Fundamentals of Corporate Finance, 2/e

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Chapter 7: Risk and Return

Learning Objectives

1. EXPLAIN THE RELATION BETWEEN RISK AND RETURN.
2. DESCRIBE THE TWO COMPONENTS OF A TOTAL HOLDING PERIOD RETURN, AND CALCULATE THIS RETURN FOR AN ASSET.
3. EXPLAIN WHAT AN EXPECTED RETURN IS AND CALCULATE THE EXPECTED RETURN FOR AN ASSET.

Learning Objectives

4. EXPLAIN WHAT THE STANDARD DEVIATION OF RETURNS IS AND WHY IT IS VERY USEFUL IN FINANCE AND CALCULATE IT FOR AN ASSET.
5. EXPLAIN THE CONCEPT OF DIVERSIFICATION.
6. DISCUSS WHICH TYPE OF RISK MATTERS TO INVESTORS AND WHY.

Learning Objectives

7. DESCRIBE WHAT THE CAPITAL ASSET PRICING MODEL (CAPM) TELLS US AND HOW TO USE IT TO EVALUATE WHETHER THE EXPECTED RETURN OF AN ASSET IS SUFFICIENT TO COMPENSATE AN INVESTOR FOR THE RISKS ASSOCIATED WITH THAT ASSET.

Risk and Return

- PEOPLE DO NOT WANT TO LOSE MONEY
  - **Why would a person choose an investment with a higher risk of loss when there is a lower-risk opportunity available?**

Risk and Return

- PEOPLE DO NOT WANT TO LOSE MONEY
  - **A person will prefer a higher-risk opportunity if the probability of an adequate reward is high enough**

    A higher-risk investment must offer a potential return high enough to make it as attractive as the lower-risk alternative.

    The potential return a person requires depends on the amount of risk – the probability of being dissatisfied with an outcome.

Risk and Return

- RISK/RETURN RELATIONSHIP
  - **The higher the risk, the higher the required rate-of-return (possible/expected return)**

    This is the risk/return relationship.

Risk and Return

- INSIGHT INTO THE RISK/RETURN RELATIONSHIP
  - **Most people are risk averse – they do not like risk**
  - **People vary in their risk tolerance –the amount of risk they will accept**

Risk and Return

- INSIGHT INTO THE RISK/RETURN RELATIONSHIP
  - **An optimal combination of risk and return is the highest expected return for a given amount of risk**
  - **An optimal combination of risk and return is the lowest level of risk for a given expected return**

Risk and Return

- RISK
  - default
  - misuse
  - slow pay
  - theft
- RISK
  - cost increase
  - price decline
  - missed opportunity
  - not enough
  - ….. many others

Risk and Return

- RETURN
  - **Refers to expected return.**

    "Expected" means there is some uncertainty about what the return will actually be.

    - *"I expect to earn around 9%."*
  - **The higher the risk, the higher the required rate of (expected) return**

Quantitative Measures of Return

- EXPECTED RETURN AND REALIZED RETURN
  - **Expected return**

    estimated or predicted before the outcome is known
  - **Realized return**

    calculated after the outcome is known
    - *Both are important in financial decision-making.*

Quantitative Measures of Return

- HOLDING PERIOD RETURN
  - **Total holding period return consists of capital appreciation (R_{ca}) and income (R_i)**

$$R_{ca} = \frac{capital\ appreciation}{initial\ price} = \frac{P_1 - P_0}{P_0} = \frac{\Delta P}{P_0}$$

$$R_i = \frac{cash\ flow}{initial\ price} = \frac{CF_1}{initial\ price} = \frac{CF_1}{P_0}$$

Quantitative Measures of Return

- TOTAL HOLDING PERIOD RETURN

$$R_t = R_{ca} + R_i = \frac{\Delta P}{P_0} + \frac{CF_1}{P_0} = \frac{\Delta P + CF_1}{P_0} \qquad (7.1)$$

Quantitative Measures of Return

- TOTAL HOLDING PERIOD RETURN EXAMPLE
  - **Ella buys a stock for $26.00. After one year, the stock price is $29.00 and she receives a dividend of $0.80. What is her return for the period?**

$$R_t = R_{ca} + R_i = \frac{\Delta P + CF_1}{P_0}$$

$$= \frac{(\$29.00 - \$26.00) + \$0.80}{\$26.00}$$

$$= \frac{\$3.80}{\$26.00} = 0.14615 \; or \; 14.62\%$$

Quantitative Measures of Return

- EXPECTED RETURN
  - **$E(R_{Asset})$, is the weighted average of the possible investment returns. Multiply each return by the probability that it will occur, then add.**

$$E(R_{asset}) = \sum_{i=1}^{n}(p_i \times R_i) = (p_1 \times R_1) + (p_2 \times R_2) + \ldots + (p_n \times R_n) \quad (7.2)$$

Quantitative Measures of Return

- EXPECTED RETURN EXAMPLE
  - **There is 30% chance the total return on Dell stock will be -3.45%, a 30% chance it will be +5. 17% , a 30% chance it will be +12.07% and a 10% chance that it will be +24.14%. Calculate the expected return.**

$$E(R_{Dell}) = [.30 \times (-0.0345)] + (.30 \times 0.0517)$$

$$+ (.30 \times 0.1207) + (.10 \times 0.2414)$$

$$= -0.010305 + 0.01551 + 0.03621 + 0.02414$$

$$= 0.0655 \; or \; 6.55\%$$

Quantitative Measures of Return

- EXPECTED RETURN
  - **If each possible outcome is equally likely ($p_1 = p_2 = p_3 = \ldots = p_n = p = 1/n$), the expected return formula reduces to**

$$E(R_{asset}) = \frac{\sum_{i=1}^{n}(R_i)}{n} = \frac{R_1 + R_2 + R_3 + \ldots + R_n}{n}$$

Variance and Standard Deviation as Measures of Risk

- CALCULATE VARIANCE
  1. **Square the difference between each possible outcome and the mean**
  2. **Multiply each squared difference by its probability of occurring**
  3. **Add**

$$Var(R) = \sigma_R^2 = \sum_{i=1}^{n} \left\{ p_i \times \left[R_i - E(R) \right]^2 \right\} \qquad (7.3)$$

Variance and Standard Deviation as Measures of Risk

- CALCULATE VARIANCE
  - **If all possible outcomes are equally likely, the formula becomes**

$$\sigma_R^2 = \frac{\sum_{i=1}^{n} [R_i - E(R)]^2}{n}$$

Variance and Standard Deviation as Measures of Risk

- CALCULATE STANDARD DEVIATION
  - **Standard deviation is the square root of the variance**

$$\sqrt{\sigma_R^2} = \sigma$$

Variance and Standard Deviation as Measures of Risk

- VARIANCE AND STANDARD DEVIATION
  - **Variance and Standard Deviation for Dell Stock**

$$
\begin{aligned}
\sigma^2_{Dell} &= \left[.30 \times (-0.0345 - .0655)^2\right] + \left[.30 \times (0.0517 - 0.0655)^2\right] \\
&\quad + \left[.30 \times (0.1207 - 0.0655)^2\right] + \left[.10 \times (0.2414 - 0.0655)^2\right] \\
&= 0.0030 + 0.0009 + 0.00006 + 0.0031 \\
&= 0.0071 \\
\sigma_{Dell} &= \sqrt{0.0071} = 0.084
\end{aligned}
$$

Variance and Standard Deviation as Measures of Risk

- NORMAL DISTRIBUTION
  - **A symmetric distribution completely described by its mean (average) and standard deviation**

    Completely described by its mean and standard deviation says they are all we need to draw conclusions about its shape and the location of items in the distribution.

Variance and Standard Deviation as Measures of Risk

- NORMAL DISTRIBUTION
  - **Mean (average) is at the center**
  - **Areas to the left and right of the mean are mirror images of each other**
  - **Values less than the mean are on the left and values greater than the mean are on the right**

Variance and Standard Deviation as Measures of Risk

- NORMAL DISTRIBUTION
  - **The mean is the reference point to which all other values in the distribution are compared**
  - **To use standard deviation as a distance measure, consider how many standard deviations are between a value in the distribution and the mean**

Variance and Standard Deviation as Measures of Risk

- STANDARD DEVIATION
  - **For a normal distribution, the standard deviation tells us, based on what has happened in the past, the probability that an outcome will occur**

Variance and Standard Deviation as Measures of Risk

- STANDARD DEVIATION
  - **Is used in a context similar to "The average return on the S&P 500 is 3%. What is the probability of it being between 3% and 1%?"**

    When the difference between 3% and 1% is converted to a standard deviation, it becomes a distance.

