RETURN, RISK, AND THE SECURITY MARKET LINE

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On July 20, 2006, Apple Computer, Honeywell, and Yum Brands joined a host of other companies in announcing earnings. All three companies announced earnings increases, ranging from 8 percent for Yum Brands to 48 percent for Apple. You would expect an earnings increase to be good news, and it is usually is. Apple's stock jumped 12 percent on the news; but unfortunately for Honeywell and Yum Brands, their stock prices fell by 4.2 percent and 6.4 percent, respectively.

The news for all three of these companies seemed positive, but one stock rose on the news and the other two stocks fell. So when is good news really good news? The answer is fundamental to understanding risk and return, and—the good news is—this chapter explores it in some detail.

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In our last chapter, we learned some important lessons from capital market history. Most important, we learned that there is a reward, on average, for bearing risk. We called this reward a *risk premium.* The second lesson is that this risk premium is larger for riskier investments. This chapter explores the economic and managerial implications of this basic idea.

Thus far, we have concentrated mainly on the return behavior of a few large portfolios. We need to expand our consideration to include individual assets. Specifically, we have two tasks to accomplish. First, we have to define risk and discuss how to measure it. We then must quantify the relationship between an asset's risk and its required return.

When we examine the risks associated with individual assets, we find there are two types of risk: systematic and unsystematic. This distinction is crucial because, as we will see, systematic risk affects almost all assets in the economy, at least to some degree, whereas unsystematic risk affects at most a small number of assets. We then develop the principle of diversification, which shows that highly diversified portfolios will tend to have almost no unsystematic risk.

The principle of diversification has an important implication: To a diversified investor, only systematic risk matters. It follows that in deciding whether to buy a particular individual asset, a diversified investor will only be concerned with that asset's systematic risk. This is a key observation, and it allows us to say a great deal about the risks and returns on individual assets. In particular, it is the basis for a famous relationship between risk and return called the *security market line,* or SML. To develop the SML, we introduce the equally famous "beta" coefficient, one of the centerpieces of modern finance. Beta and the SML are key concepts because they supply us with at least part of the answer to the question of how to determine the required return on an investment.

13.1 Expected Returns and Variances

In our previous chapter, we discussed how to calculate average returns and variances using historical data. We now begin to discuss how to analyze returns and variances when the information we have concerns future possible returns and their probabilities.

EXPECTED RETURN

We start with a straightforward case. Consider a single period of time—say a year. We have two stocks, L and U, which have the following characteristics: Stock L is expected to have a return of 25 percent in the coming year. Stock U is expected to have a return of 20 percent for the same period.

In a situation like this, if all investors agreed on the expected returns, why would anyone want to hold Stock U? After all, why invest in one stock when the expectation is that another will do better? Clearly, the answer must depend on the risk of the two investments. The return on Stock L, although it is *expected* to be 25 percent, could actually turn out to be higher or lower.

For example, suppose the economy booms. In this case, we think Stock L will have a 70 percent return. If the economy enters a recession, we think the return will be −20 percent. In this case, we say that there are two *states of the economy,* which means that these are the only two possible situations. This setup is oversimplified, of course, but it allows us to illustrate some key ideas without a lot of computation.

Suppose we think a boom and a recession are equally likely to happen, for a 50–50 chance of each. Table 13.1 illustrates the basic information we have described and some additional information about Stock U. Notice that Stock U earns 30 percent if there is a recession and 10 percent if there is a boom.

Obviously, if you buy one of these stocks, say Stock U, what you earn in any particular year depends on what the economy does during that year. However, suppose the probabilities stay the same through time. If you hold Stock U for a number of years, you'll earn 30 percent about half the time and 10 percent the other half. In this case, we say that your **expected return** on Stock U, $E(R_U)$, is 20 percent:

expected return
The return on a risky asset expected in the future.

$$E(R_U) = .50 \times 30\% + .50 \times 10\% = 20\%$$

In other words, you should expect to earn 20 percent from this stock, on average.

For Stock L, the probabilities are the same, but the possible returns are different. Here, we lose 20 percent half the time, and we gain 70 percent the other half. The expected return on L, $E(R_L)$, is thus 25 percent:

$$E(R_L) = .50 \times -20\% + .50 \times 70\% = 25\%$$

Table 13.2 illustrates these calculations.

In our previous chapter, we defined the risk premium as the difference between the return on a risky investment and that on a risk-free investment, and we calculated the historical risk premiums on some different investments. Using our projected returns,

TABLE 13.1

States of the Economy and Stock Returns

State of Economy	Probability of State of Economy	Rate of Return if State Occurs	
		Stock L	**Stock U**
Recession	.50	−20%	30%
Boom	.50	70	10
	1.00		

		Stock L			Stock U	
(1) State of Economy	**(2) Probability of State of Economy**	**(3) Rate of Return if State Occurs**	**(4) Product (2) × (3)**	**(5) Rate of Return if State Occurs**	**(6) Product (2) × (5)**
Recession	.50	−.20	−.10	.30	.15
Boom	.50	.70	.35	.10	.05
	1.00		$E(R_L) = .25 = 25\%$		$E(R_U) = .20 = 20\%$

TABLE 13.2

Calculation of Expected Return

we can calculate the *projected,* or *expected, risk premium* as the difference between the expected return on a risky investment and the certain return on a risk-free investment.

For example, suppose risk-free investments are currently offering 8 percent. We will say that the risk-free rate, which we label as R_f, is 8 percent. Given this, what is the projected risk premium on Stock U? On Stock L? Because the expected return on Stock U, $E(R_U)$, is 20 percent, the projected risk premium is:

$$\text{Risk premium} = \text{Expected return} - \text{Risk-free rate} \qquad \text{[13.1]}$$
$$= E(R_U) - R_f$$
$$= 20\% - 8\%$$
$$= 12\%$$

Similarly, the risk premium on Stock L is $25\% - 8\% = 17\%$.

In general, the expected return on a security or other asset is simply equal to the sum of the possible returns multiplied by their probabilities. So, if we had 100 possible returns, we would multiply each one by its probability and add up the results. The result would be the expected return. The risk premium would then be the difference between this expected return and the risk-free rate.

Unequal Probabilities

Look again at Tables 13.1 and 13.2. Suppose you think a boom will occur only 20 percent of the time instead of 50 percent. What are the expected returns on Stocks U and L in this case? If the risk-free rate is 10 percent, what are the risk premiums?

The first thing to notice is that a recession must occur 80 percent of the time $(1 - .20 = .80)$ because there are only two possibilities. With this in mind, we see that Stock U has a 30 percent return in 80 percent of the years and a 10 percent return in 20 percent of the years. To calculate the expected return, we again just multiply the possibilities by the probabilities and add up the results:

$$E(R_U) = .80 \times 30\% + .20 \times 10\% = 26\%$$

Table 13.3 summarizes the calculations for both stocks. Notice that the expected return on L is −2 percent.

The risk premium for Stock U is $26\% - 10\% = 16\%$ in this case. The risk premium for Stock L is negative: $-2\% - 10\% = -12\%$. This is a little odd; but, for reasons we discuss later, it is not impossible.

(continued)

TABLE 13.3

Calculation of Expected Return

(1) State of Economy	(2) Probability of State of Economy	Stock L		Stock U	
		(3) Rate of Return if State Occurs	(4) Product (2) × (3)	(5) Rate of Return if State Occurs	(6) Product (2) × (5)
Recession	.80	−.20	−.16	.30	.24
Boom	.20	.70	.14	.10	.02
			$E(R_L) = -2\%$		$E(R_U) = 26\%$

CALCULATING THE VARIANCE

To calculate the variances of the returns on our two stocks, we first determine the squared deviations from the expected return. We then multiply each possible squared deviation by its probability. We add these up, and the result is the variance. The standard deviation, as always, is the square root of the variance.

To illustrate, let us return to the Stock U we originally discussed, which has an expected return of $E(R_U) = 20\%$. In a given year, it will actually return either 30 percent or 10 percent. The possible deviations are thus $30\% - 20\% = 10\%$ and $10\% - 20\% = -10\%$. In this case, the variance is:

$$\text{Variance} = \sigma^2 = .50 \times (10\%)^2 + .50 \times (-10\%)^2 = .01$$

The standard deviation is the square root of this:

$$\text{Standard deviation} = \sigma = \sqrt{.01} = .10 = 10\%$$

Table 13.4 summarizes these calculations for both stocks. Notice that Stock L has a much larger variance.

When we put the expected return and variability information for our two stocks together, we have the following:

	Stock L	Stock U
Expected return, $E(R)$	25%	20%
Variance, σ^2	.2025	.0100
Standard deviation, σ	45%	10%

Stock L has a higher expected return, but U has less risk. You could get a 70 percent return on your investment in L, but you could also lose 20 percent. Notice that an investment in U will always pay at least 10 percent.

Which of these two stocks should you buy? We can't really say; it depends on your personal preferences. We can be reasonably sure that some investors would prefer L to U and some would prefer U to L.

You've probably noticed that the way we have calculated expected returns and variances here is somewhat different from the way we did it in the last chapter. The reason is that in Chapter 12, we were examining actual historical returns, so we estimated the average return and the variance based on some actual events. Here, we have projected *future* returns and their associated probabilities, so this is the information with which we must work.

TABLE 13.4

Calculation of Variance

(1) State of Economy	(2) Probability of State of Economy	(3) Return Deviation from Expected Return	(4) Squared Return Deviation from Expected Return	(5) Product (2) × (4)
Stock L				
Recession	.50	$-.20 - .25 = -.45$	$-.45^2 = .2025$	.10125
Boom	.50	$.70 - .25 = .45$	$.45^2 = .2025$	.10125
				$\sigma_L^2 = .20250$
Stock U				
Recession	.50	$.30 - .20 = .10$	$.10^2 = .01$	.005
Boom	.50	$.10 - .20 = -.10$	$-.10^2 = .01$	.005
				$\sigma_U^2 = .010$

More Unequal Probabilities
EXAMPLE 13.2

Going back to Example 13.1, what are the variances on the two stocks once we have unequal probabilities? The standard deviations?

   We can summarize the needed calculations as follows:

(1) State of Economy	(2) Probability of State of Economy	(3) Return Deviation from Expected Return	(4) Squared Return Deviation from Expected Return	(5) Product (2) × (4)
Stock L				
Recession	.80	$-.20 - (-.02) = -.18$	.0324	.02592
Boom	.20	$.70 - (-.02) = .72$	.5184	.10368
				$\sigma_L^2 = .12960$
Stock U				
Recession	.80	$.30 - .26 = .04$	.0016	.00128
Boom	.20	$.10 - .26 = -.16$	.0256	.00512
				$\sigma_U^2 = .00640$

Based on these calculations, the standard deviation for L is $\sigma_L = \sqrt{.1296} = .36 = 36\%$. The standard deviation for U is much smaller: $\sigma_U = \sqrt{.0064} = .08$ or 8%.

