CFA Institute®
CFA Program

PORTFOLIO MANAGEMENT

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OTHER FEEDBACK

Please send any comments or suggestions to info@cfainstitute.org, and we will review your feedback thoughtfully.

Portfolio Management

LEARNING MODULE

1

Portfolio Risk and Return: Part I

by Vijay Singal, PhD, CFA.

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LEARNING OUTCOMES

Mastery	*The candidate should be able to:*
☐	describe characteristics of the major asset classes that investors consider in forming portfolios
☐	explain risk aversion and its implications for portfolio selection
☐	explain the selection of an optimal portfolio, given an investor's utility (or risk aversion) and the capital allocation line
☐	calculate and interpret the mean, variance, and covariance (or correlation) of asset returns based on historical data
☐	calculate and interpret portfolio standard deviation
☐	describe the effect on a portfolio's risk of investing in assets that are less than perfectly correlated
☐	describe and interpret the minimum-variance and efficient frontiers of risky assets and the global minimum-variance portfolio

INTRODUCTION

1

Construction of an optimal portfolio is an important objective for an investor. In this reading, we will explore the process of examining the risk and return characteristics of individual assets, creating all possible portfolios, selecting the most efficient portfolios, and ultimately choosing the optimal portfolio tailored to the individual in question.

During the process of constructing the optimal portfolio, several factors and investment characteristics are considered. The most important of those factors are risk and return of the individual assets under consideration. Correlations among individual assets along with risk and return are important determinants of portfolio risk. Creating a portfolio for an investor requires an understanding of the risk profile of the investor. Although we will not discuss the process of determining risk aversion for individuals or institutional investors, it is necessary to obtain such information for making an informed decision. In this reading, we will explain the broad types of investors and how their risk–return preferences can be formalized to select the optimal portfolio from among the infinite portfolios contained in the investment opportunity set.

The reading is organized as follows: Sections 2–3 discuss the investment characteristics of assets. Sections 4–6 discuss risk aversion and how indifference curves, which incorporate individual preferences, can be constructed. The indifference curves are then applied to the selection of an optimal portfolio using two risky assets. Sections 7–9 provide an understanding and computation of portfolio risk. The role of correlation and diversification of portfolio risk are examined in detail. Sections 10–12 begins with the risky assets available to investors and constructs a large number of risky portfolios. It illustrates the process of narrowing the choices to an efficient set of risky portfolios before identifying the optimal risky portfolio. The risky portfolio is combined with investor risk preferences to generate the investor's optimal portfolio. A summary concludes this reading.

2 HISTORICAL RETURN AND RISK

☐ describe characteristics of the major asset classes that investors consider in forming portfolios

Before examining historical data, it is useful to distinguish between the historical mean return and expected return, which are very different concepts but easy to confuse. Historical return is what was actually earned in the *past*, whereas expected return is what an investor anticipates to earn in the *future*.

Expected return is the nominal return that would cause the marginal investor to invest in an asset based on the real risk-free interest rate (r_{rF}), expected inflation [$E(\pi)$], and expected risk premium for the risk of the asset [$E(RP)$]. The real risk-free interest rate is expected to be positive as compensation for postponing consumption. Similarly, the risk premium is expected to be positive in most cases.[1] The expected inflation rate is generally positive, except when the economy is in a deflationary state and prices are falling. Thus, expected return is generally positive. The relationship between the expected return and the real risk-free interest rate, inflation rate, and risk premium can be expressed by the following equation:

$$1 + E(R) = (1 + r_{rF}) \times [1 + E(\pi)] \times [1 + E(RP)]$$

The historical mean return for investment in a particular asset, however, is obtained from the actual return that was earned by an investor. Because the investment is risky, there is no guarantee that the actual return will be equal to the expected return. In fact, it is very unlikely that the two returns are equal for a specific time period being considered. Given a long enough period of time, we can *expect* that the future (expected) return will equal the average historical return. Unfortunately, we do not know how long that period is—10 years, 50 years, or 100 years. As a practical matter, we often assume that the historical mean return is an adequate representation of the expected return, although this assumption may not be accurate. For example, Exhibit 1 shows that the historical equity returns in the last eight years (2010–2017) for large US company stocks were positive whereas the actual return was negative the prior decade, but nearly always positive historically. Nonetheless, longer-term returns (1926–2017) were positive and could be consistent with expected return. Though it is unknown if the historical mean returns accurately represent expected returns, it is an assumption that is commonly made.

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1 There are exceptions when an asset reduces overall risk of a portfolio. We will consider those exceptions in Section 9.

Exhibit 1: Risk and Return for US Asset Classes by Decade (%)

		1930s	1940s	1950s	1960s	1970s	1980s	1990s	2000s	2010s*	1926–2017
Large company stocks	Return	−0.1	9.2	19.4	7.8	5.9	17.6	18.2	−1.0	13.9	10.2
	Risk	41.6	17.5	14.1	13.1	17.2	19.4	15.9	16.3	13.6	19.8
Small company stocks	Return	1.4	20.7	16.9	15.5	11.5	15.8	15.1	6.3	14.8	12.1
	Risk	78.6	34.5	14.4	21.5	30.8	22.5	20.2	26.1	19.4	31.7
Long-term corporate bonds	Return	6.9	2.7	1	1.7	6.2	13	8.4	7.7	8.3	6.1
	Risk	5.3	1.8	4.4	4.9	8.7	14.1	6.9	11.7	8.8	8.3
Long-term government bonds	Return	4.9	3.2	−0.1	1.4	5.5	12.6	8.8	7.7	6.8	5.5
	Risk	5.3	2.8	4.6	6	8.7	16	8.9	12.4	10.8	9.9
Treasury bills	Return	0.6	0.4	1.9	3.9	6.3	8.9	4.9	2.8	0.2	3.4
	Risk	0.2	0.1	0.2	0.4	0.6	0.9	0.4	0.6	0.1	3.1
Inflation	Return	−2.0	5.4	2.2	2.5	7.4	5.1	2.9	2.5	1.7	2.9
	Risk	2.5	3.1	1.2	0.7	1.2	1.3	0.7	1.6	1.1	4.0

** Through 31 December 2017*
Note: Returns are measured as annualized geometric mean returns.
Risk is measured by annualizing monthly standard deviations.
Source: 2018 SBBI Yearbook (Exhibits 1.2,1.3, 2.3 and 6.2).

Going forward, be sure to distinguish between expected return and historical mean return. We will alert the reader whenever historical returns are used to estimate expected returns.

Nominal Returns of Major US Asset Classes

We focus on three major asset categories in Exhibit 1: stocks, bonds, and T-bills. The mean nominal returns for US asset classes are reported decade by decade since the 1930s. The total for the 1926–2017 period is in the last column. All returns are annual geometric mean returns. Large company stocks had an overall annual return of 10.2 percent during the 92-year period. The return was negative in the 1930s and 2000s, and positive in all remaining decades. The 1950s and 1990s were the best decades for large company stocks. Small company stocks fared even better. The nominal return was never negative for any decade, and had double-digit growth in all decades except two, leading to an overall 92-year annual return of 12.1 percent.

Long-term corporate bonds and long-term government bonds earned overall returns of 6.1 percent and 5.5 percent, respectively. The corporate bonds did not have a single negative decade, although government bonds recorded a negative return in the 1950s when stocks were doing extremely well. Bonds also had some excellent decades, earning double-digit returns in the 1980s and 2000s.

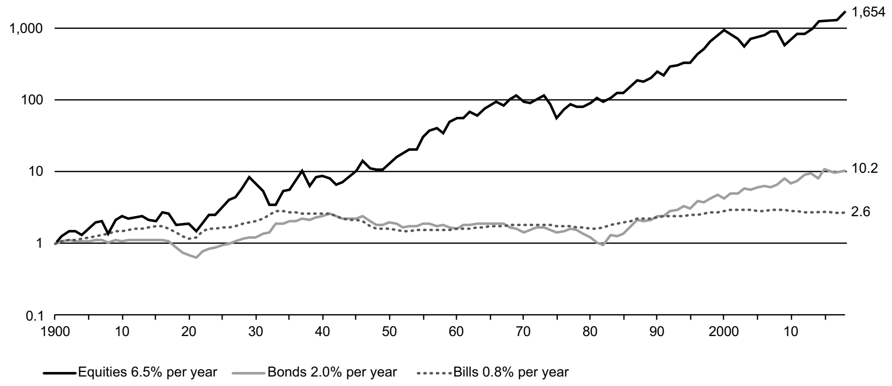
Treasury bills (short-term government securities) did not earn a negative return in any decade. In fact, Treasury bills earned a negative return only in 1938 (−0.02 percent) when the inflation rate was −2.78 percent. Consistently positive returns for Treasury bills are not surprising because nominal interest rates are almost never negative and the Treasury bills suffer from little interest rate or inflation risk. Since the Great Depression, there has been no deflation in any decade, although inflation rates were highly negative in 1930 (−6.03 percent), 1931 (−9.52 percent), and 1932 (−10.30 percent). Conversely, inflation rates were very high in the late 1970s and early

1980s, reaching 13.31 percent in 1979. Inflation rates have been largely range bound between 1 and 3 percent from 1991 to 2017. Overall, the inflation rate was 2.9 percent for the 92-year period.

Real Returns of Major US Asset Classes

Because annual inflation rates can vary greatly, from –10.30 percent to +13.31 percent in the last 92 years, comparisons across various time periods are difficult and misleading using nominal returns. Therefore, it is more effective to rely on real returns. Real returns on stocks, bonds, and T-bills are reported from 1900 in Exhibit 2 and Exhibit 3.

Exhibit 2: Cumulative Returns on US Asset Classes in Real Terms, 1900–2017



Source: E. Dimson, P. Marsh, and M. Staunton, *Credit Suisse Global Investment Returns Yearbook 2018*, Credit Suisse Research Institute (February 2018). This chart is updated annually and can be found at https://www.credit-suisse.com/media/assets/corporate/docs/about-us/media/media-release/2018/02/giry-summary-2018.pdf.

Exhibit 2 shows that $1 would have grown to $1,654 if invested in stocks, to only $10.20 if invested in bonds, and to $2.60 if invested in T-bills. The difference in growth among the three asset categories is huge, although the difference in real returns does not seem that large: 6.5 percent per year for equities compared with 2.0 percent per year for bonds. This difference represents the effect of compounding over a 118-year period.

Exhibit 3 reports real rates of return. As we discussed earlier and as shown in the table, geometric mean is never greater than the arithmetic mean. Our analysis of returns focuses on the geometric mean because it is a more accurate representation of returns for multiple holding periods than the arithmetic mean. We observe that the real returns for stocks are higher than the real returns for bonds.

Exhibit 3: Real Returns and Risk Premiums for Asset Classes (1900–2017)

		United States			World			World excluding United States		
	Asset	***GM* (%)**	***AM* (%)**	***SD* (%)**	***GM* (%)**	***AM* (%)**	***SD* (%)**	***GM* (%)**	***AM* (%)**	***SD* (%)**
Real Returns	Equities	6.5	8.4	20.0	5.2	6.6	17.4	4.5	6.2	18.9
	Bonds	2.0	2.5	10.4	2.0	2.5	11.0	1.7	2.7	14.4
Premiums	Equities vs. bonds	4.4	6.5	20.7	3.2	4.4	15.3	2.8	3.8	14.4

Note: All returns are in percent per annum measured in US$. GM = geometric mean, AM = arithmetic mean, SD = standard deviation.
"World" consists of 21 developed countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, South Africa, Spain, Sweden, Switzerland, United Kingdom, and the United States. Weighting is by each country's relative market capitalization size. See source for details of calculations.
Source: Credit Suisse Global Investment Returns Sourcebook, 2018.

Nominal and Real Returns of Asset Classes in Major Countries

Along with US returns, real returns of major asset classes for a 21-country world and the world excluding the United States are also presented in Exhibit 3. Equity returns are weighted by each country's GDP before 1968 because of a lack of reliable market capitalization data. Returns are weighted by a country's market capitalization beginning with 1968. Similarly, bond returns are defined by a 21-country bond index, except GDP is used to create the weights because equity market capitalization weighting is inappropriate for a bond index and bond market capitalizations were not readily available.

The real geometric mean return for the world stock index over the last 117 years was 5.2 percent, and bonds had a real geometric mean return of 2.0 percent. The real geometric mean return for the world excluding the United States were 4.5 percent for stocks and 1.7 percent for bonds. For both stocks and bonds, the United States earned higher returns than the world excluding the United States. Similarly, real returns for stocks and bonds in the United States were higher than the real returns for rest of the world.

Risk of Major Asset Classes

Risk for major asset classes in the United States is reported for 1926–2017 in Exhibit 1, and the risk for major asset classes for the United States, the world, and the world excluding the United States are reported for 1900–2017 in Exhibit 3. Exhibit 1 shows that US small company stocks had the highest risk, 31.7 percent, followed by US large company stocks, 19.8 percent. Long-term government bonds and long-term corporate bonds had lower risk at 9.9 percent and 8.3 percent, with Treasury bills having the lowest risk at about 3.1 percent.

Exhibit 3 shows that the risk for world stocks is 17.4 percent and for world bonds is 11.0 percent. The world excluding the United States has risks of 18.9 percent for stocks and 14.4 percent for bonds. The effect of diversification is apparent when world risk is compared with US risk and world excluding US risk. Although the risk of US stocks is 20.0 percent and the risk of world excluding US stocks is 18.9 percent, the combination gives a risk of only 17.4 percent for world stocks.

Risk–Return Trade-off

The expression “risk–return trade-off” refers to the positive relationship between expected risk and return. In other words, a higher return is not possible to attain in **efficient markets** and over long periods of time without accepting higher risk. Expected returns should be greater for assets with greater risk.

The historical data presented above show the risk–return trade-off. Exhibit 1 shows for the United States that small company stocks had higher risk and higher return than large company stocks. Large company stocks had higher returns and higher risk than both long-term corporate bonds and government bonds. Bonds had higher returns and higher risk than Treasury bills. Uncharacteristically, however, long-term government bonds had higher total risk than long-term corporate bonds, although the returns of corporate bonds were slightly higher. These factors do not mean that long-term government bonds had greater default risk, just that they were more variable than corporate bonds during this historic period.

Exhibit 3 reveals that the risk and return for stocks were the highest of the asset classes, and the risk and return for bonds were lower than stocks for the United States, the world, and the world excluding the United States.

Another way of looking at the risk–return trade-off is to focus on the **risk premium**, which is the extra return investors can expect for assuming additional risk, after accounting for the risk-free interest rate. The nominal risk premium is the nominal risky return minus the nominal risk-free rate (which includes both compensation for expected inflation and the real risk-free interest rate). The real risk premium is the real risky return minus the real risk-free rate. Worldwide equity risk premiums reported at the bottom of Exhibit 3 show that equities outperformed bonds. Investors in equities earned a higher return than investors in bonds because of the higher risk in equities.

A more dramatic representation of the risk–return trade-off is shown in Exhibit 2, which shows the cumulative returns of US asset classes in real terms. The line representing T-bills is much less volatile than the other lines. Adjusted for inflation, the average real return on T-bills was 0.8 percent per year. The line representing bonds is more volatile than the line for T-bills but less volatile than the line representing stocks. The total return for equities including dividends and capital gains shows how $1 invested at the beginning of 1900 grows to $1,654, generating an annualized return of 6.5 percent in real terms.

Over long periods of time, we observe that higher risk does result in higher mean returns. Thus, it is reasonable to claim that, over the long term, market prices reward higher risk with higher returns, which is a characteristic of a risk-averse investor, a topic that we discuss in Section 4.

3 OTHER INVESTMENT CHARACTERISTICS

☐ describe characteristics of the major asset classes that investors consider in forming portfolios

In evaluating investments using only the mean (expected return) and variance (risk), we are implicitly making two important assumptions: 1) that the returns are normally distributed and can be fully characterized by their means and variances and 2) that markets are not only informationally efficient but that they are also operationally efficient. To the extent that these assumptions are violated, we need to consider additional investment characteristics. These are discussed below.

Distributional Characteristics

As explained in an earlier reading, a **normal distribution** has three main characteristics: its mean and median are equal; it is completely defined by two parameters, mean and variance; and it is symmetric around its mean with:

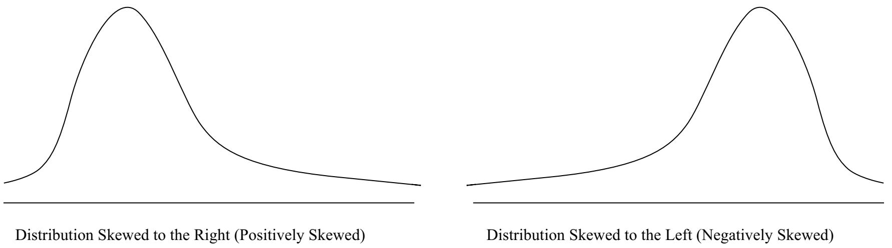
- 68 percent of the observations within ±1σ of the mean,
- 95 percent of the observations within ±2σ of the mean, and
- 99 percent of the observations within ±3σ of the mean.

Using only mean and variance would be appropriate to evaluate investments if returns were distributed normally. Returns, however, are not normally distributed; deviations from normality occur both because the returns are skewed, which means they are not symmetric around the mean, and because the probability of extreme events is significantly greater than what a normal distribution would suggest. The latter deviation is referred to as kurtosis or fat tails in a return distribution. The next sections discuss these deviations more in-depth.

Skewness

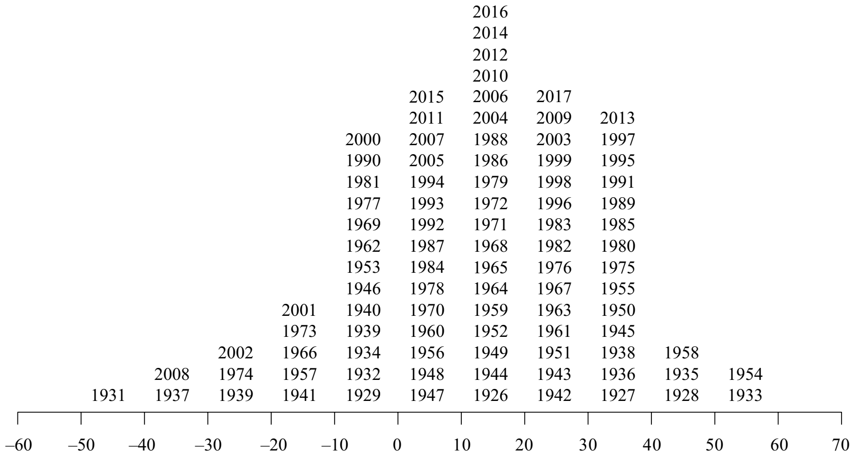
Skewness refers to asymmetry of the return distribution, that is, returns are not symmetric around the mean. A distribution is said to be left skewed or negatively skewed if most of the distribution is concentrated to the right, and right skewed or positively skewed if most is concentrated to the left. Exhibit 4 shows a typical representation of negative and positive skewness, whereas Exhibit 5 demonstrates the negative skewness of stock returns by plotting a histogram of US large company stock returns for 1926–2017.

Exhibit 4: Skewness



Source: Reprinted from *Fixed Income Readings for the Chartered Financial Analyst® Program.* Copyright CFA Institute.

Exhibit 5: Histogram of US Large Company Stock Returns, 1926–2017 (Percent)



Source: 2018 SBBI Yearbook (Appendix A1)

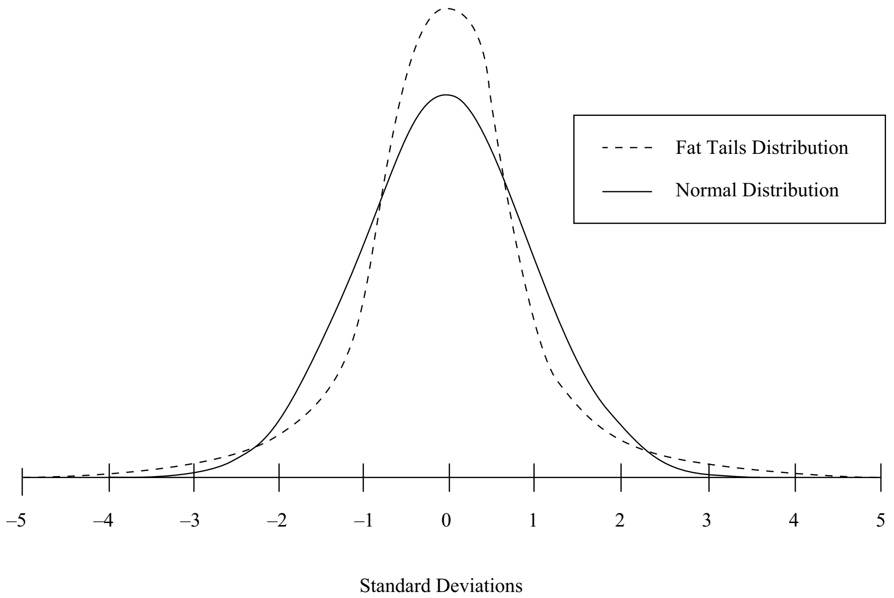
Kurtosis

Kurtosis refers to fat tails or higher than normal probabilities for extreme returns and has the effect of increasing an asset's risk that is not captured in a mean–variance framework, as illustrated in Exhibit 6. Investors try to evaluate the effect of kurtosis by using such statistical techniques as value at risk (VaR) and conditional tail expectations.[2] Several market participants note that the probability and the magnitude of extreme events is underappreciated and was a primary contributing factor to the financial crisis of 2008.[3] The higher probability of extreme negative outcomes among stock returns can also be observed in Exhibit 5.

2 Value at risk is a money measure of the minimum losses expected on a portfolio during a specified time period at a given level of probability. It is commonly used to measure the losses a portfolio can suffer under normal market conditions. For example, if a portfolio's one-day 10 percent VaR is £200,000, it implies that there is a 10 percent probability that the value of the portfolio will decrease by more than £200,000 over a single one-day period (under normal market conditions). This probability implies that the portfolio will experience a loss of at least £200,000 on one out of every ten days.

3 For example, see Bogle (2008) and Taleb (2007).

Exhibit 6: Kurtosis



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Market Characteristics

In the previous analysis, we implicitly assumed that markets are both informationally and operationally efficient. Although informational efficiency of markets is a topic beyond the purview of this reading, we should highlight certain operational limitations of the market that affect the choice of investments. One such limitation is **liquidity**.

The cost of trading has three main components—brokerage commission, bid–ask spread, and price impact. Liquidity affects the latter two. Stocks with low liquidity can have wide bid–ask spreads. The bid–ask spread, which is the difference between the buying price and the selling price, is incurred as a cost of trading a security. The larger the bid–ask spread, the higher the cost of trading. If a $100 stock has a spread of 10 cents, the bid–ask spread is only 0.1 percent ($0.10/$100). On the other hand, if a $10 stock has a spread of 10 cents, the bid–ask spread is 1 percent. Clearly, the $10 stock is more expensive to trade and an investor will need to earn 0.9 percent extra to make up the higher cost of trading relative to the $100 stock.

Liquidity also has implications for the price impact of trade. Price impact refers to how the price moves in response to an order in the market. Small orders usually have little impact, especially for liquid stocks. For example, an order to buy 100 shares of a $100 stock with a spread of 1 cent may have no effect on the price. On the other hand, an order to buy 100,000 shares may have a significant impact on the price as the buyer has to induce more and more stockholders to tender their shares. The extent of the price impact depends on the liquidity of the stock. A stock that trades millions of shares a day may be less affected than a stock that trades only a few hundred thousand shares a day. Investors, especially institutional investors managing large sums of money, must keep the liquidity of a stock in mind when making investment decisions.

Liquidity is a bigger concern in emerging markets than in developed markets because of the smaller volume of trading in those markets. Similarly, liquidity is a more important concern in corporate bond markets and especially for bonds of lower credit quality than in equity markets because an individual corporate bond issue may not trade for several days or weeks. This certainly became apparent during the global financial crisis.

There are other market-related characteristics that affect investment decisions because they might instill greater confidence in the security or might affect the costs of doing business. These include analyst coverage, availability of information, firm size, etc. These characteristics about companies and financial markets are essential components of investment decision making.

4 RISK AVERSION AND PORTFOLIO SELECTION

☐ explain risk aversion and its implications for portfolio selection

As we have seen, stocks, bonds, and T-bills provide different levels of returns and have different levels of risk. Although investment in equities may be appropriate for one investor, another investor may not be inclined to accept the risk that accompanies a share of stock and may prefer to hold more cash. In the last section, we considered investment characteristics of assets in understanding their risk and return. In this section, we consider the characteristics of investors, both individual and institutional, in an attempt to pair the right kind of investors with the right kind of investments.

First, we discuss risk aversion and utility theory. Later we discuss their implications for portfolio selection.

The Concept of Risk Aversion

The concept of **risk aversion** is related to the behavior of individuals under uncertainty. Assume that an individual is offered two alternatives: one where he will get £50 for sure and the other is a gamble with a 50 percent chance that he gets £100 and 50 percent chance that he gets nothing. The expected value in both cases is £50, one with certainty and the other with uncertainty. What will an investor choose? There are three possibilities: an investor chooses the gamble, the investor chooses £50 with certainty, or the investor is indifferent. Let us consider each in turn. However, please understand that this is only a representative example, and a single choice does not determine the risk aversion of an investor.

Risk Seeking

If an investor chooses the gamble, then the investor is said to be risk loving or risk seeking. The gamble has an uncertain outcome, but with the same expected value as the guaranteed outcome. Thus, an investor choosing the gamble means that the investor gets extra "utility" from the uncertainty associated with the gamble. How much is that extra utility worth? Would the investor be willing to accept a smaller expected value because he gets extra utility from risk? Indeed, risk seekers will accept less return because of the risk that accompanies the gamble. For example, a risk seeker may choose a gamble with an expected value of £45 in preference to a guaranteed outcome of £50.

There is a little bit of gambling instinct in many of us. People buy lottery tickets although the expected value is less than the money they pay to buy it. Or people gamble at casinos with the full knowledge that the expected return is negative, a characteristic of risk seekers. These or any other isolated actions, however, cannot be taken at face value except for compulsive gamblers.

Risk Neutral

If an investor is indifferent about the gamble or the guaranteed outcome, then the investor may be risk neutral. Risk neutrality means that the investor cares only about return and not about risk, so higher return investments are more desirable even if they come with higher risk. Many investors may exhibit characteristics of risk neutrality when the investment at stake is an insignificant part of their wealth. For example, a billionaire may be indifferent about choosing the gamble or a £50 guaranteed outcome.

Risk Averse

If an investor chooses the guaranteed outcome, he/she is said to be **risk averse** because the investor does not want to take the chance of not getting anything at all. Depending on the level of aversion to risk, an investor may be willing to accept a guaranteed outcome of £45 instead of a gamble with an expected value of £50.

In general, investors are likely to shy away from risky investments for a lower, but guaranteed return. That is why they want to minimize their risk for the same amount of return, and maximize their return for the same amount of risk. The risk–return trade-off discussed earlier is an indicator of risk aversion. A risk-neutral investor would maximize return irrespective of risk and a risk-seeking investor would maximize both risk and return.

Data presented in the last section illustrate the historically positive relationship between risk and return, which demonstrates that market prices were based on transactions and investments by risk-averse investors and reflect risk aversion. Therefore, for all practical purposes and for our future discussion, we will assume that the representative investor is a risk-averse investor. This assumption is the standard approach taken in the investment industry globally.

Risk Tolerance

Risk tolerance refers to the amount of risk an investor can tolerate to achieve an investment goal. The higher the risk tolerance, the greater is the willingness to take risk. Thus, risk tolerance is negatively related to risk aversion.

5 UTILITY THEORY AND INDIFFERENCE CURVES

☐ explain risk aversion and its implications for portfolio selection

Continuing with our previous example, a risk-averse investor would rank the guaranteed outcome of £50 higher than the uncertain outcome with an expected value of £50. We can say that the utility that an investor or an individual derives from the guaranteed outcome of £50 is greater than the utility or satisfaction or happiness he/she derives from the alternative. In general terms, utility is a measure of relative satisfaction from consumption of various goods and services or in the case of investments, the satisfaction that an investor derives from a portfolio.

Because individuals are different in their preferences, all risk-averse individuals may not rank investment alternatives in the same manner. Consider the £50 gamble again. All risk-averse individuals will rank the guaranteed outcome of £50 higher than the gamble. What if the guaranteed outcome is only £40? Some risk-averse investors might consider £40 inadequate, others might accept it, and still others may now be indifferent about the uncertain £50 and the certain £40.

A simple implementation of utility theory allows us to quantify the rankings of investment choices using risk and return. There are several assumptions about individual behavior that we make in the definition of utility given in the equation below. We assume that investors are risk averse. They always prefer more to less (greater return to lesser return). They are able to rank different portfolios in the order of their preference and that the rankings are internally consistent. If an individual prefers X to Y and Y to Z, then he/she must prefer X to Z. This property implies that the indifference curves (see Exhibit 7) for the same individual can never touch or intersect. An example of a utility function is given below

$$U = E(r) - \frac{1}{2}A\sigma^2$$

where, U is the utility of an investment, $E(r)$ is the expected return, and σ^2 is the variance of the investment.

In the above equation, A is a measure of risk aversion, which is measured as the marginal reward that an investor requires to accept additional risk. More risk-averse investors require greater compensation for accepting additional risk. Thus, A is higher for more risk-averse individuals. As was mentioned previously, a risk-neutral investor would maximize return irrespective of risk and a risk-seeking investor would maximize both risk and return.

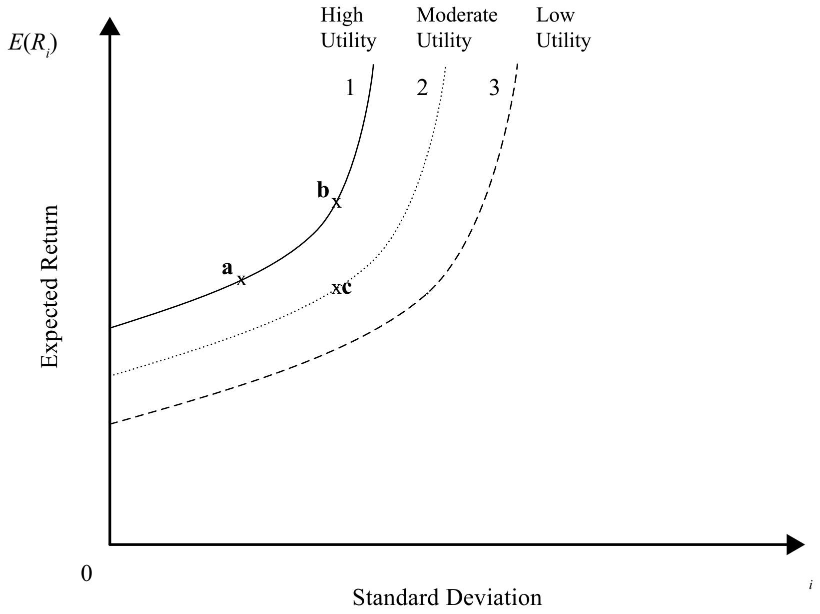
We can draw several conclusions from the utility function. First, utility is unbounded on both sides. It can be highly positive or highly negative. Second, higher return contributes to higher utility. Third, higher variance reduces the utility but the reduction in utility gets amplified by the risk aversion coefficient, A. Utility can always be increased, albeit marginally, by getting higher return or lower risk. Fourth, utility does not indicate or measure satisfaction itself—it can be useful only in ranking various investments. For example, a portfolio with a utility of 4 is not necessarily two times better than a portfolio with a utility of 2. The portfolio with a utility of 4 could increase our happiness 10 times or just marginally. But we do prefer a portfolio with a utility of 4 to a portfolio with a utility of 2. Utility cannot be compared among individuals or investors because it is a very personal concept. From a societal point of view, by the same argument, utility cannot be summed among individuals.

Let us explore the utility function further. The risk aversion coefficient, A, is greater than zero for a risk-averse investor. So any increase in risk reduces his/her utility. The risk aversion coefficient for a risk-neutral investor is 0, and changes in risk do not affect his/her utility. For a risk lover, the risk aversion coefficient is negative, creating an inverse situation so that additional risk contributes to an increase in his/her utility. Note that a risk-free asset ($\sigma^2 = 0$) generates the same utility for all individuals.

Indifference Curves

An **indifference curve** plots the combinations of risk–return pairs that an investor would accept to maintain a given level of utility (i.e., the investor is indifferent about the combinations on any one curve because they would provide the same level of overall utility). Indifference curves are thus defined in terms of a trade-off between expected rate of return and variance of the rate of return. Because an infinite number of combinations of risk and return can generate the same utility for the same investor, indifference curves are continuous at all points.

Exhibit 7: Indifference Curves for Risk-Averse Investors



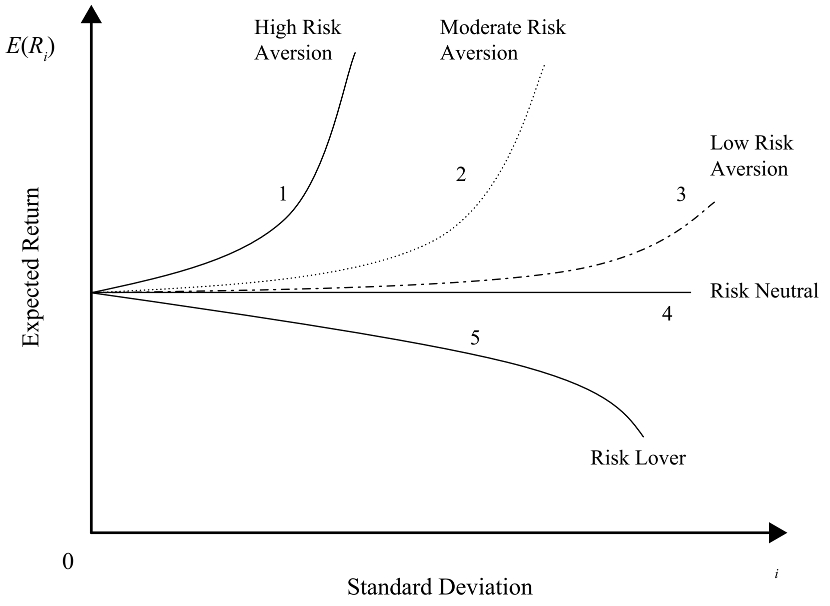
A set of indifference curves is plotted in Exhibit 7. By definition, all points on any one of the three curves have the same utility. An investor does not care whether he/she is at Point **a** or Point **b** on indifference Curve 1. Point **a** has lower risk and lower return than Point **b**, but the utility of both points is the same because the higher return at Point **b** is offset by the higher risk.

Like Curve 1, all points on Curve 2 have the same utility and an investor is indifferent about where he/she is on Curve 2. Now compare Point **c** with Point **b**. Point **c** has the same risk but significantly lower return than Point **b**, which means that the utility at Point **c** is less than the utility at Point **b**. Given that all points on Curve 1 have the same utility and all points on Curve 2 have the same utility and Point **b** has higher utility than Point **c**, Curve 1 has higher utility than Curve 2. Therefore, a risk-averse investor with indifference Curves 1 and 2 will prefer Curve 1 to Curve 2. The utility of a risk-averse investor always increases as you move northwest—higher return with lower risk. Because all investors prefer more utility to less, investors want to move northwest to the indifference curve with the highest utility.

The indifference curve for risk-averse investors runs from the southwest to the northeast because of the risk–return trade-off. If risk increases (going east) then it must be compensated by higher return (going north) to generate the same utility. The indifference curves are convex because of diminishing marginal utility of return (or wealth). As risk increases, an investor needs greater return to compensate for higher risk at an increasing rate (i.e., the curve gets steeper). The upward-sloping convex indifference curve has a slope coefficient closely related to the risk aversion coefficient. The greater the slope, the higher is the risk aversion of the investor as a greater increment in return is required to accept a given increase in risk.

Indifference curves for investors with different levels of risk aversion are plotted in Exhibit 8. The most risk-averse investor has an indifference curve with the greatest slope. As volatility increases, this investor demands increasingly higher returns to compensate for risk. The least risk-averse investor has an indifference curve with the least slope and so the demand for higher return as risk increases is not as acute as for the more risk-averse investor. The risk-loving investor's indifference curve, however, exhibits a negative slope, implying that the risk-lover is happy to substitute risk for return. For a risk lover, the utility increases both with higher risk and higher return. Finally, the indifference curves of risk-neutral investors are horizontal because the utility is invariant with risk.

Exhibit 8: Indifference Curves for Various Types of Investors



In the remaining parts of this reading, all investors are assumed to be risk averse unless stated otherwise.

EXAMPLE 1

Comparing a Gamble with a Guaranteed Outcome

Assume that you are given an investment with an expected return of 10 percent and a risk (standard deviation) of 20 percent, and your risk aversion coefficient is 3.

1. What is your utility of this investment?

   Solution:

   $U = 0.10 - 0.5 \times 3 \times 0.20^2 = 0.04.$

2. What must be the minimum risk-free return you should earn to get the same utility?

   Solution:

   A risk-free return's σ is zero, so the second term disappears. To get the same utility (0.04), the risk-free return must be at least 4 percent. Thus, in your mind, a risky return of 10 percent is equivalent to a risk-free return or a guaranteed outcome of 4 percent.

EXAMPLE 2

Computation of Utility

Based on investment information given below and the utility formula $U = E(r) - 0.5A\sigma^2$, answer the following questions. Returns and standard deviations are both expressed as percent per year. When using the utility formula, however, returns and standard deviations must be expressed in decimals.

Investment	Expected Return $E(r)$	Standard Deviation σ
1	12%	30%
2	15	35
3	21	40
4	24	45

1. Which investment will a risk-averse investor with a risk aversion coefficient of 4 choose, and which investment will a risk-averse investor with a risk aversion coefficient of 2 choose?

   Solution:

   The utility for risk-averse investors with $A = 4$ and $A = 2$ for each of the four investments are shown in the following table. Complete calculations for Investment 1 with $A = 4$ are as follows: $U = 0.12 - 0.5 \times 4 \times 0.30^2 = -0.06$.

Investment	Expected Return $E(r)$	Standard Deviation σ	Utility $A = 4$	Utility $A = 2$
1	12%	30%	−0.0600	0.0300
2	15	35	−0.0950	0.0275
3	21	40	−0.1100	0.0500
4	24	45	−0.1650	0.0375

   The risk-averse investor with a risk aversion coefficient of 4 should choose Investment 1. The risk-averse investor with a risk aversion coefficient of 2 should choose Investment 3.

2. Which investment will a risk-neutral investor choose?

   Solution:

   A risk-neutral investor cares only about return. In other words, his risk aversion coefficient is 0. Therefore, a risk-neutral investor will choose Investment 4 because it has the highest return.

3. Which investment will a risk-loving investor choose?

   Solution:

   A risk-loving investor likes both higher risk and higher return. In other words, his risk aversion coefficient is negative. Therefore, a risk-loving investor will choose Investment 4 because it has the highest return and highest risk among the four investments.

6 APPLICATION OF UTILITY THEORY TO PORTFOLIO SELECTION

- ☐ explain risk aversion and its implications for portfolio selection
- ☐ explain the selection of an optimal portfolio, given an investor's utility (or risk aversion) and the capital allocation line

The simplest application of utility theory and risk aversion is to a portfolio of two assets, a risk-free asset and a risky asset. The risk-free asset has zero risk and a return of R_f. The risky asset has a risk of σ_i (> 0) and an expected return of $E(R_i)$. Because the risky asset has risk that is greater than that of the risk-free asset, the expected return from the risky asset will be greater than the return from the risk-free asset, that is, $E(R_i) > R_f$.

We can construct a portfolio of these two assets with a portfolio expected return, $E(R_p)$, and portfolio risk, σ_p, based on the formulas provided below. In the equations given below, w_1 is the weight in the risk-free asset and $(1 - w_1)$ is the weight in the risky asset. Because $\sigma_f = 0$ for the risk-free asset, the first and third terms in the formula for variance are zero leaving only the second term. We arrive at the last equation by taking the square root of both sides, which shows the expression for standard deviation for a portfolio of two assets when one asset is the risk-free asset:

$$E(R_p) = w_1 R_f + (1 - w_1)E(R_i)$$

$$\sigma_P^2 = w_1^2\sigma_f^2 + (1 - w_1)^2\sigma_i^2 + 2w_1(1 - w_1)\rho_{12}\sigma_f\sigma_i = (1 - w_1)^2\sigma_i^2$$

$$\sigma_p = (1 - w_1)\sigma_i$$

The two-asset portfolio is drawn in Exhibit 9 by varying w_1 from 0 percent to 100 percent. The portfolio standard deviation is on the horizontal axis and the portfolio return is on the vertical axis. If only these two assets are available in the economy and the risky asset represents the market, the line in Exhibit 9 is called the **capital allocation line**. The capital allocation line represents the portfolios available to an investor. The equation for this line can be derived from the above two equations by rewriting the second equation as $w_1 = 1 - \frac{\sigma_p}{\sigma_i}$. Substituting the value of w_1 in the equation for expected return, we get the following equation for the capital allocation line:

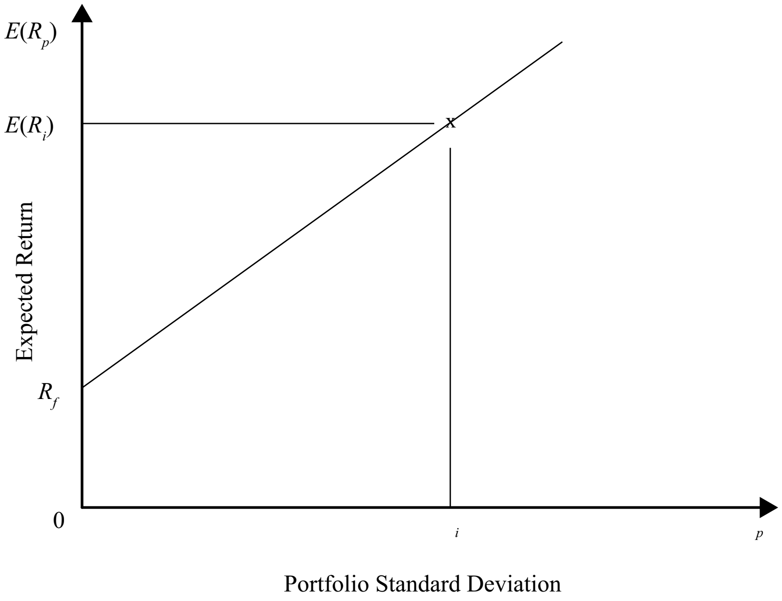
$$E(R_p) = \left(1 - \frac{\sigma_p}{\sigma_i}\right)R_f + \frac{\sigma_p}{\sigma_i}E(R_i)$$

This equation can be rewritten in a more usable form:

$$E(R_p) = R_f + \frac{(E(R_i) - R_f)}{\sigma_i}\sigma_p$$

The capital allocation line has an intercept of R_f, and a slope of $\frac{(E(R_i) - R_f)}{\sigma_i}$, which is the additional required return for every increment in risk, and is sometimes referred to as the market price of risk.

Exhibit 9: Capital Allocation Line with Two Assets

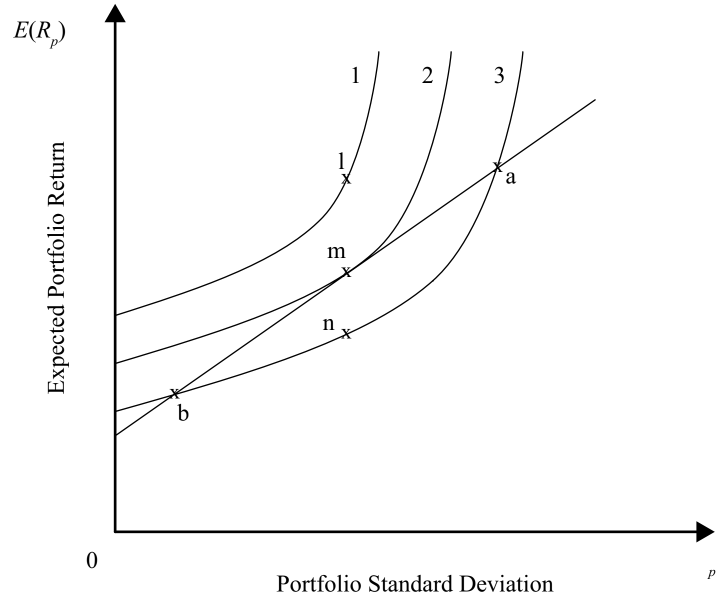


Because the equation is linear, the plot of the capital allocation line is a straight line. The line begins with the risk-free asset as the leftmost point with zero risk and a risk-free return, R_f. At that point, the portfolio consists of only the risk-free asset. If 100 percent is invested in the portfolio of all risky assets, however, we have a return of $E(R_i)$ with a risk of σ_i.

We can move further along the line in pursuit of higher returns by borrowing at the risk-free rate and investing the borrowed money in the portfolio of all risky assets. If 50 percent is borrowed at the risk-free rate, then $w_1 = -0.50$ and 150 percent is placed in the risky asset, giving a return = $1.50E(R_i) - 0.50R_f$, which is > $E(R_i)$ because $E(R_i) > R_f$.

The line plotted in Exhibit 9 is comprised of an unlimited number of risk–return pairs or portfolios. Which *one* of these portfolios should be chosen by an investor? The answer lies in combining indifference curves from utility theory with the capital allocation line from portfolio theory. Utility theory gives us the utility function or the indifference curves for an individual, as in Exhibit 9, and the capital allocation line gives us the set of feasible investments. Overlaying each individual's indifference curves on the capital allocation line will provide us with the optimal portfolio for that investor. Exhibit 10 illustrates this process of portfolio selection.

Exhibit 10: Portfolio Selection



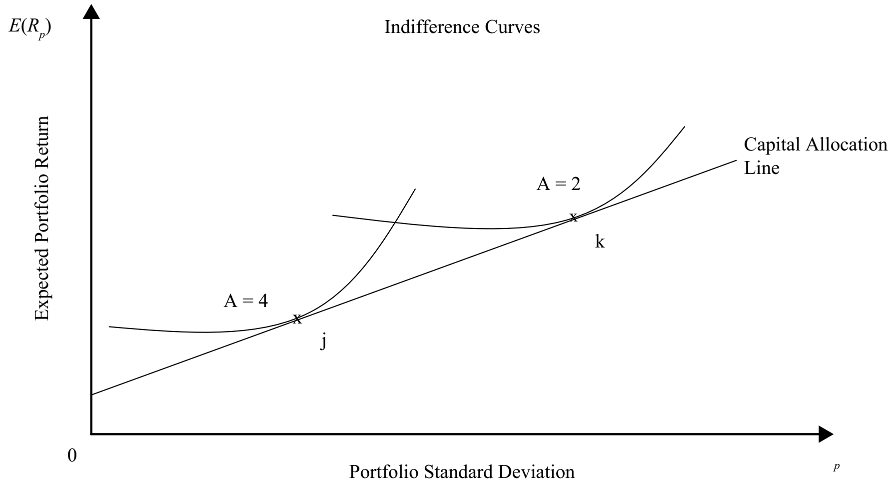
The capital allocation line consists of the set of feasible portfolios. Points under the capital allocation line may be attainable but are not preferred by any investor because the investor can get a higher return for the same risk by moving up to the capital allocation line. Points above the capital allocation line are desirable but not achievable with available assets.

Three indifference curves for the same individual are also shown in Exhibit 10. Curve 1 is above the capital allocation line, Curve 2 is tangential to the line, and Curve 3 intersects the line at two points. Curve 1 has the highest utility and Curve 3 has the lowest utility. Because Curve 1 lies completely above the capital allocation line, points on Curve 1 are not achievable with the available assets on the capital allocation line. Curve 3 intersects the capital allocation line at two Points, **a** and **b**. The investor is able to invest at either Point **a** or **b** to derive the risk–return trade-off and utility associated with Curve 3. Comparing points with the same risk, observe that Point **n** on Curve 3 has the same risk as Point **m** on Curve 2, yet Point **m** has the higher expected return. Therefore, all investors will choose Curve 2 instead of Curve 3. Curve 2 is tangential to the capital allocation line at Point **m**. Point **m** is on the capital allocation line and investable. Point **m** and the utility associated with Curve 2 is the best that the investor can do because he/she cannot move to a higher utility indifference curve. Thus, we have been able to select the optimal portfolio for the investor with indifference Curves 1, 2, and 3. Point **m**, the optimal portfolio for one investor, may not be optimal for another investor. We can follow the same process, however, for finding the optimal portfolio for other investors: the optimal portfolio is the point of tangency between the capital allocation line and the indifference curve for that investor. In other words, the optimal portfolio maximizes the return per unit of risk (as it is on the capital allocation line), and it simultaneously supplies the investor with the most satisfaction (utility).

As an illustration, Exhibit 11 shows two indifference curves for two different investors: Kelly with a risk aversion coefficient of 2 and Jane with a risk aversion coefficient of 4. The indifference curve for Kelly is to the right of the indifference curve for Jane because Kelly is less risk averse than Jane and can accept a higher amount of risk, i.e. has a higher tolerance for risk. Accordingly, their optimal portfolios are different:

Point **k** is the optimal portfolio for Kelly and Point **j** is the optimal portfolio for Jane. In addition, for the same return, the slope of Jane's curve is higher than Kelly's suggesting that Jane needs greater incremental return as compensation for accepting an additional amount of risk compared with Kelly.

Exhibit 11: Portfolio Selection for Two Investors with Various Levels of Risk Aversion



PORTFOLIO RISK & PORTFOLIO OF TWO RISKY ASSETS

7

- ☐ calculate and interpret the mean, variance, and covariance (or correlation) of asset returns based on historical data
- ☐ calculate and interpret portfolio standard deviation
- ☐ describe the effect on a portfolio's risk of investing in assets that are less than perfectly correlated

We have seen before that investors are risk averse and demand a higher return for a riskier investment. Therefore, ways of controlling portfolio risk without affecting return are valuable. As a precursor to managing risk, this section explains and analyzes the components of portfolio risk. In particular, it examines and describes how a portfolio consisting of assets with low correlations have the potential of reducing risk without necessarily reducing return.

Portfolio of Two Risky Assets

The return and risk of a portfolio of two assets was introduced in Sections 2–3 of this reading. In this section, we briefly review the computation of return and extend the concept of portfolio risk and its components.

Portfolio Return

When several individual assets are combined into a portfolio, we can compute the portfolio return as a weighted average of the returns in the portfolio. The portfolio return is simply a weighted average of the returns of the individual investments, or assets. If Asset 1 has a return of 20 percent and constitutes 25 percent of the portfolio's investment, then the contribution to the portfolio return is 5 percent (= 25% of 20%). In general, if Asset i has a return of R_i and has a weight of w_i in the portfolio, then the portfolio return, R_P, is given as:

$$R_P = \sum_{i=1}^{N} w_i R_i, \quad \sum_{i=1}^{N} w_i = 1$$

Note that the weights must add up to 1 because the assets in a portfolio, including cash, must account for 100 percent of the investment. Also, note that these are single period returns, so there are no cash flows during the period and the weights remain constant.

When two individual assets are combined in a portfolio, we can compute the portfolio return as a weighted average of the returns of the two assets. Consider Assets 1 and 2 with weights of 25 percent and 75 percent in a portfolio. If their returns are 20 percent and 5 percent, the weighted average return = (0.25 × 20%) + (0.75 × 5%) = 8.75%. More generally, the portfolio return can be written as below, where R_p is return of the portfolio, w_1 and w_2 are the weights of the two assets, and R_1, R_2 are returns on the two assets:

$$R_p = w_1 R_1 + (1 - w_1) R_2$$

Portfolio Risk

Like a portfolio's return, we can calculate a portfolio's variance. Although the return of a portfolio is simply a weighted average of the returns of each security, this is not the case with the standard deviation of a portfolio (unless all securities are perfectly correlated—that is, correlation equals one). Variance can be expressed more generally for N securities in a portfolio using the notation from the portfolio return calculation above:

$$\sum_{i=1}^{N} w_i = 1$$

$$\sigma_P^2 = \text{Var}(R_P) = \text{Var}\left(\sum_{i=1}^{N} w_i R_i\right)$$

Note that the weights must add up to 1. The right side of the equation is the variance of the weighted average returns of individual securities. Weight is a constant, but the returns are variables whose variance is shown by Var(R_i). We can rewrite the equation as shown next. Because the covariance of an asset with itself is the variance of the asset, we can separate the variances from the covariances in the second equation:

$$\sigma_P^2 = \sum_{i,j=1}^{N} w_i w_j \text{Cov}\left(R_i, R_j\right)$$

$$\sigma_P^2 = \sum_{i=1}^{N} w_i^2 \text{Var}(R_i) + \sum_{i,j=1, i \neq j}^{N} w_i w_j \text{Cov}\left(R_i, R_j\right)$$

Cov(R_i,R_j) is the covariance of returns, R_i and R_j, and can be expressed as the product of the correlation between the two returns ($\rho_{1,2}$) and the standard deviations of the two assets. Thus, Cov(R_i,R_j) = $\rho_{ij}\sigma_i\sigma_j$.

For a two asset portfolio, the expression for portfolio variance simplifies to the following using covariance and then using correlation:

$$\sigma_P^2 = w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\text{Cov}(R_1,R_2)$$
$$\sigma_P^2 = w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\rho_{12}\sigma_1\sigma_2$$

The standard deviation of a two asset portfolio is given by the square root of the portfolio's variance:

$$\sigma_P = \sqrt{w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\text{Cov}(R_1,R_2)}$$

or,

$$\sigma_P = \sqrt{w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\rho_{12}\sigma_1\sigma_2}$$

EXAMPLE 3

Return and Risk of a Two-Asset Portfolio

1. Assume that as a US investor, you decide to hold a portfolio with 80 percent invested in the S&P 500 US stock index and the remaining 20 percent in the MSCI Emerging Markets index. The expected return is 9.93 percent for the S&P 500 and 18.20 percent for the Emerging Markets index. The risk (standard deviation) is 16.21 percent for the S&P 500 and 33.11 percent for the Emerging Markets index. What will be the portfolio's expected return and risk given that the covariance between the S&P 500 and the Emerging Markets index is 0.5 percent or 0.0050? Note that units for covariance and variance are written as $\%^2$ when not expressed as a fraction. These are units of measure like squared feet and the numbers themselves are not actually squared.

   Solution:

   Portfolio return, $R_P = w_1R_1 + (1 - w_1), R_2 = (0.80 \times 0.0993) + (0.20 \times 0.1820)$ $= 0.1158$

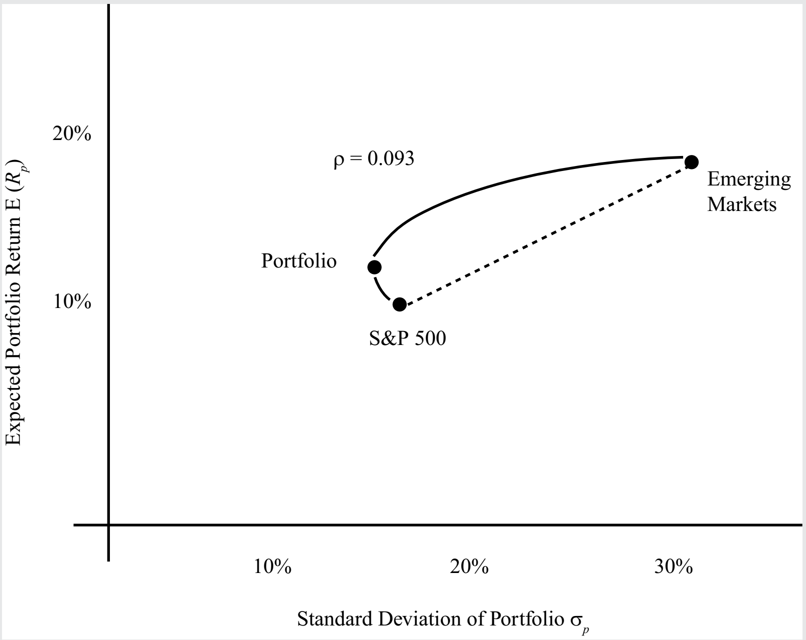
   $= 11.58\%.$

   $$\text{Portfolio risk} = \sigma_P = \sqrt{w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2 Cov(R_1,R_2)}$$

   $$\sigma_p^2 = w_{US}^2\sigma_{US}^2 + w_{EM}^2\sigma_{EM}^2 + 2w_{US}w_{EM}Cov_{US,EM}$$
   $$\sigma_p^2 = (0.80^2 \times 0.1621^2) + (0.20^2 \times 0.3311^2)$$
   $$+ (2 \times 0.80 \times 0.20 \times 0.0050)$$
   $$\sigma_p^2 = 0.01682 + 0.00439 + 0.00160 = 0.02281$$
   $$\sigma_p = 0.15103 = 15.10\%$$

   The portfolio's expected return is 11.58 percent and the portfolio's risk is 15.10 percent. Look at this example closely. It shows that we can take the portfolio of a US investor invested only in the S&P 500, combine it with a *riskier* portfolio consisting of emerging markets securities, and the return of the US investor increases from 9.93 percent to 11.58 percent while the risk of the portfolio actually falls from 16.21 percent to 15.10 percent. Exhibit 12 depicts how the combination of the two assets results in a superior risk–return trade-off. Not only does the investor get a higher return, but he also gets it at a lower risk. That is the power of diversification as you will see later in this reading.

Exhibit 12: Combination of Two Assets



Covariance and Correlation

The **covariance** in the formula for portfolio standard deviation can be expanded as $\text{Cov}(R_1,R_2) = \rho_{12}\sigma_1\sigma_2$ where ρ_{12} is the correlation between returns, R_1, R_2. Although covariance is important, it is difficult to interpret because it is unbounded on both sides. It is easier to understand the **correlation coefficient** (ρ_{12}), which is bounded but provides similar information.

Correlation is a measure of the consistency or tendency for two investments to act in a similar way. The correlation coefficient, ρ_{12}, can be positive or negative and ranges from −1 to +1. Consider three different values of the correlation coefficient:

- $\rho_{12} = +1$: Returns of the two assets are perfectly *positively* correlated. Assets 1 and 2 move together 100 percent of the time.
- $\rho_{12} = -1$: Returns of the two assets are perfectly *negatively* correlated. Assets 1 and 2 move in opposite directions 100 percent of the time.
- $\rho_{12} = 0$: Returns of the two assets are *uncorrelated*. Movement of Asset 1 provides no prediction regarding the movement of Asset 2.

The correlation coefficient between two assets determines the effect on portfolio risk when the two assets are combined. To see how this works, consider two different values of ρ_{12}. You will find that portfolio risk is unaffected when the two assets are perfectly correlated ($\rho_{12} = +1$). In other words, the portfolio's standard deviation is simply a weighted average of the standard deviations of the two assets and as such a portfolio's risk is unchanged with the addition of assets with the same risk parameters. Portfolio risk falls, however, when the two assets are not perfectly correlated (ρ_{12} < +1). Sufficiently low values of the correlation coefficient can make the portfolio riskless under certain conditions.

First, let $\rho_{12} = +1$

$$\sigma_p^2 = w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\rho_{12}\sigma_1\sigma_2 = w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\sigma_1\sigma_2$$
$$= (w_1\sigma_1 + w_2\sigma_2)^2$$
$$\sigma_p = w_1\sigma_1 + w_2\sigma_2$$

The first set of terms on the right side of the first equation contain the usual terms for portfolio variance. Because the correlation coefficient is equal to +1, the right side can be rewritten as a perfect square. The third row shows that portfolio risk is a weighted average of the risks of the individual assets' risks. We showed earlier that the portfolio return is a weighted average of the assets' returns. Because both risk and return are just weighted averages of the two assets in the portfolio there is no reduction in risk when ρ_{12} = +1.

Now let ρ_{12} < +1

The above analysis showed that portfolio risk is a weighted average of asset risks when ρ_{12} = + 1. When ρ_{12} < +1, the portfolio risk is less than the weighted average of the individual assets' risks.

To show this, we begin by reproducing the general formula for portfolio risk, which is expressed by the terms to the left of the "<" sign below. The term to the right of "<" shows the portfolio risk when ρ_{12} = + 1:

$$\sigma_p = \sqrt{w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\rho_{12}\sigma_1\sigma_2} < \sqrt{w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\sigma_1\sigma_2}$$
$$= (w_1\sigma_1 + w_2\sigma_2)$$
$$\sigma_p < (w_1\sigma_1 + w_2\sigma_2)$$

The left side is smaller than the right side because the correlation coefficient on the left side for the new portfolio is <1. Thus, the portfolio risk is less than the weighted average of risks while the portfolio return is still a weighted average of returns.

As you can see, we have achieved diversification by combining two assets that are not perfectly correlated. For an extreme case in which ρ_{12} = −1 (that is, the two asset returns move in opposite directions), the portfolio can be made risk free.

EXAMPLE 4

Effect of Correlation on Portfolio Risk

Two stocks have the same return and risk (standard deviation): 10 percent return with 20 percent risk. You form a portfolio with 50 percent each of Stock 1 and Stock 2 to examine the effect of correlation on risk.

1. Calculate the portfolio return and risk if the correlation is 1.0.

Solution:

$R_1 = R_2 = 10\% = 0.10;\ \sigma_1 = \sigma_2 = 20\% = 0.20;\ w_1 = w_2 = 50\%$
$= 0.50$. Case 1: $\rho_{12} = +1$

$$R_p = w_1R_1 + w_2R_2$$
$$R_p = (0.5 \times 0.1) + (0.5 \times 0.1) = 0.10 = 10\%$$
$$\sigma_p^2 = w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\sigma_1\sigma_2\rho_{12}$$
$$\sigma_p^2 = (0.5^2 \times 0.2^2) + (0.5^2 \times 0.2^2) + (2 \times 0.5 \times 0.5 \times 0.2 \times 0.2 \times 1) = 0.04$$
$$\sigma_p = \sqrt{0.04} = 0.20 = 20\%$$

This equation demonstrates the earlier point that with a correlation of 1.0 the risk of the portfolio is the same as the risk of the individual assets.

2. Calculate the portfolio return and risk if the correlation is 0.0.

   Solution:

$$\rho_{12} = 0$$
$$R_p = w_1 R_1 + w_2 R_2 = 0.10 = 10\%$$
$$\sigma_p^2 = w_1^2 \sigma_1^2 + w_2^2 \sigma_2^2 + 2 w_1 w_2 \sigma_1 \sigma_2 \rho_{12}$$
$$\sigma_p^2 = (0.5^2 \times 0.2^2) + (0.5^2 \times 0.2^2)$$
$$+ (2 \times 0.5 \times 0.5 \times 0.2 \times 0.2 \times 0) = 0.02$$
$$\sigma_p = \sqrt{0.02} = 0.14 = 14\%$$

   This equation demonstrates the earlier point that, when assets have correlations of less than 1.0, they can be combined in a portfolio that has less risk than either of the assets individually.

3. Calculate the portfolio return and risk if the correlation is –1.0.

   Solution:

$$\rho_{12} = -1$$
$$R_p = w_1 R_1 + w_2 R_2 = 0.10 = 10\%$$
$$\sigma_p^2 = w_1^2 \sigma_1^2 + w_2^2 \sigma_2^2 + 2 w_1 w_2 \sigma_1 \sigma_2 \rho_{12}$$
$$\sigma_p^2 = (0.5^2 \times 0.2^2) + (0.5^2 \times 0.2^2)$$
$$+ (2 \times 0.5 \times 0.5 \times 0.2 \times 0.2 \times -1) = 0$$
$$\sigma_p = 0\%$$

   This equation demonstrates the earlier point that, if the correlation of assets is low enough, in this case 100 percent negative correlation or –1.00 (exactly inversely related), a portfolio can be designed that eliminates risk. The individual assets retain their risk characteristics, but the portfolio is risk free.

4. Compare the return and risk of portfolios with different correlations.

   Solution:

   The expected return is 10 percent in all three cases; however, the returns will be more volatile in Case 1 and least volatile in Case 3. In the first case, there is no diversification of risk (same risk as before of 20 percent) and the return remains the same. In the second case, with a correlation coefficient of 0, we have achieved diversification of risk (risk is now 14 percent instead of 20 percent), again with the same return. In the third case with a correlation coefficient of –1, the portfolio is risk free, although we continue to get the same return of 10 percent. This example shows the power of diversification that we expand on further in Section 9.

