when paid.

Source: Standard & Poor’s, Microsoft and U.S. Treasury Data

10.3 Historical Returns of Stocks and Bonds (4 of 4)

- Computing Historical Returns
  - By counting the number of times a realized return falls within a particular range, we can estimate the underlying probability distribution
  - Empirical Distribution
    - When the probability distribution is plotted using historical data

Figure 10.5 The Empirical Distribution of Annual Returns for U.S. Large Stocks (S&P 500), Small Stocks, Corporate Bonds, and Treasury Bills, 1926–2017

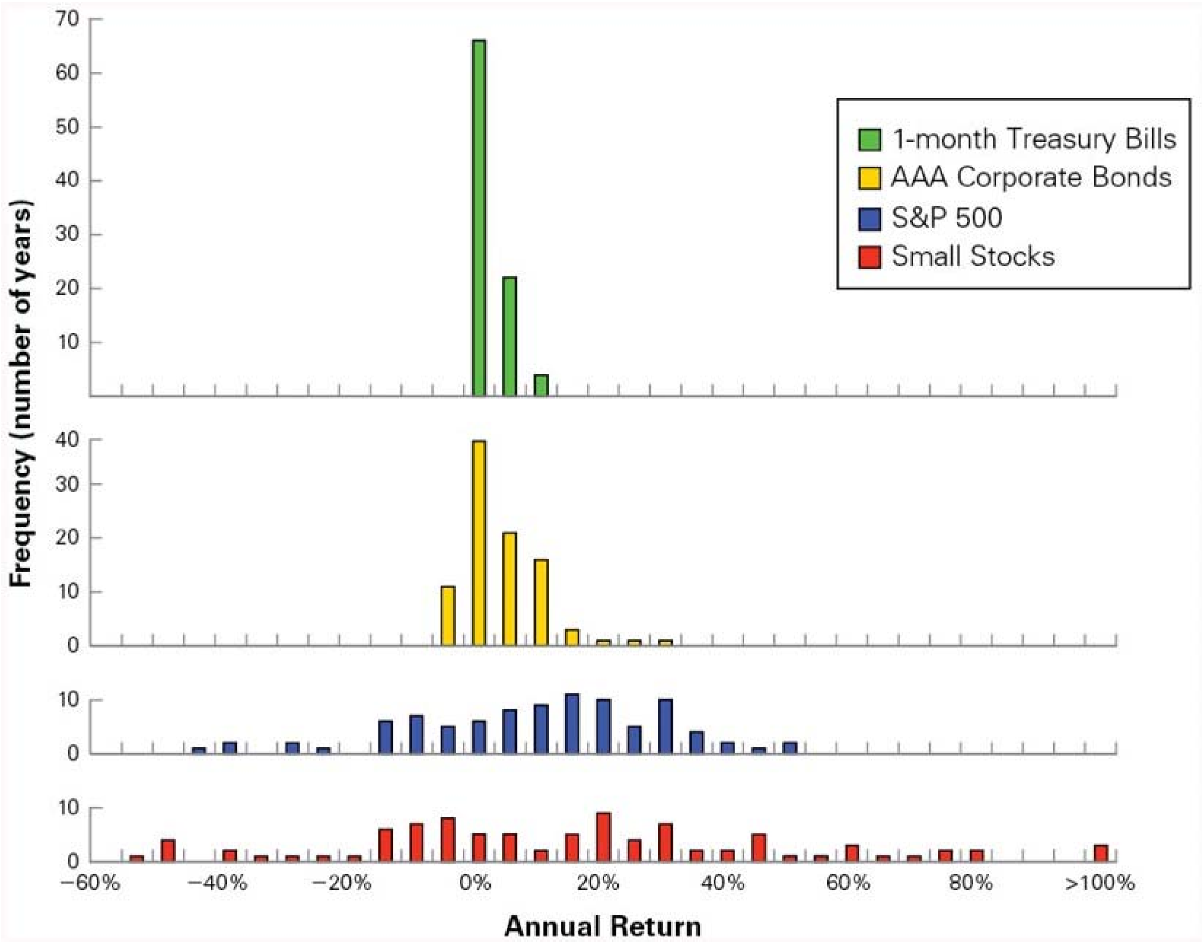


Table 10.3 Average Annual Returns for U.S. Small Stocks, Large Stocks (S&P 500), Corporate Bonds, and Treasury Bills, 1926–2017

Investment	Average Annual Return
Small stocks	18.7%
S&P 500	12.0%
Corporate bonds	6.2%
Treasury bills	3.4%

Average Annual Return

$$\bar{R} = \frac{1}{T}\left(R_1 + R_2 + \cdots + R_T\right) = \frac{1}{T}\sum_{t=1}^{T} R_t$$