Concept Questions

13.1a How do we calculate the expected return on a security?

13.1b In words, how do we calculate the variance of the expected return?

Portfolios
13.2

Thus far in this chapter, we have concentrated on individual assets considered separately. However, most investors actually hold a **portfolio** of assets. All we mean by this is that investors tend to own more than just a single stock, bond, or other asset. Given that this is so, portfolio return and portfolio risk are of obvious relevance. Accordingly, we now discuss portfolio expected returns and variances.

TABLE 13.5

Expected Return on an Equally Weighted Portfolio of Stock L and Stock U

(1) State of Economy	(2) Probability of State of Economy	(3) Portfolio Return if State Occurs	(4) Product (2) × (3)
Recession	.50	.50 × −20% + .50 × 30% = 5%	.025
Boom	.50	.50 × 70% + .50 × 10% = 40%	.200
			E(R_P) = 22.5%

PORTFOLIO WEIGHTS

portfolio

A group of assets such as stocks and bonds held by an investor.

There are many equivalent ways of describing a portfolio. The most convenient approach is to list the percentage of the total portfolio's value that is invested in each portfolio asset. We call these percentages the **portfolio weights**.

For example, if we have $50 in one asset and $150 in another, our total portfolio is worth $200. The percentage of our portfolio in the first asset is $50/$200 = .25. The percentage of our portfolio in the second asset is $150/$200, or .75. Our portfolio weights are thus .25 and .75. Notice that the weights have to add up to 1.00 because all of our money is invested somewhere.[1]

PORTFOLIO EXPECTED RETURNS

portfolio weight

The percentage of a portfolio's total value that is in a particular asset.

Let's go back to Stocks L and U. You put half your money in each. The portfolio weights are obviously .50 and .50. What is the pattern of returns on this portfolio? The expected return?

To answer these questions, suppose the economy actually enters a recession. In this case, half your money (the half in L) loses 20 percent. The other half (the half in U) gains 30 percent. Your portfolio return, R_P, in a recession is thus:

$$R_P = .50 \times -20\% + .50 \times 30\% = 5\%$$

Table 13.5 summarizes the remaining calculations. Notice that when a boom occurs, your portfolio will return 40 percent:

$$R_P = .50 \times 70\% + .50 \times 10\% = 40\%$$

As indicated in Table 13.5, the expected return on your portfolio, E(R_P), is 22.5 percent.

We can save ourselves some work by calculating the expected return more directly. Given these portfolio weights, we could have reasoned that we expect half of our money to earn 25 percent (the half in L) and half of our money to earn 20 percent (the half in U). Our portfolio expected return is thus:

$$\begin{aligned} E(R_P) &= .50 \times E(R_L) + .50 \times E(R_U) \\ &= .50 \times 25\% + .50 \times 20\% \\ &= 22.5\% \end{aligned}$$

Want more information about investing? Take a look at TheStreet.com's investing basics at www.thestreet.com/basics.

This is the same portfolio expected return we calculated previously.

This method of calculating the expected return on a portfolio works no matter how many assets there are in the portfolio. Suppose we had n assets in our portfolio, where n is any number. If we let x_i stand for the percentage of our money in Asset i, then the expected return would be:

$$E(R_P) = x_1 \times E(R_1) + x_2 \times E(R_2) + \cdots + x_n \times E(R_n) \qquad [13.2]$$

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[1]Some of it could be in cash, of course, but we would then just consider the cash to be one of the portfolio assets.

This says that the expected return on a portfolio is a straightforward combination of the expected returns on the assets in that portfolio. This seems somewhat obvious; but, as we will examine next, the obvious approach is not always the right one.

| Portfolio Expected Return | EXAMPLE 13.3 |

Suppose we have the following projections for three stocks:

State of Economy	Probability of State of Economy	Returns if State Occurs		
		Stock A	**Stock B**	**Stock C**
Boom	.40	10%	15%	20%
Bust	.60	8	4	0

We want to calculate portfolio expected returns in two cases. First, what would be the expected return on a portfolio with equal amounts invested in each of the three stocks? Second, what would be the expected return if half of the portfolio were in A, with the remainder equally divided between B and C?

Based on what we've learned from our earlier discussions, we can determine that the expected returns on the individual stocks are (check these for practice):

$E(R_A) = 8.8\%$
$E(R_B) = 8.4\%$
$E(R_C) = 8.0\%$

If a portfolio has equal investments in each asset, the portfolio weights are all the same. Such a portfolio is said to be *equally weighted.* Because there are three stocks in this case, the weights are all equal to $\frac{1}{3}$. The portfolio expected return is thus:

$E(R_P) = (1/3) \times 8.8\% + (1/3) \times 8.4\% + (1/3) \times 8\% = 8.4\%$

In the second case, verify that the portfolio expected return is 8.5 percent.

PORTFOLIO VARIANCE

From our earlier discussion, the expected return on a portfolio that contains equal investment in Stocks U and L is 22.5 percent. What is the standard deviation of return on this portfolio? Simple intuition might suggest that because half of the money has a standard deviation of 45 percent and the other half has a standard deviation of 10 percent, the portfolio's standard deviation might be calculated as:

$\sigma_P = .50 \times 45\% + .50 \times 10\% = 27.5\%$

Unfortunately, this approach is completely incorrect!

Let's see what the standard deviation really is. Table 13.6 summarizes the relevant calculations. As we see, the portfolio's variance is about .031, and its standard deviation is less than we thought—it's only 17.5 percent. What is illustrated here is that the variance on a portfolio is not generally a simple combination of the variances of the assets in the portfolio.

We can illustrate this point a little more dramatically by considering a slightly different set of portfolio weights. Suppose we put 2/11 (about 18 percent) in L and the other 9/11 (about 82 percent) in U. If a recession occurs, this portfolio will have a return of:

$R_P = (2/11) \times -20\% + (9/11) \times 30\% = 20.91\%$

TABLE 13.6

Variance on an Equally Weighted Portfolio of Stock L and Stock U

(1) State of Economy	(2) Probability of State of Economy	(3) Portfolio Return if State Occurs	(4) Squared Deviation from Expected Return	(5) Product (2) × (4)
Recession	.50	5%	$(.05 - .225)^2 = .030625$	.0153125
Boom	.50	40	$(.40 - .225)^2 = .030625$	.0153125
			$\sigma_P^2 = .030625$	
			$\sigma_P = \sqrt{.030625} = 17.5\%$	

If a boom occurs, this portfolio will have a return of:

$$R_P = (2/11) \times 70\% + (9/11) \times 10\% = 20.91\%$$

Notice that the return is the same no matter what happens. No further calculations are needed: This portfolio has a zero variance. Apparently, combining assets into portfolios can substantially alter the risks faced by the investor. This is a crucial observation, and we will begin to explore its implications in the next section.

EXAMPLE 13.4 **Portfolio Variance and Standard Deviation**

In Example 13.3, what are the standard deviations on the two portfolios? To answer, we first have to calculate the portfolio returns in the two states. We will work with the second portfolio, which has 50 percent in Stock A and 25 percent in each of Stocks B and C. The relevant calculations can be summarized as follows:

State of Economy	Probability of State of Economy	Stock A	Stock B	Stock C	Portfolio
		Rate of Return if State Occurs			
Boom	.40	10%	15%	20%	13.75%
Bust	.60	8	4	0	5.00

The portfolio return when the economy booms is calculated as:

$$E(R_P) = .50 \times 10\% + .25 \times 15\% + .25 \times 20\% = 13.75\%$$

The return when the economy goes bust is calculated the same way. The expected return on the portfolio is 8.5 percent. The variance is thus:

$$\sigma_P^2 = .40 \times (.1375 - .085)^2 + .60 \times (.05 - .085)^2$$
$$= .0018375$$

The standard deviation is thus about 4.3 percent. For our equally weighted portfolio, check to see that the standard deviation is about 5.4 percent.

Concept Questions

13.2a What is a portfolio weight?

13.2b How do we calculate the expected return on a portfolio?

13.2c Is there a simple relationship between the standard deviation on a portfolio and the standard deviations of the assets in the portfolio?

Announcements, Surprises, and Expected Returns

Now that we know how to construct portfolios and evaluate their returns, we begin to describe more carefully the risks and returns associated with individual securities. Thus far, we have measured volatility by looking at the difference between the actual return on an asset or portfolio, R, and the expected return, $E(R)$. We now look at why those deviations exist.

EXPECTED AND UNEXPECTED RETURNS

To begin, for concreteness, we consider the return on the stock of a company called Flyers. What will determine this stock's return in, say, the coming year?

The return on any stock traded in a financial market is composed of two parts. First, the normal, or expected, return from the stock is the part of the return that shareholders in the market predict or expect. This return depends on the information shareholders have that bears on the stock, and it is based on the market's understanding today of the important factors that will influence the stock in the coming year.

The second part of the return on the stock is the uncertain, or risky, part. This is the portion that comes from unexpected information revealed within the year. A list of all possible sources of such information would be endless, but here are a few examples:

News about Flyers research

Government figures released on gross domestic product (GDP)

The results from the latest arms control talks

The news that Flyers sales figures are higher than expected

A sudden, unexpected drop in interest rates

Based on this discussion, one way to express the return on Flyers stock in the coming year would be:

$$\text{Total return} = \text{Expected return} + \text{Unexpected return}$$
$$R = E(R) + U$$

[13.3]

where R stands for the actual total return in the year, $E(R)$ stands for the expected part of the return, and U stands for the unexpected part of the return. What this says is that the actual return, R, differs from the expected return, $E(R)$, because of surprises that occur during the year. In any given year, the unexpected return will be positive or negative; but, through time, the average value of U will be zero. This simply means that on average, the actual return equals the expected return.

ANNOUNCEMENTS AND NEWS

We need to be careful when we talk about the effect of news items on the return. For example, suppose Flyers's business is such that the company prospers when GDP grows at a relatively high rate and suffers when GDP is relatively stagnant. In this case, in deciding what return to expect this year from owning stock in Flyers, shareholders either implicitly or explicitly must think about what GDP is likely to be for the year.