Relationship between Portfolio Risk and Return

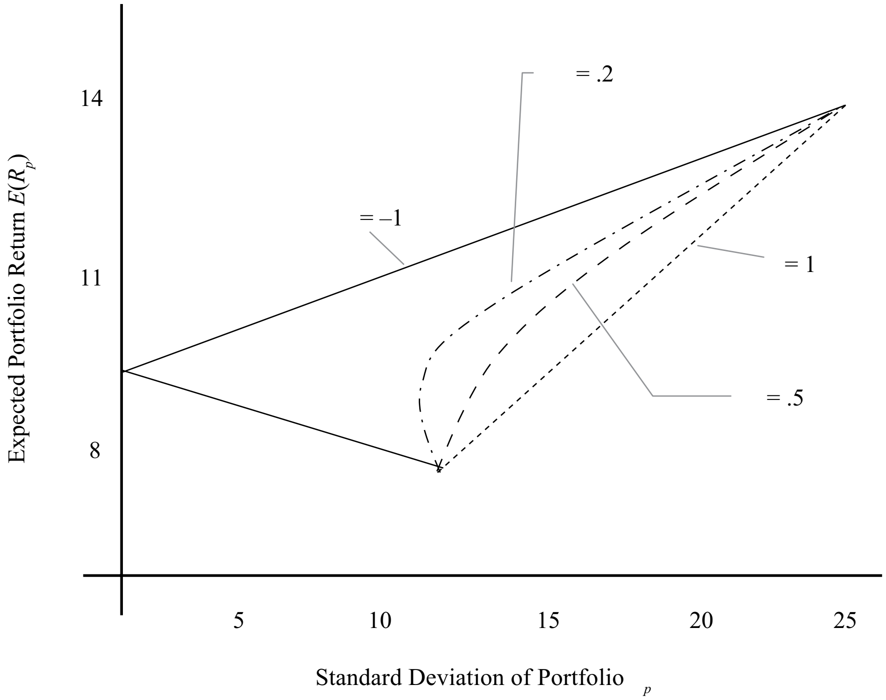
The previous example illustrated the effect of correlation on portfolio risk while keeping the weights in the two assets equal and unchanged. In this section, we consider how portfolio risk and return vary with different portfolio weights and different correlations.

Asset 1 has an annual return of 7 percent and annualized risk of 12 percent, whereas Asset 2 has an annual return of 15 percent and annualized risk of 25 percent. The relationship is tabulated in Exhibit 13 for the two assets and graphically represented in Exhibit 14.

Exhibit 13: Relationship between Risk and Return

Weight in Asset 1 (%)	Portfolio Return	Portfolio Risk with Correlation of			
		1.0	0.5	0.2	−1.0
0	15.0	25.0	25.0	25.0	25.0
10	14.2	23.7	23.1	22.8	21.3
20	13.4	22.4	21.3	20.6	17.6
30	12.6	21.1	19.6	18.6	13.9
40	11.8	19.8	17.9	16.6	10.2
50	11.0	18.5	16.3	14.9	6.5
60	10.2	17.2	15.0	13.4	2.8
70	9.4	15.9	13.8	12.3	0.9
80	8.6	14.6	12.9	11.7	4.6
90	7.8	13.3	12.2	11.6	8.3
100	7.0	12.0	12.0	12.0	12.0

Exhibit 14: Relationship between Risk and Return



The table shows the portfolio return and risk for four correlation coefficients ranging from +1.0 to −1.0 and 11 weights ranging from 0 percent to 100 percent. The portfolio return and risk are 15 percent and 25 percent, respectively, when 0 percent is invested in Asset 1, versus 7 percent and 12 percent when 100 percent is invested in Asset 1. The portfolio return varies with weights but is unaffected by the correlation coefficient.

Portfolio risk becomes smaller with each successive decrease in the correlation coefficient, with the smallest risk when $\rho_{12} = -1$. The graph in Exhibit 14 shows that the risk–return relationship is a straight line when $\rho_{12} = +1$. As the correlation falls, the risk becomes smaller and smaller as in the table. The curvilinear nature of a portfolio of assets is recognizable in all investment opportunity sets (except at the extremes where $\rho_{12} = -1$ or $+1$).

EXAMPLE 5

Portfolio of Two Assets

Assume you are a UK investor holding a portfolio invested 60% in UK large-capitalization equities (as proxied by the FTSE 100 Index) and 40% in local medium-duration Treasury bonds ("gilts"). The expected return on the FTSE 100 is 5.5% and on the medium-duration gilts it is 0.7%. The risk (standard deviation of returns) is 13.2% and 4.2%, respectively. The correlation between the two assets is –0.01.

The expected return of this portfolio is

$$R_p = w_1 \times R_1 + (1 - w_1) \times R_2 = 0.6 \times 0.055 + 0.4 \times 0.07 = 0.0358 \approx 3.6\%.$$

The risk of this portfolio is

$$\sigma_p = \sqrt{w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2 \times w_1 w_2 \times \rho \times \sigma_1\sigma_2}.$$

$$\sigma_p = \sqrt{(0.6^2 \times 0.132^2) + (0.4^2 \times 0.042^2) + 2 \times 0.6 \times 0.4 \times -0.01 \times 0.132 \times 0.042}.$$

$$\sigma_p = 0.0808 \approx 8.1\%$$

You notice that compared with US Treasury bonds, the expected return on gilts is lower and the risk of gilts is higher. US Treasury bonds have an expected return for a US-based investor of 1.5% and a risk of 4.0%. You wonder whether replacing the gilts in your portfolio with US Treasury bonds ("Treasuries") would improve the risk and return profile of your portfolio.

1. Do the given risk and return assumptions for US Treasury bonds allow you as a UK-based investor to calculate the expected return and risk of your portfolio with US Treasury bonds replacing UK gilts?

   Solution:

   No. The expected return and risk for Treasuries apply to a US investor, who invests in US dollars. To calculate expected return and risk in sterling for a UK-based portfolio of FTSE 100 equities and US Treasuries, one needs to take into account the exchange rate between the US dollar and UK pound sterling. This exchange rate has a volatility (risk) of its own, and a return expectation for the GBP/USD exchange rate has to be specified.

   For the purpose of calculating the return and risk of a foreign asset in a domestic investor's portfolio, the foreign asset can be seen as a "portfolio" of two assets. The return of a foreign asset in domestic (i.e., non-foreign) currency can be decomposed into a local currency return component and an exchange rate component:

   $$R_D = (1 + R_{lc}) \times (1 + R_{FX}) - 1$$

   Because the portfolio is fully exposed to the movement in both the asset's value in local currency and the currency exchange rate, the foreign currency and the asset each have a 100% portfolio weight. Note that the exchange rate must be specified as domestic currency/foreign currency to convert the foreign currency return into the investor's domestic currency. The risk can be calculated as follows:

$$\sigma_D = \sqrt{w_1^2\sigma_{lc}^2 + w_2^2\sigma_{FX}^2 + 2 \times w_1 w_2 \times \rho \times \sigma_{lc}\sigma_{FX}}$$
$$= \sqrt{\sigma_{lc}^2 + \sigma_{FX}^2 + 2 \times \rho \times \sigma_{lc} \times \sigma_{FX}}.$$

Assume in what follows that the risk (measured as expected standard deviation) of the GBP/USD currency exchange rate is 9.0% and the returns on Treasuries have a correlation with the GBP/USD exchange rate of 0.33. Assume also that you have no forecast for the future value of the USD/GBP exchange rate, and hence assume a 0% return.

2. What would be the expected risk of US Treasuries to you as a UK investor?

Solution:

$$\sigma_D = \sqrt{\sigma_{lc}^2 + \sigma_{FX}^2 + 2 \times \rho \times \sigma_{lc} \times \sigma_{FX}}$$
$$= \sqrt{0.040^2 + 0.090^2 + 2 \times 0.33 \times 0.040 + 0.090}.$$

$$\sigma_D = 0.110 = 11.0\%.$$

The correlations between the FTSE 100, US Treasuries, and the USD/GBP exchange rate are as depicted in the following correlation matrix.

	FTSE 100	US Treasuries	GBP/USD
FTSE 100	1.00	–0.32	–0.06
US Treasuries	–0.32	1.00	0.33
GBP/USD	–0.06	0.33	1.00

3. What would be the expected return and risk for your portfolio if you replace the UK gilts with US Treasuries?

Solution:

The expected return is the weighted average of the expected returns in British pound sterling (GBP) of UK large-capitalization equities and of US Treasuries. Recall that the return of a foreign asset in domestic currency consists of a foreign currency component and an asset component. All expected returns can be found above.

$$R_p = w_1 \times R_1 + (1 - w_1) \times [(1 + R_{lc}) \times (1 + R_{FX}) - 1].$$

$$R_p = 0.6 \times 0.055 + 0.4 \times [(1 + 0.015) \times (1 + 0.0) - 1] = 0.039 = 3.9\%.$$

Calculation of the risk of the portfolio involves a slightly more complicated formula. Recall that the risk of a two-asset portfolio depends on the risk and the weights of the individual assets and the co-movements between the two. For a three-asset portfolio (an equity portion, a foreign fixed-income portion, and the associated foreign currency exposure), the calculation is essentially the same, however there are three pairs of co-movements between assets, rather than one.

The formula for the standard deviation of a three-asset portfolio is therefore

$$\sigma_p = \sqrt{w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + w_3^2\sigma_3^2 + 2\rho_{1,2}w_1w_2\sigma_1\sigma_2 + 2\rho_{1,3}w_1w_3\sigma_1\sigma_3 + 2\rho_{2,3}w_2w_3\sigma_2\sigma_3}.$$

The portfolio weight of the foreign currency exposure is equal to the portfolio weight of the US Treasuries.

Using the information provided above, we can calculate the risk of the portfolio with UK large-capitalization equities and US Treasuries as follows:

$\sigma_p = (0.6^2 \times 0.132^2 + 0.4^2 \times 0.040^2 + 0.4^2 \times 0.090^2 + 2 \times -0.32 \times 0.6 \times 0.4 \times 0.132 \times 0.040 + 2 \times -0.06 \times 0.6 \times 0.4 \times 0.132 \times 0.090 + 2 \times 0.33 \times 0.4 \times 0.4 \times 0.040 \times 0.090)^{1/2}$.

$\sigma_p = 0.0841 \approx 8.4\%$.

Compared to the UK equity/gilt portfolio, the UK equity/US Treasury portfolio has a higher expected return, because the UK gilts were replaced with an asset with superior return expectations. The risk of the new portfolio, however, is slightly higher despite the lower risk in local currency terms of US Treasuries compared to gilts. Owning US Treasuries as a non-US investor means being exposed to exchange rate risk, which should be considered when evaluating the risk profile.

8 PORTFOLIO OF MANY RISKY ASSETS

- ☐ calculate and interpret portfolio standard deviation
- ☐ describe the effect on a portfolio's risk of investing in assets that are less than perfectly correlated

In the previous section, we discussed how the correlation between two assets can affect the risk of a portfolio and the smaller the correlation the lower is the risk. The above analysis can be extended to a portfolio with many risky assets (N). Recall the previous equations for portfolio return and variance:

$$E(R_p) = \sum_{i=1}^{N} w_i E(R_i), \quad \sigma_P^2 = \left(\sum_{i=1}^{N} w_i^2\sigma_i^2 + \sum_{i,j=1,i\neq j}^{N} w_i w_j \mathrm{Cov}(i,j)\right), \quad \sum_{i=1}^{N} w_i = 1$$

To examine how a portfolio with many risky assets works and the ways in which we can reduce the risk of a portfolio, assume that the portfolio has equal weights ($1/N$) for all N assets. In addition, assume that $\bar{\sigma}^2$ and $\overline{\mathrm{Cov}}$ are the average variance and average covariance. Given equal weights and average variance/covariance, we can rewrite the portfolio variance as below (intermediate steps are omitted to focus on the main result):

$$\sigma_P^2 = \left(\sum_{i=1}^{N} w_i^2\sigma_i^2 + \sum_{i,j=1,i\neq j}^{N} w_i w_j \mathrm{Cov}(i,j)\right)$$

$$\sigma_P^2 = \frac{\bar{\sigma}^2}{N} + \frac{(N-1)}{N}\overline{\mathrm{Cov}}$$

The equation in the second line shows that as N becomes large, the first term on the right side with the denominator of N becomes smaller and smaller, implying that the contribution of one asset's variance to portfolio variance gradually becomes negligible. The second term, however, approaches the average covariance as N increases. It is reasonable to say that for portfolios with a large number of assets, covariance among the assets accounts for almost all of the portfolio's risk.

Importance of Correlation in a Portfolio of Many Assets

The analysis becomes more instructive and interesting if we assume that all assets in the portfolio have the same variance and the same correlation among assets. In that case, the portfolio risk can then be rewritten as:

$$\sigma_p = \sqrt{\frac{\sigma^2}{N} + \frac{(N-1)}{N}\rho\sigma^2}$$

The first term under the root sign becomes negligible as the number of assets in the portfolio increases leaving the second term (correlation) as the main determining factor for portfolio risk. If the assets are unrelated to one another, the portfolio can have close to zero risk. In the next section, we review these concepts to learn how portfolios can be diversified.

THE POWER OF DIVERSIFICATION

9

- ☐ describe characteristics of the major asset classes that investors consider in forming portfolios
- ☐ describe the effect on a portfolio's risk of investing in assets that are less than perfectly correlated

Diversification is one of the most important and powerful concepts in investments. Because investors are risk averse, they are interested in reducing risk preferably without reducing return. In other cases, investors may accept a lower return if it will reduce the chance of catastrophic losses. In previous sections of this reading, you learned the importance of correlation and covariance in managing risk. This section applies those concepts to explore ways for risk diversification. We begin with a simple but intuitive example.

EXAMPLE 6

Diversification with Rain and Shine

Assume a company Beachwear rents beach equipment. The annual return from the company's operations is 20 percent in years with many sunny days but falls to 0 percent in rainy years with few sunny days. The probabilities of a sunny year and a rainy year are equal at 50 percent. Thus, the average return is 10 percent, with a 50 percent chance of 20 percent return and a 50 percent chance of 0 percent return. Because Beachwear can earn a return of 20 percent or 0 percent, its average return of 10 percent is risky.

You are excited about investing in Beachwear but do not like the risk. Having heard about diversification, you decide to add another business to the portfolio to reduce your investment risk.

- There is a snack shop on the beach that sells all the healthy food you like. You estimate that the annual return from the Snackshop is also 20 percent in years with many sunny days and 0 percent in other years. As with the Beachwear shop, the average return is 10 percent.

You decide to invest 50 percent each in Snackshop and Beachwear. The average return is still 10 percent, with 50 percent of 10 percent from Snackshop and 50 percent of 10 percent from Beachwear. In a sunny year, you would earn

20 percent (= 50% of 20% from Beachwear + 50% of 20% from Snackshop). In a rainy year, you would earn 0 percent (=50% of 0% from Beachwear + 50% of 0% from Snackshop). The results are tabulated in Exhibit 15.

Exhibit 15

Type	Company	Percent Invested	Return in Sunny Year (%)	Return in Rainy Year (%)	Average Return (%)
Single stock	Beachwear	100	20	0	10
Single stock	Snackshop	100	20	0	10
Portfolio of two stocks	Beachwear	50	20	0	10
	Snackshop	50	20	0	10
	Total	100	20	0	10

These results seem counterintuitive. You thought that by adding another business you would be able to diversify and reduce your risk, but the risk is exactly the same as before. What went wrong? Note that both businesses do well when it is sunny and both businesses do poorly when it rains. The correlation between the two businesses is +1.0. No reduction in risk occurs when the correlation is +1.0.

- To reduce risk, you must consider a business that does well in a rainy year. You find a company that rents DVDs. DVDrental company is similar to the Beachwear company, except that its annual return is 20 percent in a rainy year and 0 percent in a sunny year, with an average return of 10 percent. DVDrental's 10 percent return is also risky just like Beachwear's return.

If you invest 50 percent each in DVDrental and Beachwear, then the average return is still 10 percent, with 50 percent of 10 percent from DVDrental and 50 percent of 10 percent from Beachwear. In a sunny year, you would earn 10 percent (= 50% of 20% from Beachwear + 50% of 0% from DVDrental). In a rainy year also, you would earn 10 percent (=50% of 0% from Beachwear + 50% of 20% from DVDrental). You have no risk because you earn 10 percent in both sunny and rainy years. Thus, by adding DVDrental to Beachwear, you have reduced (eliminated) your risk without affecting your return. The results are tabulated in Exhibit 16.

Exhibit 16

Type	Company	Percent Invested	Return in Sunny Year (%)	Return in Rainy Year (%)	Average Return (%)
Single stock	Beachwear	100	20	0	10
Single stock	DVDrental	100	0	20	10

Type	Company	Percent Invested	Return in Sunny Year (%)	Return in Rainy Year (%)	Average Return (%)
Portfolio of two stocks	Beachwear	50	20	0	10
	DVDrental	50	0	20	10
	Total	100	10	10	10

In this case, the two businesses have a correlation of –1.0. When two businesses with a correlation of –1.0 are combined, risk can always be reduced to zero.

Correlation and Risk Diversification

Correlation is the key in diversification of risk. Notice that the returns from Beachwear and DVDrental always go in the opposite direction. If one of them does well, the other does not. Therefore, adding assets that do not behave like other assets in your portfolio is good and can reduce risk. The two companies in the above example have a correlation of –1.0.

Even when we expand the portfolio to many assets, correlation among assets remains the primary determinant of portfolio risk. Lower correlations are associated with lower risk. Unfortunately, most assets have high positive correlations. The challenge in diversifying risk is to find assets that have a correlation that is much lower than +1.0.

Historical Risk and Correlation

When we previously discussed asset returns, we were careful to distinguish between historical or past returns and expected or future returns because historical returns may not be a good indicator of future returns. Returns may be highly positive in one period and highly negative in another period depending on the risk of that asset. Exhibit 1 showed that returns for large US company stocks were high in the 1990s but were very low in the 2000s.

Risk for an asset class, however, does not usually change dramatically from one period to the next. Stocks have been risky even in periods of low returns. T-bills are always less risky even when they earn high returns. From Exhibit 1, we can see that risk has typically not varied much from one decade to the next, except that risk for bonds has been much higher in recent decades when compared with earlier decades. Therefore, it is not unreasonable to assume that historical risk can work as a good proxy for future risk.

As with risk, correlations are quite stable among assets of the same country. Intercountry correlations, however, have been on the rise in the last few decades as a result of globalization and the liberalization of many economies. A correlation above 0.90 is considered high because the assets do not provide much opportunity for diversification of risk Low correlations—generally less than 0.50—are desirable for portfolio diversification.

Historical Correlation among Asset Classes

Correlations among major US asset classes and international stocks are reported in Exhibit 17 for 1970–2017. The highest correlation is between US large company stocks and US small company stocks at about 70 percent, whereas the correlation between US large company stocks and international stocks is approximately 66 percent. Although these are the highest correlations, they still provide diversification benefits because the correlations are less than 100 percent. The correlation between international stocks and US small company stocks is lower, at 50 percent. The lowest correlations are between stocks and bonds, with some correlations being negative, such as that between US small company stocks and US long-term government bonds. Similarly, the correlation between T-bills and stocks is close to zero.[4]

Exhibit 17: Correlation Among US Assets and International Stocks (1970–2017)

Series	International Stocks	US Large Company Stocks	US Small Company Stocks	US Long-Term Corporate Bonds	US Long-Term Treasury Bonds	US T-Bills	US Inflation
International stocks	1.00						
US large company stocks	0.66	1.00					
US small company stocks	0.50	0.72	1.00				
US long-term corporate bonds	0.02	0.23	0.06	1.00			
US long-term Treasury bonds	−0.13	0.01	−0.15	0.89	1.00		
US T-bills	0.01	0.04	0.02	0.05	0.09	1.00	
US inflation	−0.06	−0.11	0.04	−0.32	−0.26	0.69	1.00

Source: 2018 SBBI Yearbook (Exhibit 12.13).

The low correlations between stocks and bonds are attractive for portfolio diversification. Similarly, including international securities in a portfolio can also control portfolio risk. It is not surprising that most diversified portfolios of investors contain domestic stocks, domestic bonds, foreign stocks, foreign bonds, real estate, cash, and other asset classes.

Avenues for Diversification

The reason for diversification is simple. By constructing a portfolio with assets that do not move together, you create a portfolio that reduces the ups and downs in the short term but continues to grow steadily in the long term. Diversification thus makes a portfolio more resilient to gyrations in financial markets.

4 In any short period, T-bills are riskless and uncorrelated with other asset classes. For example, a 3-month US Treasury bill is redeemable at its face value upon maturity irrespective of what happens to other assets. When we consider multiple periods, however, returns on T-bills may be related to other asset classes because short-term interest rates vary depending on the strength of the economy and outlook for inflation.

We describe a number of approaches for diversification, some of which have been discussed previously and some of which might seem too obvious. Diversification, however, is such an important part of investing that it cannot be emphasized enough, especially when we continue to meet and see many investors who are not properly diversified.

- *Diversify with asset classes.* Correlations among major asset classes[5] are not usually high, as can be observed from the few US asset classes listed in Exhibit 17. Correlations for other asset classes and other countries are also typically low, which provides investors the opportunity to benefit from diversifying among many asset classes to achieve the biggest benefit from diversification. A partial list of asset classes includes domestic large caps, domestic small caps, growth stocks, value stocks, domestic corporate bonds, long-term domestic government bonds, domestic Treasury bills (cash), emerging market stocks, emerging market bonds, developed market stocks (i.e., developed markets excluding domestic market), developed market bonds, real estate, and gold and other commodities. In addition, industries and sectors are used to diversify portfolios. For example, energy stocks may not be well correlated with health care stocks. The exact proportions in which these assets should be included in a portfolio depend on the risk, return, and correlation characteristics of each and the home country of the investor.
- *Diversify with index funds.* Diversifying among asset classes can become costly for small portfolios because of the number of securities required. For example, creating diversified exposure to a single category, such as a domestic large company asset class, may require a group of at least 30 stocks. Exposure to 10 asset classes may require 300 securities, which can be expensive to trade and track. Instead, it may be effective to use exchange-traded funds or mutual funds that track the respective indexes, which could bring down the costs associated with building a well-diversified portfolio. Therefore, many investors should consider index mutual funds as an investment vehicle as opposed to individual securities.
- *Diversification among countries.* Countries are different because of industry focus, economic policy, and political climate. The US economy produces many financial and technical services and invests a significant amount in innovative research. The Chinese and Indian economies, however, are focused on manufacturing. Countries in the European Union are vibrant democracies whereas East Asian countries are experimenting with democracy. Thus, financial returns in one country over time are not likely to be highly correlated with returns in another country. Country returns may also be different because of different currencies. In other words, the return on a foreign investment may be different when translated to the home country's currency. Because currency returns are uncorrelated with stock returns, they may help reduce the risk of investing in a foreign country even when that country, in isolation, is a very risky emerging market from an equity investment point of view. Investment in foreign countries is an essential part of a well-diversified portfolio.
- *Diversify by* not *owning your employer's stock.* Companies encourage their employees to invest in company stock through employee stock plans and retirement plans. You should evaluate investing in your company, however, just as you would evaluate any other investment. In addition, you should consider the nonfinancial investments that you have made, especially the

5 Major asset classes are distinguished from sub-classes, such as US value stocks and US growth stocks.

human capital you have invested in your company. Because you work for your employer, you are already heavily invested in it—your earnings depend on your employer. The level of your earnings, whether your compensation improves or whether you get a promotion, depends on how well your employer performs. If a competitor drives your employer out of the market, you will be out of a job. Additional investments in your employer will concentrate your wealth in one asset even more so and make you less diversified.

- *Evaluate each asset before adding to a portfolio.* Every time you add a security or an asset class to the portfolio, recognize that there is a cost associated with diversification. There is a cost of trading an asset as well as the cost of tracking a larger portfolio. In some cases, the securities or assets may have different names but belong to an asset class in which you already have sufficient exposure. A general rule to evaluate whether a new asset should be included to an existing portfolio is based on the following risk–return trade-off relationship:

$$E(R_{new}) = R_f + \frac{\sigma_{new}\rho_{new,p}}{\sigma_p} \times \left[E(R_p) - R_f\right]$$

where $E(R)$ is the return from the asset, R_f is the return on the risk-free asset, σ is the standard deviation, ρ is the correlation coefficient, and the subscripts *new* and *p* refer to the new stock and existing portfolio. If the new asset's risk-adjusted return benefits the portfolio, then the asset should be included. The condition can be rewritten using the Sharpe ratio on both sides of the equation as:

$$\frac{E(R_{new}) - R_f}{\sigma_{new}} > \frac{E(R_p) - R_f}{\sigma_p} \times \rho_{new,p}$$

If the Sharpe ratio of the new asset is greater than the Sharpe ratio of the current portfolio times the correlation coefficient, it is beneficial to add the new asset.

- *Buy insurance for risky portfolios.* It may come as a surprise, but insurance is an investment asset—just a different kind of asset. Insurance has a negative correlation with your assets and is thus very valuable. Insurance gives you a positive return when your assets lose value, but pays nothing if your assets maintain their value. Over time, insurance generates a negative average return. Many individuals, however, are willing to accept a small negative return because insurance reduces their exposure to an extreme loss. In general, it is reasonable to add an investment with a negative return if that investment significantly reduces risk (an example of a classic case of the risk–return trade-off).

  Alternatively, investments with negative correlations also exist. Historically, gold has a negative correlation with stocks; however, the expected return is usually small and sometimes even negative. Investors often include gold and other commodities in their portfolios as a way of reducing their overall portfolio risk, including currency risk and inflation risk.

  Buying put options is another way of reducing risk. Because put options pay when the underlying asset falls in value (negative correlation), they can protect an investor's portfolio against catastrophic losses. Of course, put options cost money, and the expected return is zero or marginally negative.

EFFICIENT FRONTIER: INVESTMENT OPPORTUNITY SET & MINIMUM VARIANCE PORTFOLIOS

10

- ☐ describe the effect on a portfolio's risk of investing in assets that are less than perfectly correlated
- ☐ describe and interpret the minimum-variance and efficient frontiers of risky assets and the global minimum-variance portfolio

In this section, we formalize the effect of diversification and expand the set of investments to include all available risky assets in a mean–variance framework. The addition of a risk-free asset generates an optimal risky portfolio and the capital allocation line. We can then derive an investor's optimal portfolio by overlaying the capital allocation line with the indifference curves of investors.

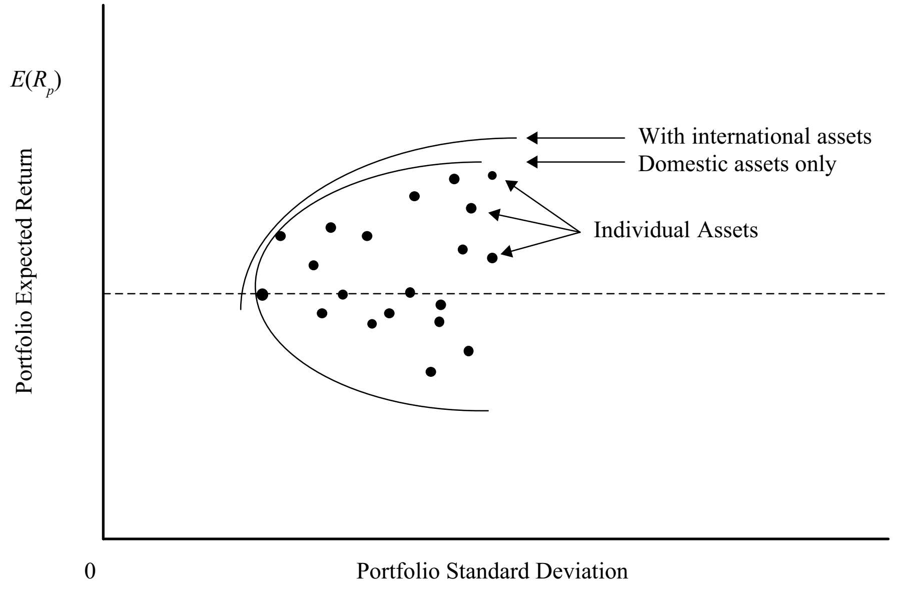
Investment Opportunity Set

If two assets are perfectly correlated, the risk–return opportunity set is represented by a straight line connecting those two assets. The line contains portfolios formed by changing the weight of each asset invested in the portfolio. This correlation was depicted by the straight line (with $\rho = 1$) in Exhibit 14. If the two assets are not perfectly correlated, the portfolio's risk is less than the weighted average risk of the components, and the portfolio formed from the two assets bulges on the left as shown by curves with the correlation coefficient (ρ) less than 1.0 in Exhibit 14. All of the points connecting the two assets are achievable (or feasible). The addition of new assets to this portfolio creates more and more portfolios that are either a linear combination of the existing portfolio and the new asset or a curvilinear combination, depending on the correlation between the existing portfolio and the new asset.

As the number of available assets increases, the number of possible combinations increases rapidly. When all investable assets are considered, and there are hundreds and thousands of them, we can construct an opportunity set of investments. The opportunity set will ordinarily span all points within a frontier because it is also possible to reach every possible point within that curve by judiciously creating a portfolio from the investable assets.

We begin with individual investable assets and gradually form portfolios that can be plotted to form a curve as shown in Exhibit 18. All points on the curve and points to the right of the curve are attainable by a combination of one or more of the investable assets. This set of points is called the investment opportunity set. Initially, the opportunity set consists of domestic assets only and is labeled as such in Exhibit 18.

Exhibit 18: Investment Opportunity Set



Addition of Asset Classes

Exhibit 18 shows the effect of adding a new asset class, such as international assets. As long as the new asset class is not perfectly correlated with the existing asset class, the investment opportunity set will expand out further to the northwest, providing a superior risk–return trade-off.

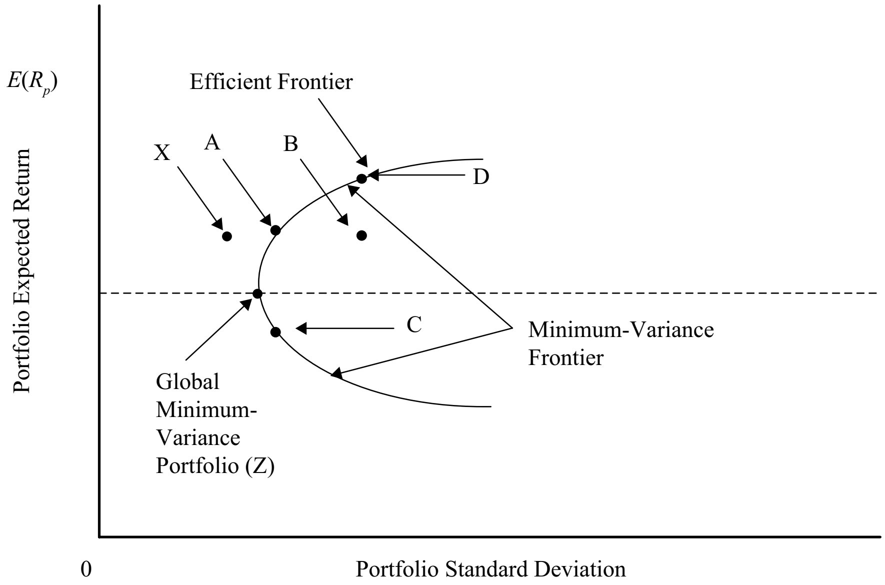
The investment opportunity set with international assets dominates the opportunity set that includes only domestic assets. Adding other asset classes will have the same impact on the opportunity set. Thus, we should continue to add asset classes until they do not further improve the risk–return trade-off. The benefits of diversification can be fully captured in this way in the construction of the investment opportunity set, and eventually in the selection of the optimal portfolio.

In the discussion that follows in this section, we will assume that *all* investable assets available to an investor are included in the investment opportunity set and no special attention needs to be paid to new asset classes or new investment opportunities.

Minimum-Variance Portfolios

The investment opportunity set consisting of all available investable sets is shown in Exhibit 19. There are a large number of portfolios available for investment, but we must choose a single optimal portfolio. In this subsection, we begin the selection process by narrowing the choice to fewer portfolios.

Exhibit 19: Minimum-Variance Frontier



Minimum-Variance Frontier

Risk-averse investors seek to minimize risk for a given return. Consider Points A, B, and X in Exhibit 19 and assume that they are on the same horizontal line by construction. Thus, the three points have the same expected return, $E(R_1)$, as do all other points on the imaginary line connecting A, B, and X. Given a choice, an investor will choose the point with the minimum risk, which is Point X. Point X, however, is unattainable because it does not lie within the investment opportunity set. Thus, the minimum risk that we can attain for $E(R_1)$ is at Point A. Point B and all points to the right of Point A are feasible but they have higher risk. Therefore, a risk-averse investor will choose only Point A in preference to any other portfolio with the same return.

Similarly, Point C is the minimum variance point for the return earned at C. Points to the right of C have higher risk. We can extend the above analysis to all possible returns. In all cases, we find that the **minimum-variance portfolio** is the one that lies on the solid curve drawn in Exhibit 19. The entire collection of these minimum-variance portfolios is referred to as the minimum-variance frontier. The minimum-variance frontier defines the smaller set of portfolios in which investors would want to invest. Note that no risk-averse investor will choose to invest in a portfolio to the right of the minimum-variance frontier because a portfolio on the minimum-variance frontier can give the same return but at a lower risk.

Global Minimum-Variance Portfolio

The left-most point on the minimum-variance frontier is the portfolio with the minimum variance among all portfolios of risky assets, and is referred to as the **global minimum-variance portfolio**. An investor cannot hold a portfolio consisting of *risky* assets that has less risk than that of the global minimum-variance portfolio. Note the emphasis on "risky" assets. Later, the introduction of a risk-free asset will allow us to relax this constraint.

Efficient Frontier of Risky Assets

The minimum-variance frontier gives us portfolios with the minimum variance for a given return. However, investors also want to maximize return for a given risk. Observe Points A and C on the minimum-variance frontier shown in Exhibit 19. Both of them have the same risk. Given a choice, an investor will choose Portfolio A because it has a higher return. No one will choose Portfolio C. The same analysis applies to all points on the minimum-variance frontier that lie below the global minimum-variance portfolio. Thus, portfolios on the curve below the global minimum-variance portfolio and to the right of the global minimum-variance portfolio are not beneficial and are inefficient portfolios for an investor.

The curve that lies above and to the right of the global minimum-variance portfolio is referred to as the **Markowitz efficient frontier** because it contains all portfolios of risky assets that rational, risk-averse investors will choose.

An important observation that is often ignored is the slope at various points on the efficient frontier. As we move right from the global minimum-variance portfolio (Point Z) in Exhibit 19, there is an increase in risk with a concurrent increase in return. The increase in return with every unit increase in risk, however, keeps decreasing as we move from left to the right because the slope continues to decrease. The slope at Point D is less than the slope at Point A, which is less than the slope at Point Z. The increase in return by moving from Point Z to Point A is the same as the increase in return by moving from Point A to Point D. It can be seen that the additional risk in moving from Point A to Point D is 3 to 4 times more than the additional risk in moving from Point Z to Point A. Thus, investors obtain decreasing increases in returns as they assume more risk.

11 EFFICIENT FRONTIER: A RISK-FREE ASSET AND MANY RISKY ASSETS

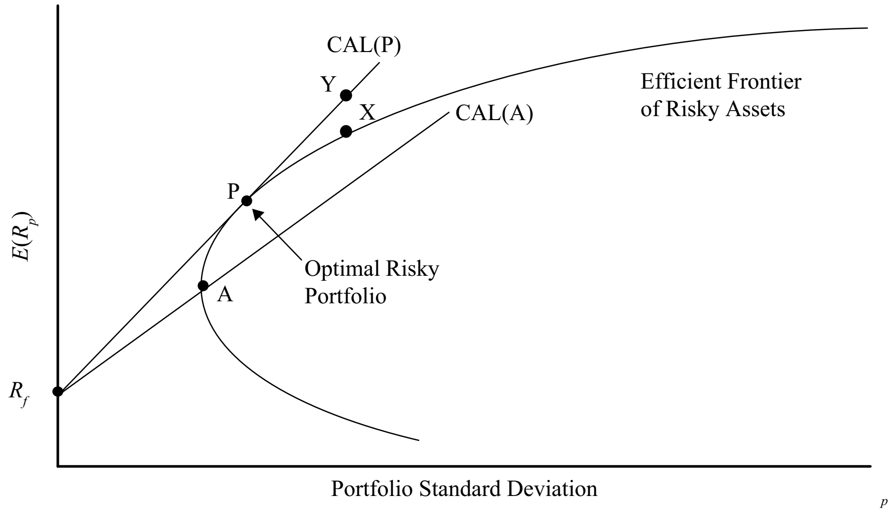
- ☐ explain the selection of an optimal portfolio, given an investor's utility (or risk aversion) and the capital allocation line

Until now, we have only considered risky assets in which the return is risky or uncertain. Most investors, however, have access to a risk-free asset, most notably from securities issued by the government. The addition of a risk-free asset makes the investment opportunity set much richer than the investment opportunity set consisting only of risky assets.

Capital Allocation Line and Optimal Risky Portfolio

By definition, a risk-free asset has zero risk so it must lie on the y-axis in a mean-variance graph. A risk-free asset with a return of R_f is plotted in Exhibit 20. This asset can now be combined with a portfolio of risky assets. The combination of a risk-free asset with a portfolio of risky assets is a straight line, such as in Section 6 (see Exhibit 9). Unlike in Section 6, however, we have many risky portfolios to choose from instead of a single risky portfolio.

Exhibit 20: Optimal Risky Portfolio



All portfolios on the efficient frontier are candidates for being combined with the risk-free asset. Two combinations are shown in Exhibit 20: one between the risk-free asset and efficient Portfolio A and the other between the risk-free asset and efficient Portfolio P. Comparing capital allocation line A and capital allocation line P reveals that there is a point on CAL(P) with a higher return and same risk for each point on CAL(A). In other words, the portfolios on CAL(P) dominate the portfolios on CAL(A). Therefore, an investor will choose CAL(P) over CAL(A). We would like to move further northwest to achieve even better portfolios. None of those portfolios, however, is attainable because they are above the efficient frontier.

What about other points on the efficient frontier? For example, Point X is on the efficient frontier and has the highest return of all risky portfolios for its risk. However, Point Y on CAL(P), achievable by leveraging Portfolio P as seen in Section 6, lies above Point X and has the same risk but higher return. In the same way, we can observe that not only does CAL(P) dominate CAL(A) but it also dominates the Markowitz efficient frontier of risky assets.

CAL(P) is the optimal capital allocation line and Portfolio P is the optimal risky portfolio. Thus, with the addition of the risk-free asset, we are able to narrow our selection of risky portfolios to a single optimal risky portfolio, P, which is at the tangent of CAL(P) and the efficient frontier of risky assets.

The Two-Fund Separation Theorem

The **two-fund separation theorem** states that all investors regardless of taste, risk preferences, and initial wealth will hold a combination of two portfolios or funds: a risk-free asset and an optimal portfolio of risky assets.[6]

The separation theorem allows us to divide an investor's investment problem into two distinct steps: the investment decision and the financing decision. In the first step, as in the previous analysis, the investor identifies the optimal risky portfolio. The optimal risky portfolio is selected from numerous risky portfolios without considering the investor's preferences. The investment decision at this step is based on the optimal risky portfolio's (a single portfolio) return, risk, and correlations.

6 In the next reading, you will learn that the optimal portfolio of risky assets is the market portfolio.

The capital allocation line connects the optimal risky portfolio and the risk-free asset. All optimal investor portfolios must be on this line. Each investor's optimal portfolio on the CAL(P) is determined in the second step. Considering each individual investor's risk preference, using indifference curves, determines the investor's allocation to the risk-free asset (lending) and to the optimal risky portfolio. Portfolios beyond the optimal risky portfolio are obtained by borrowing at the risk-free rate (i.e., buying on margin). Therefore, the individual investor's risk preference determines the amount of financing (i.e., lending to the government instead of investing in the optimal risky portfolio or borrowing to purchase additional amounts of the optimal risky portfolio).

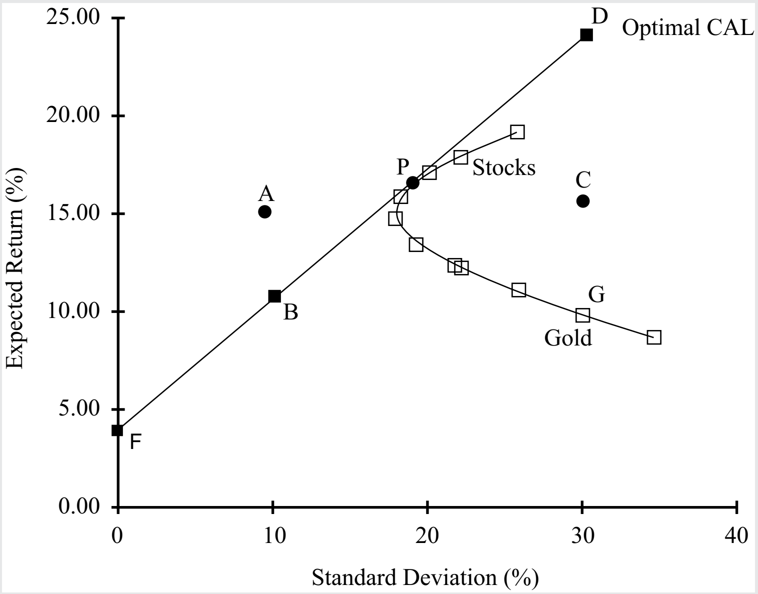
EXAMPLE 7

Choosing the Right Portfolio

In Exhibit 21, the risk and return of the points marked are as follows:

Point	Return (%)	Risk (%)	Point (%)	Return (%)	Risk (%)
A	15	10	B	11	10
C	15	30	D	25	30
F	4	0	G (gold)	10	30
P	16	17			

Exhibit 21



Answer the following questions with reference to the points plotted on Exhibit 21 and explain your answers. The investor is choosing one portfolio based on the graph.

1. Which of the above points is not achievable?

   Solution:

   Portfolio A is not attainable because it lies outside the feasible set and not on the capital allocation line.

2. Which of these portfolios will not be chosen by a rational, risk-averse investor?

   Solution:

   Portfolios G and C will not be chosen because D provides higher return for the same risk. G and C are the only investable points that do not lie on the capital allocation line.

3. Which of these portfolios is most suitable for a risk-neutral investor?

   Solution:

   Portfolio D is most suitable because a risk-neutral investor cares only about return and portfolio D provides the highest return. A = 0 in the utility formula.

4. Gold is on the inefficient part of the feasible set. Nonetheless, gold is owned by many rational investors as part of a larger portfolio. Why?

   Solution:

   Gold may be owned as part of a portfolio (not as *the* portfolio) because gold has low or negative correlation with many risky assets, such as stocks. Being part of a portfolio can thus reduce overall risk even though its standalone risk is high and return is low. Note that gold's price is not stable—its return is very risky (30 percent). Even risk seekers will choose D over G, which has the same risk but higher return.

5. What is the utility of an investor at point P with a risk aversion coefficient of 3?

   Solution:

   $U = E(r) - 0.5A\sigma^2 = 0.16 - 0.5 \times 3 \times 0.0289 = 0.1167 = 11.67\%.$

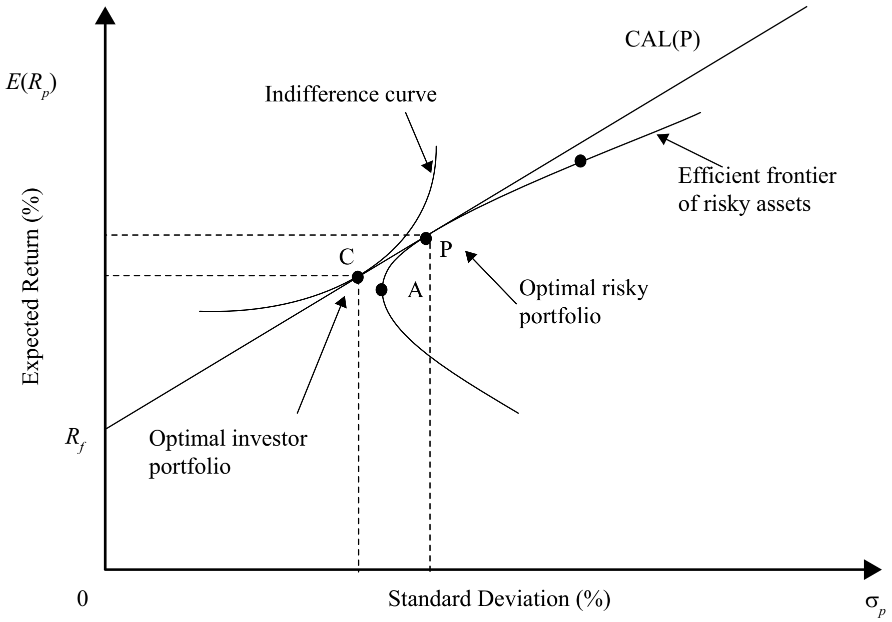
12 EFFICIENT FRONTIER: OPTIMAL INVESTOR PORTFOLIO

☐ explain the selection of an optimal portfolio, given an investor's utility (or risk aversion) and the capital allocation line

The CAL(P) in Exhibit 22 contains the best possible portfolios available to investors. Each of those portfolios is a linear combination of the risk-free asset and the optimal risky portfolio. Among the available portfolios, the selection of each investor's optimal portfolio depends on the risk preferences of an investor. In Sections 4–6, we discussed that the individual investor's risk preferences are incorporated into their indifference curves. These can be used to select the optimal portfolio.

Exhibit 22 shows an indifference curve that is tangent to the capital allocation line, CAL(P). Indifference curves with higher utility than this one lie above the capital allocation line, so their portfolios are not achievable. Indifference curves that lie below this one are not preferred because they have lower utility. Thus, the optimal portfolio for the investor with this indifference curve is portfolio C on CAL(P), which is tangent to the indifference curve.

Exhibit 22: Optimal Investor Portfolio



EXAMPLE 8

Comprehensive Example on Portfolio Selection

This comprehensive example reviews many concepts learned in this reading. The example begins with simple information about available assets and builds an optimal investor portfolio for the Lohrmanns.

Suppose the Lohrmanns can invest in only two risky assets, A and B. The expected return and standard deviation for asset A are 20 percent and 50 percent, and the expected return and standard deviation for asset B are 15 percent and 33 percent. The two assets have zero correlation with one another.

1. Calculate portfolio expected return and portfolio risk (standard deviation) if an investor invests 10 percent in A and the remaining 90 percent in B.

   Solution:

   The subscript "*rp*" means risky portfolio.

   $$R_{rp} = [0.10 \times 20\%] + [(1 - 0.10) \times 15\%] = 0.155 = 15.50\%$$

   $$\sigma_{rp} = \sqrt{w_A^2\sigma_A^2 + w_B^2\sigma_B^2 + 2w_A w_B \rho_{AB}\sigma_A\sigma_B}$$

   $$= \sqrt{(0.10^2 \times 0.50^2) + (0.90^2 \times 0.33^2) + (2 \times 0.10 \times 0.90 \times 0.0 \times 0.50 \times 0.33)}$$
   $$= 0.3012 = 30.12\%$$

   Note that the correlation coefficient is 0, so the last term for standard deviation is zero.

2. Generalize the above calculations for portfolio return and risk by assuming an investment of w_A in Asset A and an investment of $(1 - w_A)$ in Asset B.

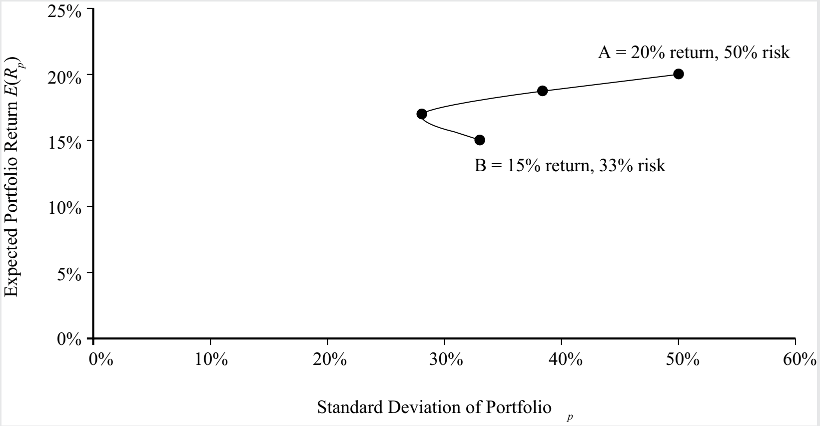
   Solution:

$$R_{rp} = w_A \times 20\% + (1 - w_A) \times 15\% = 0.05\, w_A + 0.15$$

$$\sigma_{rp} = \sqrt{w_A^2 \times 0.5^2 + (1 - w_A)^2 \times 0.33^2} = \sqrt{0.25\, w_A^2 + 0.1089\left(1 - 2\, w_A + w_A^2\right)}$$
$$= \sqrt{0.3589\, w_A^2 - 0.2178\, w_A + 0.1089}$$

The investment opportunity set can be constructed by using different weights in the expressions for $E(R_{rp})$ and σ_{rp} in Part 1 of this example. Exhibit 23 shows the combination of Assets A and B.

Exhibit 23



3. Now introduce a risk-free asset with a return of 3 percent. Write an equation for the capital allocation line in terms of w_A that will connect the risk-free asset to the portfolio of risky assets. (Hint: use the equation in Section 6 and substitute the expressions for a risky portfolio's risk and return from Part 2 above).

Solution:

The equation of the line connecting the risk-free asset to the portfolio of risky assets is given below (see Section 6), where the subscript "*rp*" refers to the risky portfolio instead of "*i*," and the subscript "*p*" refers to the new portfolio of two risky assets and one risk-free asset.

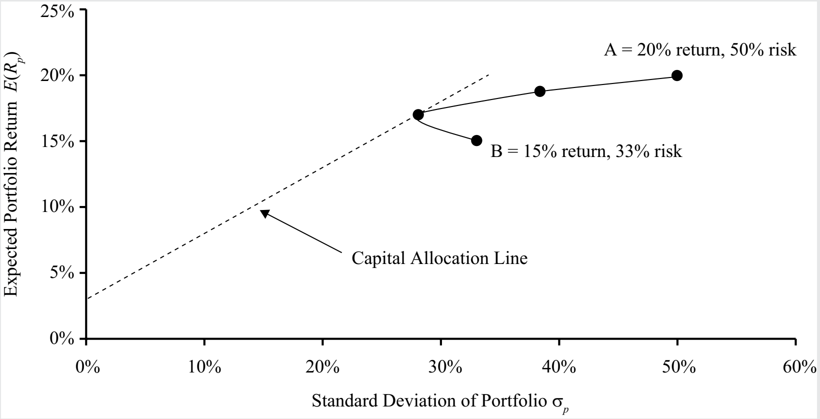
$$E\left(R_p\right) = R_f + \frac{E(R_i) - R_f}{\sigma_i}\sigma_p,$$

Rewritten as

$$E\left(R_p\right) = R_f + \frac{E\left(R_{rp}\right) - R_f}{\sigma_{rp}}\sigma_p$$
$$= 0.03 + \frac{0.05\, w_A + 0.15 - 0.03}{\sqrt{0.3589\, w_A^2 - 0.2178\, w_A + 0.1089}}\sigma_p$$
$$= 0.03 + \frac{0.05\, w_A + 0.12}{\sqrt{0.3589\, w_A^2 - 0.2178\, w_A + 0.1089}}\sigma_p$$

The capital allocation line is the line that has the maximum slope because it is tangent to the curve formed by portfolios of the two risky assets. Exhibit 24 shows the capital allocation line based on a risk-free asset added to the group of assets.

Exhibit 24



4. The slope of the capital allocation line is maximized when the weight in Asset A is 38.20 percent.[7] What is the equation for the capital allocation line using w_A of 38.20 percent?

   Solution:

   By substituting 38.20 percent for w_A in the equation in Part 3, we get $E(R_p) = 0.03 + 0.4978\sigma_p$ as the capital allocation line.

5. Having created the capital allocation line, we turn to the Lohrmanns. What is the standard deviation of a portfolio that gives a 20 percent return and is on the capital allocation line? How does this portfolio compare with asset A?

   Solution:

   Solve the equation for the capital allocation line to get the standard deviation: $0.20 = 0.03 + 0.4978\sigma_p$. $\sigma_p = 34.2\%$. The portfolio with a 20 percent return has the same return as Asset A but a lower standard deviation, 34.2 percent instead of 50.0 percent.

6. What is the risk of portfolios with returns of 3 percent, 9 percent, 15 percent, and 20 percent?

   Solution:

   You can find the risk of the portfolio using the equation for the capital allocation line: $E(R_p) = 0.03 + 0.4978\sigma_p$.
   For a portfolio with a return of 15 percent, write $0.15 = 0.03 + 0.4978\sigma_p$. Solving for σ_p gives 24.1 percent. You can similarly calculate risks of other portfolios with the given returns.
   The risk of the portfolio for a return of 3 percent is 0.0 percent, for a return of 9 percent is 12.1 percent, for a return of 15 percent is 24.1 percent, and for a return of 20 percent is 34.2 percent. The points are plotted in Exhibit 25.

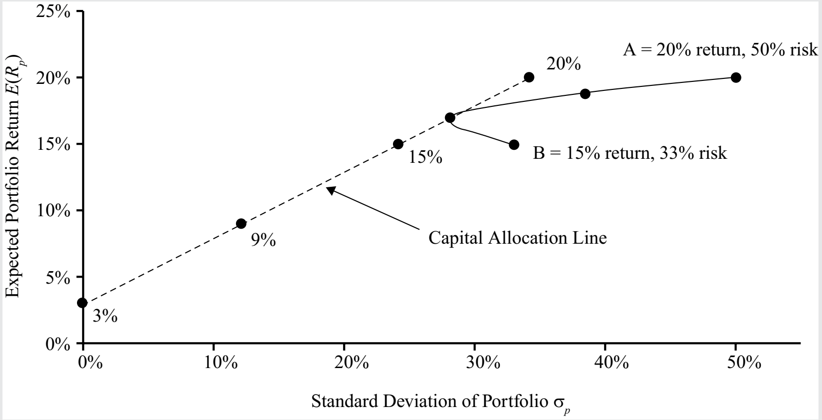
---

7 You can maximize

$$\frac{0.05w_A + 0.12}{\sqrt{0.3589w_A^2 - 0.2178w_A + 0.1089}}$$

by taking the first derivative of the slope with respect to w_A and setting it to 0.

Exhibit 25



7. What is the utility that the Lohrmanns derive from a portfolio with a return of 3 percent, 9 percent, 15 percent, and 20 percent? The risk aversion coefficient for the Lohrmanns is 2.5.

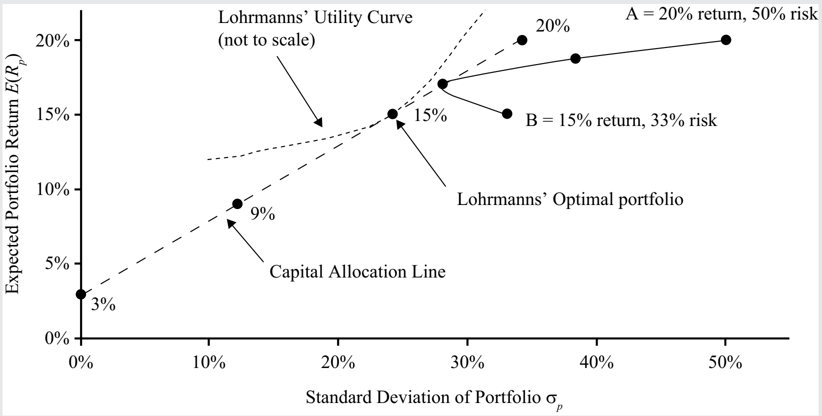
Solution:

To find the utility, use the utility formula with a risk aversion coefficient of 2.5:

$$\text{Utility} = E(R_p) - 0.5 \times 2.5\sigma_p^2$$
$$\text{Utility (3\%)} = 0.0300$$
$$\text{Utility (9\%)} = 0.09 - 0.5 \times 2.5 \times 0.121^2 = +0.0717$$
$$\text{Utility (15\%)} = 0.15 - 0.5 \times 2.5 \times 0.241^2 = +0.0774$$
$$\text{Utility (20\%)} = 0.20 - 0.5 \times 2.5 \times 0.341^2 = +0.0546$$

Based on the above information, the Lohrmanns choose a portfolio with a return of 15 percent and a standard deviation of 24.1 percent because it has the highest utility: 0.0774. Finally, Exhibit 26 shows the indifference curve that is tangent to the capital allocation line to generate Lohrmanns' optimal investor portfolio.

Exhibit 26



Investor Preferences and Optimal Portfolios

The location of an optimal investor portfolio depends on the investor's risk preferences. A highly risk-averse investor may invest a large proportion, even 100 percent, of his/her assets in the risk-free asset. The optimal portfolio in this investor's case will be located close to the *y*-axis. A less risk-averse investor, however, may invest a large portion of his/her wealth in the optimal risky asset. The optimal portfolio in this investor's case will lie closer to Point P in Exhibit 22.

Some less risk-averse investors (i.e., with a high risk tolerance) may wish to accept even more risk because of the chance of higher return. Such an investor may borrow money to invest more in the risky portfolio. If the investor borrows 25 percent of his wealth, he/she can invest 125 percent in the optimal risky portfolio. The optimal investor portfolio for such an investor will lie to the right of Point P on the capital allocation line.

Thus, moving from the risk-free asset along the capital allocation line, we encounter investors who are willing to accept more risk. At Point P, the investor is 100 percent invested in the optimal risky portfolio. Beyond Point P, the investor accepts even more risk by borrowing money and investing in the optimal risky portfolio.

Note that we are able to accommodate all types of investors with just two portfolios: the risk-free asset and the optimal risky portfolio. Exhibit 22 is also an illustration of the two-fund separation theorem. Portfolio P is the optimal risky portfolio that is selected without regard to investor preferences. The optimal investor portfolio is selected on the capital allocation line by overlaying the indifference curves that incorporate investor preferences.

SUMMARY

This reading provides a description and computation of investment characteristics, such as risk and return, that investors use in evaluating assets for investment. This was followed by sections about portfolio construction, selection of an optimal risky portfolio, and an understanding of risk aversion and indifference curves. Finally, the tangency point of the indifference curves with the capital allocation line allows identification of the optimal investor portfolio. Key concepts covered in the reading include the following:

- Holding period return is most appropriate for a single, predefined holding period.
- Multiperiod returns can be aggregated in many ways. Each return computation has special applications for evaluating investments.
- Risk-averse investors make investment decisions based on the risk–return trade-off, maximizing return for the same risk, and minimizing risk for the same return. They may be concerned, however, by deviations from a normal return distribution and from assumptions of financial markets' operational efficiency.
- Investors are risk averse, and historical data confirm that financial markets price assets for risk-averse investors.
- The risk of a two-asset portfolio is dependent on the proportions of each asset, their standard deviations and the correlation (or covariance) between the assets' returns. As the number of assets in a portfolio increases, the correlation among asset risks becomes a more important determinant of portfolio risk.

- Combining assets with low correlations reduces portfolio risk.
- The two-fund separation theorem allows us to separate decision making into two steps. In the first step, the optimal risky portfolio and the capital allocation line are identified, which are the same for all investors. In the second step, investor risk preferences enable us to find a unique optimal investor portfolio for each investor.
- The addition of a risk-free asset creates portfolios that are dominant to portfolios of risky assets in all cases except for the optimal risky portfolio.

By successfully understanding the content of this reading, you should be comfortable calculating an investor's optimal portfolio given the investor's risk preferences and universe of investable assets available.

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PRACTICE PROBLEMS

1. With respect to trading costs, liquidity is *least likely* to impact the:
   - **A.** stock price.
   - **B.** bid–ask spreads.
   - **C.** brokerage commissions.

2. Evidence of risk aversion is *best* illustrated by a risk–return relationship that is:
   - **A.** negative.
   - **B.** neutral.
   - **C.** positive.

3. With respect to risk-averse investors, a risk-free asset will generate a numerical utility that is:
   - **A.** the same for all individuals.
   - **B.** positive for risk-averse investors.
   - **C.** equal to zero for risk seeking investors.

4. With respect to utility theory, the most risk-averse investor will have an indifference curve with the:
   - **A.** most convexity.
   - **B.** smallest intercept value.
   - **C.** greatest slope coefficient.

5. With respect to an investor's utility function expressed as: $U = E(r) - \frac{1}{2}A\sigma^2$, which of the following values for the measure for risk aversion has the *least* amount of risk aversion?
   - **A.** −4.
   - **B.** 0.
   - **C.** 4.

The following information relates to questions 6-7

A financial planner has created the following data to illustrate the application of utility theory to portfolio selection:

Investment	Expected Return (%)	Expected Standard Deviation (%)
1	18	2
2	19	8
3	20	15
4	18	30

6. A risk-neutral investor is *most likely* to choose:
   A. Investment 1.
   B. Investment 2.
   C. Investment 3.

7. If an investor's utility function is expressed as $U = E(r) - \frac{1}{2}A\sigma^2$ and the measure for risk aversion has a value of −2, the risk-seeking investor is *most likely* to choose:
   A. Investment 2.
   B. Investment 3.
   C. Investment 4.

---

8. If an investor's utility function is expressed as $U = E(r) - \frac{1}{2}A\sigma^2$ and the measure for risk aversion has a value of 2, the risk-averse investor is *most likely* to choose:
   A. Investment 1.
   B. Investment 2.
   C. Investment 3.

9. If an investor's utility function is expressed as $U = E(r) - \frac{1}{2}A\sigma^2$ and the measure for risk aversion has a value of 4, the risk-averse investor is *most likely* to choose:
   A. Investment 1.
   B. Investment 2.
   C. Investment 3.

10. With respect to the mean–variance portfolio theory, the capital allocation line, CAL, is the combination of the risk-free asset and a portfolio of all:
    A. risky assets.
    B. equity securities.
    C. feasible investments.

11. Two individual investors with different levels of risk aversion will have optimal portfolios that are:
    A. below the capital allocation line.

B. on the capital allocation line.

C. above the capital allocation line.

12. With respect to capital market theory, which of the following asset characteristics is *least likely* to impact the variance of an investor's equally weighted portfolio?

A. Return on the asset.

B. Standard deviation of the asset.

C. Covariances of the asset with the other assets in the portfolio.

13. A portfolio manager creates the following portfolio:

Security	Security Weight (%)	Expected Standard Deviation (%)
1	30	20
2	70	12

If the correlation of returns between the two securities is 0.40, the expected standard deviation of the portfolio is *closest* to:

A. 10.7%.

B. 11.3%.

C. 12.1%.

14. A portfolio manager creates the following portfolio:

Security	Security Weight (%)	Expected Standard Deviation (%)
1	30	20
2	70	12

If the covariance of returns between the two securities is −0.0240, the expected standard deviation of the portfolio is *closest* to:

A. 2.4%.

B. 7.5%.

C. 9.2%.

The following information relates to questions 15-16

A portfolio manager creates the following portfolio:

Security	Security Weight (%)	Expected Standard Deviation (%)
1	30	20
2	70	12

15. If the standard deviation of the portfolio is 14.40%, the correlation between the two securities is equal to:

    A. -1.0.

    B. 0.0.

    C. 1.0.

16. If the standard deviation of the portfolio is 14.40%, the covariance between the two securities is equal to:

    A. 0.0006.

    B. 0.0240.

    C. 1.0000.

The following information relates to questions 17-19

A portfolio manager creates the following portfolio:

Security	Expected Annual Return (%)	Expected Standard Deviation (%)
1	16	20
2	12	20

17. If the portfolio of the two securities has an expected return of 15%, the proportion invested in Security 1 is:

    A. 25%.

    B. 50%.

    C. 75%.

18. If the correlation of returns between the two securities is −0.15, the expected standard deviation of an equal-weighted portfolio is *closest* to:

    A. 13.04%.

    B. 13.60%.

    C. 13.87%.

19. If the two securities are uncorrelated, the expected standard deviation of an

equal-weighted portfolio is *closest* to:

A. 14.00%.

B. 14.14%.

C. 20.00%.

The following information relates to questions 20-21

An analyst has made the following return projections for each of three possible outcomes with an equal likelihood of occurrence:

Asset	Outcome 1 (%)	Outcome 2 (%)	Outcome 3 (%)	Expected Return (%)
1	12	0	6	6
2	12	6	0	6
3	0	6	12	6

20. If the analyst constructs two-asset portfolios that are equally-weighted, which pair of assets has the *lowest* expected standard deviation?

A. Asset 1 and Asset 2.

B. Asset 1 and Asset 3.

C. Asset 2 and Asset 3.

21. If the analyst constructs two-asset portfolios that are equally weighted, which pair of assets provides the *least* amount of risk reduction?

A. Asset 1 and Asset 2.

B. Asset 1 and Asset 3.

C. Asset 2 and Asset 3.

22. As the number of assets in an equally-weighted portfolio increases, the contribution of each individual asset's variance to the volatility of the portfolio:

A. increases.

B. decreases.

C. remains the same.

23. With respect to an equally weighted portfolio made up of a large number of assets, which of the following contributes the *most* to the volatility of the portfolio?

