Risk and Return Lessons from Market History

CHAPTER

10

OPENING CASE

With the S&P 500 Index up about 23.5 percent and the NASDAQ stock market index up about 43.9 percent in 2009, stock market performance overall was well above average. Investors were particularly happy because of the market declines of 39 and 41 percent, respectively, in 2008. However, investors in Human Genome Sciences had to feel particularly happy about the 1,342 percent gain in that stock, and investors in mining company Teck Resources had to be pleased with the 611 percent gain in the price of that stock. Of course, not all stocks increased in value during the year. Stock in broadcast television company RHI Entertainment fell 96 percent during the year, and stock in Pacific Capital Bancorp dropped 94 percent. These examples show that there were tremendous potential profits to be made during 2009, but there was also the risk of losing money, and lots of it. So what should you, as a stock market investor, expect when you invest your own money? In this chapter, we study more than eight decades of market history to find out.

10.1 RETURNS

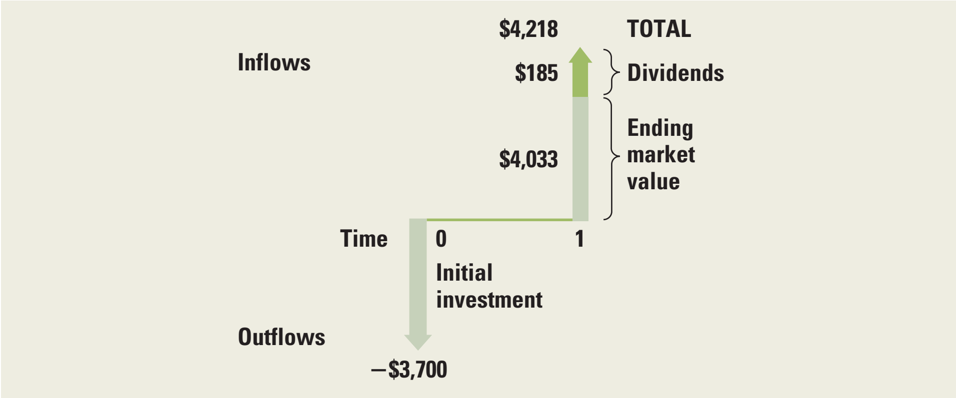
Dollar Returns

Suppose the Video Concept Company has several thousand shares of stock outstanding and you are a shareholder. Further suppose that you purchased some of the shares of stock in the company at the beginning of the year; it is now year-end and you want to figure out how well you have done on your investment. The return you get on an investment in stocks, like that in bonds or any other investment, comes in two forms.

First, over the year most companies pay dividends to shareholders. As the owner of stock in the Video Concept Company, you are a part owner of the company. If the company is profitable, it generally will distribute some of its profits to the shareholders. Therefore, as the owner of shares of stock, you will receive some cash, called a *dividend*, during the year. This cash is the *income component* of your return. In addition to the dividend, the other part of your return is the *capital gain*—or, if it is negative, the *capital loss* (negative capital gain)—on the investment.

How did the market do today? Find out at finance.yahoo.com.

FIGURE 10.1
Dollar Returns



For example, suppose we are considering the cash flows of the investment in Figure 10.1 and you purchased 100 shares of stock at the beginning of the year at a price of $37 per share. Your total investment, then, would be:

$$C_0 = \$37 \times 100 = \$3{,}700$$

Suppose that over the year the stock paid a dividend of $1.85 per share. During the year, then, you would have received income of:

$$\text{Div} = \$1.85 \times 100 = \$185$$

Suppose, lastly, that at the end of the year the market price of the stock is $40.33 per share. Because the stock increased in price, you have a capital gain of:

$$\text{Gain} = (\$40.33 - \$37) \times 100 = \$333$$

The capital gain, like the dividend, is part of the return that shareholders require to maintain their investment in the Video Concept Company. Of course, if the price of Video Concept stock had dropped in value to, say, $34.78, you would have recorded a capital loss of:

$$\text{Loss} = (\$34.78 - \$37) \times 100 = -\$222$$

The *total dollar return* on your investment is the sum of the dividend income and the capital gain or loss on the investment:

$$\text{Total dollar return} = \text{Dividend income} + \text{Capital gain (or loss)}$$