When the government actually announces GDP figures for the year, what will happen to the value of Flyers's stock? Obviously, the answer depends on what figure is released. More to the point, however, the impact depends on how much of that figure is *new* information.

www.quicken. com *is a great site for stock info.*

At the beginning of the year, market participants will have some idea or forecast of what the yearly GDP will be. To the extent that shareholders have predicted GDP, that prediction will already be factored into the expected part of the return on the stock, E(R). On the other hand, if the announced GDP is a surprise, the effect will be part of U, the unanticipated portion of the return. As an example, suppose shareholders in the market had forecast that the GDP increase this year would be .5 percent. If the actual announcement this year is exactly .5 percent, the same as the forecast, then the shareholders don't really learn anything, and the announcement isn't news. There will be no impact on the stock price as a result. This is like receiving confirmation of something you suspected all along; it doesn't reveal anything new.

A common way of saying that an announcement isn't news is to say that the market has already "discounted" the announcement. The use of the word *discount* here is different from the use of the term in computing present values, but the spirit is the same. When we discount a dollar in the future, we say it is worth less to us because of the time value of money. When we discount an announcement or a news item, we say that it has less of an impact on the market because the market already knew much of it.

Going back to Flyers, suppose the government announces that the actual GDP increase during the year has been 1.5 percent. Now shareholders have learned something—namely, that the increase is one percentage point higher than they had forecast. This difference between the actual result and the forecast, one percentage point in this example, is sometimes called the *innovation* or the *surprise*.

This distinction explains why what seems to be good news can actually be bad news (and vice versa). Going back to the companies we discussed in our chapter opener, Apple's increase in earnings was due to phenomenal growth in sales of the iPod and Macintosh computer lines. For Honeywell, although the company reported better than expected earnings and raised its forecast for the rest of the year, it noted that there appeared to be slower than expected demand for its aerospace unit. Yum Brands, operator of the Taco Bell, Pizza Hut, and KFC chains, reported that Taco Bell, its strongest brand, showed sales weakness for the first time in more than three years.

A key idea to keep in mind about news and price changes is that news about the future is what matters. For Honeywell and Yum Brands, analysts welcomed the good news about earnings, but also noted that those numbers were, in a very real sense, yesterday's news. Looking to the future, these same analysts were concerned that future profit growth might not be so robust.

To summarize, an announcement can be broken into two parts: the anticipated, or expected, part and the surprise, or innovation:

Announcement = Expected part + Surprise   [13.4]

The expected part of any announcement is the part of the information that the market uses to form the expectation, E(R), of the return on the stock. The surprise is the news that influences the unanticipated return on the stock, U.

Our discussion of market efficiency in the previous chapter bears on this discussion. We are assuming that relevant information known today is already reflected in the expected return. This is identical to saying that the current price reflects relevant publicly available information. We are thus implicitly assuming that markets are at least reasonably efficient in the semistrong form.

Henceforth, when we speak of news, we will mean the surprise part of an announcement and not the portion that the market has expected and therefore already discounted.

Risk: Systematic and Unsystematic

13.4

The unanticipated part of the return, that portion resulting from surprises, is the true risk of any investment. After all, if we always receive exactly what we expect, then the investment is perfectly predictable and, by definition, risk-free. In other words, the risk of owning an asset comes from surprises—unanticipated events.

There are important differences, though, among various sources of risk. Look back at our previous list of news stories. Some of these stories are directed specifically at Flyers, and some are more general. Which of the news items are of specific importance to Flyers?

Announcements about interest rates or GDP are clearly important for nearly all companies, whereas news about Flyers's president, its research, or its sales is of specific interest to Flyers. We will distinguish between these two types of events because, as we will see, they have different implications.

SYSTEMATIC AND UNSYSTEMATIC RISK

The first type of surprise—the one that affects many assets—we will label **systematic risk**. A systematic risk is one that influences a large number of assets, each to a greater or lesser extent. Because systematic risks have marketwide effects, they are sometimes called *market risks*.

systematic risk
A risk that influences a large number of assets. Also, market risk.

The second type of surprise we will call **unsystematic risk**. An unsystematic risk is one that affects a single asset or a small group of assets. Because these risks are unique to individual companies or assets, they are sometimes called *unique* or *asset-specific risks*. We will use these terms interchangeably.

unsystematic risk
A risk that affects at most a small number of assets. Also, unique or asset-specific risk.

As we have seen, uncertainties about general economic conditions (such as GDP, interest rates, or inflation) are examples of systematic risks. These conditions affect nearly all companies to some degree. An unanticipated increase, or surprise, in inflation, for example, affects wages and the costs of the supplies that companies buy; it affects the value of the assets that companies own; and it affects the prices at which companies sell their products. Forces such as these, to which all companies are susceptible, are the essence of systematic risk.

In contrast, the announcement of an oil strike by a company will primarily affect that company and, perhaps, a few others (such as primary competitors and suppliers). It is unlikely to have much of an effect on the world oil market, however, or on the affairs of companies not in the oil business, so this is an unsystematic event.

SYSTEMATIC AND UNSYSTEMATIC COMPONENTS OF RETURN

The distinction between a systematic risk and an unsystematic risk is never really as exact as we make it out to be. Even the most narrow and peculiar bit of news about a company ripples through the economy. This is true because every enterprise, no matter how tiny, is a part of the economy. It's like the tale of a kingdom that was lost because one horse lost

a shoe. This is mostly hairsplitting, however. Some risks are clearly much more general than others. We'll see some evidence on this point in just a moment.

The distinction between the types of risk allows us to break down the surprise portion, U, of the return on the Flyers stock into two parts. Earlier, we had the actual return broken down into its expected and surprise components:

$$R = E(R) + U$$

We now recognize that the total surprise component for Flyers, U, has a systematic and an unsystematic component, so:

$$R = E(R) + \text{Systematic portion} + \text{Unsystematic portion} \qquad [13.5]$$

Because it is traditional, we will use the Greek letter epsilon, ϵ, to stand for the unsystematic portion. Because systematic risks are often called market risks, we will use the letter m to stand for the systematic part of the surprise. With these symbols, we can rewrite the formula for the total return:

$$R = E(R) + U$$
$$= E(R) + m + \epsilon$$

The important thing about the way we have broken down the total surprise, U, is that the unsystematic portion, ϵ, is more or less unique to Flyers. For this reason, it is unrelated to the unsystematic portion of return on most other assets. To see why this is important, we need to return to the subject of portfolio risk.

Concept Questions

13.4a What are the two basic types of risk?

13.4b What is the distinction between the two types of risk?

13.5 Diversification and Portfolio Risk

We've seen earlier that portfolio risks can, in principle, be quite different from the risks of the assets that make up the portfolio. We now look more closely at the riskiness of an individual asset versus the risk of a portfolio of many different assets. We will once again examine some market history to get an idea of what happens with actual investments in U.S. capital markets.

For more about risk and diversification, visit www.investopedia.com/university.

THE EFFECT OF DIVERSIFICATION: ANOTHER LESSON FROM MARKET HISTORY

In our previous chapter, we saw that the standard deviation of the annual return on a portfolio of 500 large common stocks has historically been about 20 percent per year. Does this mean that the standard deviation of the annual return on a typical stock in that group of 500 is about 20 percent? As you might suspect by now, the answer is *no*. This is an extremely important observation.

To allow examination of the relationship between portfolio size and portfolio risk, Table 13.7 illustrates typical average annual standard deviations for equally weighted portfolios that contain different numbers of randomly selected NYSE securities.

In Column 2 of Table 13.7, we see that the standard deviation for a "portfolio" of one security is about 49 percent. What this means is that if you randomly selected a single NYSE

(1) Number of Stocks in Portfolio	(2) Average Standard Deviation of Annual Portfolio Returns	(3) Ratio of Portfolio Standard Deviation to Standard Deviation of a Single Stock
1	49.24%	1.00
2	37.36	.76
4	29.69	.60
6	26.64	.54
8	24.98	.51
10	23.93	.49
20	21.68	.44
30	20.87	.42
40	20.46	.42
50	20.20	.41
100	19.69	.40
200	19.42	.39
300	19.34	.39
400	19.29	.39
500	19.27	.39
1,000	19.21	.39

These figures are from Table 1 in M. Statman, "How Many Stocks Make a Diversified Portfolio?" *Journal of Financial and Quantitative Analysis* 22 (September 1987), pp. 353–64. They were derived from E.J. Elton and M.J. Gruber, "Risk Reduction and Portfolio Size: An Analytic Solution," *Journal of Business* 50 (October 1977), pp. 415–37.

stock and put all your money into it, your standard deviation of return would typically be a substantial 49 percent per year. If you were to randomly select two stocks and invest half your money in each, your standard deviation would be about 37 percent on average, and so on.

The important thing to notice in Table 13.7 is that the standard deviation declines as the number of securities is increased. By the time we have 100 randomly chosen stocks, the portfolio's standard deviation has declined by about 60 percent, from 49 percent to about 20 percent. With 500 securities, the standard deviation is 19.27 percent, similar to the 20 percent we saw in our previous chapter for the large common stock portfolio. The small difference exists because the portfolio securities and time periods examined are not identical.

THE PRINCIPLE OF DIVERSIFICATION

Figure 13.1 illustrates the point we've been discussing. What we have plotted is the standard deviation of return versus the number of stocks in the portfolio. Notice in Figure 13.1 that the benefit in terms of risk reduction from adding securities drops off as we add more and more. By the time we have 10 securities, most of the effect is already realized; and by the time we get to 30 or so, there is little remaining benefit.

Figure 13.1 illustrates two key points. First, some of the riskiness associated with individual assets can be eliminated by forming portfolios. The process of spreading an investment across assets (and thereby forming a portfolio) is called *diversification*. The **principle of diversification** tells us that spreading an investment across many assets will eliminate some of the risk. The blue shaded area in Figure 13.1, labeled "diversifiable risk," is the part that can be eliminated by diversification.

The second point is equally important. There is a minimum level of risk that cannot be eliminated simply by diversifying. This minimum level is labeled "nondiversifiable risk"
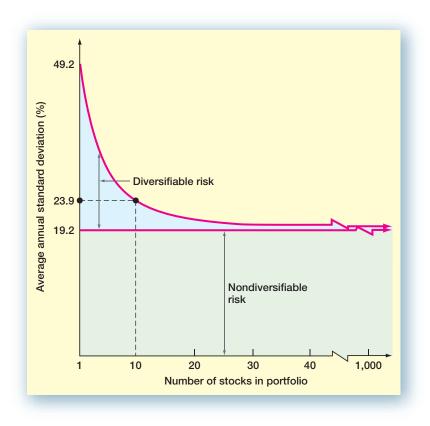
**principle of
diversification**

Spreading an investment
across a number of assets
will eliminate some, but not
all, of the risk.

in Figure 13.1. Taken together, these two points are another important lesson from capital market history: Diversification reduces risk, but only up to a point. Put another way, some risk is diversifiable and some is not.