- Where R_t is the realized return of a security in year *t*, for the years 1 through *T*
  - Using the data from Table 10.2, the average annual return for the S&P 500 from 2005 to 2017 is as follows:

$$\bar{R} = \frac{1}{13}(0.049 + 0.158 + 0.055 - 0.37 + 0.265 + 0.151 + 0.021 + 0.160 + 0.324 + 0.137 + 0.014 + 0.120 + 0.218) = 10.0\%$$

The Variance and Volatility of Returns

- Variance Estimate Using Realized Returns

$$Var(R) = \frac{1}{T-1} \sum_{t=1}^{T} \left(R_t - \bar{R}\right)^2$$

  – The estimate of the standard deviation is the square root of the variance

Textbook Example 10.3 (1 of 2)

Computing a Historical Volatility

- **Problem**
  - Using the data from Table 10.2, what are the variance and volatility of the S&P 500's returns for the years 2005–2017?

Pearson

Textbook Example 10.3 (2 of 2)

Solution

Earlier, we calculated the average annual returns of the S&P 500 during this period to be 10.0%. Therefore,

$$
\begin{aligned}
Var(R) &= \frac{1}{T-1}\sum_t (R_t - \overline{R})^2 \\
&= \frac{1}{13-1}[(0.049-0.100)^2 + (0.158-0.100)^2 + \ldots + (0.218-0.100)^2] \\
&= 0.029
\end{aligned}
$$

The volatility or standard deviation is therefore $SD(R) = \sqrt{Var(R)} = \sqrt{0.029} = 17.0\%$

Table 10.4 Volatility of U.S. Small Stocks, Large Stocks (S&P 500), Corporate Bonds, and Treasury Bills, 1926–2017

Investment	Return Volatility (Standard Deviation)
Small stocks	39.2%
S&P 500	19.8%
Corporate bonds	6.4%
Treasury bills	3.1%

Estimation Error: Using Past Returns to Predict the Future (1 of 2)

- We can use a security's historical average return to estimate its actual expected return.
- However, the average return is just an estimate of the true expected return, and subject to estimation error
  - Standard Error
    - A statistical measure of the degree of estimation error
    - Standard deviation of the average return

Estimation Error: Using Past Returns to Predict the Future (2 of 2)

- Standard Error of the Estimate of the Expected Return

$$SD(\text{Average of Independent, Identical Risks}) = \frac{SD(\text{Individual Risk})}{\sqrt{\text{Number of Observations}}}$$

- 95% Confidence Interval

$$\text{Historical Average Return} \pm (2 \times \text{Standard Error})$$

  – For the S&P 500 (1926–2017)

$$12.0\% \pm 2\left(\frac{19.8\%}{\sqrt{92}}\right) = 12.0\% \pm 4.1\%$$

    ▪ Or a range from 7.9% to 16.1%

Textbook Example 10.4 (1 of 2)

The Accuracy of Expected Return Estimates

- **Problem**
  - Using the returns for the S&P 500 from 2005 to 2017 only (see Table 10.2), what is the 95% confidence interval you would estimate for the S&P 500's expected return?

Pearson

Textbook Example 10.4 (2 of 2)

Solution

Earlier, we calculated the average return for the S&P 500 during this period to be 10.0%, with a volatility of 17.0% (see Example 10.3). The standard error of our estimate of the expected return is

$17.0\% \div \sqrt{13} = 4.7\%$, and the 95% confidence interval is $10.0\% \pm (2 \times 4.7\%)$,

or from 0.6% to 19.4%. As this example shows, with only a few years of data, we cannot reliably estimate expected returns for stocks!

10.4 The Historical Tradeoff Between Risk and Return

- The Returns of Large Portfolios
  - Excess Returns
    - The difference between the average return for an investment and the average return for T-Bills

Pearson

Table 10.5 Volatility Versus Excess Return of U.S. Small Stocks, Large Stocks (S&P 500), Corporate Bonds, and Treasury Bills, 1926–2017

Investment	Return Volatility (Standard Deviation)	Excess Return (Average Return in Excess of Treasury Bills)
Small stocks	39.2%	15.3%
S&P 500	19.8%	8.6%
Corporate bonds	6.4%	2.9%
Treasury bills (30-day)	3.1%	0.0%

