Module 2

Investment Risk & Return

by

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Table of Contents

Study Plan/Syllabus

The definitive characteristic of investing is its trade-off between risk and return. Thus, it is important to know what return and risk mean and how to measure them. Other important issues are knowing how to apply these measures to analyze and evaluate investments and understanding how these statistics change when individual investments are combined into a portfolio for the purpose of diversification.

Risk and return concepts and measurement, including the elements of modern portfolio theory, are discussed in this module. The chapters in this module are:

Risk & Return Concepts

Risk & Return Analysis—Standard Deviation & Correlation

Risk & Return Analysis—Beta & CAPM

The material in this module provides focus on issues related to portfolio construction and diversification. Much of the material covered in this module is quantitative in nature, which allows for a quantification of both risk and expected return of an asset or of a portfolio of assets.

> *Upon completion of this module, you should be able to compute various measures of risk and return for single assets and for a portfolio of assets.*

Modules 2, 3, and 4 are some of the most important in the CFP Certification Professional Education Program. You are introduced to the important concepts of modern portfolio theory. Past CFP® Certification Examinations have extensively tested these concepts.

You should know the terminology of modern portfolio theory well—beta, standard deviation, unsystematic risk, systematic risk, correlation coefficient, etc.—and should know how to compute each measure. You will be expected to know the impact of changing variables on the outcome of the computations. Exercises and illustrations are given to help show those impacts, but you are advised to develop some of your own scenarios to further solidify your understanding.

Finally, you will be expected to make judgments and decisions about portfolio design based on the concepts learned in this assignment. The ability to make judgments and decisions is critical both on exams and in practice.

Note: Beginning with this module you should become familiar with and begin using the exam formula sheet.

Learning Activities

		Learning Activities	
	Learning Objective	Readings	Module Review Questions
2–1	Explain terminology related to the analysis of risk and return in portfolio construction and management.	Module 2, Chapter 1, Risk & Return Concepts	1–4
2–2	Differentiate among the various sources of risk in investments, both systematic and unsystematic.		5–10
2–3	Calculate a weighted average return. Also calculate the standard deviation and mean return of a single asset, and understand how the range of returns is calculated within one, two, and three standard deviations.	Module 2, Chapter 2, Risk & Return Analysis, Standard Deviation & Correlation	11–21
2–4	Calculate coefficient of variation, and understand its application.	Module 2, Chapter 2, Risk & Return Analysis, Standard Deviation & Correlation	22–23

	Learning Objective	Learning Activities: Readings	Learning Activities: Module Review Questions
2–5	Identify covariance and correlation coefficient, know how to calculate one given the other, and understand their application and relevance when calculating the standard deviation of a portfolio.		24–32
2–6	Identify the coefficient of determination, know how to calculate and understand its applications		
2–7	Calculate the beta coefficient, and understand its use and limitations	Module 2, Chapter 3, Risk & Return Analysis, Beta & CAPM	33–37
2–8	Calculate required return using the capital asset pricing model (CAPM), and understand its application.		38–41
2–9	Evaluate the implications of risk and return measurement concepts for portfolio construction.		42–44

Exam Formula Sheet

$$V = \frac{D_1}{r - g}$$

$$Dur = \frac{1+y}{y} - \frac{(1+y) + t(c-y)}{c[(1+y)^t - 1] + y}$$

$$r = \frac{D_1}{P} + g$$

$$\Delta P = -D\left[\frac{\Delta y}{1+y}\right]$$

$$r_i = r_f + (r_m - r_f)\beta_i$$

$$CV = \frac{Par}{CP} \times P_s$$

$$\sigma = \sqrt{\frac{\sum (\mathrm{r_n} - \bar{\mathrm{r}})^2}{\mathrm{n} - 1}}$$

$$HPR = \frac{S + I - Pc}{Pc}$$

$$CV = \frac{\sigma_i}{\bar{x}_i} \text{ } or \text{ } \frac{S_i}{mean_i}$$

$$\mathrm{V} = \frac{\mathrm{NOI}}{\text{Capitaliza tion Rate}}$$

$$\beta = \frac{S_i}{S_m} \times R_{im} \text{ or } \quad \beta_i = \frac{\rho_{im}\sigma_i}{\sigma_m}$$

$$T_p = \frac{\overline{r_p} - \overline{r_f}}{\beta_p}$$

$$\sigma_{\mathrm{p}} = \sqrt{\mathrm{W}_i{}^2 \sigma_i{}^2 + \mathrm{W}_j{}^2 \sigma_j{}^2 + 2\mathrm{W}_i \mathrm{W}_j \mathrm{COV}_{ij}}$$

$$S_p = \frac{\overline{r_p} - \overline{r_f}}{\sigma_p}$$

$$COV_{\mathrm{ij}} = \rho_{ij}\sigma_i\sigma_j$$

$$a = \overline{r_p} - \left[\overline{r_f} + (\overline{r_m} - \overline{r_f})\beta_p\right]$$

$$\mathrm{R_{ij}} = \frac{COV_{\mathrm{ij}}}{\sigma_{\mathrm{i}} \times \sigma_{\mathrm{j}}}$$

$$IR = \frac{R_P - R_B}{\sigma_A}$$

PLEASE NOTE: You do not need to memorize these formulas for the exam. An exact copy of this formula sheet will be provided to you when you log on to take your IP exam. Also, the formula sheet for the CFP Certification Examination will be different than this exam formula sheet. Prior to taking the exam, please check with the CFP Board regarding their current exam formula sheet.

Squares, Square Roots, and Nth Roots

Students frequently have difficulty remembering how to use a calculator for problems involving squares, square roots, and nth roots. The following calculator techniques for the HP-10BII+ and HP 12C calculators will help.

Before doing these problems, set your calculator to four decimal places.

Squares

Question: What is the product of 4.5 squared? (What is 4.5^2?)

Keystrokes (HP-10BII+): 4.5, SHIFT, x^2

Answer: 20.25

Keystrokes (HP-12C): 4.5, ENTER, 2, y^x

Square Roots

Question: What is the square root of 20.25?

Keystrokes (HP-10BII+): 20.25 , SHIFT, $\sqrt{x}$

Answer: 4.5

Keystrokes (HP-12C): 20.25, ENTER, g, $\sqrt{x}$

Squares and square roots will be necessary calculations when we discuss correlation coefficients, and the coefficient of determination (R-squared) in this module.

Nth Roots

Question: What is the 5th root of 100?

Procedure:

Express the problem with a fractional exponent (⅕).

Change the exponent into a decimal (⅕ = 0.2).

Use the y^x key.

$$\sqrt[5]{100} = 100^{1/5} = 100^{0.2}$$

Keystrokes (HP-10BII+): 100, SHIFT, y^x, 0.2, =

Answer: 2.5119

Keystrokes (12-C): 100, ENTER, 0.2, y^x

The Nth root will be covered in Module 5 as one way to calculate a geometric average, and covered again in Module 7 when duration is calculated.

Chapter 1: Risk & Return Concepts

Reading this chapter will enable you to:

2–1 Explain terminology related to the analysis of risk and return in portfolio construction and management.

Before we look at the math that is used to quantify risk and return, you should understand the basic terms involved.

Definitions of Return Measures

Expected return. An investor's estimate of a return, given the economic and market prospects for an investment. The sum of the expected dividend yield and the capital gain.

Required return. The return required to induce an investor to invest in an asset, given that asset's level of risk. An asset's expected return should exceed its required return.

Realized return. The actual total return (income plus capital gain) earned on an investment.

Definitions of Risk Measures

Total risk. The uncertainty that an investment will deliver its expected return—mathematically expressed as standard deviation for a security. Total risk consists of the sum of *unsystematic* risk and *systematic* risk.

Unsystematic risk. The diversifiable component of total risk. The major types of unsystematic risk are business risk, financial risk, and country risk.

- *Business risk.* The risk associated with the nature of the business. Generally, all businesses in the same industry have similar types of business risk.
- *Call risk.* The possibility that a debt security will be called in by its issuer prior to maturity.

- *Credit risk.* The risk that an enterprise's financial condition will deteriorate, resulting in a downgrading of its debt.
- *Default risk.* The risk that an enterprise's financial conditions will deteriorate to the point where it will not meet its financial obligations, most commonly illustrated by an issuer of a bond issue not paying interest and/or principal when due.
- *Event risk.* The possibility that an investment, most often bonds, will be adversely affected by an unanticipated and damaging event.
- *Financial risk.* The risk associated with the extent to which debt has been used to finance a company's operations. Greater debt equals greater financial risk.
- *Marketability risk.* The risk that an investment does not have an active market within which to trade the investment.
- *Liquidity risk.* The degree of uncertainty associated with the time it takes to sell an investment with a minimum of capital loss from the current market price.
- *Investment manager risk.* This risk is associated with actions and decisions of the investment manager that could adversely impact one's investment in the fund he or she is managing.
- *Tax risk.* The risk associated with the uncertainty of an adverse outcome due to the interpretation of tax laws and regulations.
- *Political risk.* This type of risk is the uncertainty caused by the possibility of adverse political events occurring in a country.
- *Country risk (aka political risk).* Investment uncertainty that could be caused by a change in the political climate within a country. Country risk is a greater potential problem in emerging markets than in developed economies.

Systematic risk. The nondiversifiable component of total risk—mathematically expressed as beta for a security. There are five major types of systematic risk: purchasing power risk, reinvestment risk, interest rate risk, market risk, and exchange rate risk.

- *Purchasing power risk.* The risk that future inflation will cause the purchasing power of cash flow from an investment to fall.
- *Reinvestment risk.* Sometimes called "reinvestment rate risk," this is the risk that falling interest rates will cause the cash flow from an investment to fall when the principal or interest payments of that investment are reinvested at lower rates.
- *Interest rate risk.* The risk that a change in interest rates, especially rising rates, will cause the market value of a fixed-income security to fall.

  Note that these first three risks, purchasing power, reinvestment, and interest rate, are primary risks involved in investing in bonds.
- *Market risk.* The risk that changes in the overall market prices will cause changes in the market value of a specific security. Market risk is associated with all securities, especially equity securities, and it cannot be eliminated by diversification.
- *Exchange rate risk.* The risk that an appreciating home-country currency, compared to a foreign currency, will cause an investment in a foreign security denominated in the foreign currency to be worth less, in dollar terms, than what that investment would have been worth if the currency rates had remained stable.

Marketability risk. The risk that there is no active market for an investment.

Liquidity risk. The risk that a security currently held cannot be converted into cash quickly at a price near the current market price.

Endogenous risk. Endogenous risk is risk from shocks that are generated and amplified within the financial system. This type of risk was witnessed with the 2008 financial crisis, where an increase in volatility led to traders in a firm reducing their position, and this selling increased volatility and in turn led to traders at other firms selling, and a chain reaction ensued. The lesson here is that if the measure of risk is too simplistic or naïve, and this measure is used as policy in running a fund, then the implemented policy may create the very thing it was intended to prevent!

This very scenario played itself out during the financial crisis, where the actions of certain funds to deleverage moved prices enough to trigger other funds following similar strategies to deleverage in turn. This led to large moves that previously were considered to have virtually no possibility of occurring. Since these moves were so large and "unlikely," and since firms did not believe they would ever occur, they did not plan for them. Some believe that endogenous risk is the primary risk investors need to be concerned about.

Standard deviation. A measure of total risk, it is a statistical measure of the degree to which an investment's returns are expected to vary from a mean return. It is the basic measure of an investment's risk.

Covariance. The tendency of the returns of two assets to move, over time, in the same or in a different direction.

Correlation coefficient. The statistical measure of the strength of the relationship of the returns of two assets. It is a standardized version of covariance.

Coefficient of determination. The proportion of the total variation in returns of a security that is explained by the variation in returns of another security or of a benchmark index.

Coefficient of variation. An investment's risk per unit of expected return.

Beta. A measure of systematic risk, it is a statistical measure of a stock's volatility (as measured against a stock index).

Risk and Diversification

Reading the next part of this chapter will enable you to:

2–2	*Differentiate among the various sources of risk in investments, both systematic and unsystematic.*

The total risk associated with any investment (individual assets as well as portfolios) has two components. One (unsystematic risk) can be diversified away, and the other (systematic risk) cannot.

Unsystematic (Diversifiable) Risk

Unsystematic risk is the *diversifiable* portion of total risk. It can be eliminated by increasing the number of securities in a portfolio. It is also referred to as *unique risk* because it is unique to each asset and is not related to market-wide events. The unique risk of a portfolio can be diversified away because the unique variability of any asset can be offset by the unique variability of other assets in the portfolio. The unexpected above-average performance of one asset offsets the disappointing below-average performance of another asset so that the portfolio return as a whole is not affected by the variability unique to each component asset.

Some examples of unique risk include the sudden death of a firm's CEO, a long-lasting strike by a firm's employees or by a union, a confiscation of assets in a foreign country, and technology introduced by a competitor that is superior to that of another company—thereby making that company's products obsolete. A poorly diversified portfolio fails to eliminate a significant amount of its unique risk, while a well-diversified portfolio would have little, if any, unique risk left.

Since investors can eliminate unsystematic risk by increasing the number of securities in their portfolios, they are not rewarded for bearing this risk. The risk premium component of the required rate of return (discussed below) does not reflect unsystematic risk. The risk premium is the extra return investors expect to earn from an investment for their assuming its systematic (nondiversifiable) risk.

Systematic (Nondiversifiable) Risk

Systematic risk is the *nondiversifiable* component of total risk. It represents the variability in all risky assets attributed to macroeconomic variables. A market portfolio, by definition, consists of all risky assets traded in the global marketplace. Given the fact that the market portfolio includes all possible risky assets, and that there is a vast number of assets available for investing globally, the market portfolio is a fully diversified portfolio. All the diversifiable risk is eliminated. The only remaining risk is systematic risk.

Macroeconomic forces prevailing in the market drive the systematic risk of any investment. Some examples of such macroeconomic forces are unanticipated changes in the GNP growth rate, industrial production, inflation, interest rates, and the money supply. The extent to which the performance of an investment is affected by a shift in these fundamental economic forces may be different, but there is no way for any investment to escape from the impact.

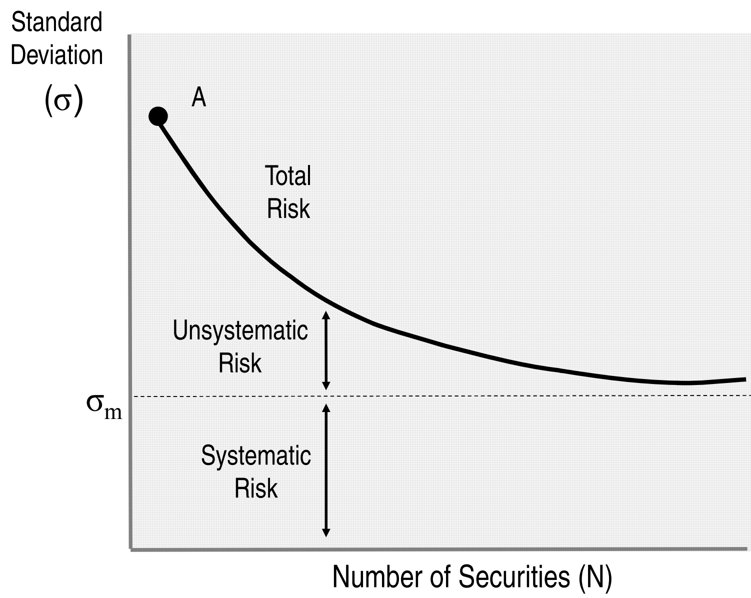
The fact that investors cannot diversify away systematic risk by increasing the number of securities in a portfolio makes systematic risk the only risk for which investors should be rewarded.

As discussed later, many believe that investors will typically act rationally, and if this is the case then the systematic and unsystematic risks covered in this module will be the relevant risks. A problem arises, though, when investors do not act rationally, especially as a group! This causes what is known as endogenous risk, which is the risk that investors will behave in the same manner and literally cause panic in the marketplace. This is what happened with the 2008 financial crisis, where buyers disappeared, assets that previously were valued based on certain assumptions plummeted, and the whole financial system came to a grinding halt. It then took massive intervention to get the engine started again. The greatest amount of damage that can be done to an investor comes from endogenous risk. Long-term market return averages mean little to an investor if the market is collapsing because of panic selling and lack of buyers. This type of risk has implications for how portfolios are constructed, especially for those approaching retirement or in retirement, since typically retirees cannot sustain large losses without impacting their lifestyle. It also has implications for younger and middleaged investors, who perhaps should lower their return expectations somewhat and prepare for potential "shocks" by saving more, while at the same time investing more carefully.

Graphical Illustration of Diversification

Figure 1 summarizes graphically how diversification works.

Figure 1: Diversification and Risk



The standard deviation for a one-asset portfolio is shown by point A on the graph. Adding assets that are not perfectly positively correlated with the portfolio (to be discussed later) causes the standard deviation of the portfolio to decline. Eventually, the portfolio approaches the standard deviation of the market portfolio (represented by the dotted line). By diversifying a portfolio, an investor is able to lower the total risk of the portfolio by eliminating the unsystematic (unique or diversifiable) risk; only systematic (nondiversifiable) risk is left.

As Figure 1 indicates, the major benefit of diversification is realized in its early stages. How far an investor should go regarding diversification depends on the trade-off between the additional benefit to be gained from further diversification and the extra transaction costs involved in adding more assets to a portfolio. The diversification process should stop as soon as the extra benefit equals the extra cost. Some studies have suggested that a well-diversified portfolio can be formed with 10 to 15 large-cap securities selected from different industries. Other studies suggest more securities are needed—some as many as 100 securities—but for the CFP Certification Examination go with the 10 to 15 securities. Studies of mutual funds have shown that four to seven funds in different asset classes optimize diversification benefits. When dealing with mid- to small-cap stocks, a greater number of securities is needed to achieve the same diversification effect as large-cap stocks. A good rule of thumb would be to allocate 25 to 30 mid- or small-cap securities.

Differentiation of Investment Risks

For each individual, risk brings to mind a different image or experience associated with this intangible and elusive concept. The perception of risk can be shaped by past experiences, recent stories in the media, the latest reported investment-related study, and incidents recounted by friends and associates. Too often these factors, not actual probabilities, shape people's expectations for the future. When we look at behavioral finance in Module 3, one of the investor biases we will look at is *recency*. Recency is the tendency to place more weight or significance on recent and current events, than on past events. When the market is going up investors project that it is going to keep going up, and plow more money into the market. When it is going down investors don't invest, or they sell, because they project that the market is just going to keep going down.

In the euphoria of sustained bull markets, such as the exceptionally strong bull market in the late 1990s, investors become overly optimistic and underestimate or ignore risk altogether. It is ironic that at such times many investors view the level of risk as being very low when in fact, it is very high. For some, only the actual experience of loss brings home the concept of risk and the importance of controlling risk. At this point, investors recognize they are not as willing to take on risk as they thought.

The opposite occurs in severe bear markets, when investors see the market as highly risky when, in fact, it has much less risk than at the top of the bull market. An example of this came during the financial crisis in the first week of October

2008, when the major market indices were all down approximately 40% for the year. At that time, the perception of the market was that it was extremely risky—riskier than it was at the beginning of the year when it was approximately 67% higher. (Note that if the market declines 40%, it takes a return of 66.67% to get back to breakeven.)

In the fundamental risk/return relationship, it is almost always return, not risk, that gets the most attention from most investors. This is understandable since the return side is the pleasant side of investing. However, controlling and managing risk is the key to good long-term investment results. The importance of controlling and managing risk is illustrated in the mathematics involved when an investment falls in price and what it takes to get back even. A 50% loss takes a 100% gain to get back even. A 95% loss, as experienced by some tech stocks between 2000–2002, would require a gain of 1900% to break even.

While the predominant view of risk is the loss of principal or the variability of returns, several other views of risk exist:

- volatility of securities' prices;
- the possibility of not achieving an expected rate of return or, simply, losing money;
- nonmatching of cash flows (investment income versus fixed living expenses); and
- uncertainty associated with future returns.

A limited or distorted view of risk can result in either (1) a portfolio containing risk that exceeds the investor's risk tolerance level, or (2) a portfolio that reflects extreme measures to minimize risk (such as investing only in money market instruments or money market funds). A portfolio that does not include enough risk may generate a return insufficient to achieve the investor's objectives.

Remember that risk and return should always be considered together. When constructing portfolios (and for the CFP Board exam) don't make a decision based on one variable without looking at the other. If one investment has a better return than another, then the adviser still needs to look at the amount of risk taken to achieve the returns. It is possible, on a risk-adjusted basis, you would choose Investment A with an 8% expected return over Investment B with a 10% expected return. Based only on the expected returns, investors would choose

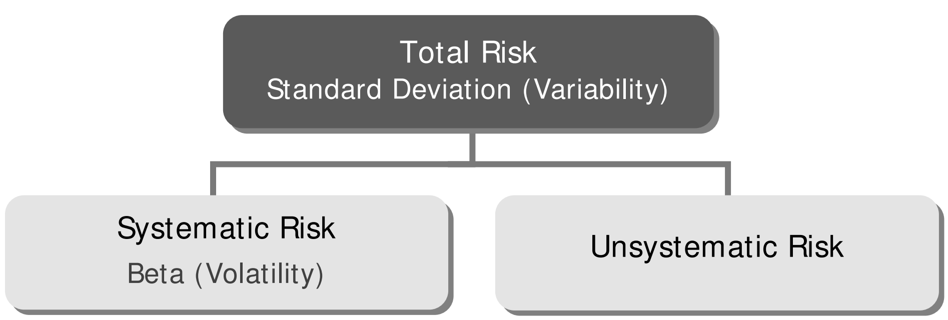
Investment B. However, perhaps Investment B has more risk than Investment A. This can be illustrated with an exaggerated example. Assume Investment A is U.S. Treasury bonds and Investment B is gold mines in North Korea. Is the additional risk in Investment B compensated by the 2% additional expected return? Obviously not, which is why risk must be assessed in conjunction with the expected return of an investment.