A. Average variance of the individual assets.

B. Standard deviation of the individual assets.

C. Average covariance between all pairs of assets.

24. The correlation between assets in a two-asset portfolio increases during a market decline. If there is no change in the proportion of each asset held in the portfolio or the expected standard deviation of the individual assets, the volatility of the portfolio is *most likely* to:

A. increase.

B. decrease.

C. remain the same.

25. Which of the following statements is *least* accurate? The efficient frontier is the set of all attainable risky assets with the:

A. highest expected return for a given level of risk.

B. lowest amount of risk for a given level of return.

C. highest expected return relative to the risk-free rate.

26. The portfolio on the minimum-variance frontier with the lowest standard deviation is:

A. unattainable.

B. the optimal risky portfolio.

C. the global minimum-variance portfolio.

27. The set of portfolios on the minimum-variance frontier that dominates all sets of portfolios below the global minimum-variance portfolio is the:

A. capital allocation line.

B. Markowitz efficient frontier.

C. set of optimal risky portfolios.

28. The dominant capital allocation line is the combination of the risk-free asset and the:

A. optimal risky portfolio.

B. levered portfolio of risky assets.

C. global minimum-variance portfolio.

29. Compared to the efficient frontier of risky assets, the dominant capital allocation line has higher rates of return for levels of risk greater than the optimal risky portfolio because of the investor's ability to:

A. lend at the risk-free rate.

B. borrow at the risk-free rate.

C. purchase the risk-free asset.

30. With respect to the mean–variance theory, the optimal portfolio is determined

by each individual investor's:

A. risk-free rate.

B. borrowing rate.

C. risk preference.

SOLUTIONS

1. C is correct. Brokerage commissions are negotiated with the brokerage firm. A security's liquidity impacts the operational efficiency of trading costs. Specifically, liquidity impacts the bid–ask spread and can impact the stock price (if the ability to sell the stock is impaired by the uncertainty associated with being able to sell the stock).

2. C is correct. Historical data over long periods of time indicate that there exists a positive risk–return relationship, which is a reflection of an investor's risk aversion.

3. A is correct. A risk-free asset has a variance of zero and is not dependent on whether the investor is risk neutral, risk seeking or risk averse. That is, given that the utility function of an investment is expressed as $U = E(r) - \frac{1}{2}A\sigma^2$, where A is the measure of risk aversion, then the sign of A is irrelevant if the variance is zero (like that of a risk-free asset).

4. C is correct. The most risk-averse investor has the indifference curve with the greatest slope.

5. A is correct. A negative value in the given utility function indicates that the investor is a risk seeker.

6. C is correct. Investment 3 has the highest rate of return. Risk is irrelevant to a risk-neutral investor, who would have a measure of risk aversion equal to 0. Given the utility function, the risk-neutral investor would obtain the greatest amount of utility from Investment 3.

Investment	Expected Return (%)	Expected Standard Deviation (%)	Utility A = 0
1	18	2	0.1800
2	19	8	0.1900
3	20	15	0.2000
4	18	30	0.1800

7. C is correct. Investment 4 provides the highest utility value (0.2700) for a risk-seeking investor, who has a measure of risk aversion equal to −2.

Investment	Expected Return (%)	Expected Standard Deviation (%)	Utility A = −2
1	18	2	0.1804
2	19	8	0.1964
3	20	15	0.2225
4	18	30	0.2700

8. B is correct. Investment 2 provides the highest utility value (0.1836) for a risk-averse investor who has a measure of risk aversion equal to 2.

Investment	Expected Return (%)	Expected Standard Deviation (%)	Utility $A = 2$
1	18	2	0.1796
2	19	8	0.1836
3	20	15	0.1775
4	18	30	0.0900

9. A is correct. Investment 1 provides the highest utility value (0.1792) for a risk-averse investor who has a measure of risk aversion equal to 4.

Investment	Expected Return (%)	Expected Standard Deviation (%)	Utility $A = 4$
1	18	2	0.1792
2	19	8	0.1772
3	20	15	0.1550
4	18	30	0.0000

10. A is correct. The CAL is the combination of the risk-free asset with zero risk and the portfolio of all risky assets that provides for the set of feasible investments. Allowing for borrowing at the risk-free rate and investing in the portfolio of all risky assets provides for attainable portfolios that dominate risky assets below the CAL.

11. B is correct. The CAL represents the set of all feasible investments. Each investor's indifference curve determines the optimal combination of the risk-free asset and the portfolio of all risky assets, which must lie on the CAL.

12. A is correct. The asset's returns are not used to calculate the portfolio's variance [only the assets' weights, standard deviations (or variances), and covariances (or correlations) are used].

13. C is correct.

$$\sigma_{port} = \sqrt{w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\rho_{1,2}\sigma_1\sigma_2}$$
$$= \sqrt{(0.3)^2(20\%)^2 + (0.7)^2(12\%)^2 + 2(0.3)(0.7)(0.40)(20\%)(12\%)}$$
$$= (0.3600\% + 0.7056\% + 0.4032\%)^{0.5} = (1.4688\%)^{0.5} = 12.11\%$$

14. A is correct.

$$\sigma_{port} = \sqrt{w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2Cov(R_1R_2)}$$
$$= \sqrt{(0.3)^2(20\%)^2 + (0.7)^2(12\%)^2 + 2(0.3)(0.7)(-0.0240)}$$
$$= (0.3600\% + 0.7056\% - 1.008\%)^{0.5} = (0.0576\%)^{0.5} = 2.40\%$$

15. C is correct. A portfolio standard deviation of 14.40% is the weighted average, which is possible only if the correlation between the securities is equal to 1.0.

16. B is correct. A portfolio standard deviation of 14.40% is the weighted average, which is possible only if the correlation between the securities is equal to 1.0. If the correlation coefficient is equal to 1.0, then the covariance must equal 0.0240, calculated as: $\text{Cov}(R_1,R_2) = \rho_{12}\sigma_1\sigma_2 = (1.0)(20\%)(12\%) = 2.40\% = 0.0240$.

17. C is correct.

$$R_p = w_1 \times R_1 + (1 - w_1) \times R_2$$
$$R_p = w_1 \times 16\% + (1 - w_1) \times 12\%$$
$$15\% = 0.75(16\%) + 0.25(12\%)$$

18. A is correct.

$$\sigma_{port} = \sqrt{w_1^2 \sigma_1^2 + w_2^2 \sigma_2^2 + 2 w_1 w_2 \rho_{1,2} \sigma_1 \sigma_2}$$
$$= \sqrt{(0.5)^2 (20\%)^2 + (0.5)^2 (20\%)^2 + 2(0.5)(0.5)(-0.15)(20\%)(20\%)}$$
$$= (1.0000\% + 1.0000\% - 0.3000\%)^{0.5} = (1.7000\%)^{0.5} = 13.04\%$$

19. B is correct.

$$\sigma_{port} = \sqrt{w_1^2 \sigma_1^2 + w_2^2 \sigma_2^2 + 2 w_1 w_2 \rho_{1,2} \sigma_1 \sigma_2}$$
$$= \sqrt{(0.5)^2 (20\%)^2 + (0.5)^2 (20\%)^2 + 2(0.5)(0.5)(0.00)(20\%)(20\%)}$$
$$= (1.0000\% + 1.0000\% - 0.0000\%)^{0.5} = (2.0000\%)^{0.5} = 14.14\%$$

20. C is correct. An equally weighted portfolio of Asset 2 and Asset 3 will have the lowest portfolio standard deviation, because for each outcome, the portfolio has the same expected return (they are perfectly negatively correlated).

21. A is correct. An equally weighted portfolio of Asset 1 and Asset 2 has the highest level of volatility of the three pairs. All three pairs have the same expected return; however, the portfolio of Asset 1 and Asset 2 provides the least amount of risk reduction.

22. B is correct. The contribution of each individual asset's variance (or standard deviation) to the portfolio's volatility decreases as the number of assets in the equally weighted portfolio increases. The contribution of the co-movement measures between the assets increases (i.e., covariance and correlation) as the number of assets in the equally weighted portfolio increases. The following equation for the variance of an equally weighted portfolio illustrates these points: $\sigma_p^2 = \frac{\bar{\sigma}^2}{N} + \frac{N-1}{N}\overline{COV} = \frac{\bar{\sigma}^2}{N} + \frac{N-1}{N}\bar{\rho}\ \bar{\sigma}^2.$

23. C is correct. The co-movement measures between the assets increases (i.e., covariance and correlation) as the number of assets in the equally weighted portfolio increases. The contribution of each individual asset's variance (or standard deviation) to the portfolio's volatility decreases as the number of assets in the equally weighted portfolio increases. The following equation for the variance of an equally weighted portfolio illustrates these points:

$$\sigma_p^2 = \frac{\bar{\sigma}^2}{N} + \frac{N-1}{N}\overline{COV} = \frac{\bar{\sigma}^2}{N} + \frac{N-1}{N}\bar{\rho}\ \bar{\sigma}^2.$$

24. A is correct. Higher correlations will produce less diversification benefits provided that the other components of the portfolio standard deviation do not change (i.e., the weights and standard deviations of the individual assets).

25. C is correct. The efficient frontier does not account for the risk-free rate. The efficient frontier is the set of all attainable risky assets with the highest expected return for a given level of risk or the lowest amount of risk for a given level of return.

26. C is correct. The global minimum-variance portfolio is the portfolio on the minimum-variance frontier with the lowest standard deviation. Although

the portfolio is attainable, when the risk-free asset is considered, the global minimum-variance portfolio is not the optimal risky portfolio.

27. B is correct. The Markowitz efficient frontier has higher rates of return for a given level of risk. With respect to the minimum-variance portfolio, the Markowitz efficient frontier is the set of portfolios above the global minimum-variance portfolio that dominates the portfolios below the global minimum-variance portfolio.

28. A is correct. The use of leverage and the combination of a risk-free asset and the optimal risky asset will dominate the efficient frontier of risky assets (the Markowitz efficient frontier).

29. B is correct. The CAL dominates the efficient frontier at all points except for the optimal risky portfolio. The ability of the investor to purchase additional amounts of the optimal risky portfolio by borrowing (i.e., buying on margin) at the risk-free rate makes higher rates of return for levels of risk greater than the optimal risky asset possible.

30. C is correct. Each individual investor's optimal mix of the risk-free asset and the optimal risky asset is determined by the investor's risk preference.

LEARNING MODULE

2

Portfolio Risk and Return: Part II

by Vijay Singal, PhD, CFA.

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LEARNING OUTCOMES

Mastery	*The candidate should be able to:*
☐	describe the implications of combining a risk-free asset with a portfolio of risky assets
☐	explain the capital allocation line (CAL) and the capital market line (CML)
☐	explain systematic and nonsystematic risk, including why an investor should not expect to receive additional return for bearing nonsystematic risk
☐	explain return generating models (including the market model) and their uses
☐	calculate and interpret beta
☐	explain the capital asset pricing model (CAPM), including its assumptions, and the security market line (SML)
☐	calculate and interpret the expected return of an asset using the CAPM
☐	describe and demonstrate applications of the CAPM and the SML
☐	calculate and interpret the Sharpe ratio, Treynor ratio, M^2, and Jensen's alpha

INTRODUCTION

1

Our objective in this reading is to identify the optimal risky portfolio for all investors by using the capital asset pricing model (CAPM). The foundation of this reading is the computation of risk and return of a portfolio and the role that correlation plays in diversifying portfolio risk and arriving at the efficient frontier. The efficient frontier and the capital allocation line consist of portfolios that are generally acceptable to all investors. By combining an investor's individual indifference curves with the market-determined capital allocation line, we are able to illustrate that the only optimal risky portfolio for an investor is the portfolio of all risky assets (i.e., the market).

Additionally, we discuss the capital market line, a special case of the capital allocation line that is used for passive investor portfolios. We also differentiate between systematic and nonsystematic risk, and explain why investors are compensated for bearing systematic risk but receive no compensation for bearing nonsystematic risk. We discuss in detail the CAPM, which is a simple model for estimating asset returns based only on the asset's systematic risk. Finally, we illustrate how the CAPM allows security selection to build an optimal portfolio for an investor by changing the asset mix beyond a passive market portfolio.

The reading is organized as follows. In Section 2, we discuss the consequences of combining a risk-free asset with the market portfolio and provide an interpretation of the capital market line. Section 3 decomposes total risk into systematic and nonsystematic risk and discusses the characteristics of and differences between the two kinds of risk. We also introduce return-generating models, including the single-index model, and illustrate the calculation of beta. In Section 4, we introduce the capital asset pricing model and the security market line. Our focus on the CAPM does not suggest that the CAPM is the only viable asset pricing model. Although the CAPM is an excellent starting point, more advanced readings expand on these discussions and extend the analysis to other models that account for multiple explanatory factors. Section 5 covers several post-CAPM developments in theory. Section 6 covers measures for evaluating the performance of a portfolio which take account of risk. Section 7 covers some applications of the CAPM in portfolio construction. A summary and practice problems conclude the reading.

2 CAPITAL MARKET THEORY: RISK-FREE AND RISKY ASSETS

- ☐ describe the implications of combining a risk-free asset with a portfolio of risky assets
- ☐ explain the capital allocation line (CAL) and the capital market line (CML)

You have learned how to combine a risk-free asset with one risky asset and with many risky assets to create a capital allocation line. In this section, we will expand our discussion of multiple risky assets and consider a special case of the capital allocation line, called the capital market line. While discussing the capital market line, we will define the market and its role in passive portfolio management. Using these concepts, we will illustrate how leveraged portfolios can enhance both risk and return.

Portfolio of Risk-Free and Risky Assets

Although investors desire an asset that produces the highest return and carries the lowest risk, such an asset does not exist. As the risk–return capital market theory illustrates, one must assume higher risk in order to earn a higher return. We can improve an investor's portfolio, however, by expanding the opportunity set of risky assets because this allows the investor to choose a superior mix of assets.

Similarly, an investor's portfolio improves if a risk-free asset is added to the mix. In other words, a combination of the risk-free asset and a risky asset can result in a better risk–return trade-off than an investment in only one type of asset because the risk-free asset has zero correlation with the risky asset. The combination is called the **capital allocation line** (and is depicted in Exhibit 2). Superimposing an investor's indifference curves on the capital allocation line will lead to the optimal investor portfolio.

Investors with different levels of risk aversion will choose different portfolios. Highly risk-averse investors choose to invest most of their wealth in the risk-free asset and earn low returns because they are not willing to assume higher levels of risk. Less risk-averse investors, in contrast, invest more of their wealth in the risky asset, which is expected to yield a higher return. Obviously, the higher return cannot come without higher risk, but the less risk-averse investor is willing to accept the additional risk.

Combining a Risk-Free Asset with a Portfolio of Risky Assets

We can extend the analysis of one risky asset to a portfolio of risky assets. For convenience, assume that the portfolio contains all available risky assets (*N*), although an investor may not wish to include all of these assets in the portfolio because of the investor's specific preferences. If an asset is not included in the portfolio, its weight will be zero. The risk–return characteristics of a portfolio of *N* risky assets are given by the following equations:

$$E\left(R_p\right) = \sum_{i=1}^{N} w_i E\left(R_i\right)$$

$$\sigma_p^2 = \left(\sum_{i=1,j=1}^{N} w_i w_j \operatorname{Cov}\left(i,j\right)\right), \text{ and } \sum_{i=1}^{N} w_i = 1$$

The expected return on the portfolio, $E(R_p)$, is the weighted average of the expected returns of individual assets, where w_i is the fractional weight in asset i and R_i is the expected return of asset i. The risk of the portfolio (σ_p), however, depends on the weights of the individual assets, the risk of the individual assets, and their interrelationships. The **covariance** between assets i and j, Cov(i,j), is a statistical measure of the interrelationship between each pair of assets in the portfolio and can be expressed as follows, where ρ_{ij} is the **correlation** between assets i and j and σ_i is the risk of asset i:

$$\operatorname{Cov}(i,j) = \rho_{ij}\sigma_i\sigma_j$$

Note from the equation below that the correlation of an asset with itself is 1; therefore:

$$\operatorname{Cov}(i,i) = \rho_{ii}\sigma_i\sigma_i = \sigma_i^2$$

By substituting the above expressions for covariance, we can rewrite the portfolio variance equation as

$$\sigma_p^2 = \left(\sum_{i=1}^{N} w_i^2 \sigma_i^2 + \sum_{i,j=1,i\neq j}^{N} w_i w_j \rho_{ij} \sigma_i \sigma_j\right)$$

The suggestion that portfolios have lower risk than the assets they contain may seem counterintuitive. These portfolios can be constructed, however, as long as the assets in the portfolio are not perfectly correlated. As an illustration of the effect of asset weights on portfolio characteristics, consider a simple two-asset portfolio with zero weights in all other assets. Assume that Asset 1 has a return of 10 percent and a standard deviation (risk) of 20 percent. Asset 2 has a return of 5 percent and a standard deviation (risk) of 10 percent. Furthermore, the correlation between the two assets is zero. Exhibit 1 shows risks and returns for Portfolio X with a weight of 25 percent in Asset 1 and 75 percent in Asset 2, Portfolio Y with a weight of 50 percent in each of the two assets, and Portfolio Z with a weight of 75 percent in Asset 1 and 25 percent in Asset 2.

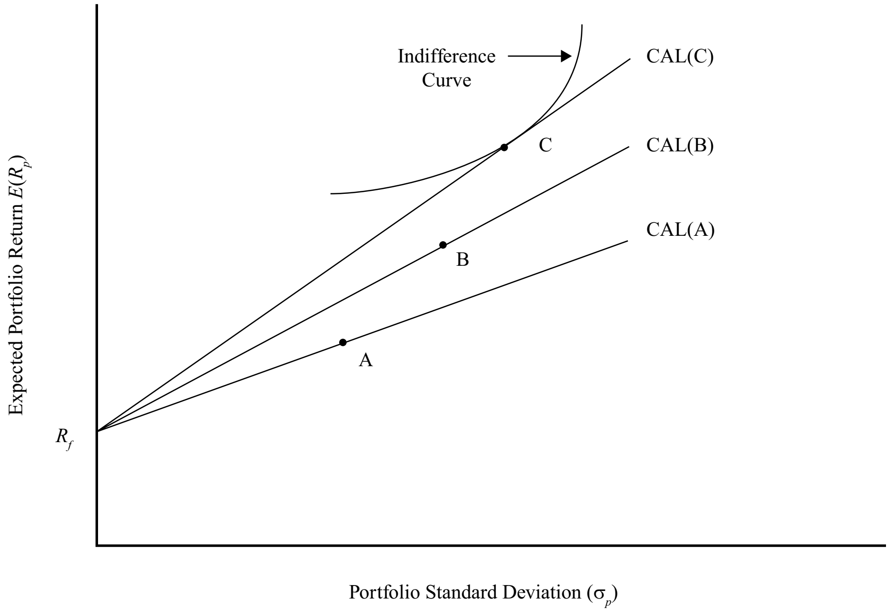
Exhibit 1: Portfolio Risk and Return

Portfolio	Weight in Asset 1 (%)	Weight in Asset 2 (%)	Portfolio Return (%)	Portfolio Standard Deviation (%)
X	25.0	75.0	6.25	9.01
Y	50.0	50.0	7.50	11.18
Z	75.0	25.0	8.75	15.21
Return	10.0	5.0		
Standard deviation	20.0	10.0		
Correlation between Assets 1 and 2		0.0		

From this example we observe that the three portfolios are quite different in terms of their risk and return. Portfolio X has a 6.25 percent return and only 9.01 percent standard deviation, whereas the standard deviation of Portfolio Z is more than two-thirds higher (15.21 percent), although the return is only slightly more than one-third higher (8.75 percent). These portfolios may become even more dissimilar as other assets are added to the mix.

Consider three portfolios of risky assets, A, B, and C, as in Exhibit 2, that may have been presented to a representative investor by three different investment advisers. Each portfolio is combined with the risk-free asset to create three capital allocation lines, CAL(A), CAL(B), and CAL(C). The exhibit shows that Portfolio C is superior to the other two portfolios because it has a greater expected return for any given level of risk. As a result, an investor will choose the portfolio that lies on the capital allocation line for Portfolio C. The combination of the risk-free asset and the risky Portfolio C that is selected for an investor depends on the investor's degree of risk aversion.

Exhibit 2: Risk-Free Asset and Portfolio of Risky Assets



Does a Unique Optimal Risky Portfolio Exist?

We assume that all investors have the same economic expectation and thus have the same expectations of prices, cash flows, and other investment characteristics. This assumption is referred to as **homogeneity of expectations**. Given these investment characteristics, everyone goes through the same calculations and should arrive at the same optimal risky portfolio. Therefore, assuming homogeneous expectations, only one optimal portfolio exists. If investors have different expectations, however, they might arrive at different optimal risky portfolios. To illustrate, we begin with an expression for the price of an asset:

$$P = \sum_{t=0}^{T} \frac{\mathrm{CF}_t}{(1 + r_t)^t}$$

where CF_t is the cash flow at the end of period t and r_t is the discount rate or the required rate of return for that asset for period t. Period t refers to all periods beginning from now until the asset ceases to exist at the end of time T. Because the current time is the end of period 0, which is the same as the beginning of period 1, there are $(T + 1)$ cash flows and $(T + 1)$ required rates of return. These conditions are based on the assumption that a cash flow, such as an initial investment, can occur now (t = 0). Ordinarily, however, CF_0 is zero.

We use the formula for the price of an asset to estimate the intrinsic value of an asset. Assume that the asset we are valuing is a share of Siemens AG which trades on Xetra. In the case of corporate stock, there is no expiration date, so T could be extremely large, meaning we will need to estimate a large number of cash flows and rates of return. Fortunately, the denominator reduces the importance of distant cash flows, so it may be sufficient to estimate, say, 20 annual cash flows and 20 rates of returns. How much will Siemens earn next year and the year after next? What will the product markets Siemens operates in look like in five years' time? Different analysts and investors will have their own estimates that may be quite different from one another. Also, as we delve further into the future, more serious issues in estimating future revenue, expenses, and growth rates arise. Therefore, to assume that cash flow estimates for Siemens will vary among these investors is reasonable. In addition to the numerator (cash flows), it is also necessary to estimate the denominator, the required rates of return. We know that riskier companies will require higher returns because risk and return are positively correlated. Siemens stock is riskier than a risk-free asset, but by how much? And what should the compensation for that additional risk be? Again, it is evident that different analysts will view the riskiness of Siemens differently and, therefore, arrive at different required rates of return.

Siemens closed at €111.84 on Xetra on 31 August 2018. The traded price represents the value that a marginal investor attaches to a share of Siemens, say, corresponding to Analyst A's expectation. Analyst B may think that the price should be €95, however, and Analyst C may think that the price should be €125. Given a price of €111.84, the expected returns of Siemens are quite different for the three analysts. Analyst B, who believes the price should be €95, concludes that Siemens is overvalued and may assign a weight of zero to Siemens in the recommended portfolio even though the market capitalization of Siemens was in excess of €100 billion as of the date of the quotation. In contrast, Analyst C, with a valuation of €125, thinks Siemens is undervalued and may significantly overweight Siemens in a portfolio.

Our discussion illustrates that analysts can arrive at different valuations that necessitate the assignment of different asset weights in a portfolio. Given the existence of many asset classes and numerous assets in each asset class, one can visualize that each investor will have his or her own optimal risky portfolio depending on his or her assumptions underlying the valuation computations. Therefore, market participants will have their own and possibly different optimal risky portfolios.

If investors have different valuations of assets, then the construction of a unique optimal risky portfolio is not possible. If we make a simplifying assumption of homogeneity in investor expectations, we will have a single optimal risky portfolio as previously mentioned. Even if investors have different expectations, market prices are a proxy of what the marginal, informed investor expects, and the market portfolio becomes the base case, the benchmark, or the reference portfolio that other portfolios can be judged against. For Siemens, the market price was €111.84 per share and the market capitalization was about €108 billion. In constructing the market portfolio, Siemens's weight in the market portfolio will be equal to its market value divided by the value of all other assets included in the market portfolio.

3 CAPITAL MARKET THEORY: THE CAPITAL MARKET LINE

☐ explain the capital allocation line (CAL) and the capital market line (CML)

In the previous section, we discussed how the risk-free asset could be combined with a risky portfolio to create a capital allocation line (CAL). In this section, we discuss a specific CAL that uses the market portfolio as the optimal risky portfolio and is known as the capital market line. We also discuss the significance of the market portfolio and applications of the capital market line (CML).

Passive and Active Portfolios

In the above subsection, we hypothesized three possible valuations for each share of Siemens: €95, €111.84, and €125. Which one is correct?

If the market is an **informationally efficient market**, the price in the market, €111.84, is an unbiased estimate of all future discounted cash flows (recall the formula for the price of an asset). In other words, the price aggregates and reflects all information that is publicly available, and investors cannot expect to earn a return that is greater than the required rate of return for that asset. If, however, the price reflects all publicly available information and there is no way to outperform the market, then there is little point in investing time and money in evaluating Siemens to arrive at your price using your own estimates of cash flows and rates of return.

In that case, a simple and convenient approach to investing is to rely on the prices set by the market. Portfolios that are based on the assumption of unbiased market prices are referred to as passive portfolios. Passive portfolios most commonly replicate and track market indexes, which are passively constructed on the basis of market prices and market capitalizations. Examples of market indexes are the S&P 500 Index, the Nikkei 300, and the CAC 40. Passive portfolios based on market indexes are called index funds and generally have low costs because no significant effort is expended in valuing securities that are included in an index.

In contrast to passive investors' reliance on market prices and index funds, active investors may not rely on market valuations. They have more confidence in their own ability to estimate cash flows, growth rates, and discount rates. Based on these estimates, they value assets and determine whether an asset is fairly valued. In an actively managed portfolio, assets that are undervalued, or have a chance of offering above-normal returns, will have a positive weight (i.e., overweight compared to the market weight in the benchmark index), whereas other assets will have a zero weight, or even a negative weight if short selling is permitted (i.e., some assets will be underweighted compared with the market weight in the benchmark index). (**Short selling** is a transaction in which borrowed securities are sold with the intention to repurchase them at a lower price at a later date and return them to the lender.) This style of investing is called active investment management, and the portfolios are referred to as active portfolios. Most open-end mutual funds and hedge funds practice active investment management, and most analysts believe that active investing adds value. Whether these analysts are right or wrong is the subject of continuing debate.

What Is the "Market"?

In the previous discussion, we referred to the "market" on numerous occasions without actually defining the market. The optimal risky portfolio and the capital market line depend on the definition of the market. So what is the market?

Theoretically, the market includes all risky assets or anything that has value, which includes stocks, bonds, real estate, and even human capital. Not all assets are tradable, however, and not all tradable assets are investable. For example, the Taj Mahal in India is an asset but is not a tradable asset. Similarly, human capital is an asset that is not tradable. Moreover, assets may be tradable but not investable because of restrictions placed on certain kinds of investors. For example, all stocks listed on the Shanghai Stock Exchange are tradable. However, whereas Class A shares are listed in RMB and open to domestic investors and qualified foreign investors, Class B shares are listed in USD and open to foreign investors and domestic investors holding foreign currency dealing accounts.

If we consider all stocks, bonds, real estate assets, commodities, etc., probably hundreds of thousands of assets are tradable and investable. The "market" should contain as many assets as possible; we emphasize the word "possible" because it is not practical to include all assets in a single risky portfolio. Even though advancements in technology and interconnected markets have made it much easier to span the major equity markets, we are still not able to easily invest in other kinds of assets like bonds and real estate except in the most developed countries.

For the rest of this reading, we will define the "market" quite narrowly because it is practical and convenient to do so. Typically, a local or regional stock market index is used as a proxy for the market because of active trading in stocks and because a local or regional market is most visible to the local investors. For our purposes, we will use the S&P 500 Index as the market's proxy. The S&P 500 is commonly used by analysts as a benchmark for market performance throughout the United States. It contains 500 of the largest stocks that are domiciled in the United States, and these stocks are weighted by their market capitalization (price times the number of outstanding shares).

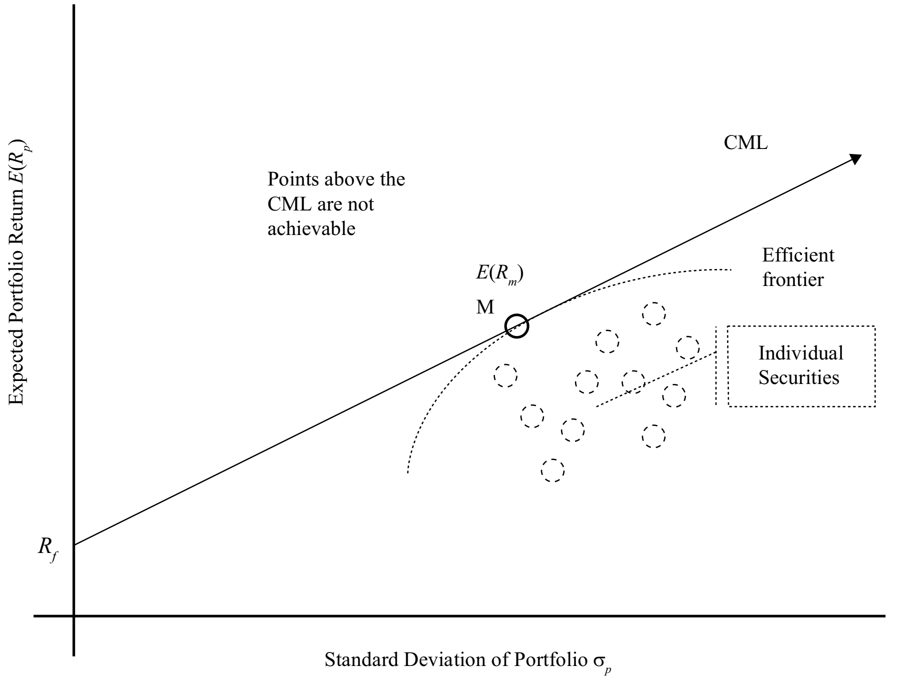
As of mid-2018, the stocks in the S&P 500 account for approximately 80 percent of the total equity market capitalization in the United States, and because the US stock markets represent about 40 percent of the world markets, the S&P 500 represents roughly 32 percent of worldwide publicly traded equity. Our definition of the market does not include non-US stock markets, bond markets, real estate, and many other asset classes, and therefore, "market" return and the "market" risk premium refer to US equity return and the US equity risk premium, respectively. The use of this proxy, however, is sufficient for our discussion, and is relatively easy to expand to include other tradable assets.

The Capital Market Line (CML)

A capital allocation line includes all possible combinations of the risk-free asset and an investor's optimal risky portfolio. The **capital market line** is a special case of the capital allocation line, where the risky portfolio is the market portfolio. The risk-free asset is a debt security with no default risk, no inflation risk, no liquidity risk, no interest rate risk, and no risk of any other kind. US Treasury bills are usually used as a proxy of the risk-free return, R_f.

The S&P 500 is a proxy of the market portfolio, which is the optimal risky portfolio. Therefore, the expected return on the risky portfolio is the expected market return, expressed as $E(R_m)$. The capital market line is shown in Exhibit 3, where the standard deviation (σ_p), or total risk, is on the x-axis and expected portfolio return, $E(R_p)$, is on the y-axis. Graphically, the market portfolio is the point on the Markowitz efficient frontier where a line from the risk-free asset is tangent to the Markowitz efficient frontier. All points on the interior of the Markowitz efficient frontier are inefficient portfolios in that they provide the same level of return with a higher level of risk or a lower level of return with the same amount of risk. When plotted together, the point at which the CML is tangent to the Markowitz efficient frontier is the optimal combination of risky assets, on the basis of market prices and market capitalizations. The optimal risky portfolio is the market portfolio.

Exhibit 3: Capital Market Line



The CML's intercept on the y-axis is the risk-free return (R_f) because that is the return associated with zero risk. The CML passes through the point represented by the market return, $E(R_m)$. With respect to capital market theory, any point above the CML is not achievable and any point below the CML is dominated by and inferior to any point on the CML.

Note that we identify the CML and CAL as lines even though they are a combination of two assets. Unlike a combination of two risky assets, which is usually not a straight line, a combination of the risk-free asset and a risky portfolio is a straight line, as illustrated below by computing the combination's risk and return.

Risk and return characteristics of the portfolio represented by the CML can be computed by using the return and risk expressions for a two-asset portfolio:

$$E(R_p) = w_1 R_f + (1 - w_1)E(R_m),$$

and

$$\sigma_p = \sqrt{w_1^2 \sigma_f^2 + (1 - w_1)^2 \sigma_m^2 + 2 w_1 (1 - w_1) \text{Cov}(R_f, R_m)}$$

The proportion invested in the risk-free asset is given by w_1, and the balance is invested in the market portfolio, $(1 - w_1)$. The risk of the risk-free asset is given by σ_f, the risk of the market is given by σ_m, the risk of the portfolio is given by σ_p, and the covariance between the risk-free asset and the market portfolio is represented by $\text{Cov}(R_f, R_m)$.

By definition, the standard deviation of the risk-free asset is zero. Because its risk is zero, the risk-free asset does not co-vary or move with any other asset. Therefore, its covariance with all other assets, including the market portfolio, is zero, making the first and third terms under the square root sign zero. As a result, the portfolio return and portfolio standard deviation can be simplified and rewritten as:

$$E(R_p) = w_1 R_f + (1 - w_1)E(R_m),$$

and

$$\sigma_p = (1 - w_1)\sigma_m$$

By substitution, we can express $E(R_p)$ in terms of σ_p. Substituting for w_1, we get:

$$E(R_p) = R_f + \left(\frac{E(R_m) - R_f}{\sigma_m}\right) \times \sigma_p$$

Note that the expression is in the form of a line, $y = a + bx$. The y-intercept is the risk-free rate, and the slope of the line referred to as the market price of risk is $[E(R_m) - R_f]/\sigma_m$. The CML has a positive slope because the market's risky return is larger than the risk-free return. As the amount of the total investment devoted to the market increases—that is, as we move up the line—both standard deviation (risk) and expected return increase.

EXAMPLE 1

Risk and Return on the CML

Mr. Miles is a first time investor and wants to build a portfolio using only US T-bills and an index fund that closely tracks the S&P 500 Index. The T-bills have a return of 5 percent. The S&P 500 has a standard deviation of 20 percent and an expected return of 15 percent.

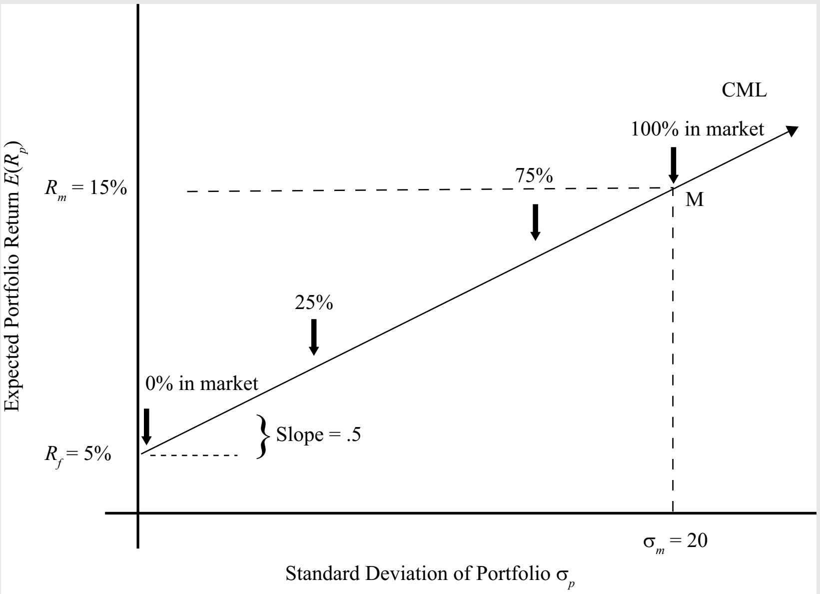
1. Draw the CML and mark the points where the investment in the market is 0 percent, 25 percent, 75 percent, and 100 percent.

Solution:

We calculate the equation for the CML as $E(R_p) = 5\% + 0.50 \times \sigma_p$ by substituting the given information into the general CML equation. The intercept of the line is 5 percent, and its slope is 0.50. We can draw the CML by arbitrarily taking any two points on the line that satisfy the above equation.

Alternatively, the CML can be drawn by connecting the risk-free return of 5 percent on the y-axis with the market portfolio at (20 percent, 15 percent). The CML is shown in Exhibit 4.

Exhibit 4: Risk and Return on the CML



2. Mr. Miles is also interested in determining the exact risk and return at each point.

Solution:

Return with 0 percent invested in the market
= 5 percent, which is the risk-free return.

Standard deviation with 0 percent invested in the market
= 0 percent because T-bills are not risky.

Return with 25 percent invested in the market = (0.75 × 5%) + (0.25 × 15%)
= 7.5%.

Standard deviation with 25 percent invested in the market = 0.25 × 20% = 5%.

Return with 75 percent invested in the market = (0.25 × 5%) + (0.75 × 15%)
= 12.50%.

Standard deviation with 75 percent invested in the market = 0.75 × 20% = 15%.

Return with 100 percent invested in the market
= 15 percent, which is the return on the S&P 500.

Standard deviation with 100 percent invested in the market
= 20 percent, which is the risk of the S&P 500.

CAPITAL MARKET THEORY: CML - LEVERAGED PORTFOLIOS

4

☐ explain the capital allocation line (CAL) and the capital market line (CML)

In the previous example, Mr. Miles evaluated an investment of between 0 percent and 100 percent in the market and the balance in T-bills. The line connecting R_f and M (market portfolio) in Exhibit 4 illustrates these portfolios with their respective levels of investment. At R_f, an investor is investing all of his or her wealth into risk-free securities, which is equivalent to lending 100 percent at the risk-free rate. At Point M he or she is holding the market portfolio and not lending any money at the risk-free rate. The combinations of the risk-free asset and the market portfolio, which may be achieved by the points between these two limits, are termed "lending" portfolios. In effect, the investor is lending part of his or her wealth at the risk-free rate.

If Mr. Miles is willing to take more risk, he may be able to move to the right of the market portfolio (Point M in Exhibit 4) by borrowing money and purchasing more of Portfolio M. Assume that he is able to borrow money at the same risk-free rate of interest, R_f, at which he can invest. He can then supplement his available wealth with borrowed money and construct a borrowing portfolio. If the straight line joining R_f and M is extended to the right of Point M, this extended section of the line represents borrowing portfolios. As one moves further to the right of Point M, an increasing amount of borrowed money is being invested in the market. This means that there is *negative* investment in the risk-free asset, which is referred to as a *leveraged position* in the risky portfolio. The particular point chosen on the CML will depend on the individual's utility function, which, in turn, will be determined by his risk and return preferences.

EXAMPLE 2

Risk and Return of a Leveraged Portfolio with Equal Lending and Borrowing Rates

1. Mr. Miles decides to set aside a small part of his wealth for investment in a portfolio that has greater risk than his previous investments because he anticipates that the overall market will generate attractive returns in the future. He assumes that he can borrow money at 5 percent and achieve the same return on the S&P 500 as before: an expected return of 15 percent with a standard deviation of 20 percent.

   Calculate his expected risk and return if he borrows 25 percent, 50 percent, and 100 percent of his initial investment amount.

Solution:

The leveraged portfolio's standard deviation and return can be calculated in the same manner as before with the following equations:

$$E(R_p) = w_1 R_f + (1 - w_1)E(R_m)$$

and

$\sigma_p = (1 - w_1)\sigma_m$

The proportion invested in T-bills becomes negative instead of positive because Mr. Miles is borrowing money. If 25 percent of the initial investment is borrowed, w_1 = –0.25, and $(1 - w_1)$ = 1.25, etc.

Return with w_1 = –0.25 = (–0.25 × 5%) + (1.25 × 15%) = 17.5%.

Standard deviation with w_1 = –0.25 = 1.25 × 20% = 25%.

Return with w_1 = –0.50 = (–0.50 × 5%) + (1.50 × 15%) = 20.0%.

Standard deviation with w_1 = –0.50 = 1.50 × 20% = 30%.

Return with w_1 = –1.00 = (–1.00 × 5%) + (2.00 × 15%) = 25.0%.

Standard deviation with w_1 = –1.00 = 2.00 × 20% = 40%.

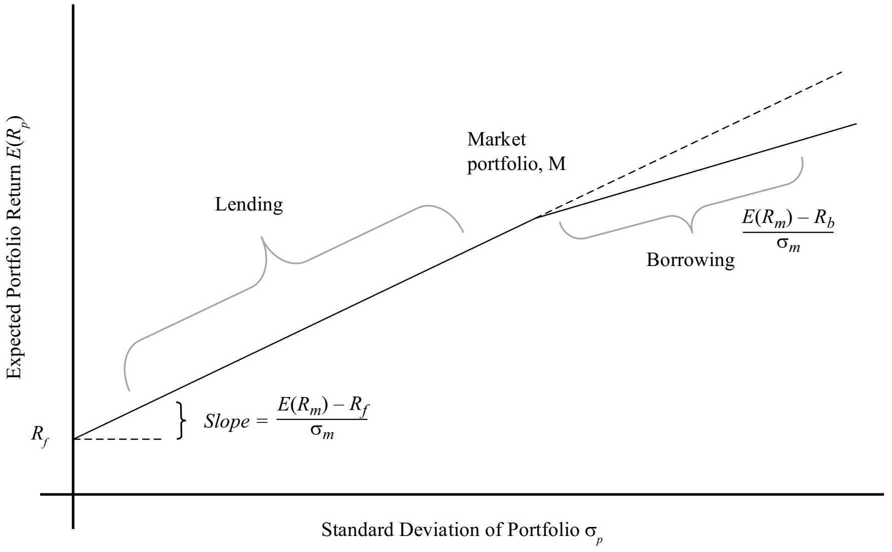
Note that negative investment (borrowing) in the risk-free asset provides a higher expected return for the portfolio but that higher return is also associated with higher risk.

Leveraged Portfolios with Different Lending and Borrowing Rates

Although we assumed that Mr. Miles can borrow at the same rate as the US government, it is more likely that he will have to pay a higher interest rate than the government because his ability to repay is not as certain as that of the government. Now consider that although Mr. Miles can invest (lend) at R_f, he can borrow at only R_b, a rate that is higher than the risk-free rate.

With different lending and borrowing rates, the CML will no longer be a single straight line. The line will have a slope of $[E(R_m) - R_f]/\sigma_m$ between Points R_f and M, where the lending rate is R_f, but will have a smaller slope of $[E(R_m) - R_b]/\sigma_m$ at points to the right of M, where the borrowing rate is R_b. Exhibit 5 illustrates the CML with different lending and borrowing rates.

Exhibit 5: CML with Different Lending and Borrowing Rates



The equations for the two lines are given below.

$$w_1 \geq 0: E\left(R_p\right) = R_f + \left(\frac{E\left(R_m\right) - R_f}{\sigma_m}\right) \times \sigma_p$$

and

$$w_1 < 0: E\left(R_p\right) = R_b + \left(\frac{E\left(R_m\right) - R_b}{\sigma_m}\right) \times \sigma_p$$

The first equation is for the line where the investment in the risk-free asset is zero or positive—that is, at M or to the left of M in Exhibit 5. The second equation is for the line where borrowing, or negative investment in the risk-free asset, occurs. Note that the only difference between the two equations is in the interest rates used for borrowing and lending.

All passive portfolios will lie on the kinked CML, although the investment in the risk-free asset may be positive (lending), zero (no lending or borrowing), or negative (borrowing). Leverage allows less risk-averse investors to increase the amount of risk they take by borrowing money and investing more than 100 percent in the passive portfolio.

EXAMPLE 3

Leveraged Portfolio with Different Lending and Borrowing Rates

1. Mr. Miles approaches his broker to borrow money against securities held in his portfolio. Even though Mr. Miles' loan will be secured by the securities in his portfolio, the broker's rate for lending to customers is 7 percent. Assuming a risk-free rate of 5 percent and a market return of 15 percent with a standard deviation of 20 percent, estimate Mr. Miles' expected return and risk if he invests 25 percent and 75 percent in the market and if he decides

to borrow 25 percent and 75 percent of his initial investment and invest the money in the market.

Solution:

The unleveraged portfolio's standard deviation and return are calculated using the same equations as before:

$$E(R_p) = w_1 R_f + (1 - w_1)E(R_m),$$

and

$$\sigma_p = (1 - w_1)\sigma_m$$

The results are unchanged. The slope of the line for the unleveraged portfolio is 0.50, just as before:

Return with 25 percent invested in the market = (0.75 × 5%) + (0.25 × 15%) = 7.5%.

Standard deviation with 25 percent invested in the market = 0.25 × 20% = 5%.

Return with 75 percent invested in the market = (0.25 × 5%) + (0.75 × 15%) = 12.5%.

Standard deviation with 75 percent invested in the market = 0.75 × 20% = 15%.

For the leveraged portfolio, everything remains the same except that R_f is replaced with R_b.

$$E(R_p) = w_1 R_b + (1 - w_1)E(R_m),$$

and

$$\sigma_p = (1 - w_1)\sigma_{m.}$$

Return with w_1 = –0.25 = (–0.25 × 7%) + (1.25 × 15%) = 17.0%.

Standard deviation with w_1 = –0.25 = 1.25 × 20% = 25%.

Return with w_1 = –0.75 = (–0.75 × 7%) + (1.75 × 15%) = 21.0%.

Standard deviation with w_1 = –0.75 = 1.75 × 20% = 35%.

The risk and return of the leveraged portfolio is higher than that of the unleveraged portfolio. As Mr. Miles borrows more money to invest in the market, the expected return increases but so does the standard deviation of the portfolio. The slope of the line for the leveraged portfolio is 0.40, compared with 0.50 for the unleveraged portfolio, which means that for every 1 percent increase in risk, the investor gets a 0.40 percent increase in expected return in the leveraged part of the portfolio, compared with a 0.50 percent increase in expected return in the unleveraged part of the portfolio. Only investors who are less risk averse will choose leveraged portfolios.

SYSTEMATIC AND NONSYSTEMATIC RISK

5

☐ explain systematic and nonsystematic risk, including why an investor should not expect to receive additional return for bearing nonsystematic risk

In constructing a portfolio, it is important to understand the concept of correlation and how less than perfect correlation can diversify the risk of a portfolio. As a consequence, the risk of an asset held alone may be greater than the risk of that same asset when it is part of a portfolio. Because the risk of an asset varies from one environment to another, which kind of risk should an investor consider and how should that risk be priced? This section addresses the question of pricing of risk by decomposing the total risk of a security or a portfolio into systematic and nonsystematic risk. The meaning of these risks, how they are computed, and their relevance to the pricing of assets are also discussed.

Systematic Risk and Nonsystematic Risk

Systematic risk, also known as non-diversifiable or market risk, is the risk that affects the entire market or economy. In contrast, nonsystematic risk is the risk that pertains to a single company or industry and is also known as company-specific, industry-specific, diversifiable, or idiosyncratic risk.

Systematic risk is risk that cannot be avoided and is inherent in the overall market. It is non-diversifiable because it includes risk factors that are innate within the market and affect the market as a whole. Examples of factors that constitute systematic risk include interest rates, inflation, economic cycles, political uncertainty, and widespread natural disasters. These events affect the entire market, and there is no way to avoid their effect. Systematic risk can be magnified through selection or by using leverage, or diminished by including securities that have a low correlation with the portfolio, assuming they are not already part of the portfolio.

Nonsystematic risk is risk that is local or limited to a particular asset or industry that need not affect assets outside of that asset class. Examples of nonsystematic risk could include the failure of a drug trial or an airliner crash. All these events will directly affect their respective companies and possibly industries, but have no effect on assets that are far removed from these industries. Investors can avoid nonsystematic risk through diversification by forming a portfolio of assets that are not highly correlated with one another.

We will derive expressions for each kind of risk later in this reading. You will see that the sum of systematic variance and nonsystematic variance equals the total variance of the security or portfolio:

Total variance = Systematic variance + Nonsystematic variance

Although the equality relationship is between variances, you will find frequent references to total risk as the sum of systematic risk and nonsystematic risk. In those cases, the statements refer to variance, not standard deviation.

Pricing of Risk

Pricing or valuing an asset is equivalent to estimating its expected rate of return. If an asset has a known terminal value, such as the face value of a bond, then a lower current price implies a higher future return and a higher current price implies a lower future return. The relationship between price and return can also be observed in the valuation expression shown in Section 2.1.2. Therefore, we will occasionally use price and return interchangeably when discussing the price of risk.

Consider an asset with both systematic and nonsystematic risk. Assume that both kinds of risk are priced—that is, you receive a return for both systematic risk and nonsystematic risk. What will you do? Realizing that nonsystematic risk can be diversified away, you would buy assets that have a large amount of nonsystematic risk. Once you have bought those assets with nonsystematic risk, you would diversify, or reduce that risk, by including other assets that are not highly correlated. In the process, you will minimize nonsystematic risk and eventually eliminate it altogether from your portfolio. You would now have a diversified portfolio with only systematic risk, yet you would be compensated for nonsystematic risk that you no longer have. Just like everyone else, you would have an incentive to take on more and more diversifiable risk because you are compensated for it even though you can get rid of it. The demand for diversifiable risk would keep increasing until its price becomes infinite and its expected return falls to zero. This means that our initial assumption of a non-zero return for diversifiable risk was incorrect and that the correct assumption is zero return for diversifiable risk. Therefore, according to theory, in an efficient market no incremental reward is earned for taking on diversifiable risk.

We have argued that investors should not be compensated for taking on nonsystematic risk. Therefore, investors who have nonsystematic risk must diversify it away by investing in many industries, many countries, and many asset classes. Because future returns are unknown and it is not possible to pick only winners, diversification helps in offsetting poor returns in one asset class by garnering good returns in another asset class, thereby reducing the overall risk of the portfolio. In contrast, investors must be compensated for accepting systematic risk because that risk cannot be diversified away. If investors do not receive a return commensurate with the amount of systematic risk they are taking, they will refuse to accept systematic risk.

In summary, according to theory, systematic or non-diversifiable risk is priced and investors are compensated for holding assets or portfolios based only on that investment's systematic risk. Investors do not receive any return for accepting nonsystematic or diversifiable risk. Therefore, it is in the interest of risk-averse investors to hold only well-diversified portfolios.

EXAMPLE 4

Systematic and Nonsystematic Risk

1. Describe the systematic and nonsystematic risk components of the following assets:
   - **A.** A risk-free asset, such as a three-month Treasury bill
   - **B.** The market portfolio, such as the S&P 500.
2. Consider two assets, A and B. Asset A has twice the amount of total risk as Asset B. For Asset A, systematic risk comprises two-thirds of total risk. For Asset B, all of total risk is systematic risk. Which asset should have a higher expected rate of return?

Solution to 1A:

By definition, a risk-free asset has no risk. Therefore, a risk-free asset has zero systematic risk and zero nonsystematic risk.

Solution to 1B:

As we mentioned earlier, a market portfolio is a diversified portfolio, one in which no more risk can be diversified away. We have also described it as an efficient portfolio. Therefore, a market portfolio does not contain any nonsystematic risk.

Solution to 2:

Based on the facts given, Asset A's systematic risk is one-third greater than Asset B's systematic risk. Because only systematic risk is priced or receives a return, the expected rate of return must be higher for Asset A.

RETURN GENERATING MODELS

6

- [ ] explain return generating models (including the market model) and their uses

As previously mentioned, in order to form the market portfolio, you should combine all available risky assets. Knowledge of the correlations among those assets allows us to estimate portfolio risk. You also learned that a fully diversified portfolio will include all asset classes and essentially all assets in those asset classes. The work required for construction of the market portfolio is formidable. For example, for a portfolio of 1,000 assets, we will need 1,000 return estimates, 1,000 standard deviation estimates, and 499,500 (1,000 × 999 ÷ 2) correlations. Other related questions that arise with this analysis are whether we really need all 1,000 assets and what happens if there are errors in these estimates.

An alternate method of constructing an optimal portfolio is simpler and easier to implement. An investor begins with a known portfolio, such as the S&P 500, and then adds other assets one at a time on the basis of the asset's standard deviation, expected return, and impact on the portfolio's risk and return. This process continues until the addition of another asset does not have a significant impact on the performance of the portfolio. The process requires only estimates of systematic risk for each asset because investors will not be compensated for nonsystematic risk. Expected returns can be calculated by using return-generating models, as we will discuss in this section. In addition to using return-generating models, we will also decompose total variance into systematic variance and nonsystematic variance and establish a formal relationship between systematic risk and return. In the next section, we will expand on this discussion and introduce the CAPM as the preferred return-generating model.

Return-Generating Models

A **return-generating model** is a model that can provide an estimate of the expected return of a security given certain parameters. If systematic risk is the only relevant parameter for return, then the return-generating model will estimate the expected return for any asset given the level of systematic risk.

As with any model, the quality of estimates of expected return will depend on the quality of input estimates and the accuracy of the model. Because it is difficult to decide which factors are appropriate for generating returns, the most general form of a return-generating model is a multi-factor model. A **multi-factor model** allows more than one variable to be considered in estimating returns and can be built using different kinds of factors, such as macroeconomic, fundamental, and statistical factors.

Macroeconomic factor models use economic factors that are correlated with security returns. These factors may include economic growth, the interest rate, the inflation rate, productivity, employment, and consumer confidence. Past relationships with returns are estimated to obtain parameter estimates, which are, in turn, used for computing expected returns. Fundamental factor models analyze and use relationships between security returns and the company's underlying fundamentals, such as, for example, earnings, earnings growth, cash flow generation, investment in research, advertising, and number of patents. Finally, in a statistical factor model, historical and cross-sectional return data are analyzed to identify factors that explain variance or covariance in observed returns. These statistical factors, however, may or may not have an economic or fundamental connection to returns. For example, the conference to which the American football Super Bowl winner belongs, whether the American Football Conference or the National Football Conference, may be a factor in US stock returns, but no obvious economic connection seems to exist between the winner's conference and US stock returns. Moreover, data mining may generate many spurious factors that are devoid of any economic meaning. Because of this limitation, analysts prefer the macroeconomic and fundamental factor models for specifying and estimating return-generating models.

A general return-generating model is expressed in the following manner:

$$E\left(R_i\right) - R_f = \sum_{j=1}^{k} \beta_{ij} E\left(F_j\right) = \beta_{i1}\left[E\left(R_m\right) - R_f\right] + \sum_{j=2}^{k} \beta_{ij} E\left(F_j\right)$$

The model has k factors, $E(F_1)$, $E(F_2)$, ... $E(F_k)$. The coefficients, β_{ij}, are the factor weights (sometimes called factor loadings) associated with each factor. The left-hand side of the model has the expected excess return (i.e., the expected return over the risk-free rate). The right-hand side provides the risk factors that would generate the return or premium required to assume that risk. We have separated out one factor, $E(R_m)$, which represents the market return. All models contain return on the market portfolio as a key factor.

Three-Factor and Four-Factor Models

Eugene Fama and Kenneth French[1] suggested that a return-generating model for stock returns should include relative market capitalization of the company ("size") relative book-to-market value of the company in addition to beta. Fama and French found that past returns could be explained better with their model than with other models available at that time, most notably, the capital asset pricing model. Mark Carhart (1997) extended the Fama and French model by adding another factor: momentum, defined as relative past stock returns.

The Single-Index Model

The simplest form of a return-generating model is a single-factor linear model, in which only one factor is considered. The most common implementation is a single-index model, which uses the market factor in the following form: $E(R_i) - R_f = \beta_i[E(R_m) - R_f]$.

Although the single-index model is simple, it fits nicely with the capital market line. Recall that the CML is linear, with an intercept of R_f and a slope of $[E(R_m) - R_f]/\sigma_m$. We can rewrite the CML by moving the intercept to the left-hand side of the equation, rearranging the terms, and generalizing the subscript from p to i, for any security:

$$E\left(R_i\right) - R_f = \left(\frac{\sigma_i}{\sigma_m}\right)\left[E\left(R_m\right) - R_f\right]$$

1 Fama and French (1992).

The factor loading or factor weight, σ_i/σ_m, refers to the ratio of total security risk to total market risk. To obtain a better understanding of factor loading and to illustrate that the CML reduces to a single-index model, we decompose total risk into its components.

Decomposition of Total Risk for a Single-Index Model

With the introduction of return-generating models, particularly the single-index model, we are able to decompose total variance into systematic and nonsystematic variances. Instead of using expected returns in the single index, let us use realized returns. The difference between expected returns and realized returns is attributable to non-market changes, as an error term, e_i, in the second equation below:

$$E(R_i) - R_f = \beta_i[E(R_m) - R_f]$$

and

$$R_i - R_f = \beta_i(R_m - R_f) + e_i$$

The variance of realized returns can be expressed in the equation below (note that R_f is a constant). We can further drop the covariance term in this equation because, by definition, any non-market return is uncorrelated with the market. Thus, we are able to decompose total variance into systematic and nonsystematic variances in the second equation below:

$$\sigma_i^2 = \beta_i^2 \sigma_m^2 + \sigma_e^2 + 2Cov\left(R_m, e_i\right)$$

Total variance = Systematic variance + Nonsystematic variance, which can be written as

$$\sigma_i^2 = \beta_i^2 \sigma_m^2 + \sigma_e^2$$

Total risk can be expressed as

$$\sigma_i = \sqrt{\beta_i^2 \sigma_m^2 + \sigma_e^2}$$

Because nonsystematic risk is zero for well-diversified portfolios, such as the market portfolio, the total risk of a market portfolio and other similar portfolios is only systematic risk, which is $\beta_i\sigma_m$. We can now return to the CML discussed in the previous subsection and replace σ_i with $\beta_i\sigma_m$ because the CML assumes that the market is a diversified portfolio. By making this substitution for the above equation, we get the following single-index model:

$$E\left(R_i\right) - R_f = \left(\frac{\sigma_i}{\sigma_m}\right) \times \left[E\left(R_m\right) - R_f\right] = \left(\frac{\beta_i \sigma_m}{\sigma_m}\right) \times \left[E\left(R_m\right) - R_f\right],$$

$$E(R_i) - R_f = \beta_i[E(R_m) - R_f]$$

Thus, the CML, which holds only for well-diversified portfolios, is fully consistent with a single-index model.

In summary, total variance may be decomposed into systematic and nonsystematic variances and the CML is the same as a single-index model for diversified portfolios.

Return-Generating Models: The Market Model

The most common implementation of a single-index model is the **market model**, in which the market return is the single factor or single index. In principle, the market model and the single-index model are similar. The difference is that the market model is easier to work with and is normally used for estimating beta risk and computing abnormal returns. The market model is

$$R_i = \alpha_i + \beta_i R_m + e_i$$

To be consistent with the previous section, $\alpha_i = R_f(1 - \beta)$. The intercept, α_i, and slope coefficient, β_i, can be estimated by using historical security and market returns. These parameter estimates are then used to predict company-specific returns that a security may earn in a future period. Assume that a regression of Wal-Mart's historical daily returns on S&P 500 daily returns gives an α_i of 0.0001 and a β_i of 0.9. Thus, Wal-Mart's expected daily return = 0.0001 + 0.90 × R_m. If, on a given day the market rises by 1 percent and Wal-Mart's stock rises by 2 percent, then Wal-Mart's company-specific return (e_i) for that day = $R_i - E(R_i) = R_i - (\alpha_i + \beta_i R_m)$ = 0.02 – (0.0001 + 0.90 × 0.01) = 0.0109, or 1.09%. In other words, Wal-Mart earned an abnormal return of 1.09 percent on that day.

7 CALCULATION AND INTERPRETATION OF BETA

☐ calculate and interpret beta

We begin with the single-index model introduced earlier using realized returns and rewrite it as

$$R_i = (1 - \beta_i)R_f + \beta_i \times R_m + e_i$$

Because systematic risk depends on the correlation between the asset and the market, we can arrive at a measure of systematic risk from the covariance between R_i and R_m, where R_i is defined using the above equation. Note that the risk-free rate is a constant, so the first term in R_i drops out.

$$\begin{aligned}\text{Cov}\left(R_i, R_m\right) &= \text{Cov}\left(\beta_i \times R_m + e_i, R_m\right)\\ &= \beta_i \text{Cov}\left(R_m, R_m\right) + \text{Cov}\left(e_i, R_m\right)\\ &= \beta_i \sigma_m^2 + 0\end{aligned}$$

The first term is beta multiplied by the variance of R_m. Because the error term is uncorrelated with the market, the second term drops out. Then, we can rewrite the equation in terms of beta as follows:

$$\beta_i = \frac{Cov\left(R_i, R_m\right)}{\sigma_m^2} = \frac{\rho_{i,m}\sigma_i\sigma_m}{\sigma_m^2} = \frac{\rho_{i,m}\sigma_i}{\sigma_m}$$

The above formula shows the expression for beta, β_i, which is similar to the factor loading in the single-index model presented earlier. For example, if the correlation between an asset and the market is 0.70 and the asset and market have standard deviations of return of 0.25 and 0.15, respectively, the asset's beta would be (0.70)(0.25)/0.15 = 1.17. If the asset's covariance with the market and market variance were given as 0.026250 and 0.02250, respectively, the calculation would be 0.026250/0.02250 = 1.17. The beta in the market model includes an adjustment for the correlation between asset *i* and the market because the market model covers all assets whereas the CML works only for fully diversified portfolios.

As shown in the above equation, **beta** is a measure of how sensitive an asset's return is to the market as a whole and is calculated as the covariance of the return on *i* and the return on the market divided by the variance of the market return; that expression is equivalent to the product of the asset's correlation with the market with a ratio of standard deviations of return (i.e., the ratio of the asset's standard deviation to the market's). As we have shown, beta captures an asset's systematic risk, or the portion of an asset's risk that cannot be eliminated by diversification. The variances and correlations required for the calculation of beta are usually based on historical returns.

A positive beta indicates that the return of an asset follows the general market trend, whereas a negative beta shows that the return of an asset generally follows a trend that is opposite to that of the market. In other words, a positive beta indicates that the return of an asset moves in the same direction of the market, whereas a negative beta indicates that the return of an asset moves in the opposite direction of the market. A risk-free asset's beta is zero because its covariance with other assets is zero. In other words, a beta of zero indicates that the asset's return has no correlation with movements in the market. The market's beta can be calculated by substituting σ_m for σ_i in the numerator. Also, any asset's correlation with itself is 1, so the beta of the market is 1:

$$\beta_i = \frac{\rho_{i,m}\sigma_i}{\sigma_m} = \frac{\rho_{m,m}\sigma_m}{\sigma_m} = 1$$

Because the market's beta is 1, the average beta of stocks in the market, by definition, is 1. In terms of correlation, most stocks, especially in developed markets, tend to be highly correlated with the market, with correlations in excess of 0.70. Some US broad market indexes, such as the S&P 500, the Dow Jones 30, and the NASDAQ 100, have even higher correlations that are in excess of 0.90. The correlations among different sectors are also high, which shows that companies have similar reactions to the same economic and market changes. As a consequence and as a practical matter, finding assets that have a consistently negative beta is unusual because of the market's broad effects on all assets.

EXAMPLE 5

Calculation of Beta

Assuming that the risk (standard deviation) of the market is 25 percent, calculate the beta for the following assets:

We use the formula for beta in answering the above questions: $\beta_i = \frac{\rho_{i,m}\sigma_i}{\sigma_m}$

1. A short-term US Treasury bill.

Solution:

By definition, a short-term US Treasury bill has zero risk. Therefore, its beta is zero.

2. Gold, which has a standard deviation equal to the standard deviation of the market but a zero correlation with the market.

Solution:

Because the correlation of gold with the market is zero, its beta is zero.

3. A new emerging market that is not currently included in the definition of "market"—the emerging market's standard deviation is 60 percent, and the correlation with the market is –0.1.

Solution:

Beta of the emerging market is –0.1 × 0.60 ÷ 0.25 = –0.24.

4. An initial public offering or new issue of stock with a standard deviation of 40 percent and a correlation with the market of 0.7 (IPOs are usually very risky but have a relatively low correlation with the market).

Solution:

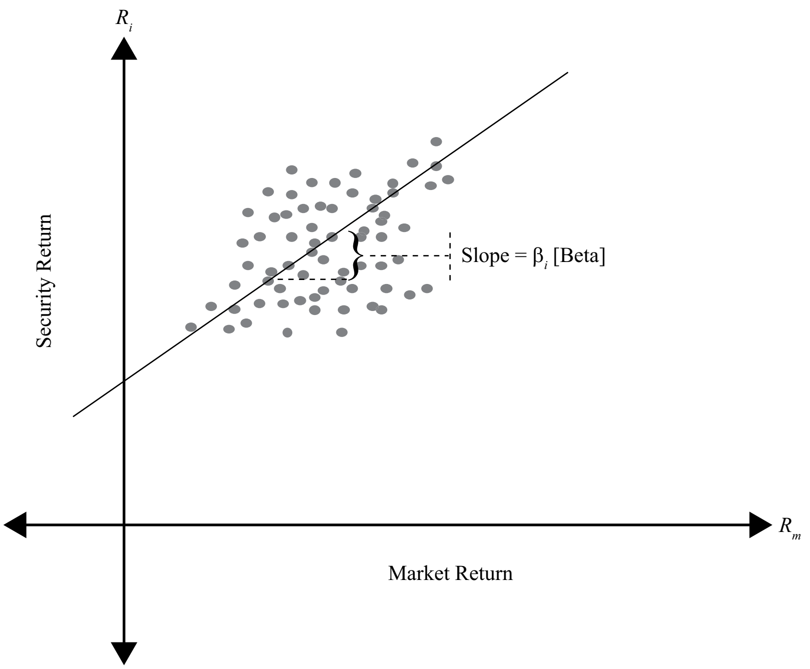
Beta of the initial public offering is 0.7 × 0.40 ÷ 0.25 = 1.12.