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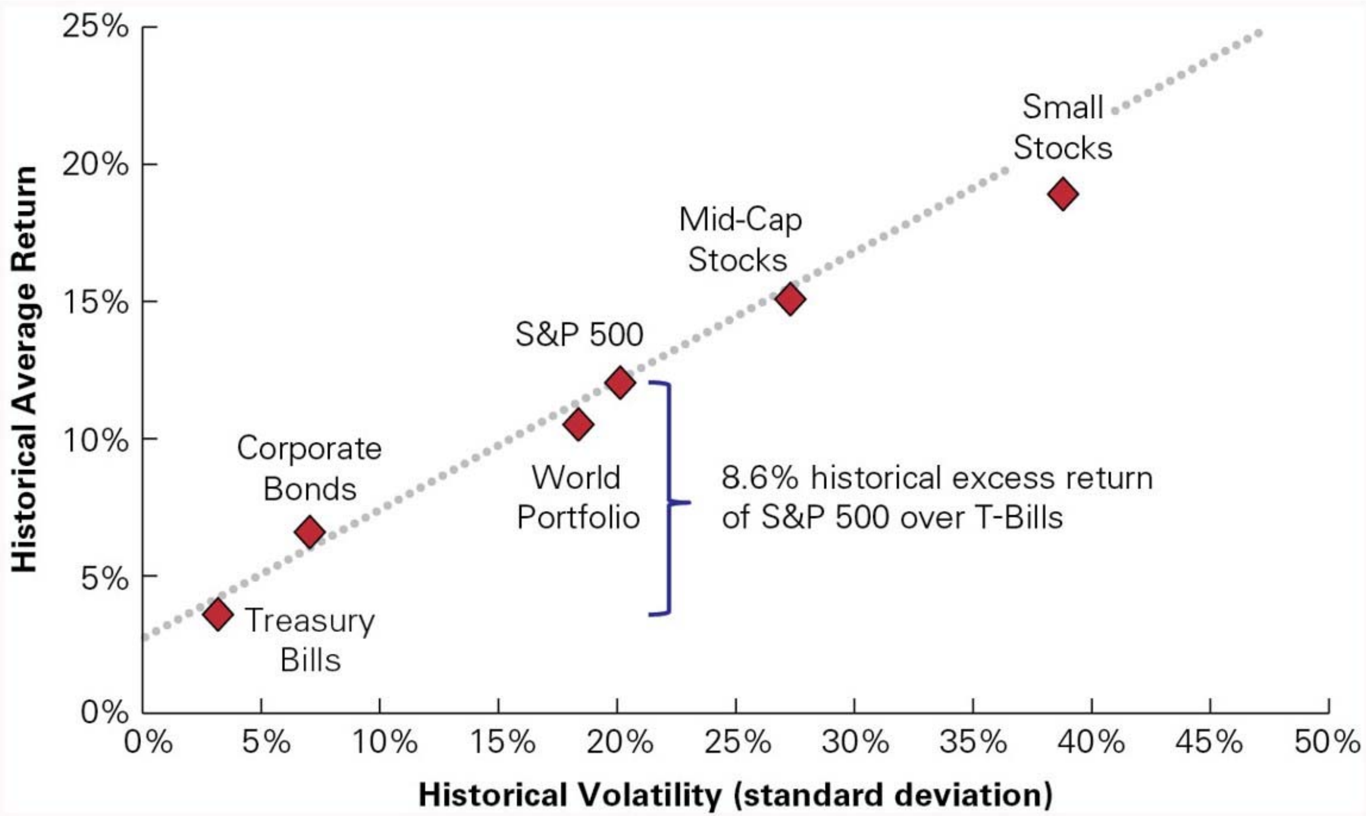
Figure 10.6 The Historical Tradeoff Between Risk and Return in Large Portfolios