To give a recent example of the impact of diversification, the Dow Jones Industrial Average (DJIA), which contains 30 large, well-known U.S. stocks, was about flat in 2005, meaning no gain or loss. As we saw in our previous chapter, this performance represents a fairly bad year for a portfolio of large-cap stocks. The biggest individual gainers for the year were Hewlett-Packard (up 37 percent), Boeing (up 36 percent), and Altria Group (up 22 percent). However, offsetting these nice gains were General Motors (down 52 percent), Verizon Communications (down 26 percent), and IBM (down 17 percent). So, there were big winners and big losers, and they more or less offset in this particular year.

DIVERSIFICATION AND UNSYSTEMATIC RISK

From our discussion of portfolio risk, we know that some of the risk associated with individual assets can be diversified away and some cannot. We are left with an obvious question: Why is this so? It turns out that the answer hinges on the distinction we made earlier between systematic and unsystematic risk.

By definition, an unsystematic risk is one that is particular to a single asset or, at most, a small group. For example, if the asset under consideration is stock in a single company, the discovery of positive NPV projects such as successful new products and innovative cost savings will tend to increase the value of the stock. Unanticipated lawsuits, industrial accidents, strikes, and similar events will tend to decrease future cash flows and thereby reduce share values.

Here is the important observation: If we held only a single stock, the value of our investment would fluctuate because of company-specific events. If we hold a large portfolio, on the other hand, some of the stocks in the portfolio will go up in value because of positive company-specific events and some will go down in value because of negative events. The net effect on the overall value of the portfolio will be relatively small, however, because these effects will tend to cancel each other out.

Now we see why some of the variability associated with individual assets is eliminated by diversification. When we combine assets into portfolios, the unique, or unsystematic, events—both positive and negative—tend to "wash out" once we have more than just a few assets.

This is an important point that bears repeating:

> **Unsystematic risk is essentially eliminated by diversification, so a portfolio with many assets has almost no unsystematic risk.**

In fact, the terms *diversifiable risk* and *unsystematic risk* are often used interchangeably.

DIVERSIFICATION AND SYSTEMATIC RISK

We've seen that unsystematic risk can be eliminated by diversifying. What about systematic risk? Can it also be eliminated by diversification? The answer is no because, by definition, a systematic risk affects almost all assets to some degree. As a result, no matter how many assets we put into a portfolio, the systematic risk doesn't go away. Thus, for obvious reasons, the terms *systematic risk* and *nondiversifiable risk* are used interchangeably.

Because we have introduced so many different terms, it is useful to summarize our discussion before moving on. What we have seen is that the total risk of an investment, as measured by the standard deviation of its return, can be written as:

$$\text{Total risk} = \text{Systematic risk} + \text{Unsystematic risk} \qquad \text{[13.6]}$$

Systematic risk is also called *nondiversifiable risk* or *market risk.* Unsystematic risk is also called *diversifiable risk, unique risk,* or *asset-specific risk.* For a well-diversified portfolio, the unsystematic risk is negligible. For such a portfolio, essentially all of the risk is systematic.

Concept Questions

13.5a What happens to the standard deviation of return for a portfolio if we increase the number of securities in the portfolio?

13.5b What is the principle of diversification?

13.5c Why is some risk diversifiable? Why is some risk not diversifiable?

13.5d Why can't systematic risk be diversified away?

Systematic Risk and Beta   13.6

The question that we now begin to address is this: What determines the size of the risk premium on a risky asset? Put another way, why do some assets have a larger risk premium than other assets? The answer to these questions, as we discuss next, is also based on the distinction between systematic and unsystematic risk.

THE SYSTEMATIC RISK PRINCIPLE

Thus far, we've seen that the total risk associated with an asset can be decomposed into two components: systematic and unsystematic risk. We have also seen that unsystematic risk can be essentially eliminated by diversification. The systematic risk present in an asset, on the other hand, cannot be eliminated by diversification.

systematic risk principle
The expected return on a risky asset depends only on that asset's systematic risk.

Based on our study of capital market history, we know that there is a reward, on average, for bearing risk. However, we now need to be more precise about what we mean by risk. The **systematic risk principle** states that the reward for bearing risk depends only on the systematic risk of an investment. The underlying rationale for this principle is straightforward: Because unsystematic risk can be eliminated at virtually no cost (by diversifying), there is no reward for bearing it. Put another way, the market does not reward risks that are borne unnecessarily.

The systematic risk principle has a remarkable and very important implication:

> **The expected return on an asset depends only on that asset's systematic risk.**

For more about beta, see www.wallstreetcity.com *and* moneycentral.msn.com.

There is an obvious corollary to this principle: No matter how much total risk an asset has, only the systematic portion is relevant in determining the expected return (and the risk premium) on that asset.

MEASURING SYSTEMATIC RISK

Because systematic risk is the crucial determinant of an asset's expected return, we need some way of measuring the level of systematic risk for different investments. The specific measure we will use is called the **beta coefficient**, for which we will use the Greek symbol β. A beta coefficient, or beta for short, tells us how much systematic risk a particular asset has relative to an average asset. By definition, an average asset has a beta of 1.0 relative to itself. An asset with a beta of .50, therefore, has half as much systematic risk as an average asset; an asset with a beta of 2.0 has twice as much.

beta coefficient
The amount of systematic risk present in a particular risky asset relative to that in an average risky asset.

Table 13.8 contains the estimated beta coefficients for the stocks of some well-known companies. (This particular source rounds numbers to the nearest .05.) The range of betas in Table 13.8 is typical for stocks of large U.S. corporations. Betas outside this range occur, but they are less common.

The important thing to remember is that the expected return, and thus the risk premium, of an asset depends only on its systematic risk. Because assets with larger betas have greater systematic risks, they will have greater expected returns. Thus, from Table 13.8, an investor who buys stock in ExxonMobil, with a beta of .85, should expect to earn less, on average, than an investor who buys stock in eBay, with a beta of about 1.35.

TABLE 13.8

Beta Coefficients for Selected Companies

	Beta Coefficient (β_i)
General Mills	0.55
Coca-Cola Bottling	0.65
ExxonMobil	0.85
3M	0.90
The Gap	1.20
eBay	1.35
Yahoo!	1.80

SOURCE: *Value Line Investment Survey,* 2006.

One cautionary note is in order: Not all betas are created equal. Different providers use somewhat different methods for estimating betas, and significant differences sometimes occur. As a result, it is a good idea to look at several sources. See our nearby *Work the Web* box for more about beta.

| **Total Risk versus Beta** | **EXAMPLE 13.5** |

Consider the following information about two securities. Which has greater total risk? Which has greater systematic risk? Greater unsystematic risk? Which asset will have a higher risk premium?

	Standard Deviation	**Beta**
Security A	40%	0.50
Security B	20	1.50

From our discussion in this section, Security A has greater total risk, but it has substantially less systematic risk. Because total risk is the sum of systematic and unsystematic risk, Security A must have greater unsystematic risk. Finally, from the systematic risk principle, Security B will have a higher risk premium and a greater expected return, despite the fact that it has less total risk.

WORK THE WEB

You can find beta estimates at many sites on the Web. One of the best is finance.yahoo.com. Here is a snapshot of the "Key Statistics" screen for Amazon.com (AMZN):

Stock Price History	
Beta:	2.93
52-Week Change[3]:	-2.33%
S&P500 52-Week Change[3]:	7.71%
52-Week High (19-Dec-05)[3]:	50.00
52-Week Low (18-May-06)[3]:	31.52
50-Day Moving Average[3]:	34.75
200-Day Moving Average[3]:	40.43

Management Effectiveness	
Return on Assets (ttm):	10.39%
Return on Equity (ttm):	409.88%

Income Statement	
Revenue (ttm):	8.87B
Revenue Per Share (ttm):	21.431
Qtrly Revenue Growth (yoy):	19.80%
Gross Profit (ttm):	2.04B
EBITDA (ttm):	587.00M
Net Income Avl to Common (ttm):	332.00M
Diluted EPS (ttm):	0.78
Qtrly Earnings Growth (yoy):	-34.60%

(continued)

The reported beta for Amazon.com is 2.93, which means that Amazon has about three times the systematic risk of a typical stock. You would expect that the company is very risky; and, looking at the other numbers, we agree. Amazon's ROA is 10.39 percent, a relatively good number. The reported ROE is about 410 percent, an amazing number! Why is Amazon's ROE so high? Until recently, the company had consistently lost money, and its accumulated losses over the years had entirely wiped out its book equity. As the result of recent profits, the shareholders equity account has become positive; but it is small, which leads to the large ROE. Also, the quarterly earnings growth over the past year was negative. Given all of this, Amazon appears to be a good candidate for a high beta.

PORTFOLIO BETAS

Earlier, we saw that the riskiness of a portfolio has no simple relationship to the risks of the assets in the portfolio. A portfolio beta, however, can be calculated, just like a portfolio expected return. For example, looking again at Table 13.8, suppose you put half of your money in Exxon-Mobil and half in Yahoo!. What would the beta of this combination be? Because ExxonMobil has a beta of .85 and Yahoo! has a beta of 1.80, the portfolio's beta, β_P, would be:

$$\beta_P = .50 \times \beta_{ExxonMobil} + .50 \times \beta_{Yahoo!}$$
$$= .50 \times .85 + .50 \times 1.80$$
$$= 1.325$$

In general, if we had many assets in a portfolio, we would multiply each asset's beta by its portfolio weight and then add the results to get the portfolio's beta.

EXAMPLE 13.6 **Portfolio Betas**

Suppose we had the following investments:

Security	Amount Invested	Expected Return	Beta
Stock A	$1,000	8%	.80
Stock B	2,000	12	.95
Stock C	3,000	15	1.10
Stock D	4,000	18	1.40

What is the expected return on this portfolio? What is the beta of this portfolio? Does this portfolio have more or less systematic risk than an average asset?

To answer, we first have to calculate the portfolio weights. Notice that the total amount invested is $10,000. Of this, $1,000/10,000 = 10% is invested in Stock A. Similarly, 20 percent is invested in Stock B, 30 percent is invested in Stock C, and 40 percent is invested in Stock D. The expected return, $E(R_P)$, is thus:

$$E(R_P) = .10 \times E(R_A) + .20 \times E(R_B) + .30 \times E(R_C) + .40 \times E(R_D)$$
$$= .10 \times 8\% + .20 \times 12\% + .30 \times 15\% + .40 \times 18\%$$
$$= 14.9\%$$

Similarly, the portfolio beta, β_P, is:

$$\beta_P = .10 \times \beta_A + .20 \times \beta_B + .30 \times \beta_C + .40 \times \beta_D$$
$$= .10 \times .80 + .20 \times .95 + .30 \times 1.10 + .40 \times 1.40$$
$$= 1.16$$

This portfolio thus has an expected return of 14.9 percent and a beta of 1.16. Because the beta is larger than 1, this portfolio has greater systematic risk than an average asset.