(From now on we will refer to *capital losses* as *negative capital gains* and not distinguish them.) In our first example, then, the total dollar return is given by:

$$\text{Total dollar return} = \$185 + \$333 = \$518$$

Notice that if you sold the stock at the end of the year, your total amount of cash would be the initial investment plus the total dollar return. In the preceding example, then, you would have:

$$\begin{aligned} \text{Total cash if stock is sold} &= \text{Initial investment} + \text{Total dollar return} \\ &= \$3{,}700 + \$518 \\ &= \$4{,}218 \end{aligned}$$

As a check, notice that this is the same as the proceeds from the sale of stock plus the dividends:

$$\begin{aligned} &\text{Proceeds from stock sale} + \text{Dividends} \\ &\quad = \$40.33 \times 100 + \$185 \\ &\quad = \$4{,}033 + \$185 \\ &\quad = \$4{,}218 \end{aligned}$$

Suppose, however, that you hold your Video Concept stock and don't sell it at year-end. Should you still consider the capital gain as part of your return? Does this violate our previous present value rule that only cash matters?

The answer to the first question is a strong yes, and the answer to the second question is an equally strong no. The capital gain is every bit as much a part of your return as is the dividend, and you should certainly count it as part of your total return. That you have decided to hold onto the stock and not sell or *realize* the gain or the loss in no way changes the fact that, if you want to, you could get the cash value of the stock. After all, you could always sell the stock at year-end and immediately buy it back. The total amount of cash you would have at year-end would be the \$518 gain plus your initial investment of \$3,700. You would not lose this return when you bought back 100 shares of stock. In fact, you would be in exactly the same position as if you had not sold the stock (assuming, of course, that there are no tax consequences and no brokerage commissions from selling the stock).

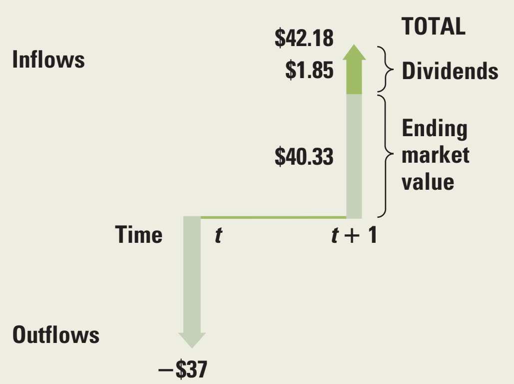
Percentage Returns

It is more convenient to summarize the information about returns in percentage terms than in dollars, because the percentages apply to any amount invested. The question we want to answer is: How much return do we get for each dollar invested? To find this out, let t stand for the year we are looking at, let P_t be the price of the stock at the beginning of the year, and let Div_{t+1} be the dividend paid on the stock during the year. Consider the cash flows in Figure 10.2.

In our example, the price at the beginning of the year was \$37 per share and the dividend paid during the year on each share was \$1.85. Hence the percentage income return, sometimes called the *dividend yield,* is:

Go to www.smartmoney.com/marketmap for a Java applet that shows today's returns by market sector.

$$\begin{aligned}\textbf{Dividend yield} &= \text{Div}_{t+1}/P_t \\ &= \$1.85/\$37 \\ &= .05 \\ &= 5\%\end{aligned}$$



$$\textbf{Percentage return} = \frac{\text{Dividends paid at end of period} + \text{Change in market value over period}}{\text{Beginning market value}}$$

$$\textbf{1 + Percentage return} = \frac{\text{Dividends paid at end of period} + \text{Market value at end of period}}{\text{Beginning market value}}$$

FIGURE 10.2
Percentage Returns

The **capital gain** (or loss) is the change in the price of the stock divided by the initial price. Letting P_{t+1} be the price of the stock at year-end, the capital gain can be computed:

$$
\begin{aligned}
\textbf{Capital gain} &= (P_{t+1} - P_t)/P_t \\
&= (\$40.33 - \$37)/\$37 \\
&= \$3.33/\$37 \\
&= .09 \\
&= 9\%
\end{aligned}
$$

Combining these two results, we find that the *total return* on the investment in Video Concept stock over the year, which we will label R_{t+1}, was:

$$
\begin{aligned}
R_{t+1} &= \frac{\text{Div}_{t+1}}{P_t} + \frac{(P_{t+1} - P_t)}{P_t} \\
&= 5\% + 9\% \\
&= 14\%
\end{aligned}
$$

From now on we will refer to returns in percentage terms.