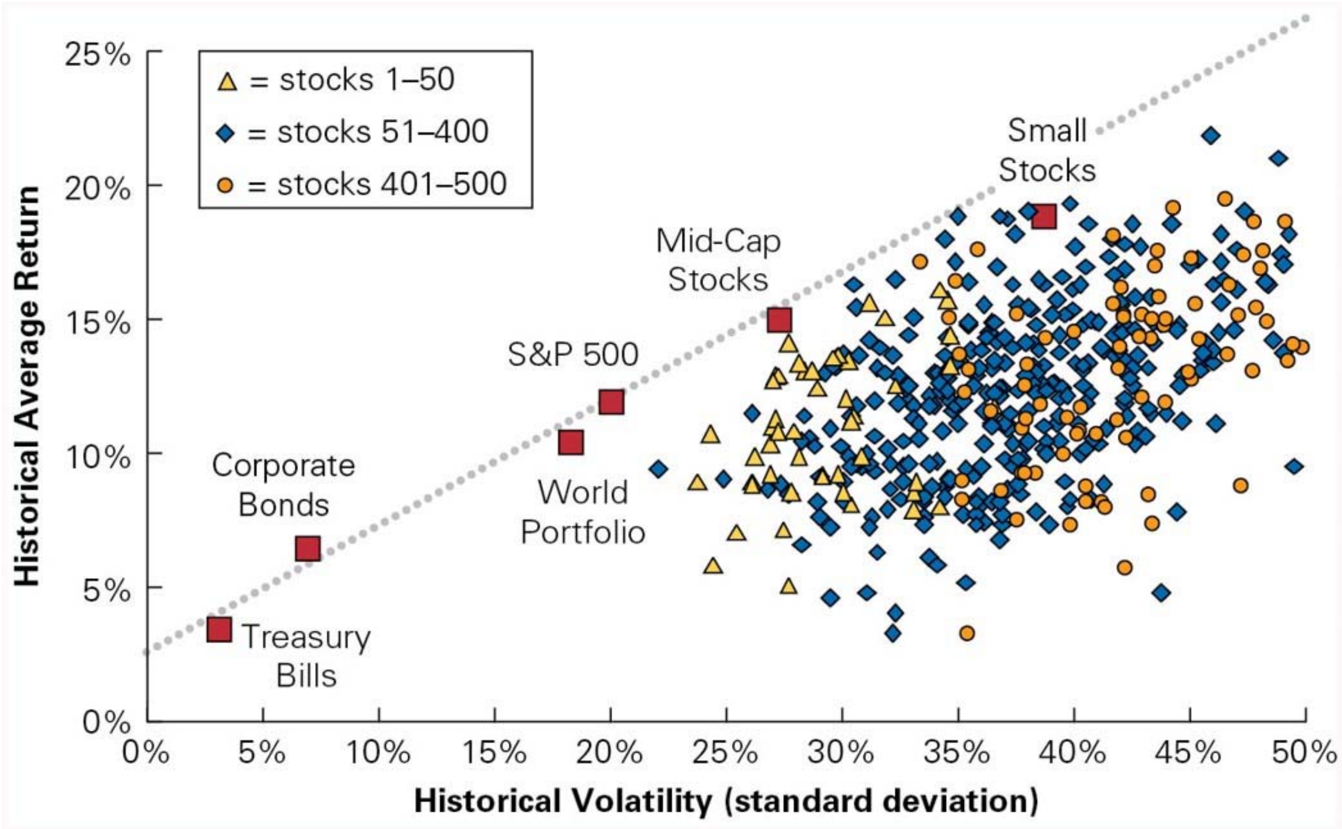


Source: CRSP, Morgan Stanley Capital International

The Returns of Individual Stocks

- Is there a positive relationship between volatility and average returns for individual stocks?
  - As shown on the next slide, there is no precise relationship between volatility and average return for individual stocks
    - Larger stocks tend to have lower volatility than smaller stocks
    - All stocks tend to have higher risk and lower returns than large portfolios

Figure 10.7 Historical Volatility and Return for 500 Individual Stocks, Ranked Annually by Size



Source: CRSP

10.5 Common Versus Independent Risk

- Common Risk
  - Risk that is perfectly correlated
    - Risk that affects all securities
- Independent Risk
  - Risk that is uncorrelated
    - Risk that affects a particular security
- Diversification
  - The averaging out of independent risks in a large portfolio

Textbook Example 10.5 (1 of 3)

Diversification and Gambling

Problem

Roulette wheels are typically marked with the numbers 1 through 36 plus 0 and 00. Each of these outcomes is equally likely every time the wheel is spun. If you place a bet on any one number and are correct, the payoff is $35:1$; that is, if you bet $1, you will receive $36 if you win ($35 plus your original $1) and nothing if you lose. Suppose you place a $1 bet on your favorite number.

What is the casino's expected profit?

What is the standard deviation of this profit for a single bet?

Suppose 9 million similar bets are placed throughout the casino in a typical month. What is the standard deviation of the casino's average revenues per dollar bet each month?

Textbook Example 10.5 (2 of 3)

Solution

Because there are 38 numbers on the wheel, the odds of winning are $1/38$. The casino loses \$35 if you win, and makes \$1 if you lose. Therefore, using Eq. 10.1, the casino's expected profit is

$$E(\text{Payoff}) = (1/38)\times(-\$35) + (37/38)\times(\$1) = \$0.0526$$

That is, for each dollar bet, the casino earns 5.26 cents on average. For a single bet, we calculate the standard deviation of this profit using Eq. 10.2 as

$$SD(\text{Payoff}) = \sqrt{(1/38)\times(-35-0.0526)^2 + (37/38)\times(1-0.0526)^2} = \$5.76$$

Textbook Example 10.5 (3 of 3)

This standard deviation is quite large relative to the magnitude of the profits. But if many such bets are placed, the risk will be diversified. Using Eq. 10.8, the standard deviation of the casino's average revenues per dollar bet (i.e., the standard error of their payoff) is only

$$\text{SD(Average Payoff)} = \frac{\$5.76}{\sqrt{9{,}000{,}000}} = \$0.0019$$

In other words, by the same logic as Eq. 10.9, there is roughly 95% chance the casino's profit per dollar bet will be in the interval $\$0.0526 \pm (2 \times 0.0019) = \$0.0488 \text{ to } \$0.0564$.