At the same time, looking at risk only is not the right approach when selecting an investment. An investor should not just choose the lower or higher risk investment without looking at the return achieved for the level of risk taken. In order to get a higher return, an investor must take greater risk. However, that does not mean that taking higher risks will automatically generate higher returns. If that were the case, buying the most speculative stocks possible would provide the highest returns, and such purchases would make everyone rich. Of course in the real world this does not work, and no one should take this approach to building wealth. The key, then, is taking intelligent, informed risks. Risk-adjusted return is important, and we will be discussing it more as you work through the material.

Types of Risk

To manage investment risk, the investment professional must first understand the types of risk that exist in investing: *systematic* and *unsystematic* risk. Together, systematic risk and unsystematic risk comprise total risk, which is measured by standard deviation (which measures variability). Systematic risk, as we will see later on, is measured by beta (which measures volatility).

Figure 2: Types of Risk



Systematic (Nondiversifiable) Risk

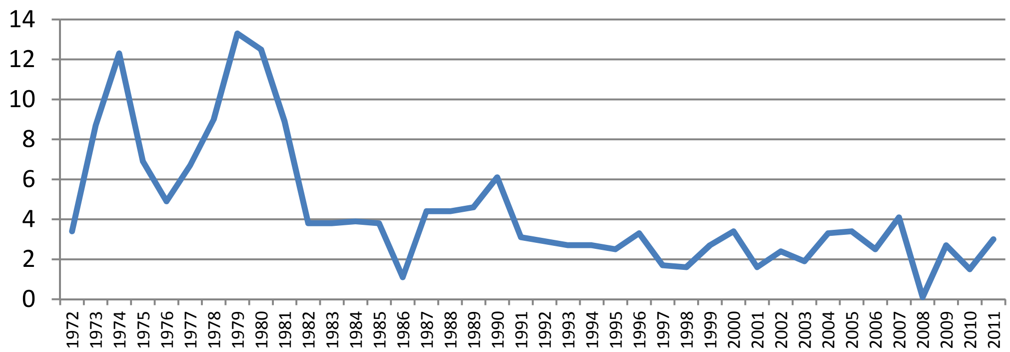
Systematic risk is composed of risk types that reflect broad economic activity, are inherent in the market, and affect all similar types of investments. These risks cannot be eliminated within their own asset class and therefore are said to be nondiversifiable—adding more issues to a certain asset class cannot diversify away that risk. For example, adding 10 more bonds to a portfolio of, say, 20 bonds will not diversify away interest rate risk or purchasing power risk (explained below). However, within the context of a *portfolio*, those risks can be mitigated with the addition of different assets. To take a second example, if the 20-bond portfolio is changed to a portfolio of 50% bonds and 50% stocks, the *portfolio's* purchasing power risk can be lessened because, over time, stocks outperform inflation.

Systematic risk includes the following types, and can be remembered with the acronym "PRIME":

- **P**urchasing power risk
- **R**einvestment risk
- **I**nterest rate risk
- **M**arket risk
- **E**xchange rate risk

Purchasing power risk. Sometimes called inflation risk, purchasing power risk is the risk associated with the loss of purchasing power due to a rise in the general price level. If inflation exists during the holding period of an investment, the investor loses some purchasing power. Investments with fixed rates of return, in particular bonds (other than Treasury inflation-protected securities, commonly referred to as TIPS), are especially subject to this risk. The Consumer Price Index is the most widely used gauge of changes in U.S. general price levels. Although changes in price levels have been fairly low since 1987, there have been periods when consumers had high periods of inflation, as illustrated in Figure 3.

Figure 3: Consumer Price Index, Annual Changes



As inflation increases, interest rates usually rise, because lenders demand larger inflation premiums to compensate for the loss of purchasing power. The CPI rate was 0.1% for 2008, but as of the third quarter of 2009 it was actually negative for the year, down 1.3%. This is a deflationary, rather than an inflationary, environment. Generally deflation is good for bonds (assuming the issuer doesn't default because of the economy) since this means that any income being generated by the bond can buy more (since prices are lower).

Reinvestment risk. Also called reinvestment rate risk, this is the risk of reinvesting cash flows at a lower rate than was being earned. It is the other side of interest rate risk in that they are inversely related. If interest rates rise, bond prices fall, but the periodic interest payments can be reinvested at higher rates. On the other hand, if interest rates decline, bond prices will rise, but the periodic interest payments can be reinvested only at a lower rate. This risk relates even more to principal repayments. If principal is paid back when interest rates are low, then reinvestment of that principal at those lower rates will produce lower interest payments. Reinvestment risk can be eliminated by buying zero coupon bonds, since there are no interest payments to reinvest.

Interest rate risk. This risk is associated with fluctuations in the general level of interest rates, and in particular with an increase in interest rates. This risk applies primarily to bonds because as interest rates increase, the prices of fixed-income securities decrease, and vice versa. The longer the bond's maturity, or the lower the coupon rate on the security, the greater the change in the bond's price in response to changing interest rates. Interest rates also impact stocks, as we will see later.

Market risk. In the macro sense, securities prices tend to rise and fall in unison. For example, most stocks, even those enjoying robust earnings, experience price drops during general downturns in the stock market. Likewise, even stocks of mediocre companies generally benefit from a rising market. Market risk is caused by investor reaction to factors independent of a particular security. This kind of risk is the effect an investor can expect from a significant market move in response to some new negative economic, political, or earnings information, a change in investor psychology, or a consensus of market overvaluation. Most stocks are affected to some degree, even though there may have been no new information about any particular stock. The prime example of market risk took place on October 19, 1987, when the Dow Jones Industrial Average fell almost 23% during that one day.

Exchange rate risk. Also called currency risk, exchange rate risk is the possibility that a change in the value between U.S. and foreign currencies will provide an adverse investment outcome. If U.S. investors buy and sell securities denominated in foreign currencies, they face the additional uncertainty of returns when securities are sold and the proceeds are converted back into dollars. If the sale takes place after the dollar has strengthened against the foreign currency, the return to the U.S. investor is lower in terms of dollars received on the exchange. If the dollar has weakened against the foreign currency since the security was first purchased, the return to the investor is higher because more dollars are received on the exchange.

For example, assume a U.S. investor owns a British bond that pays an interest payment of one pound, and six months ago one pound equaled $1.80. Assume that now the U.S. dollar has strengthened (because it takes less U.S. currency to buy one pound) so that it takes only $1.70 to equal one pound. For the U.S. investor, that interest payment decreased $0.10 due to exchange rate risk when exchanging British pounds for U.S. dollars. If the dollar had weakened to the same degree, the interest payment would have increased in U.S. dollar terms since the interest payments are initially in appreciated British pounds. A weakening U.S. dollar is advantageous for U.S. investors owning foreign securities.

Unsystematic (Diversifiable) Risk

Unsystematic risk, also called diversifiable risk, describes risk factors specific to an individual investment. Factors such as a company's management (both ability and creditability), financial structure, earning power, fundamental business plan, patents, product line, position within its industry, and marketing strengths are just some of the specific aspects that can impact the risk of an investment. It is called diversifiable risk because these risks can be diversified away in a portfolio of several different stocks in several different industries.

Unsystematic risks include the following types; it is especially important to understand business and financial risk.

Business risk. Business risk is related to the uncertainty inherently associated with a particular investment. Most commonly, business risk is applicable to a specific company or the industry in which it operates. It generally is concerned with the degree of uncertainty associated with a company's earnings and its ability to pay dividends or interest to investors. This uncertainty is directly related to the company's management, product line, marketing ability, and other factors specific to that company.

Financial risk. Businesses finance their assets in different ways. Some use only the owners' money (equity). Others make heavy use of borrowed money (debt). Usually, it is some combination of the two. Financial risk is the risk associated with the degree to which debt is used by a company to finance its operations. *An entity with no debt has no financial risk.* The larger the proportion of debt to equity, the greater the degree of financial leverage, and, therefore, the greater the financial risk. The increased risk results from the fact that debt financing creates legal obligations to make timely interest and principal payments. These obligations raise "the bar" the company must clear just to stay in business. As the bar is raised higher with added debt financing, investing in the company becomes riskier. These fixed-payment obligations must be met prior to distributing any earnings to the owners of the company.

Default risk. A security's default risk is closely associated with the financial condition of the issuing company. The weaker the firm's financial condition, the greater the chance of the firm defaulting on its financial obligations and of the investors not receiving some or all of their interest and principal. This risk usually relates to the company's bonds but can include its commercial paper, as well as its lease and loan obligations. Defaulting on financial obligations can lead to forced bankruptcy proceedings by creditors.

Credit risk. This risk is closely related to default risk. The degree of a company's default risk is reflected in its credit rating, as determined by major credit rating companies for those companies that choose to have their issues rated. An unanticipated lowering of the credit rating on a company's debt can cause the market price of that debt to drop significantly. The prices of all corporate debt issues can also be affected if the risk premium demanded by investors for a given credit rating changes. One aspect of credit risk to heed is the extent to which the same insurance company or letter of credit insures individual issues in a bond portfolio.

Political risk. Also called country risk, this type of risk is the uncertainty caused by the possibility of adverse political events occurring in a country. The less stable the political, economic, or social structure of a country, the greater the risk. The risk could be manifested in the expropriation of assets, exchange control laws, the overthrow of governments, war, corruption, riots, and so forth. A security or portfolio of securities from developing countries would, of course, have more political risk than securities from developed countries. The United States is considered to be the most stable country in the world for investment. When uncertainty exists in the world, investment funds tend to flow into the United States as a safe haven for wealth.

Liquidity and marketability risk. These risks are closely related and therefore are discussed together. Liquidity is a financial concept that most often describes the ability of a security or other asset to be turned into cash quickly with little, if any, change from the market price, which generally is the price at which the last trade occurred. Liquidity risk, then, is the degree of uncertainty associated with the time it takes to sell an investment with a minimum of capital loss from the current market price. In other words, the less liquidity an investment has, the more liquidity risk it has.

Another definition of liquidity risk, used less often, centers on the important concept of safety of principal—that is, getting back the amount of original dollars invested. In this context, for example, a money market fund that does not fluctuate in net asset value has very low liquidity risk (or very high safety of principal) because it is very unlikely to lose any principal invested in it. You should be familiar with both definitions and concepts of liquidity risk and apply them within the usage of the situation.

Almost any investment can be sold quickly if the investor is willing to take a discount from its current market price. Liquidity and "marketability" are frequently used synonymously. Both imply that an asset will sell at its current market price or at a price reasonably close to the last traded price. Specifically, however, marketability is defined as the extent to which there is an active market for the investment. Therefore, marketability risk is the risk that there is not an active market for an investment. Marketability, however, does not necessarily imply investors would have difficulty obtaining their money. For example, mutual fund shares do not have an active market but redemptions can be made and investors can obtain their money quickly.

Stocks listed on the New York Stock Exchange are considered very liquid; that is, a round lot can be sold usually with a small bid/ask spread. Because there is an active market of buyers and sellers (high marketability), each listed stock can usually be sold very quickly at a price close to its last posted sale value (unless it is a very large sale that would require some price concession to sell quickly). Stocks (or bonds) that trade infrequently and/or in low volume are said to trade in a "thin" market. An office building, on the other hand, is very illiquid; its liquidity risk is high due to the uncertainty of the time it will take to sell the building and the price concessions required to sell it quickly.

Sometimes the quality of a security affects its liquidity. For example, during 1998 there was a "flight to quality" in the bond market as economic problems in emerging countries spread. Investors, looking for safety, bought Treasury securities and sold lower-grade bonds, which caused liquidity risk in some issues. That is, because investors wanted to quickly sell their low-quality bonds, these bond prices were quickly falling so, in many cases, it was not possible to sell at or near the last market price. In addition, there was safety of principal risk in that it was quite possible for investors to lose money on these bond investments. This type of scenario happened again in the summer of 2007, when the subprime mortgage crisis hit. The market for any investments involving subprime debt essentially evaporated, making it very difficult to price, much less sell, any debt containing subprime paper. At the same time the demand for Treasuries dramatically increased because of a flight to quality.

The situation continued to worsen in 2008, and the ensuing financial crisis led to unprecedented action by both the U.S. government and the Federal Reserve. The flight to quality during this time was so strong that short-term U.S. Treasury bill rates temporarily went all the way down to 0%, and even below. This meant that investors were willing to accept a negative real return in order to have a safe haven for their funds.

The more efficient and active a market, the more liquid the investments bought and sold there will be and, therefore, the lower the degree of liquidity risk. This is true whether applied to stock, real estate, or collectibles.

The words “liquid,” “illiquid,” or “liquidity” are used frequently in the investment world, but often without precision. When you encounter them, ascertain how the words are being used with respect to safety of principal, accessibility of funds, minimum capital loss on conversion into cash, or small price concessions incurred in selling.

Call risk. Call risk is the possibility that a debt security will be called in by its issuer prior to maturity. This option is a feature of most municipal and corporate bond issues, making it possible for the issuers to pay off existing high-coupon bond issues with new ones that have lower coupon rates. Only a very small number of issues of U.S. Treasury securities are subject to call, so, in general, they are thought of as not callable. Call risk increases when interest rates decline. When investors receive their principal from called bonds, they find that they are able to reinvest the funds only at a lower rate (thereby encountering reinvestment risk). *Call dates* indicate the first and successive dates on which bonds may be called, and *call premium* is the amount above par value to be paid if the issue is called.

Event risk. Event risk is the possibility that an investment, most often bonds, will be adversely affected by an unanticipated and damaging event. The event may take the form of a major tax or regulatory change; a change in a company’s capital structure due to a merger or buyout, such as loading up the acquired company with debt thereby decreasing its bond rating; disclosure of fraud or other significant misdeeds; negative media attention to a particular product; or a major, unexpected event. Municipal bonds can experience event risk as well. For example, in 1993 and 1994 the treasurer of Orange County, California, invested in derivative securities, which eventually caused large, unexpected losses. This, in turn, caused a large selloff of the county's bonds due to serious questions about the county's ability to make bond payments (the county declared bankruptcy on December 6, 1994, due to $1.7 billion of losses from these derivatives).

Event risk can also impact a company's stock. To illustrate, in April 2010, there was a massive oil leak in the Gulf of Mexico from a well owned by BP, the large British oil company. Certainly this was an unexpected event that had a huge effect on BP, as it had to spend billions of dollars to cover the damage caused by the leak. The total cost of this event was in the billions of dollars. This had a major impact on both BP's corporate reputation and its stock price. Two months after the oil leak, the BP stock price fell 50%, along with a dividend suspension, as the cost of this event climbed.

Tax risk. Tax risk is the risk associated with the uncertainty of an adverse outcome due to the interpretation of tax laws and regulations. This is most prevalent in situations where tax law is unclear, such as innovative tax strategies or innovative financial instruments, often derivatives. Using such strategies and/or financial instruments can result in transactions that are assumed to be tax-advantaged or tax-free, but later found by the Internal Revenue Service to be taxable. If that occurs, the investor is subject not only to back taxes, but possibly to interest and penalties as well.

Investment manager risk. This risk is associated with actions and decisions of the investment manager that could adversely impact one's investment in the fund he or she is managing. While most often seen with a mutual fund manager, this risk applies to the management of any type of portfolio, including separately managed accounts and hedge funds. One aspect of this risk is the possibility that the securities selected will underperform other securities, producing an unintended result. Another aspect of this risk is that a good manager will leave the fund, so the investor may no longer benefit from his or her expertise. A third aspect of this risk includes a good manager taking on too many responsibilities, such as managing too many portfolios or, if a principal of the firm, spending considerable time managing the operations of the investment firm, thus taking away time spent managing money.

There are obviously many other risks that investors and advisers are exposed to, such as fraud risk. In recent years, for example, there have been a number of notable Ponzi schemes, the largest of which was run by Bernard Madoff. *Ponzi scheme* gets its name from Charles Ponzi, who offered investors unrealistic high returns and accomplished this by paying off old investors (and himself) with money coming in from new investors. The merry-go-round always stops, though, and investors are left holding the bag.

Chapter 2: Risk & Return Analysis—Standard Deviation & Correlation

Reading the next part of this chapter will enable you to:

> *2–3 Calculate a weighted average return. Also calculate the standard deviation and mean return of a single asset, and understand how the range of returns is calculated within one, two, and three standard deviations.*

Knowledge of investment theory requires familiarity with many mathematical terms. In this chapter, students will learn how to compute many of the terms that are necessary in a discussion about portfolio construction.

Weighted-Average Return

The return on a portfolio of securities is the sum of the individual assets' returns, each weighted by that asset's proportion of the total market value of the portfolio. The following example demonstrates how to calculate a portfolio's weighted-average return.

Example. Sherman has a \$75,000 investment portfolio with \$40,000 invested in TRO stock fund, \$20,000 invested in PES bonds, and \$15,000 invested in HXQ REIT. The rates of return earned by each security were 12%, 9%, and 8%, respectively. What is the weighted-average rate of return on the portfolio?

Table 1: Calculating the Weighted-Average Portfolio Return

Investment	Amount	Rate of Return	Portfolio Weight	Weight × Return
TRO Stock Fund	$40,000	12%	40÷75 = .53	.53 × 12% = 6.36%
PES Bonds	20,000	9%	20÷75 = .27	.27 × 9% = 2.43%
HXQ REIT	15,000	8%	15÷75 = .20	.20 × 8% = 1.60%
Total	$75,000			10.39%

or

Calculator Keystrokes

HP-10BII+		HP-12C	
12	INPUT	12	ENTER
40	Σ+	40	Σ+
9	INPUT	9	ENTER
20	Σ+	20	Σ+
8	INPUT	8	ENTER
15	Σ+	15	Σ+
	SHIFT $\bar{x}_w$ (6 key)		g $\bar{x}_w$ (6 key)
	Rate of return = 10.40%		Rate of return = 10.40%

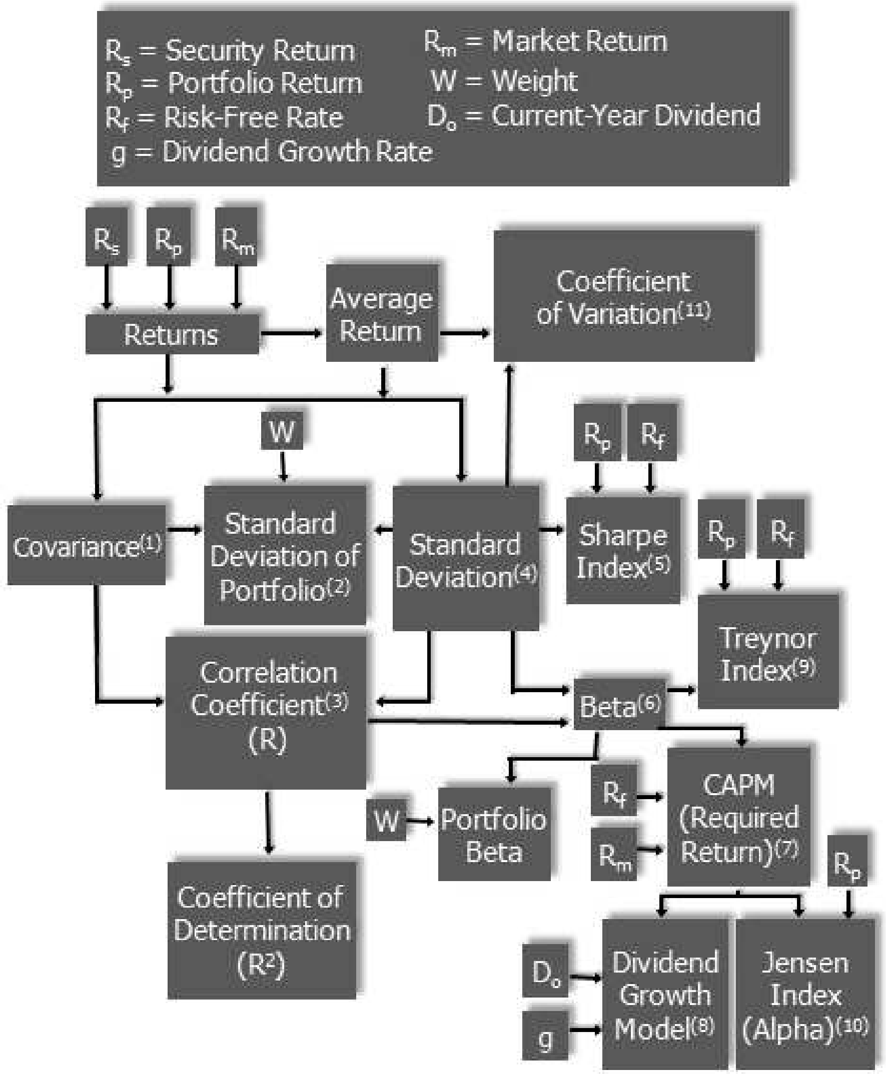
Investment Risk/Return Relationships

Before we cover other investment math, Figure 4, which follows, is introduced so that you can follow the process of how the various computations relate to one another. You will not understand Figure 4 in its entirety now—but you will later! As you move through the material that follows, you will see how the chart develops, and it is likely you will have to review the chart several times before you truly understand it.

Of the formulas following Figure 4, we will cover numbers 1, 2, 3, 4, 7, and 11 in this module. We will cover the other formulas in modules 4 and 5. You may want to develop your own study notes, perhaps listing one formula per page, and then taking notes about it. Just as writing the answers out in the back of each module is a tremendous help, taking your own written notes will greatly help comprehension and retention.

Refer also to the "Exam Formula Sheet" in the introduction to this module. That formula sheet is identical to the one that you will download when you take your Investment Planning exam.