To give a more concrete example, stock in consumer products giant Colgate-Palmolive began 2009 at $66.46 a share. The company paid dividends of $1.72 during 2009, and the stock price at year-end was $81.69. What was the return for the year? For practice, see if you agree that the answer is 25.50 percent. Of course, negative returns occur as well. For example, in 2009, oil company Sunoco's stock price at the beginning of the year was $41.61 per share, and dividends of $1.20 were paid. The stock ended the year at $25.95 per share. Verify that the loss was 34.75 percent for the year.

EXAMPLE 10.1

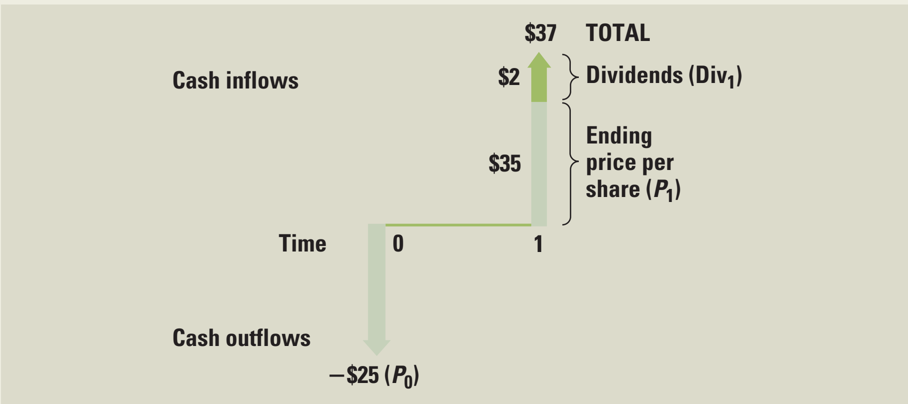
Calculating Returns

Suppose a stock begins the year with a price of $25 per share and ends with a price of $35 per share. During the year it paid a $2 dividend per share. What are its dividend yield, its capital gain, and its total return for the year? We can imagine the cash flows in Figure 10.3.

$$
\begin{aligned}
R_1 &= \frac{\text{Div}_1}{P_0} + \frac{P_1 - P_0}{P_0} \\
&= \frac{\$2}{\$25} + \frac{\$35 - 25}{\$25} = \frac{\$12}{\$25} \\
&= 8\% + 40\% = 48\%
\end{aligned}
$$

FIGURE 10.3

Cash Flow—An Investment Example



(*continued*)

Thus, the stock's dividend yield, its capital gain yield, and its total return are 8 percent, 40 percent, and 48 percent, respectively.

Suppose you had $5,000 invested. The total dollar return you would have received on an investment in the stock is $\$5{,}000 \times .48 = \$2{,}400$. If you know the total dollar return on the stock, you do not need to know how many shares you would have had to purchase to figure out how much money you would have made on the $5,000 investment. You just use the total dollar return.

10.2 HOLDING PERIOD RETURNS

A famous set of studies dealing with rates of return on common stocks, bonds, and Treasury bills was conducted by Roger Ibbotson and Rex Sinquefield.[1] They present year-by-year historical rates of return for the following five important types of financial instruments in the United States:

1. *Large-Company Common Stocks*. The common stock portfolio is based on the Standard & Poor's (S&P) composite index. At present, the S&P composite includes 500 of the largest (in terms of market value) stocks in the United States.
2. *Small-Company Common Stocks*. This is a portfolio corresponding to the bottom fifth of stocks traded on the New York Stock Exchange in which stocks are ranked by market value (i.e., the price of the stock multiplied by the number of shares outstanding).
3. *Long-Term Corporate Bonds*. This is a portfolio of high-quality corporate bonds with a 20-year maturity.
4. *Long-Term U.S. Government Bonds*. This is based on U.S. government bonds with a maturity of 20 years.
5. *U.S. Treasury Bills*. This is based on Treasury bills with a one-month maturity.

For more on market history, visit www.globalfinancialdata.com.