Given \$9 million in bets placed, the casino's monthly profits will almost always be between \$439,000 and \$508,000, which is very little risk. The key assumption, of course, is that each bet is separate so that their outcomes are independent of each other. If the \$9 million were placed in a single bet, the casino's risk would be large—losing $35 \times \$9 \text{ million} = \$315 \text{ million}$ if the bet wins. For this reason, casinos often impose limits on the amount of any individual bet.

10.6 Diversification in Stock Portfolios (1 of 7)

- Firm-Specific Versus Systematic Risk
  - Firm Specific News
    - Good or bad news about an individual company
  - Market-Wide News
    - News that affects all stocks, such as news about the economy

10.6 Diversification in Stock Portfolios (2 of 7)

- Firm-Specific Versus Systematic Risk
  - Independent Risks
    - Due to firm-specific news
      - Also known as
        - Firm-Specific Risk
        - Idiosyncratic Risk
        - Unique Risk
        - Unsystematic Risk
        - Diversifiable Risk

10.6 Diversification in Stock Portfolios (3 of 7)

- Firm-Specific Versus Systematic Risk
  - Common Risks
    - Due to market-wide news
      - Also known as
        - Systematic Risk
        - Undiversifiable Risk
        - Market Risk

Pearson

10.6 Diversification in Stock Portfolios (4 of 7)

- Firm-Specific Versus Systematic Risk
  - When many stocks are combined in a large portfolio, the firm-specific risks for each stock will average out and be diversified
  - The systematic risk, however, will affect all firms and will not be diversified

10.6 Diversification in Stock Portfolios (5 of 7)

- Firm-Specific Versus Systematic Risk
  - Consider two types of firms:
    - Type S firms are affected only by systematic risk
      - There is a 50% chance the economy will be strong and type S stocks will earn a return of 40%
      - There is a 50% chance the economy will be weak and their return will be -20%,
      - Because all these firms face the same systematic risk, holding a large portfolio of type S firms will not diversify the risk

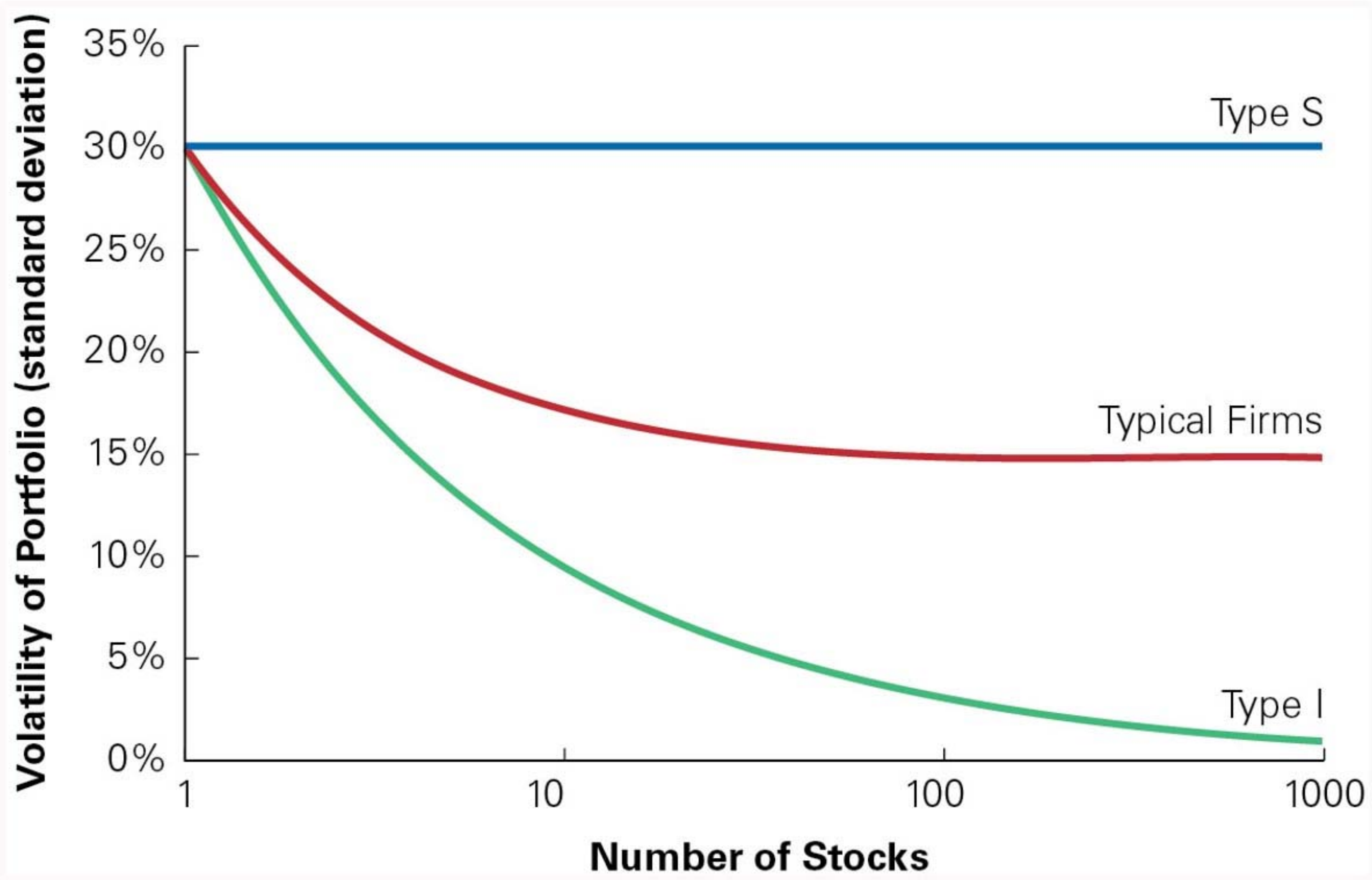
10.6 Diversification in Stock Portfolios (6 of 7)