Figure 4: Investment Risk/Return Relationships



As we cover the formulas and computations that follow, we will refer back to Figure 4 and discuss how the formulas relate to each other. Start at the upper left-hand corner of the figure. The title of each formula is identified in Figure 4 and is referenced by number to the set of formulas that follows. These formulas cover only stock formulas; a complete list of formulas is provided on the formula sheet in the introduction to this module.

(1) $COV_{ij} = \rho_{ij}\,\sigma_i\,\sigma_j$	(7) $r_i = r_f + (r_m - r_f)\beta_i$
(2) $\sigma_p = \sqrt{W_i^2\sigma_i^2 + W_j^2\sigma_j^2 + 2W_iW_jCOV_{ij}}$	(8) $V = \frac{D_1}{r - g}$
(3) $R_{ij} = \frac{COV_{ij}}{\sigma_i \times \sigma_j}$	(9) $T_p = \frac{\overline{r_p} - \overline{r_f}}{\beta_p}$
(4) $\sigma = \sqrt{\frac{\sum (r_n - \bar{r})^2}{n - 1}}$	(10) $a = \overline{r_p} - [\overline{r_f} + (\overline{r_m} - \overline{r_f})\beta]$
(5) $S_p = \frac{\overline{r_p} - \overline{r_f}}{\sigma_p}$	(11) $CV = \frac{\sigma_i}{\bar{x}_i}$ or $\frac{S_i}{mean_i}$
(6) $\beta = \frac{S_i}{S_m} \times R_{im}$ or $\beta_i = \frac{\rho_{im}\sigma_i}{\sigma_m}$	

Standard Deviation of a Single Asset

The standard deviation of an asset has evolved into the single most important measure of a security's risk. The standard deviation tells an investor how far from the mean (average) return a security's returns are likely to vary. Standard deviation measures dispersion, which is the amount of deviation from the mean return. The wider the range of returns, the higher the standard deviation. The lower the range of returns, the lower the standard deviation. Risk-averse investors do not like much variation. Many investors are satisfied with a moderate level of variation, and some investors like securities that have a high degree of variability. Another way to think of standard deviation is the "bumpiness of the ride." The more variability, the bumpier the ride, and the more risk there is. Risk-averse investors would of course want a smoother ride, meaning less variability.

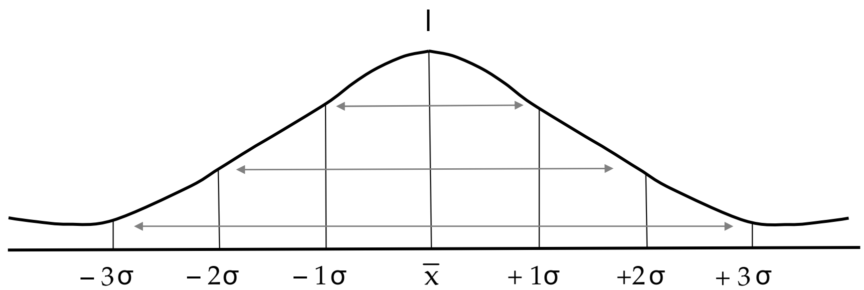
Normal Distribution

The standard deviation is a critical element of what is called a "normal distribution" of investment returns. In the statistics of investment analysis, an assumption is made that investment returns, when examined over a large number of years, are normally distributed around the mean return. Figure 5 illustrates a "normal distribution" curve.

Assuming a normal distribution simplifies the statistical analysis of investment returns, even though the normal distribution is not truly representative of the actual distribution of investment returns, as is discussed below. By assuming a normal distribution, however, we can make investment decisions based on mean returns and standard deviations, which are assumed to completely describe a normal distribution. We do not have to consider skewness and kurtosis in our analysis of returns.

A normal distribution is always symmetric; a lognormal distribution is always asymmetric (or skewed, not balanced). A normal distribution can be used when discussing investment returns, because returns can be positive or negative. When discussing investment asset prices, a lognormal distribution is more appropriate, because asset prices can never go below zero. Lognormal distribution is useful in more advanced applications of investment theory, and you will not use a lognormal distribution in this course; simply know what it is for the CFP Certification Examination.

Figure 5: Normal Distribution



Normal Distribution
(Symmetrical)

Skewness

As noted above, an asymmetric distribution is skewed. What skewness means is that the nice, neat, symmetrical curve shown above looks off-center and the tails at either end will be fat or skinny, and longer or shorter. A positively skewed distribution has a large hump to the left and a long tail to the right; a negatively skewed distribution has a large hump to the right and a long tail to the left. Generally, investment returns are positively skewed, with larger positive returns and fewer negative returns. Small levels of negative skewness and large levels of positive skewness are preferred by most investors with long-only strategies, which fit the profile of clients of most financial planners.

With positive skewness the mean return will be to the left of the normal bell curve, and this is good for investors since it means that more returns are positive than negative. In the "real world" there are about two positive years for every negative year, and this would be reflected by a positive skewness. If there were more down years than up years, you would then have a negative skewness (shown below with the dotted lines).

Figure 6: Positive Skewness

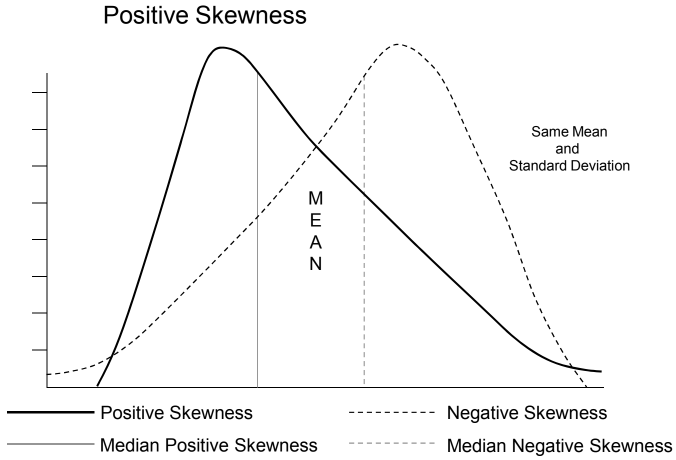
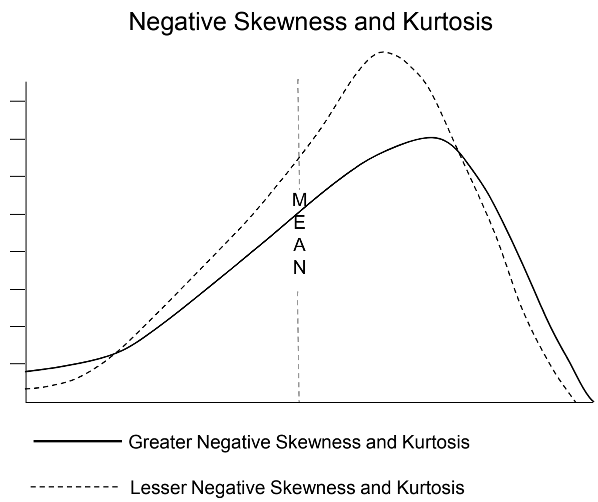


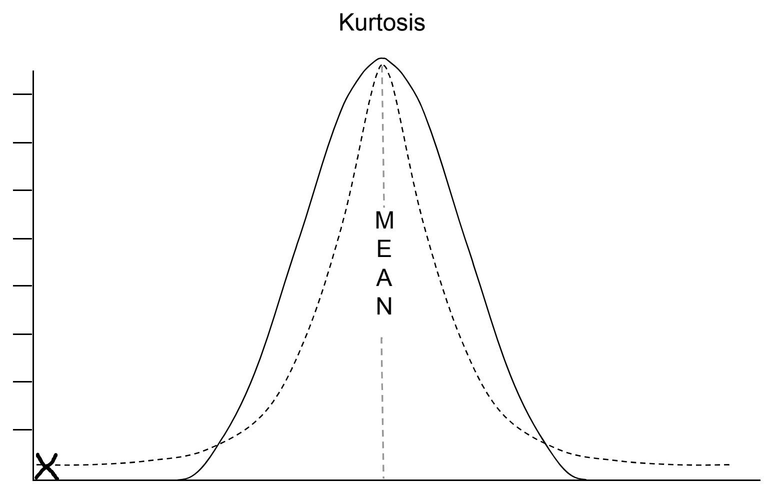
Figure 7: Negative Skewness and Kurtosis



Kurtosis

Kurtosis is another statistical measure that is of some concern to advisers who prefer less frequent large surprises, especially negative surprises. The graph for a distribution that has a lot of returns clustered around the mean (many small surprises), but some extremely large positive or negative returns (few large surprises), has a higher peak and fatter tails than a normal distribution. Most equity returns have this characteristic. The 2008 financial crisis, with its dramatic negative returns, would show up as a large negative return, and be reflected on the far left tail (represented by the "x" in Figure 8 below). The shorter the measuring period (e.g., monthly rather than yearly) the larger the kurtosis. When available, the kurtosis figures for different investments give the adviser an indicator of the relative frequency of large negative or positive returns.

Figure 8: Kurtosis



A leptokurtic distribution is a type of kurtosis in which the statistical value is positive. There are high peaks around the mean return and thick tails on both sides. This is generally good for investors as the asset has a relatively low amount of variance with most returns close to the mean. A platykurtic distribution, on the other hand, is a type of kurtosis with a negative statistical value. It has a flatter peak around the mean when compared to a normal distribution. The wide dispersion of returns indicates a high amount of variance among those returns, and a higher than usual probability for extreme price movements.

Computing Standard Deviation

To compute the standard deviation, first we must decide on the period of time that we want to use to measure variability. Generally, a relatively long period (at least three years) is better than a short period. Some investors prefer three years, some five years, and others ten years. Morningstar Inc. generally uses a three-year period for many of its calculations, with 36 monthly returns in the series.

In the upper left corner of Figure 4, we see that we start with a series of returns; let's assume that we have 36 monthly returns. We add up the returns for all 36 months and divide by 36 to obtain the average return for that 36-month period. We now have 36 monthly returns and the average return for that period of time. With these numbers we can compute the standard deviation for that security's returns.

The formula for computing standard deviation of a single asset's returns is as follows:

$$S_p = \sqrt{\frac{\sum (r_n - \bar{r})^2}{n - 1}}$$

where

r_n = Return for each period

$\bar{r}$ = Average return

n = Number of periods

The following example shows how to compute the standard deviation of an asset using this formula. Following the example are the keystrokes for making the same computation using a calculator's standard deviation function keys, which is much easier and faster than doing the computation under the first set of manual calculations. You will not need to refer to the standard deviation formula to calculate standard deviation—you can calculate it easily on your financial calculator. Also, you can solve for the mean return using the same entries you have made for standard deviation.

Example. Assume that RMC stock has had the following series of annual returns, signified by "r_n." Note that, to simplify the methodology of plus and minus signs, any number lower than the average is shown to be negative and any number higher than the average is shown to be positive.

r_n	$\bar{r}$	$r_n - \bar{r}$	$(r_n - \bar{r})^2$
10.00	7.20	2.80	7.84
12.00	7.20	4.80	23.04
7.00	7.20	-0.20	0.04
13.00	7.20	5.80	33.64
-9.00	7.20	-16.20	262.44
9.00	7.20	1.80	3.24
-8.00	7.20	-15.20	231.04
11.00	7.20	3.80	14.44
15.00	7.20	7.80	60.84
12.00	7.20	4.80	23.04
		$\sum$	659.60

$$S_p = \sqrt{\frac{659.60}{(10-1)}} = \pm 8.56\%$$

Calculator Keystrokes

HP-10BII+		HP-12C	
10	$\sum$ +	10	$\sum$ +
12	$\sum$ +	12	$\sum$ +
7	$\sum$ +	7	$\sum$ +
13	$\sum$ +	13	$\sum$ +
9	+/-, $\sum$ +	9	CHS, $\sum$ +
9	$\sum$ +	9	$\sum$ +
8	+/-, $\sum$ +	8	CHS, $\sum$ +
11	$\sum$ +	11	$\sum$ +
15	$\sum$ +	15	$\sum$ +
12	$\sum$ +	12	$\sum$ +
	SHIFT, $\bar{x}$, $\bar{y}$ (7 key) for mean return 7.20%		g, x (0 key) for mean return 7.20%
	SHIFT, S_x, S_y (8 key) for standard deviation 8.5609		g, s (. Key) for standard deviation 8.5609

Be careful to hit the S_x key (and not the σ_x key) on the HP–10BII+ calculator. The first key is used when "n – 1" is in the denominator, and the second key is used when "n" is in the denominator. When the entire population of returns is used in the equation, "n" is used; "n – 1" is used when only a subset of the entire spectrum of returns is used. We use "n – 1" in this course because we use the returns from only a few periods in our calculations.

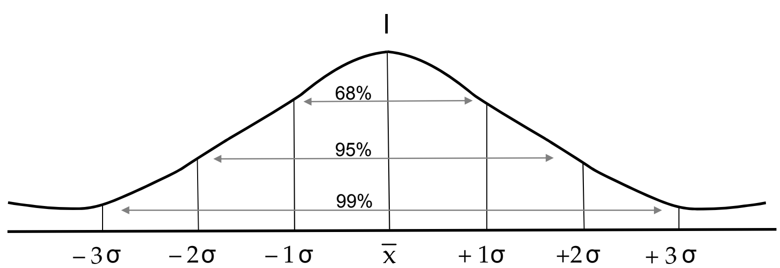
The value of one standard deviation is added to and subtracted from the mean return to determine the range within which the security's returns can be expected to fall 68% of the time. For simplicity we will round up the standard deviation from 8.5609 to 8.6. We take the mean return of 7.2%, and add and subtract the standard deviation of 8.6% to it. This then tells us that 68% of the time, the returns for RMC stock can be expected to be between –1.4% (7.2% – 8.6%) and +15.8% (7.2% + 8.6%).

Returns can be expected to be within two standard deviations 95% of the time, and this is calculated by again adding and subtracting the 8.6% standard deviation. So we take the –1.4% and subtract 8.6% from it to arrive at –10.0. On the positive side we take the 15.8% and add 8.6% to it to arrive at 24.4%. This means that 95% of the time (two standard deviations) the range of returns will fall within –10.0 to +24.4%.

Returns can be expected to be within three standard deviations 99% of the time. To calculate we would again add and subtract the standard deviation: –10% – 8.6% = –18.6%, and 24.4% + 8.6% = 33%. So three standard deviations fall within the range of –18.6% to +33%.

The following graph shows these statistical relationships.

Figure 9: Investment Return Dispersion



Normal Distribution
(Symmetrical)

Remember that the mean return is in the middle of the equally distributed bell curve. This means that half of the returns are higher than the mean return, and half of them are lower. So in our example, half of the returns are higher than 7.2%, and half are lower than 7.2%. Also, the standard distributions are equally distributed, meaning with one standard deviation 34% of the returns are higher than the mean return, and 34% lower (totaling 68%). So if we know that on the positive side one standard deviation is 15.8%, then the percentage probability of achieving a return of greater than 15.8% is 16%, since one standard deviation is 68%; with 34% of the returns greater than the mean, only 16% is left of the 50% of returns greater than the mean.

A Historical Perspective—Returns and Risk (as measured by standard deviation)

We have looked at how standard deviation is measured, and how we calculate the ranges for one, two, and three standard deviations. We have also looked at the probabilities of each standard deviation occurring. Let's now look at long-range returns and see how they compare to the recent market environment. Here are long-term return numbers from the *Ibbotson 2013 Classic Yearbook*:

Table 2: Returns from 1926 to 2013

	Geometric Mean	Arithmetic Mean	Standard Deviation
Large Company Stocks	10.1%	12.1%	20.2%
Small Company Stocks	12.3%	16.9%	32.3%
Long-Term Corporate Bonds	6.0%	6.3%	8.4%
Long-Term Government	5.5%	5.9%	9.8%
Intermediate-Term Government	5.3%	5.4%	5.7%
U.S. Treasury Bills	3.5%	3.5%	3.1%
Inflation	3.0%	3.0%	4.1%

Source: *Ibbotson SBBI 2014 Classic Yearbook*

Note the geometric mean and standard deviation for large company stocks: a 10.1% geometric mean and a 20.2% standard deviation. Using these numbers, we would get the following standard deviation ranges:

- –10.1% to + 30.3% would be 1 standard deviation (68% of the returns)
- –30.3% to +50.5% would be 2 standard deviations (95% of the returns)
- –50.5% to +70.7% would be 3 standard deviations (99% of the returns)

Now let's take a look at the difference that a few years can make, even on long-term returns. The first table we looked at represented the 1926 to 2013 time period; now we will look at 1926 to 2007, which gives us long-term returns prior to the financial crisis of 2008. Here are the numbers from the *Ibbotson 2008 Classic Yearbook*:

Table 3: Returns from 1926 to 2007

	Geometric Mean	Arithmetic Mean	Standard Deviation
Large Company Stocks	10.4%	12.3%	20.0%
Small Company Stocks	12.5%	17.1%	32.6%
Long-Term Corporate Bonds	5.9%	6.2%	8.4%
Long-Term Government	5.5%	5.8%	9.2%
Intermediate-Term Government	5.3%	5.5%	5.7%
U.S. Treasury Bills	3.7%	3.8%	3.1%
Inflation	3.0%	3.1%	4.2%

Source: *Ibbotson SBBI 2008 Classic Yearbook*

Note what has happened in just four years. The long-term geometric return for large-cap stocks dropped from 10.4% in 2007 to 10.1% in 2013. Also the risk increased, from a standard deviation of 20.0% through 2007, to a standard deviation of 20.2% through 2013. This is obviously not what investors want, lower return and higher risk. The problem, of course, with any of these numbers is that we are always looking back, and the big question investors want answered is what to expect going forward. There are no easy answers, and it is what makes investing both an art and a science. We use the past to help us with investment decisions, but it can only help so much. Telling an investor that the historical long-term return of large company stocks is 10.1% when his or her portfolio is down 30% and they are about to retire doesn't do much good. Expectations regarding what the markets will do in the future are called *capital market expectations* (CME).

Historical Perspective of the Financial Crisis of 2008

The total market capitalization of the world stock markets at the end of 2007 (right before the financial crisis) was $64.5 trillion (*S&P Global Stock Markets Factbook, 2008*). Of this $64.5 trillion, the leading developed market country was the United States, with $19.9 trillion of stock market capitalization, 30.9% of the world total. The leading emerging market country was China with $6.2 trillion of the world stock market capitalization, 9.6% of the world total. Overall, developed markets accounted for $46.3 trillion (71.7% of the world total), and emerging markets $18.2 trillion (28.3% of the world total).

Table 4: World Ranking of Market Capitalizations—End of 2007

Rank	Market	Total Market Cap ($ millions)
1	United States	$19,947,284
2	China	6,226,305
3	Japan	4,453,475
4	United Kingdom	3,851,706
5	France	2,771,217
6	Canada	2,186,550
7	Germany	2,105,506
8	India	1,819,101
9	Spain	1,800,097
10	Russia	1,503,011
11	Brazil	1,370,377
12	Australia	1,298,429

Source: *Standard & Poor's Global Stock Markets Factbook 2008*

Fast-forward now to the end of 2008, and the world stock market capitalization had fallen from $64.5 trillion to $35.8 trillion, a decline of 44.5%! Table 5 illustrates the world rankings for stock market capitalization as of the end of 2008:

Table 5: World Ranking of Market Capitalizations—End of 2008

Rank	Market	Total Market Cap ($ millions)
1	United States	$11,737,646
2	Japan	3,220,485
3	China	2,793,613
4	United Kingdom	1,851,954

Rank	Market	Total Market Cap ($ millions)
5	France	1,492,327
6	Russia	1,321,833
7	Germany	1,107,957
8	Canada	1,002,215
9	Spain	946,113
10	Switzerland	862,663
11	Australia	675,619
12	India	645,478

Source: *Standard & Poor's Global Stock Markets Factbook 2009*

Table 6 shows some returns as of the end of 2008:

Table 6: Historical Major Market Returns

	1 yr	3 yr	5 yr	10 yr
EAFE	-45.1%	-9.7%	-0.8%	-1.3%
BRIC	-60.3%	-1.8%	+8.5%	+10.4%
Emerging Mkts	-54.5%	-7.1%	+5.1%	+6.6%
S&P 500	-37.0%	-8.4%	-2.2%	-1.4%

Source: MSCI Barra, *Standard & Poor's*

Note that both the Emerging Markets and BRIC (Brazil, Russia, India, and China, whose populations represent about 42% of the world population) were down more than the U.S. market. But also notice that BRIC and the Emerging Markets (of which BRIC is part) both had positive 5- and 10-year returns at the end of 2008, whereas the 5- and 10-year returns for the S&P 500 and EAFE (Europe, Australasia, and Far East developed markets) are negative for that period.

Semi-Variance

Semi-variance is an alternative measure of risk that considers only returns lower than expectations (mean return, zero, or a benchmark return). It recognizes that investors are concerned less about the risk of overperformance and more about the risk of underperformance. The computation is the same as that of computing the standard deviation of an asset, as previously shown, except that returns greater than the mean are ignored—only returns less than the mean are used.

Although theoretically appealing and easy to compute, this method is not very practical because of the difficulty in understanding and explaining it clearly, the difficulty of using semi-variance in an optimizer, and the fact that different users may choose different mean returns as the base for computation. We do not expect students to be able to compute semi-variance; just to know about the concept and the definition that was just provided.

Reading the next part of this chapter will enable you to:

2–4 Calculate coefficient of variation, and understand its application.

Coefficient of Variation

One simple calculation investors can do if they know both the standard deviation and mean return is calculating the coefficient of variation. This is a measure of risk per unit of expected return. It is one of the methods for computing a risk-adjusted return for a security. It is primarily used to compare the relative performances of two or more securities. Rather than simply selecting the security that has the greatest absolute return or the lowest absolute risk over the period measured, an investor can use the coefficient of variation to determine which security gave the least risk per unit of return. The formula for coefficient of variation (designated as Equation (11) in Figure 4) is as follows.

$$CV = \frac{\sigma}{\overline{x}}$$

CV represents the coefficient of variation; σ represents the standard deviation of an asset; and $\bar{x}$ represents the mean return of the asset.