Betas are easy to find on the Web. Try finance.yahoo.com *and* money.cnn.com.

The Security Market Line   **13.7**

We're now in a position to see how risk is rewarded in the marketplace. To begin, suppose that Asset A has an expected return of $E(R_A) = 20\%$ and a beta of $\beta_A = 1.6$. Furthermore, suppose that the risk-free rate is $R_f = 8\%$. Notice that a risk-free asset, by definition, has no systematic risk (or unsystematic risk), so a risk-free asset has a beta of zero.

BETA AND THE RISK PREMIUM

Consider a portfolio made up of Asset A and a risk-free asset. We can calculate some different possible portfolio expected returns and betas by varying the percentages invested in these two assets. For example, if 25 percent of the portfolio is invested in Asset A, then the expected return is:

$$E(R_P) = .25 \times E(R_A) + (1 - .25) \times R_f$$
$$= .25 \times 20\% + .75 \times 8\%$$
$$= 11\%$$

Similarly, the beta on the portfolio, β_P, would be:

$$\beta_P = .25 \times \beta_A + (1 - .25) \times 0$$
$$= .25 \times 1.6$$
$$= .40$$

Notice that because the weights have to add up to 1, the percentage invested in the risk-free asset is equal to 1 minus the percentage invested in Asset A.

One thing that you might wonder about is whether it is possible for the percentage invested in Asset A to exceed 100 percent. The answer is yes. This can happen if the investor borrows at the risk-free rate. For example, suppose an investor has $100 and borrows an additional $50 at 8 percent, the risk-free rate. The total investment in Asset A would be $150, or 150 percent of the investor's wealth. The expected return in this case would be:

$$E(R_P) = 1.50 \times E(R_A) + (1 - 1.50) \times R_f$$
$$= 1.50 \times 20\% - .50 \times 8\%$$
$$= 26\%$$

The beta on the portfolio would be:

$$\beta_P = 1.50 \times \beta_A + (1 - 1.50) \times 0$$
$$= 1.50 \times 1.6$$
$$= 2.4$$

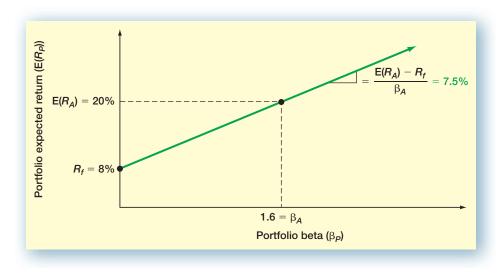**FIGURE 13.2A**

Portfolio Expected
Returns and Betas for
Asset A

We can calculate some other possibilities, as follows:

Percentage of Portfolio in Asset A	Portfolio Expected Return	Portfolio Beta
0%	8%	.0
25	11	.4
50	14	.8
75	17	1.2
100	20	1.6
125	23	2.0
150	26	2.4

In Figure 13.2A, these portfolio expected returns are plotted against the portfolio betas. Notice that all the combinations fall on a straight line.

The Reward-to-Risk Ratio   What is the slope of the straight line in Figure 13.2A? As always, the slope of a straight line is equal to "the rise over the run." In this case, as we move out of the risk-free asset into Asset A, the beta increases from zero to 1.6 (a "run" of 1.6). At the same time, the expected return goes from 8 percent to 20 percent, a "rise" of 12 percent. The slope of the line is thus $12\%/1.6 = 7.5\%$.

Notice that the slope of our line is just the risk premium on Asset A, $E(R_A) - R_f$, divided by Asset A's beta, β_A:

$$\text{Slope} = \frac{E(R_A) - R_f}{\beta_A}$$

$$= \frac{20\% - 8\%}{1.6} = 7.5\%$$

What this tells us is that Asset A offers a *reward-to-risk* ratio of 7.5 percent.[2] In other words, Asset A has a risk premium of 7.50 percent per "unit" of systematic risk.

---

[2]This ratio is sometimes called the *Treynor index,* after one of its originators.

The Basic Argument   Now suppose we consider a second asset, Asset B. This asset has a beta of 1.2 and an expected return of 16 percent. Which investment is better, Asset A or Asset B? You might think that, once again, we really cannot say—some investors might prefer A; some investors might prefer B. Actually, however, we can say: A is better because, as we will demonstrate, B offers inadequate compensation for its level of systematic risk, at least, relative to A.

To begin, we calculate different combinations of expected returns and betas for portfolios of Asset B and a risk-free asset, just as we did for Asset A. For example, if we put 25 percent in Asset B and the remaining 75 percent in the risk-free asset, the portfolio's expected return will be:

$$E(R_P) = .25 \times E(R_B) + (1 - .25) \times R_f$$
$$= .25 \times 16\% + .75 \times 8\%$$
$$= 10\%$$

Similarly, the beta on the portfolio, β_P, would be:

$$\beta_P = .25 \times \beta_B + (1 - .25) \times 0$$
$$= .25 \times 1.2$$
$$= .30$$

Some other possibilities are as follows:

Percentage of Portfolio in Asset B	Portfolio Expected Return	Portfolio Beta
0%	8%	.0
25	10	.3
50	12	.6
75	14	.9
100	16	1.2
125	18	1.5
150	20	1.8

When we plot these combinations of portfolio expected returns and portfolio betas in Figure 13.2B, we get a straight line just as we did for Asset A.

The key thing to notice is that when we compare the results for Assets A and B, as in Figure 13.2C, the line describing the combinations of expected returns and betas for Asset A
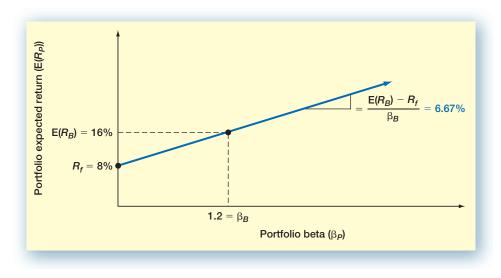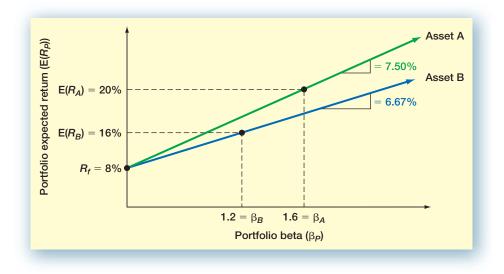

FIGURE 13.2B

Portfolio Expected Returns and Betas for Asset B

$$= \frac{E(R_B) - R_f}{\beta_B} = 6.67\%$$

$E(R_B) = 16\%$

$R_f = 8\%$

$1.2 = \beta_B$

Portfolio beta (β_P)

Portfolio expected return ($E(R_P)$)

FIGURE 13.2C

Portfolio Expected
Returns and Betas for
Both Assets

is higher than the one for Asset B. This tells us that for any given level of systematic risk (as measured by β), some combination of Asset A and the risk-free asset always offers a larger return. This is why we were able to state that Asset A is a better investment than Asset B.

Another way of seeing that A offers a superior return for its level of risk is to note that the slope of our line for Asset B is:

$$\text{Slope} = \frac{E(R_B) - R_f}{\beta_B}$$

$$= \frac{16\% - 8\%}{1.2} = 6.67\%$$

Thus, Asset B has a reward-to-risk ratio of 6.67 percent, which is less than the 7.5 percent offered by Asset A.

The Fundamental Result   The situation we have described for Assets A and B could not persist in a well-organized, active market, because investors would be attracted to Asset A and away from Asset B. As a result, Asset A's price would rise and Asset B's price would fall. Because prices and returns move in opposite directions, A's expected return would decline and B's would rise.

This buying and selling would continue until the two assets plotted on exactly the same line, which means they would offer the same reward for bearing risk. In other words, in an active, competitive market, we must have the situation that:

$$\frac{E(R_A) - R_f}{\beta_A} = \frac{E(R_B) - R_f}{\beta_B}$$

This is the fundamental relationship between risk and return.

Our basic argument can be extended to more than just two assets. In fact, no matter how many assets we had, we would always reach the same conclusion:

> **The reward-to-risk ratio must be the same for all the assets in the market.**

This result is really not so surprising. What it says is that, for example, if one asset has twice as much systematic risk as another asset, its risk premium will simply be twice as large.

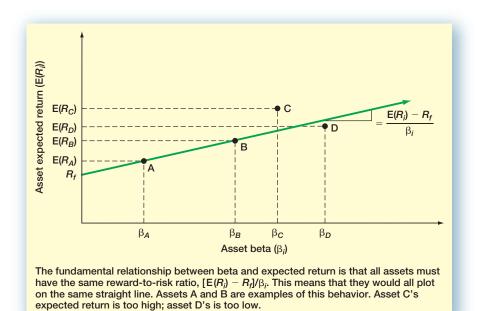The fundamental relationship between beta and expected return is that all assets must
have the same reward-to-risk ratio, $[E(R_i) - R_f]/\beta_i$. This means that they would all plot
on the same straight line. Assets A and B are examples of this behavior. Asset C's
expected return is too high; asset D's is too low.

Because all of the assets in the market must have the same reward-to-risk ratio, they all
must plot on the same line. This argument is illustrated in Figure 13.3. As shown, Assets A
and B plot directly on the line and thus have the same reward-to-risk ratio. If an asset plotted
above the line, such as C in Figure 13.3, its price would rise and its expected return would fall
until it plotted exactly on the line. Similarly, if an asset plotted below the line, such as D in
Figure 13.3, its expected return would rise until it too plotted directly on the line.

The arguments we have presented apply to active, competitive, well-functioning mar-
kets. The financial markets, such as the NYSE, best meet these criteria. Other markets,
such as real asset markets, may or may not. For this reason, these concepts are most useful
in examining financial markets. We will thus focus on such markets here. However, as
we discuss in a later section, the information about risk and return gleaned from financial
markets is crucial in evaluating the investments that a corporation makes in real assets.

Buy Low, Sell High   **EXAMPLE 13.7**

An asset is said to be *overvalued* if its price is too high given its expected return and risk.
Suppose you observe the following situation:

Security	Beta	Expected Return
SWMS Co.	1.3	14%
Insec Co.	.8	10

The risk-free rate is currently 6 percent. Is one of the two securities overvalued relative to
the other?