- Firm-Specific Versus Systematic Risk
  - Consider two types of firms:
    - Type I firms are affected only by firm-specific risks
      - Their returns are equally likely to be 35% or –25%, based on factors specific to each firm's local market
      - Because these risks are firm specific, if we hold a portfolio of the stocks of many type I firms, the risk is diversified

10.6 Diversification in Stock Portfolios (7 of 7)

- Firm-Specific Versus Systematic Risk
  - Actual firms are affected by both market-wide risks and firm-specific risks
  - When firms carry both types of risk, only the unsystematic risk will be diversified when many firm's stocks are combined into a portfolio
  - The volatility will therefore decline until only the systematic risk remains

Figure 10.8 Volatility of Portfolios of Type S and I Stocks



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Textbook Example 10.6 (1 of 2)

Portfolio Volatility

- **Problem**
  - What is the volatility of the average return of ten type S firms? What is the volatility of the average return of ten type I firms?

Textbook Example 10.6 (2 of 2)

Solution

Type S firms have equally likely returns of 40% or −20%. Their expected return is

$$\frac{1}{2}(40\%)+\frac{1}{2}(-20\%)=10\%,\ \text{so} \qquad SD(R_S)=\sqrt{\frac{1}{2}(0.40-0.10)^2+\frac{1}{2}(-0.20-0.10)^2}=30\%$$

Because all type S firms have high or low returns at the same time, the average return of ten type S firms is also 40% or −20%. Thus, it has the same volatility of 30%, as shown in Figure 10.8.Type I firms have equally likely returns of 35% or −25%. Their expected return is

$$\frac{1}{2}(35\%)+\frac{1}{2}(-25\%)=5\%,\ \text{so} \qquad SD(R_1)=\sqrt{\frac{1}{2}(0.35-0.05)^2+\frac{1}{2}(-0.25-0.05)^2}=30\%$$

Because the returns of type I firms are independent, using Eq. 10.8, the average return of 10 type I firms has volatility of

$30\% \div \sqrt{10}=9.5\%,$ as shown in Figure 10.8.

No Arbitrage and the Risk Premium (1 of 4)

- **The risk premium for diversifiable risk is zero, so investors are not compensated for holding firm-specific risk**
  – If the diversifiable risk of stocks were compensated with an additional risk premium, then investors could buy the stocks, earn the additional premium, and simultaneously diversify and eliminate the risk

No Arbitrage and the Risk Premium (2 of 4)

- By doing so, investors could earn an additional premium without taking on additional risk
- This opportunity to earn something for nothing would quickly be exploited and eliminated
- Because investors can eliminate firm-specific risk "for free" by diversifying their portfolios, they will not require or earn a reward or risk premium for holding it

No Arbitrage and the Risk Premium (3 of 4)

- **The risk premium of a security is determined by its systematic risk and does not depend on its diversifiable risk**
  - This implies that a stock's volatility, which is a measure of total risk (that is, systematic risk plus diversifiable risk), is not especially useful in determining the risk premium that investors will earn

No Arbitrage and the Risk Premium (4 of 4)