Variance and Standard Deviation as Measures of Risk

- STANDARD DEVIATION
  - **For a normal distribution, the standard deviation distance between 3% and 1% is the same as between 3% and 5%**
  - **Outcomes that occur most often are closest to the mean – convert to fewer standard deviations. Outcomes that rarely occur are farthest from the mean – convert to more standard deviations**

Variance and Standard Deviation as Measures of Risk

- STANDARD DEVIATION
  - **A unit of measure or distance**

    "Forty-three percent of the time, the number is more than the average but less than 62."
  - **A measure of frequency**

    "A professional makes that putt more than 99% of the time."

Variance and Standard Deviation as Measures of Risk

- STANDARD DEVIATION
  - **For a normal distribution, a standard deviation is associated with the probability that an outcome occurs within a certain distance from the mean**

Variance and Standard Deviation as Measures of Risk

- STANDARD DEVIATION
  - **For a normal distribution**

    90% of outcomes are not more than 1.645 standard deviations from the mean

    95% of outcomes are not more than 1.960 standard deviations from the mean

    99% of outcomes are not more than 2.575 standard deviations from the mean

Normal Distribution

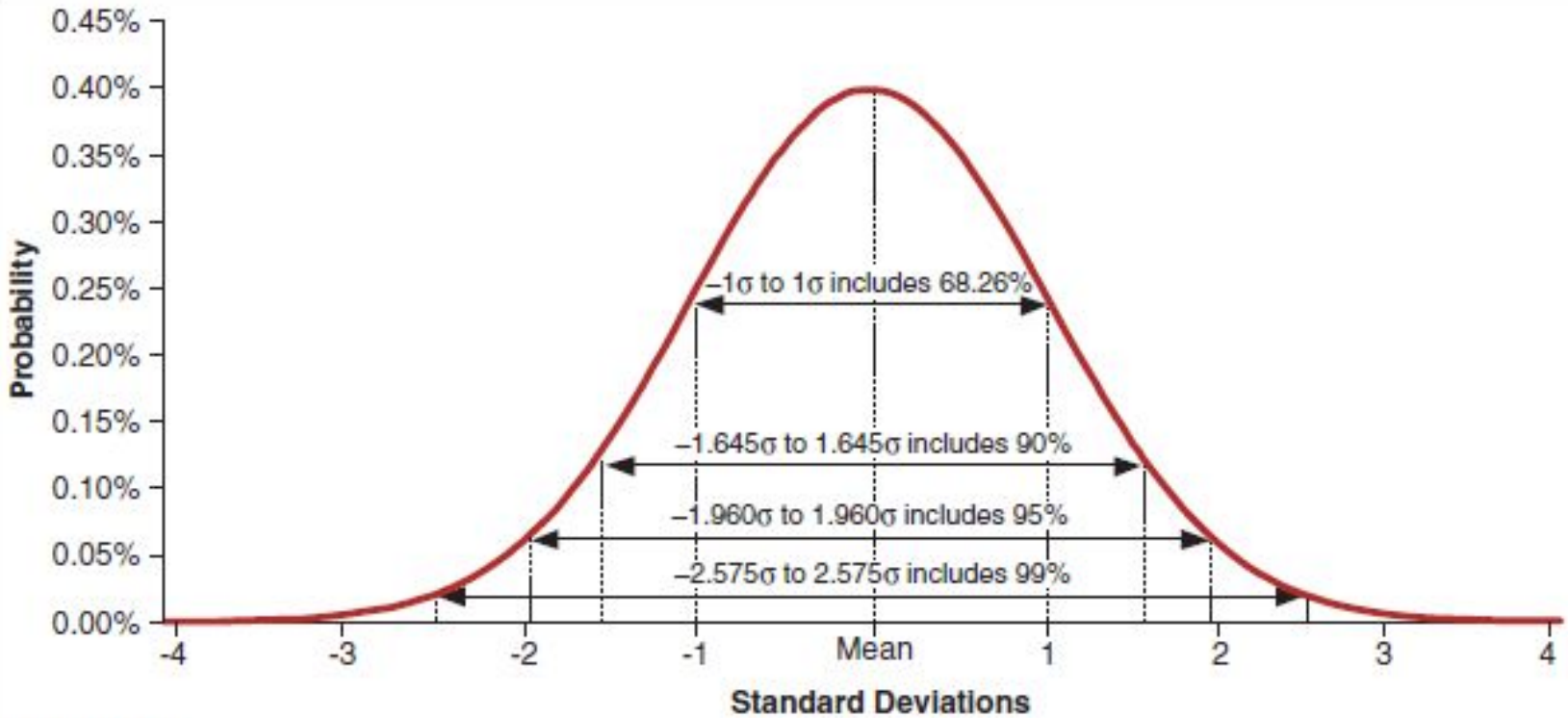


EXHIBIT 7.1
Normal Distribution

The normal distribution is a symmetric distribution that is completely described by its mean and standard deviation. The mean is the value that defines the center of the distribution, and the standard deviation, σ, describes the dispersion of the values centered around the mean.