To answer, we compute the reward-to-risk ratio for both. For SWMS, this ratio is
$(14\% - 6\%)/1.3 = 6.15\%$. For Insec, this ratio is 5 percent. What we conclude is that Insec
offers an insufficient expected return for its level of risk, at least relative to SWMS. Because
its expected return is too low, its price is too high. In other words, Insec is overvalued rela-
tive to SWMS, and we would expect to see its price fall relative to SWMS's. Notice that we
could also say SWMS is undervalued relative to Insec.

THE SECURITY MARKET LINE

security market line (SML)
A positively sloped straight line displaying the relationship between expected return and beta.

The line that results when we plot expected returns and beta coefficients is obviously of some importance, so it's time we gave it a name. This line, which we use to describe the relationship between systematic risk and expected return in financial markets, is usually called the **security market line (SML)**. After NPV, the SML is arguably the most important concept in modern finance.

Market Portfolios   It will be very useful to know the equation of the SML. There are many different ways we could write it, but one way is particularly common. Suppose we consider a portfolio made up of all of the assets in the market. Such a portfolio is called a market portfolio, and we will express the expected return on this market portfolio as $E(R_M)$.

Because all the assets in the market must plot on the SML, so must a market portfolio made up of those assets. To determine where it plots on the SML, we need to know the beta of the market portfolio, β_M. Because this portfolio is representative of all of the assets in the market, it must have average systematic risk. In other words, it has a beta of 1. We could therefore express the slope of the SML as:

market risk premium
The slope of the SML—the difference between the expected return on a market portfolio and the risk-free rate.

$$\text{SML slope} = \frac{E(R_M) - R_f}{\beta_M} = \frac{E(R_M) - R_f}{1} = E(R_M) - R_f$$

The term $E(R_M) - R_f$ is often called the **market risk premium** because it is the risk premium on a market portfolio.

The Capital Asset Pricing Model   To finish up, if we let $E(R_i)$ and β_i stand for the expected return and beta, respectively, on any asset in the market, then we know that asset must plot on the SML. As a result, we know that its reward-to-risk ratio is the same as the overall market's:

$$\frac{E(R_i) - R_f}{\beta_i} = E(R_M) - R_f$$

If we rearrange this, then we can write the equation for the SML as:

$$E(R_i) = R_f + [E(R_M) - R_f] \times \beta_i \qquad [13.7]$$

capital asset pricing model (CAPM)
The equation of the SML showing the relationship between expected return and beta.

This result is the famous **capital asset pricing model (CAPM)**.

The CAPM shows that the expected return for a particular asset depends on three things:

1. *The pure time value of money:* As measured by the risk-free rate, R_f, this is the reward for merely waiting for your money, without taking any risk.
2. *The reward for bearing systematic risk:* As measured by the market risk premium, $E(R_M) - R_f$, this component is the reward the market offers for bearing an average amount of systematic risk in addition to waiting.
3. *The amount of systematic risk:* As measured by β_i, this is the amount of systematic risk present in a particular asset or portfolio, relative to that in an average asset.

By the way, the CAPM works for portfolios of assets just as it does for individual assets. In an earlier section, we saw how to calculate a portfolio's β. To find the expected return on a portfolio, we simply use this β in the CAPM equation.

The slope of the security market line is equal to the market risk premium—that is, the reward for bearing an average amount of systematic risk. The equation describing the SML can be written:

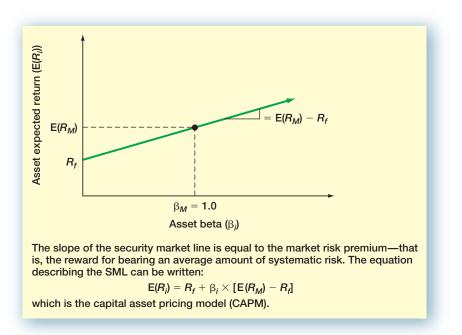$$E(R_i) = R_f + \beta_i \times [E(R_M) - R_f]$$

which is the capital asset pricing model (CAPM).

Figure 13.4 summarizes our discussion of the SML and the CAPM. As before, we plot expected return against beta. Now we recognize that, based on the CAPM, the slope of the SML is equal to the market risk premium, $E(R_M) - R_f$.

This concludes our presentation of concepts related to the risk–return trade-off. For future reference, Table 13.9 summarizes the various concepts in the order in which we discussed them.

Risk and Return	**EXAMPLE 13.8**

Suppose the risk-free rate is 4 percent, the market risk premium is 8.6 percent, and a particular stock has a beta of 1.3. Based on the CAPM, what is the expected return on this stock? What would the expected return be if the beta were to double?

With a beta of 1.3, the risk premium for the stock is $1.3 \times 8.6\%$, or 11.18 percent. The risk-free rate is 4 percent, so the expected return is 15.18 percent. If the beta were to double to 2.6, the risk premium would double to 22.36 percent, so the expected return would be 26.36 percent.

Concept Questions

13.7a What is the fundamental relationship between risk and return in well-functioning markets?

13.7b What is the security market line? Why must all assets plot directly on it in a well-functioning market?

13.7c What is the capital asset pricing model (CAPM)? What does it tell us about the required return on a risky investment?

TABLE 13.9

Summary of Risk and Return

I.	**Total Risk**
	The *total risk* of an investment is measured by the variance or, more commonly, the standard deviation of its return.

II.	**Total Return**
	The *total return* on an investment has two components: the expected return and the unexpected return. The unexpected return comes about because of unanticipated events. The risk from investing stems from the possibility of an unanticipated event.

III.	**Systematic and Unsystematic Risks**
	Systematic risks (also called *market risks*) are unanticipated events that affect almost all assets to some degree because the effects are economywide. *Unsystematic risks* are unanticipated events that affect single assets or small groups of assets. Unsystematic risks are also called *unique* or *asset-specific risks*.

IV.	**The Effect of Diversification**
	Some, but not all, of the risk associated with a risky investment can be eliminated by diversification. The reason is that unsystematic risks, which are unique to individual assets, tend to wash out in a large portfolio, but systematic risks, which affect all of the assets in a portfolio to some extent, do not.

V.	**The Systematic Risk Principle and Beta**
	Because unsystematic risk can be freely eliminated by diversification, the *systematic risk principle* states that the reward for bearing risk depends only on the level of systematic risk. The level of systematic risk in a particular asset, relative to the average, is given by the beta of that asset.

VI.	**The Reward-to-Risk Ratio and the Security Market Line**
	The *reward-to-risk ratio* for Asset i is the ratio of its risk premium, $E(R_i) - R_f$, to its beta, β_i: $$\frac{E(R_i) - R_f}{\beta_i}$$ In a well-functioning market, this ratio is the same for every asset. As a result, when asset expected returns are plotted against asset betas, all assets plot on the same straight line, called the *security market line* (SML).

VII.	**The Capital Asset Pricing Model**
	From the SML, the expected return on Asset i can be written: $$E(R_i) = R_f + [E(R_M) - R_f] \times \beta_i$$ This is the *capital asset pricing model* (CAPM). The expected return on a risky asset thus has three components. The first is the pure time value of money (R_f), the second is the market risk premium $[E(R_M) - R_f]$, and the third is the beta for that asset, (β_i).

13.8 The SML and the Cost of Capital: A Preview

Our goal in studying risk and return is twofold. First, risk is an extremely important consideration in almost all business decisions, so we want to discuss just what risk is and how it is rewarded in the market. Our second purpose is to learn what determines the appropriate discount rate for future cash flows. We briefly discuss this second subject now; we will discuss it in more detail in a subsequent chapter.

THE BASIC IDEA

The security market line tells us the reward for bearing risk in financial markets. At an absolute minimum, any new investment our firm undertakes must offer an expected return

that is no worse than what the financial markets offer for the same risk. The reason for this is simply that our shareholders can always invest for themselves in the financial markets.

The only way we benefit our shareholders is by finding investments with expected returns that are superior to what the financial markets offer for the same risk. Such an investment will have a positive NPV. So, if we ask, "What is the appropriate discount rate?" the answer is that we should use the expected return offered in financial markets on investments with the same systematic risk.

In other words, to determine whether an investment has a positive NPV, we essentially compare the expected return on that new investment to what the financial market offers on an investment with the same beta. This is why the SML is so important: It tells us the "going rate" for bearing risk in the economy.

THE COST OF CAPITAL

The appropriate discount rate on a new project is the minimum expected rate of return an investment must offer to be attractive. This minimum required return is often called the **cost of capital** associated with the investment. It is called this because the required return is what the firm must earn on its capital investment in a project just to break even. It can thus be interpreted as the opportunity cost associated with the firm's capital investment.

cost of capital
The minimum required return on a new investment.

Notice that when we say an investment is attractive if its expected return exceeds what is offered in financial markets for investments of the same risk, we are effectively using the internal rate of return (IRR) criterion that we developed and discussed in Chapter 9. The only difference is that now we have a much better idea of what determines the required return on an investment. This understanding will be critical when we discuss cost of capital and capital structure in Part 6 of our book.

> **Concept Questions**
>
> **13.8a** If an investment has a positive NPV, would it plot above or below the SML? Why?
>
> **13.8b** What is meant by the term *cost of capital*?

Summary and Conclusions
13.9

This chapter has covered the essentials of risk. Along the way, we have introduced a number of definitions and concepts. The most important of these is the security market line, or SML. The SML is important because it tells us the reward offered in financial markets for bearing risk. Once we know this, we have a benchmark against which we compare the returns expected from real asset investments to determine if they are desirable.

Because we have covered quite a bit of ground, it's useful to summarize the basic economic logic underlying the SML as follows:

1. Based on capital market history, there is a reward for bearing risk. This reward is the risk premium on an asset.
2. The total risk associated with an asset has two parts: systematic risk and unsystematic risk. Unsystematic risk can be freely eliminated by diversification (this is the principle

of diversification), so only systematic risk is rewarded. As a result, the risk premium on an asset is determined by its systematic risk. This is the systematic risk principle.

3. An asset's systematic risk, relative to the average, can be measured by its beta coefficient, β_i. The risk premium on an asset is then given by its beta coefficient multiplied by the market risk premium, $[E(R_M) - R_f] \times \beta_i$.

4. The expected return on an asset, $E(R_i)$, is equal to the risk-free rate, R_f, plus the risk premium:

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

This is the equation of the SML, and it is often called the capital asset pricing model (CAPM).

This chapter completes our discussion of risk and return. Now that we have a better understanding of what determines a firm's cost of capital for an investment, the next several chapters will examine more closely how firms raise the long-term capital needed for investment.