Example. Assume that two mutual funds, A and B, have the following mean (average) returns and standard deviations.

Fund	Mean Return	Standard Deviation
A	10%	7
B	20%	11

$$CV = \frac{\sigma}{\bar{x}}$$

$$CV_A = \frac{7}{10} = .70 \qquad CV_B = \frac{11}{20} = .55$$

A risk-averse investor might be inclined to select Fund A because of its lower standard deviation. A growth-oriented investor might be inclined to select Fund B because of its higher mean return. By adjusting for risk, or normalizing, it is clear that Fund A has taken more risk than Fund B to achieve its return. Fund A's risk is 70% of its return, whereas Fund B's risk is only 55% of its return.

Another way to look at it is that the higher the number, the more risk per unit of return, and the lower the number, the less risk per unit of return. When using coefficient of variation an investor would choose the lower number with the lower risk per unit of return. With this and other formulas, an easy way to see how the formula works, and whether you would want a higher or lower number, is to change just one variable. For example, assume the following scenario:

Fund	Mean Return	Standard Deviation
A	10%	10
Z	10%	20

Notice that each fund has the same return (10%) but Fund Z's standard deviation (20) is twice that of Fund A's (10). Calculating the coefficient of variation we get the following results:

$$\text{CVa} = \frac{10}{10} = 1.00 \quad \text{CVz} = \frac{20}{10} = 2.00$$

It is obvious without even doing a calculation that we would prefer Fund A over Fund Z. They both give us the same return, but Fund Z has twice the risk as measured by standard deviation (20 versus 10). Would an investor want to take twice the risk to achieve the same return? Probably not. As you can see by the coefficient of variation for each, Fund A has a lower coefficient of variation than Fund Z, and Fund A is the investment an investor would choose.

The coefficient of variation formula will be provided to you on the course exam, but it is not on the CFP exam sheet, so you will need to memorize it. Remember that it is simply the standard deviation divided by the mean return (S/M), and the lower the number the better.

Reading the next part of this chapter will enable you to:

2–5 *Identify covariance and correlation coefficient, know how to calculate one given the other, and understand their application and relevance when calculating the standard deviation of a portfolio.*

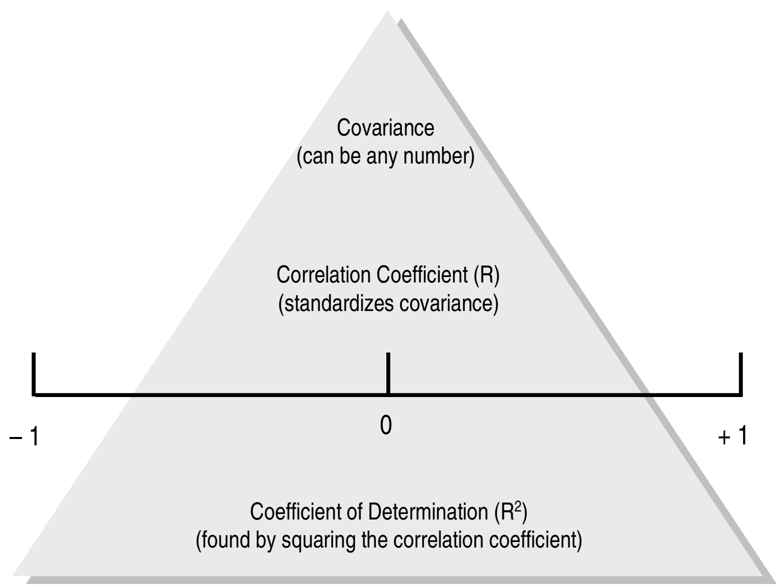
2–6 *Identify the coefficient of determination, know how to calculate and understand its applications.*

Covariance Between Two Assets

Covariance is a very important concept to understand. Covariance measures the extent to which two variables (such as two stocks) are related to each other, or how the price movements of one of the securities are related to the price movements of a second security. Understanding the relevance of covariance between two assets gets to the crux of what diversification is all about; if we want to diversify we need to add an asset that does not behave in the same way as the asset we already have.

We will be discussing covariance, correlation coefficient (sometimes referred to as "R"), and coefficient of determination (referred to as "R-squared" or R^2). As you will see, once we have calculated covariance we can then calculate the correlation coefficient, and once we have the correlation coefficient we can then calculate the coefficient of determination (R^2). All three are related, and all three deal with correlation.

Figure 10: Covariance



Refer again to the upper left part of Figure 4. When we have the set of individual returns and the average of those returns for two (or more) assets, we can compute the standard deviation of each security and we can use the same numbers to compute the covariance of returns.

In this course, you will not be required to compute covariance using the individual returns and the average return for each asset. In the "real world" this is how covariance is calculated, and then you would be able to calculate the correlation coefficient once you knew the covariance. There is a simpler way to calculate covariance if we already know the correlation coefficient, and this is the formula you would use:

$$COV_{ij} = \rho_{ij}\sigma_i\sigma_j$$

" ρ_{ij} " is the correlation coefficient between the first asset (represented by the letter "i") and second asset (represented by the letter "j"). Note that the symbol " ρ " is the Greek letter "rho" which is typically translated into our letter "r". We used "R" to represent the correlation coefficient in the diagram above. Continuing with the formula, you would multiply the correlation coefficient between the two assets by the standard deviation of each of the assets to arrive at their covariance.

Example. The Pueblo Fund has a standard deviation of 18, and the Durango Fund has a standard deviation of 24. The correlation coefficient between the two is .64, what is their covariance?

$$COV_{ij} = (.64)(18)(24)$$

$$COV_{ij} = 276.48$$

If you were to compute covariance using individual returns and average returns, first you would compute each security's difference from its own average return for each period (assume monthly periods over a three-year period). You would then multiply the monthly difference of Security A by the monthly difference of Security B. If the differences were both positive or both negative, you would get a positive number; if one were positive and the other negative, you would get a negative number. A positive product means that both securities move in the same direction (either up or down); a negative product means that while one security moves up in price, the second moves down in price.

After you have computed each one of these 36 monthly products, you would compute the sum of the 36 products and then divide by n – 1. Your answer would be either a negative or a positive number. A negative answer means that, generally, the two security prices move in opposite directions; a positive answer means that the two security prices move in the same direction. The higher the number the more the two assets move together; the lower the number, the more they move apart.

The problem with covariance is that there are no boundaries on the number; if there were boundaries, you would have a reference point to know how large or small the positive or negative number is. Your answer could be –112, –47, +32, or + 276.48 that we came up with our example. Because of this problem, covariance is not commonly used by investment professionals to describe the relationship between the price movements of two securities. Instead, correlation coefficient is used because a correlation coefficient has boundaries that range from –1.0 to +1.0. This process is called "normalizing the values." We can easily calculate the correlation coefficient between two assets once we know the covariance. The formula can be arrived at algebraically by taking $COV_{ij} = \rho_{ij}\sigma_i\sigma_j$ and dividing each side by $\sigma_i\sigma_j$. This would leave just 'R" (ρ_{ij}) on one side of the equation, and covariance divided by $\sigma_i\sigma_j$ on the other, and would look like this:

$$R_{ij} = \frac{COV_{ij}}{\sigma_i \times \sigma_j}$$

Looking at our previous example, we came up with a covariance of 276.48, and we had standard deviations of 18 and 24:

$$R_{ij} = \frac{276.48}{18 \times 24}$$

$$R_{ij} = .64$$

Note that this brings us back to the correlation coefficient of 0.64 with which we started.

Our application for covariance is to use it in the formula for computing the standard deviation of a portfolio of two or more assets. We will discuss that computation later.

Correlation Coefficient (R)

We need the correlation coefficient to better understand the relative degree of covariance of two assets. The correlation coefficient standardizes covariance for us, and puts boundaries of –1 and +1 on the relationship of two assets. Once the covariance is computed, the following formula is used to convert the covariance to a correlation coefficient:

$$R_{ij} = \frac{COV_{ij}}{\sigma_i \times \sigma_j}$$

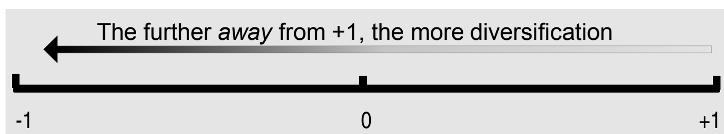
In the formula, R_{ij} is the symbolic representation of correlation coefficient between assets “i” and “j”; “σ” represents the standard deviation of each asset (i and j); and covariance is the positive or negative relationship between the two assets. By dividing the covariance by the product of the standard deviations of the two assets, we standardize the covariance and give it boundaries. This helps investors understand the relative degree of the relationship between two assets.

When we have the standard deviation of two assets (or an asset and the market) and we have the covariance between those two assets, we have all we need to compute the correlation coefficient.

Generally, investors do not compute the correlation coefficient between two individual assets (although this is important to do when constructing a portfolio). Most often, investors want to know the correlation coefficient of one asset with the market. Therefore, the standard deviation of an individual asset and the standard deviation of the market are computed; the covariance of the asset with the market is then computed; and finally, the correlation coefficient between the asset and the market is computed.

Correlation coefficients range from +1 (meaning that the asset and the market have a perfectly positive relationship), through 0 (meaning that the asset and the market have no relationship), to –1 (meaning that the asset and the market have a perfectly negative relationship).

With a perfectly positive relationship (+1), when the market rises 10%, the asset can be expected to rise 10%; conversely, when the market falls 10%, the asset can be expected to fall 10%. With a correlation coefficient of 0 (no relationship), the asset could rise, fall, or do nothing when the market rises. An investor may or may not participate in a market rise when the relationship is 0. And, with a perfectly negative relationship (–1), the asset can be expected to fall by 10% when the market rises by 10% (this would have to be some kind of derivative). The closer a correlation coefficient is to +1, the closer the relationship between the asset and the market. The further a correlation coefficient is from +1 (in other words, going to the left on this diagram, moving toward 0 or –1) then the lower the correlation, and subsequently the more diversification. The further to the left you go, the more diversification you achieve.



When constructing an investment portfolio using mutual funds, one should not purchase a fund with a +.88 correlation coefficient with the S&P 500 and another with a +.931 correlation coefficient with the S&P 500. These two funds are far too related. The investor may as well invest all of his or her money in one of the two funds. The names, management companies, portfolio managers, and even companies in which the two funds invest may be different, but both funds move in the same direction, and in about the same proportion, as the market. A better combination of funds would be one with a correlation coefficient of +.88 with the S&P 500 and a second with a correlation coefficient of +.35 with the S&P 500. When constructing portfolios, it is not necessary (and it is virtually impossible) to have negative correlation coefficients among all assets and the market. Assets with low positive correlation coefficients diversify a portfolio quite well.

Determination of “the market” or an appropriate benchmark can be difficult. Most often, investors use the S&P 500 index as a proxy for the market. This can be appropriate in circumstances when an investor has, say, a large-cap U.S. stock fund that mirrors the performance of the S&P 500 index and the investor wants to purchase a second fund that will perform differently. The investor can look for another fund that has a low correlation with the S&P 500, and he or she can be relatively assured that the two funds are, in fact, different.

Using the S&P 500 index as the market proxy can be more difficult when an investor does not own any mutual funds and finds two funds that have correlation coefficients with the S&P 500 index of +.21 and +.42, respectively. This tells the investor that both funds react independently of the S&P 500 index, but it does not tell the investor if both funds are closely correlated with each other or if they act independently of each other. In this case, a correlation coefficient of the two funds with each other would have to be computed.

Example. Assume that the Small-Cap Mutual Fund has a standard deviation of 17.2, that the S&P 500 index has a standard deviation of 14.7, and that the covariance between the fund and the index is +41. What is the correlation coefficient between the fund and the market?

$$R_{ij} = \frac{COV_{ij}}{\sigma_i \times \sigma_j}$$

$$R_{ij} = \frac{+41}{(17.2) \times (14.7)} = .16$$

The correlation coefficient of one asset (or one asset class) can be compared to only one other asset (or asset class) at a time. Therefore, investors typically use a table that is similar to the following correlation coefficient table.

Table 7: Correlation of Returns Among Asset Classes (1970–2013)

	Intl. Stocks	Large Co. Stocks	Small Co. Stocks	L-T Corp. Bond	L-T Gov't Bond	Inter.-term Gov't Bond	T-bills	Inflation
Intl. Stocks	1.00							
Large co. Stocks	0.66	1.00						
Small Co. Stocks	0.50	0.73	1.00					
L-T Corp. bond	0.02	0.22	0.06	1.00				
L-T Gov't Bond	–0.13	0.00	–0.15	0.89	1.00			
Inter.-term Gov't Bond	–0.16	0.03	–0.12	0.87	0.89	1.00		
T-bills	-0.03	0.04	-0.02	0.05	0.09	0.36	1.00	
Inflation	–0.10	–0.12	0.01	–0.35	–0.28	–0.10	0.66	1.00

Source: *Ibbotson SBBI 2014 Classic Yearbook*. Used with permission.

An investor who just owns large-cap stocks and is looking to diversify would interpret the preceding table as follows: He has several choices, including small-cap stocks, which have a correlation of .73 with the large-cap market. International stocks, represented by the EAFE (Europe, Australia, and Far East) index, have a correlation of just .66. Bonds make a very good diversifier, as you can see from their low correlations, .22 for corporate bonds, and 0.0 for long-term government bonds. Table 8 illustrates how bonds were an effective diversifier during the 2008 financial crisis.

Table 8: Returns During the Financial Crisis

	Financial Crisis 4th qtr 2008	Financial Crisis 1st qtr 2009
U.S. (S&P 500 Index)	–21.90%	–11.00%
International (MSCI EAFE)	–20.33%	–14.64%
U.S. Bonds (Barclay's Capital Aggregate Bond Index)	+ 4.60%	+ 0.10%
International Bonds (S&P/Citigroup Int'l Treasury Bond x-U.S.)	+ 6.92%	–4.65%

Source: *Standard & Poor's*, Citigroup, Jewish Community Foundation

Note that while U.S. stocks were down 21.9% in the fourth quarter of 2008, U.S. bonds were up 4.6%, and international bonds up 6.92%. Historically, even recently, bonds (and cash) have been effective diversifiers (meaning low correlations) with stocks. During the recent crisis, diversifying within the asset class of stocks was not effective—the whole global stock market went down. However, diversifying across asset classes, such as having bonds and commodities along with stocks, helped to buffer some of the downside movement in stocks.

Table 9 shows what happens to risk and return as you go from entirely stocks to a blend of stocks and bonds:

Table 9: Stock & Bond Allocations

1/1/26 to 12/31/13	Geometric mean	Standard deviation
Large Company Stocks	10.1	20.2
90% Stocks/10% Bonds	9.8	18.2
70% Stocks/30% Bonds	9.1	14.4
50% Stocks/50% Bonds	8.3	11.2
30% Stocks/70% Bonds	7.3	9.2
10% Stocks/90% Bonds	6.1	9.1

Source: *Ibbotson SBBI 2014 Classic Yearbook*

Note how much the risk drops with a mix of 70% stocks and 30% bonds—down to a standard deviation of 14.4 compared with 20.2 with all stocks. Then look at the return, which goes from 10.1% down to just 9.1%. So return has declined 9.9% (on a percentage basis), whereas the risk, as measured by standard deviation, has fallen 28.71% (on a percentage basis). This is made possible by the low correlations between the stocks and bonds. The difference is even more dramatic at 50% stocks and 50% bonds, where the return declines 17.82% from 10.1% to 8.3%, yet the standard deviation declines 44.55% from 20.2% to 11.2%!

Investors can obtain recent asset class correlation coefficients from brokerage firms or publications that report on asset class relationships. Professionals will often have access to asset correlations through their company's research department. Correlations do change over time, so remember that these calculations are based on past data. They can be extremely helpful in constructing portfolios, but the correlations are not set in stone. For example, the correlation of foreign markets with U.S. markets used to be lower, but now with the effects of globalization, the correlation is higher. Foreign stocks are still a good diversifier, but not to the extent they were in the past. Another factor to consider is the time period being used to calculate the correlations. You may think that the longer the time period the better, but if the correlation has changed recently, then this may not be picked up if a longer rather than a more recent time frame is being used.

Changing Correlations

We have taken a look at some correlations, but these are "static" numbers reflecting the past, not the future. So what else should we take into account when using correlations? One important fact is that correlations change over time, sometimes quite dramatically. Therefore, one needs to be careful about assuming that past correlations will stay the same in the future.

The *Ibbotson 2014 SBBI Yearbook* calculates a 60-month rolling correlation between international and U.S. large company stocks. Their studies show that the benefit of diversifying between these two groups has suffered in recent years. Looking at a period from 1975 through 2013, the lowest correlation (thus, the most diversification) occurred in the 60-month period ending July 1987, when the correlation coefficient was just 0.26. The highest correlation (thus, the least amount of diversification) occurred in the 60-month period ending February 2013, when the correlation coefficient was 0.93. Note that this period includes the bear market from October 2007 to March 2009; when diversification from U.S. stocks was needed most, international stocks did not provide that diversification. During this entire time horizon (1975–2013), the correlation averaged 0.61.

This is an example in which using a long-term historical average correlation is misleading. A U.S. investor may believe that by investing internationally they are achieving a relatively high level of diversification (for example, relying on the 0.61 correlation) when, in fact, they are adding an asset class that is moving much closer to their own markets (the more current 0.93 correlation). The benefits of diversification have been highly touted for decades, but our understanding of correlation (which is how we measure the amount of diversification we are achieving) is often limited and biased in ways that many financial professionals either overlook or are not even aware.

In order to be knowledgeable about international investing and correlations (and thus, diversification), investors and advisers should be aware of the following:

- Correlations will be different depending upon the time frame used. This means that long-term correlations may be misleading if correlations have changed recently. Since correlations are not constant and change over time, investors and advisers need to be aware of the possibility of significant changes in correlation.
- Correlations are also inconsistent in rising and falling markets. Studies show that correlations tend to decrease (become lower) in rising markets, and increase (become higher) in falling markets, which is the opposite effect an investor would desire. When markets are falling investors would prefer to reap the benefits of more diversification, not less. Think about the ramifications of correlation changes in rising and falling markets, and what this means for investors and advisers.

It is important not only to look at average correlations, but also at the volatility of the average. William J. Coaker, II has covered this very issue in a series of articles he wrote for the *Journal of Financial Planning*. Coaker looked at the correlation of International and Emerging Markets stocks compared with the S&P 500 over one-, three-, five-, and ten-year rolling average periods and came up with the following results:

Table 10: Correlation of International & Emerging Stocks with the S&P 500

International Stocks—Correlation of the Morgan Stanley Country Index (1970–2004) with the S&P 500	Emerging Markets—Correlation of the Morgan Stanley Emerging Markets Index (1988–2004) with the S&P 500
▪ One year: –0.41 to 0.96	▪ One year: –0.17 to 0.96
▪ Three years: 0.11 to 0.89	▪ Three years: 0.29 to 0.87
▪ Five years: 0.26 to 0.86	▪ Five years: 0.28 to 0.79
▪ Ten years: 0.36 to 0.78	▪ Ten years: 0.40 to 0.69
▪ Annual standard deviation of correlations is 29.4%	▪ Annual standard deviation of correlations is 24.4%

One can see an extremely high variability in correlations, especially for shorter time frames. International stocks have seen correlations as low as –0.41 for a one-year time horizon up to +0.96, which is very close to being perfectly correlated. A –0.41 correlation provides a high degree of diversification, whereas a 0.96 correlation provides almost none. The range of historical correlations is still fairly substantial even at three or five years. With emerging stocks we also find a high variability in one-year correlations, ranging from –0.17 to 0.96. Even at five years, the correlation range is still fairly substantial, from 0.28 to 0.79. These wide ranges show how difficult it can be to construct a portfolio that has assets with low correlations with one another, especially over a short time horizon of five years or less. An investment may be made with the expectation that it will continue to have a low correlation with current holdings, only to find it is of minimal help if the correlation changes substantially the next year or so. Advisers need to be aware of this volatility with correlations so that they do not have unrealistic expectations on what the future may hold.

Here are some other correlations for various international markets with each other:

Table 11: S&P/Citigroup BMI Global Index Correlations
Developed Markets U.S. $, December 2002–December 2007

	U.S. S&P 500	U.K. FTSE 100	Japan Nikkei 225	S&P/ Citi BMI Global	World	Asia Paci- fic	Europe	North America
U.S. S&P 500	1.00							
U.K. FTSE 100	0.74	1.00						
Japan Nikkei 225	0.38	0.31	1.00					
S&P/Citi BMI Global	0.92	0.85	0.55	1.00				
World*	0.94	0.85	0.54	1.00	1.00			
Asia Pacific	0.47	0.47	0.93	0.69	0.67	1.00		
Europe	0.84	0.94	0.36	0.93	0.94	0.52	1.00	
North America	0.99	0.74	0.42	0.95	0.96	0.52	0.85	1.00

Source: *Standard & Poor's Global Stock Markets Factbook 2008*

* World Index consists of 26 developed countries in the Asia Pacific, European, and North American regions

Coefficient of Determination (R-squared)

Few investors have heard of the term coefficient of determination; many, however, have heard of the term "R-squared (R^2)." They both refer to the same thing. R^2 is the square of the correlation coefficient. (R-squared is the terminology used by Morningstar.) Refer to the bottom of the covariance pyramid in Figure 10.

R^2 indicates the percentage of one asset's movement that can be explained by the movement of a second asset. Generally, the second asset is a market index or benchmark, such as the S&P 500 index, and the first asset is an individual stock or a mutual fund.