Standard Deviation and Width of the Normal Distribution

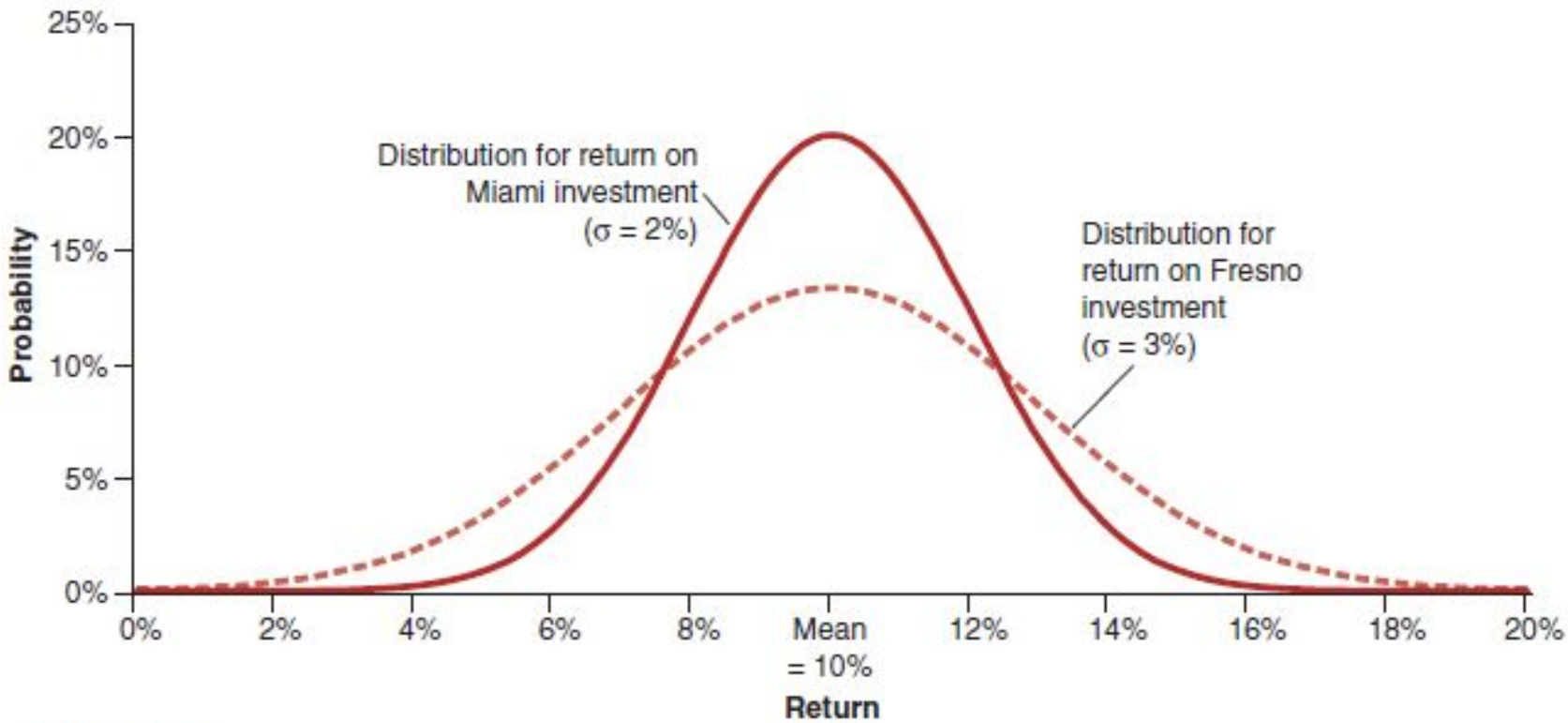


EXHIBIT 7.2

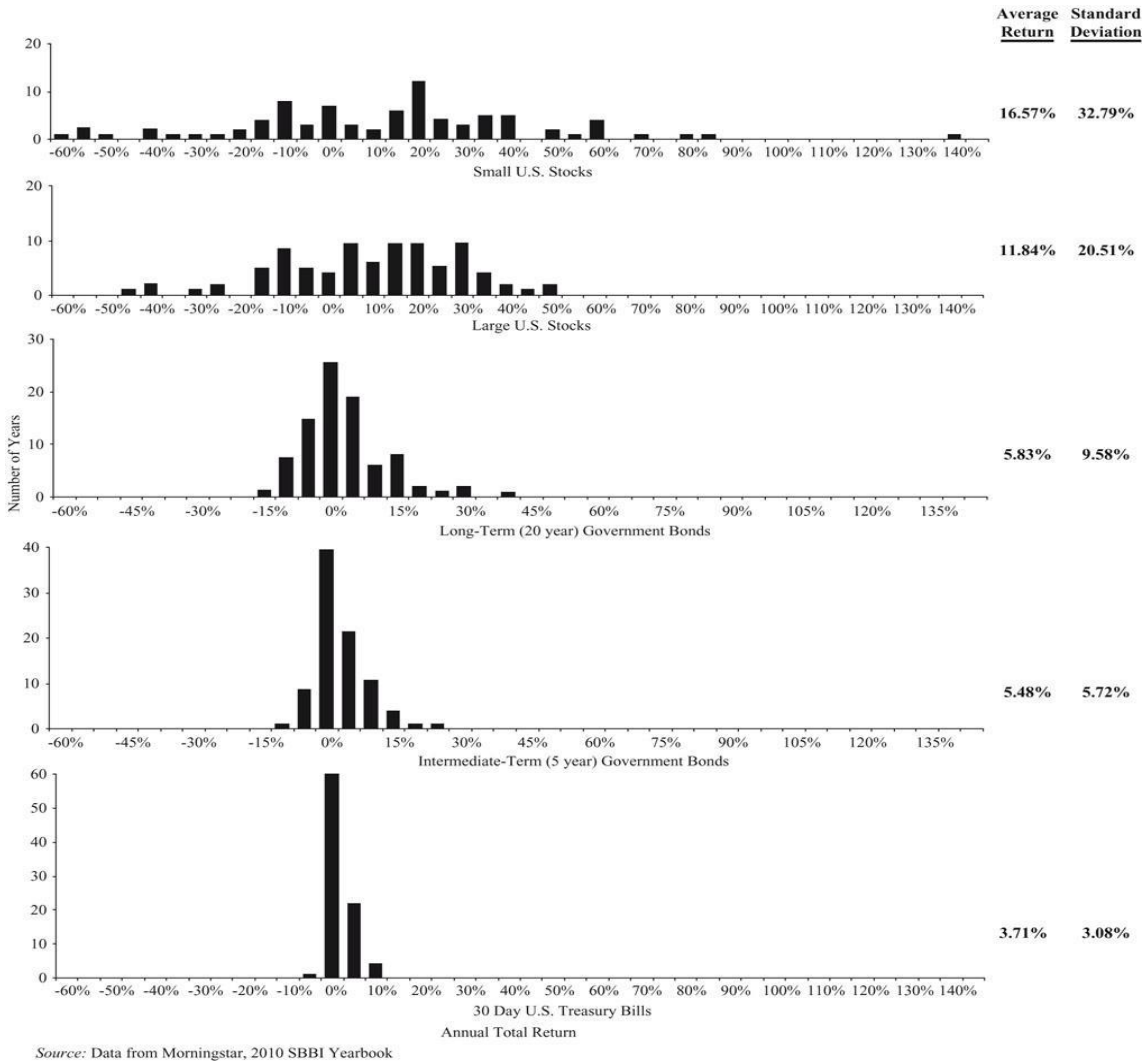
Standard Deviation and Width of the Normal Distribution

The larger standard deviation for the return on the Fresno investment means that the Fresno investment is riskier than the Miami investment. The actual return for the Fresno investment is more likely to be further from its expected return.

Variance and Standard Deviation as Measures of Risk

- HISTORICAL MARKET PERFORMANCE
  - **On average, annual returns have been higher for riskier securities**
  - **Exhibit 7.3 shows that small stocks have the largest standard deviation of returns and the largest average return**
  - **On other end of spectrum, Treasury bills have the smallest standard deviation and the smallest average return**