CHAPTER REVIEW AND SELF-TEST PROBLEMS

13.1 Expected Return and Standard Deviation This problem will give you some practice calculating measures of prospective portfolio performance. There are two assets and three states of the economy:

State of Economy	Probability of State of Economy	Rate of Return if State Occurs	
		Stock A	Stock B
Recession	.20	−.15	.20
Normal	.50	.20	.30
Boom	.30	.60	.40

What are the expected returns and standard deviations for these two stocks?

13.2 Portfolio Risk and Return Using the information in the previous problem, suppose you have $20,000 total. If you put $15,000 in Stock A and the remainder in Stock B, what will be the expected return and standard deviation of your portfolio?

13.3 Risk and Return Suppose you observe the following situation:

Security	Beta	Expected Return
Cooley, Inc.	1.8	22.00%
Moyer Co.	1.6	20.24%

If the risk-free rate is 7 percent, are these securities correctly priced? What would the risk-free rate have to be if they are correctly priced?

13.4 CAPM Suppose the risk-free rate is 8 percent. The expected return on the market is 16 percent. If a particular stock has a beta of .7, what is its expected return based on the CAPM? If another stock has an expected return of 24 percent, what must its beta be?

ANSWERS TO CHAPTER REVIEW AND SELF-TEST PROBLEMS

13.1 The expected returns are just the possible returns multiplied by the associated probabilities:

$E(R_A) = (.20 \times -.15) + (.50 \times .20) + (.30 \times .60) = 25\%$

$E(R_B) = (.20 \times .20) + (.50 \times .30) + (.30 \times .40) = 31\%$

The variances are given by the sums of the squared deviations from the expected returns multiplied by their probabilities:

$\sigma_A^2 = .20 \times (-.15 - .25)^2 + .50 \times (.20 - .25)^2 + .30 \times (.60 - .25)^2$

$\quad = (.20 \times -.40^2) + (.50 \times -.05^2) + (.30 \times .25^2)$

$\quad = (.20 \times .16) + (.50 \times .0025) + (.30 \times .1225)$

$\quad = .0700$

$\sigma_B^2 = .20 \times (.20 - .31)^2 + .50 \times (.30 - .31)^2 + .30 \times (.40 - .31)^2$

$\quad = (.20 \times .11^2) + (.50 \times -.01^2) + (.30 \times .09^2)$

$\quad = (.20 \times .0121) + (.50 \times .0001) + (.30 \times .0081)$

$\quad = .0049$

The standard deviations are thus:

$\sigma_A = \sqrt{.0700} = 26.46\%$

$\sigma_B = \sqrt{.0049} = 7\%$

13.2 The portfolio weights are $15,000/20,000 = .75$ and $5,000/20,000 = .25$. The expected return is thus:

$E(R_P) = .75 \times E(R_A) + .25 \times E(R_B)$

$\quad = (.75 \times 25\%) + (.25 \times 31\%)$

$\quad = 26.5\%$

Alternatively, we could calculate the portfolio's return in each of the states:

State of Economy	Probability of State of Economy	Portfolio Return if State Occurs
Recession	.20	$(.75 \times -.15) + (.25 \times .20) = -.0625$
Normal	.50	$(.75 \times .20) + (.25 \times .30) = .2250$
Boom	.30	$(.75 \times .60) + (.25 \times .40) = .5500$

The portfolio's expected return is:

$E(R_P) = (.20 \times -.0625) + (.50 \times .2250) + (.30 \times .5500) = 26.5\%$

This is the same as we had before.

The portfolio's variance is:

$\sigma_P^2 = .20 \times (-.0625 - .265)^2 + .50 \times (.225 - .265)^2$

$\quad\quad + .30 \times (.55 - .265)^2$

$\quad = 0.0466$

So the standard deviation is $\sqrt{.0466} = 21.59\%$.

13.3 If we compute the reward-to-risk ratios, we get $(22\% - 7\%)/1.8 = 8.33\%$ for Cooley versus 8.4% for Moyer. Relative to that of Cooley, Moyer's expected return is too high, so its price is too low.

If they are correctly priced, then they must offer the same reward-to-risk ratio. The risk-free rate would have to be such that:

$$(22\% - R_f)/1.8 = (20.44\% - R_f)/1.6$$

With a little algebra, we find that the risk-free rate must be 8 percent:

$$22\% - R_f = (20.44\% - R_f)(1.8/1.6)$$
$$22\% - 20.44\% \times 1.125 = R_f - R_f \times 1.125$$
$$R_f = 8\%$$

13.4 Because the expected return on the market is 16 percent, the market risk premium is $16\% - 8\% = 8\%$. The first stock has a beta of .7, so its expected return is $8\% + .7 \times 8\% = 13.6\%$.

For the second stock, notice that the risk premium is $24\% - 8\% = 16\%$. Because this is twice as large as the market risk premium, the beta must be exactly equal to 2. We can verify this using the CAPM:

$$E(R_i) = R_f + [E(R_M) - R_f] \times \beta_i$$
$$24\% = 8\% + (16\% - 8\%) \times \beta_i$$
$$\beta_i = 16\%/8\%$$
$$= 2.0$$

CONCEPTS REVIEW AND CRITICAL THINKING QUESTIONS

1. **Diversifiable and Nondiversifiable Risks** In broad terms, why is some risk diversifiable? Why are some risks nondiversifiable? Does it follow that an investor can control the level of unsystematic risk in a portfolio, but not the level of systematic risk?

2. **Information and Market Returns** Suppose the government announces that, based on a just-completed survey, the growth rate in the economy is likely to be 2 percent in the coming year, as compared to 5 percent for the past year. Will security prices increase, decrease, or stay the same following this announcement? Does it make any difference whether the 2 percent figure was anticipated by the market? Explain.

3. **Systematic versus Unsystematic Risk** Classify the following events as mostly systematic or mostly unsystematic. Is the distinction clear in every case?
    a. Short-term interest rates increase unexpectedly.
    b. The interest rate a company pays on its short-term debt borrowing is increased by its bank.
    c. Oil prices unexpectedly decline.
    d. An oil tanker ruptures, creating a large oil spill.
    e. A manufacturer loses a multimillion-dollar product liability suit.
    f. A Supreme Court decision substantially broadens producer liability for injuries suffered by product users.

4. **Systematic versus Unsystematic Risk** Indicate whether the following events might cause stocks in general to change price, and whether they might cause Big Widget Corp.'s stock to change price:
    a. The government announces that inflation unexpectedly jumped by 2 percent last month.
    b. Big Widget's quarterly earnings report, just issued, generally fell in line with analysts' expectations.

c. The government reports that economic growth last year was at 3 percent, which generally agreed with most economists' forecasts.

d. The directors of Big Widget die in a plane crash.

e. Congress approves changes to the tax code that will increase the top marginal corporate tax rate. The legislation had been debated for the previous six months.

5. **Expected Portfolio Returns** If a portfolio has a positive investment in every asset, can the expected return on the portfolio be greater than that on every asset in the portfolio? Can it be less than that on every asset in the portfolio? If you answer yes to one or both of these questions, give an example to support your answer.

6. **Diversification** True or false: The most important characteristic in determining the expected return of a well-diversified portfolio is the variance of the individual assets in the portfolio. Explain.

7. **Portfolio Risk** If a portfolio has a positive investment in every asset, can the standard deviation on the portfolio be less than that on every asset in the portfolio? What about the portfolio beta?

8. **Beta and CAPM** Is it possible that a risky asset could have a beta of zero? Explain. Based on the CAPM, what is the expected return on such an asset? Is it possible that a risky asset could have a negative beta? What does the CAPM predict about the expected return on such an asset? Can you give an explanation for your answer?

9. **Corporate Downsizing** In recent years, it has been common for companies to experience significant stock price changes in reaction to announcements of massive layoffs. Critics charge that such events encourage companies to fire longtime employees and that Wall Street is cheering them on. Do you agree or disagree?

10. **Earnings and Stock Returns** As indicated by a number of examples in this chapter, earnings announcements by companies are closely followed by, and frequently result in, share price revisions. Two issues should come to mind. First, earnings announcements concern past periods. If the market values stocks based on expectations of the future, why are numbers summarizing past performance relevant? Second, these announcements concern accounting earnings. Going back to Chapter 2, such earnings may have little to do with cash flow—so, again, why are they relevant?

™

QUESTIONS AND PROBLEMS

1. **Determining Portfolio Weights** What are the portfolio weights for a portfolio that has 100 shares of Stock A that sell for $40 per share and 130 shares of Stock B that sell for $22 per share?

BASIC
(Questions 1–20)

2. **Portfolio Expected Return** You own a portfolio that has $2,300 invested in Stock A and $3,400 invested in Stock B. If the expected returns on these stocks are 11 percent and 16 percent, respectively, what is the expected return on the portfolio?

3. **Portfolio Expected Return** You own a portfolio that is 50 percent invested in Stock X, 30 percent in Stock Y, and 20 percent in Stock Z. The expected returns on these three stocks are 10 percent, 16 percent, and 12 percent, respectively. What is the expected return on the portfolio?

4. **Portfolio Expected Return** You have $10,000 to invest in a stock portfolio. Your choices are Stock X with an expected return of 15 percent and Stock Y with an expected return of 10 percent. If your goal is to create a portfolio with an expected return of 12.2 percent, how much money will you invest in Stock X? In Stock Y?

5. **Calculating Expected Return** Based on the following information, calculate the expected return:

State of Economy	Probability of State of Economy	Rate of Return if State Occurs
Recession	.30	−.09
Boom	.70	.33

6. **Calculating Expected Return** Based on the following information, calculate the expected return:

State of Economy	Probability of State of Economy	Rate of Return if State Occurs
Recession	.25	−.05
Normal	.40	.12
Boom	.35	.25

7. **Calculating Returns and Standard Deviations** Based on the following information, calculate the expected return and standard deviation for the two stocks:

State of Economy	Probability of State of Economy	Rate of Return if State Occurs	
		Stock A	Stock B
Recession	.15	.06	−.20
Normal	.60	.07	.13
Boom	.25	.11	.33

8. **Calculating Expected Returns** A portfolio is invested 10 percent in Stock G, 75 percent in Stock J, and 15 percent in Stock K. The expected returns on these stocks are 8 percent, 15 percent, and 24 percent, respectively. What is the portfolio's expected return? How do you interpret your answer?

9. **Returns and Standard Deviations** Consider the following information:

State of Economy	Probability of State of Economy	Rate of Return if State Occurs		
		Stock A	Stock B	Stock C
Boom	.75	.07	.15	.33
Bust	.25	.13	.03	−.06

a. What is the expected return on an equally weighted portfolio of these three stocks?

b. What is the variance of a portfolio invested 20 percent each in A and B and 60 percent in C?