Continuing with the preceding example from the correlation coefficient section, the correlation coefficient of the small-cap fund with the S&P 500 index was determined to be .16. If we square that number, $(.16)^2$, we get .0256, or 2.56%. This tells an investor that only 2% to 3% of the price movements of the small-cap fund can be explained by the movements of the S&P 500 index. The remaining 97% to 98% of the fund's price movements are due to other factors. These other factors could include management's stock-picking ability, inefficiencies in the small-cap market compared to the large-cap market, or other factors. We do not know what those other factors are, but we generally assume that the main factor is the stock-picking ability of the portfolio manager. Another way to look at R^2 is as a measure of systematic risk (explained by the benchmark), with the balance being unsystematic risk (explained by other factors).

Morningstar Inc. assumes that a mutual fund with an R^2 that exceeds 70% is fairly highly correlated with the market and thus is not an effective diversifier. The square root of 70% is approximately .84. Therefore, we can assume, using the Morningstar criteria, that a mutual fund with a correlation coefficient higher than +.84 is not a good fund to add to a portfolio that already holds a fund indexed to the S&P 500 index. However, a fund with a –.84 correlation coefficient is a good diversifier, even though its coefficient of determination will also be approximately 70%. The difference is that it is highly negatively correlated. Remember, though, that negative correlations are rare, and not necessary for diversification.

Calculating the Correlation Coefficient

You should be able to calculate the correlation coefficient (R) if given the coefficient of determination (R^2), or vice versa. You may be given one in a problem and need the other to arrive at an answer—be prepared! If given the correlation coefficient, you just square it to arrive at the coefficient of determination. This is an easy function on your calculator:

Example. What is the coefficient of determination if the correlation coefficient between the Thor Fund and the S&P 500 Index is .70?

HP-10BII+: .70, SHIFT, x^2 (the "+" key), answer is .49

HP-12C: .70, ENTER, 2, y^x, answer is .49

This then means that 49% of the risk is systematic risk, explained by the S&P 500 benchmark, and the other 51% of the risk is unsystematic risk, explained by other factors.

You should also know how to calculate the correlation coefficient (R) if given the coefficient of determination (R^2). This is done by taking the square root of the coefficient of determination, and is easily done on your calculator:

HP-10BII+: .49, SHIFT, $\sqrt{x}$ (the "–" key), answer is .70

HP-12C: .49, ENTER, g, $\sqrt{x}$ (the "y^x" key), answer is .70

Portfolio Standard Deviation

We have now been all around the left side of Figure 4 and surrounded the "Standard Deviation of a Portfolio" box. An investor has to know all that we have covered so far to understand how all these factors enter into the design of a well-diversified investment portfolio.

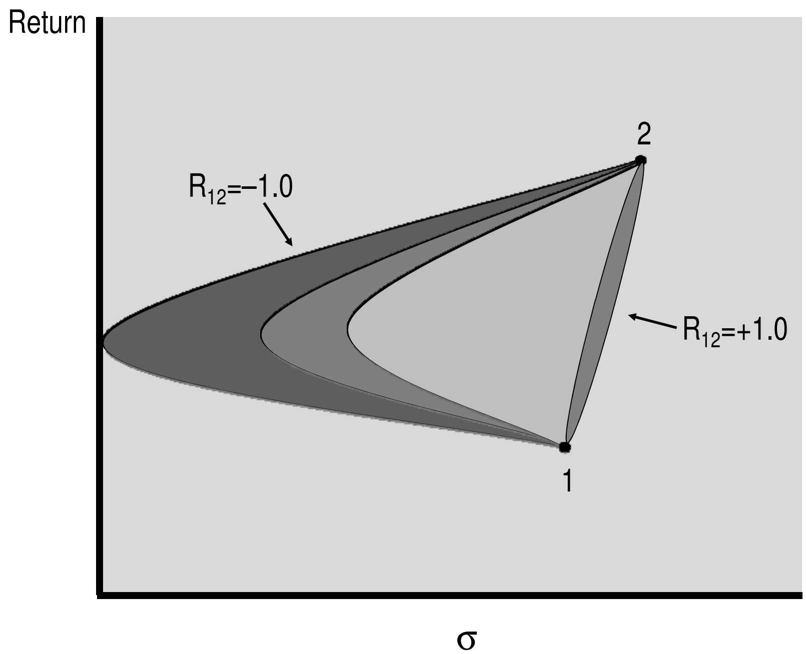
The formula for computing the standard deviation of a two-asset portfolio is as follows:

$$\sigma_p = \sqrt{W_i^2\sigma_i^2 + W_j^2\sigma_j^2 + 2W_iW_jCOV_{ij}}$$

In this formula, W represents the percentage weight of each asset in the portfolio, expressed as a decimal (e.g., .40); σ represents the standard deviation of each asset, expressed as a whole number (e.g., 27); and COV represents the covariance of assets i and j, expressed as a whole number (e.g., +57). Note that for the purposes of this course, we use only a two-asset portfolio. The formula would be expressed slightly differently if we were calculating the standard deviation for a portfolio of more than two assets, and the formula would become longer and longer as we added assets. This is because the formula has to take into account all the possible combinations of assets. With a two-asset portfolio we just have the covariance between asset 1 and asset 2. With a three-asset portfolio you would need to include the covariance (and weightings) between assets 1 & 2, assets 1 & 3, and assets 2 & 3. You can see how this can become extremely cumbersome as you add more and more assets! (Note also that we recommend that you use whole numbers for standard deviation and covariance so that you can more easily remember where to put the decimal point in the calculation. This may not be technically correct, but it does simplify recall and understanding.)

Although the relative weights of the assets in the portfolio are important, the most important variable in the equation is the covariance of the two assets. The impact of covariance can be seen in Figure 11. The figure shows a straight line between Asset 1 and Asset 2 when the correlation coefficient is +1.0. As the correlation coefficient moves from +1.0 to –1.0, you can see how risk is reduced at each level of expected return for the portfolio. When the correlation coefficient is -1 (perfectly negatively correlated) there is a point at which your risk is zero, assuming you are 50% invested in each asset, and each asset has the same standard deviation.

Figure 11: Correlation and Risk Reduction



Note that the only time that the weighted-average approach can be used to compute the standard deviation of a portfolio of assets is when the correlation coefficient is a perfectly positive +1.0. All other times, the formula must be used, because you must take into account how much the assets move together or apart, measured by covariance. When the correlation coefficient is less than +1, then you know that the standard deviation of the portfolio (two assets in this case) is going to be less than the weighted average standard deviation of the two assets.

We have already seen the power of covariance in reducing risk when we looked at the Morningstar Ibbotson numbers:

1/1/26 to 12/31/11	Geometric Mean	Standard Deviation
Large Company Stocks	9.8	20.3
70% Stocks/30% Bonds	9.0	14.5

In our example, the return goes from 9.8% down to 9.0%, a percentage decline of 8.2%, whereas the risk, as measured by standard deviation, has fallen 28.6%. How does the risk fall more than if we just took 70% of the stock standard deviation and 30% of the bond standard deviation (in other words, a weighted average of the standard deviations, which is 18.6%)? And the answer is covariance (or correlation, which is the same thing). If it were not for covariance and its impact on risk, then the standard deviation of a 70% stock/30% bond portfolio would not be 14.5, but would be the higher number of 18.6% that would reflect the weighted average of the standard deviations of the stocks and bonds. All else being equal, as the correlation falls, so will the risk as measured by standard deviation.

Example. Consider two securities, A and B. Their expected returns, standard deviations, and weights in the portfolio are as follows:

Security	Expected Return	σ	Weight
A	15%	10	.40
B	25%	20	.60

The expected return for the portfolio is simply the weighted-average return of the two assets. This is computed as follows:

$$.40 \times 15\% + .60 \times 25\% = 21\%$$

Calculating the standard deviation of a portfolio is not this easy, and in almost all cases we cannot use a weighted average. What is the standard deviation of a portfolio of the two securities if the correlation coefficient between the two assets is 1.0, 0.5, 0, –0.5, and –1.0?

Using the preceding formula, the standard deviation of the portfolio when the correlation coefficient is 1.0 is calculated as follows:

$$\sigma_p = \sqrt{W_i^2\sigma_i^2 + W_j^2\sigma_j^2 + 2W_iW_jCOV_{ij}}$$

$$\sigma_p = \sqrt{(.40)^2\ (10)^2\ +\ (.60)^2\ (20)^2\ +\ 2(.40)(.60)(10)(20)(1.0)}$$

Break this formula down into three sections:

1st asset: $(.40)^2\,(10)^2$

$= .16 \times 100$

$= \mathbf{16}$

2nd asset: $(.60)^2\,(20)^2$

$= .36 \times 400$

$= \mathbf{144}$

Weightings and covariance: $2(.40)(.60)(10)(20)(1.0)$

$= \mathbf{96}$

So now we have:

$$\sigma_p = \sqrt{16+144+96}$$

$$\sigma_p = \sqrt{256}$$

$$\sigma_p = 16$$

Remember how to solve for a square root on your calculator:

HP-10BII+: 256, SHIFT, $\sqrt{x}$

HP-12C: 256, g, $\sqrt{x}$

In this scenario we could have used a weighted average of the standard deviations, since the two assets had a perfect positive correlation (+1). However, once the correlation is any number less than 1, the formula has to be used.

Note that to enter the covariance in the formula, the correlation coefficient must first be converted to covariance. Using algebra, the formula for correlation coefficient is restated to make this computation as follows:

$$R_{ij}\text{ (correlation coefficient)} = \frac{\text{COVij}}{(\sigma_i) \times (\sigma_j)}$$

When both sides of the equation are multiplied by $(\sigma_i) \times (\sigma_j)$:

$$R_{ij}\text{ (correlation coefficient)} \times (\sigma_i) \times (\sigma_j) = \text{COV}_{ij}$$

or

$$COV_{ij} = \rho_{ij}\sigma_i\sigma_j$$

This restated formula is provided to you both on the Exam Formula Sheet for the course exam, and on the exam formula sheet provided by the CFP Board.

For the other correlations, the portfolio standard deviations are as follows, and you can see that as the correlation coefficient falls, so does the standard deviation. Remember that the expected returns and the weightings are staying the same, we are just changing the correlation.

R_{12}	σ_p
+1.0	16.0
+0.5	14.4
+0.0	12.6
–0.5	10.6
–1.0	8.0

So the lower the correlation between two assets, the lower the risk will be as measured by standard deviation.

You may be required to calculate the standard deviation of a portfolio on the CFP exam, as it is being tested more often than it was in the past. You must also understand it and be prepared for conceptual questions. For example, if the correlation coefficient is less than 1 (perfectly positively correlated), you need to know that the standard deviation of the portfolio is going to be less than the weighted average standard deviation of the assets. If we look at the problem we have just done, the standard deviation weighted average was 16. And the standard deviation of the portfolio came out to be 16, which is logical given the +1 correlation. Let's see what happens if the correlation is +.95:

$$\sigma_p = \sqrt{(.40)^2 (10)^2 + (.60)^2 (20)^2 + 2(.40)(.60)(10)(20)(0.95)}$$

1st asset: $(.40)^2 (10)^2$

$= .16 \times 100$

$= \mathbf{16}$

2nd asset: $(.60)^2 (20)^2$

$= .36 \times 400$

$= 144$

Weightings and covariance: $2(.40)(.60)(10)(20)(0.95)$

$= \mathbf{91.20}$

$$\sigma_p = \sqrt{16 + 144 + 91.20}$$

$$\sigma_p = \sqrt{251.20}$$

$$\sigma_p = 15.85$$

Now that the correlation has dropped from +1 to +0.95 we can see that the standard deviation of the portfolio has also dropped, from 16 to 15.85. This shows the power of diversification: the lower the correlation, the lower the risk as measured by standard deviation. A good starting point for any problem is to take the weighted average of the standard deviations of the two assets, and you then know that is the *maximum* standard deviation possible (if the two assets are perfectly correlated). If they are not perfectly correlated then the standard deviation of the two assets together must be less, and the lower the correlation, the lower the standard deviation.

In the examples above, a number of correlation coefficients between the two assets were given. However, only one unique correlation coefficient actually exists for each set of assets at any given point in time. As we have discussed earlier, these correlations change over time. The correlations provided above show how the standard deviation of a portfolio decreases as the correlation between the assets decreases. As long as the correlation is less than +1.0, there will be benefits from diversification. An investor will be able to achieve a given expected return at a lower risk level.

Example: Correlation

Michael has $50,000 invested in a U.S. large-cap stock fund that has a three-year average return of 7%, and a standard deviation of 16. He is considering investing another $50,000 into an emerging market stock fund that has a three-year average return of 11%, and a standard deviation of 32. The correlation coefficient between the two funds is 0.35. What is the standard deviation of the portfolio?

If the two funds were perfectly correlated (+1) with each other we could just use a weighted average of the two standard deviations, which would be 24. Since these two funds are not perfectly correlated we know that the standard deviation is going to be less than 24.

$$\sigma_p = \sqrt{W_i^2\sigma_i^2 + W_j^2\sigma_j^2 + 2W_iW_jCOV_{ij}}$$

$$\sigma_p = \sqrt{(.50)^2\,(16)^2 + (.50)^2\,(32)^2 + 2(.50)(.50)(16)(32)(0.35)}$$

Notice that we need covariance at the end of the formula, but that has not been given to us, the correlation coefficient has. We can then go to the formula sheet for the formula for covariance:

$$COV_{ij} = \rho_{ij}\sigma_i\sigma_j$$

So covariance = (0.35)(16)(32), which we have put at the end of the equation. To solve this equation we will now break it down into three sections, as we did in our earlier example:

$$\sqrt{(.50)^2\ (16)^2} = (.25)(.256) = 64$$

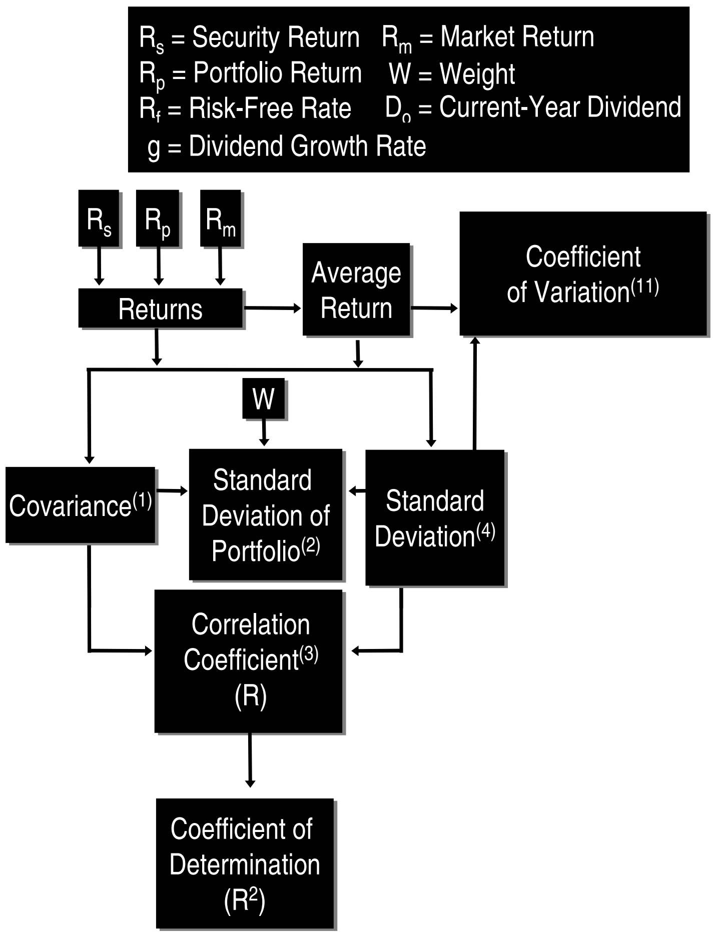
$$\sqrt{\ (.50)^2\ (32)^2} = (.25)(1024) = 256$$

$$\sqrt{\ 2(.50)(.50)(16)(32)(0.35)} = 89.6$$

$$\sigma_p = \sqrt{64 + 256 + 89.6} = \sqrt{409.6} = 20.24$$

If you want to experiment and see what various correlations would do to the standard deviation of these two assets, then just change the last number (the 0.35) to any number between –1 to +1 and you can see the impact of correlation on the standard deviation of the two assets.

Here is what we have covered so far from Figure 4:



Hopefully this diagram is beginning to make more sense, and helping you to organize your thoughts about these various concepts.

Chapter 3: Risk & Return Analysis—Beta & CAPM

Reading this chapter will enable you to:

2–7	*Calculate the beta coefficient, and understand its use and limitations.*

Beta Coefficient

As noted earlier in this module, once unsystematic risk has been diversified away, only systematic risk remains in a portfolio. The total risk of a security or a portfolio, the sum of unsystematic and systematic risk, is measured by standard deviation (variability). Systematic risk of a security is measured by beta (volatility). Once we have assembled a portfolio of sufficient size—generally one that has at least 10 to 15 securities from different industries—we can assume that we have little or no unsystematic risk in the portfolio. We can also assume that beta can now be used to measure the risk of the portfolio and the risk of each individual asset within that portfolio.

Beta tells us how volatile an asset is compared to another, typically an index benchmark, such as the S&P 500. A beta of 1 means that the asset is just as volatile as the market, so if the market moves up 10%, so should the individual asset. If the beta is 1.2, this means that the asset has 120% of the volatility of the benchmark. So if the market moves up 10%, then the individual asset should move up approximately 12% (10% × 1.20). Conversely, if the beta is 0.80 (just 80% of the volatility of the benchmark) then the individual asset should move up approximately 8% (10% × 0.80). Aggressive investors will be comfortable with higher betas over 1, whereas risk averse investors will prefer lower betas, below 1. Negative betas are rare, but they would indicate movement in the opposite direction, so if an individual asset had a beta of –0.80 and the market was up 10%, the individual asset would be down 8%. Negative betas would provide positive returns in a down market.

The computation of beta requires calculating the standard deviations of both the individual security and of the market; it also requires calculating the correlation coefficient between the security and the market. The formula is as follows:

$$\beta = \frac{S_i}{S_m} \times R_{im}$$

Another way to state the same thing is:

$$\beta_i = \frac{\rho_{im}\sigma_i}{\sigma_m}$$

In the formula, σ_i (S_i) is the standard deviation of the individual asset; σ_m (S_m) is the standard deviation of the market, and ρ_{im} (R_{im}) is the correlation coefficient between the individual asset and the market.

Example. Assume that the standard deviation of Mountain Enterprises is 22, the standard deviation of the market index is 16, and that the correlation coefficient between Mountain Enterprises and the market is .66. What is the beta of Mountain Enterprises?

$$\beta = \frac{S_i}{S_m} \times R_{im}$$

$$\beta = \frac{22}{16} \times .66 = .9075$$

Or, when expressed the other way we get the same result:

$$\beta_i = \frac{\rho_{im}\sigma_i}{\sigma_m}$$

$$\beta_i = \frac{(.66)(22)}{16} = .9075$$

Interpreting Beta

Interpreting beta can be problematic. Obviously, Mountain Enterprises has a greater variability than the market, evidenced by its higher standard deviation of 22 compared to the market's variability of 16. Dividing the standard deviation of Mountain Enterprises by the standard deviation of the market gives a relative variability of 1.38. The lower correlation of Mountain Enterprises with the market, however, means that Mountain Enterprises will not necessarily move in concert with the market. For example, gold funds often have low betas relative to the S&P 500 index, but they do not have low volatility.

The reason for this is that the correlation coefficient is used in the formula for beta, and we multiply the standard deviation of the individual asset divided by the standard deviation of the market by it. Here is what happens to beta as the correlation falls:

Standard Deviation of the Individual Asset	÷	Standard Deviation of the Market	×	Correlation Coefficient	=	Beta
20		10		1.00		2
20		10		.75		1.5
20		10		.50		1
20		10		.25		.50

You can see in this example that the individual asset has a standard deviation twice that of the market, and when the correlation coefficient is +1 the beta is 2. This means that this particular individual asset has twice the volatility of the market benchmark to which it is being compared. Notice what happens, though, as the correlation falls. When the correlation coefficient is .75 the beta drops to 1.5. The standard deviation has not fallen, it is still twice that of the market, but it now appears that the volatility is only 1½ times the market. When the correlation coefficient is .25 beta drops to .50, meaning that our individual asset has half the volatility of the market, which is obviously not the case. The lesson here is that as correlation falls, so does beta reliability.

Returning to our beta calculation for Mountain Enterprises, it means that Mountain Enterprises may be a good diversifier to add to a portfolio because its lower correlation should help reduce the standard deviation of the portfolio. This lower correlation may also result in a lower beta for the portfolio if the portfolio beta before the addition of Mountain Enterprises was higher than .90 and if the entire portfolio is otherwise fully diversified.

However, if an investor wants to predict next year's return for Mountain Enterprises without regard to its role in a portfolio, another beta may have to be computed. Going back to our earlier discussion on R^2 (coefficient of determination), when we square the correlation coefficient (R), $(.66)^2$, we get an R^2 of 44%. This tells us that the base against which Mountain Enterprises' beta is measured (the market index) may not be appropriate if we want to predict its return for next year. It tells us that only 44% (systematic risk) of the price movement of Mountain Enterprises is explained by the benchmark we are comparing it to, and the other 56% is unsystematic risk not explained by the benchmark.

We should therefore identify another base against which this security's correlation will be higher (***for testing purposes you are looking for an R^2 of 70% or greater, the threshold used by Morningstar***). For example, if the security is a gold fund, we should compute its beta with respect to a gold index; if it is an emerging markets fund, we should compute its beta with respect to an emerging markets index. Even though you are using an R^2 of 70 or higher to determine if beta is reliable or not, it is important to understand that it is not as if beta is a good number at an R^2 of 70 and then suddenly at 69 it is not. Beta is most reliable when the R^2 is 100 (an index fund will have an R^2 of 100 with the index it is mirroring), and the reliability declines as R^2 declines. There is no one specific point at which beta is no longer useful, it just becomes more unreliable as R^2 declines. For testing purposes, though, you need a cutoff point, and the cutoff point that the CFP Board uses is an R-squared of 70 or higher. This issue of whether beta is a reliable number or not is very important since we will cover other formulas that use beta. If beta is unreliable (below 70), then we will not be able to use a formula with beta in it. This will be discussed in more detail later when we cover additional formulas.