Estimation of Beta

An alternative and more practical approach is to estimate beta directly by using the market model described above. The market model, $R_i = \alpha_i + \beta_i R_m + e_i$, is estimated by using regression analysis, which is a statistical process that evaluates the relationship between a given variable (the dependent variable) and one or more other (independent) variables. Historical security returns (R_i) and historical market returns (R_m) are inputs used for estimating the two parameters α_i and β_i.

Regression analysis is similar to plotting all combinations of the asset's return and the market return (R_i, R_m) and then drawing a line through all points such that it minimizes the sum of squared linear deviations from the line. Exhibit 6 illustrates the market model and the estimated parameters. The intercept, α_i (sometimes referred to as the constant), and the slope term, β_i, are all that is needed to define the security characteristic line and obtain beta estimates.

Exhibit 6: Beta Estimation Using a Plot of Security and Market Returns



Although beta estimates are important for forecasting future levels of risk, there is much concern about their accuracy. In general, shorter periods of estimation (e.g., 12 months) represent betas that are closer to the asset's current level of systematic risk. Shorter period beta estimates, however, are also less accurate than beta estimates measured over three to five years because they may be affected by special events in that short period. Although longer period beta estimates are more accurate, they may be a poor representation of future expectations, especially if major changes in the asset have occurred. Therefore, it is necessary to recognize that estimates of beta, whether obtained through calculation or regression analysis, may or may not represent current or future levels of an asset's systematic risk.

Beta and Expected Return

Although the single-index model, also called the **capital asset pricing model** (CAPM), will be discussed in greater detail in the next section, we will use the CAPM in this section to estimate returns, given asset betas. The CAPM is usually written with the risk-free rate on the right-hand side:

$$E(R_i) = R_f + \beta_i[E(R_m) - R_f]$$

The model shows that the primary determinant of expected return for a security is its beta, or how well the security correlates with the market. The higher the beta of an asset, the higher its expected return will be. Assets with a beta greater than 1 have an expected return that is higher than the market return, whereas assets with a beta of less than 1 have an expected return that is less than the market return.

In certain cases, assets may require a return less than the risk-free return. For example, if an asset's beta is negative, the required return will be less than the risk-free rate. When combined with the market, the asset reduces the risk of the overall portfolio, which makes the asset very valuable. Insurance is one such asset. Insurance gives a positive return when the insured's wealth is reduced because of a catastrophic loss. In the absence of such a loss or when the insured's wealth is growing, the insured is required to pay an insurance premium. Thus, insurance has a negative beta and a negative expected return, but helps in reducing overall risk.

EXAMPLE 6

Calculation of Expected Return

1. Alpha Natural Resources (ANR), a coal producer, buys a large but privately held coal producer in China. As a result of the cross-border acquisition of a private company, ANR's standard deviation of returns is reduced from 50 percent to 30 percent and its correlation with the market falls from 0.95 to 0.75. Assume that the standard deviation and return of the market remain unchanged at 25 percent and 10 percent, respectively, and that the risk-free rate is 3 percent.
   - **A.** Calculate the beta of ANR stock and its expected return before the acquisition.
   - **B.** Calculate the expected return after the acquisition.

Solution to 1A:

Using the formula for β_i, we can calculate β_i and then the return.

$$\beta_i = \frac{\rho_{i,m}\sigma_i}{\sigma_m} = \frac{0.95 \times 0.50}{0.25} = 1.90$$

$$E(R_i) = R_f + \beta_i[E(R_m) - R_f] = 0.03 + 1.90 \times (0.10 - 0.03) = 0.163 = 16.3\%$$

Solution to 1B:

We follow the same procedure but with the after-acquisition correlation and risk.

$$\beta_i = \frac{\rho_{i,m}\sigma_i}{\sigma_m} = \frac{0.75 \times 0.30}{0.25} = 0.90$$

$$E(R_i) = R_f + \beta_i[E(R_m) - R_f] = 0.03 + 0.90 \times (0.10 - 0.03) = 0.093 = 9.3\%$$

The market risk premium is 7 percent (10% – 3%). As the beta changes, the change in the security's expected return is the market risk premium multiplied by the change in beta. In this scenario, ANR's beta decreased by 1.0, so the new expected return for ANR is 7 percentage points lower.

2. Mr. Miles observes the strong demand for iPods and iPhones and wants to invest in Apple stock. Unfortunately, Mr. Miles doesn't know the return he should expect from his investment. He has been given a risk-free rate of 3 percent, a market return of 10 percent, and Apple's beta of 1.5.

A. Calculate Apple's expected return.

B. An analyst looking at the same information decides that the past performance of Apple is not representative of its future performance. He decides that, given the increase in Apple's market capitalization, Apple acts much more like the market than before and thinks Apple's beta should be closer to 1.1. What is the analyst's expected return for Apple stock?

Solution to 2A:

$$E(R_i) = R_f + \beta_i[E(R_m) - R_f] = 0.03 + 1.5 \times (0.10 - 0.03) = 0.135 = 13.5\%$$

Solution to 2B:

$$E(R_i) = R_f + \beta_i[E(R_m) - R_f] = 0.03 + 1.1 \times (0.10 - 0.03) = 0.107 = 10.7\%$$

This example illustrates the lack of connection between estimation of past returns and projection into the future. Investors should be aware of the limitations of using past returns for estimating future returns.

8 CAPITAL ASSET PRICING MODEL: ASSUMPTIONS AND THE SECURITY MARKET LINE

- ☐ explain the capital asset pricing model (CAPM), including its assumptions, and the security market line (SML)
- ☐ calculate and interpret the expected return of an asset using the CAPM

The capital asset pricing model is one of the most significant innovations in portfolio theory. The model is simple, yet powerful; is intuitive, yet profound. The CAPM was introduced independently by William Sharpe, John Lintner, Jack Treynor, and Jan Mossin and builds on Harry Markowitz's earlier work on diversification and modern portfolio theory.[2] The model provides a linear expected return–beta relationship that precisely determines the expected return given the beta of an asset. In doing so, it makes the transition from total risk to systematic risk, the primary determinant of expected return. Recall the following equation:

2 See, for example, Markowitz (1952), Sharpe (1964), Lintner (1965a, 1965b), Treynor (1961, 1962), and Mossin (1966).

$$E(R_i) = R_f + \beta_i[E(R_m) - R_f]$$

The CAPM asserts that the expected returns of assets vary only by their systematic risk as measured by beta. Two assets with the same beta will have the same expected return irrespective of the nature of those assets. Given the relationship between risk and return, all assets are defined only by their beta risk, which we will explain as the assumptions are described.

In the remainder of this section, we will examine the assumptions made in arriving at the CAPM and the limitations those assumptions entail. Second, we will implement the CAPM through the security market line to price any portfolio or asset, both efficient and inefficient. Finally, we will discuss ways in which the CAPM can be applied to investments, valuation, and capital budgeting.

Assumptions of the CAPM

Similar to all other models, the CAPM ignores many of the complexities of financial markets by making simplifying assumptions. These assumptions allow us to gain important insights into how assets are priced without complicating the analysis. Once the basic relationships are established, we can relax the assumptions and examine how our insights need to be altered. Some of these assumptions are constraining, whereas others are benign. And other assumptions affect only a particular set of assets or only marginally affect the hypothesized relationships.

1. ***Investors are risk-averse, utility-maximizing, rational individuals.***

   Risk aversion means that investors expect to be compensated for accepting risk. Note that the assumption does not require investors to have the same degree of risk aversion; it only requires that they are averse to risk. Utility maximization implies that investors want higher returns, not lower returns, and that investors always want more wealth (i.e., investors are never satisfied). Investors are understood to be rational in that they correctly evaluate and analyze available information to arrive at rational decisions. Although rational investors may use the same information to arrive at different estimates of expected risk and expected returns, homogeneity among investors (see Assumption 4) requires that investors be rational individuals.

   Risk aversion and utility maximization are generally accepted as reflecting a realistic view of the world. Yet, rationality among investors has been questioned because investors may allow their personal biases and experiences to disrupt their decision making, resulting in suboptimal investments. Nonetheless, the model's results are unaffected by such irrational behavior as long as it does not affect prices in a significant manner (i.e., the trades of irrational investors cancel each other or are dominated by the trades of rational investors).

2. ***Markets are frictionless, including no transaction costs and no taxes.***

   Frictionless markets allow us to abstract the analysis from the operational characteristics of markets. In doing so, we do not allow the risk–return relationship to be affected by, for example, the trading volume on the New York Stock Exchange or the difference between buying and selling prices. Specifically, frictionless markets do not have transaction costs, taxes, or any costs or restrictions on short selling. We also assume that borrowing and lending at the risk-free rate is possible.

   The transaction costs of many large institutions are negligible, and many institutions do not pay taxes. Even the presence of non-zero transaction costs, taxes, or the inability to borrow at the risk-free rate does not materially affect the general conclusions of the CAPM. Costs of short selling or restrictions on short selling, however, can introduce an upward bias in asset prices, potentially jeopardizing important conclusions of the CAPM.

3. ***Investors plan for the same single holding period.***

   The CAPM is a single-period model, and all investor decisions are made on the basis of that one period. The assumption of a single period is applied for convenience because working with multi-period models is more difficult. A single-period model, however, does not allow learning to occur, and bad decisions can persist. In addition, maximizing utility at the end of a multi-period horizon may require decisions in certain periods that may seem suboptimal when examined from a single-period perspective. Nonetheless, the single holding period does not severely limit the applicability of the CAPM to multi-period settings.

4. ***Investors have homogeneous expectations or beliefs.***

   This assumption means that all investors analyze securities in the same way using the same probability distributions and the same inputs for future cash flows. In addition, given that they are rational individuals, the investors will arrive at the same valuations. Because their valuations of all assets are identical, they will generate the same optimal risky portfolio, which we call the market portfolio.

   The assumption of homogeneous beliefs can be relaxed as long as the differences in expectations do not generate significantly different optimal risky portfolios.

5. ***All investments are infinitely divisible.***

   This assumption implies that an individual can invest as little or as much as he or she wishes in an asset. This supposition allows the model to rely on continuous functions rather than on discrete jump functions. The assumption is made for convenience only and has an inconsequential impact on the conclusions of the model.

6. ***Investors are price takers.***

   The CAPM assumes that there are many investors and that no investor is large enough to influence prices. Thus, investors are price takers, and we assume that security prices are unaffected by investor trades. This assumption is generally true because even though investors may be able to affect prices of small stocks, those stocks are not large enough to affect the primary results of the CAPM.

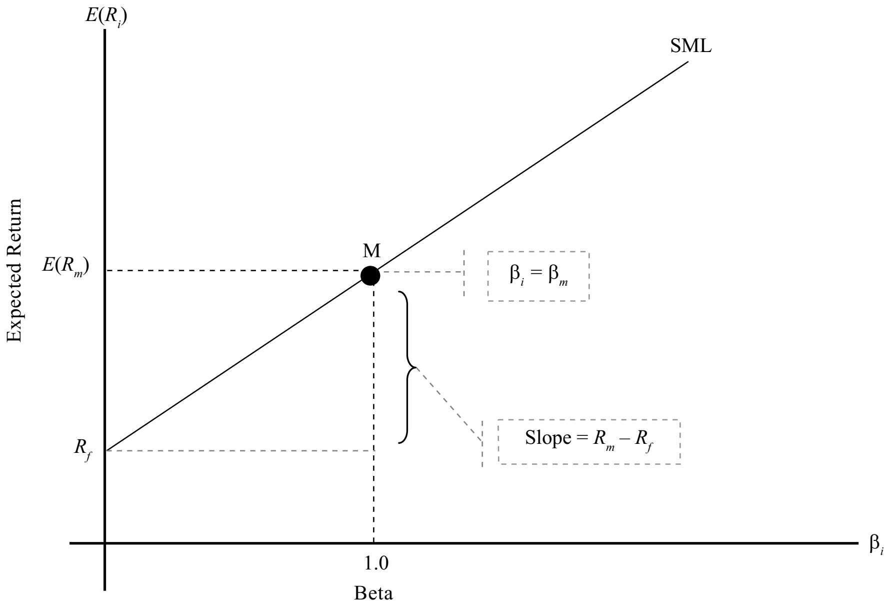
The main objective of these assumptions is to create a marginal investor who rationally chooses a mean–variance-efficient portfolio in a predictable fashion. We assume away any inefficiency in the market from both operational and informational perspectives. Although some of these assumptions may seem unrealistic, relaxing most of them will have only a minor influence on the model and its results. Moreover, the CAPM, with all its limitations and weaknesses, provides a benchmark for comparison and for generating initial return estimates.

The Security Market Line

In this subsection, we apply the CAPM to the pricing of securities. The **security market line** (SML) is a graphical representation of the capital asset pricing model with beta, reflecting systematic risk, on the x-axis and expected return on the y-axis. Using the same concept as the capital market line, the SML intersects the y-axis at the risk-free rate of return, and the slope of this line is the market risk premium, $R_m - R_f$. Recall that the capital market line (CML) does not apply to all securities or assets but only to portfolios on the efficient frontier. The efficient frontier gives optimal combinations of expected return and total risk. In contrast, the security market line applies to any security, efficient or not. Total risk and systematic risk are equal only for efficient portfolios because those portfolios have no diversifiable risk remaining.

Exhibit 7 is a graphical representation of the CAPM, the security market line. As shown earlier in this reading, the beta of the market is 1 (x-axis) and the market earns an expected return of R_m (y-axis). Using this line, it is possible to calculate the expected return of an asset. The next example illustrates the beta and return calculations.

Exhibit 7: The Security Market Line



EXAMPLE 7

Security Market Line and Expected Return

1. Suppose the risk-free rate is 3 percent, the expected return on the market portfolio is 13 percent, and its standard deviation is 23 percent. An Indian company, Bajaj Auto, has a standard deviation of 50 percent but is uncorrelated with the market. Calculate Bajaj Auto's beta and expected return.

Solution:

Using the formula for β_i, we can calculate β_i and then the return.

$$\beta_i = \frac{\rho_{i,m}\sigma_i}{\sigma_m} = \frac{0.0 \times 0.50}{0.23} = 0$$

$E(R_i) = R_f + \beta_i[E(R_m) - R_f] = 0.03 + 0 \times (0.13 - 0.03) = 0.03 = 3.0\%$

Because of its zero correlation with the market portfolio, Bajaj Auto's beta is zero. Because the beta is zero, the expected return for Bajaj Auto is the risk-free rate, which is 3 percent.

2. Suppose the risk-free rate is 3 percent, the expected return on the market portfolio is 13 percent, and its standard deviation is 23 percent. A German company, Mueller Metals, has a standard deviation of 50 percent and a correlation of 0.65 with the market. Calculate Mueller Metal's beta and expected return.

Solution:

Using the formula for β_i, we can calculate β_i and then the return.

$$\beta_i = \frac{\rho_{i,m}\sigma_i}{\sigma_m} = \frac{0.65 \times 0.50}{0.23} = 1.41$$

$E(R_i) = R_f + \beta_i[E(R_m) - R_f] = 0.03 + 1.41 \times (0.13 - 0.03) = 0.171 = 17.1\%$

Because of the high degree of correlation with the market, the beta for Mueller Metals is 1.41 and the expected return is 17.1 percent. Because Mueller Metals has systematic risk that is greater than that of the market, it has an expected return that exceeds the expected return of the market.

Portfolio Beta

As we stated above, the security market line applies to all securities. But what about a combination of securities, such as a portfolio? Consider two securities, 1 and 2, with a weight of w_i in Security 1 and the balance in Security 2. The return for the two securities and return of the portfolio can be written as:

$$\begin{aligned}
E(R_1) &= R_f + \beta_1[E(R_m) - R_f] \\
E(R_2) &= R_f + \beta_2[E(R_m) - R_f] \\
E(R_p) &= w_1 E(R_1) + w_2 E(R_2) \\
&= w_1 R_f + w_1\beta_1[E(R_m) - R_f] + w_2 R_f + w_2\beta_2[E(R_m) - R_f] \\
&= R_f + (w_1\beta_1 + w_2\beta_2)[E(R_m) - R_f]
\end{aligned}$$

The last equation gives the expression for the portfolio's expected return. From this equation, we can conclude that the portfolio's beta = $w_1\beta_1 + w_2\beta_2$. In general, the portfolio beta is a weighted sum of the betas of the component securities and is given by:

$$\beta_p = \sum_{i=1}^{n} w_i\beta_i;\ \sum_{i=1}^{n} w_i = 1$$

The portfolio's return given by the CAPM is

$$E(R_p) = R_f + \beta_p[E(R_m) - R_f]$$

This equation shows that a linear relationship exists between the expected return of a portfolio and the systematic risk of the portfolio as measured by β_p.

EXAMPLE 8

Portfolio Beta and Return

1. You invest 20 percent of your money in the risk-free asset, 30 percent in the market portfolio, and 50 percent in RedHat, a US stock that has a beta of 2.0. Given that the risk-free rate is 4 percent and the market return is 16 percent, what are the portfolio's beta and expected return?

Solution:

The beta of the risk-free asset = 0, the beta of the market = 1, and the beta of RedHat is 2.0. The portfolio beta is

$$\beta_p = w_1\beta_1 + w_2\beta_2 + w_3\beta_3 = (0.20 \times 0.0) + (0.30 \times 1.0) + (0.50 \times 2.0) = 1.30$$

$$E(R_i) = R_f + \beta_i[E(R_m) - R_f] = 0.04 + 1.30 \times (0.16 - 0.04) = 0.196 = 19.6\%$$

The portfolio beta is 1.30, and its expected return is 19.6 percent.

Alternate Method:

Another method for calculating the portfolio's return is to calculate individual security returns and then use the portfolio return formula (i.e., weighted average of security returns) to calculate the overall portfolio return.

Return of the risk-free asset = 4 percent; return of the market = 16 percent

RedHat's return based on its beta = 0.04 + 2.0 × (0.16 – 0.04) = 0.28

Portfolio return = (0.20 × 0.04) + (0.30 × 0.16) + (0.50 × 0.28) = 0.196 = 19.6%

Not surprisingly, the portfolio return is 19.6 percent, as calculated in the first method.

9 CAPITAL ASSET PRICING MODEL: APPLICATIONS

- ☐ calculate and interpret the expected return of an asset using the CAPM
- ☐ describe and demonstrate applications of the CAPM and the SML

The CAPM offers powerful and intuitively appealing predictions about risk and the relationship between risk and return. The CAPM is not only important from a theoretical perspective but is also used extensively in practice. In this section, we will discuss some common applications of the model. When applying these tools to different scenarios, it is important to understand that the CAPM and the SML are functions that give an indication of what the return in the market *should* be, given a certain level of risk. The actual return may be quite different from the expected return.

Applications of the CAPM include estimates of the expected return for capital budgeting, comparison of the actual return of a portfolio or portfolio manager with the CAPM return for performance appraisal, and the analysis of alternate return estimates and the CAPM returns as the basis for security selection. The applications are discussed in more detail in this section.

Estimate of Expected Return

Given an asset's systematic risk, the expected return can be calculated using the CAPM. Recall that the price of an asset is the sum of all future cash flows discounted at the required rate of return, where the discount rate or the required rate of return is commensurate with the asset's risk. The expected rate of return obtained from the CAPM is normally the first estimate that investors use for valuing assets, such as stocks, bonds, real estate, and other similar assets. The required rate of return from the CAPM is also used for capital budgeting and determining the economic feasibility of projects. Again, recall that when computing the net present value of a project, investments and net revenues are considered cash flows and are discounted at the required rate of return. The required rate of return, based on the project's risk, is calculated using the CAPM.

Because risk and return underlie almost all aspects of investment decision making, it is not surprising that the CAPM is used for estimating expected return in many scenarios. Other examples include calculating the cost of capital for regulated companies by regulatory commissions and setting fair insurance premiums. The next example shows an application of the CAPM to capital budgeting.

EXAMPLE 9

Application of the CAPM to Capital Budgeting

GlaxoSmithKline Plc is examining the economic feasibility of developing a new medicine. The initial investment in Year 1 is $500 million. The investment in Year 2 is $200 million. There is a 50 percent chance that the medicine will be developed and will be successful. If that happens, GlaxoSmithKline must spend another $100 million in Year 3, but its income from the project in Year 3 will be $500 million, not including the third-year investment. In Years 4, 5, and 6, it will earn $400 million a year if the medicine is successful. At the end of Year 6, it intends to sell all rights to the medicine for $600 million. If the medicine is unsuccessful, none of GlaxoSmithKline's investments can be salvaged. Assume that the market return is 12 percent, the risk-free rate is 2 percent, and the beta risk of the project is 2.3. All cash flows occur at the end of each year.

1. Calculate the expected annual cash flows using the probability of success.

Solution:

There is a 50 percent chance that the cash flows in Years 3–6 will occur. Taking that into account, the expected annual cash flows are:

Year 1: –$500 million (outflow)

Year 2: –$200 million (outflow)

Year 3: 50% of –$100 million (outflow) + 50% of $500 million = $200 million

Year 4: 50% of $400 million = $200 million

Year 5: 50% of $400 million = $200 million

Year 6: 50% of $400 million + 50% of $600 million = $500 million

2. Calculate the expected return.

Solution:

The expected or required return for the project can be calculated using the CAPM, which is = 0.02 + 2.3 × (0.12 – 0.02) = 0.25.

3. Calculate the net present value.

Solution:

The net present value is the discounted value of all cash flows:

$$NPV = \sum_{t=0}^{T} \frac{CF_t}{(1 + r_t)^t}$$

$$= \frac{-500}{(1 + 0.25)} + \frac{-200}{(1 + 0.25)^2} + \frac{200}{(1 + 0.25)^3} + \frac{200}{(1 + 0.25)^4}$$

$$+ \frac{200}{(1 + 0.25)^5} + \frac{500}{(1 + 0.25)^6}$$

$$= -400 - 128 + 102.40 + 81.92 + 65.54 + 131.07 = -147.07.$$

Because the net present value is negative (–$147.07 million), the project should not be accepted by GlaxoSmithKline.

10 BEYOND CAPM: LIMITATIONS AND EXTENSIONS OF CAPM

- [ ] describe and demonstrate applications of the CAPM and the SML

In general, return-generating models allow us to estimate an asset's return given its characteristics, where the asset characteristics required for estimating the return are specified in the model. Estimating an asset's return is important for investment decision making. These models are also important as a benchmark for evaluating portfolio, security, or manager performance. The return-generating models were briefly introduced in Section 3.2.1, and one of those models, the capital asset pricing model, was discussed in detail in Section 4.

The purpose of this section is to make readers aware that, although the CAPM is an important concept and model, the CAPM is not the only return-generating model. In this section, we revisit and highlight the limitations of the CAPM and preview return-generating models that address some of those limitations.

Limitations of the CAPM

The CAPM is subject to theoretical and practical limitations. Theoretical limitations are inherent in the structure of the model, whereas practical limitations are those that arise in implementing the model.

Theoretical Limitations of the CAPM

- Single-factor model: Only systematic risk or beta risk is priced in the CAPM. Thus, the CAPM states that no other investment characteristics should be considered in estimating returns. As a consequence, it is prescriptive and easy to understand and apply, although it is very restrictive and inflexible.
- Single-period model: The CAPM is a single-period model that does not consider multi-period implications or investment objectives of future periods, which can lead to myopic and suboptimal investment decisions. For example, it may be optimal to default on interest payments in the current period to maximize current returns, but the consequences may be negative in the next period. A single-period model like the CAPM is unable to capture factors that vary over time and span several periods.

Practical Limitations of the CAPM

In addition to the theoretical limitations, implementation of the CAPM raises several practical concerns, some of which are listed below.

- Market portfolio: The true market portfolio according to the CAPM includes all assets, financial and nonfinancial, which means that it also includes many assets that are not investable, such as human capital and assets in closed economies. Richard Roll[3] noted that one reason the CAPM is not testable is that the true market portfolio is unobservable.
- Proxy for a market portfolio: In the absence of a true market portfolio, market participants generally use proxies. These proxies, however, vary among analysts, the country of the investor, etc. and generate different return estimates for the same asset, which is impermissible in the CAPM.
- Estimation of beta risk: A long history of returns (three to five years) is required to estimate beta risk. The historical state of the company, however, may not be an accurate representation of the current or future state of the company. More generally, the CAPM is an *ex ante* model, yet it is usually applied using *ex post* data. In addition, using different periods for estimation results in different estimates of beta. For example, a three-year beta is unlikely to be the same as a five-year beta, and a beta estimated with daily returns is unlikely to be the same as the beta estimated with monthly returns. Thus, we are likely to estimate different returns for the same asset depending on the estimate of beta risk used in the model.
- The CAPM is a poor predictor of returns: If the CAPM is a good model, its estimate of asset returns should be closely associated with realized returns. However, empirical support for the CAPM is weak.[4] In other words, tests of the CAPM show that asset returns are not determined only by systematic risk. Poor predictability of returns when using the CAPM is a serious limitation because return-generating models are used to estimate future returns.
- Homogeneity in investor expectations: The CAPM assumes that homogeneity exists in investor expectations for the model to generate a single optimal risky portfolio (the market) and a single security market line. Without this assumption, there will be numerous optimal risky portfolios and numerous security market lines. Clearly, investors can process the same information in a rational manner and arrive at different optimal risky portfolios.

3 Roll (1977).
4 See, for example, Fama and French (1992).

Extensions to the CAPM

Given the limitations of the CAPM, it is not surprising that other models have been proposed to address some of these limitations. These new models are not without limitations of their own, which we will mention while discussing the models. We divide the models into two categories—theoretical models and practical models—and provide one example of each type.

Theoretical Models

Theoretical models are based on the same principle as the CAPM but expand the number of risk factors. The best example of a theoretical model is the arbitrage pricing theory (APT), which was developed by Stephen Ross.[5] Like the CAPM, APT proposes a linear relationship between expected return and risk:

$$E(R_p) = R_F + \lambda_1\beta_{p,1} + \ldots + \lambda_K\beta_{p,K}$$

where

$E(R_p)$ = the expected return of portfolio p

R_F = the risk-free rate

λ_j = the risk premium (expected return in excess of the risk-free rate) for factor j

$\beta_{p,j}$ = the sensitivity of the portfolio to factor j

K = the number of risk factors

Unlike the CAPM, however, APT allows numerous risk factors—as many as are relevant to a particular asset. Moreover, other than the risk-free rate, the risk factors need not be common and may vary from one asset to another. A no-arbitrage condition in asset markets is used to determine the risk factors and estimate betas for the risk factors.

Although it is theoretically elegant, flexible, and superior to the CAPM, APT is not commonly used in practice because it does not specify any of the risk factors and it becomes difficult to identify risk factors and estimate betas for each asset in a portfolio. So from a practical standpoint, the CAPM is preferred to APT.

Practical Models

If beta risk in the CAPM does not explain returns, which factors do? Practical models seek to answer this question through extensive research. As mentioned in Section 3.2.1, the best example of such a model is the four-factor model proposed by Fama and French (1992) and Carhart (1997).

Based on an analysis of the relationship between past returns and a variety of different factors, Fama and French (1992) proposed that three factors seem to explain asset returns better than just systematic risk. Those three factors are relative size, relative book-to-market value, and beta of the asset. With Carhart's (1997) addition of relative past stock returns, the model can be written as follows:

$$E\left(R_{it}\right) = \alpha_i + \beta_{i,MKT}MKT_t + \beta_{i,SMB}SMB_t + \beta_{i,HML}HML_t + \beta_{i,UMD}UMD_t$$

5 Ross (1976).

where

$E(R_i)$ = the return on an asset in excess of the one-month T-bill return

MKT = the excess return on the market portfolio

SMB = the difference in returns between small-capitalization stocks and large-capitalization stocks (size)

HML = the difference in returns between high-book-to-market stocks and low-book-to-market stocks (value versus growth)

UMD = the difference in returns of the prior year's winners and losers (momentum)

Historical analysis shows that the coefficient on *MKT* is not significantly different from zero, which implies that stock return is unrelated to the market. The factors that explain stock returns are size (smaller companies outperform larger companies), book-to-market ratio (value companies outperform glamour companies), and momentum (past winners outperform past losers).

The four-factor model has been found to predict asset returns much better than the CAPM and is extensively used in estimating returns for US stocks.

Two observations are in order. First, the model is not underpinned by a theory of market equilibrium, as is the case for the CAPM. Second, there is no assurance that the model will continue to work well in the future.

11 PORTFOLIO PERFORMANCE APPRAISAL MEASURES

☐ calculate and interpret the Sharpe ratio, Treynor ratio, M^2, and Jensen's alpha

In the investment industry, **performance evaluation** refers to the measurement, attribution, and appraisal of investment results. In particular, performance evaluation provides information about the return and risk of investment portfolios over specified investment period(s). By providing accurate data and analysis on investment decisions and their consequences, performance evaluation allows portfolio managers to take corrective measures to improve investment decision-making and management processes. Performance evaluation information helps in understanding and controlling investment risk and should, therefore, lead to improved risk management. Performance evaluation seeks to answer the following questions:

- What was the investment portfolio's past performance, and what may be expected in the future?

Answering this question is the subject of performance measurement. *Performance measurement is concerned with the measurement of return and risk.*

- How did the investment portfolio produce its observed performance, and what are the expected sources of expected future performance?

Answering this question is the subject of performance attribution. *Performance attribution is concerned with identifying and quantifying the sources of performance of a portfolio.*

- Was the observed investment portfolio's performance the result of investment skill or luck?

Answering this question is the subject of performance appraisal. *Performance appraisal is concerned with identifying and measuring investment skill.*

The information provided by performance evaluation is of great interest to all stakeholders in the investment management process because of its value in evaluating the overall quality of the investment management process as well as individual investment decisions.

In this reading, performance appraisal is based only on the CAPM. However, it is easy to extend this analysis to multi-factor models that may include industry or other special factors. Four ratios are commonly used in performance appraisal.

The Sharpe Ratio

Performance has two components, risk and return. Although return maximization is a laudable objective, comparing just the return of a portfolio with that of the market is not sufficient. Because investors are risk averse, they will require compensation for higher risk in the form of higher returns. A commonly used measure of performance is the **Sharpe ratio**, which is defined as the portfolio's risk premium divided by its risk. An appealing feature of the Sharpe ratio is that its use can be justified on a theoretical *ex ante* (before the fact) basis and *ex post* (after the fact) values can easily be determined by using readily available market data. The Sharpe ratio is also easy to interpret, essentially being an efficiency ratio relating reward to risks taken. It is the most widely recognized and used appraisal measure.

The equation below defines the *ex ante* Sharpe ratio in terms of three inputs: (1) the portfolio's expected return, $E(R_p)$; (2) the risk-free rate of interest, R_f; and (3) the portfolio's *ex ante* standard deviation of returns (return volatility), σ_p, a quantitative measure of total risk.

$$\text{SR} = \frac{E\left(R_p\right) - R_F}{\sigma_p}$$

The Sharpe ratio can also be used on an *ex post* basis to evaluate historical risk-adjusted returns. Assume we have a sample of historical data that can be used to determine the sample mean portfolio return, $\overline{R}_p$; the standard deviation of the sample returns, here denoted by $\hat{\sigma}_p$ (s_p is a familiar notation in other contexts); and the sample mean risk-free rate, $\overline{R}_f$. The *ex post* (or realized or historical) Sharpe ratio can then be determined by using the following:

$$\widehat{SR} = \frac{\overline{R}_p - \overline{R}_F}{\hat{\sigma}_p}$$

Recalling the CAL from earlier in the reading, one can see that the Sharpe ratio, also called the reward-to-variability ratio, is simply the slope of the capital allocation line. Note, however, that the ratio uses the *total risk* of the portfolio, not its systematic risk. The use of total risk is appropriate if the portfolio is an investor's total portfolio—that is, the investor does not own any other assets. Sharpe ratios of the market and other portfolios can also be calculated in a similar manner. The portfolio with the highest Sharpe ratio has the best risk-adjusted performance, and the one with the lowest Sharpe ratio has the worst risk-adjusted performance, provided that the numerator is positive for all comparison portfolios. If the numerator is negative, the ratio will be less negative for riskier portfolios, resulting in incorrect rankings.

The Sharpe ratio, however, suffers from two limitations. First, it uses total risk as a measure of risk when only systematic risk is priced. Second, the ratio itself (e.g., 0.2 or 0.3) is not informative. To rank portfolios, the Sharpe ratio of one portfolio must be compared with the Sharpe ratio of another portfolio. Nonetheless, the ease of computation makes the Sharpe ratio a popular tool.

The Treynor Ratio

The **Treynor ratio** is a simple extension of the Sharpe ratio and resolves the Sharpe ratio's first limitation by substituting beta (systematic risk) for total risk. The *ex ante* and *ex post* Treynor ratios are provided below.

$$TR = \frac{E\left(R_p\right) - R_f}{\beta_p}$$

$$\widehat{TR} = \frac{\overline{R}_p - \overline{R}_f}{\hat{\beta}_p}$$

Just like the Sharpe ratio, the numerators must be positive for the Treynor ratio to give meaningful results. In addition, the Treynor ratio does not work for negative-beta assets—that is, the denominator must also be positive for obtaining correct estimates and rankings. Although both the Sharpe and Treynor ratios allow for ranking of portfolios, neither ratio gives any information about the economic significance of differences in performance. For example, assume the Sharpe ratio of one portfolio is 0.75 and the Sharpe ratio for another portfolio is 0.80. The second portfolio is superior, but is that difference meaningful? In addition, we do not know whether either of the portfolios is better than the passive market portfolio. The remaining two measures, M^2 and Jensen's alpha, attempt to address that problem by comparing portfolios while also providing information about the extent of the overperformance or underperformance.

M^2: Risk-Adjusted Performance (RAP)

M^2 provides a measure of portfolio return that is adjusted for the total risk of the portfolio relative to that of some benchmark. In 1997, Nobel Prize winner Franco Modigliani and his granddaughter, Leah Modigliani, developed what they called a risk-adjusted performance measure, or RAP. The RAP measure has since become more commonly known as M^2 reflecting the Modigliani names. It is related to the Sharpe ratio and ranks portfolios identically, but it has the useful advantage of being denominated in familiar terms of percentage return advantage assuming the same level of total risk as the market.

M^2 borrows from capital market theory by assuming a portfolio is leveraged or de-leveraged until its volatility (as measured by standard deviation) matches that of the market. This adjustment produces a portfolio-specific leverage ratio that equates the portfolio's risk to that of the market. The portfolio's excess return times the leverage ratio plus the risk-free rate is then compared with the markets actual return to determine whether the portfolio has outperformed or underperformed the market on a risk-adjusted basis.

The equations below provide the *ex ante* and *ex post* formulas for M^2, where σ_m is the standard deviation of the market portfolio and σ_m/σ_p is the portfolio-specific leverage ratio. Because the Sharpe ratio is defined as

$$\frac{E\left(R_p\right) - R_f}{\sigma_p}$$

the equation shows that M^2 can be thought of as a rescaling of the Sharpe ratio that allows for easier comparisons among different portfolios. The reason that M^2 and Sharpe ratios rank portfolios identically is because, in a given time period—and for any given comparison of the market portfolio—both the risk-free rate and the market volatility are constant across all comparisons. Only the Sharpe ratio differs, so it determines all rankings.

$$M^2 = \left[E\left(R_p\right) - R_f\right]\frac{\sigma_m}{\sigma_p} + R_f = \text{SR} \times \sigma_m + R_f \text{ (ex ante)}$$

$$\widehat{M^2} = \left(\overline{R}_p - \overline{R}_f\right)\frac{\hat{\sigma}_m}{\hat{\sigma}_p} + R_f = \widehat{\text{SR}} \times \hat{\sigma}_m + R_f \text{ (ex post)}$$

For example, assume that $\overline{R}_f$ = 4.0%, $\overline{R}_p$ = 14.0%, $\hat{\sigma}_p$ = 25.0% and $\hat{\sigma}_m$ = 20.0%. The Sharpe ratio is 0.4,

$$\widehat{\text{SR}} = \frac{0.14 - 0.04}{0.25} = 0.4,$$

and $\widehat{M^2}$ is 12.0%, $\widehat{M^2}$ = 0.4(0.2) + 0.04 = 0.12 = 12.0%. If the market return was 10%, then the portfolio outperformed the market on a risk-adjusted basis by 12.0% – 10.0% = 2.0%. This difference between the risk-adjusted performance of the portfolio and the performance of the market is frequently referred to as **M^2 alpha**.

The Sharpe ratio of the market portfolio is

$$\widehat{\text{SR}} = \frac{0.10 - 0.04}{0.20}$$

= 0.3. Comparing the Sharpe ratio of the portfolio with the Sharpe ratio of the market portfolio shows that the fund outperformed the market. But the 2.0% difference between M^2 and the market's return tells us the risk-adjusted outperformance as a percentage return.

Jensen's Alpha

Like the Treynor ratio, Jensen's alpha is based on systematic risk. We can measure a portfolio's systematic risk by estimating the market model, which is done by regressing the portfolio's daily return on the market's daily return. The coefficient on the market return is an estimate of the beta risk of the portfolio. We can calculate the risk-adjusted return of the portfolio using the beta of the portfolio and the CAPM. The difference between the actual portfolio return and the calculated risk-adjusted return is a measure of the portfolio's performance relative to the market portfolio and is called Jensen's alpha. By definition, α_m of the market is zero. Jensen's alpha is also the vertical distance from the SML measuring the excess return for the same risk as that of the market and is given by

$$\alpha_p = R_p - \{R_f + \beta_p[\text{E}(R_m) - R_f]\}$$

If the period is long, it may contain different risk-free rates, in which case R_f represents the average risk-free rate. Furthermore, the returns in the equation are all realized, actual returns. The sign of α_p indicates whether the portfolio has outperformed the market. If α_p is positive, then the portfolio has outperformed the market; if α_p is negative, the portfolio has underperformed the market. Jensen's alpha is commonly used for evaluating most institutional managers, pension funds, and mutual funds. Values of alpha can be used to rank different managers and the performance of their portfolios, as well as the magnitude of underperformance or overperformance. For example, if a portfolio's alpha is 2 percent and another portfolio's alpha is 5 percent, the second portfolio has outperformed the first portfolio by 3 percentage points and the market by 5 percentage points. Jensen's alpha is the maximum amount that you should be willing to pay the manager to manage your money. As with other performance appraisal measures, Jensen's alpha has *ex ante* and *ex post* forms. The use context usually clarifies which one is being referred to. Where we want to underscore a reference to *ex post* Jensen's alpha based on an estimated beta, $\hat{\beta}_p$, and an average market return, the notation $\hat{\alpha}_p$ is used.

EXAMPLE 10

Portfolio Performance Evaluation

1. A British pension fund has employed three investment managers, each of whom is responsible for investing in one-third of all asset classes so that the pension fund has a well-diversified portfolio. Information about the managers is given below.

Manager	Average Return	$\hat{\sigma}$	$\hat{\beta}$
X	10%	20%	1.1
Y	11	10	0.7
Z	12	25	0.6
Market (M)	9	19	
Risk-free rate (R_f)	3		

Calculate the expected return for each manager, based on using the average market return and the CAPM. Then also calculate for the managers (ex post) Sharpe ratio, Treynor ratio, M^2 alpha, and Jensen's alpha. Analyze your results and plot the returns and betas of these portfolios.

Solution:

In each case, the calculations are shown only for Manager X. All answers are tabulated below. Note that the β of the market is 1 and the σ and β of the risk-free rate are both zero.

Expected return: $E(R_X) = R_f + \beta_X[E(R_m) - R_f] = 0.03 + 1.10 \times (0.09 - 0.03) = 0.096 = 9.6\%$

$$\widehat{SR} = \frac{\overline{R}_x - \overline{R}_f}{\hat{\sigma}_x} = \frac{0.10 - 0.03}{0.20} = 0.35$$

$$\widehat{TR} = \frac{\overline{R}_x - \overline{R}_f}{\hat{\beta}_x} = \frac{0.10 - 0.03}{1.1} = 0.064$$

$$\widehat{M^2} = (\overline{R}_x - \overline{R}_f)\frac{\hat{\sigma}_m}{\hat{\sigma}_x} + \overline{R}_f = \widehat{SR} \times \hat{\sigma}_m + \overline{R}_f$$
$$= 0.35 \times 0.19 + 0.03 = 0.0965 = 9.65\%$$

Since the market return is 9%, M^2 alpha is 0.65% (9.65% – 9%).

$$\hat{\alpha}_X = R_X - [\overline{R}_f + \hat{\beta}_X(\overline{R}_m - \overline{R}_f)] = 0.10 - (0.03 + 1.1 \times 0.06)$$
$$= 0.004 = 0.40\%$$

Exhibit 8: Measures of Portfolio Performance Evaluation

Manager	$\bar{R}_i$	$\hat{\sigma}_i$	$\hat{\beta}_i$	$E(R_i)$	Sharpe Ratio	Treynor Ratio	M^2 alpha	$\hat{\alpha}_i$
X	10.0%	20.0%	1.10	9.6%	0.35	0.064	0.65%	0.40%
Y	11.0	10.0	0.70	7.2	0.80	0.114	9.20	3.80
Z	12.0	25.0	0.60	6.6	0.36	0.150	0.84	5.40
M	9.0	19.0	1.00	9.0	0.32	0.060	0.00	0.00
R_f	3.0	0.0	0.00	3.0	–	–	–	0.00

Let us begin with an analysis of the risk-free asset. Because the risk-free asset has zero risk and a beta of zero, calculating the Sharpe ratio, Treynor ratio, or M^2 is not possible because they all require the portfolio risk in the denominator. The risk-free asset's alpha, however, is zero. Turning to the market portfolio, we see that the absolute measures of performance, the Sharpe ratio and the Treynor ratio, are positive for the market portfolio. These ratios are positive as long as the portfolio earns a return that is in excess of that of the risk-free asset. $\widehat{M}^2$ and $\hat{\alpha}_i$ are performance measures relative to the market, so they are both equal to zero for the market portfolio. All three managers have Sharpe and Treynor ratios greater than those of the market, and all three managers' M^2 alpha and α_i are positive; therefore, the pension fund should be satisfied with their performance. Among the three managers, Manager X has the worst performance, irrespective of whether total risk or systematic risk is considered for measuring performance. The relative rankings are depicted in Exhibit 9.

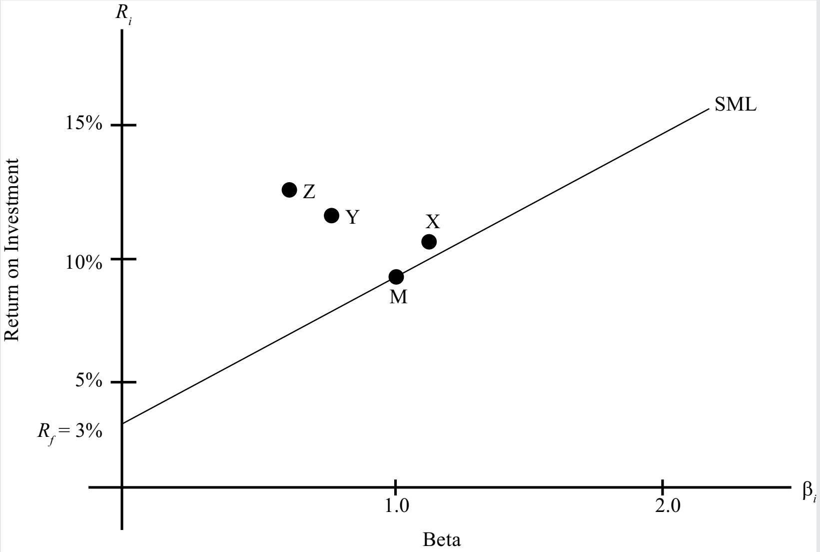
Exhibit 9: Ranking of Portfolios by Performance Measure

Rank	Sharpe Ratio	Treynor Ratio	M^2 alpha	α_i
1	Y	Z	Y	Z
2	Z	Y	Z	Y
3	X	X	X	X
4	M	M	M	M
5	–	–	–	R_f

Comparing Y and Z, we can observe that Y performs much better than Z when total risk is considered. Y has a Sharpe ratio of 0.80, compared with a Sharpe ratio of 0.36 for Z. Similarly, M^2 alpha is higher for Y (9.20 percent) than for Z (0.84 percent). In contrast, when systematic risk is used, Z outperforms Y. The Treynor ratio is higher for Z (0.150) than for Y (0.114), and Jensen's alpha is also higher for Z (5.40 percent) than for Y (3.80 percent), which indicates that Z has done a better job of generating excess return relative to systematic risk than Y.

Exhibit 10 confirms these observations in that all three managers outperform the benchmark because all three points lie above the SML. Among the three portfolios, Z performs the best when we consider risk-adjusted returns because it is the point in Exhibit 10 that is located northwest relative to the portfolios X and Y.

Exhibit 10: Portfolios Along the SML



When do we use total risk performance measures like the Sharpe ratio and M^2, and when do we use beta risk performance measures like the Treynor ratio and Jensen's alpha? Total risk is relevant for an investor when he or she holds a portfolio that is not fully diversified, which is not a desirable portfolio. In such cases, the Sharpe ratio and M^2 are appropriate performance measures. Thus, if the pension fund were to choose only one fund manager to manage all its assets, it should choose Manager Y. Performance measures relative to beta risk—Treynor ratio and Jensen's alpha—are relevant when the investor holds a well-diversified portfolio with negligible diversifiable risk. In other words, if the pension fund is well diversified and only the systematic risk of the portfolio matters, the fund should choose Manager Z.

The measures of performance evaluation assume that the market portfolio is the correct benchmark. As a result, an error in the benchmark may cause the results to be misleading. For example, evaluating a real estate fund against the S&P 500 is incorrect because real estate has different characteristics than equity. In addition to errors in benchmarking, errors could occur in the measurement of risk and return of the market portfolio and the portfolios being evaluated. Finally, many estimates are based on historical data. Any projections based on such estimates assume that this level of performance will continue in the future.

12 APPLICATIONS OF THE CAPM IN PORTFOLIO CONSTRUCTION

- ☐ calculate and interpret the expected return of an asset using the CAPM
- ☐ describe and demonstrate applications of the CAPM and the SML

This section introduces applications of the CAPM in portfolio construction. First, the security characteristic line, which graphically indicates *ex post* Jensen's alpha, is described. If we relax the assumption that investors have the same expectations about risk and return, a positive Jensen's alpha can be interpreted as an indication of superior information or investment ability. The section on security selection covers that possibility. The last section summarizes how the CAPM and related concepts can be applied to portfolio construction.

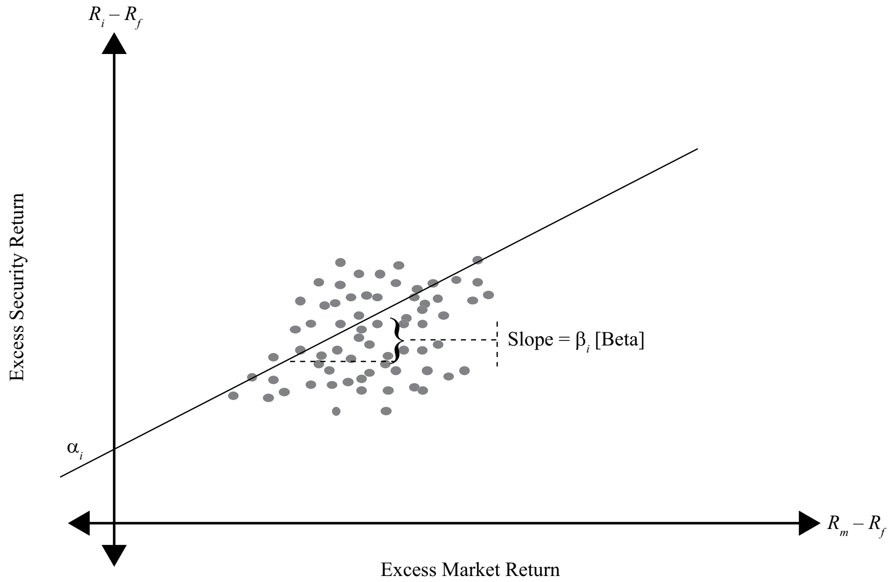
Security Characteristic Line

Similar to the SML, we can draw a **security characteristic line** (SCL) for a security. The SCL is a plot of the excess return of the security on the excess return of the market. In Exhibit 8, Jensen's alpha is the intercept and the beta is the slope. The equation of the line can be obtained by rearranging the terms in the expression for Jensen's alpha and replacing the subscript p with i:

$$R_i - R_f = \alpha_i + \beta_i(R_m - R_f)$$

As an example, the SCL is drawn in Exhibit 11 using Manager X's portfolio from Exhibit 8. The security characteristic line can also be estimated by regressing the excess security return, $R_i - R_f$, on the excess market return, $R_m - R_f$.

Exhibit 11: The Security Characteristic Line



Security Selection

When discussing the CAPM, we assumed that investors have homogeneous expectations and are rational, risk-averse, utility-maximizing investors. With these assumptions, we were able to state that all investors assign the same value to all assets and, therefore, have the same optimal risky portfolio, which is the market portfolio. In other words, we assumed that there is commonality among beliefs about an asset's future cash flows and the required rate of return. Given the required rate of return, we can discount the future cash flows of the asset to arrive at its current value, or price, which is agreed upon by all or most investors.

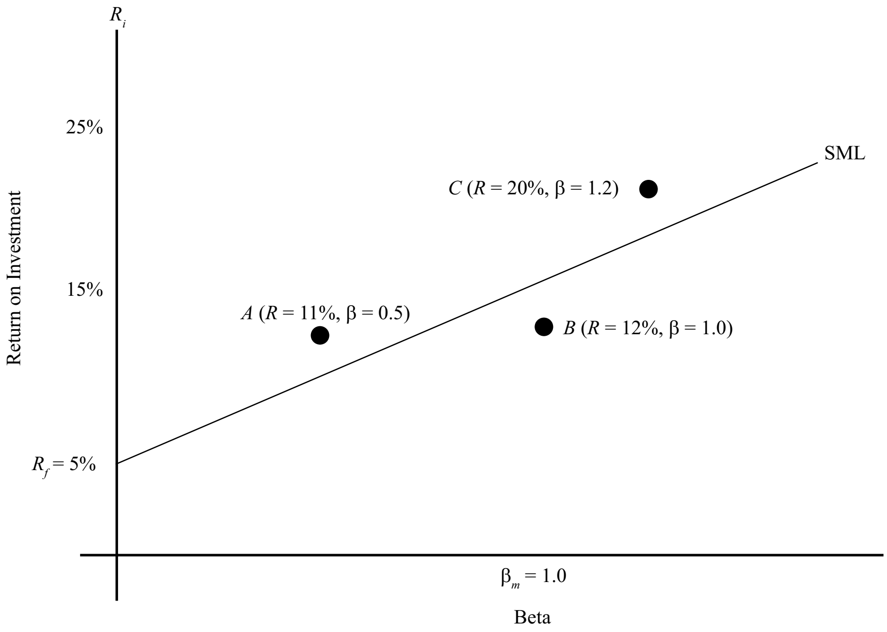
In this section, we introduce heterogeneity in beliefs of investors. Because investors are price takers, it is assumed that such heterogeneity does not significantly affect the market price of an asset. The difference in beliefs can relate to future cash flows, the systematic risk of the asset, or both. Because the current price of an asset is the discounted value of the future cash flows, the difference in beliefs could result in an investor-estimated price that is different from the CAPM-calculated price. The CAPM-calculated price is the current market price because it reflects the beliefs of all other investors in the market. If the investor-estimated current price is higher (lower) than the market price, the asset is considered undervalued (overvalued). Therefore, the CAPM is an effective tool for determining whether an asset is undervalued or overvalued and whether an investor should buy or sell the asset.

Although portfolio performance evaluation is backward looking and security selection is forward looking, we can apply the concepts of portfolio evaluation to security selection. The best measure to apply is Jensen's alpha because it uses systematic risk and is meaningful even on an absolute basis. A positive Jensen's alpha indicates a superior security, whereas a negative Jensen's alpha indicates a security that is likely to underperform the market when adjusted for risk.

Another way of presenting the same information is with the security market line. Potential investors can plot a security's expected return and beta against the SML and use this relationship to decide whether the security is overvalued or undervalued in the market.[6] Exhibit 12 shows a number of securities along with the SML. All securities that reflect the consensus market view are points directly on the SML (i.e., properly valued). If a point representing the estimated return of an asset is above the SML (Points A and C), the asset has a low level of risk relative to the amount of expected return and would be a good choice for investment. In contrast, if the point representing a particular asset is below the SML (Point B), the stock is considered overvalued. Its return does not compensate for the level of risk and should not be considered for investment. Of course, a short position in Asset B can be taken if short selling is permitted.

6 In this reading, we do not consider transaction costs, which are important whenever deviations from a passive portfolio are considered. Thus, the magnitude of undervaluation or overvaluation should be considered in relation to transaction costs prior to making an investment decision.

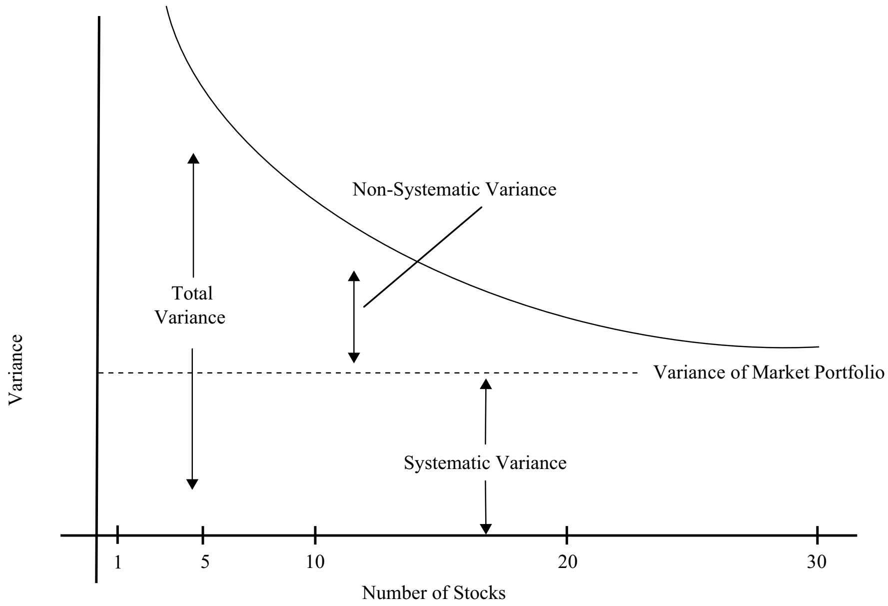
Exhibit 12: Security Selection Using SML



Implications of the CAPM for Portfolio Construction

Based on the CAPM, investors should hold a combination of the risk-free asset and the market portfolio. The true market portfolio consists of a large number of securities, and an investor would have to own all of them in order to be completely diversified. Because owning all existing securities is not practical, in this section, we will consider an alternate method of constructing a portfolio that may not require a large number of securities and will still be sufficiently diversified. Exhibit 13 shows the reduction in risk as we add more and more securities to a portfolio. As can be seen from the exhibit, much of the nonsystematic risk can be diversified away in as few as 30 securities. These securities, however, should be randomly selected and represent different asset classes for the portfolio to effectively diversify risk. Otherwise, one may be better off using an index (e.g., the S&P 500 for a diversified large-cap equity portfolio and other indexes for other asset classes).

Exhibit 13: Diversification with Number of Stocks



Let's begin constructing the optimal portfolio with a portfolio of securities like the S&P 500. Although the S&P 500 is a portfolio of 500 securities, it is a good starting point because it is readily available as a single security for trading. In contrast, it represents only the large corporations that are traded on the US stock markets and, therefore, does not encompass the global market entirely. Because the S&P 500 is the base portfolio, however, we treat it is as the market for the CAPM.

Any security not included in the S&P 500 can be evaluated to determine whether it should be integrated into the portfolio. That decision is based on the α_i of the security, which is calculated using the CAPM with the S&P 500 as the market portfolio. Note that security i may not necessarily be priced incorrectly for it to have a non-zero α_i; α_i can be positive merely because it is not well correlated with the S&P 500 and its return is sufficient for the amount of systematic risk it contains. For example, assume a new stock market, ABC, opens to foreign investors only and is being considered for inclusion in the portfolio. We estimate ABC's model parameters relative to the S&P 500 and find an α_i of approximately 3 percent, with a β_i of 0.60. Because α_i is positive, ABC should be added to the portfolio. Securities with a significantly negative α_i may be short sold to maximize risk-adjusted return. For convenience, however, we will assume that negative positions are not permitted in the portfolio.

In addition to the securities that are correctly priced but enter the portfolio because of their risk–return superiority, securities already in the portfolio (S&P 500) may be undervalued or overvalued based on investor expectations that are incongruent with the market. Securities in the S&P 500 that are overvalued (negative α_i) should be dropped from the S&P 500 portfolio, if it is possible to exclude individual securities, and positions in securities in the S&P 500 that are undervalued (positive α_i) should be increased.

This brings us to the next question: What should the relative weight of securities in the portfolio be? Because we are concerned with maximizing risk-adjusted return, securities with a higher α_i should have a higher weight, and securities with greater nonsystematic risk should be given less weight in the portfolio. A complete analysis of portfolio optimization is beyond the scope of this reading, but the following principles are helpful. The weight in each nonmarket security should be proportional to $\frac{\alpha_i}{\sigma_{ei}^2}$, where the denominator is the nonsystematic variance of security i. The total weight of nonmarket securities in the portfolio is proportional to

$$\frac{\sum_{i=1}^{N} w_i \alpha_i}{\sum_{i=1}^{N} w_i^2 \sigma_{ei}^2}.$$

The weight in the market portfolio is a function of

$$\frac{E(R_m)}{\sigma_m^2}.$$

The information ratio, $\frac{\alpha_i}{\sigma_{ei}}$ (i.e., alpha divided by nonsystematic risk), measures the abnormal return per unit of risk added by the security to a well-diversified portfolio. The larger the information ratio is, the more valuable the security.

EXAMPLE 11

Optimal Investor Portfolio with Heterogeneous Beliefs

A Japanese investor is holding the Nikkei 225 index, which is her version of the market. She thinks that three stocks, P, Q, and R, which are not in the Nikkei 225, are undervalued and should form a part of her portfolio. She has the following information about the stocks, the Nikkei 225, and the risk-free rate (the information is given as expected return, standard deviation, and beta):

P: 15%, 30%, 1.5

Q: 18%, 25%, 1.2

R: 16%, 23%, 1.1

Nikkei 225: 12%, 18%, 1.0

Risk-free rate: 2%, 0%, 0.0

1. Calculate Jensen's alpha for P, Q, and R.

Solution:

Stock P's α: $R_i - [R_f + \beta_i(R_m - R_f)] = 0.15 - (0.02 + 1.5 \times 0.10) = -0.02$

Stock Q's α: $R_i - [R_f + \beta_i(R_m - R_f)] = 0.18 - (0.02 + 1.2 \times 0.10) = 0.04$

Stock R's α: $R_i - [R_f + \beta_i(R_m - R_f)] = 0.16 - (0.02 + 1.1 \times 0.10) = 0.03$

2. Calculate nonsystematic variance for P, Q, and R.

Solution:

Total variance = Systematic variance + Nonsystematic variance. From Section 3.2.2, we write the equation as $\sigma_{ei}^2 = \sigma_i^2 - \beta_i^2 \sigma_m^2$.

Stock P's nonsystematic variance = (0.30 × 0.30) – (1.5 × 1.5 × 0.18 × 0.18) = 0.09 – 0.0729

= 0.0171

Stock Q's nonsystematic variance = (0.25 × 0.25) – (1.2 × 1.2 × 0.18 × 0.18) = 0.0625 – 0.0467

= 0.0158

Stock R's nonsystematic variance = (0.23 × 0.23) – (1.1 × 1.1 × 0.18 × 0.18) = 0.0529 – 0.0392

= 0.0137

3. Should any of the three stocks be included in the portfolio? If so, which stock should have the highest weight in the portfolio?

Solution:

Stock P has a negative α and should not be included in the portfolio, unless a negative position can be assumed through short selling. Stocks Q and R have a positive α; therefore, they should be included in the portfolio with positive weights.

The relative weight of Q is 0.04/0.0158 = 2.53.

The relative weight of R is 0.03/0.0137 = 2.19.

Stock Q will have the largest weight among the nonmarket securities to be added to the portfolio. In relative terms, the weight of Q will be 15.5 percent greater than the weight of R (2.53/2.19 = 1.155). As the number of securities increases, the analysis becomes more complex. However, the contribution of each additional security toward improvement in the risk–return trade-off will decrease and eventually disappear, resulting in a well-diversified portfolio.

SUMMARY

In this reading, we discussed the capital asset pricing model in detail and covered related topics such as the capital market line. The reading began with an interpretation of the CML, uses of the market portfolio as a passive management strategy, and leveraging of the market portfolio to obtain a higher expected return. Next, we discussed systematic and nonsystematic risk and why one should not expect to be compensated for taking on nonsystematic risk. The discussion of systematic and nonsystematic risk was followed by an introduction to beta and return-generating models. This broad topic was then broken down into a discussion of the CAPM and, more specifically, the relationship between beta and expected return. The final section included applications of the CAPM to capital budgeting, portfolio performance evaluation, and security selection. The highlights of the reading are as follows:

- The capital market line is a special case of the capital allocation line, where the efficient portfolio is the market portfolio.
- Obtaining a unique optimal risky portfolio is not possible if investors are permitted to have heterogeneous beliefs because such beliefs will result in heterogeneous asset prices.

- Investors can leverage their portfolios by borrowing money and investing in the market.
- Systematic risk is the risk that affects the entire market or economy and is not diversifiable.
- Nonsystematic risk is local and can be diversified away by combining assets with low correlations.
- Beta risk, or systematic risk, is priced and earns a return, whereas nonsystematic risk is not priced.
- The expected return of an asset depends on its beta risk and can be computed using the CAPM, which is given by $E(R_i) = R_f + \beta_i[E(R_m) - R_f]$.
- The security market line is an implementation of the CAPM and applies to all securities, whether they are efficient or not.
- Expected return from the CAPM can be used for making capital budgeting decisions.
- Portfolios can be evaluated by several CAPM-based measures, such as the Sharpe ratio, the Treynor ratio, M^2, and Jensen's alpha.
- The SML can assist in security selection and optimal portfolio construction.

By successfully understanding the content of this reading, you should feel comfortable decomposing total variance into systematic and nonsystematic variance, analyzing beta risk, using the CAPM, and evaluating portfolios and individual securities.

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PRACTICE PROBLEMS

1. The line depicting the total risk and expected return of portfolio combinations of a risk-free asset and any risky asset is the:

   A. security market line.

   B. capital allocation line.

   C. security characteristic line.

2. The portfolio of a risk-free asset and a risky asset has a better risk-return tradeoff than investing in only one asset type because the correlation between the risk-free asset and the risky asset is equal to:

   A. −1.0.

   B. 0.0.

   C. 1.0.

3. With respect to capital market theory, an investor's optimal portfolio is the combination of a risk-free asset and a risky asset with the highest:

   A. expected return.

   B. indifference curve.

   C. capital allocation line slope.

4. Highly risk-averse investors will *most likely* invest the majority of their wealth in:

   A. risky assets.

   B. risk-free assets.

   C. the optimal risky portfolio.

5. The capital market line (CML) is the graph of the risk and return of portfolio combinations consisting of the risk-free asset and:

   A. any risky portfolio.

   B. the market portfolio.

   C. the leveraged portfolio.

6. Which of the following statements *most accurately* defines the market portfolio in capital market theory? The market portfolio consists of all:

   A. risky assets.

   B. tradable assets.

   C. investable assets.

7. With respect to capital market theory, the optimal risky portfolio:

   A. is the market portfolio.

B. has the highest expected return.

C. has the lowest expected variance.

8. Relative to portfolios on the CML, any portfolio that plots above the CML is considered:

   A. inferior.

   B. inefficient.

   C. unachievable.

9. A portfolio on the capital market line with returns greater than the returns on the market portfolio represents a(n):

   A. lending portfolio.

   B. borrowing portfolio.

   C. unachievable portfolio.

10. With respect to the capital market line, a portfolio on the CML with returns less than the returns on the market portfolio represents a(n):

    A. lending portfolio.

    B. borrowing portfolio.

    C. unachievable portfolio.

11. Which of the following types of risk is *most likely* avoided by forming a diversified portfolio?

    A. Total risk.

    B. Systematic risk.

    C. Nonsystematic risk.

12. Which of the following events is *most likely* an example of nonsystematic risk?

    A. A decline in interest rates.

    B. The resignation of chief executive officer.

    C. An increase in the value of the US dollar.

13. With respect to the pricing of risk in capital market theory, which of the following statements is *most accurate*?

    A. All risk is priced.

    B. Systematic risk is priced.

    C. Nonsystematic risk is priced.

14. The sum of an asset's systematic variance and its nonsystematic variance of returns is equal to the asset's:

    A. beta.

B. total risk.

C. total variance.

The following information relates to questions 15-17

An analyst gathers the following information:

Security	Expected Annual Return (%)	Expected Standard Deviation (%)	Correlation between Security and the Market
Security 1	11	25	0.6
Security 2	11	20	0.7
Security 3	14	20	0.8
Market	10	15	1.0

15. Which security has the *highest* total risk?

A. Security 1.

B. Security 2.

C. Security 3.

16. Which security has the *highest* beta measure?

A. Security 1.

B. Security 2.

C. Security 3.

17. Which security has the *least* amount of market risk?

A. Security 1.

B. Security 2.

C. Security 3.

---

18. With respect to return-generating models, the intercept term of the market model is the asset's estimated:

A. beta.

B. alpha.

C. variance.

19. With respect to return-generating models, the slope term of the market model is an estimate of the asset's:

A. total risk.

B. systematic risk.

C. nonsystematic risk.

20. With respect to return-generating models, which of the following statements is *most accurate*? Return-generating models are used to directly estimate the:

A. expected return of a security.

B. weights of securities in a portfolio.

C. parameters of the capital market line.

21. With respect to capital market theory, the average beta of all assets in the market is:

A. less than 1.0.

B. equal to 1.0.

C. greater than 1.0.

22. With respect to the capital asset pricing model, the primary determinant of expected return of an individual asset is the:

A. asset's beta.

B. market risk premium.

C. asset's standard deviation.

23. With respect to the capital asset pricing model, which of the following values of beta for an asset is *most likely* to have an expected return for the asset that is less than the risk-free rate?