Distributions of Annual Total Returns for U.S. Stocks & Bonds



Monthly Returns for Apple Inc. Stock and the S&P 500 Index

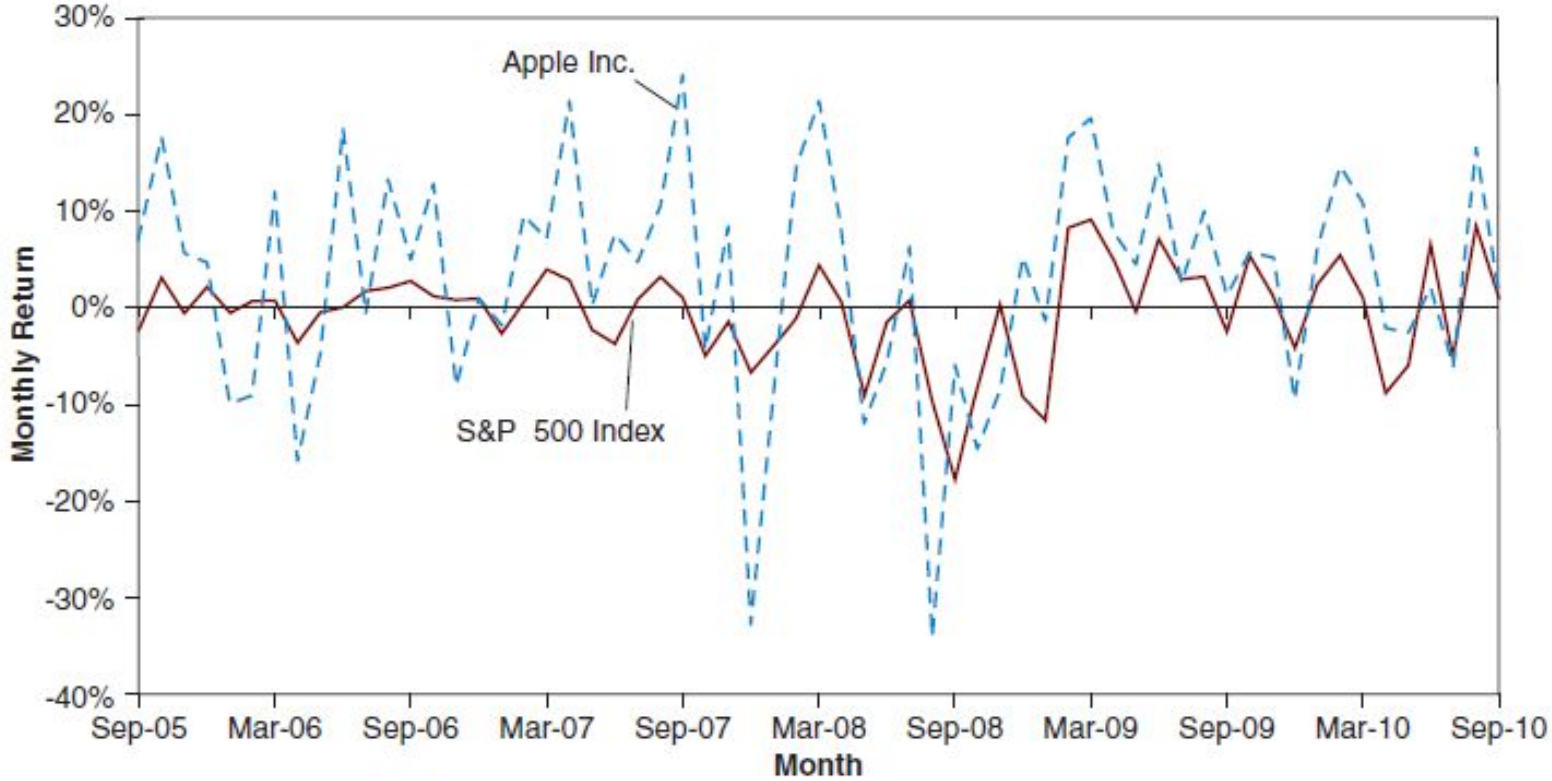


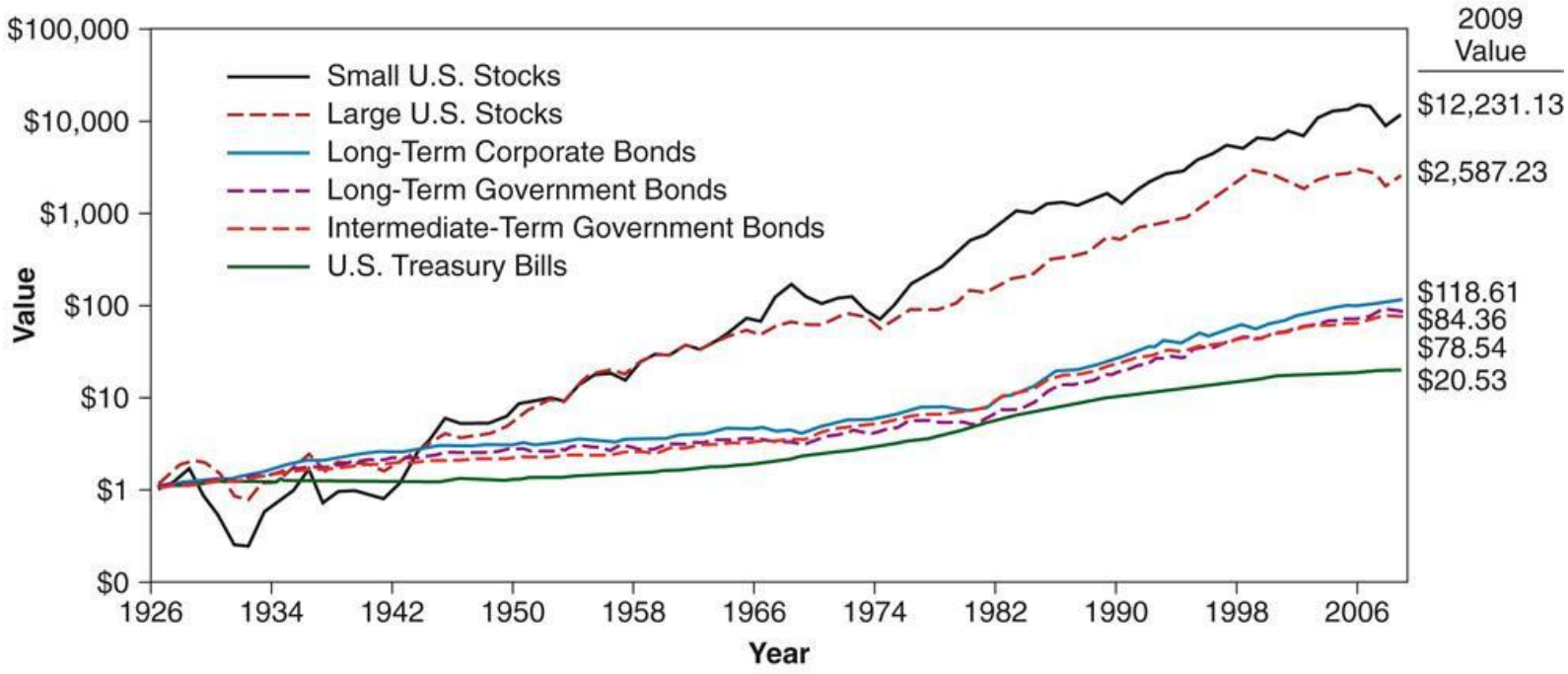
EXHIBIT 7.4

Monthly Returns for Apple Inc. stock and the S&P 500 Index from September 2005 through September 2010

The returns on shares of individual stocks tend to be much more volatile than the returns on portfolios of stocks, such as the S&P 500.

Cumulative Value of $1 Invested in 1926

Exhibit 7.5



Risk and Diversification

- DIVERSIFICATION
  - **By investing in two or more assets whose returns do not always move in same direction at the same time, investors can reduce the risk in their investment portfolios**

Risk and Diversification

- SINGLE-ASSET PORTFOLIOS
  - **Returns for individual stocks are largely independent of each other and approximately normally distributed. A simple tool for comparing risk and return for individual stocks is the coefficient of variation (CV).**

$$CV_i = \frac{\sigma_{Ri}}{E(R_i)} \qquad (7.4)$$

Risk and Diversification

- COEFFICIENT OF VARIATION EXAMPLE
  - **Stock A has an expected return of 12% and a standard deviation of 12% while Stock B has an expected return of 16% and a standard deviation of 20%. What is the coefficient of variation for these stocks?**

$$CV(R_A) = \frac{0.12}{0.12} = 1$$

$$CV(R_B) = \frac{.16}{.20} = .75$$

Risk and Diversification

- SHARPE RATIO
  - **A modified version of the coefficient of variation**

$$Sharpe\,Ratio = S = \frac{E(R_i) - R_{rf}}{\sigma_{Ri}} \qquad (7.5)$$

Risk and Diversification

- PORTFOLIOS OF MORE THAN ONE ASSET
  - **The coefficient of variation and Sharpe Ratio have a critical shortcoming when applied to a portfolio of assets – they cannot account for the interaction of assets' risks when they are grouped into a portfolio**
  - **Expected return for portfolio made up of two assets**

$$E(R_{Portfolio}) = x_1 E(R_1) + x_2 E(R_2)$$

Risk and Diversification

- PORTFOLIOS WITH MORE THAN ONE ASSET
  - **Expected return for portfolio made up of multiple assets**

$$E(R_{Portfolio}) = \sum_{i=1}^{n}[(x_i \times E(R_i)] = [(x_1 \times E(R_1)] + [(x_2 \times E(R_2)] + \ldots$$

$$+ [(x_n \times E(R_n)] \qquad (7.6)$$

Risk and Diversification

- EXPECTED RETURN FOR PORTFOLIO EXAMPLE
  - **A portfolio consists of $100,000 in Treasury bills that yield 4.5%; $150,000 in Proctor and Gamble stock with an expected return of 7.5%; and $150,000 in Exxon Mobil stock with an expected return of 9.0%. What is the expected return for this $400,000 portfolio?**