Here is a theoretical example of how a beta may be chosen:

ABC Real Estate Fund

R-squared	Index	Beta
28	EAFE	0.45
98	Wilshire REIT	0.95

In this example we see that ABC has a low beta when compared with the EAFE Index. The problem with this beta is that there is only 28% systematic risk explained by the EAFE, and the balance of 72% is unsystematic risk. For all intents and purposes, beta is a meaningless number when using this index. It is misleading to believe that this fund has less than half the volatility of the market (as measured by EAFE in this case). The low R^2, though, means that this real estate fund would be a very good diversifier if the investor were currently holding a portfolio highly correlated with the EAFE index.

A much better indicator of volatility would be the beta of 0.95 when compared with the Wilshire REIT index. Here we have 98% systematic risk (remember you want at least 70% systematic risk for testing purposes), and just 2% unsystematic risk.

Oftentimes investors may take a beta for stocks blindly, without knowing the correlation and index the beta is based on. This can lead to investing in a stock with the impression that is has low volatility, when in fact it is an extremely volatile stock. It may just be that there is a low correlation between the market benchmark being used and the stock and this is causing the beta to be low.

Duality of R-squared (and correlation coefficient)

We have now discussed how correlation coefficients (and coefficient of determinations—R-squareds) can be used in two different ways, and whether we want a higher or lower number depends upon how we are using it. For diversification purposes the lower the number, the better—this is because the lower the number the less correlation there is between our asset and the benchmark (or other asset) we are comparing it to. Less correlation means more diversification, so for diversification purposes the lower the correlation coefficient or R-squared, the better.

The opposite is true if we are trying to determine if beta is a reliable number and whether it can be used or not. For beta to be considered reliable we need a high amount of systematic risk, so the higher the correlation coefficient or R-squared, the better. For testing purposes you want to see an R-squared of 70 or higher (which would be a correlation coefficient of 0.84 or higher) to have a high enough correlation, and thus enough systematic risk, in order to use beta, or to use any of the formulas that use beta.

Weighted-Average Beta

The computation of a weighted beta for a portfolio is similar to the computation of a weighted return for a portfolio. We'll use the same example as earlier, with the substitution of beta for returns.

Example. Sherman has a $75,000 investment portfolio with $40,000 invested in TRO stock fund, $20,000 invested in PES bonds, and $15,000 invested in HXQ REIT. The individual betas for each security were 1.2, 0.9, and 0.8, respectively. What is the weighted-average beta for the portfolio?

Table 12: Calculating the Weighted-Average Beta

Investment	Amount	Beta	Portfolio Weight	Weight × Beta
TRO stock fund	$40,000	1.2	40/75 = .53	.53 × 1.2 = .636
PES bonds	20,000	0.9	20/75 = .27	.27 × 0.9 = .243
HXQ REIT	15,000	0.8	15/75 = .2	.20 × 0.8 = .160
Total	$75,000			1.039

or

Calculator Keystrokes

HP-10BII+		HP-12C	
1.2	INPUT	1.2	ENTER
40	Σ +	40	Σ +
.9	INPUT	.9	ENTER
20	Σ +	20	Σ +
0.8	INPUT	0.8	ENTER
15	Σ +	15	Σ +
	SHIFT $\bar{x}_w$ (6 key)		g, $\bar{x}_w$ (6 key)
	Beta = 1.040		Beta = 1.040

Remember that you can use weighted averages for beta and returns; however, you can only use a weighted average for standard deviation if the two assets are perfectly correlated (+1 correlation). If the two assets are not perfectly correlated, then you must use the standard deviation of a portfolio formula that we covered earlier.

Reading the next part of this chapter will enable you to:

2–8 Calculate required return using the capital asset pricing model (CAPM), and understand its application.

Required Return—CAPM

Refer again to Figure 4. On the right side of the figure are all the factors that depend on beta. In the formula below, beta is an essential element of the required return formula—also known as the capital asset pricing model (CAPM) formula.

Once beta has been calculated for a security, the required return for that security can be determined. This is the total return (income plus capital gain) that an investor should expect to obtain from a security given that security's level of risk. The risk level is measured by the security's beta.

The formula for CAPM (required return) is as follows:

$$r_i = r_f + (r_m - r_f)\beta_i$$

where

r_i	=	the required return of the individual asset
r_f	=	the risk-free rate (generally a Treasury security, usually T-bills)
r_m	=	the return of the market (such as the S&P 500)
$r_m - r_f$	=	the difference between the return of the market and the risk-free rate, this is the "market risk premium"—the additional return investors expect that rewards them for the extra risk they are taking by investing in the market
βi	=	beta of the individual asset

Some controversy exists over the appropriate Treasury security to use for the risk-free rate. In this course, we will follow the most widely used method, which is to use the rate for the three-month Treasury bill. This is also what the CFP Board favors.

Some portfolio managers like to use the rate for the five-year or the ten-year Treasury note. The theory behind this is that the alternative investment for a stock is not a three-month Treasury bill, but rather it is a five- or ten-year Treasury security. A stock is a long-term investment, requiring a holding period of at least five or ten years. If a person is going to invest for a five- or ten-year period, he or she could invest in a Treasury security of that maturity and have no risk. Therefore, the longer-term Treasury security should be the more appropriate risk-free rate.

Example. Assume that the risk-free rate is the three-month Treasury bill rate of 3.5%, that the market's expected return is 8%, and that the beta of ABC stock is 1.1. What return would an investor require to induce him or her to invest in ABC?

$$r_i = r_f + (r_m - r_f)\beta_i$$

$$r_i = 3.5 + (8.0 - 3.5)1.1$$

$$r_i = 3.5 + 4.95 = 8.45\%$$

Note that we multiply beta times the market's risk premium ($r_m - r_f$), and then add the risk-free rate to that number.

In this example the market risk premium is 4.50% (the difference between 8.0% and 3.5%). This is the amount of return the investor requires in order to compensate them for investing in the market. This is easy to see if we use a beta of 1 in the CAPM formula:

$$r_i = 3.5 + (8.0 - 3.5)1.0 = 8.0\%$$

$$r_i = 3.5 + 4.5 = 8.0\%$$

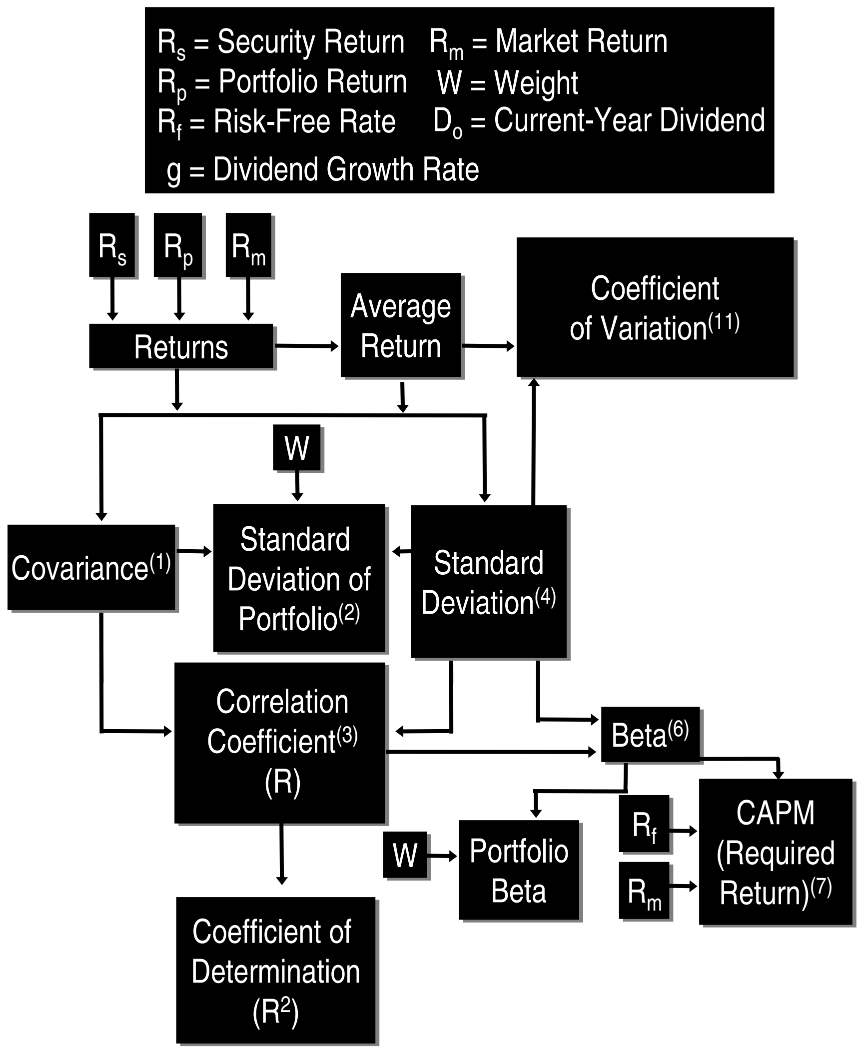
Note that when beta is 1, all we are really doing is adding the risk-free rate to the market risk premium to come up with our required return. In other words, our required return is whatever the risk-free rate is plus the market risk premium. Then all we are doing is adjusting our required return based on the amount of risk we are taking, as measured by beta. As beta increases our required return increases, and as beta decreases, our required return decreases. The formula itself is easy, the big challenge for investors and analysts is to come up with an appropriate future market risk premium.

We used whole numbers in the calculation, but you can also use decimals, as long as you are consistent. For example, we could have done the above formula this way:

$$r_i = .035 + (.08 - .035)1.0 = .08$$

Historically, we can look back and see past risk premiums. Using Ibbotson data from 1972 to 2013, large company stocks had a geometric mean return of 10.5%; with a geometric mean return on Treasury bills of 5.2%. If we take the difference, we would come up with a market risk premium of 5.3% over this 41-year period. If we look at a longer period from 1926 to 2013 (87 years) large company stocks had a geometric mean return of 10.1%, and Treasury bills a geometric mean return of 3.5%. The difference between these two would give us a market risk premium of 6.6%. Realize, though, that these are long time periods, and the market risk premium, just like the market itself, can vary widely on a year-to-year basis. There are always varying opinions on the size of future market risk premiums, with a wide range of projections from different market experts. Sometimes there is an expectation that there is going to be little or no risk premium in the near future, or even a negative risk premium. Obviously, if you don't think there is going to be much of a risk premium, or a negative one, then you would avoid stocks altogether. It doesn't make sense to take extra risk and invest in stocks if you don't think you are going to be rewarded for it. The long-term historical risk premium in the United States has been 4.5% (1900–2005, Dimson, Marsh, and Staunton, 2006).

Here is what we have now covered in Figure 4 so far:



Quantitative Analysis

Modeling and Simulation (aka Multiple Scenario Analysis)

Modeling is used to develop an optimistic, pessimistic, and most probable outcome for a base scenario. It helps an analyst develop a more realistic analysis in conditions of uncertainty.

It is used for many purposes, including enabling the presence of economic forecasts in capital market analysis and retirement planning in financial planning engagements. Modeling generally involves developing a spreadsheet program using many assumptions (e.g., a retirement planning analysis); pessimistic assumptions are then made for a second scenario, and optimistic assumptions are made for a third scenario.

For example, the base (most likely scenario) for a retirement analysis might assume that retirement is at age 65, that 70% of pre-retirement income will be needed, and that life expectancy is to age 78. A pessimistic scenario might assume that retirement is at age 60, that 90% of pre-retirement income is needed, and that life expectancy is to age 85. An optimistic scenario might assume that retirement is at age 67, that 60% of pre-retirement income is needed, and that life expectancy is to age 75.

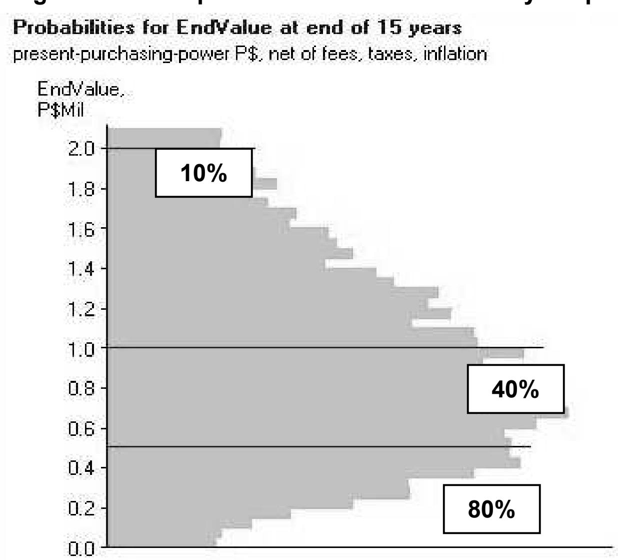
Sensitivity analysis is often performed in such an analysis to determine the impact of unexpected, low probability outcomes. This type of analysis includes many more than three scenarios, sometimes with probabilities included in the analysis. One or more inputs are changed, with all other inputs held constant to see the impact on the final outcome if the changed inputs occur. The inputs changed are the ones that the client believes are most likely to change, or that the planner or client believes might have the greatest impact on the final decision. Sensitivity analysis is also used in an optimization program to determine the impact of changes in return or risk assumptions on an asset allocation.

Monte Carlo Simulation

Monte Carlo simulation is an example of a multiple scenario process used to develop a probability distribution table for retirement planning that is more realistic than the single-point approach that has been used historically by financial planners. The single-point approach uses a rate of return and inflation rate, and applies this in a linear fashion, assuming the same return and inflation rate, year after year. Obviously the market does not behave in this fashion, and this is what Monte Carlo attempts to address, the possibility of various returns over time. A growing number of financial advisers now use Monte Carlo simulation with clients.

Monte Carlo simulation allows a planner to show a client not just one or several possible outcomes, but an almost infinite range of outcomes, with thousands of simulations being the typical product. The output is a probability graph that shows the probability of a wide range of possible outcomes. The graph looks something like the following:

Figure 12: Example of Monte Carlo Probability Graph



Source: Produced using the Portfolio PATHFINDER software, described at www.planscan.net.

In Figure 12, the probability, in 15 years, of having $2 million or more is 10%, of having $1 million or more is 40%, and of having $500,000 or more is 80%. Planners must purchase software to perform these computations, or can help clients use a web-based program to run the analysis.

Monte Carlo analysis helps clients understand that there is no single answer to a complex problem, such as retirement planning. Rather, a range of possible outcomes is likely. It helps clients understand the risk element in the plan, and that their final outcome may be substantially lower or higher than a single number. In addition, if they are concerned about a high probability of not having enough at retirement, they can better understand that they may have to take more risk in their asset allocation. The analysis then can be used to develop an asset allocation that takes into account the risk of not achieving the retirement planning goal. Most Monte Carlo software includes an efficient frontier analysis to accommodate the asset allocation.

The "Black Box." "Black box" refers to situations in which data is inputted and results come out without the individual understanding how the results were arrived at. It is important for the adviser to understand what assumptions are being used to come up with the probabilities in Monte Carlo. Different software will be using different assumptions on the rates of return, standard deviation, and time frame. The adviser should be knowledgeable about the assumptions being used, and have at least a basic understanding of how the probabilities are being calculated. Advisers and clients have to be careful and understand the limitations of Monte Carlo analysis; it can be a very helpful tool, but it is not infallible and can be misleading.

Reading the next part of this chapter will enable you to:

2–9 Evaluate the implications of risk and return measurement concepts for portfolio construction.

Over many decades of investing history, investors have found that attempting to predict investment returns can be a fruitless exercise. More times than not, the market moves contrary to what most prognosticators believe it will do. Although we have learned in this chapter how to compute a required return for a security, we must be careful not to turn our computed number into an expectation. What our calculations say should happen may not necessarily happen in reality. So we must simply accept the fact that returns cannot be managed.

On the other hand, we have been provided with many analytical tools to help us compute, understand, and manage risk. If you are considering investing in a portfolio or a single security and you know what your required return is, you can select from a wide variety of investment opportunities that can meet your return requirement. Your job, then, is to select from all those opportunities one or more investments that have the lowest risk per unit of return.

Selecting Individual Securities

As an example, consider the following mutual funds and their performance data, as reported in a past *Morningstar Mutual Funds* report. All funds are in the small-cap value asset class.

Table 13: Mutual Fund Performance Data

Fund	Standard Deviation	Mean Return	Coefficient of Variation
Fidelity Low-Priced Stock	11.12	23.44%	.47
FPA Capital	14.74	30.05%	.49
MAS Small-Cap Value	17.23	27.44%	.63
Skyline Special Equities	15.19	25.17%	.60

If an investor were interested solely in the best return among the four, he or she would probably eliminate Fidelity Low-Priced Stock on a first review and concentrate on the other three. On the other hand, an investor interested solely in low risk would eliminate all but Fidelity Low-Priced Stock. So it appears, on the surface, that an investor has to select either high return or low risk as an objective. However, Fidelity Low-Priced Stock, with the lowest coefficient of variation, has the best combination of risk and return, making it the best choice among the four. (Remember that to get coefficient of variation you simply take the standard deviation and divide by the mean.) FPA Capital also might be chosen because its risk-adjusted return is about the same as Fidelity's (.49 versus .47), but its total return is significantly higher.

Building a Portfolio

Selecting individual securities is difficult, but combining individual securities (or mutual funds) to build a diversified portfolio with minimal risk is even more difficult. Many investors have a portfolio that is nothing more than a collection of different investments. They may be different in name and outward appearance, but in all likelihood, they do not comprise a diversified portfolio that was created in a systematic manner.

Constructing a systematically developed portfolio requires paying attention to two factors:

- eliminating unsystematic risk, and
- minimizing the total risk (standard deviation) of the portfolio by adding assets that are not highly correlated with each other.

Elimination of Unsystematic Risk

To minimize unsystematic risk, a minimum of 10 to 15 large-cap securities in different industries should be held. For individual stocks, this could mean having a utility company, an automobile manufacturer, an oil and gas company, etc.

Some people assume that a mutual fund that owns more than 15 large-cap securities is automatically diversified. Index funds generally have eliminated all unsystematic risk by having a broad cross-section of industries. Some funds, although not concentrated in terms of the number of different issues held, may be heavily concentrated in two or three industries.

Some mutual fund investors may unknowingly have industry concentration even when they own four or five different funds. If each of the funds owns approximately the same percentages in several industry groups, a fund investor could have realized the same industry allocation by investing all of his or her money in one fund. An important step in the fund selection process is to check the industry concentration levels of each fund under consideration before making a final decision.

Mutual fund investors should also diversify by asset class. The most common equity asset classes include the following:

Large-cap value	Large-cap growth
Mid-cap value	Mid-cap growth
Small-cap value	Small-cap growth
Micro-cap value	Micro-cap growth
Developed international	Emerging markets international

It is not necessary to have one fund in each asset class, but having a fund in four to seven of the asset classes generally will suffice.

Minimization of Total Risk

As noted earlier, the key to minimizing the standard deviation of a portfolio of securities is covariance. Long-term (and shorter-term) correlation coefficient statistics are helpful in the initial design of a portfolio. Several sources are available that report long-term correlation coefficient statistics by asset class.

Using the data from the example in the earlier section on correlation coefficient, an investor could design a well-diversified, lower-risk equity portfolio by selecting a mutual fund from each of the four asset classes shown in that chapter (large cap, small cap, foreign, and emerging market). Each successive asset class has a lower correlation coefficient with large-cap stocks, ensuring that the portfolio standard deviation would be reduced by including an equal weighting of each of the four asset classes. Remember, though, that we also learned that correlations tend to increase in down markets, meaning there will be less diversification when it is needed most. That is why it is important to look beyond equities, and introduce other asset classes such as cash, bonds (corporate, government, and international), and commodities. We will be discussing bonds in more detail in Modules 6 and 7. Real estate and commodities will be covered in Module 9. The many types of mutual funds will be discussed in Module 10.

Once the initial portfolio is set, additional money is often available for investment. Assuming that the value of the initial portfolio rises before additional money is available for investment, an investor should be looking for a fund (from an asset class, an industry group, etc.) that has a falling value while the value of the first portfolio is rising. These falling stocks would generate negative correlation coefficients with the currently held portfolio. Adding these securities to the portfolio would help lower the portfolio's standard deviation even further. Of course, the investor must be satisfied that the falling securities are in only a temporary downdraft, not in a permanent decline. There are always asset classes or industry groups that are declining in price while the overall market is rising in price.

Finally, putting together diversified portfolios is both an art and a science. Other factors that are important will be the risk tolerance of the client, and the portfolio return objective of the client (the return they need to meet their goals). We will discuss these in more detail when we take a look at Investment Policy Statements (IPSs) in Module 4.

Summary

The material in this module introduced you to the most important concepts required to construct an efficient investment portfolio. Before constructing an efficient portfolio, investors must understand the essential elements of investment risk, including the specific types of unsystematic and systematic risk. Diversification occurs when sufficient securities are purchased for a portfolio to eliminate unsystematic risk.

Much of investment portfolio theory can be quantified. The most important calculations revolve around security and portfolio risk. Combining individual securities into a portfolio requires an understanding of covariance and how different securities interact with each other. The best combinations of securities involve securities that have low covariances with one other. But even though there is much that we can quantify, there are still other risks, the most significant being *endogenous risk*. This is the risk that shocks within the financial system itself are amplified and cause a ripple effect not explained by rational markets or quantitative formulas.