A. –0.5

B. 0.0

C. 0.5

24. With respect to the capital asset pricing model, the market risk premium is:

A. less than the excess market return.

B. equal to the excess market return.

C. greater than the excess market return.

25. The graph of the capital asset pricing model is the:

A. capital market line.

B. security market line.

C. security characteristic line.

26. With respect to capital market theory, correctly priced individual assets can be plotted on the:

    A. capital market line.

    B. security market line.

    C. capital allocation line.

The following information relates to questions 27-30

An analyst gathers the following information:

Security	Expected Standard Deviation (%)	Beta
Security 1	25	1.50
Security 2	15	1.40
Security 3	20	1.60

27. With respect to the capital asset pricing model, if the expected market risk premium is 6% and the risk-free rate is 3%, the expected return for Security 1 is *closest* to:

    A. 9.0%.

    B. 12.0%.

    C. 13.5%.

28. With respect to the capital asset pricing model, if expected return for Security 2 is equal to 11.4% and the risk-free rate is 3%, the expected return for the market is *closest* to:

    A. 8.4%.

    B. 9.0%.

    C. 10.3%.

29. With respect to the capital asset pricing model, if the expected market risk premium is 6% the security with the *highest* expected return is:

    A. Security 1.

    B. Security 2.

    C. Security 3.

30. With respect to the capital asset pricing model, a decline in the expected market return will have the *greatest* impact on the expected return of:

    A. Security 1.

B. Security 2.

C. Security 3.

---

31. With respect to capital market theory, which of the following statements *best* describes the effect of the homogeneity assumption? Because all investors have the same economic expectations of future cash flows for all assets, investors will invest in:

A. the same optimal risky portfolio.

B. the Standard and Poor's 500 Index.

C. assets with the same amount of risk.

32. With respect to capital market theory, which of the following assumptions allows for the existence of the market portfolio? All investors:

A. are price takers.

B. have homogeneous expectations.

C. plan for the same, single holding period.

33. Three equity fund managers have performance records summarized in the following table:

	Mean Annual Return (%)	Standard Deviation of Return (%)
Manager 1	14.38	10.53
Manager 2	9.25	6.35
Manager 3	13.10	8.23

Given a risk-free rate of return of 2.60%, which manager performed best based on the Sharpe ratio?

A. Manager 1

B. Manager 2

C. Manager 3

34. Which of the following performance measures is consistent with the CAPM?

A. M^2.

B. Sharpe ratio.

C. Jensen's alpha.

35. Which of the following performance measures does *not* require the measure to be compared to another value?

A. Sharpe ratio.

B. Treynor ratio.

C. Jensen's alpha.

36. Which of the following performance measures is *most* appropriate for an investor who is *not* fully diversified?

    A. M^2.

    B. Treynor ratio.

    C. Jensen's alpha.

37. The slope of the security characteristic line is an asset's:

    A. beta.

    B. excess return.

    C. risk premium.

38. Analysts who have estimated returns of an asset to be greater than the expected returns generated by the capital asset pricing model should consider the asset to be:

    A. overvalued.

    B. undervalued.

    C. properly valued.

39. The intercept of the best fit line formed by plotting the excess returns of a manager's portfolio on the excess returns of the market is *best* described as Jensen's:

    A. beta.

    B. ratio.

    C. alpha.

40. Portfolio managers who are maximizing risk-adjusted returns will seek to invest *more* in securities with:

    A. lower values of Jensen's alpha.

    B. values of Jensen's alpha equal to 0.

    C. higher values of Jensen's alpha.

41. Portfolio managers, who are maximizing risk-adjusted returns, will seek to invest *less* in securities with:

    A. lower values for nonsystematic variance.

    B. values of nonsystematic variance equal to 0.

    C. higher values for nonsystematic variance.

SOLUTIONS

1. B is correct. A capital allocation line (CAL) plots the expected return and total risk of combinations of the risk-free asset and a risky asset (or a portfolio of risky assets).

2. B is correct. A portfolio of the risk-free asset and a risky asset or a portfolio of risky assets can result in a better risk-return tradeoff than an investment in only one type of an asset, because the risk-free asset has zero correlation with the risky asset.

3. B is correct. Investors will have different optimal portfolios depending on their indifference curves. The optimal portfolio for each investor is the one with highest utility; that is, where the CAL is tangent to the individual investor's highest possible indifference curve.

4. B is correct. Although the optimal risky portfolio is the market portfolio, highly risk-averse investors choose to invest most of their wealth in the risk-free asset.

5. B is correct. Although the capital allocation line includes all possible combinations of the risk-free asset and any risky portfolio, the capital market line is a special case of the capital allocation line, which uses the market portfolio as the optimal risky portfolio.

6. A is correct. The market includes all risky assets, or anything that has value; however, not all assets are tradable, and not all tradable assets are investable.

7. A is correct. The optimal risky portfolio is the market portfolio. Capital market theory assumes that investors have homogeneous expectations, which means that all investors analyze securities in the same way and are rational. That is, investors use the same probability distributions, use the same inputs for future cash flows, and arrive at the same valuations. Because their valuations of all assets are identical, all investors will invest in the same optimal risky portfolio (i.e., the market portfolio).

8. C is correct. Theoretically, any point above the CML is not achievable and any point below the CML is dominated by and inferior to any point on the CML.

9. B is correct. As one moves further to the right of point M on the capital market line, an increasing amount of borrowed money is being invested in the market portfolio. This means that there is negative investment in the risk-free asset, which is referred to as a leveraged position in the risky portfolio.

10. A is correct. The combinations of the risk-free asset and the market portfolio on the CML where returns are less than the returns on the market portfolio are termed 'lending' portfolios.

11. C is correct. Investors are capable of avoiding nonsystematic risk by forming a portfolio of assets that are not highly correlated with one another, thereby reducing total risk and being exposed only to systematic risk.

12. B is correct. Nonsystematic risk is specific to a firm, whereas systematic risk affects the entire economy.

13. B is correct. Only systematic risk is priced. Investors do not receive any return for accepting nonsystematic or diversifiable risk.

14. C is correct. The sum of systematic variance and nonsystematic variance equals the total variance of the asset. References to total risk as the sum of systematic risk and nonsystematic risk refer to variance, not to risk.

15. A is correct. Security 1 has the highest total risk = 0.25 compared to Security 2 and Security 3 with a total risk of 0.20.

16. C is correct. Security 3 has the highest beta value;

$$1.07 = \frac{\rho_{3,m}\sigma_3}{\sigma_m} = \frac{(0.80)\ (20\%)}{15\%}$$

compared to Security 1 and Security 2 with beta values of 1.00 and 0.93, respectively.

17. B is correct. Security 2 has the lowest beta value;

$$0.93 = \frac{\rho_{2,m}\sigma_2}{\sigma_m} = \frac{(0.70)\ (20\%)}{15\%}$$

compared to Security 1 and 3 with beta values of 1.00 and 1.07, respectively.

18. B is correct. In the market model, $R_i = \alpha_i + \beta_i R_m + e_i$, the intercept, α_i, and slope coefficient, β_i, are estimated using historical security and market returns.

19. B is correct. In the market model, $R_i = \alpha_i + \beta_i R_m + e_i$, the slope coefficient, β_i, is an estimate of the asset's systematic or market risk.

20. A is correct. In the market model, $R_i = \alpha_i + \beta_i R_m + e_i$, the intercept, α_i, and slope coefficient, β_i, are estimated using historical security and market returns. These parameter estimates then are used to predict firm-specific returns that a security may earn in a future period.

21. B is correct. The average beta of all assets in the market, by definition, is equal to 1.0.

22. A is correct. The CAPM shows that the primary determinant of expected return for an individual asset is its beta, or how well the asset correlates with the market.

23. A is correct. If an asset's beta is negative, the required return will be less than the risk-free rate in the CAPM. When combined with a positive market return, the asset reduces the risk of the overall portfolio, which makes the asset very valuable. Insurance is an example of a negative beta asset.

24. B is correct. In the CAPM, the market risk premium is the difference between the return on the market and the risk-free rate, which is the same as the return in excess of the market return.

25. B is correct. The security market line (SML) is a graphical representation of the capital asset pricing model, with beta risk on the x-axis and expected return on the y-axis.

26. B is correct. The security market line applies to any security, efficient or not. The CAL and the CML use the total risk of the asset (or portfolio of assets) rather than its systematic risk, which is the only risk that is priced.

27. B is correct. The expected return of Security 1, using the CAPM, is 12.0% = 3% + 1.5(6%); $E(R_i) = R_f + \beta_i[E(R_m) - R_f]$.

28. B is correct. The expected risk premium for Security 2 is 8.4%, (11.4% − 3%), indicates that the expected market risk premium is 6%; therefore, since the risk-free

rate is 3% the expected rate of return for the market is 9%. That is, using the CAPM, $E(R_i) = R_f + \beta_i[E(R_m) - R_f]$, 11.4% = 3% + 1.4(X%), where X% = (11.4% – 3%)/1.4 = 6.0% = market risk premium.

29. C is correct. Security 3 has the highest beta; thus, regardless of the value for the risk-free rate, Security 3 will have the highest expected return:

    $E(R_i) = R_f + \beta_i[E(R_m) - R_f]$

30. C is correct. Security 3 has the highest beta; thus, regardless of the risk-free rate the expected return of Security 3 will be most sensitive to a change in the expected market return.

31. A is correct. The homogeneity assumption refers to all investors having the same economic expectation of future cash flows. If all investors have the same expectations, then all investors should invest in the same optimal risky portfolio, therefore implying the existence of only one optimal portfolio (i.e., the market portfolio).

32. B is correct. The homogeneous expectations assumption means that all investors analyze securities in the same way and are rational. That is, they use the same probability distributions, use the same inputs for future cash flows, and arrive at the same valuations. Because their valuation of all assets is identical, they will generate the same optimal risky portfolio, which is the market portfolio.

33. C is correct. The Sharpe ratio $\left(\widehat{\mathrm{SR}}\right)$ is the mean excess portfolio return per unit of risk, where a higher Sharpe ratio indicates better performance:

$$\widehat{SR}_1 = \frac{\overline{R}_p - \overline{R}_f}{\hat{\sigma}_p} = \frac{14.38 - 2.60}{10.53} = 1.12$$

$$\widehat{SR}_2 = \frac{\overline{R}_p - \overline{R}_f}{\hat{\sigma}_p} = \frac{9.25 - 2.60}{6.35} = 1.05$$

$$\widehat{SR}_3 = \frac{\overline{R}_p - \overline{R}_f}{\hat{\sigma}_p} = \frac{13.10 - 2.60}{8.23} = 1.28$$

34. C is correct. Jensen's alpha adjusts for systematic risk, and M^2 and the Sharpe Ratio adjust for total risk.

35. C is correct. The sign of Jensen's alpha indicates whether or not the portfolio has outperformed the market. If alpha is positive, the portfolio has outperformed the market; if alpha is negative, the portfolio has underperformed the market.

36. A is the correct. M^2 adjusts for risk using standard deviation (i.e., total risk).

37. A is correct. The security characteristic line is a plot of the excess return of the security on the excess return of the market. In such a graph, Jensen's alpha is the intercept and the beta is the slope.

38. B is correct. If the estimated return of an asset is above the SML (the expected return), the asset has a lower level of risk relative to the amount of expected return and would be a good choice for investment (i.e., undervalued).

39. C is correct. This is because of the plot of the excess return of the security on the excess return of the market. In such a graph, Jensen's alpha is the intercept and the beta is the slope.

40. C is correct. Since managers are concerned with maximizing risk-adjusted returns, securities with a higher value of Jensen's alpha, α_i, should have a higher weight.

41. C is correct. Since managers are concerned with maximizing risk-adjusted returns, securities with greater nonsystematic risk should be given less weight in the portfolio.

LEARNING MODULE

3

Portfolio Management: An Overview

by Owen M. Concannon, CFA, Robert M. Conroy, DBA, CFA, Alistair Byrne, PhD, CFA, and Vahan Janjigian, PhD, CFA.

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LEARNING OUTCOMES

Mastery	*The candidate should be able to:*
☐	describe the portfolio approach to investing
☐	describe the steps in the portfolio management process
☐	describe types of investors and distinctive characteristics and needs of each
☐	describe defined contribution and defined benefit pension plans
☐	describe aspects of the asset management industry
☐	describe mutual funds and compare them with other pooled investment products

1 INTRODUCTION

This reading provides an overview of portfolio management and the asset management industry, including types of investors and investment plans and products. A portfolio approach is important to investors in achieving their financial objectives. We outline the steps in the portfolio management process in managing a client's investment portfolio. We next compare the financial needs of different types of investors: individual and institutional investors. We then describe both defined contribution and defined benefit pension plans. The asset management[1] industry, which serves as a critical link between providers and seekers of investment capital around the world, is broadly discussed. Finally, we describe mutual funds and other types of pooled investment products offered by asset managers.

1 Note that both "investment management" and "asset management" are commonly used throughout the CFA Program curriculum. The terms are often used interchangeably in practice.

2 PORTFOLIO PERSPECTIVE: DIVERSIFICATION AND RISK REDUCTION

☐ describe the portfolio approach to investing

One of the biggest challenges faced by individuals and institutions is to decide how to invest for future needs. For individuals, the goal might be to fund retirement needs. For such institutions as insurance companies, the goal is to fund future liabilities in the form of insurance claims, whereas endowments seek to provide income to meet the ongoing needs of such institutions as universities. Regardless of the ultimate goal, all face the same set of challenges that extend beyond just the choice of what asset classes to invest in. They ultimately center on formulating basic principles that determine how to think about investing. One important question is: Should we invest in individual securities, evaluating each in isolation, or should we take a portfolio approach? By "portfolio approach," we mean evaluating individual securities in relation to their contribution to the investment characteristics of the whole portfolio. In the following section, we illustrate a number of reasons why a diversified portfolio perspective is important.

Historical Example of Portfolio Diversification: Avoiding Disaster

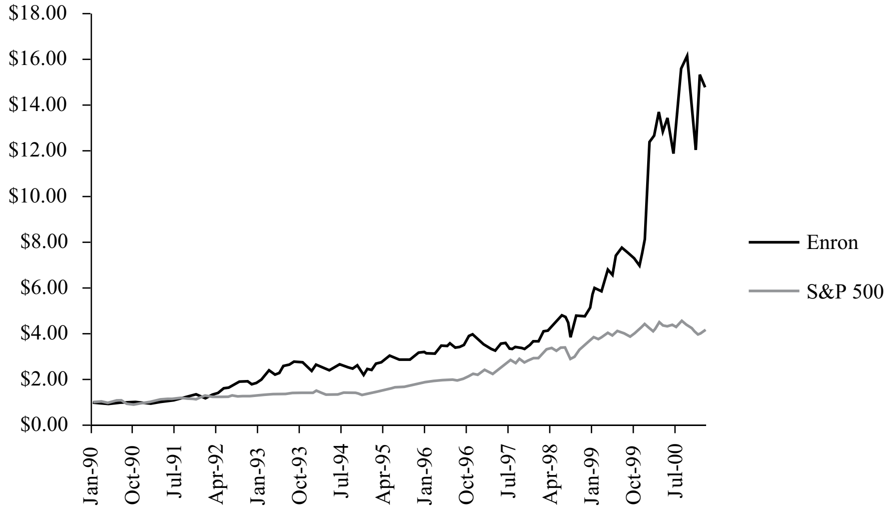
Portfolio diversification helps investors avoid disastrous investment outcomes. This benefit is most convincingly illustrated by examining what may happen when individuals have *not* diversified.

We are usually not able to observe how individuals manage their personal investments. However, in the case of US 401(k) individual retirement portfolios,[2] it is possible to see the results of individuals' investment decisions. When we examine their retirement portfolios, we find that some individual participants make sub-optimal investment decisions.

During the 1990s, Enron Corporation was one of the most admired corporations in the United States. A position in Enron shares returned over 27 percent per year from 1990 to September 2000, compared to 13 percent for the S&P 500 Index for the same time period.

2 In the United States, 401(k) plans are employer-sponsored individual retirement savings plans. They allow individuals to save a portion of their current income and defer taxation until the time when the savings and earnings are withdrawn. In some cases, the sponsoring firm will also make matching contributions in the form of cash or shares. Individuals within certain limits have control of the invested funds and consequently can express their preferences as to which assets to invest in.

Exhibit 1: Value of US$1 Invested from January 1990 to September 2000 Enron vs. S&P 500 Composite Index (01/01/1990 = US$1.00)



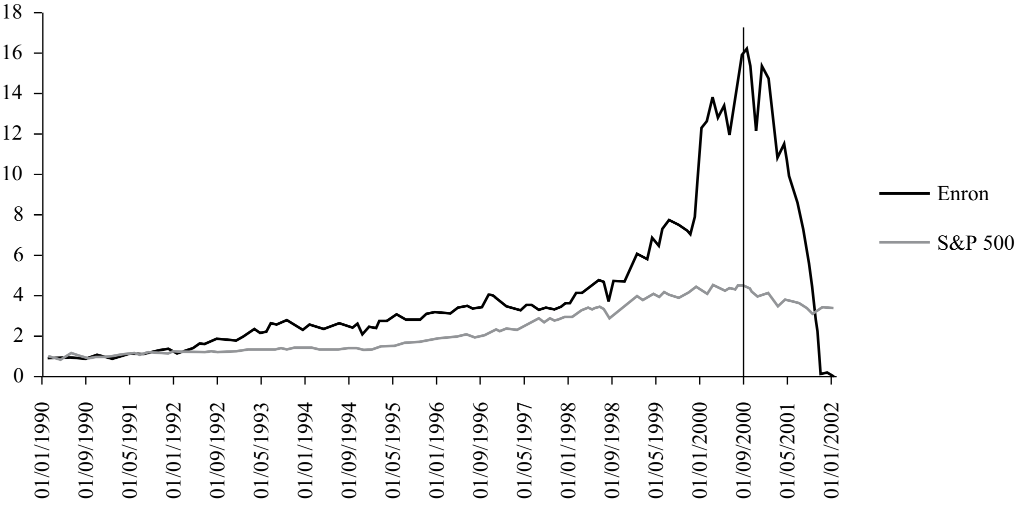
Source: Thomson Reuters Datastream.

During this time period, thousands of Enron employees participated in the company's 401(k) retirement plan. The plan allowed employees to set aside some of their earnings in a tax-deferred account. Enron participated by matching the employees' contributions. Enron made the match by depositing required amounts in the form of Enron shares. Enron restricted the sale of its contributed shares until an employee turned 50 years old. In January 2001, the employees' 401(k) retirement accounts were valued at over US$2 billion, of which US$1.3 billion (or 62 percent) was in Enron shares. Although Enron restricted the sale of shares it contributed, less than US$150 million of the total of US$1.3 billion in shares had this restriction. The implication was that Enron employees continued to hold large amounts of Enron shares even though they were free to sell them and invest the proceeds in other assets.

A typical individual was Roger Bruce,[3] a 67-year-old Enron retiree who held all of his US$2 million in retirement funds in Enron shares. Between January 2001 and January 2002, Enron's share price fell from about US$90 per share to zero.

3 Singletary (2001).

Exhibit 2: Value of US$1 Invested from January 1990 to January 2002 Enron vs. S&P 500 Composite Index (1/1/1990 = US$1.00)



Source: Thomson Reuters Datastream.

Employees and retirees who had invested all or most of their retirement savings in Enron shares, just like Mr. Bruce, experienced financial ruin. The hard lesson that the Enron employees learned from this experience was to "not put all your eggs in one basket."[4] Unfortunately, the typical Enron employee did have most of his or her eggs in one basket. Most employees' wages and financial assets were dependent on Enron's continued viability; hence, any financial distress on Enron would have a material impact on an employee's financial health. The bankruptcy of Enron resulted in the closing of its operations, the dismissal of thousands of employees, and its shares becoming worthless. Hence, the failure of Enron was disastrous to the typical Enron employee.

Enron employees were not the only ones to be victims of over-investment in a single company's shares. In the defined contribution retirement plans at Owens Corning, Northern Telecom, Corning, and ADC Telecommunications, employees all held more than 25 percent of their assets in the company's shares during a time (March 2000 to December 2001) in which the share prices in these companies fell by almost 90 percent. The good news in this story is that the employees participating in employer-matched 401(k) plans since 2001 have significantly reduced their holdings of their employers' shares.

Thus, by taking a diversified portfolio approach, investors can spread away some of the risk. Rational investors are concerned about the risk–return trade-off of their investments. The portfolio approach provides investors with a way to reduce the risk associated with their wealth without necessarily decreasing their expected rate of return.

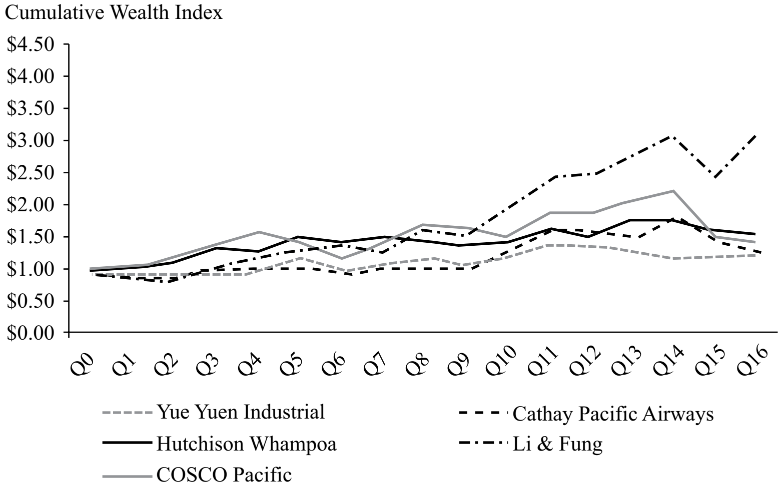
Portfolios: Reduce Risk

In addition to avoiding a potential disaster associated with over investing in a single security, portfolios also generally offer equivalent expected returns with lower overall **volatility** of returns—as represented by a measure such as standard deviation. Consider

4 This expression, which most likely originated in England in the 1700s, has a timeless sense of wisdom.

this simple example: Suppose you wish to make an investment in companies listed on the Hong Kong Stock Exchange (HKSE) and you start with a sample of five companies.[5] The cumulative returns for 16 fiscal quarters are shown in Exhibit 3.

Exhibit 3: Cumulative Wealth Index of Sample of Shares Listed on HKSE (initial amount= US$1.00)



Source: Thomson Reuters Datastream.

The individual quarterly returns for each of the five shares are shown in Exhibit 4. The annualized means and annualized standard deviations for each are also shown.[6]

Exhibit 4: Quarterly Returns (in Percent) for Sample of HKSE Listed Shares over 16 Fiscal Quarters

	Yue Yuen Industrial	Cathay Pacific Airways	Hutchison Whampoa	Li & Fung	COSCO Pacific	Equally Weighted Portfolio
Q1	–11.1%	–2.3%	0.6%	–13.2%	–1.1%	–5.4%
Q2	–0.5	–5.4	10.8	1.7	21.0	5.5
Q3	5.7	6.8	19.1	13.8	15.5	12.2
Q4	5.3	4.6	–2.1	16.9	12.4	7.4
Q5	17.2	2.4	12.6	14.5	–7.9	7.8
Q6	–17.6	–10.4	–0.9	4.4	–16.7	–8.2
Q7	12.6	7.4	4.2	–10.9	15.4	5.7
Q8	7.5	–0.4	–3.6	29.2	21.9	10.9
Q9	–7.9	1.3	–5.1	–2.0	–1.6	–3.1
Q10	8.2	27.5	0.1	26.0	–10.1	10.3
Q11	18.3	24.3	16.5	22.8	25.7	21.5
Q12	0.1	–2.6	–6.7	–0.4	0.3	–1.8

5 A sample of five companies from a similar industry group was arbitrarily selected for illustration purposes.
6 Mean quarterly returns are annualized by multiplying the quarterly mean by 4. Quarterly standard deviations are annualized by taking the quarterly standard deviation and multiplying it by 2.

	Yue Yuen Industrial	Cathay Pacific Airways	Hutchison Whampoa	Li & Fung	COSCO Pacific	Equally Weighted Portfolio
Q13	–6.2	–4.2	16.7	11.9	11.1	5.8
Q14	–8.0	17.9	–1.8	12.4	8.4	5.8
Q15	3.5	–20.1	–8.5	–20.3	–31.5	–15.4
Q16	2.1	–11.8	–2.6	24.2	–6.1	1.2
Mean annual return	7.3%	8.7%	12.3%	32.8%	14.2%	15.1%
Annual standard deviation	20.2%	25.4%	18.1%	29.5%	31.3%	17.9%
Diversification ratio						71.9%

Source: Thomson Reuters Datastream.

Suppose you want to invest in one of these five securities next year. There is a wide variety of risk–return trade-offs for the five shares selected. If you believe that the future will replicate the past, then choosing Li & Fung would be a good choice. For the prior four years, Li & Fung provided the best trade-off between return and risk. In other words, it provided the most return per unit of risk. However, if there is no reason to believe that the future will replicate the past, it is more likely that the risk and return on the one security selected will be more like selecting one randomly. When we randomly selected one security each quarter, we found an average annualized return of 15.1 percent and an average annualized standard deviation of 24.9 percent, which would now become your expected return and standard deviation, respectively.

Alternatively, you could invest in an equally weighted portfolio of the five shares, which means that you would invest the same dollar amount in each security for each quarter. The quarterly returns on the equally weighted portfolio are just the average of the returns of the individual shares. As reported in Exhibit 4, the equally weighted portfolio has an average return of 15.1 percent and a standard deviation of 17.9 percent. As expected, the equally weighted portfolio's return is the same as the return on the randomly selected security. However, the same does not hold true for the portfolio standard deviation. That is, the standard deviation of an equally weighted portfolio is not simply the average of the standard deviations of the individual shares. In a more advanced reading we will demonstrate in greater mathematical detail how such a portfolio offers a lower standard deviation of return than the average of its individual components due to the correlations or interactions between the individual securities.

Because the mean return is the same, a simple measure of the value of diversification is calculated as the ratio of the standard deviation of the equally weighted portfolio to the standard deviation of the randomly selected security. This ratio may be referred to as the **diversification ratio**. In this case, the equally weighted portfolio's standard deviation is approximately 72 percent of the average standard deviation of the 5 stocks (24.9%). The diversification ratio of the portfolio's standard deviation to the individual asset's standard deviation measures the risk reduction benefits of a simple portfolio construction method, equal weighting. Even though the companies were chosen from a similar industry grouping, we see significant risk reduction. An even greater portfolio effect (i.e., lower diversification ratio) could have been realized if we had chosen companies from completely different industries.

This example illustrates one of the critical ideas about portfolios: Portfolios affect risk more than returns. In the prior section portfolios helped avoid the effects of downside risk associated with investing in a single company's shares. In this section we extended the notion of risk reduction through portfolios to illustrate why individuals and institutions should hold portfolios.

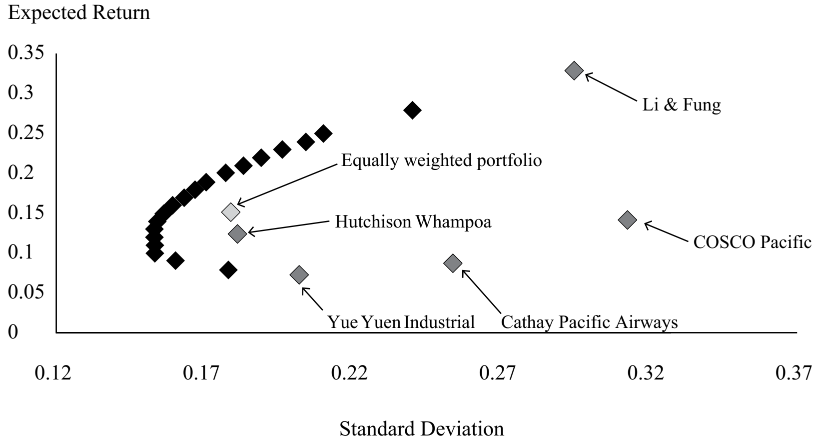
PORTFOLIO PERSPECTIVE: RISK-RETURN TRADE-OFF, DOWNSIDE PROTECTION, MODERN PORTFOLIO THEORY

3

☐ describe the portfolio approach to investing

In the previous section we compared an equally weighted portfolio to the selection of a single security. In this section we examine additional combinations of the same set of shares and observe the trade-offs between portfolio volatility of returns and expected return (for short, their risk–return trade-offs). If we select the portfolios with the best combination of risk and return (taking historical statistics as our expectations for the future), we produce the set of portfolios shown in Exhibit 5.

Exhibit 5: Optimal Portfolios for Sample of HKSE Listed Shares



Source: Thomson Reuters Datastream.

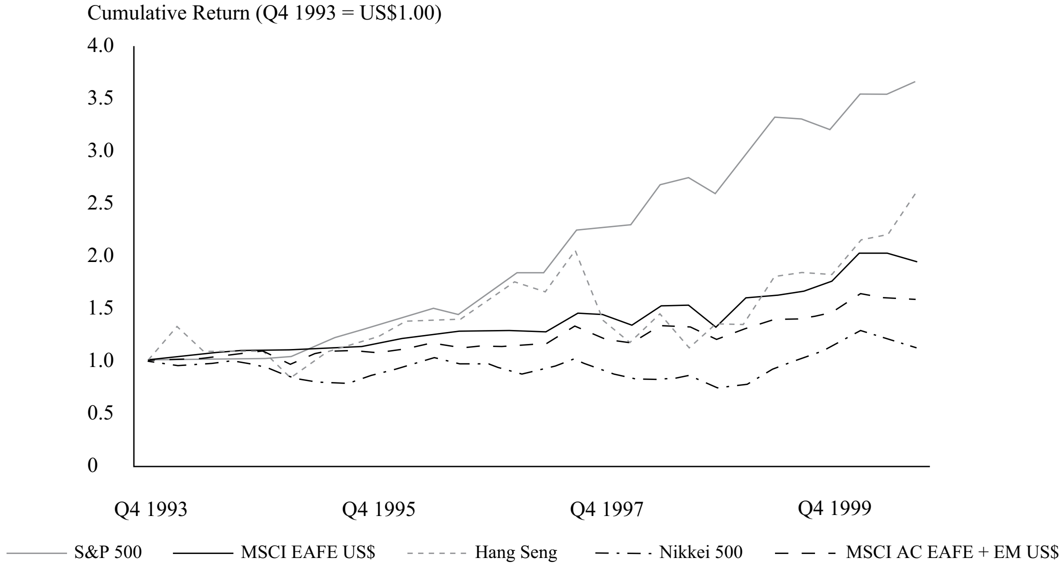
In addition to illustrating that the diversified portfolio approach reduces risk, Exhibit 5 also shows that the composition of the portfolio matters. For example, an equally weighted portfolio (20 percent of the portfolio in each security) of the five shares has an expected return of 15.1 percent and a standard deviation of 17.9 percent. Alternatively, a portfolio with 25 percent in Yue Yuen Industrial (Holdings), 3 percent in Cathay Pacific, 52 percent in Hutchison Whampoa, 20 percent in Li & Fung, and 0 percent in COSCO Pacific produces a portfolio with an expected return of 15.1 percent and a standard deviation of 15.6 percent. Compared to a simple equally weighted portfolio, this provides an improved trade-off between risk and return because a lower level of risk was achieved for the same level of return.

Historical Portfolio Example: Not Necessarily Downside Protection

A major reason that portfolios can effectively reduce risk is that combining securities whose returns do not move together provides diversification. Sometimes a subset of assets will go up in value at the same time that another will go down in value. The fact that these may offset each other creates the potential diversification benefit we attribute to portfolios. However, an important issue is that the co-movement or correlation pattern of the securities' returns in the portfolio can change in a manner unfavorable to the investor. We use historical return data from a set of global indexes to show the impact of changing co-movement patterns.

When we examine the returns of a set of global equity indexes over the last 15 years, we observe a reduction in the diversification benefit due to a change in the pattern of co-movements of returns. Exhibit 6 and Exhibit 7 show the cumulative returns for a set of five global indexes[7] for two different time periods. Comparing the first time period, from Q4 1993 through Q3 2000 (as shown in Exhibit 6), with the last time period, from Q1 2006 through Q1 2009 (as shown in Exhibit 7), we show that the degree to which these global equity indexes moved together increased over time.

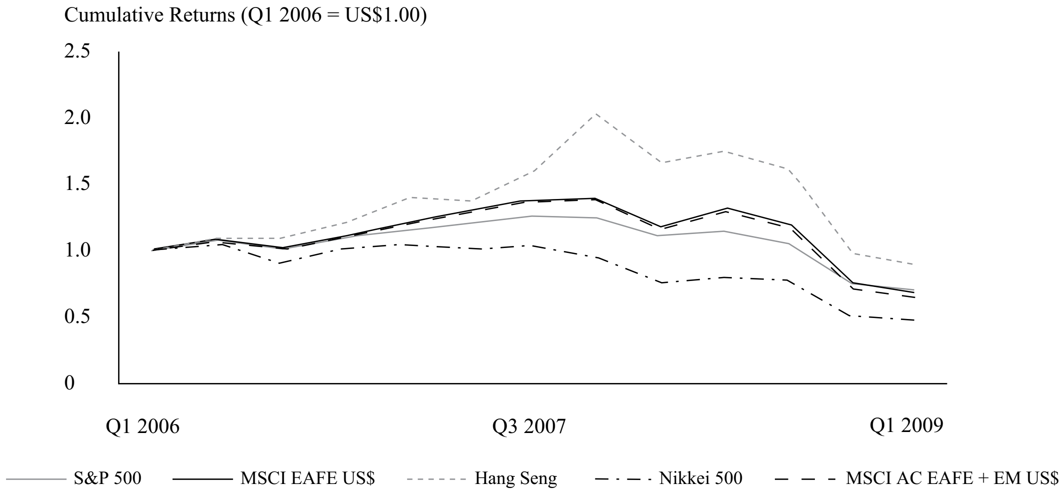
Exhibit 6: Returns to Global Equity Indexes Q4 1993–Q3 2000



Source: Thomson Reuters Datastream.

7 The S&P 500, Hang Seng, and Nikkei 500 are broad-based composite equity indexes designed to measure the performance of equities in the United States, Hong Kong SAR, and Japan. MSCI stands for Morgan Stanley Capital International. EAFE refers to developed markets in Europe, Australasia, and the Far East. AC indicates all countries, and EM is emerging markets. All index returns are in US dollars.

Exhibit 7: Returns to Global Equity Indexes Q1 2006–Q1 2009



Source: Thomson Reuters Datastream.

The latter part of the second time period, from Q4 2007 to Q1 2009, was a period of dramatic declines in global share prices. Exhibit 8 shows the mean annual returns and standard deviation of returns for this time period.

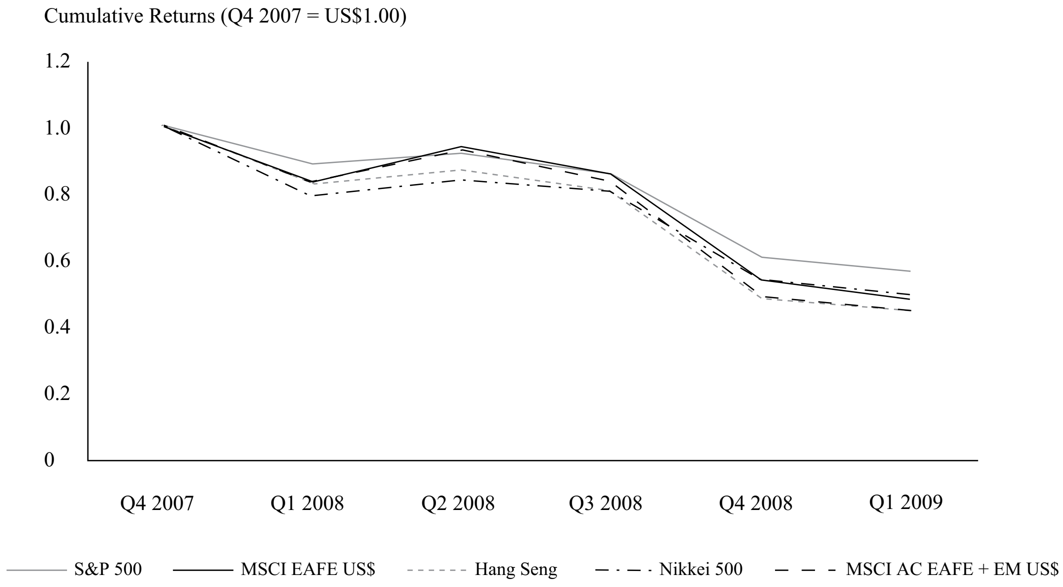
Exhibit 8: Returns to Global Equity Indexes

	Q4 1993–Q3 2000		Q1 2006–Q1 2009		Q4 2007–Q1 2009	
Global Index	**Mean**	**Stand. Dev.**	**Mean**	**Stand. Dev.**	**Mean**	**Stand. Dev.**
S&P 500	20.5%	13.9%	−6.3%	21.1%	−40.6%	23.6%
MSCI EAFE US$	10.9	14.2	−3.5	29.4	−48.0	35.9
Hang Seng	20.4	35.0	5.1	34.2	−53.8	34.0
Nikkei 500	3.3	18.0	−13.8	27.6	−48.0	30.0
MSCI AC EAFE + EM US$	7.6	13.2	−4.9	30.9	−52.0	37.5
Randomly selected index	12.6%	18.9%	−4.7%	28.6%	−48.5%	32.2%
Equally weighted portfolio	12.6%	14.2%	−4.7%	27.4%	−48.5%	32.0%
Diversification ratio		75.1%		95.8%		99.4%

Source: Thomson Reuters Datastream.

During the period Q4 2007 through Q1 2009, the average return for the equally weighted portfolio, including dividends, was −48.5 percent. Other than reducing the risk of earning the return of the worst performing market, the diversification benefits were small. Exhibit 9 shows the cumulative quarterly returns of each of the five indexes over this time period. All of the indexes declined in unison. The lesson is that although portfolio diversification generally does reduce risk, it does not necessarily provide the same level of risk reduction during times of severe market turmoil as it does when the economy and markets are operating ‘normally’. In fact, if the economy or markets fail totally (which has happened numerous times around the world), then diversification is a false promise. In the face of a worldwide contagion, diversification was ineffective, as illustrated at the end of 2008.

Exhibit 9: Return to Global Equity Indexes Q4 2007–Q1 2009



Source: Thomson Reuters Datastream.

KNOWLEDGE CHECK

Portfolios are *most likely* to provide:

- **A.** risk reduction.
- **B.** risk elimination.
- **C.** downside protection.

Solution:

A is correct. Combining assets into a portfolio should reduce the portfolio's volatility. However, the portfolio approach does not necessarily provide downside protection or eliminate all risk.

Portfolios: Modern Portfolio Theory

The concept of diversification has been around for a long time and has a great deal of intuitive appeal. However, the actual theory underlying this basic concept and its application to investments only emerged in 1952 with the publication of Harry Markowitz's classic article on portfolio selection.[8] The article provided the foundation for what is now known as **modern portfolio theory** (MPT). The main conclusion of MPT is that investors should not only hold portfolios but should also focus on how individual securities in the portfolios are related to one another. In addition to the

8 Markowitz (1952).

diversification benefits of portfolios to investors, the work of William Sharpe (1964), John Lintner (1965), and Jack Treynor (1961) demonstrated the role that portfolios play in determining the appropriate individual asset risk premium (i.e., the return in excess of the risk-free return expected by investors as compensation for the asset's risk). According to capital market theory, the priced risk of an individual security is affected by holding it in a well-diversified portfolio. The early research provided the insight that an asset's risk should be measured in relation to the remaining systematic or non-diversifiable risk, which should be the only risk that affects the asset's price. This view of risk is the basis of the capital asset pricing model, or CAPM, which is discussed in greater detail in other readings. Although MPT has limitations, the concepts and intuitions illustrated in the theory continue to be the foundation of knowledge for portfolio managers.

STEPS IN THE PORTFOLIO MANAGEMENT PROCESS

4

☐ describe the steps in the portfolio management process

In the previous section we discussed a portfolio approach to investing. When establishing and managing a client's investment portfolio, certain critical steps are followed in the process. We describe these steps in this section.

- The Planning Step
  - Understanding the client's needs
  - Preparation of an investment policy statement (IPS)
- The Execution Step
  - Asset allocation
  - Security analysis
  - Portfolio construction
- The Feedback Step
  - Portfolio monitoring and rebalancing
  - Performance measurement and reporting

Step One: The Planning Step

The first step in the investment process is to understand the client's needs (objectives and constraints) and develop an **investment policy statement** (IPS). A portfolio manager is unlikely to achieve appropriate results for a client without a prior understanding of the client's needs. The IPS is a written planning document that describes the client's investment objectives and the constraints that apply to the client's portfolio. The IPS may state a benchmark—such as a particular rate of return or the performance of a particular market index—that can be used in the feedback stage to assess the performance of the investments and whether objectives have been met. The IPS should be reviewed and updated regularly (for example, either every three years or when a major change in a client's objectives, constraints, or circumstances occurs).

Step Two: The Execution Step

The next step is for the portfolio manager to construct a suitable portfolio based on the IPS of the client. The portfolio execution step consists of first deciding on a target asset allocation, which determines the weighting of asset classes to be included in the portfolio. This step is followed by the analysis, selection, and purchase of individual investment securities.

Asset Allocation

The next step in the process is to assess the risk and return characteristics of the available investments. The analyst forms economic and capital market expectations that can be used to form a proposed allocation of asset classes suitable for the client. Decisions that need to be made in the **asset allocation** of the portfolio include the distribution between equities, fixed-income securities, and cash; sub-asset classes, such as corporate and government bonds; and geographical weightings within asset classes. Alternative assets—such as real estate, commodities, hedge funds, and private equity—may also be included.

Economists and market strategists may set the top down view on economic conditions and broad market trends. The returns on various asset classes are likely to be affected by economic conditions; for example, equities may do well when economic growth has been unexpectedly strong whereas bonds may do poorly if inflation increases. The economists and strategists will attempt to forecast these conditions.

Top down—A **top-down analysis** begins with consideration of macroeconomic conditions. Based on the current and forecasted economic environment, analysts evaluate markets and industries with the purpose of investing in those that are expected to perform well. Finally, specific companies within these industries are considered for investment.

Bottom up—Rather than emphasizing economic cycles or industry analysis, a **bottom-up analysis** focuses on company-specific circumstances, such as management quality and business prospects. It is less concerned with broad economic trends than is the case for top-down analysis, but instead focuses on company specifics.

Security Analysis

The top-down view can be combined with the bottom-up insights of security analysts who are responsible for identifying attractive investments in particular market sectors. They will use their detailed knowledge of the companies and industries they cover to assess the expected level and risk of the cash flows that each security will produce. This knowledge allows the analysts to assign a valuation to the security and identify preferred investments.

Portfolio Construction

The portfolio manager will then construct the portfolio, taking account of the target asset allocation, security analysis, and the client's requirements as set out in the IPS. A key objective will be to achieve the benefits of diversification (i.e., to avoid putting all the eggs in one basket). Decisions need to be taken on asset class weightings, sector weightings within an asset class, and the selection and weighting of individual securities or assets. The relative importance of these decisions on portfolio performance depends at least in part on the investment strategy selected; for example, consider an investor that actively adjusts asset sector weights in relation to forecasts of sector performance and one who does not. Although all decisions have an effect on portfolio performance, the asset allocation decision is commonly viewed as having the greatest impact.

Exhibit 10 shows the broad portfolio weights of the endowment funds of Yale University and the University of Virginia as of June 2017. As you can see, the portfolios have a heavy emphasis on such alternative assets as hedge funds, private equity, and real estate—Yale University particularly so.

Exhibit 10: Endowment Portfolio Weights, June 2017

Asset Class	Yale University Endowment	University of Virginia Endowment
Public equity	19.1%	26.7%
Fixed income	4.6	9.1
Private equity	14.2	15.7
Real assets (e.g., real estate)	18.7	12.1
Absolute return (e.g., hedge funds)	25.1	19.6
Cash	1.2	2.3
Other	17.2	14.5
Portfolio value	US$27.2bn	US$8.6bn

Sources: "2017 Yale Endowment Annual Report" (p. 2): www.yale.edu/investments/Yale_Endowment_17.pdf; "University of Virginia Investment Management Company Annual Report 2017" (p. 26): http://uvm-web.eservices.virginia.edu/public/reports/FinancialStatements_2017.pdf.

Risk management is an important part of the portfolio construction process. The client's risk tolerance will be set out in the IPS, and the portfolio manager must make sure the portfolio is consistent with it. As noted above, the manager will take a diversified portfolio perspective: What is important is not the risk of any single investment, but rather how all the investments perform as a portfolio.

The endowments shown above are relatively risk tolerant investors. Contrast the asset allocation of the endowment funds with the portfolio mix of the insurance companies shown in Exhibit 11. You will notice that the majority of the insurance assets are invested in fixed-income investments, typically of high quality. Note that the Yale University portfolio has less than 5 percent invested in fixed income, with the remainder invested in such growth assets as equity, real estate, and hedge funds. This allocation is in sharp contrast to the Massachusetts Mutual Life Insurance Company (MassMutual) portfolio, which is 80 percent invested in bonds, mortgages, loans, and cash—reflecting the differing risk tolerance and constraints (life insurers face regulatory constraints on their investments).

Exhibit 11: MassMutual Portfolio, December 2017[9]

Asset Classes	Portfolio %
Bonds	56%
Preferred and common shares	9
Mortgages	14
Real estate	1
Policy loans	8
Partnerships	5
Other assets	5
Cash	2

Source: "MassMutual Financial Group 2017 Annual Report" (p. 8): www.massmutual.com/mmfg/docs/annual_report/index.html.

The portfolio construction phase also involves trading. Once the portfolio manager has decided which securities to buy and in what amounts, the securities must be purchased. In many investment firms, the portfolio manager will pass the trades to a buy-side trader—a colleague who specializes in securities trading—who will contact a stockbroker or dealer to have the trades executed.

Step Three: The Feedback Step

Finally, the feedback step assists the portfolio manager in rebalancing the portfolio due to a change in, for example, market conditions or the circumstances of the client.

Portfolio Monitoring and Rebalancing

Once the portfolio has been constructed, it needs to be monitored and reviewed and the composition revised as the security analysis changes because of changes in security prices and changes in fundamental factors. When security and asset weightings have drifted from the intended levels as a result of market movements, some rebalancing may be required. The portfolio may also need to be revised if it becomes apparent that the client's needs or circumstances have changed.

Performance Evaluation and Reporting

Finally, the performance of the portfolio must be evaluated, which will include assessing whether the client's objectives have been met. For example, the investor will wish to know whether the return requirement has been achieved and how the portfolio has performed relative to any benchmark that has been set. Analysis of performance may suggest that the client's objectives need to be reviewed and perhaps changes made to the IPS. As we will discuss in the next section, there are numerous investment products that clients can use to meet their investment needs. Many of these products are diversified portfolios that an investor can purchase.

9 Asset class definitions: Bonds—Debt instruments of corporations and governments as well as various types of mortgage- and asset-backed securities; Preferred and Common Shares—Investments in preferred and common equities; Mortgages—Mortgage loans secured by various types of commercial property as well as residential mortgage whole loan pools; Real Estate—Investments in real estate; Policy Loans—Loans by policyholders that are secured by insurance and annuity contracts; Partnerships—Investments in partnerships and limited liability companies; Cash—Cash, short-term investments, receivables for securities, and derivatives. Cash equivalents have short maturities (less than one year) or are highly liquid and able to be readily sold.

TYPES OF INVESTORS

5

- ☐ describe types of investors and distinctive characteristics and needs of each
- ☐ describe defined contribution and defined benefit pension plans

The portfolio management process described in the previous section may apply to different types of investment clients. Such clients are broadly divided among individual (or retail) and institutional investors. Each of these segments has distinctive characteristics and needs, as discussed in the following sub-sections.

Individual Investors

Individual investors have a variety of motives for investing and constructing portfolios. Short-term goals can include providing for children's education, saving for a major purchase (such as a vehicle or a house), or starting a business. The retirement goal—investing to provide for an income in retirement—is a major part of the investment planning of most individuals. Many employees of public and private companies invest for retirement through **defined contribution pension plans** (DC plans). DC plans are retirement plans in the employee's name usually funded by both the employee and the employer. Examples include 401(k) plans in the United States, group personal pension schemes in the United Kingdom, and superannuation plans in Australia. With DC plans, individuals will invest part of their wages while working, expecting to draw on the accumulated funds to provide income during retirement or to transfer some of their wealth to their heirs. The key to a DC plan is that the employee accepts the investment and inflation risk and is responsible for ensuring that there are enough assets in the plan to meet their needs upon retirement.

Some individuals will be investing for growth and will therefore seek assets that have the potential for capital gains. Others, such as retirees, may need to draw an income from their assets and may therefore choose to invest more in fixed-income and dividend-paying shares. The investment needs of individuals will depend in part on their broader financial circumstances, such as their employment prospects and whether or not they own their own residence. They may also need to consider such issues as building up a cash reserve and the purchase of appropriate insurance policies before undertaking longer-term investments.

Asset managers serving individual investors typically distribute their products directly to investors or through intermediaries such as financial advisers and/or retirement plan providers. The distribution network for individual investors varies globally. In the United States, financial advisers are independent or employed by national or regional broker–dealers, banks, and trust companies. Additionally, many asset managers distribute investment strategies to investors through major online brokerage and custodial firms.

In Europe, retail investment product distribution is fragmented and, in turn, varies by country/region. In continental Europe, for example, distribution is primarily driven through financial advisers affiliated with retail and private banks. In the United Kingdom, products are sold through independent advisers as well as through advisers representing a bank or insurance group. Retail distribution in Switzerland and in the Nordic countries is driven mainly through large regional and private banks. In contrast to the United States and Europe, in many Asian markets retail distribution is dominated by large regional retail banks and global banks with private banking divisions.

Globally, many wealth management firms and asset managers target high-net-worth investors. These clients often require more customized investment solutions alongside tax and estate planning services.

Institutional Investors

Institutional investors primarily include defined benefit pension plans, endowments and foundations, banks, insurance companies, investment companies, and sovereign wealth funds. Each of these has unique goals, asset allocation preferences, and investment strategy needs.

Defined Benefit Pension Plans

Pension plans are typically categorized as either defined contribution (DC) or defined benefit (DB). We previously described DC plans, which relate to individual investors. **Defined benefit pension plans** (DB plans) are company-sponsored plans that offer employees a predefined benefit on retirement. The future benefit is defined because the DB plan requires the plan sponsor to specify the obligation stated in terms of the retirement income benefits owed to participants. Generally, employers are responsible for the contributions made to a DB plan and bear the risk associated with adequately funding the benefits offered to employees. Plans are committed to paying pensions to members, and the assets of these plans are there to fund those payments. Plan managers need to ensure that sufficient assets will be available to pay pension benefits as they come due. The plan may have an indefinitely long time horizon if new plan members are being admitted or a finite time horizon if the plan has been closed to new members. In some cases, the plan managers attempt to match the fund's assets to its liabilities by, for example, investing in bonds that will produce cash flows corresponding to expected future pension payments. There may be many different investment philosophies for pension plans, depending on funded status and other variables.

An ongoing trend is that plan sponsors increasingly favor DC plans over DB plans because DC plans typically have lower costs/risk to the company. As a result, DB plans have been losing market share of pension assets to DC plans. Nevertheless, DB plans, both public and private, remain sizable sources of investment funds for asset managers. As Exhibit 12 shows, global pension assets totaled more than US$41 trillion by the end of 2017. The United States, United Kingdom, and Japan represent the three largest pension markets in the world, comprising more than 76% of global pension assets.

Exhibit 12: Global Pension Assets (as of year-end 2017)

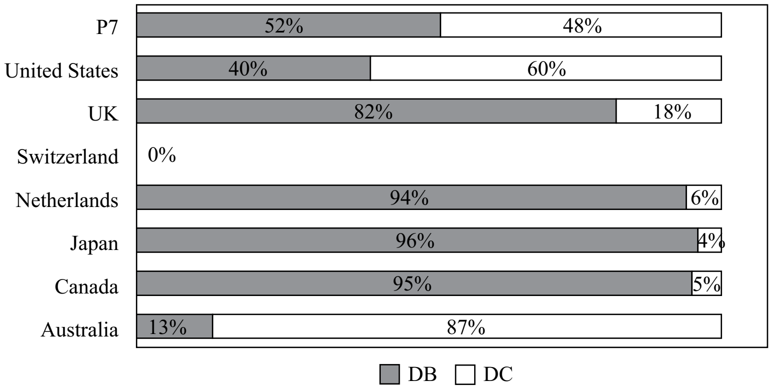
Country/Region	Total Assets (US$ billions)
United States	25,411
United Kingdom	3,111
Japan	3,054
Australia	1,924
Canada	1,769
Netherlands	1,598
Switzerland	906
South Korea	725
Germany	472
Brazil	269
South Africa	258

Country/Region	Total Assets (US$ billions)
Finland	233
Malaysia	227
Chile	205
Mexico	177
Italy	184
France	167
Chinese mainland	177
Hong Kong SAR	164
Ireland	157
India	120
Spain	44
Total	**41,355**

Note: Column does not sum precisely because of rounding.
Source: Willis Towers Watson.

By geography, the United States and Australia have a higher proportion of pension assets in DC plans, whereas Canada, Japan, the Netherlands, and the United Kingdom remain weighted toward DB plans (see Exhibit 13).

Exhibit 13: Pension Plan Type by Geography



Notes: "P7" represents the combination of the seven countries listed. No data were available for Switzerland for this study.

Sources: Willis Towers Watson and secondary sources.

Endowments and Foundations

Endowments are funds of non-profit institutions that help the institutions provide designated services. In contrast, foundations are grant-making entities. Endowments and foundations collectively represent an estimated US$1.6 trillion in assets in the United States, which is the primary market for endowments and foundations.

Endowments and foundations typically allocate a sizable portion of their assets in alternative investments (Exhibit 14). This large allocation to alternative investments primarily reflects the typically long time horizon of endowments and foundations, as well as the popularity of endowment-specific asset allocation models developed by Yale University's endowment managers David Swensen and Dean Takahashi.

Exhibit 14: Asset Allocations for US College and University Endowments and Affiliated Foundations (as of 30 June 2017, dollar weighted)

Asset Class	Percentage Allocation
Domestic equity	15
Fixed income	7
Foreign equity	20
Alternatives	54
Cash	4

Source: National Association of College and University Budget Officers and Commonfund Institute.

A typical investment objective of an endowment or a foundation is to maintain the real (inflation-adjusted) capital value of the fund while generating income to fund the objectives of the institution. Most foundations and endowments are established with the intent of having perpetual lives. Exhibit 15 describes the Yale University endowment's approach to balancing short-term spending needs with ensuring that future generations also benefit from the endowment, and it also shows the Wellcome Trust's approach. The investment approach undertaken considers the objectives and constraints of the institution (for example, no tobacco investments for a medical endowment).

Exhibit 15: Spending Rules

The following examples of spending rules are excerpts from the Yale University endowment (in the United States) and from the Wellcome Trust (in the United Kingdom).

Yale University Endowment

> The spending rule is at the heart of fiscal discipline for an endowed institution. Spending policies define an institution's compromise between the conflicting goals of providing substantial support for current operations and preserving purchasing power of Endowment assets. The spending rule must be clearly defined and consistently applied for the concept of budget balance to have meaning.
>
> The Endowment spending policy, which allocates Endowment earnings to operations, balances the competing objectives of providing a stable flow of income to the operating budget and protecting the real value of the Endowment over time. The spending policy manages the trade-of between these two objectives by combining a long-term spending rate target with a smoothing rule, which adjusts spending in any given year gradually in response to changes in Endowment market value.
>
> The target spending rate approved by the Yale Corporation currently stands at 5.25%. According to the smoothing rule, Endowment spending in a given year sums to 80% of the previous year's spending and 20% of the targeted long-term spending rate applied to the fiscal year-end market value two years prior.

Source: 2017 Yale Endowment Annual Report (p.18) [http://investments.yale.edu/endowment-update/]

Wellcome Trust

> Our overall investment objective is to generate 4.5% percent real return over the long term.
>
> This is to provide for real increases in annual expenditure while reserving the Trust's capital base to balance the needs of current and future beneficiaries.
>
> We use this absolute return strategy because it aligns asset allocation with funding requirements and provides a competitive framework in which to judge individual investments.

Source: Wellcome Trust website (https://wellcome.ac.uk/about-us/investments)

Banks

Banks are financial intermediaries that accept deposits and lend money. Banks often have excess reserves that are invested in relatively conservative and very short-duration fixed-income investments, with a goal of earning an excess return above interest obligations due to depositors. Liquidity is a paramount concern for banks that stand ready to meet depositor requests for withdrawals. Many large banks have asset management divisions that offer retail and institutional products to their clients.

Insurance Companies

Insurance companies receive premiums for the policies they write, and they need to invest these premiums in a manner that will allow them to pay claims.

Insurance companies can be segmented into two broad types: life insurers and property and casualty (P&C) insurers. Insurance premiums from policyholders comprise an insurance company's general account. To pay claims to policyholders, regulatory guidelines maintain that an insurance company's general account is typically invested conservatively in a diverse allocation of fixed-income securities. General account portfolio allocations differ among life, P&C, and other specialty insurers (e.g., reinsurance) because of both the varying duration of liabilities and the unique liquidity considerations across insurance type.[10] In contrast to the general account, an insurer's surplus account is the difference between its assets and liabilities. An insurer's surplus account typically targets a higher return than the general account and thus often invests in less-conservative asset classes, such as public and private equities, real estate, infrastructure, and hedge funds.

Many insurance companies have in-house portfolio management teams responsible for managing general account assets. Some insurance companies offer portfolio management services and products in addition to their insurance offerings. An increasing trend among insurers (particularly in the United States) is outsourcing some of the portfolio management responsibilities—primarily sophisticated alternative asset classes—to unaffiliated asset managers. Several insurers manage investments for third-party clients, often through separately branded subsidiaries.

Sovereign Wealth Funds

Sovereign wealth funds (SWFs) are state-owned investment funds or entities that invest in financial or real assets. SWFs do not typically manage specific liability obligations, such as pensions, and have varying investment horizons and objectives based on funding the government's goals (for example, budget stabilization or future

10 For example, life insurers tend to invest in longer-term assets (e.g., 30-year government and corporate bonds) relative to P&C insurers because of the longer-term nature of their liabilities.

development projects). SWF assets more than doubled from 2007 to March 2018, totaling more than US$7.6 trillion.[11] Exhibit 16 lists the 10 largest SWFs in the world. The largest SWFs tend to be concentrated in Asia and in natural resource-rich places.

Exhibit 16: Largest Sovereign Wealth Funds (as of August 2018, in US$ billions)

Place	Sovereign Wealth Fund (Inception Year)	Assets
Norway	Government Pension Fund—Global (1990)	1,058
Chinese Mainland	China Investment Corporation (2007)	941
UAE – Abu Dhabi	Abu Dhabi Investment Authority (1976)	683
Kuwait	Kuwait Investment Authority (1953)	592
Hong Kong SAR	Hong Kong Monetary Authority Investment Portfolio (1993)	523
Saudi Arabia	SAMA Foreign Holdings (1952)	516
Chinese Mainland	SAFE Investment Company (1997)	441
Singapore	Government of Singapore Investment Authority (1981)	390
Singapore	Temasek Holdings (1974)	375
Saudi Arabia	Public Investment Fund (2008)	360
Total SWF Assets under Management		**8,109**

Source: SWF Institute (www.swfinstitute.org).

Investment needs vary across client groups. With some groups of clients, generalizations are possible. In other groups, needs vary by client. Exhibit 17 summarizes needs within each group.

Exhibit 17: Summary of Investment Needs by Client Type

Client	Time Horizon	Risk Tolerance	Income Needs	Liquidity Needs
Individual investors	Varies by individual	Varies by individual	Varies by individual	Varies by individual
Defined benefit pension plans	Typically long term	Typically quite high	High for mature funds; low for growing funds	Varies by maturity of the plan
Endowments and foundations	Very long term	Typically high	To meet spending commitments	Typically quite low
Banks	Short term	Quite low	To pay interest on deposits and operational expenses	High to meet repayment of deposits
Insurance companies	Short term for property and casualty; long term for life insurance companies	Typically quite low	Typically low	High to meet claims

11 SWFI, "Sovereign Wealth Fund Rankings" (https://www.swfinstitute.org/sovereign-wealth-fund-rankings/ ; retrieved October 2018).

Client	Time Horizon	Risk Tolerance	Income Needs	Liquidity Needs
Investment companies	Varies by fund	Varies by fund	Varies by fund	High to meet redemptions
Sovereign wealth funds	Varies by fund	Varies by fund	Varies by fund	Varies by fund

THE ASSET MANAGEMENT INDUSTRY

6

☐ describe aspects of the asset management industry

The portfolio management process and investor types are broad components of the asset management industry, which is an integral component of the global financial services sector. At the end of 2017, the industry managed more than US$79 trillion of assets owned by a broad range of institutional and individual investors (Exhibit 18).[12] Although nearly 80% of the world's professionally managed assets are in North America and Europe, the fastest-growing markets are in Asia and Latin America.

Exhibit 18: Global Assets under Management (AUM) by Region (year-end 2017)

	Market Size (US$ trillions)	Market Share (%)
North America	37.4	47%
Europe	22.2	28
Japan and Australia	6.2	8
Chinese mainland	4.2	5
Asia (excluding Japan, Australia, and Chinese mainland)	3.5	4
Latin America	1.8	2
Middle East and Africa	1.4	2
Total Global AUM	79.2	100%

Notes: Total Global AUM in this exhibit represents assets professionally managed in exchange for a fee. The total of US$79.2 trillion includes certain offshore assets that are not represented in the specific regional categories above.
Source: Boston Consulting Group.

The asset management industry is highly competitive. The universe of firms in the industry is broad, ranging from "pure-play" independent asset managers to diversified commercial banks, insurance companies, and brokerages that offer asset management services in addition to their core business activities. Given the increasingly global nature of the industry, many asset managers have investment research and distribution offices around the world. An asset manager is commonly referred to as a

12 http://image-src.bcg.com/Images/BCG-Seizing-the-Analytics-Advantage-June-2018-R-3_tcm9-194512.pdf (accessed on 6 September 2018).

buy-side firm given that it uses (buys) the services of sell-side firms. A **sell-side firm** is a broker/dealer that sells securities and provides independent investment research and recommendations to their clients (i.e., buy-side firms).

Asset managers offer a broad range of strategies. Specialist asset managers may focus on a specific asset class (e.g., emerging market equities) or style (e.g., quantitative investing), while "full service" managers typically offer a wide variety of asset classes and styles. Another type of asset manager firm is a "multi-boutique," in which a holding company owns several asset management firms that typically have specialized investment strategies. The multi-boutique structure allows individual asset management firms to retain their own unique investment cultures—and often equity ownership stakes—while also benefiting from the centralized, shared services of the holding company (e.g., technology, sales and marketing, operations, and legal services).

Active versus Passive Management

Asset managers may offer either active or passive management. As of year-end 2017, active management considerably exceeded passive management in terms of global assets under management and industry revenue (Exhibit 19), although passive management has demonstrated significant growth.

Exhibit 19: Global Asset Management Industry Assets and Revenue (as of year-end 2017)

Category	Assets (US$ trillions)	Revenue (US$ billions)	Market Share by Assets (%)	Market Share by Revenue (%)
Actively Managed	**64**	**258**	**80%**	**94%**
Alternatives	12	117	15	43
Active Specialties	15	55	19	20
Multi Asset Class	11	27	14	10
Core	26	59	33	21
Passively Managed	**16**	**17**	**20%**	**6%**
Total	**80**	**275**	**100%**	**100%**

Note: Some columns may not sum precisely because of rounding.
Source: Boston Consulting Group.