- Standard deviation is not an appropriate measure of risk for an individual security
- There should be no clear relationship between volatility and average returns for individual securities
- Consequently, to estimate a security's expected return, we need to find a measure of a security's systematic risk

Textbook Example 10.7 (1 of 2)

Diversifiable Versus Systematic Risk

Problem

Which of the following risks of a stock are likely to be firm-specific, diversifiable risks, and which are likely to be systematic risks? Which risks will affect the risk premium that investors will demand?

a. The risk that the founder and CEO retires

b. The risk that oil prices rise, increasing production costs

c. The risk that a product design is faulty and the product must be recalled

d. The risk that the economy slows, reducing demand for the firm's products

Textbook Example 10.7 (2 of 2)

Solution

Because oil prices and the health of the economy affect all stocks, risks (b) and (d) are systematic risks. These risks are not diversified in a large portfolio, and so will affect the premium that investors require to invest in a stock. Risks (a) and (c) are firm-specific risks, and so are diversifiable. While these risks should be considered when estimating a firm's future cash flows, they will not affect the risk premium that investors will require and, therefore, will not affect a firm's cost of capital.

10.7 Measuring Systematic Risk (1 of 4)

- To measure the systematic risk of a stock, determine how much of the variability of its return is due to systematic risk versus unsystematic risk
  - To determine how sensitive a stock is to systematic risk, look at the average change in the return for each 1% change in the return of a portfolio that fluctuates solely due to systematic risk

10.7 Measuring Systematic Risk (2 of 4)

- Efficient Portfolio
  - A portfolio that contains only systematic risk
  - There is no way to reduce the volatility of the portfolio without lowering its expected return
- Market Portfolio
  - An efficient portfolio that contains all shares and securities in the market
    - The S&P 500 is often used as a proxy for the market portfolio

10.7 Measuring Systematic Risk (3 of 4)

- Sensitivity to Systematic Risk: Beta (β)
  - *Beta of a security is the expected % change in its return for a 1% change in the return of the market portfolio.*
    - Beta differs from volatility. Volatility measures total risk (systematic plus unsystematic risk), while beta is a measure of only systematic risk

Textbook Example 10.8 (1 of 2)

Estimating Beta

Problem

Suppose the market portfolio tends to increase by 47% when the economy is strong and decline by 25% when the economy is weak. What is the beta of a type S firm? What is the beta of a type I firm?

Textbook Example 10.8 (2 of 2)

Solution

The systematic risk of the strength of the economy produces a $47\% - (-25\%) = 72\%$ change in the return of the market portfolio. The type S firm's return changes by $40\% - (-20\%) = 60\%$ on average. Thus the firm's beta is $\beta_s = \dfrac{60\%}{72\%} = 0.833.$

That is, each 1% change in the return of the market portfolio leads to a 0.833% change in the type S firm's return on average.

The return of a type I firm has only firm-specific risk, however, and so is not affected by the strength of the economy. Its return is affected only by factors specific to the firm. Because it will have the same excepted return, whether the economy is strong or weak, $\beta_1 = \dfrac{0\%}{72\%} = 0.$

Table 10.6 Betas with Respect to the S&P 500 for Individual Stocks (Based on Monthly Data for 2013–2018) (1 of 4)

Company	**Ticker**	**Industry**	**Equity Beta**
Edison International	EIX	Utilities	0.15
Tyson Foods	TSN	Packaged Foods	0.19
Newmont Mining	NEM	Gold	0.31
The Hershey Company	HSY	Packaged Foods	0.33
Clorox	CLX	Household Products	0.34
Walmart	WMT	Superstores	0.55
Procter & Gamble	PG	Household Products	0.55
McDonald's	MCD	Restaurants	0.63
Nike	NKE	Footwear	0.64
Pepsico	PEP	Soft Drinks	0.68
Williams-Sonoma	WSM	Home Furnishing Retail	0.71
Coca-Cola	KO	Soft Drinks	0.73
Johnson & Johnson	JNJ	Pharmaceuticals	0.73

Table 10.6 Betas with Respect to the S&P 500 for Individual Stocks (Based on Monthly Data for 2013–2018) (2 of 4)

Company	Ticker	Industry	Equity Beta
Macy's	M	Department Stores	0.75
Molson Coors Brewing	TAP	Brewers	0.78
Starbucks	SBUX	Restaurants	0.80
Foot Locker	FL	Apparel Retail	0.83
Harley-Davidson	HOG	Motorcycle Manufacturers	0.88
Pfizer	PFE	Pharmaceuticals	0.89
Sprouts Farmers Market	SFM	Food Retail	0.89
Philip Morris	PM	Tobacco	0.89
Intel	INTC	Semiconductors	0.93
Netflix	NFLX	Internet Retail	0.98
Kroger	KR	Food Retail	1.04
Microsoft	MSFT	Systems Software	1.04
Alphabet	GOOGL	Internet Software and Services	1.06