Risk and Diversification

- EXPECTED RETURN FOR PORTFOLIO EXAMPLE

$$x_{TB} = \frac{\$100{,}000}{\$400{,}000} = 0.25$$

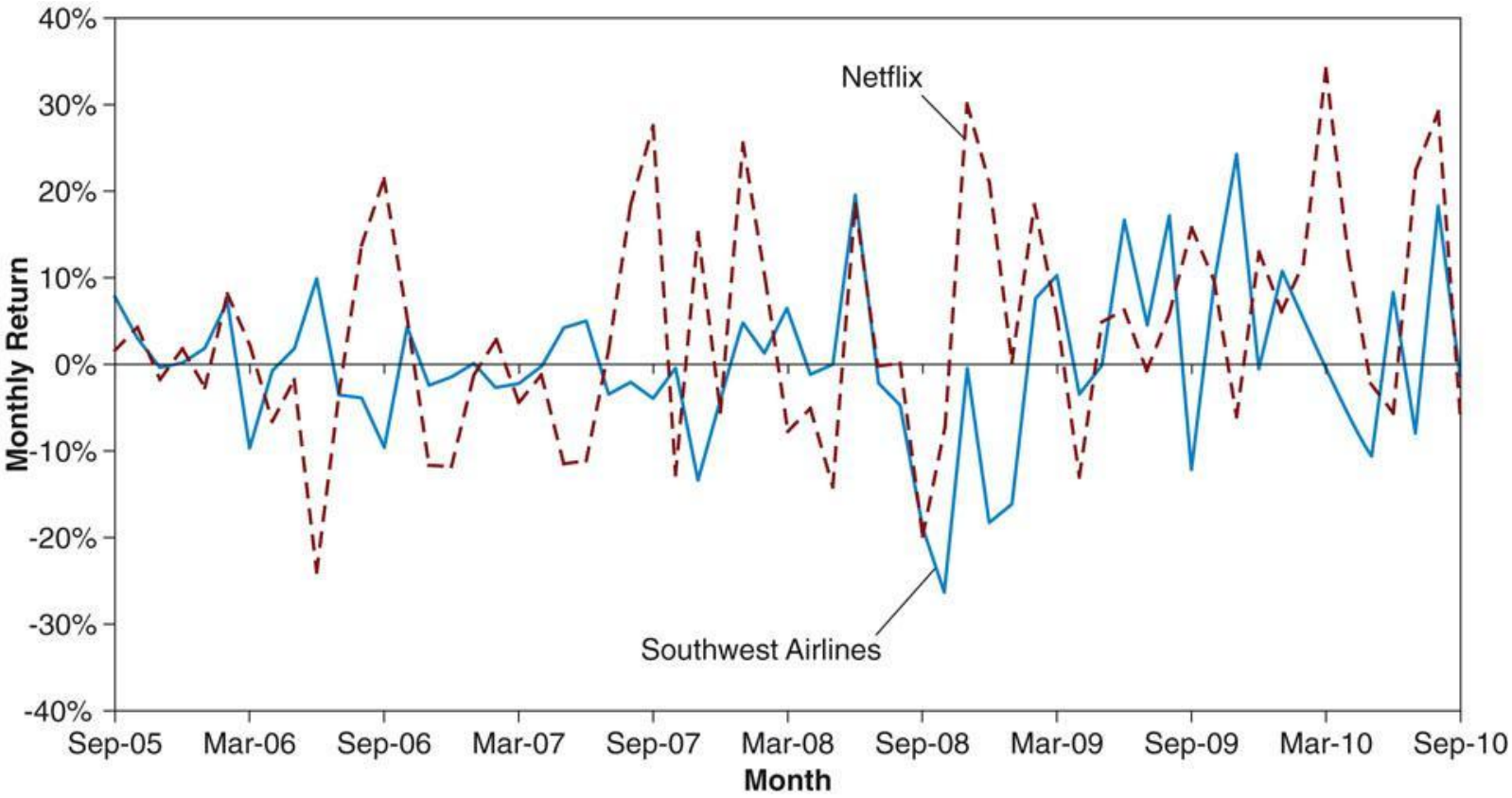
$$x_{P\&G} = x_{EM} = \frac{\$150{,}000}{\$400{,}000} = 0.375$$

$$E(R_{Portfolio}) = (0.25 \times 0.045) + (0.375 \times 0.075) + (0.375 \times 0.90)$$

$$= 0.0731 \, or \, 7.3\%$$

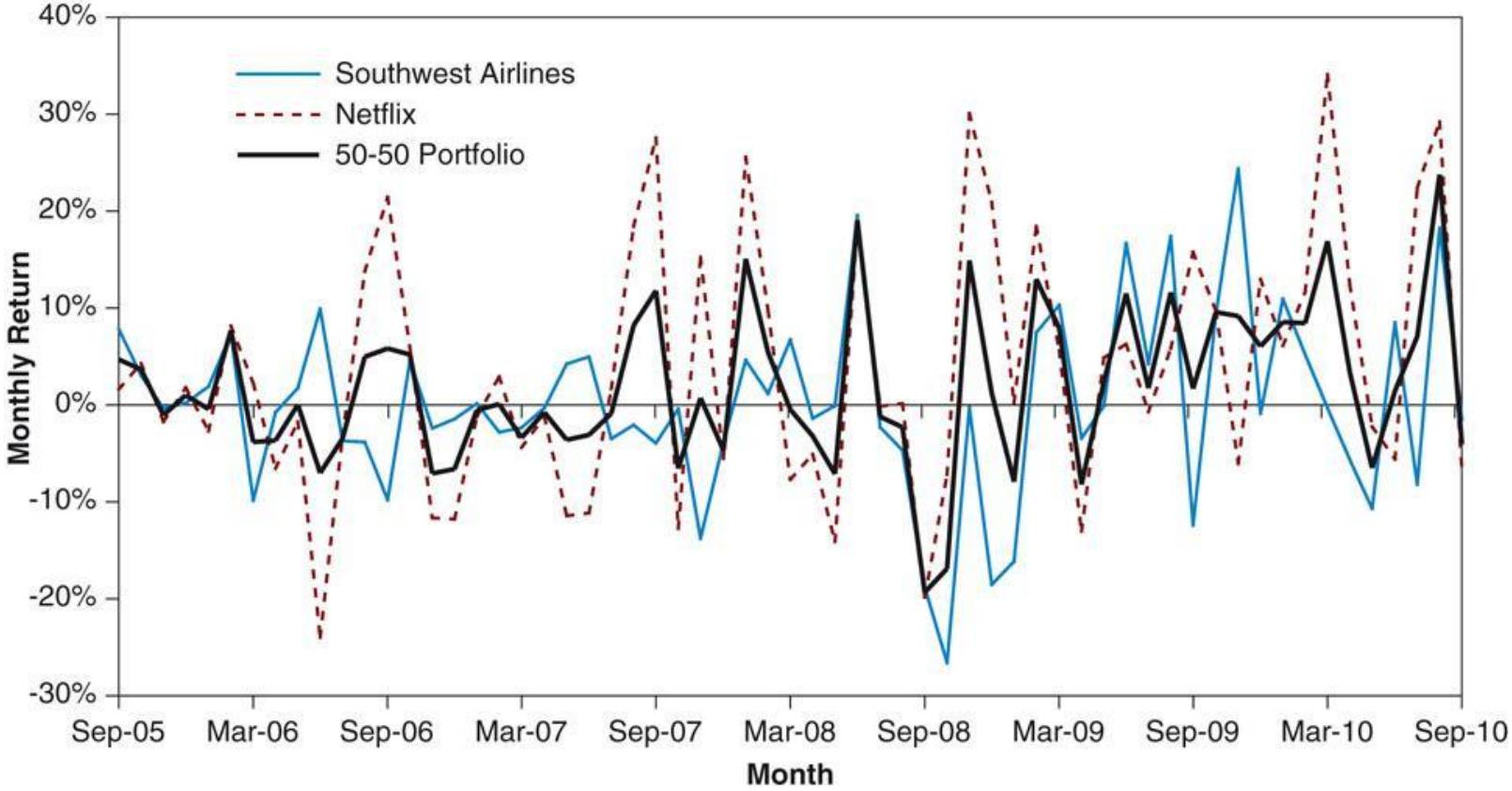
Monthly Returns for Netflix & Southwest Airlines (1 of 2)

Exhibit 7.6



Monthly Returns for Netflix & Southwest Airlines (2 of 2)

Exhibit 7.7



Risk and Diversification

- PORTFOLIOS WITH MORE THAN ONE ASSET
  - **When stock prices move in opposite directions, the price change of one stock offsets some of the price change of another stock**

Risk and Diversification

- PORTFOLIOS WITH MORE THAN ONE ASSET
  - **Risk for a portfolio of two stocks is less than the average of the risks associated with the individual stocks. The portfolio's risk is**

$$\sigma^2_{2\,Asset\,Portfolio} = x_1^2\sigma^2_{R1} + x_2^2\sigma^2_{R2} + 2x_1x_2\sigma_{R1,2} \qquad (7.7)$$