Through fundamental research, quantitative research, or a combination of both, active asset managers generally attempt to outperform either predetermined performance benchmarks, such as the S&P 500, or, for multi-asset class portfolios, a combination of benchmarks. In contrast to active managers, passive managers attempt to replicate the returns of a market index. Despite the rise of passive management in asset share, its share of industry revenue remains small given the low management fees relative to active management. As Exhibit 19 illustrates, passive management represents a fifth of global assets under management but only 6% of industry revenue.

Asset managers are increasingly offering other strategies beyond traditional market-cap-weighted exposures. Some of these other strategies, commonly known as **smart beta**, are based on such factors as size, value, momentum, or dividend characteristics. Smart beta involves the use of simple, transparent, rules-based strategies as a basis for investment decisions. Typically, smart beta strategies feature somewhat higher management fees and higher portfolio turnover relative to passive market-cap weighted strategies.

Traditional versus Alternative Asset Managers

Asset managers are typically categorized as either "traditional" or "alternative." Traditional managers generally focus on long-only equity, fixed-income, and multi-asset investment strategies, generating most of their revenues from asset-based management fees. Alternative asset managers, however, focus on hedge fund, private equity, and venture capital strategies, among others, while generating revenue from both management and performance fees (or "carried interest"). As Exhibit 19 demonstrates, alternative asset managers have a relatively low proportion of total global assets under management but generate a disproportionately high total of industry revenue.

Increasingly, the line between traditional and alternative managers has blurred. Many traditional managers have introduced higher-margin alternative products to clients. Concurrently, alternative managers seeking to reduce the revenue volatility associated with performance fees have increasingly offered retail versions of their institutional alternative strategies (typically referred to as "liquid alternatives") as well as long-only investment strategies. These liquid alternatives are often offered through highly regulated pooled investment products (e.g., mutual funds) and typically feature less leverage, no performance fees, and more liquid holdings than typical alternative products.

Ownership Structure

The ownership structure of an asset manager can play an important role in retaining and incentivizing key personnel. Portfolio managers who have personal capital invested in their firms or investment strategies are often viewed favorably by potential investors because of perceived alignment of management and client interests.

The majority of asset management firms are privately owned, typically by individuals who either established their firms or play key roles in their firms' management. Privately owned firms are typically structured as limited liability companies or limited partnerships.

While less common than privately owned managers, publicly traded asset managers have substantial assets under management. A prevalent ownership form in the industry is represented by asset management divisions of large, diversified financial services companies that offer asset management alongside insurance and banking services.

Asset Management Industry Trends

The asset management industry is evolving and continues to be shaped by socio-economic trends, shifting investor demands, advances in technology, and the expansion of global capital markets. Three key trends that we discuss in this section include the growth of passive investing, "big data" in the investment process, and the emergence of robo-advisers in the wealth management industry.

Growth of Passive Investing

As we saw in Exhibit 19, passively managed assets comprised nearly a fifth of global assets under management at the end of 2017. Management of passive assets is concentrated among a reasonably small group of asset managers and tends to be concentrated in equity strategies. As shown in Exhibit 20, the top three managers account for 70% of industry's assets. One key catalyst supporting the growth of passive investing is low cost for investors—management fees for index (or other passive) funds are often a fraction of those for active strategies. Another catalyst is the challenge that many active asset managers face in generating ex ante alpha, especially in somewhat more-efficiently priced markets, such as large-cap US equities.

Exhibit 20: Top Five ETP Managers Globally (as of 30 July 2017)

ETP Provider	Assets (US$ billions)	Market Share (%)
iShares	1,583	37
Vanguard	803	19
State Street Global Advisors	596	14
PowerShares	132	3
Nomura	100	2

Source: ETFGI.

Use of "Big Data" in the Investment Process

The prevalence of new data is extraordinary: In 2013, IBM estimated that 90% of the world's entire universe of data was created in the previous two years. The digitization of data and an exponential increase in computing power and data storage capacity have expanded additional information sources for asset managers. Massive amounts of data containing information of potential value to investors are created and captured daily. These data include both structured data—such as order book data and security returns—and data lacking recognizable structure, which is generated by a vast number of activities on the internet and elsewhere (e.g., compiled search information). The term "big data" is used to refer to these massively large datasets and their analysis.

Asset managers are using advanced statistical and machine-learning techniques to help process and analyze these new sources of data. Such techniques are used in both fundamentally driven and quantitatively driven investment processes. For example, computers are used to "read" earnings and economic data releases much faster than humans can and react with short-term trading strategies.

Third-party research vendors are supplying a vast range of relevant new data for asset managers, such as data used for time-series and predictive models. Among the most popular new sources of data are social media data and imagery and sensor data.

- **Social media data**. Real-time media and content outlets, such as Twitter and Facebook, provide meaningful market and company-specific announcements for investors and asset managers. In addition, the aggregation and analysis of social media users can aid key market sentiment indicators (e.g., short-term directional market movements) and indicate potential specific user trends related to products and services.
- **Imagery and sensor data**. Satellite imagery and geolocation devices provide vast real-time data to investment professionals. As the cost of launching and maintaining satellites has decreased, more satellites have been launched to track sensors and imagery that are relevant to economic considerations (e.g., weather conditions, cargo ship traffic patterns) and company-specific considerations (e.g., retailer parking capacity/usage, tracking of retail customers).

The challenge for asset managers is to discover data with predictive potential and to do so faster than fellow market participants. Many market participants are participating in an "information arms race" that has required substantial investments in specialized human capital (e.g., programmers, data scientists), technology, and information technology infrastructure to effectively convert various forms of structured and unstructured data into alpha-generating portfolio and security-level decisions.

Robo-Advisers: An Expanding Wealth Management Channel

Robo-advisers represent technology solutions that use automation and investment algorithms to provide several wealth management services—notably, investment planning, asset allocation, tax loss harvesting, and investment strategy selection. Investment and advice services provided by robo-advisers typically reflect an investor's general investment goals and risk tolerance preferences (often obtained from an investor questionnaire). Robo-adviser platforms range from exclusively digital investment advice platforms to hybrid offerings that offer both digital investment advice and the services of a human financial adviser.

At the end of 2017, robo-advisers managed an estimated US$180 billion in assets,[13] and market participants expect that number to grow considerably over time. This expected rapid growth in robo-advisory assets is based on several industry trends:

- **Growing demand from "mass affluent" and younger investors**: Traditional investment advice has often underserved younger and "mass affluent" investors with lower relative levels of investable assets. Given the efficiencies of robo-advisers and the scalability of technology, customized but standardized investment advice now can be offered to a wide range and size of investors.
- **Lower fees**: The cost of digital investment advice provided by robo-advisers is often a fraction of traditional investment advice channels because of scalability. For example, in the United States, a typical financial adviser may charge a 1% annual advisory fee[14] based on a client's assets, while robo-adviser fees typically average 0.20% annually.[15] Additionally, robo-advisers often rely on lower fee underlying portfolio investment options, such as index funds or ETFs, when constructing portfolios for clients.
- **New entrants**: Reflecting low barriers to entry, large wealth management firms have introduced robo-adviser solutions to service certain customer segments and appeal to a new generation of investors. In addition to these large wealth managers, other less-traditional entrants, such as insurance companies and asset managers, are developing solutions to cross-sell into their existing clients. Many market observers expect that non-financial firms (large technology leaders) will also become key players in the robo-adviser industry as they look to monetize their access to user data.

POOLED INTEREST - MUTUAL FUNDS 7

☐ describe mutual funds and compare them with other pooled investment products

In the asset management industry, a challenge faced by all investors is to find the right set of investment products to meet their needs. There is a diverse set of investment products available to investors, ranging from a simple brokerage account in which

13 S&P Global Market Intelligence.

14 http://www.riainabox.com/blog/2016-ria-industry-study-average-investment-advisory-fee-is-0-99-percent.

15 Deloitte, "Robo-Advisors Capitalizing on a Growing Opportunity" (https://www2.deloitte.com/content/dam/Deloitte/us/Documents/strategy/us-cons-robo-advisors.pdf).

the individual creates her own portfolio by assembling individual securities, to large institutions that employ individual portfolio managers to meet clients' investment management needs. Among the major investment products offered by asset managers are mutual funds and other pooled investment products, such as separately managed accounts, exchange-traded funds, hedge funds, and private equity/venture capital funds.

Mutual Funds

Rather than assemble a portfolio on their own, individual investors and institutions can turn over the selection and management of their investment portfolio to a third party. One way of doing this is through a **mutual fund**. This type of fund is a comingled investment pool in which investors in the fund each have a pro-rata claim on the income and value of the fund. The value of a mutual fund is referred to as the "net asset value." It is computed daily based on the closing price of the securities in the portfolio.

Mutual funds represent a primary investment product of individual investors globally. According to the International Investment Funds Association, worldwide regulated open-end fund assets totaled US$50 trillion as of the first quarter of 2018. Exhibit 21 shows the growth of global open-end funds over the past five years by region. Mutual funds provide several advantages, including low investment minimums, diversified portfolios, daily liquidity, and standardized performance and tax reporting.

Exhibit 21: Worldwide Regulated Open-End Funds: Total Net Assets (as of year-end, in US$ trillions)

	2011	2012	2013	2014	2015	2016	Q1 2018
World	**27.9**	**31.9**	**36.3**	**38.0**	**38.2**	**40.4**	**50.0**
Americas	14.6	16.5	18.9	20.0	19.6	21.1	24.9
Europe	10.3	11.9	13.6	13.8	13.7	14.1	18.1
Asia and Pacific	2.9	3.3	3.7	4.1	4.7	5.0	6.8
Africa	0.1	0.1	0.1	0.1	0.1	0.1	0.2

Notes: Components may not add to the total because of rounding. Regulated open-end funds include mutual funds, exchange-traded funds (ETFs), and institutional funds.
Source: International Investment Funds Association (IIFA).

Mutual funds are one of the most important investment vehicles for individuals and institutions. The best way to understand how a mutual fund works is to consider a simple example. Suppose that an investment firm wishes to start a mutual fund with a target amount of US$10 million. It is able to reach this goal through investments from five individuals and two institutions. The investment of each is as follows:

Investor	Amount Invested (US$)	Percent of Total	Number of Shares
Individuals			
A	$1.0 million	10%	10,000
B	1.0	10	10,000
C	0.5	5	5,000
D	2.0	20	20,000
E	0.5	5	5,000
Institutions			
X	2.0	20	20,000

Investor	Amount Invested (US$)	Percent of Total	Number of Shares
Y	3.0	30	30,000
Totals	**$10.0 million**	**100%**	**100,000**

Based on the US$10 million value (net asset value), the investment firm sets a total of 100,000 shares at an initial value of US$100 per share (US$10 million/100,000 = US$100). The investment firm will appoint a portfolio manager to be responsible for the investment of the US$10 million. Going forward, the total value of the fund or net asset value will depend on the value of the assets in the portfolio.

The fund can be set up as an open-end fund or a closed-end fund. If it is an **open-end fund**, it will accept new investment money and issue additional shares at a value equal to the net asset value of the fund at the time of investment. For example, assume that at a later date the net asset value of the fund increases to US$12 million and the new net asset value per share is US$120. A new investor, F, wishes to invest US$0.96 million in the fund. If the total value of the assets in the fund is now US$12 million or US$120 per share, in order to accommodate the new investment the fund would create 8,000 (US$0.96 million/US$120) new shares. After this investment, the net asset value of the fund would be US$12.96 million and there would be a total of 108,000 shares.

Funds can also be withdrawn at the net asset value per share. Suppose on the same day Investor E wishes to withdraw all her shares in the mutual fund. To accommodate this withdrawal, the fund will have to liquidate US$0.6 million in assets to retire 5,000 shares at a net asset value of US$120 per share (US$0.6 million/US$120). The combination of the inflow and outflow on the same day would be as follows:

Type	Investment (US$)	Shares
Inflow (Investor F buys)	$960,000	8,000
Outflow (Investor E sells)	–$600,000	–5,000
Net	$360,000	3,000

The net of the inflows and outflows on that day would be US$360,000 of new funds to be invested and 3,000 new shares created. However, the number of shares held and the value of the shares of all remaining investors, except Investor E, would remain the same.

An alternative to setting the fund up as an open-end fund would be to create a **closed-end fund** in which no new investment money is accepted into the fund. New investors invest by buying existing shares, and investors in the fund liquidate by selling their shares to other investors. Hence, the number of outstanding shares does not change. One consequence of this fixed share base is that, unlike open-end funds in which new shares are created and sold at the current net asset value per share, closed-end funds can sell for a premium or discount to net asset value depending on the demand for the shares.

There are advantages and disadvantages to each type of fund. The open-end fund structure makes it easy to grow in size but creates pressure on the portfolio manager to manage the cash inflows and outflows. One consequence of this structure is the need to liquidate assets that the portfolio manager might not want to sell at the time to meet redemptions. Conversely, the inflows require finding new assets in which to invest. As such, open-end funds tend not to be fully invested but rather keep some cash for redemptions not covered by new investments. Closed-end funds do not have these problems, but they do have a limited ability to grow. Of the total net asset value of all US mutual funds at the end of 2017 (US$19 trillion), only approximately 1 percent were in the form of closed-end funds.

In addition to open-end or closed-end funds, mutual funds can be classified as load or no-load funds. The primary difference between the two is whether the investor pays a sales charge (a "load") to purchase, hold, or redeem shares in the fund. In the case of the **no-load fund**, there is no fee for investing in the fund or for redemption but there is an annual fee based on a percentage of the fund's net asset value. **Load funds** are funds in which, in addition to the annual fee, a percentage fee is charged to invest in the fund and/or for redemptions from the fund. In addition, load funds are usually sold through retail brokers who receive part of the upfront fee. Overall, the number and importance of load funds has declined over time.

8 POOLED INTEREST - TYPE OF MUTUAL FUNDS

☐ describe mutual funds and compare them with other pooled investment products

The following section introduces the major types of mutual funds differentiated by the asset type that they invest in: money market funds, bond mutual funds, stock mutual funds, and hybrid or balanced funds.

Money Market Funds

Money market funds are mutual funds that invest in short-term money market instruments such as treasury bills, certificates of deposit, and commercial paper. They aim to provide security of principal, high levels of liquidity, and returns in line with money market rates. Many funds operate on a constant net asset value (CNAV) basis where the share price is maintained at $1 (or local currency equivalent). Others operate on a variable net asset value (VNAV) basis where the unit price can vary. In the United States, there are two basic types of money market funds: taxable and tax-free. Taxable money market funds invest in high-quality, short-term corporate debt and federal government debt. Tax-free money market funds invest in short-term state and local government debt. Although money market funds have been a substitute for bank savings accounts since the early 1980s, they are not insured in the same way as bank deposits.

Bond Mutual Funds

A bond mutual fund is an investment fund consisting of a portfolio of individual bonds and, occasionally, preferred shares. The net asset value of the fund is the sum of the value of each bond in the portfolio divided by the number of shares. Investors in the mutual fund hold shares, which account for their pro-rata share or interest in the portfolio. The major difference between a bond mutual fund and a money market fund is the maturity of the underlying assets. In a money market fund the maturity is as short as overnight and rarely longer than 90 days. A bond mutual fund, however, holds bonds with maturities as short as one year and as long as 30 years (or more). Exhibit 22 illustrates the general categories of bond mutual funds.[16]

16 In the United States, judicial rulings on federal powers of taxation have created a distinction between (federally) taxable and (federally) tax-exempt bonds and a parallel distinction for US bond mutual funds.

Exhibit 22: Bond Mutual Funds

Type of Bond Mutual Fund	Securities Held
Global	Domestic and non-domestic government, corporate, and securitized debt
Government	Government bonds and other government-affiliated bonds
Corporate	Corporate debt
High yield	Below investment-grade corporate debt
Inflation protected	Inflation-protected government debt
National tax-free bonds	National tax-free bonds (e.g., US municipal bonds)

Stock Mutual Funds

Historically, the largest types of mutual funds based on market value of assets under management are stock (equity) funds.

There are two types of stock mutual funds. The first is an actively managed fund in which the portfolio manager seeks outstanding performance through the selection of the appropriate stocks to be included in the portfolio. Passive management is followed by index funds that are very different from actively managed funds. Their goal is to match or track the performance of different indexes. The first index fund was introduced in 1976 by the Vanguard Group.

There are several major differences between actively managed funds and index funds. First, management fees for actively managed funds are higher than for index funds. The higher fees for actively managed funds reflect its goal to outperform an index, whereas the index fund simply aims to match the return on the index. Higher fees are required to pay for the research conducted to actively select securities. A second difference is that the level of trading in an actively managed fund is much higher than in an index fund, which depending on the jurisdiction, has tax implications. Mutual funds are often required to distribute all income and capital gains realized in the portfolio, so the actively managed fund tends to have more opportunity to realize capital gains. This results in higher taxes relative to an index fund, which uses a buy-and-hold strategy. Consequently, there is less buying and selling in an index fund and less likelihood of realizing capital gains distributions.

Hybrid/Balanced Funds

Hybrid or balanced funds are mutual funds that invest in both bonds and stocks. These types of funds represent a small fraction of the total investment in US mutual funds but are more common in Europe. These types of funds, however, have gained popularity with the growth of lifecycle funds. Lifecycle or Target Date funds manage the asset mix based on a desired retirement date. For example, if an investor is 40 years old in 2019 and planned to retire at the age of 67, he could invest in a mutual fund with a target date of 2046 and the fund would manage the appropriate asset mix over the next 27 years. In 2019 it might be 90 percent invested in shares and 10 percent in bonds. As time passes, however, the fund would gradually change the mix of shares and bonds to reflect the appropriate mix given the time to retirement.

9 POOLED INTEREST - OTHER INVESTMENT PRODUCTS

☐ describe mutual funds and compare them with other pooled investment products

A fund management service for institutions or individual investors with substantial assets is the **separately managed account** (SMA), which is also commonly referred to as a "managed account," "wrap account," or "individually managed account."

SMAs are managed exclusively for the benefit of a single individual or institution. Unlike a mutual fund, the assets of an SMA are owned directly by the individual or institution. The main disadvantage of an SMA is that the required minimum investment is usually much higher than with a mutual fund.

Large institutional investors are generally the dominant users of SMAs. SMAs enable asset managers to implement an investment strategy that matches an investor's specific objectives, portfolio constraints, and tax considerations, where applicable. For example, a public pension plan investing in an asset manager's large value equity strategy might have a socially responsible investment preference. In this case, the plan sponsor may wish to exclude certain industries, such as tobacco and defense, while also including additional companies that are deemed favorable according to other environmental, social, and governance (ESG) considerations.

Exchange-Traded Funds

Exchange-traded funds (ETFs) are investment funds that trade on exchanges (similar to individual stocks) and are generally structured as open-end funds. ETFs represent one of the fastest-growing investment products in the asset management industry. According to BlackRock, global ETF assets increased from US$428 billion in 2005 to US$4.9 trillion as of June 2018. Long-term investors—both institutional and retail—use ETFs in building a diversified asset allocation. While ETFs are structured similarly to open-end mutual funds, some key differences exist between the two products. One difference relates to transaction price. Because they are traded on exchanges, ETFs can be transacted (and are priced) intraday. That is, ETF investors buy the shares from other investors just as if they were buying or selling shares of stock. ETF investors can also short shares or purchase the shares on margin. In contrast, mutual funds typically can be purchased or sold only once a day, and short sales or purchasing shares on margin is not allowed. Mutual fund investors buy the fund shares directly from the fund, and all investments are settled at the net asset value. In practice, the market price of the ETF is likely to be close to the net asset value of the underlying investments.

Other key differences between ETFs and mutual funds relate to transaction costs and treatment of dividends and the minimum investment amount. Dividends on ETFs are paid out to the shareholders whereas mutual funds usually reinvest the dividends. Finally, the minimum required investment in ETFs is usually smaller than that of mutual funds.

Hedge Funds

Hedge funds are private investment vehicles that typically use leverage, derivatives, and long and short investment strategies. The origin of hedge funds can be traced back as far as 1949 to a fund managed by A.W. Jones & Co. It offered a strategy of a non-correlated offset to the "long-only" position typical of most portfolios. Since then, the hedge fund industry has grown considerably, with global hedge fund assets totaling US$3.3 trillion as of May 2017.

Hedge fund investment strategies are diverse and can range from specific niche strategies (e.g., long–short financial services) to global multi-strategy approaches. Consequently, hedge funds are often used by investors for portfolio diversification purposes. In general, hedge funds share a few distinguishing characteristics:

- *Short selling*: Many hedge funds implement short positions directly or synthetically using such derivatives as options, futures, and credit default swaps.
- *Absolute return seeking:* Hedge funds often seek positive returns in all market environments.
- *Leverage:* Many hedge funds use financial leverage (bank borrowing) or implicit leverage (using derivatives). The use and amount of leverage are dependent on the investment strategy being implemented.
- *Low correlation:* Some hedge funds have historically exhibited low return correlations with traditional equity and/or fixed-income asset classes.
- *Fee structures:* Hedge funds typically charge two distinct fees: a traditional asset-based management fee (AUM fee) and an incentive (or performance) fee in which the hedge fund earns a portion of the fund's realized capital gains.[17] Hedge funds have traditionally charged management fees of 2% and incentive fees of up to 20%, although there has been downward pressure on those fees amid increased competition and the availability of competing products.

Hedge funds are not readily available to all investors. They typically require a high minimum investment and often have restricted liquidity by allowing only periodic (e.g., quarterly) withdrawals or having a long fixed-term commitment.

Private Equity and Venture Capital Funds

Private equity funds and **venture capital funds** are alternative funds that seek to buy, optimize, and ultimately sell portfolio companies to generate profits. As of December 2017, assets under management in the private equity industry totaled US$3.1 trillion, a historical high point.[18] Most private equity and venture capital funds have a lifespan of approximately 7–10 years (but usually subject to contractual extensions). Unlike most traditional asset managers that trade in public securities, private equity and venture firms often take a "hands-on" approach to their portfolio companies through a combination of financial engineering (e.g., realizing expense synergies, changing capital structures), installment of executive management and board members, and significant contributions to the development of a target company's business strategy. The final investment stage, often referred to as the "exit" or "harvesting" stage, occurs when a private equity or venture capital fund divests its portfolio companies through a merger with another company, the acquisition by another company, or an initial public offering (IPO).

17 Performance fees are often subject to high-water mark provisions, which preclude a manager from earning a performance fee unless the value of a fund at the end of a predefined measurement period is higher than the value of the fund at the beginning of the measurement period. The unpredictability of future performance leads to uncertainty in performance fee revenue, which is regarded as less reliable than revenue derived from management fees.

18 https://www.pionline.com/article/20180724/ONLINE/180729930/preqin-private-equity-aum-grows-20-in-2017-to-record-306-trillion# (accessed 13 November 2018)

As with most alternative funds, the majority of private equity and venture capital funds are structured as limited partnerships. These limited partnership agreements exist between the fund manager, called the general partner (GP), and the fund's investors, called limited partners (LPs). The funds generate revenue through several types of fees:

- *Management fees:* Fees are based on committed capital (or sometimes net asset value or invested capital) and typically range from 1–3% annually. Sometimes these fees step down several years into the investment period of a fund.
- *Transaction fees:* Fees are paid by portfolio companies to the fund for various corporate and structuring services. Typically, a percentage of the transaction fee is shared with the LPs by offsetting the management fee.
- *Carried interest:* Carried interest is the GP's share of profits (typically 20%) on sales of portfolio companies. Most GPs do not earn the incentive fee until LPs have recovered their initial investment.
- *Investment income.* Investment income includes profits generated on capital contributed to the fund by the GP.

SUMMARY

- A portfolio approach to investing could be preferable to simply investing in individual securities.
- The problem with focusing on individual securities is that this approach may lead to the investor "putting all her eggs in one basket."
- Portfolios provide important diversification benefits, allowing risk to be reduced without necessarily affecting or compromising return.
- Understanding the needs of your client and preparing an investment policy statement represent the first steps of the portfolio management process. Those steps are followed by asset allocation, security analysis, portfolio construction, portfolio monitoring and rebalancing, and performance measurement and reporting.
- Types of investors include individual and institutional investors. Institutional investors include defined benefit pension plans, endowments and foundations, banks, insurance companies, and sovereign wealth funds.
- The asset management industry is an integral component of the global financial services sector. Asset managers offer either active management, passive management, or both. Asset managers are typically categorized as traditional or alternative, although the line between traditional and alternative has blurred.
- Three key trends in the asset management industry include the growth of passive investing, "big data" in the investment process, and robo-advisers in the wealth management industry.
- Investors use different types of investment products in their portfolios. These include mutual funds, separately managed accounts, exchange-traded funds, hedge funds, and private equity and venture capital funds.

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PRACTICE PROBLEMS

1. Investors should use a portfolio approach to:
   - **A.** reduce risk.
   - **B.** monitor risk.
   - **C.** eliminate risk.

2. Which of the following is the *best* reason for an investor to be concerned with the composition of a portfolio?
   - **A.** Risk reduction.
   - **B.** Downside risk protection.
   - **C.** Avoidance of investment disasters.

3. With respect to the formation of portfolios, which of the following statements is *most accurate*?
   - **A.** Portfolios affect risk less than returns.
   - **B.** Portfolios affect risk more than returns.
   - **C.** Portfolios affect risk and returns equally.

4. With respect to the portfolio management process, the asset allocation is determined in the:
   - **A.** planning step.
   - **B.** feedback step.
   - **C.** execution step.

5. The planning step of the portfolio management process is *least likely* to include an assessment of the client's
   - **A.** securities.
   - **B.** constraints.
   - **C.** risk tolerance.

6. With respect to the portfolio management process, the rebalancing of a portfolio's composition is *most likely* to occur in the:
   - **A.** planning step.
   - **B.** feedback step.
   - **C.** execution step.

7. An analyst gathers the following information for the asset allocations of three

portfolios:

Portfolio	Fixed Income (%)	Equity (%)	Alternative Assets (%)
1	25	60	15
2	60	25	15
3	15	60	25

Which of the portfolios is *most likely* appropriate for a client who has a high degree of risk tolerance?

A. Portfolio 1.

B. Portfolio 2.

C. Portfolio 3.

8. Which of the following institutions will *on average* have the greatest need for liquidity?

A. Banks.

B. Investment companies.

C. Non-life insurance companies.

9. Which of the following institutional investors will *most likely* have the longest time horizon?

A. Defined benefit plan.

B. University endowment.

C. Life insurance company.

10. A defined benefit plan with a large number of retirees is *likely* to have a high need for:

A. income.

B. liquidity.

C. insurance.

11. Which of the following institutional investors is *most likely* to manage investments in mutual funds?

A. Insurance companies.

B. Investment companies.

C. University endowments.

12. Which of the following investment products is *most likely* to trade at their net asset value per share?

A. Exchange traded funds.

B. Open-end mutual funds.

C. Closed-end mutual funds.

13. Which of the following financial products is *least likely* to have a capital gain distribution?
    - **A.** Exchange traded funds.
    - **B.** Open-end mutual funds.
    - **C.** Closed-end mutual funds.

14. Which of the following forms of pooled investments is subject to the *least* amount of regulation?
    - **A.** Hedge funds.
    - **B.** Exchange traded funds.
    - **C.** Closed-end mutual funds.

15. Which of the following pooled investments is *most likely* characterized by a few large investments?
    - **A.** Hedge funds.
    - **B.** Buyout funds.
    - **C.** Venture capital funds.

SOLUTIONS

1. A is correct. Combining assets into a portfolio should reduce the portfolio's volatility. Specifically, "individuals and institutions should hold portfolios to reduce risk." As illustrated in the reading, however, risk reduction may not be as great during a period of dramatic economic change.

2. A is correct. Combining assets into a portfolio should reduce the portfolio's volatility. The portfolio approach does not necessarily provide downside protection or guarantee that the portfolio always will avoid losses.

3. B is correct. As illustrated in the reading, portfolios reduce risk more than they increase returns.

4. C is correct. The client's objectives and constraints are established in the investment policy statement and are used to determine the client's target asset allocation, which occurs in the execution step of the portfolio management process.

5. A is correct. Securities are analyzed in the execution step. In the planning step, a client's objectives and constraints are used to develop the investment policy statement.

6. B is correct. Portfolio monitoring and rebalancing occurs in the feedback step of the portfolio management process.

7. C is correct. Portfolio 3 has the same equity exposure as Portfolio 1 and has a higher exposure to alternative assets, which have greater volatility (as discussed in the section of the reading comparing the endowments from Yale University and the University of Virginia).

8. A is correct. The excess reserves invested by banks need to be relatively liquid. Although investment companies and non-life insurance companies have high liquidity needs, the liquidity need for banks is on average the greatest.

9. B is correct. Most foundations and endowments are established with the intent of having perpetual lives. Although defined benefit plans and life insurance companies have portfolios with a long time horizon, they are not perpetual.

10. A is correct. Income is necessary to meet the cash flow obligation to retirees. Although defined benefit plans have a need for income, the need for liquidity typically is quite low. A retiree may need life insurance; however, a defined benefit plan does not need insurance.

11. B is correct. Investment companies manage investments in mutual funds. Although endowments and insurance companies may own mutual funds, they do not issue or redeem shares of mutual funds.

12. B is correct. Open-end funds trade at their net asset value per share, whereas closed-end funds and exchange traded funds can trade at a premium or a discount.

13. A is correct. Exchange traded funds do not have capital gain distributions. If an investor sells shares of an ETF (or open-end mutual fund or closed-end mutual fund), the investor may have a capital gain or loss on the shares sold; however, the gain (or loss) from the sale is not a distribution.

14. A is correct. Hedge funds are currently exempt from the reporting requirements of a typical public investment company.

15. B is correct. Buyout funds or private equity firms make only a few large investments in private companies with the intent of selling the restructured companies in three to five years. Venture capital funds also have a short time horizon; however, these funds consist of many small investments in companies with the expectation that only a few will have a large payoff (and that most will fail).

LEARNING MODULE

4

Basics of Portfolio Planning and Construction

by Alistair Byrne, PhD, CFA, and Frank E. Smudde, MSc, CFA.

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LEARNING OUTCOMES

Mastery	The candidate should be able to:
☐	describe the reasons for a written investment policy statement (IPS)
☐	describe the major components of an IPS
☐	describe risk and return objectives and how they may be developed for a client
☐	explain the difference between the willingness and the ability (capacity) to take risk in analyzing an investor's financial risk tolerance
☐	describe the investment constraints of liquidity, time horizon, tax concerns, legal and regulatory factors, and unique circumstances and their implications for the choice of portfolio assets
☐	explain the specification of asset classes in relation to asset allocation
☐	describe the principles of portfolio construction and the role of asset allocation in relation to the IPS
☐	describe how environmental, social, and governance (ESG) considerations may be integrated into portfolio planning and construction

1 INTRODUCTION

To build a suitable portfolio for a client, investment advisers should first seek to understand the client's investment goals, resources, circumstances, and constraints. Investors can be categorized into broad groups based on shared characteristics with respect to these factors (e.g., various types of individual investors and institutional investors). Even investors within a given type, however, will invariably have a number of distinctive requirements. In this reading, we consider in detail the planning for investment success based on an individualized understanding of the client.

CFA Institute would like to thank Hardik Sanjay Shah, CFA, for his contributions to the 2022 update of this reading.

This reading is organized as follows: Section 2 discusses the investment policy statement, a written document that captures the client's investment objectives and the constraints. Section 3 discusses the portfolio construction process, including the first step of specifying a strategic asset allocation for the client. Section 4 concludes and summarizes the reading.

2 THE INVESTMENT POLICY STATEMENT

- ☐ describe the reasons for a written investment policy statement (IPS)
- ☐ describe the major components of an IPS

Portfolio planning can be defined as a program developed in advance of constructing a portfolio that is expected to define the client's investment objectives. The written document governing this process is the investment policy statement (IPS). The IPS is sometimes complemented by a document outlining policy on responsible investing—the broadest (umbrella) term used to describe principles that typically address one or more environmental, social, and governance themes that an investor requires to be considered when evaluating whether to invest in a particular company, as well as during the period of ownership. Sustainable investing, a term used in a similar context to responsible investing, focuses on factoring in sustainability issues during the investment process. Policies on responsible investing may also be integrated within the IPS itself. In the remainder of this reading, the integration of responsible investing within the IPS will be our working assumption.

The Investment Policy Statement

The IPS is the starting point of the portfolio management process. Without a full understanding of the client's situation and requirements, it is unlikely that successful results will be achieved. "Success" can be defined as a client achieving his important investment goals using means that he is comfortable with (in terms of risks taken and other concerns). The IPS essentially communicates a plan for achieving investment success.

The IPS is typically developed following a fact-finding discussion with the client. This discussion can include the use of a questionnaire designed to articulate the client's risk tolerance as well as address expectations in connection with specific circumstances. In the case of institutional clients, the fact finding may involve asset–liability management reviews, identification of liquidity needs, and a wide range of tax, legal, and other considerations.

The IPS can take a variety of forms.[1] A typical format will include the client's investment objectives and the constraints that apply to the client's portfolio.

The client's objectives are specified in terms of risk tolerance and return requirements. These elements must be consistent with each other: a client is unlikely to be able to find a portfolio that offers a relatively high expected return without taking

1 In this reading, an IPS is assumed to be a document governing investment management activities covering all or most of a client's financial wealth. In many practical contexts, investment professionals work with investment mandates that cover only parts of a client's wealth or financial risk. Governance documents such as "Limited Partnership Agreements" and "Investment Management Agreements" will govern such mandates. Their contents are to a large degree comparable to the contents of the IPS as described in this reading.

on a relatively high level of expected risk. As part of their financial planning, clients may specify specific spending goals, which need to be considered when setting risk tolerance and return requirements.

The constraints section covers factors that need to be taken into account when constructing a portfolio for the client that meets the objectives. The typical categories are liquidity requirements, time horizon, regulatory requirements, tax status, and unique needs. The constraints may be either internal (i.e., set by the client) or external (i.e., set by law or regulation), as we discuss in detail later.

Having a well-constructed IPS for all clients should be standard procedure for an investment manager. The investment manager should build the portfolio with reference to the IPS and be able to refer to it to assess a particular investment's suitability for the client. In some cases, the need for the IPS goes beyond simply being a matter of standard procedure. In certain countries, the IPS (or an equivalent document) is a legal or regulatory requirement. For example, UK pension schemes must have a statement of investment principles under the Pensions Act 1995 (Section 35), and this statement is in essence an IPS. The UK Financial Services Authority also has requirements for investment firms to "know their customers." The European Union's Markets in Financial Instruments Directive ("MiFID") requires firms to assign clients to categories (eligible counterparties, institutional clients, or retail clients), with the category type determining the types of protections and limitations relevant for the client by law.

In the case of an institution, such as a pension plan or university endowment, the IPS may set out the governance arrangements that apply to the investment portfolio. For example, this information could cover the investment committee's approach to appointing and reviewing investment managers for the portfolio, and the discretion that those managers have.

The IPS should be reviewed on a regular basis to ensure that it remains consistent with the client's circumstances and requirements. For example, the UK Pensions Regulator suggests that a pension scheme's statements of investment principles—a form of IPS—should be reviewed at least every three years. The IPS should also be reviewed if the manager becomes aware of a material change in the client's circumstances, as well as on the initiative of the client when her objectives, time horizon, or liquidity needs change.

Major Components of an IPS

There is no single standard format for an IPS. Many IPS and investment governance documents with a similar purpose (as noted previously), however, include the following sections:

- *Introduction*. This section describes the client.
- *Statement of Purpose*. This section states the purpose of the IPS.
- *Statement of Duties and Responsibilities*. This section details the duties and responsibilities of the client, the custodian of the client's assets, and the investment managers.
- *Procedures*. This section explains the steps to take to keep the IPS current and the procedures to follow to respond to various contingencies.
- *Investment Objectives*. This section explains the client's objectives in investing.
- *Investment Constraints*. This section presents the factors that constrain the client in seeking to achieve the investment objectives.

- *Investment Guidelines*. This section provides information about how policy should be executed (e.g., on the permissible use of leverage and derivatives) and on specific types of assets excluded from investment, if any.
- *Evaluation and Review*. This section provides guidance on obtaining feedback on investment results.
- *Appendices*: (A) Strategic Asset Allocation and (B) Rebalancing Policy. Many investors specify a strategic asset allocation (SAA), also known as the policy portfolio, which is the baseline allocation of portfolio assets to asset classes in view of the investor's investment objectives and the investor's policy with respect to rebalancing asset class weights. This SAA may include a statement of policy concerning hedging risks such as currency risk and interest rate risk.

The sections that are most closely linked to the client's distinctive needs, and probably the most important from a planning perspective, are those dealing with investment objectives and constraints. An IPS focusing on these two elements has been called an IPS in an "objectives and constraints" format.

In the following sections, we discuss the investment objectives and constraints format of an IPS beginning with risk and return objectives. The process of developing the IPS is the basic mechanism for evaluating and trying to improve an investor's overall expected return–risk stance. In a portfolio context, return objectives and expectations must be tailored to be consistent with risk objectives. The risk and return objectives must also be consistent with the constraints that apply to the portfolio. A growing proportion of investors explicitly include non-financial considerations when formulating their investment policies. This approach is often referred to as responsible investing (discussed earlier alongside related terms), which reflects environmental, social, and governance (ESG) considerations. Responsible investing recognizes that ESG considerations may eventually affect the portfolio's financial risk–return profile and may express the investor's societal convictions. In this reading, we discuss responsible investing aspects of investment policy, where relevant.

3 IPS RISK AND RETURN OBJECTIVES

- ☐ describe the major components of an IPS
- ☐ describe risk and return objectives and how they may be developed for a client
- ☐ explain the difference between the willingness and the ability (capacity) to take risk in analyzing an investor's financial risk tolerance

When constructing a portfolio for a client, it is important to ensure that the risk of the portfolio is suitable for the client. The IPS should state clearly the risk tolerance of the client. Risk objectives are specifications for portfolio risk that reflect the client's risk tolerance. Quantitative risk objectives can be absolute, relative, or a combination of the two.

Examples of an absolute risk objective would be a desire not to suffer any loss of capital or not to lose more than a given percentage of capital in any 12-month period. Note that these objectives are unrelated to investment market performance, good or bad, and are absolute in the sense of being self-standing. The fulfillment of such objectives could be achieved by not taking any risk—for example, by investing in an insured bank certificate of deposit at a creditworthy bank. If investments in risky assets are undertaken, however, such statements could be restated as a probability statement to be more operational (i.e., practically useful). For example, the desire not to lose more than 4% of capital in any 12-month period might be restated as an objective that with 95% probability the portfolio not lose more than 4% in any 12-month period. Measures of absolute risk include the variance or standard deviation of returns and **value at risk**.[2]

Some clients may choose to express relative risk objectives, which relate risk relative to one or more benchmarks perceived to represent appropriate risk standards. For example, investments in large-cap UK equities could be benchmarked to an equity market index, such as the FTSE 100 Index. The S&P 500 Index could be used as a benchmark for large-cap US equities; for investments with cash-like characteristics, the benchmark could be an interest rate such as Treasury bill rate. For risk relative to a benchmark, the measure could be **tracking risk**, or **tracking error**.[3] In practice, such risk objectives are used in situations where the total wealth management activities on behalf of a client are divided into partial mandates.

Other clients take both the investor's assets and liabilities into consideration when establishing an IPS risk objective. In some cases where the size, timing and/or relative certainty of future investor financial obligations are known, an IPS may be tailored to meet these objectives in what is called a **liability-driven investment (LDI)** approach. Examples of LDI include life insurance companies, defined benefit pension plans or an individual's budget after retirement. For example, a pension plan must meet the pension payments as they come due, and the risk objective will be to minimize the probability that it will fail to do so. A related return objective might be to outperform the discount rate used in finding the present value of liabilities over a multi-year time horizon.

When a policy portfolio (that is, a specified set of long-term asset class weightings and hedge ratios) is used, the risk objective may be expressed as a desire for the portfolio return to be within a band of plus or minus X% of the benchmark return calculated by assigning an index or benchmark to represent each asset class present in the policy portfolio. Again, this objective may be more usefully interpreted as a statement of probability—for example, a 95% probability that the portfolio return will be within X% of the benchmark return over a stated period. Example 1 reviews this material.

EXAMPLE 1

Types of Risk Objectives

A Japanese institutional investor has a portfolio valued at ¥10 billion. The investor expresses her first risk objective as a desire not to lose more than ¥1 billion in the coming 12-month period. She specifies a second risk objective of achieving returns within 4% of the return to the TOPIX stock market index, which is her benchmark. Based on this information, address the following:

1.

   a. Characterize the first risk objective as absolute or relative.

2 **Value at risk** is a money measure of the minimum value of losses expected during a specified period at a given level of probability.

3 **Tracking risk** (sometimes called **tracking error**) is the standard deviation of the differences between a portfolio's returns and its benchmark's returns.

b. Give an example of how the risk objective could be restated in a practical manner.

Solution

a. This is an absolute risk objective.

b. This risk objective could be restated in a practical manner by specifying that the 12-month 95% value at risk of the portfolio must be no more than ¥1 billion.

2.

a. Characterize the second risk objective as absolute or relative.

b. Identify a measure for quantifying the risk objective.

Solution

a. This is a relative risk objective.

b. This risk objective could be quantified using the tracking risk as a measure. For example, assuming returns follow a normal distribution, an expected tracking risk of 2% would imply a return within 4% of the index return approximately 95% of the time. Remember that tracking risk is stated as a one standard deviation measure.

A client's overall risk tolerance is a function of the client's ability to bear (accept) risk and her "risk attitude," which might be considered as the client's willingness to take risk. For ease of expression, from this point on we will refer to ability to bear risk and willingness to take risk as the two components of risk tolerance. Above-average ability to bear risk and above-average willingness to take risk imply above-average risk tolerance. Below-average ability to bear risk and below-average willingness to take risk imply below-average risk tolerance. These interactions are shown in Exhibit 1.

Exhibit 1: Risk Tolerance

	Ability to Bear Risk	
Willingness to Take Risk	**Below Average**	**Above Average**
Below Average	Below-average risk tolerance	Resolution needed
Above Average	Resolution needed	Above-average risk tolerance

The *ability* to bear risk is measured mainly in terms of objective factors, such as time horizon, expected income, and level of wealth relative to liabilities. For example, an investor with a 20-year time horizon can be considered to have a greater ability to bear risk, other things being equal, than an investor with a 2-year horizon. This difference is because over 20 years, there is more scope for losses to be recovered or other adjustments made to circumstances than there is over 2 years.

Similarly, an investor whose assets are comfortably in excess of their liabilities has more ability to bear risk than an investor whose wealth and expected future expenditure are more closely balanced. For example, a wealthy individual who can sustain a comfortable lifestyle after a very substantial investment loss has a relatively high ability to bear risk. A pension plan that has a large surplus of assets over liabilities has a relatively high ability to bear risk.

The *willingness* to take risk, or risk attitude, is a more subjective factor based on the client's psychology and perhaps also his current circumstances. Although the list of factors related to an individual's risk attitude remains open to debate, it is believed that some psychological factors, such as personality type, self-esteem, and inclination to independent thinking, are correlated with risk attitude. Some individuals are comfortable taking financial and investment risk, whereas others find it distressing. Although there is no single agreed-upon method for measuring risk tolerance, a willingness to take risk may be gauged by discussing risk with the client or by asking the client to complete a psychometric questionnaire. For example, financial planning academic John Grable and collaborators have developed 13-item and 5-item risk attitude questionnaires that have undergone some level of technical validation. The five-item questionnaire is shown in Exhibit 2.

Exhibit 2: A Five-Item Risk Assessment Instrument

1. Investing is too difficult to understand.
   - **a.** Strongly agree
   - **b.** Tend to agree
   - **c.** Tend to disagree
   - **d.** Strongly disagree
2. I am more comfortable putting my money in a bank account than in the stock market.
   - **a.** Strongly agree
   - **b.** Tend to agree
   - **c.** Tend to disagree
   - **d.** Strongly disagree
3. When I think of the word "risk," the term "loss" comes to mind immediately.
   - **a.** Strongly agree
   - **b.** Tend to agree
   - **c.** Tend to disagree
   - **d.** Strongly disagree
4. Making money in stocks and bonds is based on luck.
   - **a.** Strongly agree
   - **b.** Tend to agree
   - **c.** Tend to disagree
   - **d.** Strongly disagree
5. In terms of investing, safety is more important than returns.
   - **a.** Strongly agree
   - **b.** Tend to agree
   - **c.** Tend to disagree
   - **d.** Strongly disagree

Source: Grable and Joo (2004).

The responses, a), b), c), and d), are coded 1, 2, 3, and 4, respectively, and summed. The lowest score is 5 and the highest score is 20, with higher scores indicating greater risk tolerance. For two random samples drawn from the faculty and staff of large US universities (n = 406), the mean score was 12.86 with a standard deviation of 3.01 and a median score (i.e., the middle score) of 13.

Note that a question, such as the first one in Exhibit 2, indicates that risk attitude may be associated with non-psychological factors (such as level of financial knowledge and understanding and decision-making style) as well as psychological factors.

The adviser needs to examine whether a client's ability to accept risk is consistent with the client's willingness to take risk. For example, a wealthy investor with a 20-year time horizon, who is thus able to take risk, may also be comfortable taking risk; in this case the factors are consistent. If the wealthy investor has a low willingness to take risk, there would be a conflict.

The conflict between ability and willingness to take risk can also arise in the institutional context. In addition, different stakeholders within the institution may take different views. For example, the trustees of a well-funded pension plan may desire a low-risk approach to safeguard the funding of the scheme and beneficiaries of the scheme may take a similar view. The sponsor, however, may wish a higher-risk/higher-return approach in an attempt to reduce future funding costs. When a trustee bears a fiduciary responsibility to pension beneficiaries and the interests of the pension sponsor and the pension beneficiaries conflict, the trustee should act in the best interests of the beneficiaries.

When both the ability and willingness to take risk are consistent, the investment adviser's task is the simplest. When ability to take risk is below average and willingness to take risk is above average, the investor's risk tolerance should be assessed as below average overall. When ability to take risk is above average but willingness is below average, the portfolio manager or adviser may seek to counsel the client and explain the conflict and its implications. For example, the adviser could outline the reasons why the client is considered to have a high ability to take risk and explain the likely consequences, in terms of reduced expected return, of not taking risk. The investment adviser, however, should not aim to change a client's willingness to take risk that is not a result of a miscalculation or misperception. Modification of elements of personality is not within the purview of the investment adviser's role. The prudent approach is to reach a conclusion about risk tolerance consistent with the lower of the two factors (ability and willingness) and to document the decisions made.

Example 2 is the first of a set that follows the analysis of an investment client through the preparation of the major elements of an IPS.

EXAMPLE 2

The Case of Henri Gascon: Risk Tolerance

1. Henri Gascon is an energy trader who works for a major French oil company based in Paris. He is 30 years old and married with one son, aged 5. Gascon has decided that it is time to review his financial situation and consults a financial adviser, who notes the following aspects of Gascon's situation:

   - Gascon's annual salary of €250,000 is more than sufficient to cover the family's outgoings.
   - Gascon owns his apartment outright and has €1,000,000 of savings.
   - Gascon perceives that his job is reasonably secure.
   - Gascon has a good knowledge of financial matters and is confident that equity markets will deliver positive returns over the long term.
   - In the risk tolerance questionnaire, Gascon strongly disagrees with the statements that "making money in stocks and bonds is based on luck" and "in terms of investing, safety is more important than returns."

- Gascon expects that most of his savings will be used to fund his retirement, which he hopes to start at age 50.

Based only on the information given, which of the following statements is *most* accurate?

A. Gascon has a low ability to take risk but a high willingness to take risk.
B. Gascon has a high ability to take risk but a low willingness to take risk.
C. Gascon has a high ability to take risk and a high willingness to take risk.

Solution:

C is correct. Gascon has a high income relative to outgoings, a high level of assets, a secure job, and a time horizon of 20 years. This information suggests a high *ability* to take risk. At the same time, Gascon is knowledgeable and confident about financial markets and responds to the questionnaire with answers that suggest risk tolerance. This result suggests he also has a high *willingness* to take risk.

EXAMPLE 3

The Case of Jacques Gascon: Risk Tolerance

1. Marie Gascon is so pleased with the services provided by her financial adviser that she suggests to her brother Jacques that he should also consult the adviser. Jacques thinks it is a good idea. Jacques, a self-employed computer consultant also based in Paris, is 40 years old and divorced with four children, aged between 12 and 16. The financial adviser notes the following aspects of Jacques' situation:

   - Jacques' consultancy earnings average €40,000 per annum but are quite volatile.
   - Jacques is required to pay €10,000 per year to his ex-wife and children.
   - Jacques has a mortgage on his apartment of €100,000 and €10,000 of savings.
   - Jacques has a good knowledge of financial matters and expects that equity markets will deliver very high returns over the long term.
   - In the risk tolerance questionnaire, Jacques strongly disagrees with the statements "I am more comfortable putting my money in a bank account than in the stock market" and "When I think of the word 'risk', the term 'loss' comes to mind immediately."
   - Jacques expects that most of his savings will be required to support his children at university.

   Based only on the information given, which statement is correct?

   A. Jacques has a low ability to take risk but a high willingness to take risk.
   B. Jacques has a high ability to take risk but a low willingness to take risk.
   C. Jacques has a high ability to take risk and a high willingness to take risk.

Solution:

A is correct. Jacques does not have a particularly high income, his income is unstable, and he has reasonably high outgoings for his mortgage and maintenance payments. His investment time horizon is approximately two to six years given the ages of his children and his desire to support them at university. This finely balanced financial situation and short time horizon suggests a low ability to take risk. In contrast, his expectations for financial market returns and risk tolerance questionnaire answers suggest a high willingness to take risk. The financial adviser may wish to explain to Jacques how finely balanced his financial situation is and suggest that, despite his desire to take more risk, a relatively cautious portfolio might be the most appropriate approach to take.

Return Objectives

A client's return objectives can be stated in a number of ways. Similar to risk objectives, return objectives may be stated on an absolute or a relative basis.

As an example of an absolute objective, the client may want to achieve a particular percentage rate of return. This objective could be a nominal rate of return or could be expressed in real (inflation-adjusted) terms.

Alternatively, the return objective can be stated on a relative basis—for example, relative to a benchmark return. The benchmark could be an equity market index, such as the S&P 500 or the FTSE 100, or a cash rate of interest such as the market reference rate (MRR). A relative return objective might be stated as, for example, a desire to outperform the benchmark index by one percentage point per year.

Some institutions also set their return objectives relative to a peer group or universe of managers—for example, an endowment aiming for a return that is in the top 50% of returns of similar institutions, or a private equity mandate aiming for returns in the top quartile among the private equity universe. This objective can be problematic when limited information is known about the investment strategies or the return calculation methodology being used by peers, and we must bear in mind the impossibility of *all* institutions being "above average." Furthermore, a good benchmark should be investable—that is, able to be replicated by the investor—and a peer benchmark typically does not meet that criterion.

In each case, the return requirement can be stated before or after fees. Care should be taken that the fee basis used is clear and understood by both the manager and client. The return can also be stated on either a pre- or post-tax basis when the investor is required to pay tax. For a taxable investor, the baseline is to state and analyze returns on an after-tax basis.

The return objective could be a required return—that is, the amount the investor needs to earn to meet a particular future goal—such as a certain level of retirement income.

The manager or adviser must ensure that the return objective is realistic. Care should be taken that client and manager are in agreement on whether the return objective is nominal (which is more convenient for measurement purposes) or real (i.e., inflation-adjusted, which usually relates better to the objective). It must be consistent with the client's risk objective (high expected returns are unlikely to be possible without high levels of risk) and also with the current economic and market environment. For example, 15% nominal returns might be possible when inflation is 10% but will be unlikely when inflation is 3%.

When a client has unrealistic return expectations, the manager or adviser will need to counsel her about what is achievable in the current market environment and within the client's tolerance for risk.

EXAMPLE 4

The Case of Marie Gascon: Return Objectives

Having assessed her risk tolerance, Marie Gascon now begins to discuss her retirement income needs with the financial adviser. She wishes to retire at age 50, which is 20 years from now. Her salary meets current and expected future expenditure requirements, but she does not expect to be able to make any additional pension contributions to her fund. Gascon sets aside €100,000 of her savings as an emergency fund to be held in cash. The remaining €900,000 is invested for her retirement.

Gascon estimates that a before-tax amount of €2,000,000 in today's money will be sufficient to fund her retirement income needs. The financial adviser expects inflation to average 2% per year over the next 20 years. Pension fund contributions and pension fund returns in France are exempt from tax, but pension fund distributions are taxable upon retirement.

1. Which of the following is closest to the amount of money Gascon will have to accumulate in nominal terms by her retirement date to meet her retirement income objective (i.e., expressed in money of the day in 20 years)?

   A. €900,000

   B. €2,000,000

   C. €3,000,000

Solution:

C is correct. At 2% annual inflation, €2,000,000 in today's money equates to €2,971,895 in 20 years measured in money of the day [€2,000,000 × $(1 + 2\%)^{20}$].

2. Which of the following is closest to the annual rate of return that Gascon must earn on her pension portfolio to meet her retirement income objective?

   A. 2.0%

   B. 6.2%

   C. 8.1%

Solution:

B is correct. €900,000 growing at 6.2% per year for 20 years will accumulate to €2,997,318, which is just above the required amount. (The solution of 6.2% comes from €2,997,318/€900,000 = $(1 + X)^{20}$, where X is the required rate of return.)

4 IPS CONSTRAINTS

- ☐ describe the major components of an IPS
- ☐ describe the investment constraints of liquidity, time horizon, tax concerns, legal and regulatory factors, and unique circumstances and their implications for the choice of portfolio assets

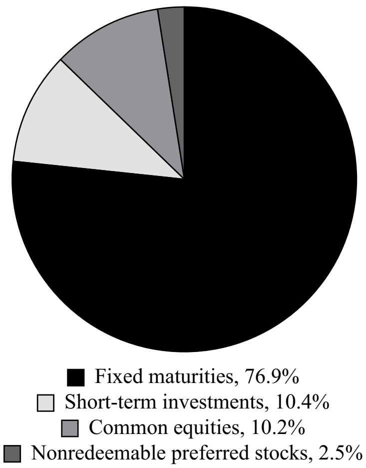
In the following sections, we analyze five major types of constraints on portfolio selection: liquidity, time horizon, tax concerns, legal and regulatory factors, and unique circumstances.

Liquidity Requirements

The IPS should state what the likely requirements are to withdraw funds from the portfolio. Examples for an individual investor would be outlays for covering healthcare payments or tuition fees. For institutions, it could be spending rules and requirements for endowment funds, the existence of claims coming due in the case of property and casualty insurance, or benefit payments for pension funds and life insurance companies.

When the client does have such a requirement, the manager should allocate part of the portfolio to cover the liability. This part of the portfolio will be invested in assets that are liquid—that is, easily converted to cash—and have low risk when the liquidity need is actually present (e.g., a bond maturing at the time when private education expenses will be incurred), so that their value is known with reasonable certainty. For example, the asset allocation in the insurance portfolios of US insurer Progressive Corporation (see Exhibit 3) shows a large allocation to fixed-income investments (called "Fixed maturities" by the company), some of which are either highly liquid or have a short maturity. These investments enable the company, in the case of automobile insurance, to pay claims for which the timing is unpredictable.

Exhibit 3: Asset Allocation of Progressive Corporation



Source: Progressive Corporation, 2018 Second Quarter Report.

Time Horizon

The IPS should state the time horizon over which the investor is investing. It may be the period over which the portfolio is accumulating before any assets need to be withdrawn; it could also be the period until the client's circumstances are likely to change. For example, a 55-year-old pension plan investor hoping to retire at age 65 has a 10-year horizon. The portfolio may not be liquidated at age 65, but its structure may need to change, for example, as the investor begins to draw an income from the fund.

The time horizon of the investor will affect the nature of investments used in the portfolio. Illiquid or risky investments may be unsuitable for an investor with a short time horizon because the investor may not have enough time to recover from investment losses, for example. Such investments, however, may be suitable for an investor with a longer horizon, especially if the risky investments are expected to have higher returns.

EXAMPLE 5

Investment Time Horizon

1. Frank Johnson is investing for retirement and has a 20-year horizon. He has an average risk tolerance. Which investment is likely to be the *least* suitable for a major allocation in Johnson's portfolio?

   A. Listed equities
   B. Private equity
   C. US Treasury bills

Solution:

C is correct. With a 20-year horizon and average risk tolerance, Johnson can accept the additional risk of listed equities and private equity compared with US Treasury bills.

2. Al Smith has to pay a large tax bill in six months and wants to invest the money in the meantime. Which investment is likely to be the *least* suitable for a major allocation in Smith's portfolio?

   A. Listed equities
   B. Private equity
   C. US Treasury bills

Solution:

B is correct. Private equity is risky, has no public market, and is the least liquid among the assets mentioned.

Tax Concerns

Tax status varies among investors. Some investors will be subject to taxation on investment returns and some will not. For example, in many countries, returns to pension funds are exempt from tax. Some investors will face a different tax rate on income (dividends and interest payments) than they do on capital gains (associated with increases in asset prices). Typically, when there is a differential, income is taxed more highly than gains. Gains may be subject to a lower tax rate, or part or all of the gain may be exempt from taxation. Furthermore, income may be taxed as it is earned, whereas gains may be taxed when they are realized. Hence, in such cases there is a time value of money benefit in the deferment of taxation of gains relative to income.

In many cases, the portfolio should reflect the tax status of the client. For example, a taxable investor may wish to hold a portfolio that emphasizes capital gains and receives little income. A taxable investor based in the United States is also likely to consider including US municipal bonds ("munis") in his portfolio because interest income from munis, unlike from Treasuries and corporate bonds, is exempt from taxes. A tax-exempt investor, such as a pension fund, will be relatively indifferent to the form of returns.

Legal and Regulatory Factors

The IPS should state any legal and regulatory restrictions that constrain how the portfolio is invested.

In some countries, such institutional investors as pension funds are subject to restrictions on portfolio composition. For example, there may be a limit on the proportion of equities or other risky assets in the portfolio or on the proportion of the portfolio that may be invested overseas. The United States has no limits on pension fund asset allocation, but some countries do, examples of which are shown in Exhibit 4. Pension funds also often face restrictions on the percentage of assets that can be invested in securities issued by the plan sponsor, so called **self-investment limits**.

Exhibit 4: Examples of Pension Fund Investment Restrictions

Country	Listed Equity	Real Estate	Government Bonds	Corporate Bonds	Foreign Currency Exposure
Switzerland	50%	30%	100%	100%	Unhedged 30%
Japan	100%	Not permitted	100%	100%	No limits
South Africa	75%	25%	100%	75%	25%

Source: OECD "Survey of Investment Regulations of Pension Funds," July 2018.

When an individual has access to material nonpublic information about a particular security, this situation may also form a constraint. For example, the directors of a public company may need to refrain from trading the company's stock at certain points of the year before financial results are published. The IPS should note this constraint so that the portfolio manager does not inadvertently trade the stock on the client's behalf.

Unique Circumstances and ESG Considerations

This section of the IPS should cover any other aspect of the client's circumstances, including beliefs and values, that is likely to have a material impact on portfolio composition. A client may have considerations derived from her faith or moral values that could constrain investment choices. For instance, an investor seeking compliance with Shari'a (the Islamic law) will avoid investing in businesses and financial instruments inconsistent with Shari'a, such as casinos and bonds, because Shari'a prohibits gambling and lending money on interest. Similarly, an investor may wish to avoid investments that he believes are inconsistent with his faith. Charitable and pension fund investors may have constituencies that want to express their values in an investment portfolio.

Whether rooted in religious beliefs or not, a client may have personal objections to certain products (e.g., weapons, tobacco, gambling) or practices (e.g., environmental impact of business activities, human impact of government policies, labor standards), which could lead to the exclusion of certain companies, countries, or types of securities (e.g., interest-bearing debt) from the investable universe as well as the client's benchmark. Investing in accordance with such considerations is referred to as socially responsible investing (SRI).

Specific ESG investment approaches can be classified in a variety of ways, and the investment community lacks clear consensus on terminology. We define six generic ESG investment approaches:

- *Negative screening*: Excluding companies or sectors based on business activities or environmental or social concerns;
- *Positive screening*: Including sectors or companies based on specific ESG criteria, typically ESG performance relative to industry peers;
- *ESG integration*: Systematic consideration of material ESG factors in asset allocation, security selection, and portfolio construction decisions;
- *Thematic investing*: Investing in themes or assets related to ESG factors;
- *Engagement/active ownership*: Using shareholder power to influence corporate behavior to achieve targeted ESG objectives along with financial returns; and
- *Impact investing*: Investments made with the intention to generate positive, measurable social and environmental impact alongside a financial return.

These ESG investment approaches may impact a portfolio manager's investment universe and may also require the investment management firm to put in place a process to systematically incorporate ESG factors into the investment process.

EXAMPLE 6

Ethical Preferences

The BMO Responsible UK Equity Fund is designed for investors who wish to have ethical and ESG principles applied to the selection of their investments. The fund's managers apply both positive (features to be emphasized in the portfolio) and negative (features to be avoided in the portfolio) screening criteria:

Product-Based Screening Criteria

- Alcohol
- Arctic and oil sands
- Coal mining
- Gambling
- Nuclear power generation
- Pornography
- Tobacco
- Weapons

Conduct-Based Screening Criteria

Environmental

- Environmental management

Social

- Animal welfare
- Health and safety
- Human rights and oppressive regimes
- Labor standards

Governance

- Business ethics

[Excerpted from BMO Responsible UK Equity Fund documents; https://www.bmogam.com/gb-en/intermediary/bmo-responsible-uk-equity-2-inc/.]

When the portfolio represents only part of the client's total wealth, there may be aspects or portions of wealth not under the control of the manager that have implications for the portfolio. For example, an employee of a public company whose labor income and retirement income provision are reliant on that company, and who may have substantial investment exposure to the company through employee share options and stock holdings, may decide that his portfolio should not invest additional amounts in that stock. An entrepreneur may be reluctant to see her portfolio invested in the shares of competing businesses or in any business that has risk exposures aligned with her entrepreneurial venture.

A client's income may rely on a particular industry or asset class. Appropriate diversification requires that industry or asset class to be de-emphasized in the client's investments. For example, a stockbroker should consider having a relatively low weighting in equities, as his skills and thus his income-generating ability are worth less when equities do not perform well. Employees should similarly be wary of having concentrated share positions in the equity of the company where they work. If the employer encounters difficulties, not only may its employees lose their jobs but their investment portfolios could also suffer a significant loss of value.

5 GATHERING CLIENT INFORMATION

- ☐ describe risk and return objectives and how they may be developed for a client
- ☐ describe the investment constraints of liquidity, time horizon, tax concerns, legal and regulatory factors, and unique circumstances and their implications for the choice of portfolio assets

As noted earlier, it is important for portfolio managers and investment advisers to know their clients. For example, in the EU, MiFID II requires financial intermediaries to undertake substantial fact finding. This is required not only in the case of full-service wealth management or in the context of an IPS but also in "lighter" forms of financial intermediation, such as advisory relationships (in which clients make investment decisions after consultation with their investment adviser or broker) or execution-only relationships (in which the client makes investment decisions independently).

An exercise in fact finding about the customer should take place at the beginning of the client relationship. This process will involve gathering information about the client's circumstances as well as discussing the client's objectives and requirements.

Important data to gather from a client should cover family and employment situation as well as financial information. If the client is an individual, it may also be necessary to know about the situation and requirements of the client's spouse or other family members. The health of the client and her dependents is also relevant information. In an institutional relationship, it will be important to know about key stakeholders in the organization and what their perspective and requirements are. Information gathering may be done in an informal way or may involve structured interviews, questionnaires, or analysis of data. Many advisers will capture data electronically and use special systems that record data and produce customized reports.

Good recordkeeping is very important and may be crucial in a case in which any aspect of the client relationship comes into dispute at a later stage.

EXAMPLE 7

Marie Gascon: Description of Constraints

Marie Gascon continues to discuss her investment requirements with her financial adviser. The adviser begins to draft the constraints section of the IPS.

Gascon expects that she will continue to work for the oil company and that her relatively high income will continue for the foreseeable future. Gascon and her husband plan to have no additional children but expect that their son will go to a university at age 18. They expect that their son's education costs can be met out of their salary income.

Gascon's emergency reserve of €100,000 is considered to be sufficient as a reserve for unforeseen expenditures and emergencies. Her retirement savings of €900,000 has been contributed to her defined-contribution pension plan account to fund her retirement. Under French regulation, pension fund contributions are paid from gross income (i.e., income prior to deduction of tax), and pension fund returns are exempt from tax, but pension payments from a fund to retirees are taxed as income to the retiree.

With respect to Gascon's retirement savings portfolio, refer back to Example 2 as needed and address the following:

1. As concerns liquidity,

   A. a maximum of 50% of the portfolio should be invested in liquid assets.

   B. the portfolio should be invested entirely in liquid assets because of high spending needs.

   C. the portfolio has no need for liquidity because there are no short-term spending requirements.

Solution:

C is correct. The assets are for retirement use, which is 20 years away. Any short-term spending needs will be met from other assets or income.