10. **Returns and Standard Deviations** Consider the following information:

State of Economy	Probability of State of Economy	Rate of Return if State Occurs		
		Stock A	**Stock B**	**Stock C**
Boom	.20	.30	.45	.33
Good	.40	.12	.10	.15
Poor	.30	.01	−.15	−.05
Bust	.10	−.06	−.30	−.09

    a. Your portfolio is invested 30 percent each in A and C, and 40 percent in B. What is the expected return of the portfolio?

    b. What is the variance of this portfolio? The standard deviation?

11. **Calculating Portfolio Betas** You own a stock portfolio invested 25 percent in Stock Q, 20 percent in Stock R, 15 percent in Stock S, and 40 percent in Stock T. The betas for these four stocks are .75, 1.24, 1.09, and 1.42, respectively. What is the portfolio beta?

12. **Calculating Portfolio Betas** You own a portfolio equally invested in a risk-free asset and two stocks. If one of the stocks has a beta of 1.65 and the total portfolio is equally as risky as the market, what must the beta be for the other stock in your portfolio?

13. **Using CAPM** A stock has a beta of 1.25, the expected return on the market is 14 percent, and the risk-free rate is 5.2 percent. What must the expected return on this stock be?

14. **Using CAPM** A stock has an expected return of 13 percent, the risk-free rate is 4.5 percent, and the market risk premium is 7 percent. What must the beta of this stock be?

15. **Using CAPM** A stock has an expected return of 10 percent, its beta is .70, and the risk-free rate is 5.5 percent. What must the expected return on the market be?

16. **Using CAPM** A stock has an expected return of 15 percent, its beta is 1.45, and the expected return on the market is 12 percent. What must the risk-free rate be?

17. **Using CAPM** A stock has a beta of 1.30 and an expected return of 17 percent. A risk-free asset currently earns 5 percent.

    a. What is the expected return on a portfolio that is equally invested in the two assets?

    b. If a portfolio of the two assets has a beta of .75, what are the portfolio weights?

    c. If a portfolio of the two assets has an expected return of 8 percent, what is its beta?

    d. If a portfolio of the two assets has a beta of 2.60, what are the portfolio weights? How do you interpret the weights for the two assets in this case? Explain.

18. **Using the SML** Asset W has an expected return of 15 percent and a beta of 1.2. If the risk-free rate is 5 percent, complete the following table for portfolios of Asset W and a risk-free asset. Illustrate the relationship between portfolio expected return and portfolio beta by plotting the expected returns against the betas. What is the slope of the line that results?

Percentage of Portfolio in Asset W	Portfolio Expected Return	Portfolio Beta
0%		
25		
50		
75		
100		
125		
150		

19. Reward-to-Risk Ratios Stock Y has a beta of 1.40 and an expected return of 19 percent. Stock Z has a beta of .65 and an expected return of 10.5 percent. If the risk-free rate is 6 percent and the market risk premium is 8.8 percent, are these stocks correctly priced?

20. Reward-to-Risk Ratios In the previous problem, what would the risk-free rate have to be for the two stocks to be correctly priced?

INTERMEDIATE
(Questions 21–28)

21. Portfolio Returns Using information from the previous chapter on capital market history, determine the return on a portfolio that is equally invested in large-company stocks and long-term government bonds. What is the return on a portfolio that is equally invested in small-company stocks and Treasury bills?

22. CAPM Using the CAPM, show that the ratio of the risk premiums on two assets is equal to the ratio of their betas.

23. Portfolio Returns and Deviations Consider the following information about three stocks:

State of Economy	Probability of State of Economy	Rate of Return if State Occurs		
		Stock A	**Stock B**	**Stock C**
Boom	.40	.24	.36	.55
Normal	.40	.17	.13	.09
Bust	.20	.00	−.28	−.45

a. If your portfolio is invested 40 percent each in A and B and 20 percent in C, what is the portfolio expected return? The variance? The standard deviation?

b. If the expected T-bill rate is 3.80 percent, what is the expected risk premium on the portfolio?

c. If the expected inflation rate is 3.50 percent, what are the approximate and exact expected real returns on the portfolio? What are the approximate and exact expected real risk premiums on the portfolio?

24. Analyzing a Portfolio You want to create a portfolio equally as risky as the market, and you have $1,000,000 to invest. Given this information, fill in the rest of the following table:

Asset	Investment	Beta
Stock A	$175,000	.80
Stock B	$300,000	1.30
Stock C		1.50
Risk-free asset		

25. Analyzing a Portfolio You have $100,000 to invest in a portfolio containing Stock X, Stock Y, and a risk-free asset. You must invest all of your money. Your goal is to create a portfolio that has an expected return of 13 percent and that has only 70 percent of the risk of the overall market. If X has an expected return of 31 percent and a beta of 1.8, Y has an expected return of 20 percent and a beta of 1.3, and the risk-free rate is 7 percent, how much money will you invest in Stock X? How do you interpret your answer?

26. **Systematic versus Unsystematic Risk** Consider the following information about Stocks I and II:

State of Economy	Probability of State of Economy	Rate of Return if State Occurs	
		Stock I	**Stock II**
Recession	.25	.09	−.30
Normal	.50	.42	.12
Irrational exuberance	.25	.26	.44

The market risk premium is 8 percent, and the risk-free rate is 4 percent. Which stock has the most systematic risk? Which one has the most unsystematic risk? Which stock is "riskier"? Explain.

27. **SML** Suppose you observe the following situation:

Security	Beta	Expected Return
Pete Corp.	1.4	.150
Repete Co.	.9	.115

Assume these securities are correctly priced. Based on the CAPM, what is the expected return on the market? What is the risk-free rate?

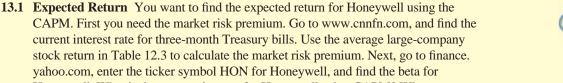28. **SML** Suppose you observe the following situation:

State of Economy	Probability of State	Return if State Occurs	
		Stock A	**Stock B**
Bust	.25	−.10	−.30
Normal	.50	.10	.05
Boom	.25	.20	.40

a. Calculate the expected return on each stock.
b. Assuming the capital asset pricing model holds and stock A's beta is greater than stock B's beta by .25, what is the expected market risk premium?

WEB EXERCISES

13.1 **Expected Return** You want to find the expected return for Honeywell using the CAPM. First you need the market risk premium. Go to www.cnnfn.com, and find the current interest rate for three-month Treasury bills. Use the average large-company stock return in Table 12.3 to calculate the market risk premium. Next, go to finance.yahoo.com, enter the ticker symbol HON for Honeywell, and find the beta for Honeywell. What is the expected return for Honeywell using CAPM? What assumptions have you made to arrive at this number?

13.2 **Portfolio Beta** You have decided to invest in an equally weighted portfolio consisting of American Express, Procter & Gamble, Home Depot, and DuPont and need to find the beta of your portfolio. Go to finance.yahoo.com and find the ticker symbols for each of these companies. Now find the beta for each of the companies. What is the beta for your portfolio?

13.3 Beta Which companies currently have the highest and lowest betas? Go to www. amex.com and follow the "Screening" link. Enter 0 as the maximum beta and enter search. How many stocks currently have a beta less than 0? What is the lowest beta? Go back to the stock screener and enter 3 as the minimum. How many stocks have a beta above 3? What stock has the highest beta?

13.4 Security Market Line Go to finance.yahoo.com and enter the ticker symbol IP for International Paper. Find the beta for the company. Next, follow the "Research" link to find the estimated price in 12 months according to market analysts. Using the current share price and the mean target price, compute the expected return for this stock. Don't forget to include the expected dividend payments over the next year. Now go to money.cnn.com, and find the current interest rate for three-month Treasury bills. Using this information, calculate the expected return on the market using the reward-to-risk ratio. Does this number make sense? Why or why not?

MINICASE

The Beta for American Standard

Joey Moss, a recent finance graduate, has just begun his job with the investment firm of Covili and Wyatt. Paul Covili, one of the firm's founders, has been talking to Joey about the firm's investment portfolio.

As with any investment, Paul is concerned about the risk of the investment as well as the potential return. More specifically, because the company holds a diversified portfolio, Paul is concerned about the systematic risk of current and potential investments. One position the company currently holds is stock in American Standard (ASD). American Standard manufactures air conditioning systems, bath and kitchen fixtures and fittings, and vehicle control systems. Additionally, the company offers commercial and residential heating, ventilation, and air conditioning equipment, systems, and controls.

Covili and Wyatt currently uses a commercial data vendor for information about its positions. Because of this, Paul is unsure exactly how the numbers provided are calculated. The data provider considers its methods proprietary, and it will not disclose how stock betas and other information are calculated. Paul is uncomfortable with not knowing exactly how these numbers are being computed and also believes that it could be less expensive to calculate the necessary statistics in-house. To explore this question, Paul has asked Joey to do the following assignments:

1. Go to finance.yahoo.com and download the ending monthly stock prices for American Standard (ASD) for the last 60 months. Also, be sure to download the dividend payments over this period as well. Next, download the ending value of the S&P 500 index over the same period. For the historical risk-free rate, go to the St. Louis Federal Reserve Web site (www.stlouisfed.org) and find the three-month Treasury bill secondary market rate. Download this file. What are the monthly returns, average monthly returns, and standard deviations for American Standard stock, the three-month Treasury bill, and the S&P 500 for this period?

2. Beta is often estimated by linear regression. A model often used is called the *market model,* which is:

$$R_t - R_{ft} = \alpha_i + \beta_i[R_{Mt} - R_{ft}] + \varepsilon_t$$

In this regression, R_t is the return on the stock and R_{ft} is the risk-free rate for the same period. R_{Mt} is the return on a stock market index such as the S&P 500 index. α_i is the regression intercept, and β_i is the slope (and the stock's estimated beta). ε_t represents the residuals for the regression. What do you think is the motivation for this particular regression? The intercept, α_i, is often called *Jensen's alpha.* What does it measure? If an asset has a positive Jensen's alpha, where would it plot with respect to the SML? What is the financial interpretation of the residuals in the regression?

3. Use the market model to estimate the beta for American Standard using the last 36 months of returns (the regression procedure in Excel is one easy way to do this). Plot the monthly returns on American Standard against the index and also show the fitted line.

4. When the beta of a stock is calculated using monthly returns, there is a debate over the number of months that should be used in the calculation. Rework the previous questions using the last 60 months of returns. How does this answer compare to what you calculated previously? What are some arguments for and against using shorter versus longer periods? Also, you've used monthly data, which are a common choice. You could have used daily, weekly, quarterly, or even annual data. What do you think are the issues here?

5. Compare your beta for American Standard to the beta you find on finance.yahoo.com. How similar are they? Why might they be different?