Risk and Diversification

- PORTFOLIOS WITH MORE THAN ONE ASSET
  - **In the variance equation, $\sigma_{R1,2}$ is the covariance between stocks 1 and 2. Covariance indicates whether stocks' returns tend to move in the same direction at the same time. If so, the covariance is positive. If not, it is negative or zero.**

$$COV(R_1, R_2) = \left\{ \sum_{i=1}^{n} p_i \left[(R_{1,i} - E(R_1) \right] \times \left[(R_{2,i} - E(R_2) \right] \right\} \qquad (7.8)$$

Risk and Diversification

- PORTFOLIO VARIANCE EXAMPLE
  - **The variance of the annual returns of CSX and Wal-Mart stock are 0.03949 and 0.02584 respectively. The covariance between returns is 0.00782. Calculate the variance of a portfolio consisting of 50% CSX and 50% Wal-Mart.**

$$\sigma^2_{2\,Asset\,Portfolio} = x_1^2\sigma^2_{R1} + x_2^2\sigma^2_{R2} + 2x_1x_2\sigma_{R1,2}$$

$$= (0.5)^2(0.03949) + (0.5)^2(0.02584) + 2(0.5)(0.5)(0.00782)$$

$$= 0.02024$$

Risk and Diversification

- PORTFOLIOS WITH MORE THAN ONE ASSET
- **To measure the strength of the covariance relationship, divide the covariance by the product of the standard deviations of the assets' returns. This result is the correlation coefficient that measures the strength of the relationship between the assets' returns.**

$$\rho_{R1,2} = \frac{\sigma_{R1,2}}{\sigma_{R1}\sigma_{R2}} \qquad (7.9)$$

- CORRELATION COEFFICIENT EXAMPLE
  - **Correlation coefficient for the annual returns of CSX and Wal-Mart**

$$\sigma_{CSX} = \sqrt{0.03949} = 0.1987$$

$$\sigma_{WalMart} = \sqrt{0.02584} = 0.1607$$

$$\rho_{CSX,Walmart} = \frac{\sigma_{CSX,Walmart}}{\sigma_{CSX}\sigma_{WalMart}} = \frac{0.00782}{0.1987 \times 0.1607} = 0.2449$$

Risk and Diversification

- PORTFOLIOS WITH MORE THAN ONE ASSET
  - **A correlation coefficient cannot be greater than +1 or less than -1**

Risk and Diversification

- PORTFOLIOS WITH MORE THAN ONE ASSET
  - **Negative correlation**

    stock X is higher when stock Y is lower; stock X is lower when stock Y is higher
  - **Positive correlation**

    stock X is higher when stock Y is higher; stock X is lower when stock Y is lower
  - **Zero Correlation**

    no relationship or pattern linking returns on the stocks.

Risk and Diversification

- PORTFOLIOS WITH MORE THAN ONE ASSET
  - **If assets are not perfectly correlated, risk can be reduced by creating a portfolio using assets having different risk characteristics**
  - **For each asset, account for the covariance between that asset and every other asset in the portfolio**

Risk and Diversification

- LIMITS ON DIVERSIFICATION BENEFITS
  - **Adding an asset whose returns do not replicate the returns on an asset already in the portfolio will reduce the standard deviation of the portfolio returns**

    The amount by which the standard deviation of portfolio returns is reduced gets smaller with each asset added

Risk and Diversification

- LIMITS OF DIVERSIFICATION
  - **When the number of assets in a portfolio is large, adding another stock has almost no effect on the standard deviation**
  - **Most risk-reduction from diversification may be achieved with 15-20 assets**
  - **Diversification can virtually eliminate risk unique to individual assets, but the risk common to all assets in the market remains**

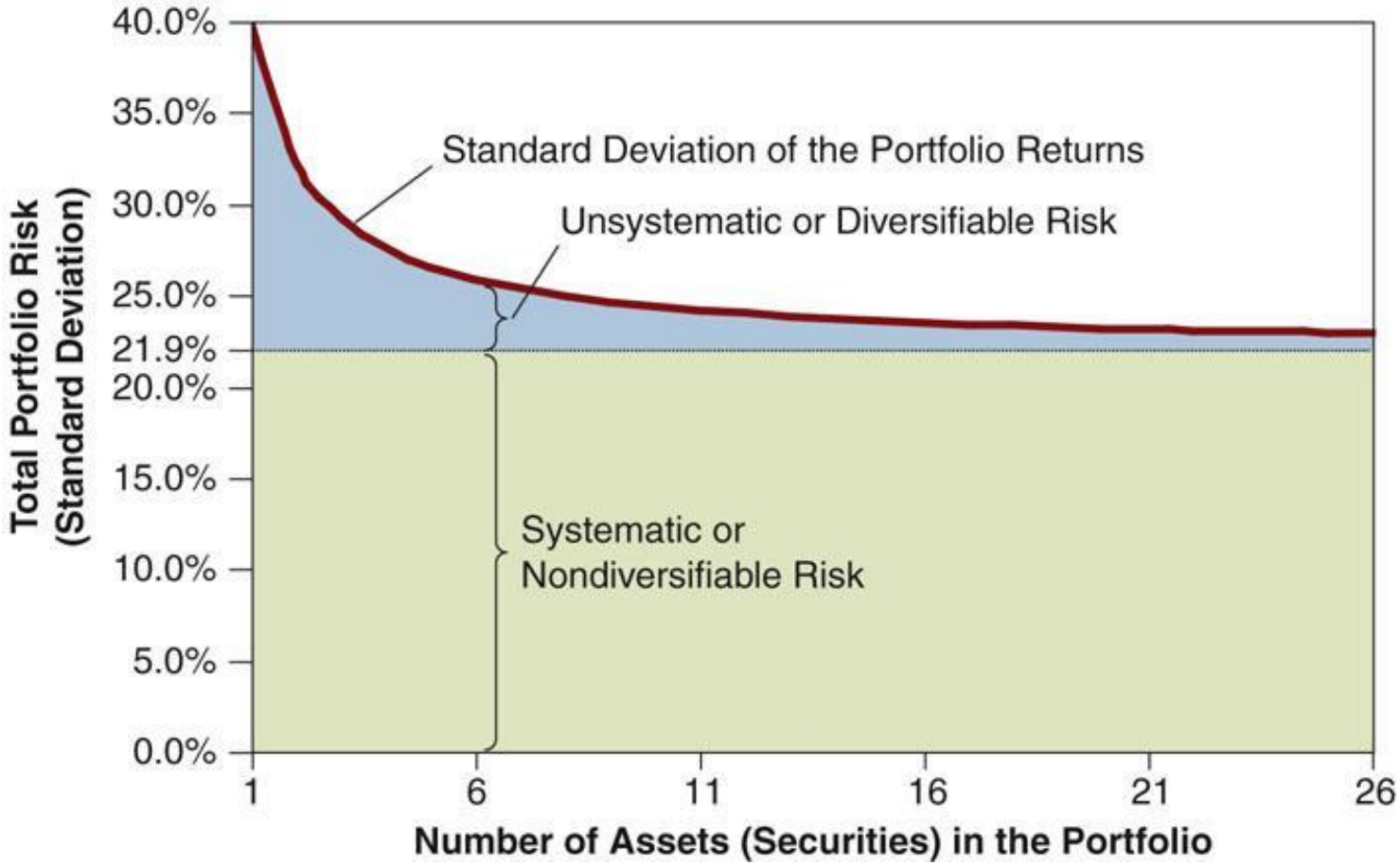
Risk and Diversification

- THE LIMITS OF DIVERSIFICATION
  - **Firm-specific risk relevant for a particular firm can be diversified away and is called diversifiable, unsystematic, or unique risk.**
  - **Risk that cannot be diversified away is non-diversifiable, or systematic risk. This is the risk inherent in the market or economy.**

    Firm-specific risk is, in effect, reduced to zero in a diversified portfolio but some systematic risk remains.

Total Risk in a Portfolio as the Number of Assets Increases

Exhibit 7.8



Systematic Risk

- WHY SYSTEMATIC RISK IS ALL THAT MATTERS
  - **Investors do not like risk and will not bear risk they can avoid by diversification**

    Well-diversified portfolios contain only systematic risk.

    Portfolios that are not well-diversified face systematic risk plus unsystematic risk.