2. The investment time horizon is closest to

   A. 5 years.

   B. 20 years.

   C. 40 years.

Solution:

B is correct. The relevant time horizon is to the retirement date, which is 20 years away. The assets may not be liquidated at that point, but a restructuring of the portfolio is to be expected as Gascon starts to draw an income from it.

3. As concerns taxation, the portfolio

   A. should emphasize capital gains because income is taxable.

   B. should emphasize income because capital gains are taxable.

   C. is tax exempt and thus indifferent between income and capital gains.

Solution:

C is correct. Because no tax is paid in the pension fund, it does not matter whether returns come in the form of income or capital gains.

4. The principle legal and regulatory factors applying to the portfolio are

   A. US securities laws.

   B. European banking laws.

   C. French pension fund regulations.

Solution:

C is correct. Management of the portfolio will have to comply with any rules relating to French pension funds.

5. As concerns unique needs, the portfolio should

   A. have a high weighting in oil and other commodity stocks.

   B. be invested only in responsible and sustainable investments.

   C. not have significant exposure to oil and other commodity stocks.

Solution:

C is correct. Gascon's human capital (i.e., future labor income) is affected by the prospects of the oil industry. If her portfolio has significant exposure to oil stocks, she would be increasing a risk exposure she already has.

Example 8, the final one based on Marie Gascon, shows how the information obtained from the fact-finding exercises might be incorporated into the objectives and constraints section of an IPS.

EXAMPLE 8

Marie Gascon: Outline of an IPS

Following is a simplified excerpt from the IPS the adviser prepares for Marie Gascon, covering objectives and constraints.

Risk Objectives:

- The portfolio may take on relatively high amounts of risk in seeking to meet the return requirements. With a 20-year time horizon and significant assets and income, the client has an above-average ability to take risk. The client is a knowledgeable investor, with an above-average willingness to take risk. Hence, the client's risk tolerance is above average, explaining the aforementioned portfolio risk objective.

- The portfolio should be well diversified with respect to asset classes and concentration of positions within an asset class. Although the client has above-average risk tolerance, his investment assets should be diversified to control the risk of catastrophic loss.

Return Objectives:

- The portfolio's long-term return requirement is 6.2% per year, in nominal terms and net of fees, to meet the client's retirement income goal.

Constraints:

- *Liquidity*: The portfolio consists of pension fund assets, and there is no need for liquidity in the short to medium term.
- *Time Horizon*: The portfolio will be invested with a 20-year time horizon. The client intends to retire in 20 years, at which time an income will be drawn from the portfolio.
- *Tax Status*: Under French law, contributions to the fund are made gross of tax and returns in the fund are tax-free. Hence, the client is indifferent between income and capital gains in the fund.
- *Legal and Regulatory Factors*: Management of the portfolio must comply with French pension fund regulations.
- *Unique Needs*: The client is an executive in the oil industry. The portfolio should strive to minimize additional exposures to oil and related stocks.

PORTFOLIO CONSTRUCTION AND CAPITAL MARKET EXPECTATIONS

6

- ☐ explain the specification of asset classes in relation to asset allocation
- ☐ describe the principles of portfolio construction and the role of asset allocation in relation to the IPS

Once the IPS has been compiled, the investment manager can construct a suitable portfolio. Strategic asset allocation is a traditional focus of the first steps in portfolio construction. The strategic asset allocation is stated in terms of percentage allocations to asset classes. An **asset class** is a category of assets that have similar characteristics, attributes, and risk–return relationships. The **strategic asset allocation** (SAA) is the set of exposures to IPS-permissible asset classes that is expected to achieve the client's long-term objectives given the client's risk profile and investment constraints. An SAA could include a policy of hedging portfolio risks not explicitly covered by asset class weights. The obvious examples are hedge ratios for foreign currency exposure, or the management of interest rate risk resulting from asset-liability mismatch, and the hedging of inflation risk. So-called "overlay" portfolios of derivatives are often used for this purpose.

The focus on the SAA is the result of a number of important investment principles. One principle is that a portfolio's systematic risk accounts for most of its change in value over the long term. **Systematic risk** is risk related to the economic system (e.g., risk related to business cycle) that cannot be eliminated by holding a diversified portfolio. This risk is different from **nonsystematic risk**, defined as the unique risks of particular assets, which may be avoided by holding other assets with offsetting risks. A second principle is that the returns to groups of similar assets (e.g., long-term debt claims) predictably reflect exposures to certain sets of systematic factors (e.g., for the debt claims, unexpected changes in the interest rate). Thus, the SAA is a means of providing the investor with exposure to the systematic risks of asset classes in proportions that meet the risk and return objectives.

The process of formulating a strategic asset allocation is based on the IPS, already discussed, and capital market expectations.

Capital Market Expectations

Capital market expectations are the investor's expectations concerning the risk and return prospects of asset classes, however broadly or narrowly the investor defines those asset classes. When associated with the client's investment objectives, the result is the strategic asset allocation that is expected to allow the client to achieve his investment objectives (at least under normal capital market conditions).

Traditionally, capital market expectations are quantified in terms of asset class expected returns, standard deviation of returns, and correlations among pairs of asset classes. Formally, the expected return of an asset class consists of the risk-free rate and one or more risk premium(s) associated with the asset class. Expected returns are in practice developed in a variety of ways, including the use of historical estimates, economic analysis, and various kinds of valuation models. Standard deviations and correlation estimates are frequently based on historical data and risk models.

7 STRATEGIC ASSET ALLOCATION

- ☐ explain the specification of asset classes in relation to asset allocation
- ☐ describe the principles of portfolio construction and the role of asset allocation in relation to the IPS

Traditionally, investors have distinguished cash, equities, bonds (government and corporate), and real estate as the major asset classes. In recent years, this list has been expanded with private equity, hedge funds, high-yield and emerging market bonds, and commodities. In addition, such assets as art and intellectual property rights may be considered asset classes for those investors prepared to take a more innovative approach and to accept some illiquidity. Combining such new asset classes as well as hedge funds and private equity under the header "alternative investments" has become accepted practice.

As the strategic asset allocation is built up by asset classes, the decision about how to define those asset classes is an important one. Defining the asset classes also determines the extent to which the investor controls the risk and return characteristics of the eventual investment portfolio. For example, separating bonds into government bonds and corporate bonds, and then further separating corporate bonds into investment grade and non-investment grade (high yield) and government bonds into domestic and foreign government bonds, creates four bond categories. For these categories, risk–return expectations can be expressed and correlations with other asset classes (and, in an asset–liability management context, with the liabilities) can be estimated. An investment manager who wants to explicitly consider the risk–return characteristics of those bond categories in the strategic asset allocation may choose to treat them as distinct asset classes. Similarly, in equities, some investors distinguish between emerging market and developed market equities, between domestic and international equities, or between large-cap and small-cap equities. In some regulatory environments for institutional investors, asset class definitions are mandatory, thereby forcing investment managers to articulate risk–return expectations (and apply risk management) on the asset classes specified. Conversely, a broader categorization of asset classes leaves the allocation between different categories of bonds and equities, for example, to managers responsible for these asset classes.

When defining asset classes, a number of criteria apply. Intuitively, an asset class should contain relatively homogeneous assets while providing diversification relative to other asset classes. In statistical terms, risk and return expectations should be similar, and paired correlations of assets should be relatively high within an asset class but should be lower versus assets in other asset classes. Also, the asset classes, while being mutually exclusive, should add up to a sufficient approximation of the relevant investable universe. Applying these criteria ensures that the strategic asset allocation process has considered all available investment alternatives.

EXAMPLE 9

Specifying Asset Classes

The strategic asset allocations of many institutional investors make a distinction between domestic equities and international equities or between developed market equities and emerging market equities. Often, equities are separated into different market capitalization brackets, resulting, for example, in an asset class such as domestic small-cap equity.

The correlation matrix in Exhibit 5 shows the paired correlations of monthly returns between different equity asset classes and other asset classes. Specifically, these correlations are measured over the period from December 2000 through August 2018. In addition, the exhibit shows the annualized volatility of monthly returns.

Exhibit 5: Asset Class Correlation Matrix

Correlations	US Equities	Emerging Markets	European Equities	Japanese Equities	US Small-Cap Equities	Commodities	European Gov't. Bonds	US Treasuries	US Credits	US High-Yield Credit
US Equities	1.00	0.78	0.88	0.59	0.89	0.32	0.08	–0.37	0.19	0.66
Emerging Markets Equities	0.78	1.00	0.84	0.64	0.75	0.46	0.21	–0.24	0.34	0.70
European Equities	0.88	0.84	1.00	0.64	0.79	0.43	0.16	–0.28	0.29	0.68
Japanese Equities	0.59	0.64	0.64	1.00	0.57	0.32	0.24	–0.18	0.29	0.52
US Small-Cap Equities	0.89	0.75	0.79	0.57	1.00	0.32	0.09	–0.36	0.19	0.69

Correlations	US Equities	Emerging Markets	European Equities	Japanese Equities	US Small-Cap Equities	Commodities	European Gov't. Bonds	US Treasuries	US Credits	US High-Yield Credit
Commodities	0.32	0.46	0.43	0.32	0.32	1.00	0.13	–0.18	0.12	0.36
European Gov't. Bonds	0.08	0.21	0.16	0.24	0.09	0.13	1.00	0.45	0.60	0.30
US Treasuries	–0.37	–0.24	–0.28	–0.18	–0.36	–0.18	0.45	1.00	0.58	–0.19
US Credits	0.19	0.34	0.29	0.29	0.19	0.12	0.60	0.58	1.00	0.54
US High-Yield Credit	0.66	0.70	0.68	0.52	0.69	0.36	0.30	–0.19	0.54	1.00
Volatility	14.3%	21.6%	18.4%	15.6%	18.4%	22.3%	4.9%	4.4%	5.5%	9.3%

Correlations and volatilities have been calculated using monthly returns from December 2000 through August 2018, unhedged, in USD.

Source: MSCI Bloomberg, S&P

Based only on the information given, address the following:

1. Contrast the correlations between equity asset classes with the correlations between equity asset classes and US Treasuries.

Solution:

The matrix reveals very strong correlation between the equity asset classes. For example, the correlation between European equities and US equities is 0.88. The correlation of equities with bonds, however, is much lower. For example, US equities, emerging markets equities, European equities, and Japanese equities all have negative correlation with US government bonds (–0.37, –0.24 and –0.28, and –0.18, respectively). It is worth noting, however, that correlations can vary through time and the values shown may be specific to the sample period used.

2. The monthly returns of which equity asset class differ the most from US equities?

Solution:

Among equity asset classes as listed in the table, the correlation between US and Japanese equities is the lowest, at 0.59. By contrast, correlations between US equities and emerging markets, European, and US small cap equities are 0.78 or higher.

Using correlation as a metric, Example 9 tends to indicate that only emerging markets were well differentiated from European equities. So, why do investors still often subdivide equities? Apart from any regulatory reasons, one explanation might be that this decomposition into smaller asset classes corresponds to the way the asset allocation is structured in portfolios. Many investment managers have expertise exclusively in specific areas of the market, such as emerging market equities, US small-cap equity, or international investment-grade credit. Bringing the asset class definitions of the asset allocation in line with investment products actually available in the market may simplify matters from an organizational perspective.

The risk–return profile of the strategic asset allocation depends on the expected returns and risks of the individual asset classes, as well as the correlation between those asset classes. In general, adding assets classes with low correlation improves the risk–return trade-off (more return for similar risk). Typically, the strategic asset allocation for risk-averse investors will have a large weight in government bonds and cash, whereas those with more willingness and ability to take risk will have more of their assets in risky asset classes, such as equities and many types of alternative investments.

It is customary to represent asset classes using benchmarks and universes calculated by providers such as FTSE, MSCI, or Bloomberg. A negative screening or a **best-in-class** policy (discussed previously) limits the number of securities to choose from, potentially impacting the risk and expected return estimates for these asset classes. Some examples of exclusions may be controversial weaponry or tobacco companies, or investments in certain countries. When such exclusions apply, risk and return estimates based on non-traditional ("off-the-shelf") asset class benchmarks may not be applicable. Separate benchmark indices reflecting the exclusions may be available from the providers to mitigate this issue.

ABP is the pension fund for the Dutch government sector employees. The fund offers teachers, police officers, members of the military, and other civil servants a defined benefit pension plan, aiming for a pension of 70% of the average career real income for employees. As of the first quarter of 2018, ABP had €405 billion under management. The strategic asset allocation as of this period is shown in Exhibit 6.

Exhibit 6: Strategic Asset Allocation for ABP

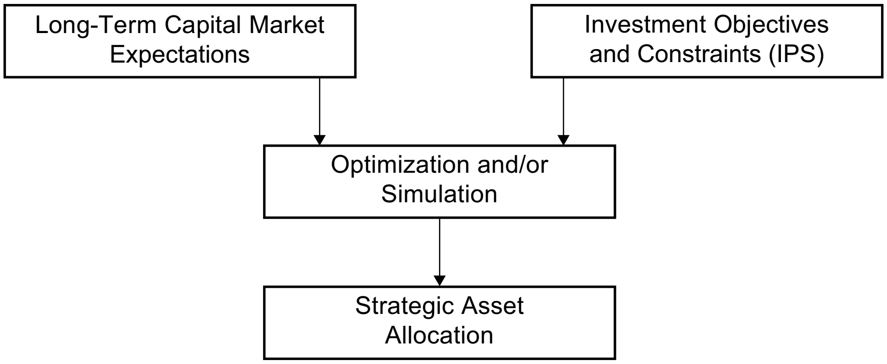
Equity	
Equities, developed countries	27%
Equities, emerging markets	9%
Total equity	***36%***
Alternatives	
Real estate	10%
Private equity	5%
Hedge funds	4%
Commodities	5%
Infrastructure	3%
Total alternatives	***27%***
Fixed-income securities	
Government bonds	13%
Corporate bonds	13%
Inflation-linked bonds	8%
Emerging market bonds	3%

Equity	
Total fixed income	***37%***
Total	100%

Source: ABP Quarterly Report Q1 2018

A strategic asset allocation results from combining the constraints and objectives articulated in the IPS and long-term capital market expectations regarding the asset classes. The strategic asset allocation or policy portfolio will subsequently be implemented into real portfolios. Exhibit 7 illustrates conceptually how investment objectives and constraints and long-term capital market expectations combine into a policy portfolio.

Exhibit 7: Strategic Asset Allocation Process



In some frameworks used in practice, the asset allocation is an integral part of the investment policy statement. This presentation, however, keeps the asset allocation separate from the investment policy statement because clients' investment objectives and constraints qualitatively differ in nature from capital market expectations, thus requiring different types of analysis, different sources of information, and different review cycles.

The combination of investment objectives/constraints and capital market expectations theoretically occurs using optimization techniques. In this section, we apply mean–variance optimization to a sample set of investment objectives and constraints, using an investment universe with associated market expectations. We assume that investors choosing from a range of asset allocations with similar returns would prefer those with lower risk. Choosing from allocations with similar levels of risk, investors would prefer those with the highest return. Formally, investors' risk and return objectives can be described as a utility function, in which utility increases with higher expected returns and lower risk. This assumption could yield an expected utility equation such as that shown in Equation 1.[4]

$$U_p = E\left(R_p\right) - \lambda \sigma_p^2 \quad (1)$$

4 Sharpe, Chen, Pinto, and McLeavey (2007).

where

U_p = the investor's expected utility from the portfolio

$E(R_p)$ = the expected return of the portfolio

σ_p = the standard deviation of returns of the portfolio

λ = a measure of the investor's risk aversion

This utility function expresses a positive relationship between utility and expected portfolio return (i.e., higher expected return increases utility, all else equal) and a negative relationship between utility and volatility of portfolio return as measured by the variance of portfolio returns. The stronger the negative relationship, the greater the investor's risk aversion. The portfolio is understood to represent a particular asset allocation. The asset allocation providing the highest expected utility is the one that is optimal for the investor given his or her risk aversion.

For different values of U_p, a line can be plotted that links those combinations of risk and expected return that produces that level of utility: an indifference curve. An investor would attain equal utility from all risk–return combinations on that curve.

Capital market expectations, specified in asset classes' expected returns, standard deviations of return, and correlations, translate into an efficient frontier of portfolios. A multi-asset class portfolio's expected return is given by

$$E\left(R_p\right) = \sum_{i=1}^{n} w_i E\left(R_i\right) \tag{2}$$

where w_i equals the weight of asset class i in the portfolio, and its risk is given by

$$\sigma_p = \sqrt{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{p,i} w_{p,j} \text{Cov}\left(R_i, R_j\right)} \tag{3}$$

The covariance between the returns on asset classes i and j is given by the product of the correlation between the two asset classes and their standard deviations of return:

$$\text{Cov}(R_i,R_j) = \rho_{i,j}\sigma_i\sigma_j \tag{4}$$

where

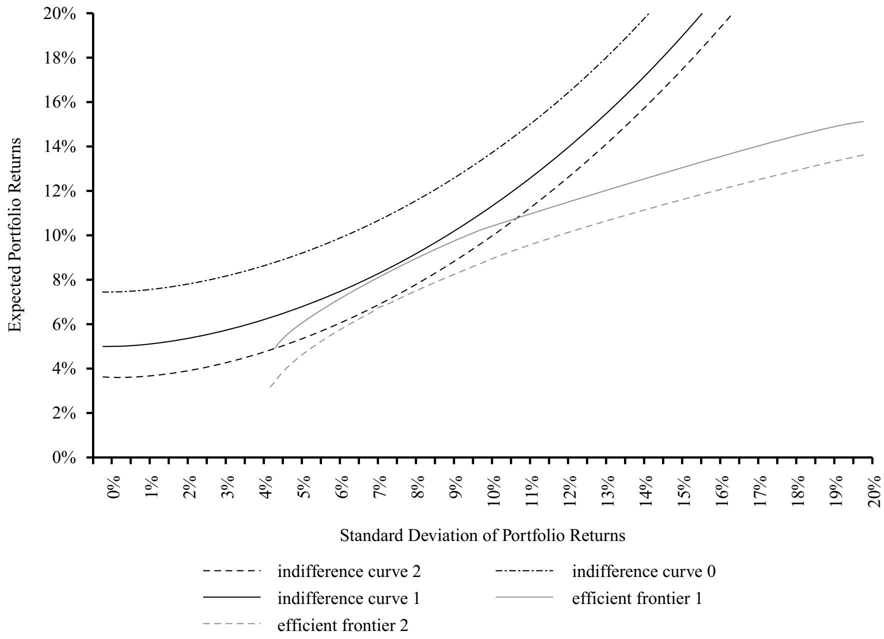
$\text{Cov}(R_i,R_j)$ = the covariance between the return of asset classes i and j

$\rho_{i,j}$ = the correlation between the returns of asset classes i and j

The resulting portfolios can be represented as a scatter of dots in a chart depicting their risk and expected return. Because a portfolio's risk is a positive function of the risk of its assets and the correlations among them, a portfolio consisting of risky assets with low correlation has lower risk than one with similarly risky assets with high correlation. It is therefore possible to construct different portfolios with equal expected returns but with different levels of risk. The line that connects those portfolios with the minimal risk for each level of expected return (above that of the **minimum-variance portfolio**—the portfolio with the minimum variance for each given level of expected return) is the efficient frontier. Clearly, the efficient frontier will move "upward" as more low-correlation assets with sufficient expected return are added to the mix because it lowers the risk in the portfolios for equal expected returns. Similarly, when return expectations increase for asset classes while volatility and correlation assumptions remain unchanged, the efficient frontier will move upward because each portfolio is able to generate higher returns for the same level of risk.

Both the efficient frontier and a range of indifference curves can be plotted in the risk–return space. In Exhibit 8, the dark-colored curves that are concave from below represent efficient frontiers associated with different assumed expected returns. The lighter-colored curves are indifference curves. The point where the efficient frontier intersects with the indifference curve with the highest utility attainable (i.e., the point of tangency) represents the optimal asset allocation for the client/investor. In Exhibit 8, efficient frontier 1 has a point of tangency with indifference curve 1. Higher levels of utility, such as those associated with indifference curve 0, can apparently not be reached with the assets underlying the efficient frontier. It is clear that when capital market expectations change, this change moves the efficient frontier away from its original location. In the chart, this movement is illustrated by efficient frontier 2, which incorporates different capital market expectations. This new efficient frontier has a point of tangency with indifference curve 2, which is associated with a lower level of expected utility. Because the point of tangency represents the strategic asset allocation, it implies the asset allocation should be adjusted. Similarly, should investment objectives or constraints change, the indifference curves will change their shape and location. This change will again move the point of tangency, and hence change the asset allocation.

Exhibit 8: Strategic Asset Allocation Efficient Frontier



This framework describes how investor objectives and capital market expectations should theoretically be reconciled. It will, however, not be the exact procedure that in practice will be followed. First, an IPS does not necessarily translate the client's investment objectives and constraint into a utility function. Rather, an IPS gives threshold levels for risk and expected return, combined with a number of additional constraints that cannot be captured in this model. Second, the model illustrated is a single-period model, whereas in practice, the constraints from the IPS will make it more appropriate to use multi-period models. Multi-period problems can be more effectively addressed using simulation.

EXAMPLE 10

Approaching a SAA for a Private Investor

1. Rainer Gottschalk recently sold his local home construction company in the south of Germany to a large homebuilder with a nationwide reach. Upon selling his company, he accepted a job as regional manager for that nationwide homebuilder. Gottschalk is now considering his and his family's financial future. He looks forward to his new job—he likes his new role, and the position provides him with income to fulfill his family's short-term and medium-term liquidity needs. Gottschalk feels strongly that he should not invest the proceeds of the sale of his company in real estate because his income already depends on the state of the real estate market. Also, reflecting family values, he feels strongly that his savings should not support the tobacco industry. He therefore wants his equity allocation to exclude any stocks of tobacco product manufacturers or retailers. Gottschalk consults a financial adviser from his bank about how to invest his money to retire in good wealth in 20 years.

   The IPS developed by his adviser suggests a return objective of 5%, with a standard deviation of 10%. The bank's asset management division provides Gottschalk and his adviser with the following data (Exhibit 9, Panel 1) on market expectations. The adviser estimates that excluding the tobacco industry from the investment universe affects expected equity returns of European equities by –0.2% and annual standard deviation by +0.1%. The impact on emerging market equities, and on the correlation structure, was considered negligible. Gottschalk accepts the results of these calculations as shown in Exhibit 9, Panel 2.

Exhibit 9: Risk, Return, and Correlation Estimates

			Correlation Matrix		
	Expected Return	Standard Deviation	European Equities	Emerging Mkt Equities	European Govt Bonds
Panel 1					
European equities	6.0%	15.0%	1.00	0.78	–0.08
Emerging market equities	8.0%	20.1%	0.78	1.00	–0.07
European government bonds	2.0%	7.8%	–0.08	–0.07	1.00
Panel 2					
European equities	5.8%	15.1%	1.00	0.78	–0.08
Emerging market equities	8.0%	20.1%	0.78	1.00	–0.07
European government bonds	2.00%	7.8%	–0.08	–0.07	1.00

Standard deviation and correlation calculated over the period March 1999–August 2018. All data *in unhedged euros.*

Sources: MSCI, Bloomberg

To illustrate the possibilities, the adviser presents Gottschalk with the following plot (Exhibit 10), in which the points forming the shaded curve outline the risk–return characteristics of the portfolios that can be constructed out of the three asset classes. An imaginary line linking the points with the lowest standard deviation for each attainable level of return would be the efficient frontier. The two straight lines show the risk and return objectives. Gottschalk should aim for portfolios that offer an expected return of at least 6% (the straight horizontal line or above) and a standard deviation of return of 12% or lower (the straight vertical line to the left).

Exhibit 10: Efficient Frontier

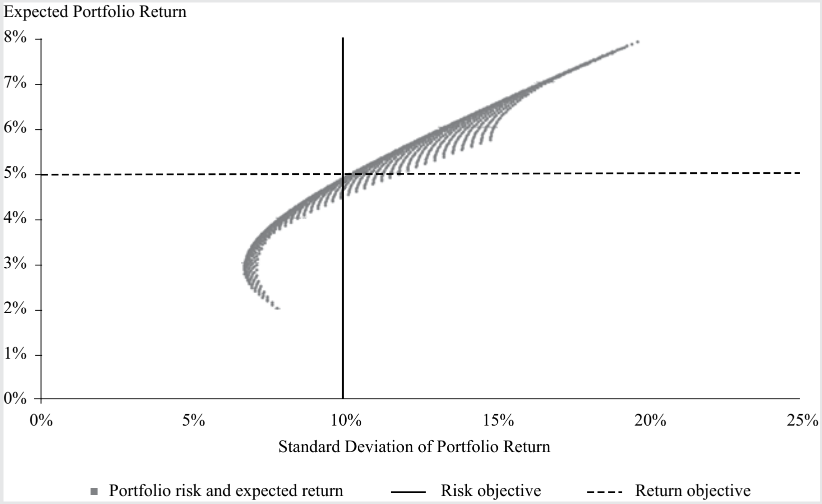


Exhibit 10 shows that no portfolio satisfies the two objectives (return of 5% and standard deviation of 10%) exactly, because the highest expected return that can be attained at a maximum volatility of 10% is 4.9%. This difference, Gottschalk and the adviser agree, is acceptable. The portfolio that would correspond with this expected return consists of 16% European stocks, 38% emerging market equities, and 46% government bonds.

8 PORTFOLIO CONSTRUCTION PRINCIPLES

☐ describe the principles of portfolio construction and the role of asset allocation in relation to the IPS

The strategic asset allocation in itself does not yet represent an actual investment portfolio. It is the first step in implementing an investment strategy. For quantitatively oriented portfolio managers, the next step is often risk budgeting.

As used in this reading, **risk budgeting** is the process of deciding on the amount of risk to assume in a portfolio (the overall risk budget) and subdividing that risk over the sources of investment return (e.g., strategic asset allocation, tactical asset allocation, and security selection). Because the decision about the total amount of risk to be taken is made in constructing the IPS, at this stage we are concerned about the subdivision of that risk.

Apart from the exposures to systematic risk factors specified in the strategic asset allocation, the returns of an investment strategy depend on two other sources: tactical asset allocation and security selection. **Tactical asset allocation** is the decision to deliberately deviate from the policy exposures to systematic risk factors (i.e., the policy weights of asset classes) with the intent to add value based on forecasts of the near-term returns of those asset classes. For instance, an investor may decide to temporarily invest more of the portfolio in equities than the SAA prescribes if the investor anticipates that equities will deliver a higher return over the short term than other asset classes. **Security selection** is an attempt to generate higher returns than the asset class benchmark by selecting securities with a higher expected return. For example, an investment manager may decide to add more IBM stock in her portfolio than the weight in her equity benchmark if she expects this stock to do better than the benchmark. To fund this purchase, she may sell another stock expected to do worse than either the benchmark or IBM. Obviously, deciding to deviate from policy weights or to select securities aiming to beat the benchmark creates additional uncertainty about returns. This risk is over and above the risk inherent in the policy portfolio. Hence, an investment policy should set risk limits and desired payoffs for each of these three activities.

Risk budgeting implies that the portfolio manager has to choose, for every asset class, whether to deploy security selection as a return generator. This choice is generally referred to as the choice between active or passive management. Contrary to strategic asset allocation, where exposures to sources of systematic risk are selected and sized, security selection is not rewarded with a long-run payoff to risk. Security selection is a zero-sum game: All investors in an asset class are competing with each other to identify a typically limited number of assets that are misvalued. In total, the gross returns of all market participants average out to the market return (the reward for taking systematic risk). This implies that the average active investor will match the market return and that one investor's gain versus the market return is the other investor's loss versus the market return. Because active managers tend to trade more and have to pay people (including themselves) to generate investment ideas or information leading to such ideas, however, the average active manager will underperform the market, net of costs. This fact does not imply that there are no skillful investment managers who, with some consistency, beat their benchmarks. Neither does it imply that all passive managers will be able to match the benchmark. The higher the turnover of an index, the more trading costs a passive manager will incur, making the task of matching the return of an index more difficult.

The likelihood of adding a significant amount of value from security selection depends on the skills of the manager and the informational efficiency of the market for the asset class his skill relates to. The more efficient an asset class or a subset of that asset class (such as a regional stock, bond, or real estate market or a size category within the stock market), the more skillful an asset manager has to be to add value. Broadly speaking, an efficient market is a market in which prices, on average, very quickly reflect newly available information. That requires a sizeable participation of investors trading risk against expected return, acting on rational expectations, using the same or similar pricing models, and having equal opportunities to access relevant information. Clearly, the market for US large-capitalization equities would be quite efficient. By contrast, some regional bond and equity markets do not have the technical and regulatory systems for information dissemination that are sufficient to serve all investors on a timely basis. Skilled managers should be able to exploit the resulting inefficiencies.

Sometimes the choice between active and passive management is actually made implicitly when the asset class is included in the asset allocation. The markets for some assets—such as those for non-listed real estate and infrastructure assets—are so illiquid that it is very difficult to buy a diversified exposure. As a result, participating in that market is not possible without engaging in security selection.

As the portfolio is constructed and its value changes with the returns of the asset classes and securities in which it is invested, the weights of the asset classes will gradually deviate from the policy weights in the strategic asset allocation. This process is referred to as drift. Periodically, or when a certain threshold deviation from the policy weight (the bandwidth) has been breached, the portfolio should be rebalanced back to the policy weights. The set of rules that guide the process of restoring the portfolio's original exposures to systematic risk factors is known as the **rebalancing policy**. Even absent a formal risk budget, formulating a rebalancing policy is an important element of risk management, as the following example illustrates.

EXAMPLE 11

Strategic and Tactical Asset Allocation for a European Charity

A European charity has an asset allocation at the beginning of the year consisting of the asset classes and weights shown in Exhibit 11.

Exhibit 11: Asset Allocation of a European Charity (beginning of year)

Asset Class	Policy Weight	Corridor (+/–)	Upper Limit	Lower Limit
European equities	30.0%	2.0%	32.0%	28.0%
International equities	15.0%	2.0%	17.0%	13.0%
European government bonds	20.0%	2.0%	22.0%	18.0%
Corporate bonds	20.0%	2.0%	22.0%	18.0%
Cash and money market instruments	15.0%	2.0%	17.0%	13.0%
Total	100.0%			

As Exhibit 11 reveals, the charity has a policy that the asset class weights cannot deviate from the policy weights by more than 2% (the corridor). The resulting upper and lower limits for the asset class weights are shown in the rightmost columns of the table. There are two reasons for asset class actual weights to deviate from policy weights: by deliberate choice (tactical asset allocation or market timing) and as a result of divergence of the returns of the different asset classes (drift). In this example, the asset class weights start the year exactly in line with policy weights.

After half a year, the investment portfolio is as shown in Exhibit 12.

Exhibit 12: Asset Allocation for a European Charity (six months later)

Asset Class	Policy Weight	Corridor (+/–)	Upper Limit	Lower Limit	Period Return	Ending Weight
European equities	30.0%	2.0%	32.0%	28.0%	15.0%	32.4%
International equities	15.0%	2.0%	17.0%	13.0%	10.0%	15.5%

Asset Class	Policy Weight	Corridor (+/–)	Upper Limit	Lower Limit	Period Return	Ending Weight
European government bonds	20.0%	2.0%	22.0%	18.0%	0.5%	18.9%
Corporate bonds	20.0%	2.0%	22.0%	18.0%	1.5%	19.1%
Cash and money market instruments	15.0%	2.0%	17.0%	13.0%	1.0%	14.2%
Total	100.0%				6.6%	100.0%

1. Discuss the returns of the portfolio and comment on the main asset weight changes.

Solution to 1:

The investment portfolio generated a return calculated on beginning (policy) weights of 6.55%, rounded to 6.6% (= 0.30 × 15% + 0.15 × 10% + 0.20 × 0.5% + 0.20 × 1.5% + 0.15 × 1.0%), mainly driven by a strong equity market. Bond returns were more subdued, leading to considerable drift in asset class weights. In particular, the European equity weight breached the upper limit of its allowed actual weight.

2. The investment committee decides against reducing European equities back to policy weight and adding to the fixed income and cash investments toward policy weights. Although this rebalancing would be prudent, the committee decides to engage in tactical asset allocation based on the view that this market will continue to be strong over the course of the year. It decides to just bring European equities back to within its bandwidth (a 32% portfolio weight) and add the proceeds to cash. Exhibit 13 shows the outcome after another half year.

Exhibit 13: Asset Allocation for a European Charity (an additional six months later)

Asset Class	Policy Weight	Starting Weight	Corridor (+/–)	Upper Limit	Lower Limit	Period Return	Ending Weight
European equities	30.0%	32.0%	2.0%	32.0%	28.0%	–9.0%	29.7%
International equities	15.0%	15.5%	2.0%	17.0%	13.0%	–6.0%	14.9%
European government bonds	20.0%	18.9%	2.0%	22.0%	18.0%	4.0%	20.0%
Corporate bonds	20.0%	19.1%	2.0%	22.0%	18.0%	4.0%	20.2%
Cash and money market instruments	15.0%	14.6%	2.0%	17.0%	13.0%	2.0%	15.2%
Total	100.0%					–2.0%	100.0%

The prior decision not to rebalance to policy weights did not have a positive result. Contrary to the investment committee's expectations, both European and international equities performed poorly while bonds recovered. The return of the portfolio was –2.0%.

How much of this return can be attributed to tactical asset allocation?

Solution to 2:

Because tactical asset allocation is the deliberate decision to deviate from policy weights, the return contribution from tactical asset allocation equals the difference between the actual return and the return that would have been made if the asset class weights were equal to the policy weights. Exhibit 14 shows this difference to be –0.30%.

Exhibit 14: Returns to Tactical Asset Allocation

Asset Class	Policy Weight I	Starting Weight II	Weights Difference III (= II – I)	Period Return IV	TAA Contribution V(= III × IV)
European equities	30.0%	32.0%	2.0%	–9.0%	–0.18%
International equities	15.0%	15.5%	0.5%	–6.0%	–0.03%
European government bonds	20.0%	18.9%	–1.1%	4.0%	–0.05%
Corporate bonds	20.0%	19.1%	–0.9%	4.0%	–0.04%
Cash and money market instruments	15.0%	14.6%	–0.4%	2.0%	–0.01%
Total	100.0%			–2.0%	–0.30%

The process of executing an investment strategy continues with selecting the appropriate manager(s) for each asset class and allocating funds to them. The investment portfolio management process is then well into the execution stage.

The investment managers' performance will be monitored, as well as the results of the tactical and strategic asset allocation. When asset class weights move outside their corridors, money is transferred from the asset classes that have become too large compared with the SAA to those that fall short. Managers as well as the strategic asset allocation will be reviewed on the basis of the outcome of the monitoring process. In addition, capital market expectations may change, as may the circumstances and objectives of the client. These changes could result in an adjustment of the strategic asset allocation.

New Developments in Portfolio Management

The portfolio planning and construction framework presented so far relies on a somewhat rigid process. Nonetheless, there are two newer, less structured developments that deserve specific mention.

The first development is the growth in the offering of exchange traded funds, or ETFs, in combination with algorithm-based financial advice (or robo-advice). ETFs are funds that track the performance of an asset class index or sub-index, are easily tradable, and are relatively cheap compared with actively managed funds or managed accounts. The broad array of ETF offerings, covering the main equity and fixed-income indices as well as commodities, enable retail investors to obtain fast, inexpensive, and liquid exposure to asset classes. Robo-advice has further reduced the costs for retail investors to create a well-diversified portfolio.

The second development relates to criticism of asset class return forecasts over relevant time horizons, as well as the perceived instability of asset class correlations and volatilities. Some market participants argue that poor investment portfolio results reflect the sensitivity of modern portfolio theory-based portfolio construction methodologies to small errors in return forecasts or estimated correlations. In response, practitioners developed an investment approach where asset classes were weighted according to risk contribution. This approach is known as *risk parity investing.* Proponents of risk parity investing argue that traditionally constructed portfolios have considerable risk from equities. That is, the typically high (60% or more) weight of equities in institutional portfolios understates the risk impact: equities tend to be much more volatile than fixed income. Opponents of risk parity argue that following the global financial crisis of 2007–2009, favorable results of risk parity portfolios were caused by the long period of decline in interest rates that benefited bond market performance.

9 ESG CONSIDERATIONS IN PORTFOLIO PLANNING AND CONSTRUCTION

- [ ] describe how environmental, social, and governance (ESG) considerations may be integrated into portfolio planning and construction

The implementation of a policy on responsible investing affects both strategic asset allocation and implementation of the portfolio construction process. The ESG investment approaches described previously require a set of instructions for investment managers with regard to the selection of securities, the exercise of shareholder rights, and the selection of investment strategies. Examples of issues driving the integration of environmental and social factors in the investment process include scarcity of natural resources, physical impacts of climate change, global economic and demographic trends, diversity and inclusion, and the rise of social media. ESG investment approaches can be implemented with structured, numeric data for many of these issues (e.g., executive salaries and bonuses, carbon footprint, employee turnover, lost time injuries and fatalities, and employee absenteeism). Although companies often are not required to disclose such data, that is changing as many stock exchanges and other regulatory bodies across developed and emerging markets have set up guidelines related to corporate sustainability disclosures for listed companies. In addition, many organizations and regulatory bodies have derived frameworks setting out standards on a number of these issues—examples include the Principles of Responsible Investment, the UN Global Compact, and the OECD Guidelines for Multinational Enterprises. These standards help form the basis of responsible investing policies for asset owners. In turn, asset owners may exclude or engage with companies in accordance with these issues, or demand from their selected investment managers consider these issues in their investment process.

We previously discussed that the limitation in the investment universe from using negative screening policies affects the expected returns and risk. When selecting or instructing active or passive managers, these managers will clearly prefer to see their performance measured against a benchmark that reflects the limited universe. There are benchmarks and investment vehicles (both active and passive) available, particularly in equities, that reflect many commonly excluded companies or sectors. It is also worth noting that with the proliferation of the ESG integration approach, more and more asset owners expect their asset managers to beat the regular benchmarks, because integration of ESG factors into traditional financial analysis and portfolio construction is viewed more as a process enhancement rather than an entirely new way to invest.

EXAMPLE 12

ESG Factors Directly Impacting Portfolio Construction

1. Based in South Africa, Mountain Materials (Mountain) is a fictitious cement manufacturing company that ranks as one of the largest cement and concrete manufacturers in the world. Mountain operates mostly in South Africa, where environmental regulations have been gradually strengthening since 2015. Because of the large scale of its operations, Mountain is a significant emitter of greenhouse gases (GHGs). During 2019, by setting a carbon price on the country's largest GHG emitters, South Africa launched a new, crucial endeavor in its efforts to tackle air pollution and climate change. Despite having some ad hoc initiatives to manage its carbon emissions, the company lacks firmwide programs to limit energy use or carbon emissions, thereby remaining exposed to increased costs to offset excess emissions. The average price on carbon across seven pilot markets in South Africa was between \$5 and \$15 per ton of carbon dioxide. In addition, the company's performance in managing toxic air emissions as well as employee health and safety falls short of industry best practices, leaving Mountain exposed to related risks.

   Ved Disha, CFA, is analyzing the effects of the environmental and social factors on Mountain's financial statements. Exhibit 15 illustrates Disha's expected internal rate of return (IRR) in the base, bear, and bull case scenarios for Mountain based on his fundamental analysis, and Exhibit 16 illustrates the same scenarios following the integration of these material environmental and social risks.

Exhibit 15: Pre-ESG Integration: Bear/Base/Bull Case Scenario

	Bear Case	Base Case	Bull Case
Revenue growth	0.0%	10.0%	15.0%
Margin improvement	–5.0%	3.0%	5.0%
Cash dividend	1.0%	2.0%	2.0%
Multiple expansion	–10.0%	0.0%	5.0%
IRR	–14.0%	15.0%	27.0%

Exhibit 16: Post-ESG Integration: Bear/Base/Bull Case Scenario

	Bear Case	Base Case	Bull Case
Revenue growth	–5.0%	10.0%	20.0%
Margin improvement	–10.0%	–3.0%	0.0%
Cash dividend	0.0%	0.0%	2.0%
Multiple expansion	–5.0%	–2.0%	0.0%
IRR	–20.0%	5.0%	22.0%

   Disha assumed that compliance with national and provincial carbon regulations would require the company to increase spending on equipment, resulting in a 1% erosion in operating margin. Moreover, to limit toxic emissions, the company would have to switch to relatively cleaner sources of energy such as gas-based powered plants. This change is expected to further dampen operating margin by 2% because of increased fuel costs. As a result of higher spending, it was assumed that the previously stable cash dividend policy would turn conservative in the short term, and hence Disha reduced the expected dividend from 2% to 0% for the base case. Lastly, there is a downside to multiples as a result of the concerns related to management of health and safety risks, because the company's performance is below that of its peers and capital markets tend to discount the share price in the event of safety incidents. Based on all of these changes, the base case IRR for the cement company case became less attractive. This outlook led Disha to undertake a relatively smaller position of 0.5% (versus 1.5% in the absence of ESG risks) in his portfolio because of the various unmanaged ESG risks at Mountain. Disha also decided to engage with company management to influence better disclosures and management of these environmental and social risks. In this manner, key ESG risks and growth opportunities were integrated with traditional financial analysis to help arrive at a more robust investment decision.

In this example, a high level of unmanaged ESG risks led to a significant change in expected IRR following the ESG integration and hence impacted the position size significantly. It is prudent to note, however, that ESG is one of the many factors that influence investment decision making. Therefore, in many cases, ESG risk and opportunities may have limited effect on a company's financial attractiveness and thereby may not cause a large change in the portfolio. These risks and opportunities have to be analyzed and interpreted on a case-by-case basis.

Shareholder engagement requires good cooperation between investor (client) and investment manager. Engagement efforts are time-consuming, and the interest in such efforts is often that of the clients rather than that of the investment managers. Clients and investment managers must be clear with each other about the exercise of voting rights, filing of shareholder proposals, or entering into conversations with company management. It may be that the engagement and voting is delegated by the client to the investment manager and implemented according to the manager's stewardship policy. Alternatively, the client may instruct some proxy agent to vote on its behalf and according to its own stewardship policies, or the client may instruct voting and maintain dialogue with its investee companies through either individual engagements or collaborative engagements. Collaborative engagement initiatives have gained popularity because it is easier to gain the attention of and encourage positive action from corporations on material ESG issues through collective action. Climate Action 100+ is one such initiative that aims to ensure the world's largest corporate GHG emitters take necessary action on climate change. The initiative aims to engage with more than 100 systemically important carbon emitters, accounting for two-thirds of annual global industrial emissions, alongside more than 60 other companies with significant opportunity to drive the clean energy transition.

Selecting thematic investments, particularly in liquid asset classes, requires finding specialist managers who can identify the right opportunities and manage thematic investment portfolios. In particular, an allocation to thematic investments will bias the total asset class portfolio toward a particular theme, so it is important for the investment manager to demonstrate the impact of the thematic investment on the total risk–return profile of the portfolio. Impact investing specifically selects investment opportunities based on their intention to create a positive environmental and social impact.

The effort and costs associated with limiting the investment universe as part of responsible investing may suggest a negative impact on investment returns. Responsible investing proponents argue, however, that potential improvements in governance, as well as the avoidance of material risks by companies that screen, favorably improve returns. Significant empirical research has been conducted on the performance of ESG factors in equities, including the return differences of ESG equity portfolios relative to mainstream equity portfolios. Academic research remains mixed on the impact of ESG factors on portfolio returns. Nevertheless, ESG investing continues to see strong adoption, with nearly US$31 trillion of AUM dedicated toward responsible investment mandates at the start of 2018. The ESG integration approach that integrates material qualitative and quantitative environmental, social, and governance factors into traditional security and industry analysis as well as portfolio construction is now widely adopted across mainstream funds and not just limited to client-specific separate accounts.

SUMMARY

In this reading, we have discussed construction of a client's investment policy statement, including discussion of risk and return objectives and the various constraints that will apply to the portfolio. We have also discussed the portfolio construction process, with emphasis on the strategic asset allocation decisions that must be made.

- The IPS is the starting point of the portfolio management process. Without a full understanding of the client's situation and requirements, it is unlikely that successful results will be achieved.
- The IPS can take a variety of forms. A typical format will include the client's investment objectives and also list the constraints that apply to the client's portfolio.
- The client's objectives are specified in terms of risk tolerance and return requirements.
- The constraints section covers factors that need to be considered when constructing a portfolio for the client that meets the objectives. The typical constraint categories are liquidity requirements, time horizon, regulatory requirements, tax status, and unique needs.
- Clients may have personal objections to certain products or practices, which could lead to the exclusion of certain companies, countries, or types of securities from the investable universe as well as the client's benchmark. Such considerations are often referred to as ESG (environmental, social, governance).
- ESG considerations can be integrated into an investment policy by negative screening, positive screening, ESG integration, thematic investing, engagement/active ownership, and impact investing.
- Risk objectives are specifications for portfolio risk that reflect the risk tolerance of the client. Quantitative risk objectives can be absolute, relative, or a combination of the two.
- The client's overall risk tolerance is a function of both the client's ability to accept risk and the client's "risk attitude," which can be considered the client's willingness to take risk.

- The client's return objectives can be stated on an absolute or a relative basis. As an example of an absolute objective, the client may want to achieve a particular percentage rate of return. Alternatively, the return objective can be stated on a relative basis—for example, relative to a benchmark return.
- The liquidity section of the IPS should state what the client's requirements are to draw cash from the portfolio.
- The time horizon section of the IPS should state the time horizon over which the investor is investing. This horizon may be the period during which the portfolio is accumulating before any assets need to be withdrawn.
- Tax status varies among investors, and a client's tax status should be stated in the IPS.
- The IPS should state any legal or regulatory restrictions that constrain the investment of the portfolio.
- The unique circumstances section of the IPS should cover any other aspect of a client's circumstances that is likely to have a material impact on portfolio composition. Certain ESG implementation approaches may be discussed in this section.
- Asset classes are the building blocks of an asset allocation. An asset class is a category of assets that have similar characteristics, attributes, and risk–return relationships. Traditionally, investors have distinguished cash, equities, bonds, and real estate as the major asset classes.
- A strategic asset allocation results from combining the constraints and objectives articulated in the IPS and capital market expectations regarding the asset classes.
- As time goes on, a client's asset allocation will drift from the target allocation, and the amount of allowable drift as well as a rebalancing policy should be formalized.
- In addition to taking systematic risk, an investment committee may choose to take tactical asset allocation risk or security selection risk. The amount of return attributable to these decisions can be measured.
- ESG considerations may be integrated into the portfolio planning and construction process. ESG implementation approaches require a set of instructions for investment managers with regard to the selection of securities, the exercise of shareholder rights, and the selection of investment strategies.

PRACTICE PROBLEMS

1. Which of the following is *least* important as a reason for a written investment policy statement (IPS)?

   A. The IPS may be required by regulation.

   B. Having a written IPS is part of best practice for a portfolio manager.

   C. Having a written IPS ensures the client's risk and return objectives can be achieved.

2. Which of the following *best* describes the underlying rationale for a written investment policy statement (IPS)?

   A. A written IPS communicates a plan for trying to achieve investment success.

   B. A written IPS provides investment managers with a ready defense against client lawsuits.

   C. A written IPS allows investment managers to instruct clients about the proper use and purpose of investments.

3. A written investment policy statement (IPS) is *most* likely to succeed if:

   A. it is created by a software program to assure consistent quality.

   B. it is a collaborative effort of the client and the portfolio manager.

   C. it reflects the investment philosophy of the portfolio manager.

4. The section of the investment policy statement (IPS) that provides information about how policy may be executed, including restrictions and exclusions, is *best* described as the:

   A. *Investment Objectives*.

   B. *Investment Guidelines*.

   C. *Statement of Duties and Responsibilities*.

5. Which of the following is *least* likely to be placed in the appendices to an investment policy statement (IPS)?

   A. *Rebalancing Policy*.

   B. *Strategic Asset Allocation*.

   C. *Statement of Duties and Responsibilities*.

6. Which of the following typical topics in an investment policy statement (IPS) is *most* closely linked to the client's "distinctive needs"?

   A. *Procedures*.

   B. *Investment Guidelines*.

   C. *Statement of Duties and Responsibilities*.

7. An investment policy statement that includes a return objective of outperforming the FTSE 100 by 120 basis points is *best* characterized as having a(n):
   A. relative return objective.
   B. absolute return objective.
   C. arbitrage-based return objective.

8. Risk assessment questionnaires for investment management clients are *most* useful in measuring:
   A. value at risk.
   B. ability to take risk.
   C. willingness to take risk.

9. Which of the following is *best* characterized as a relative risk objective?
   A. Value at risk for the fund will not exceed US$3 million.
   B. The fund will not underperform the DAX by more than 250 basis points.
   C. The fund will not lose more than €2.5 million in the coming 12-month period.

10. In preparing an investment policy statement, which of the following is *most* difficult to quantify?
   A. Time horizon.
   B. Ability to accept risk.
   C. Willingness to accept risk.

11. A client who is a 34-year old widow with two healthy young children (aged 5 and 7) has asked you to help her form an investment policy statement. She has been employed as an administrative assistant in a bureau of her national government for the previous 12 years. She has two primary financial goals—her retirement and providing for the college education of her children. This client's time horizon is *best* described as being:
   A. long term.
   B. short term.
   C. medium term.

12. The timing of payouts for property and casualty insurers is unpredictable ("lumpy") in comparison with the timing of payouts for life insurance companies. Therefore, in general, property and casualty insurers have:
   A. lower liquidity needs than life insurance companies.
   B. greater liquidity needs than life insurance companies.
   C. a higher return objective than life insurance companies.

13. A client who is a director of a publicly listed corporation is required by law to refrain from trading that company's stock at certain points of the year when dis-

closure of financial results are pending. In preparing a written investment policy statement (IPS) for this client, this restriction on trading:

A. is irrelevant to the IPS.

B. should be included in the IPS.

C. makes it illegal for the portfolio manager to work with this client.

14. After interviewing a client in order to prepare a written investment policy statement (IPS), you have established the following:

- The client has earnings that vary dramatically between £30,000 and £70,000 (pre-tax) depending on weather patterns in Britain.
- In three of the previous five years, the after-tax income of the client has been less than £20,000.
- The client's mother is dependent on her son (the client) for approximately £9,000 per year support.
- The client's own subsistence needs are approximately £12,000 per year.
- The client has more than 10 years' experience trading investments including commodity futures, stock options, and selling stock short.
- The client's responses to a standard risk assessment questionnaire suggest he has above average risk tolerance.

The client is *best* described as having a:

A. low ability to take risk, but a high willingness to take risk.

B. high ability to take risk, but a low willingness to take risk.

C. high ability to take risk and a high willingness to take risk.

15. After interviewing a client in order to prepare a written investment policy statement (IPS), you have established the following:

- The client has earnings that have exceeded €120,000 (pre-tax) each year for the past five years.
- She has no dependents.
- The client's subsistence needs are approximately €45,000 per year.
- The client states that she feels uncomfortable with her lack of understanding of securities markets.
- All of the client's current savings are invested in short-term securities guaranteed by an agency of her national government.
- The client's responses to a standard risk assessment questionnaire suggest she has low risk tolerance.

The client is *best* described as having a:

A. low ability to take risk, but a high willingness to take risk.

B. high ability to take risk, but a low willingness to take risk.

C. high ability to take risk and a high willingness to take risk.

16. Returns on asset classes are *best* described as being a function of:

A. the failure of arbitrage.

B. exposure to the idiosyncratic risks of those asset classes.

C. exposure to sets of systematic factors relevant to those asset classes.

17. Consider the pairwise correlations of monthly returns of the following asset classes:

	Brazilian Equities	East Asian Equities	European Equities	US Equities
Brazilian equities	1.00	0.70	0.85	0.76
East Asian equities	0.70	1.00	0.91	0.88
European equities	0.85	0.91	1.00	0.90
US equities	0.76	0.88	0.90	1.00

Based solely on the information in the above table, which equity asset class is *most* sharply distinguished from US equities?

A. Brazilian equities.

B. European equities.

C. East Asian equities.

18. In defining asset classes as part of the strategic asset allocation decision, pairwise correlations within asset classes should generally be:

A. equal to correlations among asset classes.

B. lower than correlations among asset classes.

C. higher than correlations among asset classes.

19. Tactical asset allocation is *best* described as:

A. attempts to exploit arbitrage possibilities among asset classes.

B. the decision to deliberately deviate from the policy portfolio.

C. selecting asset classes with the desired exposures to sources of systematic risk in an investment portfolio.

SOLUTIONS

1. C is correct. Depending on circumstances, a written IPS or its equivalent may be required by law or regulation and a written IPS is certainly consistent with best practices. The mere fact that a written IPS is prepared for a client, however, does not *ensure* that risk and return objectives will in fact be achieved.

2. A is correct. A written IPS is best seen as a communication instrument allowing clients and portfolio managers to mutually establish investment objectives and constraints.

3. B is correct. A written IPS, to be successful, must incorporate a full understanding of the client's situation and requirements. As stated in the reading, "The IPS will be developed following a fact finding discussion with the client."

4. B is correct. The major components of an IPS are listed in Section 2 of the reading. *Investment Guidelines* are described as the section that provides information about how policy may be executed, including restrictions on the permissible use of leverage and derivatives and on specific types of assets excluded from investment, if any. *Statement of Duties and Responsibilities* "detail[s] the duties and responsibilities of the client, the custodian of the client's assets, the investment managers, and so forth." *Investment Objectives* is "a section explaining the client's objectives in investing."

5. C is correct. The major components of an IPS are listed in Section 2 of the reading. Strategic Asset Allocation (also known as the policy portfolio) and Rebalancing Policy are often included as appendices to the IPS. The *Statement of Duties and Responsibilities*, however, is an integral part of the IPS and is unlikely to be placed in an appendix.

6. B is correct. According to the reading, "The sections of an IPS that are most closely linked to the client's distinctive needs are those dealing with investment objectives and constraints." *Investment Guidelines* "[provide] information about how policy may be executed, including investment constraints." *Procedures* "[detail] the steps to be taken to keep the IPS current and the procedures to follow to respond to various contingencies." *Statement of Duties and Responsibilities* "detail[s] the duties and responsibilities of the client, the custodian of the client's assets, the investment managers, and so forth."

7. A is correct. Because the return objective specifies a target return *relative to* the FTSE 100 Index, the objective is best described as a relative return objective.

8. C is correct. Risk attitude is a subjective factor and measuring risk attitude is difficult. Oftentimes, investment managers use psychometric questionnaires, such as those developed by Grable and Joo (2004), to assess a client's willingness to take risk.

9. B is correct. The reference to the DAX marks this response as a relative risk objective. Value at risk establishes a minimum value of loss expected during a specified time period at a given level of probability. A statement of maximum allowed absolute loss (€2.5 million) is an absolute risk objective.

10. C is correct. Measuring willingness to take risk (risk tolerance, risk aversion) is an exercise in applied psychology. Instruments attempting to measure risk attitudes exist, but they are clearly less objective than measurements of ability to take risk.

Ability to take risk is based on relatively objective traits such as expected income, time horizon, and existing wealth relative to liabilities.

11. A is correct. The client's financial objectives are long term. Her stable employment indicates that her immediate liquidity needs are modest. The children will not go to college until 10 or more years later. Her time horizon is best described as being long term.

12. B is correct. The unpredictable nature of property and casualty (P&C) claims forces P&C insurers to allocate a substantial proportion of their investments into liquid, short maturity assets. This need for liquidity also forces P&C companies to accept investments with relatively low expected returns. Liquidity is of less concern to life insurance companies given the greater predictability of life insurance payouts.

13. B is correct. When a client has a restriction in trading, such as this obligation to refrain from trading, the IPS "should note this constraint so that the portfolio manager does not inadvertently trade the stock on the client's behalf."

14. A is correct. The volatility of the client's income and the significant support needs for his mother and himself suggest that the client has a low ability to take risk. The client's trading experience and his responses to the risk assessment questionnaire indicate that the client has an above average willingness to take risk.

15. B is correct. On the one hand, the client has a stable, high income and no dependents. On the other hand, she exhibits above average risk aversion. Her ability to take risk is high, but her willingness to take risk is low.

16. C is correct. Strategic asset allocation depends on several principles. As stated in the reading, "One principle is that a portfolio's systematic risk accounts for most of its change in value over the long run." A second principle is that, "the returns to groups of like assets… predictably reflect exposures to certain sets of systematic factors." This latter principle establishes that returns on asset classes primarily reflect the systematic risks of the classes.

17. A is correct. The correlation between US equities and Brazilian equities is 0.76. The correlations between US equities and East Asian equities and the correlation between US equities and European equities both exceed 0.76. Lower correlations indicate a greater degree of separation between asset classes. Therefore, using solely the data given in the table, returns on Brazilian equities are most sharply distinguished from returns on US equities.

18. C is correct. As the reading states, "an asset class should contain homogeneous assets… paired correlations of securities would be high within an asset class, but should be lower versus securities in other asset classes."

19. B is correct. Tactical asset allocation allows actual asset allocation to deviate from that of the strategic asset allocation (policy portfolio) of the IPS. Tactical asset allocation attempts to take advantage of temporary dislocations from the market conditions and assumptions that drove the policy portfolio decision.

LEARNING MODULE

5

The Behavioral Biases of Individuals

by Michael M. Pompian, CFA.

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LEARNING OUTCOMES

Mastery	The candidate should be able to:
☐	compare and contrast cognitive errors and emotional biases
☐	discuss commonly recognized behavioral biases and their implications for financial decision making
☐	describe how behavioral biases of investors can lead to market characteristics that may not be explained by traditional finance

1 INTRODUCTION

Research has demonstrated that when people face complex decisions, they often rely on basic judgments and preferences to simplify the situation rather than acting completely rationally. Although such approaches are quick and intuitively appealing, they may lead to suboptimal outcomes. In contrast to this body of research, traditional economic and financial theory generally assumes that individuals act rationally by considering all available information in the decision-making process, leading them to optimal outcomes and supporting the efficiency of markets. Behavioral finance challenges these assumptions by incorporating research on how individuals and markets actually behave. In this reading, we explore a foundational concept of behavioral finance: behavioral biases. Investment professionals may be able to improve economic outcomes by understanding these biases, recognizing them in themselves and others, and learning strategies to mitigate them.

The reading proceeds as follows. Section 2 describes and broadly characterizes behavioral biases. Sections 3 and 4 discuss specific behavioral biases within two broad categories: cognitive errors and emotional biases. The discussion includes a description of each bias, potential consequences, and guidance on detecting and mitigating the effects of the bias. Section 5 discusses market anomalies, which are essentially aggregate expressions of individual biases among financial market participants. A summary and practice problems conclude the reading.

2 BEHAVIORAL BIAS CATEGORIES

☐ compare and contrast cognitive errors and emotional biases

In general, behavioral biases come in two forms: faulty cognitive reasoning, known as **cognitive errors**, and those based on feelings or emotions, known as **emotional biases**. Both forms of bias, regardless of their source, may cause decisions to deviate from what is assumed by traditional finance theory.

Cognitive errors can often be corrected or eliminated through better information, education, and advice. Emotional biases, on the other hand, are harder to correct because they stem from impulses and intuitions. They arise spontaneously rather than through conscious effort and may even be undesired to the individual feeling them. Thus, it is often possible only to recognize an emotional bias and adapt to it. The cognitive–emotional distinction will help us determine when and how to adjust for behavioral biases in financial decision making.

Researchers have identified numerous behavioral biases. This reading does not attempt to catalog all of them. Rather, it discusses some of the more publicized and recognized biases within the cognitive–emotional framework. Additionally, we limit our focus to gauging the presence or absence—not the magnitude—of each bias discussed. That is, we will not try to measure how strongly the bias is exhibited, but rather we will describe the behavioral bias, its potential consequences, and the detection of and correction for the behavioral bias. In detecting a bias, we will identify statements or thought processes that may indicate the bias. Diagnostic tests of varying degrees of complexity are available to detect biases but are beyond the scope of this reading.

Finally, the individuals of interest in this reading are "financial market participants" (FMPs) engaged in financial decision making. These include both individual investors and financial services professionals.

3 COGNITIVE ERRORS

☐ discuss commonly recognized behavioral biases and their implications for financial decision making

We classify cognitive errors into two categories: "belief perseverance biases" and "processing errors."

Belief perseverance is the tendency to cling to one's previously held beliefs by committing statistical, information-processing, or memory errors. The belief perseverance biases discussed are conservatism, confirmation, representativeness, illusion of control, and hindsight.

Processing errors describe how information may be processed and used illogically or irrationally in financial decision making. The processing errors discussed are anchoring and adjustment, mental accounting, framing, and availability.

Belief Perseverance Biases

Belief perseverance biases result from the mental discomfort that occurs when new information conflicts with previously held beliefs or cognitions, known as **cognitive dissonance**. To resolve this discomfort, people may ignore or modify conflicting information and consider only information that confirms their existing beliefs or thoughts.

Conservatism Bias

Conservatism bias is a belief perseverance bias in which people maintain their prior views or forecasts by inadequately incorporating new, conflicting information. In Bayesian terms, they tend to overweight their prior probability of the event and underweight the new information, resulting in revised beliefs about probabilities and outcomes that underreact to the new information.

Consequences of Conservatism Bias

As a result of conservatism bias, FMPs may do the following:

- Maintain or be slow to update a view or a forecast, even when presented with new information; and
- Maintain a prior belief rather than deal with the mental stress of updating beliefs given complex data. This behavior relates to an underlying difficulty in processing new information.

Detection of and Guidance for Overcoming Conservatism Bias

The effect of conservatism bias may be corrected for or reduced by properly analyzing and weighting new information. The first step is to be aware that a bias exists, especially about information that is technical, abstract, and/or statistical, because the **cognitive cost** involved in processing those forms of information is higher than for other types.

When new information is presented, the FMP should ask such questions as, "How does this information change my forecast?" or "What effect does this information have on my forecast?" FMPs should conduct careful analysis incorporating the new information and then respond appropriately. This updating of prior beliefs in light of new information is consistent with the tenets of Bayes' Rule, in which updated probabilities are derived by systematically combining previous estimates and new information.

If information is difficult to interpret or understand, FMPs should seek guidance from someone who can either explain how to interpret the information or can explain its implications.

Confirmation Bias

Confirmation bias refers to the tendency to look for and notice what confirms prior beliefs and to ignore or undervalue whatever contradicts them. A response to cognitive dissonance, confirmation bias reflects a predisposition to justify to ourselves what we want to believe.

Most experienced private wealth advisers have dealt with a client who conducts some research and insists on adding a particular investment to the portfolio. The client may insist on continuing to hold the investment, even when the adviser recommends otherwise, because the client's follow-up research seeks only information that confirms his belief that the investment is still a good value. The confirmation bias is not limited to individual investors; all FMPs should be wary of the potential confirmation biases within themselves.

EXAMPLE 1

Confirmation Bias

A portfolio manager at Sarter Investment Advisors recommended shares of Real Media Inc., a hypothetical television production and distribution company, largely on the basis of compelling analytical and valuation work from a top equity research analyst. Sarter's clients have owned the shares for several years.

Recently, the shares have underperformed significantly as a result of the company missing analysts' earnings estimates and also in response to executive management turnover. The portfolio manager's colleagues believe this underperformance is a result of Real Media losing market share to a competitor with superior technology and distribution. The competitor is publicly traded, but Sarter's portfolio managers and analysts have not done research on it.

After another poor earnings release from Real Media, the portfolio manager speaks with the equity research analyst whose work was the primary source of the investment. The equity research analyst, who maintains a buy rating on the stock, believes that Real Media is now a more compelling investment than ever because its share price has fallen while its earnings estimates remain unchanged. As a result of the conversation, the portfolio manager feels reassured and holds the position.

The portfolio manager is subject to confirmation bias. Rather than speaking with a research analyst who has a sell rating on the stock or conducting research on the competitor to consider a different perspective, the portfolio manager speaks with someone who has an opinion she already shares.

Consequences of Confirmation Bias

As a result of confirmation bias, FMPs may do the following:

- Consider only the positive information about an existing investment while ignoring any negative information about the investment.
- Develop screening criteria while ignoring information that either refutes the validity of the criteria or supports other criteria. As a result, some good investments that do not meet the screening criteria may be ignored, and conversely, some bad investments that do meet the screening criteria may be made.
- Under-diversify portfolios. FMPs may become convinced of the value of a single company's stock. They ignore negative news, and they gather and process only information confirming that the company is a good investment. They build a larger position than appropriate and hold an under-diversified portfolio.
- Hold a disproportionate amount of their investment assets in their employing company's stock, because they believe in their company and are convinced of its favorable prospects. Favorable information is cited, and unfavorable information is ignored. If the employee were to acknowledge unfavorable information, the associated mental discomfort might make work very difficult for the employee.

Detection of and Guidance for Overcoming Confirmation Bias

The effect of confirmation bias may be corrected for or reduced by actively seeking out information that challenges existing beliefs.