Finally, remember that it is extremely important that you always consider both risk and return together. Ask questions such as "How much risk did I take to achieve my return?" Or "Considering the amount of risk I have taken, did I achieve the return that I should have?"

Having read the material in this module you should be able to:

2–1 *Explain terminology related to the analysis of risk and return in portfolio construction and management.*

2–2 *Differentiate among the various sources of risk in investments, both systematic and unsystematic.*

2–3 *Calculate a weighted average return. Also calculate the standard deviation and mean return of a single asset, and understand how the range of returns is calculated within one, two, and three standard deviations.*

2–4	*Calculate coefficient of variation, and understand its application.*
2–5	*Identify covariance and correlation coefficient, know how to calculate one given the other, and understand their application and relevance when calculating the standard deviation of a portfolio.*
2–6	*Identify the coefficient of determination, know how to calculate and understand its applications*
2–7	*Calculate the beta coefficient, and understand its use and limitations*
2–8	*Calculate required return using the capital asset pricing model (CAPM), and understand its application.*
2–9	*Evaluate the implications of risk and return measurement concepts for portfolio construction.*

Module Review

Questions

2–1 Explain terminology related to the analysis of risk and return in portfolio construction and management.

1. Explain the various measures of investment return.

a. required return

b. expected return

c. realized return

2. Investors in U.S. bonds generally are subject to what three major types of systematic risk?

3. __________ risk is diversifiable;____________ risk is nondiversifiable.

4. Explain the following terms related to the measurement of investment risk.

a. total risk

b. standard deviation

c. covariance

d. correlation coefficient

e. beta

2–2 Differentiate among the various sources of risk in investments, both systematic and unsystematic.

5. ____________________ can be diversified away by holding a mix of fixed-income and equity securities from different companies, industries, and countries.

6. What is endogenous risk, and why must advisers be aware of it?

7. Unsystematic risk can be diversified away by holding approximately how many securities?

8. Explain each of the following types of systematic risk.

a. market risk

b. interest rate risk

c. reinvestment risk

d. purchasing power risk

e. exchange rate risk

9. Explain each of the following types of unsystematic risk.

a. business risk

b. financial risk

c. default risk

d. credit risk

e. liquidity and marketability risk

f. call risk

g. event risk

h. tax risk

i. investment manager risk

j. political risk

10. Identify the type of investment risk posed by the following situations.

a. Inflation is expected to rise over the next year.

b. Exxon Mobil decides to issue bonds instead of stock to finance a new tanker fleet.

c. The Fed has decided to increase short-term interest rates to fight increased inflation.

d. United Airlines fights discount carriers by lowering its fares across the country.

e. Interest rates have declined over the past year.

f. The overvalued stock market has finally fallen 15% over the past four months.

g. The value of your investment in Sony has risen 20% during the past year; during the same period, the yen has weakened against the dollar, causing the total return on the Sony investment to be only 10%.

2–3 Calculate a weighted average return. Also calculate the standard deviation and mean return of a single asset, and understand how the range of returns is calculated within one, two, and three standard deviations.

11. Steve Jenkins owns two stocks: PTV Inc. and SLK Corp. He owns 100 shares of PTV Inc. with a current market value of $5,250, and 150 shares of SLK Corp. with a current market value of $1,750. Steve expects returns of 20% and 14%, respectively, on his investments. What is the overall weighted-average expected return on Steve's portfolio? (Set your calculator to four decimal places. Also, use the calculator function keys to solve the problem more quickly.)

Investment	Amount	Rate of Return	Portfolio Weight	Weight × Return
PTV Inc.				
SLK Corp.				
Total				

12. Christa Pate owns unimproved land with a current market value of $175,000, 50 NLR convertible bonds with a current market value of $48,500, and 1,000 shares of MPT stock with a current market value of $72,500. Christa expects returns of 14%, 21%, and 9%, respectively, on her investments. What is the overall weighted-average expected return on Christa's portfolio? (Set your calculator to four decimal places. Also, use the calculator function keys to solve the problem more quickly.)

Investment	Amount	Rate of Return	Portfolio Weight	Weight × Return
Land				
NLR bonds				
MPT stock				
Total				

13. For each of the following portfolios, calculate the weighted-average expected return.

	Market Value	Expected Return	% of Total Portfolio	Weighted-Average Expected Return
PORTFOLIO # 1	$150,000	15%		
	$50,000	20%		
	$75,000	10%		
PORTFOLIO # 2	$200,000	12%		
	$40,000	7%		
	$80,000	8%		
	$60,000	18%		
PORTFOLIO # 3	$300,000	14%		
	$30,000	19%		
	$90,000	6%		
PORTFOLIO # 4	$250,000	13%		
	$20,000	16%		
	$10,000	22%		
	$35,000	9%		
PORTFOLIO # 5	$100,000	17%		
	$45,000	11%		
	$65,000	21%		

14. Walter Martin owns the following portfolio:

Amount Invested	Asset	Beta	Expected Return on Asset
$50,000	Growth Mutual Fund	1.3	15.0%
30,000	Stock MNY	.7	10.0%
$80,000			

Walter is considering a change in his investment portfolio. He is considering changing the proportion of the amounts invested in his assets as well as selling all of Stock MNY and buying Stock PQZ, which has a beta of 1.0 and an expected return of 12%. If he decides to buy Stock PQZ, he will invest $20,000 in it and increase his investment in the Growth Mutual Fund to $60,000.

a. Calculate the weighted-average expected return and the weighted beta coefficient for his *current* portfolio.

(1) weighted-average expected return

(2) weighted beta coefficient

b. Calculate the weighted-average expected return and the weighted beta coefficient for his *new* portfolio.

(1) weighted-average expected return

(2) weighted beta coefficient

c. What would happen to the overall level of risk?

d. What would happen to the overall expected rate of return?

e. Given Walter's situation and his desire to have the best risk-adjusted portfolio performance, should he sell all of Stock MNY and buy Stock PQZ?

15. A ____________________ curve assumes that investment returns are normally distributed around the mean return. Most investment returns are ________________, meaning there are generally more positive returns and fewer negative returns; ___________ occurs when there are a lot of returns clustered around the mean return with few large surprises.

16. Calculate the standard deviation and mean return for the following individual securities:

Year	A	F	P	Z
1	+8%	+22%	+7%	–12%
2	+10%	+25%	–5%	+20%
3	+12%	–23%	+15%	–6%
4	+14%	–18%	+12%	–8%
Standard deviation				
Mean return				

17. The Stargazer Fund has a mean (average) return of 10%, and a standard deviation of 15%. Assuming the returns are normally distributed, what range of returns would you expect

68% of the time? ______________________________

95% of the time? ______________________________

99% of the time? ______________________________

18. The Firmly Grounded Fund has a mean return of 8%, and a standard deviation of 12. If the returns are normally distributed, what would be your expected range of returns for

1 standard deviation? ______________________________

2 standard deviations? ______________________________

3 standard deviations? ______________________________

19. Scorpio Inc. has a mean return of 19%, and a standard deviation of 25. What is the probability that the stock will have a return greater than 19% if the returns are normally distributed?

20. Libra Inc. has a mean return of 11%, and a standard deviation of 9. Assuming the returns are normally distributed, what is the probability that the stock will have a return greater than 20%?

21. What does semi-variance measure?

2–4 Calculate coefficient of variation, and understand its application.

22. Using the possible expected annual returns given below for two stocks, calculate the standard deviation, mean return, and coefficient of variation for each stock. Which stock would you choose and why?

	Stock A	Stock B
Year 1	6%	8%
Year 2	8%	9%
Year 3	10%	9.25%
Year 4	12%	9.5%

23. You have narrowed your choice down to the following three small-cap funds. Given the following annual returns, which fund would you choose and why?

Year	Tree Fund	Bulldozer Fund	Dynamite Fund
1	+12%	+10%	+25%
2	+4%	+1%	–9%
3	+6%	+13%	+22%
4	–6%	–2%	–14%
5	+22%	+17%	+33%
Standard deviation			
Mean return			
CV (Std Dev/Mean)			

2–5 Identify covariance and correlation coefficient, know how to calculate one given the other, and understand their application and relevance when calculating the standard deviation of a portfolio.

2–6 Identify the coefficient of determination, know how to calculate and understand its applications

24. Briefly describe covariance, and its importance in constructing a well-diversified portfolio.

25. The standard deviation of the market is 14, and the standard deviation of United Enterprises Inc. is 22. The correlation coefficient between the two is .85. What is their covariance?

26. The covariance between Twin Pines Inc. and the S&P 500 is 95. The standard deviation of Twin Pines is 13, and the market's standard deviation is 12. What is their correlation coefficient?

27. A correlation coefficient of +1 means that the two assets are ______________________________, a correlation coefficient of 0 means ________________________________, and a correlation coefficient of -1 means that the two assets are ______________________________.

28. Using the data below, determine how well stocks B (10.6 standard deviation), C (16.1 standard deviation), and D (23.5 standard deviation) would work with Stock A (15.2 standard deviation) in a portfolio.

	A/B	A/C	A/D
Correlation coefficient	+ .46	+ .07	–.13

29. Consider the following information concerning stocks F and G. The covariance between stocks F and G is –22.

	Stock F	Stock G
Expected return	9%	14%
Standard deviation	7	16

a. What is the expected return of a portfolio that has 40% invested in Stock F and 60% invested in Stock G?

b. What is the standard deviation of a portfolio containing these two stocks in the percentages indicated?

c. What are the correlation coefficient and coefficient of determination of Stock F and Stock G?

30. Calculate the coefficient of determination, given the following correlation coefficients between an asset and a benchmark:

Correlation Coefficient (R)	Coefficient of Determination (R^2)
1.00	
0.95	
0.80	
0.50	
0.23	

31. Calculate the correlation coefficient, given the following coefficient of determinations between an asset and a benchmark.

Coefficient of Determination (R^2)	Correlation Coefficient
0.98	
0.86	
0.70	
0.50	
0.04	

32. What does the coefficient of determination (R^2) tell us about systematic and unsystematic risk?

2–7 Calculate the beta coefficient, and understand its use and limitations

33. Answer the following questions about beta.

a. Compute beta for the following five sets of facts.

	Standard Deviation		Correlation Coefficient
	Stock	Market	
(1)	30	15	+ 1.0
(2)	30	15	+ 0.25
(3)	30	15	0.0
(4)	30	15	–0.25
(5)	30	15	–1.0

b. What is the significance of correlation coefficient to the accurate interpretation of the meaning of beta?

34. What is the approximate price movement of the following assets, given the following betas and a market return of +15%?

Asset	Beta	Market Change	Asset Change
Triangle Fund	1.4	+ 15%	
XYZ Corp	0.8	+ 15%	
WWW Inc.	–.10	+ 15%	
Echo Lakes Inc.	0.5	+ 15%	
KJK Aggressive Fund	2.0	+ 15%	

35. Beta coefficients may be used to help select a portfolio that mirrors an investor's willingness to ________________. The beta for individual stocks _________ over time. Beta coefficients for individual securities can be very __________. In a portfolio, some individual stocks' betas will rise, and some will fall. However, over time, a portfolio's beta can be ______________, as beta increases offset beta decreases. Therefore, a portfolio's average beta can be a good indicator of how _____________ a portfolio is likely to be in relation to the ___________.

36. Assuming that the correlation of a stock and the market is high, what would beta coefficients of 0.5, 1.0, and 1.5 mean to someone investing in the stock?

37. When a portfolio is not ______________________, beta may _______________ the risk borne by an investor because ________________ has not been eliminated from the portfolio.

2–8 Calculate required return using the capital asset pricing model (CAPM), and understand its application.

38. What is the required return for the following securities? The risk-free rate is 4%, and the market return is 8%:

Fund	Beta	Required Return (r)
Triad Industries	0.9	
Triangle Inc.	1.1	
Trapeze Enterprises	2.0	
Tango Inc.	1.4	
Tangent Inc.	1.0	

39. What is the term used for the difference between the market return and the risk-free rate (Rm – Rf)?

40. What is the appropriate Treasury security to use for the risk-free rate?

41. What is the long-term historical market risk premium in the United States?

2–9 Evaluate the implications of risk and return measurement concepts for portfolio construction.

42. Assume that the following securities have the standard deviations and covariances as shown.

	Stock A	Stock B	Stock C	Stock D
Standard deviation	15.2	10.6	16.1	23.5

	A/B	A/C	A/D
Covariance	+ 74	+ 16	– 46

Compute the correlation coefficient (R) and the coefficient of determination (R^2) for stocks A/B, A/C, and A/D.

43. Constructing a systematically developed portfolio requires paying attention to which two factors?

44. An investor has an index mutual fund, and adds an actively managed fund that has an R^2 of .94 with the index fund. Has the investor effectively diversified? Why or why not?

Answers

2–1 Explain terminology related to the analysis of risk and return in portfolio construction and management.

1. Explain the various measures of investment return.

a. required return

The total return that a security should earn to induce an investor to purchase it, given its risk level (beta) relative to the market's risk level. Required return is computed before making an investment in a security. The CAPM equation is used to compute this return.

b. expected return

The total return that a security can be expected to deliver, given the current price of the security. It is also computed before making an investment in a security. If the expected return is less than the required return, the security should not be purchased.

c. realized return

The actual total return earned by a security.

2. Investors in U.S. bonds generally are subject to what three major types of systematic risk?

- interest rate risk
- reinvestment risk
- purchasing power risk

3. **Unsystematic** risk is diversifiable; **systematic** risk is nondiversifiable.

4. Explain the following terms related to the measurement of investment risk.

a. total risk

The uncertainty that an investment will deliver its expected return; measured by a security's standard deviation.

b. standard deviation

The degree to which an investment's returns can be expected to vary from its mean return.

c. covariance

The tendency of two assets to move together or apart.

d. correlation coefficient

A standardized version of covariance.

e. beta

A measure of a security's volatility with respect to an index against which the stock is measured.

2–2 Differentiate among the various sources of risk in investments, both systematic and unsystematic.

5. **Unsystematic risk** can be diversified away by holding a mix of fixed-income and equity securities from different companies, industries, and countries.

6. What is endogenous risk, and why must advisers be aware of it?

Endogenous risk is a risk found within the financial system, and occurs when there is a shock (or panic), which then spreads and is amplified within the system. As advisers saw with the 2008 financial crisis, this type of risk is extremely harmful to investors, and should be taken into account by the adviser when constructing portfolios.

7. Unsystematic risk can be diversified away by holding approximately how many securities?

Approximately 10 to 15 securities are required to diversify away unsystematic risk.

8. Explain each of the following types of systematic risk.

a. market risk

Market risk is caused by investor reaction to tangible and intangible factors independent of a particular security or property. It is the effect of a movement of the market overall.

b. interest rate risk

Interest rate risk is the negative effect on the prices of fixed-income securities caused by increases in the general level of interest rates.

c. reinvestment risk

Reinvestment risk, sometimes called reinvestment rate risk, is the problem of receiving periodic payments or principal and being able to reinvest them only at lower rates.

d. purchasing power risk

Purchasing power risk, or inflation risk, is the risk associated with the loss of purchasing power due to a rise in the general level of prices.

e. exchange rate risk

Exchange rate risk, or currency risk, is the uncertainty associated with changes in the value of foreign currencies. Relative to the U.S. dollar, it is the risk that converting a foreign currency into U.S. dollars provides fewer dollars than previously held.

9. Explain each of the following types of unsystematic risk.

a. business risk

Business risk is related to the uncertainty associated with a particular investment. It most often is concerned with the degree of uncertainty associated with a company's earnings and its ability to pay dividends or interest to investors.

b. financial risk

Financial risk is the risk associated with the degree to which debt is used by a company to finance a particular firm or property. The higher the level of debt, the higher the financial risk. An entity with no debt has no financial risk.

c. default risk

Default risk is the chance of the issuer defaulting on its financial obligations, resulting in investors not receiving some or all of their principal.

d. credit risk

Credit risk is the degree of an issuer's default risk that is reflected in its credit ratings assigned by major credit rating companies. An unanticipated lowering of the credit rating of an issuer's debt can cause the price of its debt to drop significantly in response.

e. liquidity and marketability risk

Liquidity risk most often is described as the degree of uncertainty associated with the ability to sell an investment quickly without loss of principal. An alternative definition is the chance of capital loss. Marketability risk is the risk that there is no active market for an investment.

f. call risk

Call risk is the possibility that the issuer will call in the debt issue prior to maturity, resulting in reinvesting the proceeds at lower rates of interest.

g. event risk

Event risk is the possibility that an unanticipated event or action will affect an issuer's securities in a significant manner.

h. tax risk

Tax risk is the risk associated with the uncertainty of an adverse outcome due to the interpretation of tax laws and regulations.

i. investment manager risk

This risk is associated with actions of the investment manager that could adversely impact one's investment in the fund he or she is managing.

j. political risk

Political risk is the uncertainty caused by the possibility of adverse political events occurring in a country.

10. Identify the type of investment risk posed by the following situations.

a. Inflation is expected to rise over the next year.

Purchasing power risk

b. Exxon Mobil decides to issue bonds instead of stock to finance a new tanker fleet.

Financial risk

c. The Fed has decided to increase short-term interest rates to fight increased inflation.

   Interest rate risk

d. United Airlines fights discount carriers by lowering its fares across the country.

   Business risk

e. Interest rates have declined over the past year.

   Reinvestment risk

f. The overvalued stock market has finally fallen 15% over the past four months.

   Market risk

g. The value of your investment in Sony has risen 20% during the past year; during the same period, the yen has weakened against the dollar, causing the total return on the Sony investment to be only 10%.

   Exchange rate risk

> *2–3 Calculate a weighted average return. Also calculate the standard deviation and mean return of a single asset, and understand how the range of returns is calculated within one, two, and three standard deviations.*

11. Steve Jenkins owns two stocks: PTV Inc. and SLK Corp. He owns 100 shares of PTV Inc. with a current market value of $5,250, and 150 shares of SLK Corp., with a current market value of $1,750. Steve expects returns of 20% and 14%, respectively, on his investments. What is the overall weighted-average expected return on Steve's portfolio? (Set your calculator to four decimal places. Also, use the calculator function keys to solve the problem more quickly.)

Investment	Amount	Rate of Return	Portfolio Weight	Weight × Return
PTV Inc.	$5,250	20%	5,250 ÷ 7,000 = .75	.75 × 20% = 15.00%
SLK Corp.	1,750	14%	1,750 ÷ 7,000 = .25	.25 × 14% = 3.50%
Total	$7,000			18.50%

or

Calculator Keystrokes

HP-10BII+		HP-12C	
20	INPUT	20	ENTER
5250	Σ+	5250	Σ+
14	INPUT	14	ENTER
1750	Σ+	1750	Σ+
	SHIFT $\bar{x}_w$ (6 key) Rate of return = 18.50%		g, $\bar{x}_w$ (6 key) Rate of return = 18.50%

12. Christa Pate owns unimproved land with a current market value of $175,000, 50 NLR convertible bonds with a current market value of $48,500, and 1,000 shares of MPT stock with a current market value of $72,500. Christa expects returns of 14%, 21%, and 9%, respectively, on her investments. What is the overall weighted-average expected return on Christa's portfolio? (Set your calculator to four decimal places. Also, use the calculator function keys to solve the problem more quickly.)

Investment	Amount	Rate of Return	Portfolio Weight	Weight × Return
Land	$175,000	14%	175 ÷ 296 = .5912	.5912 × 14% = 8.28%
NLR bonds	48,500	21%	48.5 ÷ 296 = .1639	.1639 × 21% = 3.44%
MPT stock	72,500	9%	72.5 ÷ 296 = .2449	.2449 × 9% = 2.20%
Total	$296,000			13.92%

or

Calculator Keystrokes

HP-10BII+		HP-12C	
14	INPUT	14	ENTER
175,000	Σ+	175,000	Σ+
21	INPUT	21	ENTER
48,500	Σ+	48,500	Σ+
9	INPUT	9	ENTER
72,500	Σ+	72,500	Σ+
	SHIFT $\bar{x}_w$ (6 key)		g $\bar{x}_w$ (6 key)
	Rate of return = 3.92%		Rate of return = 13.92%

13. For each of the following portfolios, calculate the weighted-average expected return.

	Market Value	Expected Return	% of Total Portfolio	Weighted-Average Expected Return
PORTFOLIO # 1	$150,000	15%	54.55	8.18%
	50,000	20%	18.18	3.64%
	75,000	10%	27.27	2.73%
	$275,000			14.55%
PORTFOLIO # 2	$200,000	12%	52.63	6.32%
	40,000	7%	10.53	0.74%
	80,000	8%	21.05	1.68%
	60,000	18%	15.79	2.84%
	$380,000			11.58%
PORTFOLIO # 3	$300,000	14%	71.43	10.00%
	30,000	19%	7.14	1.36%
	90,000	6%	21.43	1.29%
	$420,000			12.65%
PORTFOLIO # 4	$250,000	13%	79.37	10.32%
	20,000	16%	6.35	1.02%
	10,000	22%	3.17	0.70%
	35,000	9%	11.11	1.00%
	$315,000			13.04%
PORTFOLIO # 5	$100,000	17%	47.62	8.10%
	45,000	11%	21.43	2.36%
	65,000	21%	30.95	6.50%
	$210,000			16.96%

14. Walter Martin owns the following portfolio:

Amount Invested	Asset	Beta	Expected Return on Asset
$50,000	Growth Mutual Fund	1.3	15.0%
<u>30,000</u>	Stock MNY	.7	10.0%
$80,000			

Walter is considering a change in his investment portfolio. He is considering changing the proportion of the amounts invested in his assets as well as selling all of Stock MNY and buying Stock PQZ, which has a beta of 1.0 and an expected return of 12%. If he decides to buy Stock PQZ, he will invest $20,000 in it and increase his investment in the Growth Mutual Fund to $60,000.

a. Calculate the weighted-average expected return and the weighted beta coefficient for his *current* portfolio.