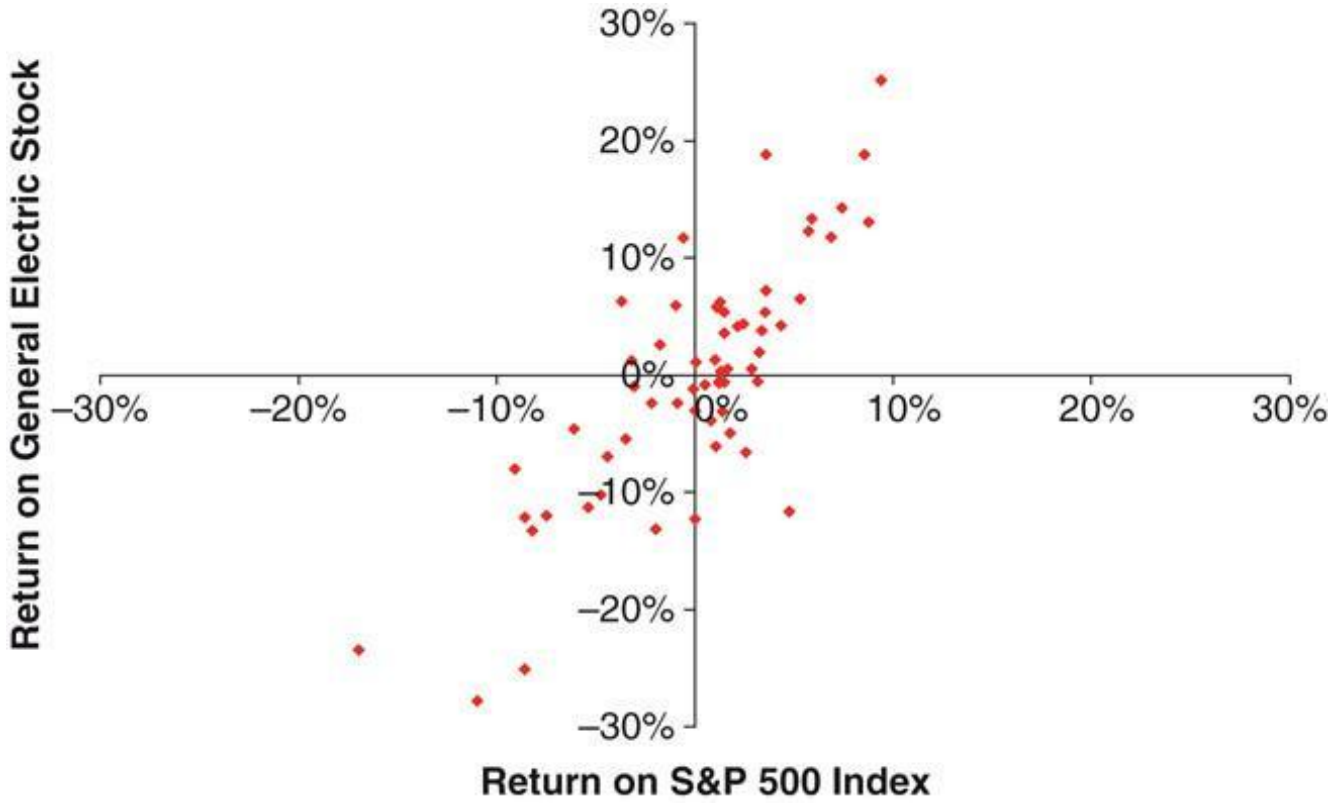
    No one compensates investors for bearing unsystematic risk, and investors will not accept risk that they are not paid to take.

Systematic Risk

- MEASURING SYSTEMATIC RISK
  - **Systematic risk of an individual asset depends on how the behavior of the market influences the return on that asset. Systematic risk cannot be eliminated by diversification.**
  - **Standard deviation measures total risk of an asset. It cannot be used to measure the risk of a diversified portfolio.**

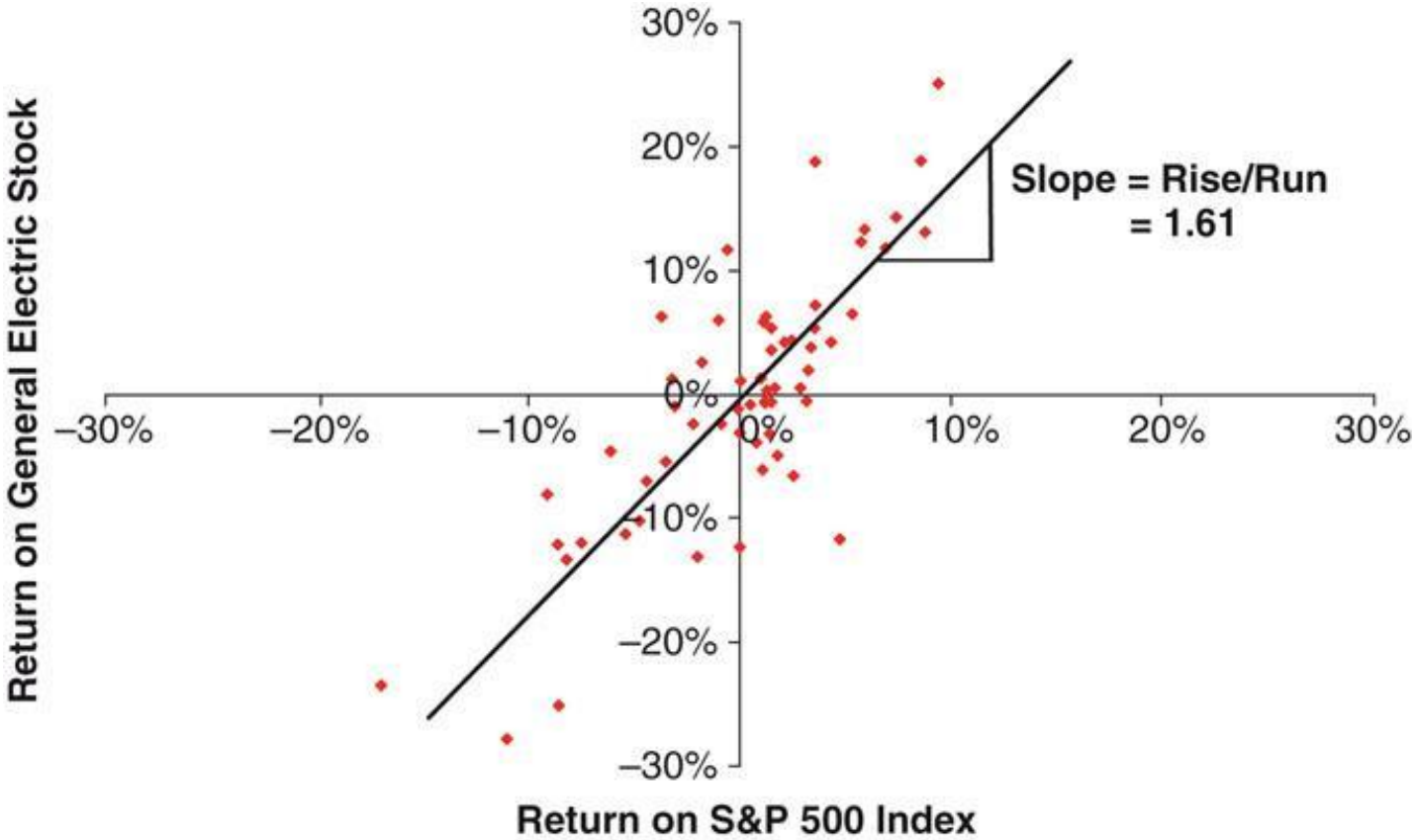
Monthly General Electric Company Stock and S&P 500 Index Returns

Exhibit 7.9



Slope of Relation Between GE Returns and S&P 500 Returns

Exhibit 7.10



Systematic Risk

- MEASURING SYSTEMATIC RISK
  - **If the average return for all assets (the market return) is used as the benchmark and its influence on the return for a specific stock can be quantified, the expected return on that stock can be calculated**
  - **The market's influence on a stock's return is quantified in the stock's beta**

Systematic Risk

- MEASURING SYSTEMATIC RISK
  - **If the beta of an asset is**

    zero, the market has no measurable effect on the asset's return

    positive, the market has a positive effect on the asset's return

    negative, the market has a negative effect on the asset's return

Systematic Risk

- MEASURING SYSTEMATIC RISK
  - **If the beta of an asset is**

    0, the asset has no measurable systematic risk

    > 1, the systematic risk for the asset is greater than the average for assets in the market