Another useful step is to corroborate an investment decision. For example, if investment selections are based on criteria confirming an existing belief, such as stocks breaking through 52-week highs, it is usually advisable to corroborate that decision with research from another perspective or source (e.g., fundamental research on the company, industry, or sector).

Representativeness Bias

Representativeness bias refers to the tendency to classify new information based on past experiences and classifications. New information may resemble or seem *representative* of familiar elements already classified, but in reality, it can be very different. In these instances, the classification reflex can deceive, producing an incorrect understanding that biases all future thinking about the information. *Base-rate neglect* and *sample-size neglect* are two types of representativeness bias that apply to FMPs.

In **base-rate neglect**, a phenomenon's rate of incidence in a larger population—its base rate—is neglected in favor of specific information. The specific, individual information may be misleading relative to the more appropriate base rate or general information. FMPs often follow this erroneous path because diligent research is often conducted on an individual security or strategy, leading FMPs to overlook or ignore general information about the "class" to which an investment belongs, such as an industry, sector, or geography.

A second type of representativeness bias is **sample-size neglect**, in which FMPs incorrectly assume that small sample sizes are *representative* of populations. Individuals prone to sample-size neglect are quick to treat properties reflected in small samples as properties that accurately describe large pools of data, overweighting the information in the small sample.

EXAMPLE 2

Representativeness Bias

Jacques Verte is evaluating the future prospects of APM Company, a large auto parts manufacturer having some difficulties. During the last 50 years, very few auto part manufacturers have failed, even during periods of difficulty. A number of recent headlines have highlighted APM's business and financial difficulties, however, with some commentators suggesting that APM may go out of business.

1. Which of the following scenarios is more likely? Explain why.

   A. APM will solve its difficulties.

   B. APM will go out of business.

Solution:

Scenario A is more likely. The base rate, based on 50 years of data, is that more auto parts companies survive difficult times than fail. Thus, it is more likely that APM will solve its difficulties than go out of business.

2. If Verte is subject to representativeness bias, is he more likely to classify APM into A or B? Explain why.

Solution:

If Verte is subject to representativeness bias, he is likely to choose Scenario B, predicting that the company will go out of business because of the headlines he has read. In classifying APM as likely to go out of business, Verte would be guilty of base-rate neglect by ignoring the low base rate of auto parts manufacturers failing even during times of difficulty.

Consequences of Representativeness Bias

As a result of representativeness bias, FMPs may do the following:

- Adopt a view or a forecast based almost exclusively on individual, specific information or a small sample; and
- Update beliefs using simple classifications rather than deal with the mental stress of updating beliefs given the high cognitive costs of complex data.

Detection of and Guidance on Overcoming Representativeness Bias

When FMPs sense that base-rate or sample-size neglect may be a problem, they should ask the following question: "What is the probability that X (the investment under consideration) belongs to Group A (the group it resembles or is considered representative of) versus Group B (the group it is statistically more likely to belong to)?" This question, or a similar question, will help FMPs think through whether they are failing to consider base-rate probabilities or neglecting the law of small numbers and thus inaccurately assessing a particular situation. It may be necessary to do more research to obtain base-rate information and/or widen the sample size of observations.

Illusion of Control Bias

In **illusion of control bias**, people tend to believe that they can control or influence outcomes when, in fact, they cannot. Many researchers have uncovered situations where people perceived themselves as possessing more control than they did, inferred causal connections where none existed, or displayed surprisingly great certainty in their predictions for the outcomes of chance events. A classic example is that people prefer choosing their own lottery numbers over random numbers selected for them.

EXAMPLE 3

Illusion of Control Bias

Adelia Scott is a wealth adviser at Sarter Investment Advisors (Sarter), an investment advisory firm for high-net-worth individuals. Scott meets with a client who has 30% of his account in shares of his employer's stock. The client is not subject to any employee holding requirement.

Prior meeting notes indicate that the client initially agreed to diversify the concentrated position over a five-year period. Scott recommends a faster schedule, however, based on recent research indicating that the company's future growth prospects have considerably worsened as a result of industry trends and macroeconomic conditions.

When presented with this information, the client is reluctant to change his diversification plan, citing the company's history of double-digit growth and his belief that this rate of growth will continue for the foreseeable future. The client remarks, "Trust me, my team and I are not going to let those forecasts you're citing come true."

The client is subject to illusion of control bias. He is unwilling to believe Scott's opinion because he believes that he and his team can control the company's performance and stock price.

Consequences of Illusion of Control

As a result of illusion of control bias, FMPs may do the following:

- Inadequately diversify portfolios. Research has found that some investors prefer to invest in companies that they feel they have control over, such as the companies they work for, leading them to hold concentrated positions. In fact, most investors have little or no control over the companies they work for. If the company performs poorly, these investors may experience both the loss of employment and investment losses.
- Trade more than is prudent. Researchers have found that portfolio turnover is negatively correlated with investment returns.
- Construct financial models and forecasts that are overly detailed. FMPs may require detailed models before making an investment decision, believing that forecasts from these models control uncertainty. Although a greater understanding of an investment, issuer, or industry is often useful, increased model complexity does not control the inherent risk and uncertainty of investment outcomes.

Detection of and Guidelines for Overcoming Illusion of Control Bias

The first and most basic idea that investors need to recognize is that investing is a probabilistic activity. Even the largest investment management firms have little control over the outcomes of the investments they make. Companies are subject to macroeconomic and industry forces, as well as the actions of competitors, customers, and suppliers.

Second, it is advisable to seek contrary viewpoints. As you contemplate a new investment, take a moment to think about considerations that might weigh against making the investment. Ask yourself: What are the downside risks? What might go wrong? When will I sell? It is often useful to speak with someone who has an opposing view, such as an equity research analyst with a sell rating on the subject stock.

Hindsight Bias

Hindsight bias refers to believing past events as having been predictable and reasonable to expect. This behavior results from the obvious fact that outcomes that did occur are more readily evident than outcomes that did not. Similarly, people tend to remember their own predictions of the future as more accurate than they actually were because they are biased by the knowledge of what actually occurred. Poorly reasoned decisions with positive results may be remembered as brilliant tactical moves, and poor results of well-reasoned decisions may be described as avoidable mistakes.

EXAMPLE 4

Hindsight Bias

Beverly Bolo, an analyst at an investment advisory firm, is giving a presentation to clients that, among other topics, explains the firm's investment results during past macroeconomic downturns. In the presentation, Bolo points out that the "occurrence of the last recession was obvious upon inspection of the yield curve and other leading indicators eight months before the downturn started."

Bolo's comment exhibits hindsight bias. Recessions, like any other event, appear obvious in hindsight but are hardly ever accurately predicted. Bolo could augment her remarks by exploring how often these leading indicators suggested that a recession is imminent against how often a recession subsequently occurred.

Consequences of Hindsight Bias

As a result of hindsight bias, FMPs may do the following:

- Overestimate the degree to which they correctly predicted an investment outcome, or the predictability of an outcome generally. This bias is closely related to overconfidence bias, which is discussed later in the reading.
- Unfairly assess money manager or security performance. Based on the ability to look back at what has taken place in securities markets, performance is compared against what has happened as opposed to expectations at the time the investment was made.

Detection of and Guidelines for Overcoming Hindsight Bias

Once understood, hindsight bias should be recognizable. FMPs should ask such questions as, "Am I re-writing history or being honest with myself about the mistakes I made?"

To guard against hindsight bias, FMPs should carefully record their investment decisions and key reasons for making those decisions in writing at or around the time the decision is made. Consulting these written records rather than memory will often produce a far more accurate examination of past decisions.

Processing Errors

Processing errors refer to information being processed and used illogically or irrationally. As opposed to belief perseverance biases, processing errors are less related to errors of memory or in assigning and updating probabilities; rather, they relate more closely to flaws in how information itself is processed.

Anchoring and Adjustment Bias

Anchoring and adjustment bias refers to relying on an initial piece of information to make subsequent estimates, judgments, and decisions. When required to estimate a value with unknown magnitude, people generally begin with some initial default number—an "anchor"—which they then adjust up or down. Regardless of how the initial anchor was chosen, people tend to adjust their anchors insufficiently and produce end approximations that are, consequently, biased. Anchoring and adjustment bias is closely related to conservatism bias. Bayes Rule again provides guidance for how new information should be incorporated into changing prior beliefs.

EXAMPLE 5

Anchoring and Adjustment Bias

Aiden Smythe is an equity research analyst at a brokerage firm. Smythe covers Industrial Lift Plc, a company that manufactures construction machinery. The company's business is sensitive to macroeconomic conditions, particularly non-residential construction activity. Last year, Industrial Lift reported £1.00 in EPS amid mostly strong non-residential construction activity levels. Smythe is updating his EPS estimate for this year. Non-residential construction activity has severely declined in the last two months, and some economists fear that a recession is likely. As a result, Smythe forecasts that EPS will fall 10% from the prior-year level, publishing a £0.90 estimate for the year.

Smythe's estimate exhibits anchoring and adjustment. Smythe's anchor is the prior year's EPS of £1.00, despite the possibility of a material change in underlying conditions.

Consequences of Anchoring and Adjustment Bias

As a result of anchoring and adjustment bias, FMPs may stick too closely to their original estimates when learning new information. This mindset is not limited to downside adjustments; the same phenomenon occurs with upside adjustments as well.

Detection of and Guidelines for Overcoming Anchoring and Adjustment Bias

The primary action FMPs can take is consciously asking questions that may reveal an anchoring and adjustment bias. Examples of such questions include, "Am I holding onto this stock based on rational analysis, or am I trying to attain a price that I am anchored to, such as the purchase price or a high water mark?" and "Am I making this forecast based on previously observed quantities or based on future expected conditions?"

It is important to remember that a company's revenues and earnings for a given period reflect conditions in that period. If the conditions in the future differ from the past, revenues and earnings will likely differ as well, sometimes radically. Similarly, security prices reflect investors' perception of the future at a given point in time; a given investor's cost basis, past market levels, and other conditions based in the past are often irrelevant. FMPs should look at the basis for any investment recommendation to see whether it is anchored to previous estimates or some "default" number.

Mental Accounting Bias

Mental accounting bias refers to mentally dividing money into "accounts" that influence decisions, even though money is **fungible** (Thaler 1980). Despite traditional finance theory assuming that FMPs consider their entire portfolio holistically in a risk–return context, Statman (1999, 2008) contends that the difficulty individuals have in addressing the interaction of different investments leads to mental accounting: Investors construct portfolios in a layered pyramid format, with each layer addressing a specific financial goal.

EXAMPLE 6

Mental Accounting Bias

Kendra Liu, an individual investor, owns shares in New Horizons Ltd., a pharmaceutical company. A drug in that company's research and development pipeline unexpectedly succeeds in a clinical trial, resulting in the shares doubling overnight. Liu sells half of her position in New Horizons and uses the proceeds to purchase shares of Cutting Edge Ltd., a small-cap biotechnology company. Liu believes that an investment in Cutting Edge is a "high-risk, high-reward bet" that could result in a total loss, but she is comfortable making the investment because she is using the proceeds from the sale of New Horizons Ltd., money that she did not expect to have anyway.

Liu's investment in Cutting Edge exhibits mental accounting bias. She has sorted the gains from New Horizons into a mental account based on its source, even though the money is fungible. Liu should invest the proceeds in a manner consistent with a holistic portfolio strategy.

Consequences of Mental Accounting Bias

As a result of mental accounting bias, FMPs may do the following:

- Neglect opportunities to reduce risk by combining assets with low correlations. Offsetting positions across various portfolio layers or mental accounts can lead to suboptimal aggregate performance.

- Irrationally distinguish between returns derived from income and those derived from capital appreciation. Although many investors feel the need to preserve principal, they focus on the idea of spending income that the principal generates. As a result, many FMPs chase income streams, unwittingly risking principal in the process.
- Irrationally bifurcate wealth or a portfolio into investment principal and investment returns. Some FMPs may believe that greater risk can be taken with returns (from either income or capital appreciation) than the principal initially contributed. A common euphemism for this scenario, from the casino world, is "playing with house money."

Detection of and Guidelines for Overcoming Mental Accounting Bias

An effective way to detect and overcome mental accounting behavior is to recognize its drawbacks. The primary drawback is that correlations between investments are not considered, leading to unintentional risk taking. FMPs should go through the exercise of combining all of their assets onto one spreadsheet (without headings or account labels) to see the holistic asset allocation. This exercise often produces information that is surprising when seen as a whole, such as higher cash balances than expected. The logical next step would be to create a portfolio strategy taking all assets into consideration.

Framing Bias

Framing bias is an information-processing bias in which a person answers a question differently based on the way in which it is asked or framed. It is often possible to frame a given decision problem in more than one way.

For example, a situation may be presented within a *gain* context (one in four start-up companies succeed) or within a *loss* context (three out of four start-ups fail). Given the first frame, an FMP may adopt a positive outlook and make venture capital investments. Given the second frame, the FMP might not.

Narrow framing occurs when people evaluate information based on a *narrow frame* of reference—that is, losing sight of the big picture in favor of one or two specific points. For example, an investor might focus solely on a company's executive management team, overlooking or even dismissing other important properties such as industry characteristics, fundamental performance, and valuation.

EXAMPLE 7

Effects of Framing Bias

Decision-making frames are quite prevalent in the context of investor behavior. Risk tolerance questionnaires can demonstrate how framing bias may occur in practice and how FMPs should be aware of its effects.

Suppose an investor is to take a risk tolerance questionnaire for the purpose of determining which "risk category" she is in. The risk category will determine asset allocations and the appropriate types of investments. The following information is provided to each questionnaire taker:

Over a 10-year period, Portfolio ABC has averaged an annual return of 10% with an annual standard deviation of 16%. Assuming a normal return distribution, in a given year there is a 67% probability that the return will fall within one standard deviation of the mean, a 95% probability that the return will fall within two standard deviations of the mean, and a 99.7% probability that the return will fall within three standard deviations of the mean. Thus, there is a

67% chance that the return earned by Portfolio ABC will be between −6% and 26%, a 95% chance that the return will be between −22% and 42%, and a 99.7% chance that the return will be between −38% and 58%.

The following two questions focus on hypothetical Portfolio ABC, DEF, and XYZ. The risk and return for each portfolio are the same in each of the two questions, but the presentation of information differs.

1. Based on the following chart, which investment portfolio fits your risk tolerance and desire for long-term return?

Portfolio	95% Probability Return Range	10-Year Average Return
XYZ	0.5% to 6.5%	3.5%
DEF	−18.0% to 30.0%	6.0%
ABC	−22.0% to 42.0%	10.0%

2. Based on the following chart, which investment portfolio fits your risk tolerance and desire for long-term return?

Portfolio	10-Year Average Return	Standard Deviation of Returns
XYZ	3.5%	1.5%
DEF	6.0%	12.0%
ABC	10.0%	16.0%

An investor may choose different portfolios when asked Question 1 compared with Question 2. Portfolio XYZ may appear more attractive in the first question, which uses two standard deviations to define the range of returns and show the risk, than in the second, which shows only the standard deviations. Also, in the second question, the returns are presented first and the measure of risk second. Thus, how questions are framed and the order in which they are presented can significantly affect how they are answered. FMPs should be acutely aware of how framing can affect investment choices.

Consequences of Framing Bias

As a result of framing bias, FMPs may do the following:

- Misidentify risk tolerances because of how questions about risk tolerance were framed, becoming more risk-averse when presented with a gain frame of reference and more risk-seeking when presented with a loss frame of reference. This misidentification may result in suboptimal portfolios.
- Focus on short-term price fluctuations, which may result in long-run considerations being ignored in the decision-making process.

Detection of and Guidelines for Overcoming Framing Bias

Framing bias is detected by asking such questions as, "Is the decision the result of focusing on a net gain or net loss position?" As discussed earlier, an investor who has framed the decision as a potential net loss is more likely to select a riskier investment; if the decision is framed as a potential net gain, however, the investor is more likely to go with a less risky investment. When making decisions, FMPs should try to eliminate any reference to gains and losses already incurred. Instead, they should focus on the future prospects of an investment and try to be as neutral and open-minded as possible when interpreting investment-related situations.

Availability Bias

Availability bias is an information-processing bias in which people estimate the probability of an outcome or the importance of a phenomenon based on how easily information is recalled. Various sources of availability bias exist; the four most applicable to FMPs are retrievability, categorization, narrow range of experience, and resonance.

Retrievability: If an answer or idea comes to mind more quickly than another answer or idea, the first answer or idea will likely be chosen as correct even if it is not the reality.

Categorization: When solving problems, people gather information from what they perceive as relevant search sets. Different problems require different search sets, which are often based on familiar categorizations. If it is difficult to come up with a search set, because the object of the search is difficult to characterize, the estimated probability of an event may be biased.

Narrow Range of Experience: When making an estimate, a person may use only a narrow range of experience instead of considering multiple perspectives. For example, assuming a product or service that has launched successfully in one country will be globally successful.

Resonance: People are often biased by how closely a situation parallels their own personal situation.

EXAMPLE 8

Availability Bias

A portfolio manager asks an analyst to research and present a list of companies that have "strong growth potential." The manager suggests looking for companies that sell a product or service different from its competitors—but with a compelling value proposition for customers—and that have a small share of a large market.

The analyst is familiar with technology companies, software in particular, based on prior work experience. The analyst has also seen a lot of news articles covering various software companies that, he believes, fit the criteria. The analyst begins screening among technology companies that have high revenue growth rates for the last two quarters. Although the analyst is aware that other companies in other sectors probably fit the criteria as well, the criteria are qualitative and vague such that they cannot be easily translated as screening input.

The analyst's behavior exhibits availability bias from by considering only technology companies in the search because he is familiar with them. The analyst should consult colleagues and/or external resources to widen his search to include all sectors and for help with creatively specifying screening criteria.

Consequences of Availability Bias

As a result of availability bias, FMPs may do the following:

- Limit their investment opportunity set. This limitation may result because they use familiar classification schemes. They may restrict investments to stocks or bonds, securities of one country or one sector, and so on.
- Choose an investment, investment adviser, or mutual fund based on advertising or the quantity of news coverage. For instance, when asked to name potential mutual fund companies to invest with, many people will name only the funds that do extensive advertising. The choice of mutual fund should be based on a variety of factors that make it a good fit given the investor's objectives and risk–return profile.

- Fail to diversify. This failure may occur because they make their choices based on a narrow range of experience. For example, an investor who works for a company in a particular industry may overweight investments in that industry.

Detection of and Guidelines for Overcoming Availability Bias

To overcome availability bias, investors need to develop an appropriate investment policy strategy, carefully research and analyze investment decisions before making them, and focus on long-term historical data. Questions such as, "How did you decide which investments to consider? Did you choose investments based on your familiarity with the industry or country? Did you see them in an article or research report?" and "Did you choose your investments because you like the companies' products?" can help identify issues of categorization, narrow range of experience, and resonance as sources of availability bias. Availability bias may cause FMPs to think that events that receive heavy media attention are more important than they actually are.

EXAMPLE 9

The following information relates to Questions 1–5

Luca Gerber recently became the chief investment officer for the Ludwigs Family Charity, a mid-size private foundation in Switzerland. Prior to assuming this role, Gerber was a well-known health care industry analyst. The Ludwigs's family fortune is primarily the result of entrepreneurship. Gerhard Ludwigs founded ABC Innovations (ABC), a biotech company dedicated to small cell lung cancer research. The foundation's portfolio is 15% invested in ABC.

Gerber initially feels that the 15% investment in ABC is high. Upon review, however, he decides it is appropriate based on the Ludwigs's involvement and their past success with similar ventures. Gerber makes a mental note to closely monitor the investment in ABC because he is unfamiliar with small-cap start-up companies. The remaining 85% of the foundation's portfolio is invested in equity of high-quality large-cap pharmaceutical companies. Gerber deems this allocation appropriate and is excited that he can continue to use his superior knowledge of the health care industry.

For the past two years, ABC has been dedicated to Project M, an effort directed at developing a drug to treat relapses in small cell lung cancer. Project M has delayed its Phase Two trials twice. Published results from Phase One trials have raised some concerns regarding the drug. In its last two quarterly investors' conference calls, ABC's CEO was very cautious in discussing expectations for Project M. ABC's stock price decreased by more than 20% during the past six months. Gerber believes that the research setbacks are temporary because of ABC's past success with projects. He expects that ABC will begin Phase Two within a year, and he also believes that once Project M goes into Phase Two, ABC's stock price should reach a new 52-week high of CHF80.

Soon after deciding to hold the stock, Gerber reads an article by ABC's chief scientist that details certain scientific results from Project M. As a conclusion, the article states: "Although we still have some major obstacles to overcome, the Project M team has seen positive signs that a treatment for small cell lung cancer is achievable." Although Gerber has difficulty interpreting the scientific results, he feels reassured after reading the concluding statement.

Today, ABC announces the news that it will no longer pursue Project M, citing early signs of the project's failure. In response to the announcement, the stock price drops by 50%. Gerber is stunned. He reviews the company's history and notes that ABC had made numerous comments on its struggles to solve Project M issues, which make the failure seem predictable at the time.

1. Gerber's assessment of the foundation's 100% allocation to biotechnology and pharmaceutical companies is most likely an example of which bias?

   A. Framing

   B. Availability

   C. Hindsight

   Solution:

   B is correct. A consequence of availability bias is a limited investment opportunity set, based on the narrow range of experience of the FMP. Gerber's prior experience has likely resulted in perceiving a portfolio concentrated in a single sector as appropriate because that sector reflects what he knows.

2. Gerber's belief that the research setbacks were merely temporary given ABC's success with past projects is most likely an example of which bias?

   A. Availability

   B. Mental accounting

   C. Conservatism

   Solution:

   C is correct. Conservatism bias can result in FMPs maintaining or only slowly updating their views when presented with new information, especially when the information is complex. Faced with complex information in the form of clinical trial delays that should have reduced his assessment of Project M's probability of success, Gerber elected to maintain his original views.

3. Researching the biotechnology industry average probability of success of Phase 2 trials, particularly those that have experienced delays, is a strategy that Gerber could have used to most likely mitigate which behavioral bias?

   A. Hindsight

   B. Representativeness

   C. Framing

   Solution:

   B is correct. A form of representativeness bias is base-rate neglect, in which general information, such as the rate of incidence of a phenomenon for its "reference class" of phenomena, is ignored in favor of individual, specific information. Gerber did not consider the "base rate" of the success of Phase 2 trials.

4. Gerber's approach to reading the article by ABC's chief scientist could best be described by exhibiting which behavioral bias?

   A. Representativeness

   B. Confirmation

C. Mental accounting

Solution:

B is correct. Confirmation bias refers to the tendency to seek confirming information and ignore contradictory information. Gerber did not adequately interpret the scientific results or the broader message of the article, choosing instead to focus on the reassuring concluding message that confirmed his existing beliefs.

5. Gerber's conclusion, upon re-examining ABC's history, is most likely an example of which behavioral bias?

   A. Confirmation

   B. Hindsight

   C. Conservatism

Solution:

B is correct. Hindsight bias is the result of selectively interpreting the past using knowledge of the present. Although Gerber should have implemented various mitigation strategies over the life of the investment, it is also true that investing, especially investing in a small-cap biotechnology company, is a probabilistic activity. Had Project M succeeded, Gerber may have been tempted to see the investment as evidence of his investment acumen, which would also be biased. The most useful examination of the past for Gerber would be investigating whether any mitigating actions or strategies would have been useful and putting them in place for subsequent investments.

EMOTIONAL BIASES

4

☐ discuss commonly recognized behavioral biases and their implications for financial decision making

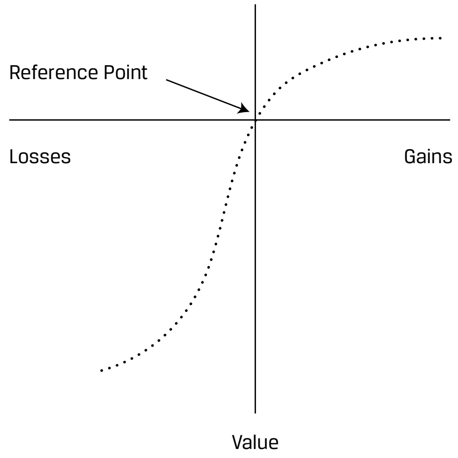
We will now review six emotional biases, their implications for investment decision making, and suggestions for managing the effects of these biases. Emotional biases are harder to correct than cognitive errors because they originate from impulse or intuition rather than conscious calculations. It is often possible only to recognize the bias and adapt to it. The six emotional biases discussed are loss aversion, overconfidence, self-control, status quo, endowment, and regret aversion.

Loss-Aversion Bias

Loss-aversion bias refers to the tendency to strongly prefer avoiding losses to achieving gains. Rational FMPs should accept more risk to increase gains, not to mitigate losses. Paradoxically, in real life, FMPs instead tend to accept more risk to avoid losses than to achieve gains. Loss aversion leads FMPs to hold their losers to avoid recognizing losses and sell their winners to lock in profits.

Kahneman and Tversky (1979) describe loss-averse investor behavior as the evaluation of gains and losses based on a reference point. A utility function that passes through this reference point appears in Exhibit 1. It is S-shaped and asymmetric, implying a greater impact of losses than of gains on utility for the same variation in absolute value. This utility function implies risk-seeking behavior in the domain of losses (below the horizontal axis) and risk avoidance in the domain of gains (above the horizontal axis). An important concept embedded in this utility representation is what has been termed the **disposition effect**: the holding of investments that have experienced losses too long, and the selling of investments that have experienced gains too quickly (i.e., holding on to losers and selling winners). The resulting portfolio may be riskier than the optimal portfolio based on the investor's risk–return objectives.

Exhibit 1: Value Function of Loss Aversion



EXAMPLE 10

Effects of Loss-Aversion Bias

Loss-aversion bias, executed in practice as the disposition effect, is observed often by wealth management practitioners. The classic case of this bias is when an investor opens her monthly account statement and scans the individual investments for winners and losers. Seeing that some investments have lost money and others have gained, the investor is likely to respond by continuing to hold the losing investments. The idea of actually losing money is so painful that the first reaction is to hold the investment until it breaks even.

The investor is acting based on emotions, not cognitive reasoning. In this case, if she did some research, the investor might learn that the company in question is experiencing difficulty and that holding the investment actually adds to the risk in the portfolio (hence the term risk-seeking in the domain of losses).

Conversely, the winners are making money. Loss-averse FMPs tend to sell these investments and realize their gains to avoid seeing gains evaporate. In this case, if the investor did some research, she might learn that the company in question actually improves the portfolio's risk–return profile. By selling the investment, not only is the potential for future losses eliminated but the potential for future gains is also eliminated. Combining the added risk of holding the losers with the elimination of potential gains from selling the winners may make investors' portfolios less efficient than portfolios based on fundamental analysis.

Consequences of Loss Aversion

As a result of loss-aversion bias, FMPs may do the following:

- Hold investments in a loss position longer than justified by fundamental analysis, in the hope that they will return to breakeven.
- Sell investments in a gain position earlier than justified by fundamental analysis, out of fear that the gains will erode.

Detection of and Guidelines for Overcoming Loss Aversion

A disciplined approach to investment is a good way to alleviate the impact of the loss-aversion bias. It is impossible to make experiencing losses any less painful emotionally, but analyzing investments and realistically considering the probabilities of future losses and gains may help guide the FMP to a rational decision.

Overconfidence Bias

Overconfidence bias is a bias in which people demonstrate unwarranted faith in their own abilities. Overconfidence may be intensified when combined with **self-attribution bias**, in which people take too much credit for successes (*self-enhancing*) and assign responsibility to others for failures (*self-protecting*). Overconfidence has aspects of both cognitive and emotional errors but is classified as emotional because the bias primarily results from emotion.

Overconfidence bias has two forms: *prediction overconfidence* and *certainty overconfidence*. Both types demonstrate faulty reasoning combined with "gut feel" and hope. Prediction overconfidence occurs when the confidence intervals that FMPs assign to their investment predictions are too narrow. For example, when estimating the future value of a stock, overconfident FMPs will incorporate far too little variation—using a narrower range of expected payoffs and a lower standard deviation of returns—than justified by historical results and fundamental analysis.

Certainty overconfidence occurs when the probabilities that FMPs assign to outcomes are too high. This certainty is often an emotional response rather than a cognitive evaluation.

EXAMPLE 11

Overconfidence Bias

An analyst estimates that the price of oil will increase by 40% over the next 12 months because prevailing prices are lower than many oil producers' cost of production. Unprofitable producers reducing production will eventually put upward pressure on prices so long as oil demand remains stable or increases. Based on this forecast, the analyst recommends several high-yield bonds of oil producers to a portfolio manager.

The portfolio manager asks the analyst for an estimate of downside risk: "How much could we lose if, say, the oil price falls another 10%?" The analyst replies, "That is unrealistic. The current oil price is as low as it can go, and yields on these bonds are as attractive as they will ever be. We must make the investment now. There is no credible downside case."

The analyst is exhibiting overconfidence bias by placing excessive certainty in his prediction and not considering the likelihood or impact of variance from that prediction.

Consequences of Overconfidence Bias

As a result of overconfidence bias, FMPs may do the following:

- Underestimate risks and overestimate expected returns.
- Hold poorly diversified portfolios, which may result in significant downside risk.

Detection of and Guidelines for Overcoming Overconfidence Bias

FMPs should review their trading records, identify *both* the winners and losers, and calculate portfolio performance over at least two years. Investors with an unfounded belief in their own ability to identify good investments may recall winners and their results but underestimate the number and results of their losers. This review will also identify the amount of trading. Overconfidence is also a cognitive error, and so more-complete information can often help FMPs understand the error of their ways.

It is critical that investors be objective when making and evaluating investment decisions. As an old Wall Street adage states, "Don't confuse brains with a bull market." It is advisable to view the reasoning behind and the results of investments, both winners and losers, as objectively as possible. When did you make money? When did you lose money? Mentally separate your good money-making decisions from your bad ones. Then, review the beneficial decisions and try to discern what, exactly, you did correctly. Did you purchase an investment at a particularly advantageous time based on fundamentals, or did you luck out by timing a market upswing? Similarly, review the decisions that you categorized as poor. Did you invest aptly based on fundamentals and then make an error when it came time to sell, or was the market going through a correction?

When reviewing unprofitable decisions, look for patterns or common mistakes that perhaps you were unaware you were making. Note any such tendencies that you discover, and try to remain mindful of them by brainstorming a rule or reminder such as: "I will do X in the future" or "I will not do Y in the future."

Self-Control Bias

Self-control bias is a bias in which people fail to act in pursuit of their long-term, overarching goals in favor of short-term satisfaction. For example, individuals pursuing the CFA charter may fail to study sufficiently because of short-term competing demands on their time. Rational behavior suggests that people would do whatever is necessary to achieve their long-term goals, but it often does not happen.

When it comes to money, many people are willing and able to save for the future, but they often have difficulty sacrificing present consumption because of a lack of self-control. This apparent lack of self-control may also be a function of hyperbolic discounting, the human tendency to prefer small payoffs now compared with larger payoffs in the future. Sacrifices in the present require much greater payoffs in the future; otherwise, people will be unwilling to make current sacrifices.

Consequences of Self-Control Bias

As a result of self-control bias, FMPs may do the following:

- Save insufficiently for the future, which may, in turn, result in accepting too much risk in portfolios in an attempt to generate higher returns.
- Borrow excessively to finance present consumption.

Detection of and Guidelines for Overcoming Self-Control Bias

FMPs should ensure that a proper investment plan is in place and should have a personal budget. Plans need to be in writing, so that they can be reviewed regularly. Similarly, FMPs should look to maintain a strategic asset allocation based on a thorough evaluation.

Status Quo Bias

Status quo bias is an emotional bias in which people choose to do nothing (i.e., maintain the "status quo") instead of making a change, even when change is warranted. Status quo bias is often discussed in tandem with endowment and regret-aversion biases because an outcome of the biases, maintaining existing positions, is similar. The reasons for maintaining the existing positions differ, however. In the status quo bias, positions are maintained largely because of inertia rather than conscious choice. In endowment and regret-aversion biases, positions are maintained because of conscious, but possibly incorrect, choices.

EXAMPLE 12

The Path of Least Resistance

Using data from three firms, Choi et al. (2001) studied the impact of automatically enrolling employees in a defined contribution pension plan and how default contribution rates and investment options affect participants' behavior.

Automatic enrollment increased employee participation in the defined contribution plan from 26%–43% after six months' tenure and 57%–69% after three years' tenure to >85% for both tenures at all three firms.

Although automatic enrollment increased participation, more than 65% of employees tended to contribute the employer-specified default amount—2% or 3%—and remained in the default investment option. Although this percentage declined slowly over time, even after two years of tenure, more than 40% of participants continued to use the default.

Consequences of Status Quo Bias

As a result of status quo bias, FMPs may do the following:

- Unknowingly maintain portfolios with risk characteristics that are inappropriate for their circumstances.
- Fail to explore other opportunities.

Detection of and Guidelines for Overcoming Status Quo Bias

Status quo bias may be exceptionally strong and difficult to overcome. Education is essential. FMPs should quantify the risk-reducing and return-enhancing advantages of diversification and proper asset allocation. For example, with a concentrated stock position, showing what can happen to overall wealth levels if the stock collapses may persuade an FMP to diversify.

Endowment Bias

Endowment bias is an emotional bias in which people value an asset more when they own it than when they do not. Endowment bias is inconsistent with standard economic theory, which asserts that the price a person is *willing to pay* for a good should equal the price at which that person would be *willing to sell* the same good. Psychologists have found, however, that people tend to state minimum selling prices for a good that exceed maximum purchase prices that they are willing to pay for the same good. Effectively, ownership "endows" the asset with added value.

Endowment bias may be the result of several other behavioral biases, such as loss aversion, anchoring and adjustment, and overconfidence. Despite the name, purchased as well as inherited securities can be subject to endowment bias.

EXAMPLE 13

Endowment Bias

Several of an investment analyst's recommended stocks have done well for the past five years, prompting the portfolio manager to ask for a brief update on each, including valuations. For each stock, the analyst estimates that fair value is at least another 40% above the current price. The portfolio manager challenges the analyst by pointing out that the fair value estimates imply valuation multiples that are at least two standard deviations above the five-year average and are well above even the most bullish sell-side analyst's target price. The analyst responds by saying that the market is overlooking these companies' fundamentals. The portfolio manager then asks, "Would you buy these shares today?" The analyst answers, "Probably not."

The analyst is likely exhibiting endowment bias by overestimating the value of shares already owned in the portfolio. This bias is likely the result of having successfully invested in the shares.

Consequences of Endowment Bias

Endowment bias may lead FMPs to do the following:

- Fail to sell certain assets and replace them with other assets.
- Continue to hold classes of assets with which they are familiar. FMPs may believe they understand the characteristics of the investments they already own and may be reluctant to purchase assets with which they have less experience. Familiarity adds to owners' perceived value of a security.
- As a result, the FMP may maintain an inappropriate asset allocation. The portfolio may be inappropriate for investors' levels of risk tolerance and financial goals.

Detection of and Guidelines for Overcoming Endowment Bias

Many wealth management practitioners have encountered clients who are reluctant to sell securities bequeathed by previous generations. Often in these situations, investors cite feelings of disloyalty associated with the prospect of selling inherited securities, general uncertainty in determining the right choice, and concerns about tax issues. An FMP should ask, "If an equivalent sum to the value of the investments inherited had been received in cash, how would you invest the cash?" Often, the answer is into a very different investment portfolio than the one inherited. It may also be useful to explore the deceased's intent in owning the investment and bequeathing it. "Was the primary intent to leave the specific investment portfolio because it was perceived to be a suitable investment based on fundamental analysis, or was it to leave financial resources to benefit the heirs?" Heirs who affirm the latter conclusion are receptive to considering alternative asset allocations.

An effective way to address endowment bias for purchased securities, when an estimated "sell price" is far higher than any reasonable FMP's estimate of a "buy price" is to ask, "Would you buy this security today at the current price?" A similar question is, "Why are you not buying more of this security today?" Answering these questions can turn the focus away from the past to the present, toward considering the upside from the current price.

Regret-Aversion Bias

Regret-aversion bias is an emotional bias in which people tend to avoid making decisions out of fear that the decision will turn out poorly. Regret-aversion bias has two dimensions: actions that people take and actions that people *could have* taken. Regret is more intense when the unfavorable outcomes are the result of an action taken versus the result of an action not taken. Thus, no action becomes the default decision.

Consequences of Regret-Aversion Bias

As a result of regret-aversion bias, FMPs may do the following:

- Be too conservative in their investment choices as a result of poor outcomes on risky investments in the past. FMPs may wish to avoid the regret of making another bad investment and decide that low-risk instruments are better. This behavior can lead to long-term underperformance and failure to reach investment goals.
- Engage in herding behavior. FMPs may feel safer in popular investments in order to limit potential future regret. It seems safe to be with the crowd, and a reduction in potential emotional pain is perceived. Regret aversion may lead to preference for stocks of well-known companies even in the face of equal risk and return expectations. Choosing the stocks of less-familiar companies is perceived as riskier and involves more personal responsibility and greater potential for regret. As John Maynard Keynes (1936) wrote, "Worldly wisdom teaches that it is better for reputation to fail conventionally than to succeed unconventionally."

Detection of and Guidelines for Overcoming Regret-Aversion Bias

FMPs should quantify the risk-reducing and return-enhancing advantages of diversification and proper asset allocation. Regret aversion can cause some FMPs to invest too conservatively or too riskily depending on the current trends. With proper diversification, FMPs will accept the appropriate level of risk in their portfolios depending, of course, on return objectives. To prevent investments from being too conservative, FMPs must recognize that losses happen to everyone and keep in mind the long-term benefits of including risky assets in portfolios. Recognizing that bubbles happen and keeping in mind long-term objectives will prevent a client from making investments that are too risky.

EXAMPLE 14

Tiffany Jordan is a hedge fund manager with a history of outstanding performance. For the past 10 years, Jordan's fund has used an equity market–neutral strategy (a long–short strategy that strives to eliminate market risk—i.e., beta should be zero), which has proved effective as a result of Jordan's hard work. An equity market–neutral strategy normally generates large daily trading volume and shifts in individual security positions. Jordan's reputation has grown over the years as her fund has consistently beaten its benchmark. Employee turnover on her team has been high; Jordan tends to be quick to blame and rarely gives credit to team members for success. During the past 12 months, her fund has been significantly underperforming its benchmark.

One of Jordan's junior analysts, Jeremy Tang, is concerned about the underperformance and notes the following:

Observation 1: Certain positions are significantly underwater, have very high risk profiles, and have been held for much longer than normal.

Observation 2: The fund's trading volume has decreased by more than 40% during the past year.

Observation 3: The portfolio is more concentrated in a few sectors than in the past.

Worried that the portfolio may be in violation of the fund's investment policy statement (IPS), Tang brings this concern to Jordan's attention during a regular weekly team meeting. Jordan dismisses Tang's analysis and tells the team not to worry because she knows what she is doing. Jordan indicates that because she believes the pricing misalignment will correct itself, the portfolio would be unable to take advantage of the reversion to the mean if she were to sell certain losing positions. She reassures the team that this strategy has performed well in the past and that the markets will revert, bringing the fund's returns back to normal levels.

Tang tactfully suggests that the team review the fund's IPS together, and Jordan interrupts him and reminds the team that she has memorized the IPS by heart. Tang contemplates his next step. He is concerned that Jordan is displaying behavioral biases that are affecting the fund's performance.

1. By taking credit for successes but assigning blame for failures, Jordan is *most likely* demonstrating:

   A. loss-aversion bias.

   B. self-attribution bias.

   C. illusion of control bias.

   Solution:

   B is correct. In self-attribution bias, people take credit for successes and assign responsibilities for failure. Jordan claims successful decisions for herself while attributing poor decisions to the team. Her self-esteem affects how she looks at success and failure. Self-attribution and illusion of knowledge biases contribute to overconfidence bias, which Jordan clearly demonstrates later when she tells the team that she knows what she is doing.

2. Which of Tang's observations is *least likely* to be the consequence of Jordan demonstrating loss-aversion bias?

   A. Observation 1

   B. Observation 2

C. Observation 3

Solution:

C is correct. Loss aversion by itself may cause a sector concentration; however, a market-neutral strategy tends to focus on individual stocks without regard to sector. The sector exposure would be mitigated with the balancing of the individual long and short positions.

3. Which of Jordan's actions *least* supports that she may be affected by the illusion of control bias?

   A. Her dismissal of Tang's analysis

   B. Her routine of holding weekly team meetings

   C. Her comment on market turnaround and current holdings

Solution:

B is correct. Holding weekly team meetings, which indicates a willingness to listen to feedback from others, is not representative of the illusion of control bias. In the illusion of control bias, people believe they can control outcomes to a greater extent than is possible. Individuals exhibiting this bias display great certainty in their predictions of outcomes of chance events and ignore others' viewpoints. Jordan is sure that the market will turn around even though it is out of her control. She chooses not to listen to Tang, who is questioning her viewpoint.

4. How does Jordan *most likely* demonstrate loss-aversion bias?

   A. Telling the team not to worry

   B. Reducing the portfolio turnover this year

   C. Deciding to hold the losing positions until they turn around

Solution:

C is correct. Jordan's behavior is a classic example of loss aversion: When a loss occurs, she holds on to these positions longer than warranted. By doing so, Jordan has accepted more risk in the portfolio. In loss-aversion bias, people exhibit a strong preference to avoid losses versus achieving gains. One of the consequences of loss aversion bias is that the financial management professional (in this case, Jordan) may hold losing investments in the hope that they will return to breakeven or better.

5. Which of the following emotional biases has Jordan *most likely* exhibited?

   A. Endowment

   B. Regret aversion

   C. Overconfidence

Solution:

C is correct. Jordan exhibits overconfidence in several ways. She ignores the analysis done by Tang. This may be because Jordan believes she is smarter and more informed than her team members, which is typical of an individual with an illusion of knowledge bias. The certainty she demonstrates that the market will revert is evidence of overconfidence. Her overconfidence is intensified by her self-attribution bias, which is demonstrated through her dealings with her team when she blames them for losses while taking credit for gains. Finally, her portfolio's underperformance against the benchmark is a consequence of overconfidence bias.

6. Which of the following biases did Jordan *not* demonstrate?

   A. Self-attribution

   B. Representativeness

   C. Illusion of knowledge

   Solution:

   B is correct. Nowhere in the scenario did it mention that Jordan classified certain information into a personalized category. Representativeness bias is a cognitive bias in which people tend to classify new information based on past experiences and classifications. Jordan is not relating her certainty about the future or her decision to hold losing positions back to anything she has done or experienced in the past.

7. Which of Tang's findings is *not* a typical consequence of self-control bias?

   A. Failure to explore other portfolio opportunities

   B. Asset allocation imbalance problems in the portfolio

   C. A higher risk profile in the portfolio resulting from pursuit of higher returns

   Solution:

   A is correct. Failing to explore other opportunities is a demonstration of status quo bias, not self-control. Self-control bias occurs when individuals deviate from their long-term goals—in this case, the IPS—because of a lack of self-discipline. Jordan is not adhering to the strategy that has succeeded in the past. The consequences of self-control bias include accepting too much risk in the portfolio (C) and asset allocation imbalance problems (B) as Jordan attempts to generate higher returns.

5 BEHAVIORAL FINANCE AND MARKET BEHAVIOR

☐ describe how behavioral biases of investors can lead to market characteristics that may not be explained by traditional finance

Some persistent market patterns run counter to market efficiency. This section focuses on the contributions of behavioral finance to understanding these exceptions to market efficiency, such as momentum, value, bubbles, and crashes, by explaining them as functions of behavioral biases.

Defining Market Anomalies

Anomalies are apparent deviations from the efficient market hypothesis, identified by persistent abnormal returns that differ from zero and are predictable in direction. Not every deviation is anomalous. Misclassifications tend to stem from three sources: choice of asset pricing model, statistical issues, and temporary disequilibria.

Classifying returns as "abnormal" presupposes a definition of "normal returns," which generally depends on the asset pricing model used. If a reasonable change in the method of estimating normal returns causes an anomaly to disappear, then it is reasonable to suggest that the anomaly is an illusion. Fama (1998) includes in this category apparently low returns following initial public offerings (called the "IPO puzzle") and the positive abnormal returns apparent in the 12 months after a stock split. Similarly, when high returns persist on a particular class of securities, or relative to a specific factor in valuation, it might simply be compensation for excess risk rather than an anomaly.

Other apparent anomalies may be explained by the small samples involved, a statistical bias in selection or survivorship, or data mining that overanalyzes data for patterns and treats spurious correlations as relevant. The magnitude of any over- or underperformance also depends critically on the choice of benchmark, which can make it hard to interpret results.

Finally, from time to time, markets can present *temporary disequilibrium behavior*, unusual features that may survive for a period of years but ultimately disappear. Publication of the anomaly, which draws attention to the pattern, usually starts the arbitrage that removes the behavior. For example, the small company January effect, part of the turn-of-the-year effect, does not appear persistent once appropriate adjustment for risk is made. The weekend effect, involving lower stock market returns on Mondays, appears to have diminished in the United States and United Kingdom.

The anomalies discussed in this section reflect behavior that has been identified and analyzed in a number of markets around the world and during different periods. The patterns have been documented in many academic studies, with broadly similar conclusions. Behavioral finance can help provide good explanations by identifying underlying behavioral biases.

Momentum

Studies have documented, in a range of markets globally, *momentum* or *trending effects* in which future price behavior correlates with that of the recent past (Jegadeesh and Titman 1993; Dimson, Marsh, and Staunton 2008). The positive correlation typically lasts for up to two years before showing a reversal or reversion to the mean, evident in two- to five-year return periods.

EXAMPLE 15

The Momentum Effect: London Business School Study

The study involves buying the top 20% of a performance-ranked list of stocks and selling short the bottom 20%. In the 52 years to 2007 in the UK market, the stocks that had outperformed the market most in the previous 12 months went on to generate an annualized return of 18.3%, whereas the market's worst underperformers rose by 6.8% on average. During that period, the market as a whole rose by 13.5% a year. In a subsequent study using data from 2000 to 2007, the momentum effect was also evident in each of the 16 other international markets researched.

The authors noted, "The momentum effect, both in the United Kingdom and globally, has been pervasive and persistent. Though costly to implement on a standalone basis, all investors need to be acutely aware of momentum. Even if they do not set out to exploit it, momentum is likely to be an important determinant of their investment performance."

Source: Dimson, Marsh, and Staunton (2008).

Momentum can be partly explained by availability, hindsight, and loss aversion biases.

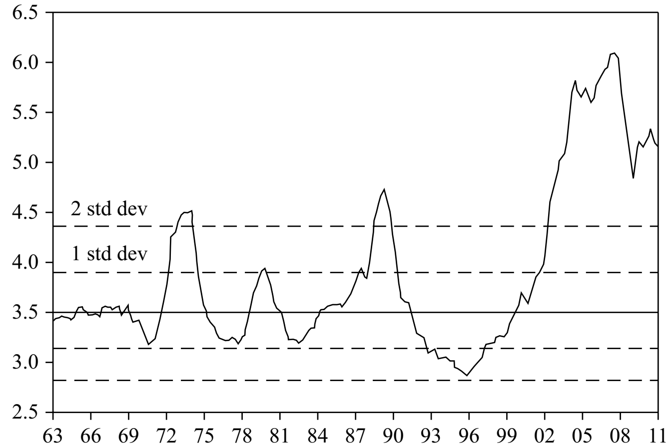
Studies have identified faulty learning models within traders, in which reasoning is based on their recent experience. Behaviorally, this is *availability bias*. In this context, availability bias is also called the *recency effect*, which is the tendency to recall recent events more vividly and give them undue weight. In such models, if the price of an asset rises for a period of time, investors may simply extrapolate this rise to the future. Research points to a tendency for individual private investors to extrapolate trends and to suffer more from recency bias, whereas many investment professionals expect reversion to the mean.

Regret is the feeling that an opportunity has been missed and is typically an expression of *hindsight bias*, which reflects the human tendency to see past events as having been predictable. Regret can be particularly acute when the market is volatile and investors feel they could have predicted the significant market moves, thereby increasing profit or reducing loss. Faced with regret from not owning a mutual fund or stock when it performed well in the previous year, investors may be driven emotionally to remedy this regret. These behavioral factors can explain short-term year-on-year trending and contribute to overtrading.

Bubbles and Crashes

Although bubbles and crashes have been documented for a long time (Mackay's *Extraordinary Popular Delusions and the Madness of Crowds* was published in 1841), their existence presents a challenge to the concept of market efficiency. Historical examples include the technology bubble of 1999–2000 and the residential property boom of 2005–2007, evident in a range of economies globally including the United States, the United Kingdom, and Australia. Exhibit 2 illustrates the residential property boom in the United Kingdom.

Exhibit 2: UK House Price Average Multiple of Average Family Income



Source: Datastream.

First, note that some bubbles may have rational explanations. Rational investors may expect a future crash but not know its exact timing. For periods of time, there may not be effective arbitrage because of the cost of selling short, unwillingness of investors to bear extended losses, or simply unavailability of suitable instruments. These factors were considerations in past technology and real estate bubbles. Investment managers incentivized on, or accountable for, short-term performance may even rationalize their participation in the bubble in terms of commercial or career risk.

Investors' behaviors and incentives during bubbles are illustrated in Exhibit 16. The manager of Fund A believed he could exit a bubble profitably by selling near the top. The manager of Fund B correctly avoided the bubble, but clients held the manager accountable for short-run performance, which resulted in the fund's closure.

EXAMPLE 16

Investor Behavior in Bubbles

Consider the differing behavior of two managers of major hedge funds during the technology stock bubble of 1998–2000:

The manager of Hedge Fund A was asked why he did not get out of internet stocks earlier even though he knew by December 1999 that technology stocks were overvalued. He replied, "We thought it was the eighth inning, and it was the ninth. I did not think the NASDAQ composite would go down 33% in 15 days." Faced with losses, and despite his previous strong 12-year record, he resigned as Hedge Fund A's manager in April 2000.

The manager of Hedge Fund B refused to invest in technology stocks in 1998 and 1999 because he thought they were overvalued. After strong performance over 17 years, Hedge Fund B was dissolved in 2000 because its returns could not keep up with the returns generated by technology stocks.

Behavioral finance does not yet provide a full explanation for bubbles and crashes, but a number of specific cognitive biases and emotional biases prevalent during such periods can be identified.

In bubbles, investors often exhibit symptoms of *overconfidence*; overtrading, underestimation of risks, failure to diversify, and rejection of contradictory information. With overconfidence, investors are more active and trading volume increases, thus lowering their expected profits. For overconfident investors (active traders), studies have shown that returns are less than returns to either less active traders or the market while risk is higher. At the market level, volatility also often increases in a market with overconfident traders.

The overconfidence and excessive trading that contribute to a bubble are linked to *confirmation bias* and *self-attribution bias*. In a rising market, sales of stocks from a portfolio will typically be profitable, even if winners are being sold too soon. Investors can have faulty learning models that bias their understanding of this profit to take personal credit for success, a form of *hindsight bias*. Selling for a gain appears to validate a good decision in an original purchase and may confer a sense of pride in locking in the profit. This dynamic fuels overconfidence that can lead to poor decisions. Regret aversion can also encourage investors to participate in a bubble, believing they are "missing out" on profit opportunities as stocks appreciate.

As a bubble unwinds, markets may underreact because of anchoring when investors do not sufficiently update their beliefs. The early stages of unwinding a bubble can involve investors in cognitive dissonance, who ignore losses and attempt to rationalize flawed decisions. Eventually, investors capitulate, which accelerates price declines.

Value

Value stocks are typically characterized by low price-to-earnings ratios, high book-to-market equity, and low price-to-dividend ratios. Growth stock characteristics are generally the opposite of value stock characteristics. For example, growth stocks are characterized by low book-to-market equity, high price-to-earnings ratios, and high price-to-dividend ratios. A number of studies have identified outperformance of value stocks relative to growth stocks over long periods. Fama and French (1998) found that value stocks (high book-to-market equity) outperformed growth stocks (low book-to-market equity) in 12 of 13 major markets during the 1975–1995 period.

Fama and French have also found, however, that the value stock anomaly disappears in a three-factor asset pricing model. This result suggests that size and book-to-market factors are not mispricing but instead represent compensation for risk exposures, such as the greater potential of companies with these characteristics to suffer distress during economic downturns.

A number of other studies have offered behavioral explanations for value anomalies, presenting the anomalies as mispricing rather than compensation for increased risk. These studies recognize the emotional factors involved in appraising stocks. The **halo effect**, for example, extends a favorable evaluation of some characteristics to other characteristics. A company with a good growth record and good previous share price performance might be seen as a good investment, with higher expected returns than its risk characteristics merit. This view is a form of representativeness that can lead investors to extrapolate recent past performance into expected returns. Overconfidence can also be involved in predicting growth rates, potentially leading growth stocks to be overvalued.

Studies have also identified that emotions play a role in estimating risk and expected return of stocks. The impact of emotional biases may be greater with less sophisticated or retail investors, but it has also been identified as a bias in analysts and professional investors. The emotional attraction of a stock can be enhanced by personal experience of products, the value of the brand, marketing expenditures, and the proximity of the headquarters to the analyst or investor. This last issue reflects the **home bias** anomaly, by which portfolios exhibit a strong bias in favor of domestic securities in the context of global portfolios. The effect has also been noted within geographical boundaries, favoring companies headquartered nearer the investor. Home bias may reflect a perceived relative informational advantage, a greater feeling of comfort with the access to company executives that proximity brings (either personal or local brokerage), or a psychological desire to invest in a local community.

To the extent to which less sophisticated investors are influenced by emotions, they may value growth companies more highly. Stock returns of funds that are rated as popular in a *Fortune* magazine survey are found to be subsequently low. A more positive emotional rating in a company leads investors to perceive the company's stock as less risky. Although the capital asset pricing model assumes risk and expected return are positively correlated, many investors behave as if the correlation is negative, expecting higher returns with lower risk.

SUMMARY

Behavioral biases potentially affect the behaviors and decisions of financial market participants. By understanding these biases, financial market participants may be able to moderate or adapt to them and, as a result, improve upon economic outcomes. Behavioral biases may be categorized as either cognitive errors or emotional biases. The type of bias influences whether its impact may be moderated or adapted to.

Among the points made in this reading are the following:

- Individuals do not necessarily act rationally and consider all available information in the decision-making process because they may be influenced by behavioral biases.
- Biases may lead to suboptimal decisions.

- Behavioral biases may be categorized as either cognitive errors or emotional biases. A single bias may have aspects of both, however, with one type of bias dominating.
- Cognitive errors stem from basic statistical, information-processing, or memory errors; cognitive errors typically result from faulty reasoning.
- Emotional biases stem from impulse or intuition and tend to result from reasoning influenced by feelings.
- Cognitive errors are more easily corrected for because they stem from faulty reasoning rather than an emotional predisposition.
- Emotional biases are harder to correct for because they are based on feelings, which can be difficult to change.
- To adapt to a bias is to recognize and accept the bias and to adjust for the bias rather than to attempt to moderate the bias.
- To moderate a bias is to recognize the bias and to attempt to reduce or even eliminate the bias within the individual.
- Cognitive errors can be further classified into two categories: belief perseverance biases and information-processing biases.
- Belief perseverance errors reflect an inclination to maintain beliefs. The belief is maintained by committing statistical, information-processing, or memory errors. Belief perseverance biases are closely related to the psychological concept of cognitive dissonance.
- Belief perseverance biases include conservatism, confirmation, representativeness, illusion of control, and hindsight.
- Information-processing biases result in information being processed and used illogically or irrationally.
- Information-processing biases include anchoring and adjustment, mental accounting, framing, and availability.
- Emotional biases include loss aversion, overconfidence, self-control, status quo, endowment, and regret aversion.
- Understanding and detecting biases is the first step in overcoming the effect of biases on financial decisions. By understanding behavioral biases, financial market participants may be able to moderate or adapt to the biases and, as a result, improve upon economic outcomes.
- Behavioral finance has the potential to explain some apparent deviations from market efficiency (market anomalies).

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PRACTICE PROBLEMS

1. Under-diversified portfolios are not a potential implication of which of the following behavioral biases?
   - **A.** Representativeness
   - **B.** Illusion of control
   - **C.** Confirmation
2. The advice "Don't confuse brains with a bull market" is aimed at mitigating which of the following behavioral biases?
   - **A.** Self-control
   - **B.** Conservatism
   - **C.** Overconfidence
3. Status quo bias is least similar to which of the following behavioral biases?
   - **A.** Endowment
   - **B.** Regret aversion
   - **C.** Confirmation
4. Which strategy would best mitigate or prevent endowment bias?
   - **A.** Actively seeking out information that challenges existing beliefs
   - **B.** When new information is presented, asking "How does this information change my forecast?"
   - **C.** Asking "Would you buy this security today at the current price?"
5. Jun Park, CFA, works at a hedge fund. Most of Park's colleagues are also CFA charterholders. At an event with recent university graduates, Park comments, "Most CFA charterholders work at hedge funds." Park's remark exhibits which behavioral bias?
   - **A.** Availability
   - **B.** Conservatism
   - **C.** Framing
6. In the 1980s, Japan was viewed by many FMPs as the model economy. Although its growth began to decelerate sharply by 1990, it was not until the mid to late 1990s that FMPs' GDP forecasts were consistently achieved. By taking several years to adapt their forecasts to the lower growth environment, FMPs exhibited which behavioral bias?
   - **A.** Mental accounting
   - **B.** Overconfidence
   - **C.** Conservatism

The following information relates to questions 7-10

Caitríona Daosri is a portfolio manager for an international bank, where she advises high-net-worth clients. Daosri is meeting with a new client, Estêvão Kai, a 40-year-old surgeon with €4 million across various accounts and a salary of €500,000 per annum. Kai explains to Daosri that he has four accounts at four different banks, each with specific sources and uses of funds, as shown in the following table:

Bank Account	Source of Deposits	Use of Funds
1	Salary	Living expenses
2	Bonus	Charitable gifts
3	Portfolio interest	Savings for retirement
4	Portfolio dividends	Mother's living expenses

7. Based on the description of how Kai manages his finances as outlined in Exhibit 1, Kai most likely exhibits the behavioral bias of:

   A. endowment.

   B. mental accounting.

   C. framing.

8. Which of the following is a likely consequence of Kai's approach to managing his finances?

   A. Concentrated portfolio positions

   B. Forgone opportunities to reduce risk by combining assets with low correlations

   C. Excessive trading

9. Which strategy should Daosri use or recommend to Kai?

   A. Keep written records of investment decisions.

   B. Ask questions such as, "Is the decision the result of focusing on a net gain or net loss position?"

   C. Aggregate all accounts and portfolios into a single spreadsheet.

10. Which of the following individual behavioral biases is most strongly associated with market bubbles?

    A. Overconfidence

    B. Representativeness

    C. Framing

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11. The halo effect, which may be evident in FMP's assessments of a company with a

history of high revenue growth, is a form of which behavioral bias?

A. Endowment

B. Representativeness

C. Regret aversion

12. All of the following are reasons that an apparent deviation from the efficient market hypothesis might not be anomalous except:

A. The abnormal returns represent compensation for exposure to risk.

B. Changing the asset pricing model makes the deviation to disappear.

C. The deviation is well known or documented.

13. Investment managers incentivized or accountable for short-term performance by current and prospective clients is a potentially rational explanation for which of the following?

A. Home bias

B. Bubbles

C. Value stocks outperforming growth stocks

14. Momentum, can be partly explained by the following behavioral biases except:

A. availability.

B. home bias.

C. regret.

15. All of the following are reasons that the historical outperformance of value stocks versus growth stocks may not be anomalous except:

A. Abnormal returns represent compensation for risk exposures, such as the heightened risk of value stocks to suffer distress during downturns.

B. Companies with strong historical growth rates are viewed as good investments, with higher expected returns than risk characteristics merit.

C. The deviation disappears by incorporating a three-factor asset pricing model.

SOLUTIONS

1. A is correct. Under-diversified portfolios are a consequence of both illusion of control and confirmation biases. Researchers have found that some investors prefer to invest in companies that they feel they have control over, such as the companies they work for, leading them to hold concentrated positions. Confirmation bias may lead to FMPs ignoring negative news, paying attention only to information confirming that a company is a good investment, which may result in large positions. Representativeness bias is not typically associated with under-diversified portfolios.

2. C is correct. This advice is specifically aimed at reducing self-attribution bias, a form of overconfidence bias. This bias may result in FMPs taking credit for investment success, as well as assigning responsibility to others for investment failures, when in reality the investment results reflect exogenous market forces.

3. C is correct. Both endowment bias and regret-aversion bias often result in indecision or inertia—a typical outcome of status quo bias, in which people prefer to not make changes even when changes are warranted.

4. C is correct. Endowment bias refers to people attributing additional, unwarranted value to things they possess versus things they do not. This bias is evident in FMPs that systematically and materially overvalue securities in their portfolio versus securities not in their portfolio. The question "Would you buy this security today at the current price?" turns the investor's attention to assessing the reasonableness of the current price as a buy price rather than solely as a selling price.

5. A is correct. Park is extrapolating his observation based on a narrow range of experience (working at a hedge fund that employs many CFA charterholders) to the entire population of CFA charterholders. Using a narrow range of experience is a form of availability bias.

6. C is correct. Conservatism bias results in maintain or only slowly updating views and forecasts despite the presence of new information. FMPs in the 1990s were reluctant to update forecasts, despite materially different new information for several years.

7. B is correct. Kai has segregated money into four different accounts based on the sources and uses of his funds. Although intuitively appealing, this approach is irrational because money is fungible across the four accounts. Nothing is stopping Kai from collapsing them into a single "account" with a holistic portfolio strategy.

8. B is correct. The most common consequence of mental accounting is neglecting opportunities to reduce risk by combining assets with low correlations, because each account's asset allocation is examined discretely. Offsetting positions across accounts, or an overall inefficient allocation with respect to risk, can lead to suboptimal aggregate performance.

9. C is correct. Aggregating mental accounts is a logical strategy to combat mental accounting. It is the opposite of disaggregating money into separate accounts.

10. A is correct. The overconfidence and excessive trading that contribute to a bubble are linked to self-attribution bias, a form of overconfidence. In a rising market, sales of stocks from a portfolio will typically be profitable, even if winners are being sold too soon, and FMPs will attribute profits and strong performance to

their investment acumen and subsequently underestimate risks.

11. B is correct. Representativeness refers to the tendency to adopt a view or forecast based on individual information or a small sample, as well to use simple classifications. The halo effect is an example of representativeness, because FMPs extend an overall favorable evaluation to an investment (e.g., a "good company") based on one or few characteristics (e.g., a "visionary CEO").

12. C is correct. Bubbles and crashes are well-known and well-documented phenomena yet represent market anomalies.

13. B is correct. Investment managers' incentives—or perhaps more accurately, their perception of their incentives—for short-term performance were named as considerations in the technology and real estate bubbles. Not participating in the bubble presented certain FMPs with commercial or career risk.

14. B is correct. Home bias refers to FMPs preferentially investing in domestic securities, likely reflecting perceived relative informational advantages, a greater feeling of comfort with the access to company executives that proximity brings (either personal or through a local brokerage), or a psychological desire to invest in a local community. Momentum, on the other hand, has been documented in a range of markets around the world, in a time-dependent manner, and reflects some FMPs' availability bias, manifested as a belief that stocks will continue to rise because recently they have only risen, as well as regret aversion by those who invest in past winners because they regret not investing in them in the past.

15. B is correct. This choice describes the halo effect, which does offer a behavioral explanation for the poor performance of growth stocks versus value stocks. Growth stocks are mispriced relative to their risk characteristics, because FMPs focusing on just a few properties, such as a high historical revenue growth rate, while neglecting other characteristics.

LEARNING MODULE

6

Introduction to Risk Management

by Don M. Chance, PhD, CFA, and Michael E. Edleson, PhD, CFA.

Don M. Chance, PhD, CFA, is at Louisiana State University (USA). Michael E. Edleson, PhD, CFA, is at the University of Chicago (USA).

LEARNING OUTCOMES

Mastery	*The candidate should be able to:*
☐	define risk management
☐	describe features of a risk management framework
☐	define risk governance and describe elements of effective risk governance
☐	explain how risk tolerance affects risk management
☐	describe risk budgeting and its role in risk governance
☐	identify financial and non-financial sources of risk and describe how they may interact
☐	describe methods for measuring and modifying risk exposures and factors to consider in choosing among the methods

INTRODUCTION

1

Risk—and risk management—is an inescapable part of economic activity. People generally manage their affairs to be as happy and secure as their environment and resources will allow. But regardless of how carefully these affairs are managed, there is risk because the outcome, whether good or bad, is seldom predictable with complete certainty. There is risk inherent in nearly everything we do, but this reading will focus on economic and financial risk, particularly as it relates to investment management.

All businesses and investors manage risk, whether consciously or not, in the choices they make. At its core, business and investing are about allocating resources and capital to chosen risks. In their decision process, within an environment of uncertainty, these organizations may take steps to avoid some risks, pursue the risks that provide the highest rewards, and measure and mitigate their exposure to these risks as necessary. Risk management processes and tools make difficult business and financial problems easier to address in an uncertain world. Risk is not just a matter of fate; it is something that organizations can actively manage with their decisions,