(1) weighted-average expected return

Growth Mutual Fund: $\boxed{\frac{\$50{,}000}{\$80{,}000} = .625}$ $\boxed{.625(.15) = .0938}$

Stock MNY: $\boxed{\frac{\$30{,}000}{\$80{,}000} = .375}$ $\boxed{.375(.10) = .0375}$

$$\boxed{.0938 + .0375 = .1313 \text{ or } 13.13\%}$$

or

HP-10BII+		HP-12C	
15	Input	15	ENTER
50,000	Σ+	50,000	Σ+
10	Input	10	ENTER
30,000	Σ+	30,000	Σ+
	SHIFT $\bar{x}_w$ (6 key)		g $\bar{x}_w$ (6 key)
	Rate of return = .13125 = 13.125%		Rate of return = .13125 = 13.125%

(2) weighted beta coefficient

Growth Mutual Fund: $\boxed{.625\,(1.3) = .8125}$

Stock MNY: $\boxed{.375\,(0.7) = .2625}$

$\boxed{.8125 + .2625 = 1.0750}$

or

HP-10BII+		HP-12C	
1.3	Input	1.3	ENTER
50,000	Σ+	50,000	Σ+
.7	Input	.7	ENTER
30,000	Σ+	30,000	Σ+
	SHIFT $\bar{x}_w$ (6 key)		g $\bar{x}_w$ (6 key)
	Weighted beta = 1.075		Weighted beta = 1.075

b. Calculate the weighted-average expected return and the weighted beta coefficient for his *new* portfolio.

(1) weighted-average expected return

Growth Mutual Fund: $\boxed{\frac{\$60{,}000}{\$80{,}000} = .750}$

$\boxed{.750\,(.15) = .1125}$

Stock PQZ: $\boxed{\frac{\$20{,}000}{\$80{,}000} = .250}$

$\boxed{.250(.12) = .0300}$

$\boxed{.1125 + .0300 = .1425 \text{ or } 14.25\%}$

or

HP-10BII+		HP-12C	
.15	Input	.15	ENTER
60,000	Σ+	60,000	Σ+
.12	Input	.12	ENTER
20,000	Σ+	20,000	Σ+
	SHIFT $\bar{x}_w$ (6 key)		g $\bar{x}_w$ (6 key)
	Rate of return = .1425 = 14.25%		Rate of return = .1425 = 14.25%

(2) weighted beta coefficient

Growth Mutual Fund: $\boxed{.750\ (1.3) = .9750}$

Stock PQZ: $\boxed{.250\ (1.0) = .2500}$

$\boxed{.9750 + .2500 = 1.2250}$

or

HP-10BII+		HP-12C	
1.3	Input	1.3	ENTER
60,000	Σ+	60,000	Σ+
1	Input	1	ENTER
20,000	Σ+	20,000	Σ+
	SHIFT $\bar{x}_w$ (6 key)		g $\bar{x}_w$ (6 key)
	Weighted beta = 1.225		Weighted beta = 1.225

c. What would happen to the overall level of risk?

The overall level of risk for Walter's portfolio would rise because the beta increases from 1.0750 for the old portfolio to 1.2250 for the new portfolio.

d. What would happen to the overall expected rate of return?

The weighted-average expected return for the new portfolio increases from 13.13% to 14.25%.

e. Given Walter's situation and his desire to have the best risk-adjusted portfolio performance, should he sell all of Stock MNY and buy Stock PQZ?

No, Walter should not make the change. The risk-adjusted return for the old portfolio is*:*

$$\boxed{\frac{13.13\%}{1.075} = 12.214\%}$$

and the risk-adjusted return for the new portfolio is:

$$\boxed{\frac{14.25\%}{1.225} = 11.633\%}$$

15. A **normally distributed** curve assumes that investment returns are normally distributed around the mean return. Most investment returns are **positively skewed**, meaning there are generally more positive returns and fewer negative returns; **leptokurtic kurtosis** occurs when there are a lot of returns clustered around the mean return with few large surprises.

16. Calculate the standard deviation and mean return for the following individual securities:

Year	A	F	P	Z
1	+ 8%	+ 22%	+ 7%	–12%
2	+ 10%	+ 25%	–5%	+ 20%
3	+ 12%	–23%	+ 15%	–6%
4	+ 14%	–18%	+ 12%	–8%
Standard deviation	2.5820	25.5147	8.8081	14.5488
Mean return	11.00	1.50	7.25	-1.50

Use the Σ+ key to enter your returns (both HP-10BII+ and 12C), for negative returns enter the number first, then change the sign ("+/–" on the 10BII+, "CHS" on the 12C).

HP-10BII+: SHIFT, 8 for standard deviation, SHIFT, 7 for mean return

12C: g, "." For standard deviation, g, "0" for mean return

Example: Security A

8 Σ+

10 Σ+

12 Σ+

14 Σ+

HP-10BII+ (set for 1 P/Yr): standard deviation: SHIFT, *SxSy* (8 key) = 2.5820

Mean return: SHIFT, $\bar{x}, \bar{y}$ (7 key) = 11.00

HP-12C: standard deviation: g, s ("." key) = 2.582

Mean return: g, $\bar{x}$ ("0" key) = 11.00

17. The Stargazer Fund has a mean (average) return of 10%, and a standard deviation of 15%. Assuming the returns are normally distributed, what range of returns would you expect

68% of the time?

–5% to +25% (10 – 15 = –5, and 10 + 15 = 25)

95% of the time?

–20% to +40% (–5 – 15 = –20, and 25 + 15 = 40)

99% of the time?

–35% to +55% (–20 – 15= –35 and 40 + 15 = 55)

18. The Firmly Grounded Fund has a mean return of 8%, and a standard deviation of 12. If the returns are normally distributed, what would be your expected range of returns for

1 standard deviation?

–4% to +20% (8 – 12 = –4 and 8 + 12 = 20)

2 standard deviations?

–16% to +32% (–4 – 12 = –16 and 20 + 12 = 32)

3 standard deviations?

–28% to +44% (–16 – 12 = –28 and 32 + 12 = 44)

19. Scorpio Inc. has a mean return of 19%, and a standard deviation of 25. What is the probability that the stock will have a return greater than 19% if the returns are normally distributed?

The answer is 50%. In a normally distributed yield curve, half of the returns will be greater than the mean return, and half of the returns will be less than the mean return.

20. Libra Inc. has a mean return of 11%, and a standard deviation of 9. Assuming the returns are normally distributed, what is the probability that the stock will have a return greater than 20%?

The answer is 16%. We know that half of the returns are going to be greater than the mean return of 11%. We also know that one standard deviation (which will be evenly distributed) accounts for 68% of the returns and would range from +2% to +20%. Half of the 68% of returns would be above the mean return, and half below. So 34% of the returns would be greater than the 11% mean return, and would fall between 11% and 20%.If we know 50% of the returns will be greater than 11%, and we know that 34% of the returns will fall between 11% and 20%, we then know that 16% (what remains of the 50%, 50 – 34) of the returns will be greater than 20%.

21. What does semi-variance measure?

Semi-variance measures only the returns that fall below the average, and is primarily used by portfolio managers. It recognizes that investors are concerned less about upside potential and more about downside risk.

2–4 Calculate coefficient of variation, and understand its application.

22. Using the possible expected annual returns given below for two stocks, calculate the standard deviation, mean return, and coefficient of variation for each stock. Which stock would you choose and why?

	Stock A	Stock B
Year 1	6%	8%
Year 2	8%	9%
Year 3	10%	9.25%
Year 4	12%	9.5%

Stock A:

HP-10BII+		HP-12C	
6	Σ+	6	Σ +
8	Σ+	8	Σ +
10	Σ+	10	Σ +
12	Σ+	12	Σ +
	SHIFT $\bar{x}$, $\bar{y}$ (7 key) = 9.0%		g, $\bar{x}$, (0 key) = 9.0%
	SHIFT, Sx, Sy (8 key) = 2.5820		SHIFT, s (“.” Key) = 2.582

Average (Mean) return = 9.0%

Standard deviation = 2.582

$$\boxed{\text{CV} = \frac{\text{S}}{\text{mean}} = \frac{2.582}{9.0} = .287}$$

Stock B:

HP-10BII+		HP-12C	
8	Σ+	8	Σ +
9	Σ+	9	Σ +
9.25	Σ+	9.25	Σ +
9.5	Σ+	9.5	Σ +
	SHIFT, $\bar{x}$, $\bar{y}$ (7 key) = 8.9375		g, $\bar{x}$, (0 key) = 8.9375
	SHIFT, Sx, Sy (8 key) = .6575		SHIFT, s (“.” Key) = .6575

Average (Mean) return = 8.9375%

Standard deviation = .6575

$$\boxed{CV = \frac{S}{\text{mean}} = \frac{.6575}{8.9375} = .074}$$

Stock A has a coefficient of variation of .29, and Stock B has a coefficient of variation of .07. Choose the lower number, so we would select Stock B, since it has less risk per unit of return.

23. You have narrowed your choice down to the following three small-cap funds. Given the following annual returns, which fund would you choose and why?

Year	Tree Fund	Bulldozer Fund	Dynamite Fund
1	+12%	+10%	+25%
2	+4%	+1%	–9%
3	+ 6%	+13%	+22%
4	–6%	–2%	–14%
5	+22%	+17%	+33%
Standard deviation	10.3344	8.0436	21.3612
Mean return	7.60	7.80	11.40
CV (Std Dev/Mean)	1.3598	1.0312	1.8738

The Bulldozer Fund would be selected, because of its lower coefficient of variation.

2–5 Identify covariance and correlation coefficient, know how to calculate one given the other, and understand their application and relevance when calculating the standard deviation of a portfolio.

2–6 Identify the coefficient of determination, know how to calculate and understand its applications

24. Briefly describe covariance, and its importance in constructing a well-diversified portfolio.

Covariance measures how much two investments are related to each other; in other words, how much they move together or apart. In order to diversify we must add an asset that does not behave in the same manner as the asset we already have, otherwise we are just duplicating our current position. The lower the covariance, the lower the correlation between the two assets, and the more diversification we achieve. As we add additional assets to a portfolio, we want to make sure they are not highly correlated with the assets we already own. Covariance can be just about any number, so it can be difficult to understand the correlation. There is a standardized form of covariance that is easier to work with and understand, since it confines the correlation between –1 and +1, and this is called the correlation coefficient.

25. The standard deviation of the market is 14, and the standard deviation of United Enterprises Inc. is 22. The correlation coefficient between the two is .85. What is their covariance?

$$COV_{ij} = \rho_{ij}\sigma_i\sigma_j$$

$$COV_{ij} \boxed{= 14 \times 22 \times .85}$$

$$COV_{ij} \boxed{= 261.80}$$

26. The covariance between Twin Pines Inc. and the S&P 500 is 95. The standard deviation of Twin Pines is 13, and the market's standard deviation is 12. What is their correlation coefficient?

$$R_{ij} = \frac{COV_{ij}}{\sigma_i \times \sigma_j}$$

$$\boxed{R_{ij} = \frac{95}{13 \text{ x } 12}}$$

$$\boxed{R_{ij} = .6090}$$

27. A correlation coefficient of +1 means that the two assets are **perfectly positively correlated**, a correlation coefficient of 0 means **there is no correlation**, and a correlation coefficient of -1 means that the two assets are **perfectly negatively correlated**.

28. Using the data below determine how well stocks B (10.6 standard deviation), C (16.1 standard deviation), and D (23.5 standard deviation) would work with Stock A (15.2 standard deviation) in a portfolio.

	A/B	A/C	A/D
Correlation coefficient	+ .46	+ .07	–.13

Stock Combination	Description
A/B	With a correlation coefficient of .46, this would be a relatively good combination. The two stocks are not highly correlated, and Stock B would help lower the standard deviation of a portfolio containing both of these stocks.

Stock Combination	Description
A/C	With a correlation coefficient of .07, this would be a good combination. There is no correlation between the two stocks, even though they both have approximately the same standard deviation. This combination would lower the standard deviation of a portfolio containing both of these stocks.
A/D	With a correlation coefficient of –.13, this would be the best combination of the three. When one stock rises, the other would most likely decline. Even though Stock D has the highest standard deviation of the three, the addition of this stock would significantly lower the standard deviation of a portfolio containing these two stocks.

The coefficient of determination for each of the three combinations is quite low, meaning that very little of the movement of stocks B, C, or D can be attributed to the movement of Stock A. In other words, it confirms that each of the three combinations would be good diversifiers and that each of the three stocks moves relatively independently of Stock A.

29. Consider the following information concerning stocks F and G. The covariance between stocks F and G is –22.

	Stock F	Stock G
Expected return	9%	14%
Standard deviation	7	16

a. What is the expected return of a portfolio that has 40% invested in Stock F and 60% invested in Stock G?

$.40 \times 9\% = 3.6\%$

$.60 \times 14\% = 8.4\%$

$3.6\% + 8.4\% = 12.0\%$ expected return

b. What is the standard deviation of a portfolio containing these two stocks in the percentages indicated?

$$\boxed{S_p = \sqrt{W_f^{\,2}S_f^{\,2} + W_g^{\,2}S_g^{\,2} + 2W_fW_gCOV_{fg}}}$$

$$\boxed{S_p = \sqrt{(.4)^2(7)^2 + (.6)^2(16)^2 + 2(.4)(.6)(-22)} = 9.5}$$

c. What are the correlation coefficient and coefficient of determination of Stock F and Stock G?

$$\boxed{R_{FG} = \frac{-22}{(7)\times(16)} = -.20}$$

$$\boxed{R_{FG}^{\;2} = (-.2)\times(-.2) = .04}$$

30. Calculate the coefficient of determination, given the following correlation coefficients between an asset and a benchmark:

Correlation Coefficient (R)	Coefficient of Determination (R^2)
1.00	1.0000
0.95	0.9025
0.80	0.6400
0.50	0.2500
0.23	0.0529

Converting the correlation coefficient (R) to the Coefficient of Determination (R^2 or R-squared) just requires squaring the correlation coefficient. You can simply multiply R by itself, or use the following keystrokes:

Example: Correlation Coefficient of .95:

HP-10BII+	HP-12C
.95	.95
SHIFT	ENTER
X^2 (the "+" key)	2
Solution: .9025	*yx*
	Solution: .9025

31. Calculate the correlation coefficient, given the following coefficient of determinations between an asset and a benchmark.

Coefficient of Determination (R^2)	Correlation Coefficient
.98	.9899
.86	.9274
.70	.8367
.50	.7071
.04	.20

When converting the coefficient of determination into the correlation coefficient, we are taking the square root of the coefficient of determination (going the other way we square the correlation coefficient).

Example: Coefficient of determination of .86:

HP-10BII+	HP-12C
.86	.86
SHIFT	ENTER
$\sqrt{x}$ (the "–" key)	g
Solution: .9274	$\sqrt{x}$ *(the y^x key)*
	Solution: .9274

32. What does the coefficient of determination (R^2) tell us about systematic and unsystematic risk?

The coefficient of determination (R^2) tells us how much of the risk is explained by the benchmark. For example, if we are comparing the Titanic Fund to the S&P 500, and the coefficient of determination is .70, this would mean that 70% of the price movement of the Titanic Fund is explained by the S&P 500 (systematic risk), and the other 30% is not explained by the S&P 500 Index (unsystematic risk). For diversification purposes, the lower the coefficient of determination (and thus the correlation coefficient) the better. However, beta is a measure of systematic risk, and since the coefficient of determination (R^2) is a measure of systematic risk, when using beta the higher the coefficient of determination (R^2), the better.

2–7 *Calculate the beta coefficient, and understand its use and limitations*

33. Answer the following questions about beta.

a. Compute beta for the following five sets of facts.

	Standard Deviation		
	Stock	**Market**	**Correlation Coefficient**
(1)	30	15	+ 1.0
(2)	30	15	+ 0.25
(3)	30	15	0.0
(4)	30	15	–0.25
(5)	30	15	–1.0

The following formula should be used:

$$\beta = \frac{S_i}{S_m} \times R_{im}$$

(1) 30/15 × 1.0 = 2.0

(2) 30/15 × +0.25 = +0.5

(3) 30/15 × 0.0 = 0.0

(4) 30/15 × –0.25 = –0.5

(5) 30/15 × –1.0 = –2.0

b. What is the significance of correlation coefficient to the accurate interpretation of the meaning of beta?

Beta is significant if properly calculated. Intuitively, an investor might conclude that a stock with a standard deviation that is twice the standard deviation of the market would have a beta of 2.0. The computations show that to be the case only when the stock in question is highly correlated with the market. Even with a low positive correlation (+0.25), the beta is only 0.5. Many investors will conclude that a stock with a beta of 0.5 is half as variable as the market; what this computation should actually tell them is that they cannot use beta to judge the volatility of the stock, but instead must refer to the stock's standard deviation to measure the volatility of the stock. Beta cannot be accepted blindly without knowing how the stock in question is correlated with the market index against which its beta is calculated.

34. What is the approximate price movement of the following assets, given the following betas, and a market return of +15%?

Asset	Beta	Market Change	Asset Change
Triangle Fund	1.4	+ 15%	+ 21%
XYZ Corp.	0.8	+ 15%	+ 12%
WWW Inc.	–.10	+ 15%	–1.50%
Echo Lakes Inc.	0.5	+ 15%	7.50%
KJK Aggressive Fund	2.0	+ 15%	+ 30%

Simply multiply the beta times the market change.

35. Beta coefficients may be used to help select a portfolio that mirrors an investor's willingness to **bear systematic risk**. The beta for individual stocks **changes** over time. Beta coefficients for individual securities can be very **unstable.** In a portfolio, some individual stocks' betas will rise, and some will fall. However, over time, a portfolio's beta can be **relatively stable**, as beta increases offset beta decreases. Therefore, a portfolio's average beta can be a good indicator of how **volatile** a portfolio is likely to be in relation to the **market.**

36. Assuming that the correlation of a stock and the market is high, what would beta coefficients of 0.5, 1.0, and 1.5 mean to someone investing in the stock?

The larger the beta coefficient is, the more volatile the security's historic price is relative to the market. Investors often use beta as a rule of thumb for estimating the percentage change in a stock's price when the overall market moves X%. A beta of 1.0 indicates the movement of the stock would be expected to be identical to the movement of the market. A beta of 0.5 means that the price of the stock has been less volatile than the market; for example, if the overall market changes by 4%, the stock would be expected to change by 2%. If a stock has a beta of 1.5, the price on the stock would be expected to change by 6% when the market changes by 4%. Stocks with high beta coefficients are referred to as "aggressive," while stocks with low beta coefficients are referred to as "defensive."

37. When a portfolio is not **well-diversified**, beta may **understate** the risk borne by an investor because **unsystematic risk** has not been eliminated from the portfolio.

> 2–8 *Calculate required return using the capital asset pricing model (CAPM), and understand its application.*

38. What is the required return for the following securities. The risk-free rate is 4%, and the market return is 8%:

Fund	Beta	Required Return (r)
Triad Industries	0.9	7.6%
Triangle Inc.	1.1	8.4%
Trapeze Enterprises	2.0	12.0%
Tango Inc.	1.4	9.6%
Tangent Inc.	1.0	8.0%

Triad Industries: 4 + (8 – 4) 0.9 = 4 + 3.60 = 7.60

Triangle Inc.: 4 + (8 – 4) 1.1 = 4 + 4.40 = 8.40

Trapeze Enterprises: 4 + (8 – 4) 2.0 = 4 + 8 = 12.0

Tango Inc.: 4 + (8 – 4) 1.4 = 4 + 5.60 = 9.60

Tangent Inc.: 4 + (8 – 4) 1.0 = 4 + 4 = 8.0

39. What is the term used for the difference between the market return and the risk-free rate (Rm – Rf)?

This is called the "market risk premium." It is the excess return earned above the risk-free rate to compensate the investor for taking extra risk by investing in the market. There is much discussion and disagreement over what the future market risk premium will be.

40. What is the appropriate Treasury security to use for the risk free rate?

The most widely used Treasury security is the three-month Treasury bill, and this is what is favored by the CFP Board for the exam. However, some portfolio managers use the five-year or ten-year Treasury note since stocks are a long-term investment, and the investor's holding period is often five or ten years, or longer.

41. What is the long-term historical market risk premium in the United States?

The long-term historical market risk premium in the United States, from 1900–2005, has been 4.5%.

2–9 Evaluate the implications of risk and return measurement concepts for portfolio construction.

42. Assume that the following securities have the standard deviations and covariances as shown.

	Stock A	Stock B	Stock C	Stock D
Standard deviation	15.2	10.6	16.1	23.5

	A/B	A/C	A/D
Covariance	+ 74	+ 16	– 46

Compute the correlation coefficient (R) and the coefficient of determination (R^2) for stocks A/B, A/C, and A/D.

$$\boxed{R_{AB} = \frac{+74}{(15.2)\times(10.6)} = .459}$$

$$\boxed{R_{AC} = \frac{+16}{(15.2)\times(16.1)} = .065}$$

$$\boxed{R_{AD} = \frac{-46}{(15.2)\times(23.5)} = -.129}$$

R^2:

$\boxed{A/B\ (+.46)^2 = 21.2\%}$

$\boxed{A/C\ (+.07)^2 = 0.49\%}$

$\boxed{A/D\ (-.13)^2 = 1.69\%}$

43. Constructing a systematically developed portfolio requires paying attention to which two factors?

- Eliminating unsystematic risk.
- Minimizing the total risk, which is measured by standard deviation.

44. An investor has an index mutual fund, and adds an actively managed fund that has an R^2 of .94 with the index fund. Has the investor effectively diversified? Why or why not?

The amount of diversification that would be achieved in this case is minimal. 94% of the price movement of the actively managed fund is explained by the index mutual fund the investor already holds. This means that the actively managed fund will essentially mirror the performance of the index fund. The investor would be better off looking for a fund that has a lower R^2 to the index fund. For diversification purposes, the lower the R^2 the better.

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Index

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