Source: Capital IQ

Table 10.6 Betas with Respect to the S&P 500 for Individual Stocks (Based on Monthly Data for 2013–2018) (3 of 4)

Company	Ticker	Industry	Equity Beta
eBay	EBAY	Internet Software and Services	1.11
Cisco Systems	CSCO	Communications Equipment	1.14
Southwest Airlines	LUV	Airlines	1.15
Apple	AAPL	Computer Hardware	1.24
salesforce.com	CRM	Application Software	1.25
Walt Disney	DIS	Movies and Entertainment	1.29
Marriott International	MAR	Hotels and Resorts	1.32
Amgen	AMGN	Biotechnology	1.37
Toll Brothers	TOL	Homebuilding	1.37
Wynn Resorts Ltd.	WYNN	Casinos and Gaming	1.38
Parker-Hannifin	PH	Industrial Machinery	1.43
Prudential Financial	PRU	Insurance	1.51
Nucor	NUE	Steel	1.57

Table 10.6 Betas with Respect to the S&P 500 for Individual Stocks (Based on Monthly Data for 2013–2018) (4 of 4)

Company	Ticker	Industry	Equity Beta
Amazon.com	AMZN	Internet Retail	1.62
General Motors	GM	Automobile Manufacturers	1.64
Autodesk	ADSK	Application Software	1.72
Hewlett-Packard	HPQ	Computer Hardware	1.77
Tiffany & Co.	TIF	Apparel and Luxury Goods	1.77
Brunswick	BC	Leisure Products	1.84
Chesapeake Energy	CHK	Oil and Gas Exploration	1.85
Netgear	NTGR	Communications Equipment	1.94
Ethan Allen Interiors	ETH	Home Furnishings	2.04
Trimble	TRMB	Electronic Equipment	2.44
Advanced Micro Devices	AMD	Semiconductors	2.83

Source: Capital IQ

10.7 Measuring Systematic Risk (4 of 4)

- Interpreting Beta (β)
  - A security's beta is related to how sensitive its underlying revenues and cash flows are to general economic conditions
  - Stocks in cyclical industries are likely to be more sensitive to systematic risk and have higher betas than stocks in less sensitive industries

10.8 Beta and the Cost of Capital (1 of 3)

- Estimating the Risk Premium
  - Market risk premium
    - The market risk premium is the reward investors expect to earn for holding a portfolio with a beta of 1

$$\text{Market Risk Premium} = E\left[R_{Mkt}\right] - r_f$$

10.8 Beta and the Cost of Capital (2 of 3)

- Adjusting for Beta
  - Estimating a Traded Security's Cost of Capital of an investment from Its Beta

$$
\begin{aligned}
E[R] &= \text{Risk-Free Interest Rate} + \text{Risk Premium} \\
&= r_f + \beta \times (E[R_{Mkt}] - r_f)
\end{aligned}
$$

Textbook Example 10.9 (1 of 2)

Expected Returns and Beta

Problem

Suppose the risk-free rate is 5% and the economy is equally likely to be strong or weak. Use Eq. 10.11 to determine the cost of capital for the type S firms considered in Example 10.8. How does this cost of capital compare with the expected return for these firms?

Textbook Example 10.9 (2 of 2)

Solution

If the economy is equally likely to be strong or weak, the expected return of the market $E[R_{Mkt}] = \frac{1}{2}(0.47) + \frac{1}{2}(-0.25) = 11\%$

and the market risk premium is $E[R_{Mkt}] - r_f = 11\% - 5\% = 6\%$.

Given the beta of 0.833 for type S firms that we calculated in Example 10.8, the estimate of the cost of capital for type S firms from Eq. 10.11 is

$$r_S = r_f + \beta_S \times (E[R_{Mkt}] - r_f) = 5\% + 0.833 \times (11\% - 5\%) = 10\%$$

This matches their expected return: $\frac{1}{2}(40\%) + \frac{1}{2}(-20\%) = 10\%$.

Thus, investors who hold these stocks can expect a return that appropriately compensates them for the systematic risk they are bearing by holding them (as we should expect in a competitive market).

10.8 Beta and the Cost of Capital (3 of 3)

- Equation 10.11 is often referred to as the **Capital Asset Pricing Model (CAPM)**
  - It is the most important method for estimating the cost of capital that is used in practice

$$E[R] = \text{Risk-Free Interest Rate} + \text{Risk Premium}$$
$$= r_f + \beta \times (E[R_{Mkt}] - r_f)$$

Pearson