    < 1, the systematic risk for the asset is less than the average for assets in the market

Compensation for Bearing Systematic Risk

- MEASURING SYSTEMATIC RISK
  - **The risk premium is the difference between the market rate of return and the risk-free rate of return**
  - **The difference between the required return on a risky asset (R_i) and the return on a risk-free asset R_{rf} is an investor's compensation for risk**
  - **$E(R_i) = R_{rf}$ + Compensation for bearing Systematic risk**

Compensation for Bearing Systematic Risk

- MEASURING SYSTEMATIC RISK
  - **Since compensation for bearing systematic risk depends on the asset**

    $E(R_i) = R_{rf} + (\text{Amount of Systematic Risk}) \times (\text{Compensation/Unit of Systematic Risk})$

Compensation for Bearing Systematic Risk

- MEASURING SYSTEMATIC RISK
  - **Beta is the number of units of systematic risk**
  - **Compensation for Risk = β × (Compensation per Unit of Systematic Risk)**
  - **Compensation per Unit of Systematic Risk = E (R_m) – R_{rf}**
  - **Equation 7.10 is the Capital Asset Pricing Model**

$$E(R_i) = R_{rf} + \beta_i [E(R_m) - R_{rf}] \qquad (7.10)$$

Compensation for Bearing Systematic Risk

- CAPITAL ASSET PRICING MODEL
  - **The Capital Asset Pricing Model (CAPM) describes the relationship between risk and required expected return for an asset**

$$E(R_i) = R_{rf} + \beta_i \left[E(R_m) - R_{rf} \right]$$

Compensation for Bearing Systematic Risk

- CAPITAL ASSET PRICING MODEL EXAMPLE
  - **A stock has a beta of 1.5. The expected return on the market is 10% and the risk-free rate is 4%. What is the expected return for the stock?**

$$E(R_i) = R_{rf} + \beta_i (E(R_m) - R_{rf})$$

$$= 0.04 + 1.50(0.10 - 0.04)$$

$$= 0.13 \; or \; 13\%$$

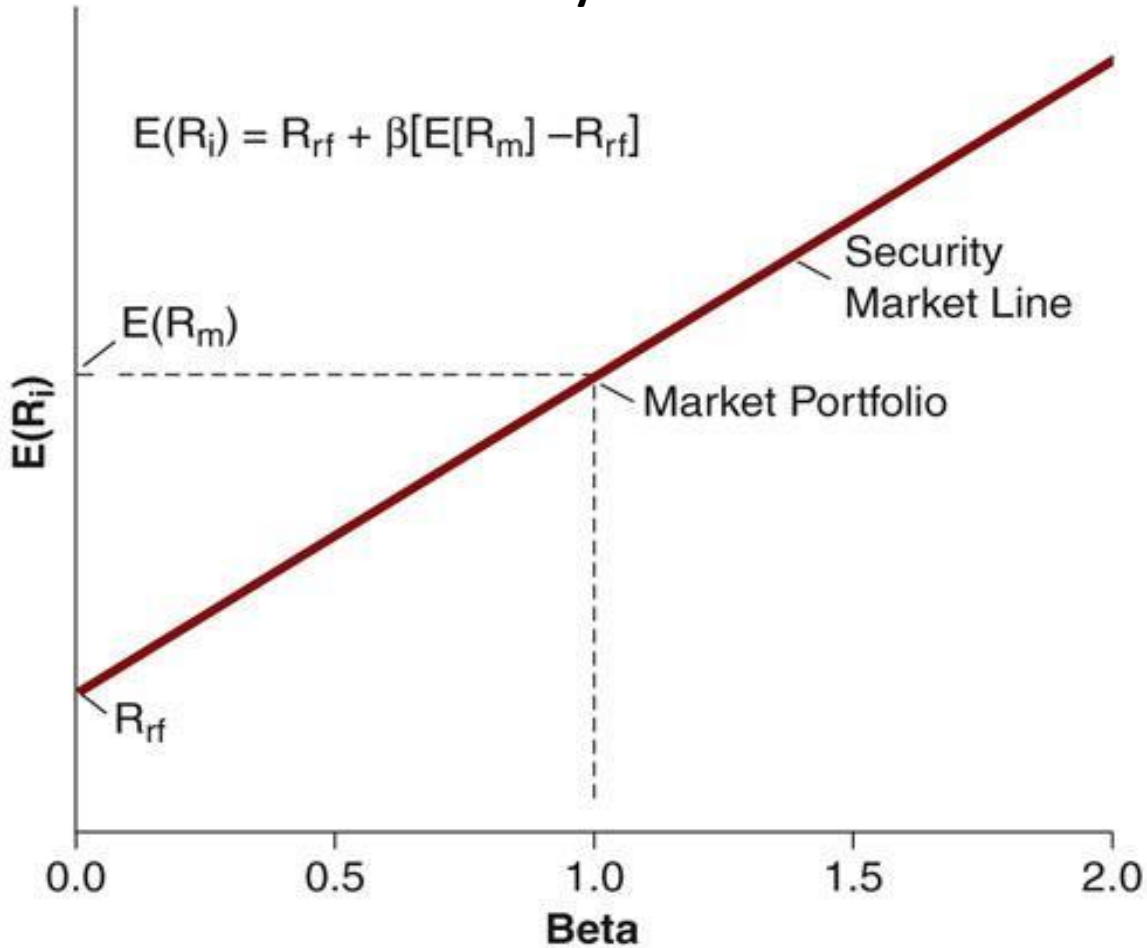
Compensation for Bearing Systematic Risk

- THE SECURITY MARKET LINE
  - **The graph of the CAPM equation is known as the Security Market Line (SML)**
  - **The SML illustrates the CAPM's prediction for the required expected total return for various values of beta. The expected total return depends on an asset's current price.**

$$E(R_T) = \frac{\Delta P + CF_1}{P_0}$$

Compensation for Bearing Systematic Risk

Exhibit 7.11 The Security Market Line



Compensation for Bearing Systematic Risk

- THE SECURITY MARKET LINE
  - **If the expected return is greater than the required return estimated with the CAPM, the expected return will plot above the SML**
  - **If the expected return is less than the required return estimated with the CAPM, the expected return will plot below the SML**

Compensation for Bearing Systematic Risk

- THE SECURITY MARKET LINE
  - **If an asset's expected return plots above the SML, the asset is considered underpriced**
  - **If an asset's expected return plots below the SML, the asset is considered overpriced**

Compensation for Bearing Systematic Risk

- THE CAPM AND PORTFOLIO RETURNS
  - **The expected return for a portfolio is the weighted average of the expected returns of the assets in the portfolio**
  - **The beta of a portfolio is the weighted average of the betas of the assets in the portfolio**

$$\beta_{n\,asset\,portfolio} = \sum_{i=1}^{n}(x_i\beta_i) = (x_1\beta_1) + (x_2\beta_2) + \ldots + (x_n\beta_n) \qquad (7.10)$$

Compensation for Bearing Systematic Risk

- PORTFOLIO BETA EXAMPLE
  - **You invest 25% of your retirement savings in a fully diversified market fund, 25% in risk-free Treasury bills, and 50% in a house with twice as much systematic risk as the market. What is the beta of your portfolio?**

$$\beta_{portfolio} = \sum_{i=1}^{n}(x_i \beta_i) = (x_{Fund}\beta_{Fund}) + (x_{TB}\beta_{TB}) + (x_{House}\beta_{House})$$

$$= (0.25 \times 1.0) + (0.25 \times 0.00) + (0.50 \times 2.00)$$

$$= 1.25$$

Compensation for Bearing Systematic Risk

- EXPECTED PORTFOLIO RETURN EXAMPLE
  - **In the previous problem, what rate of return would you expect to earn from the portfolio if the risk-free rate is 4% and the expected return on the market 10%?**

$$E(R_{\text{n Asset Portfolio}}) = R_{rf} + \beta_{\text{n Asset Portfolio}}\left[E(R_m) - R_{rf}\right]$$

$$= 0.04 + 1.25[0.10 - 0.04]$$

$$= 0.04 + 1.25\,(0.06)$$

$$= 0.115, \text{ or } 11.5\,\%$$