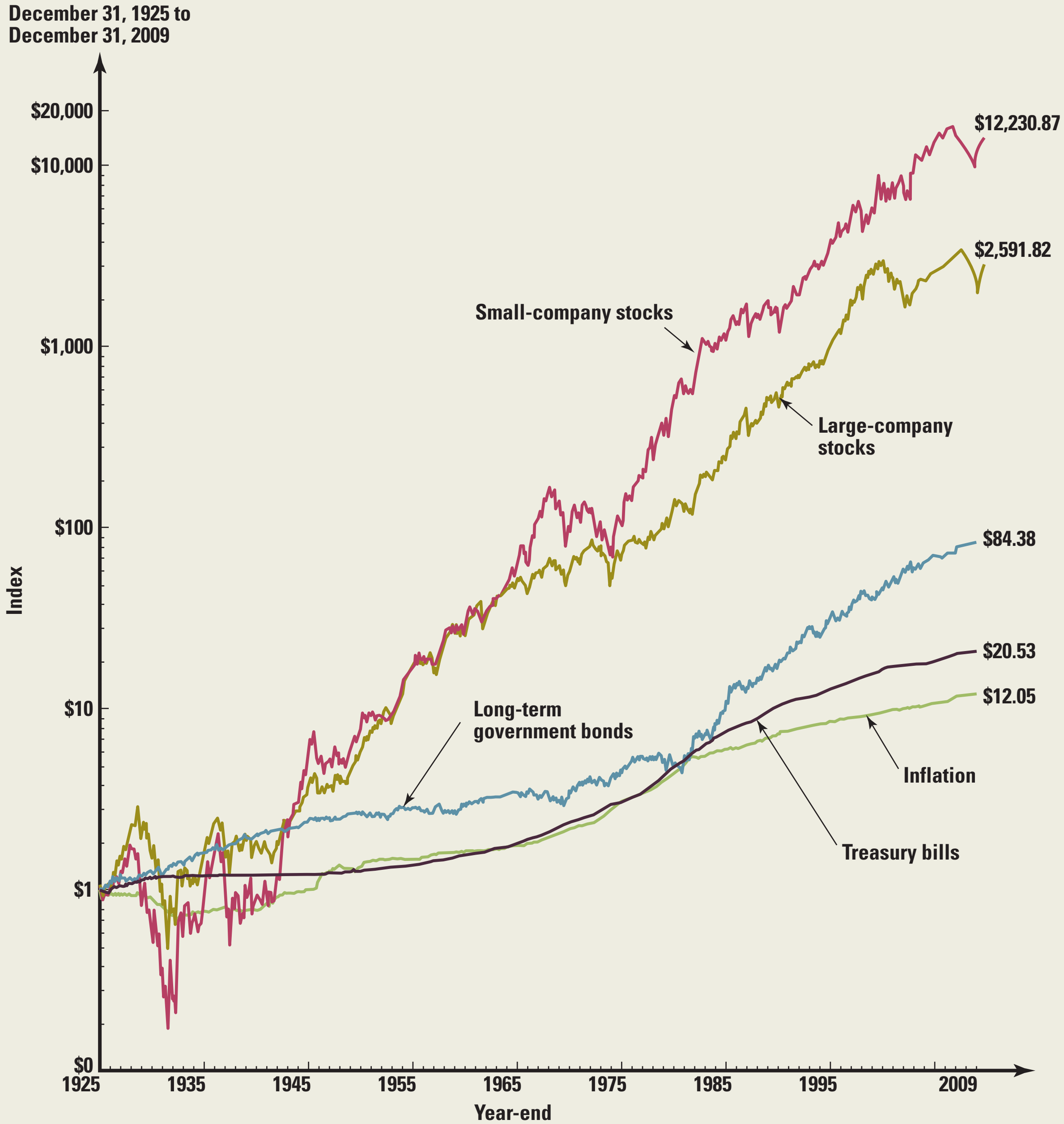
None of the returns are adjusted for taxes or transactions costs. In addition to the year-by-year returns on financial instruments, the year-to-year change in the consumer price index is computed. This is a basic measure of inflation. Year-by-year real returns can be calculated by subtracting annual inflation.

Before looking closely at the different portfolio returns, we graphically present the returns and risks available from U.S. capital markets in the 84-year period from 1926 to 2009. Figure 10.4 shows the growth of $1 invested at the beginning of 1926. Notice that the vertical axis is logarithmic, so that equal distances measure the same percentage change. The figure shows that if $1 were invested in large-company common stocks and all dividends were reinvested, the dollar would have grown to $2,591.82 by the end of 2009. The biggest growth was in the small stock portfolio. If $1 were invested in small stocks in 1926, the investment would have grown to $12,230.87. However, when you look carefully at Figure 10.4, you can see great variability in the returns on small stocks, especially in the earlier part of the period. A dollar in long-term government bonds was very stable as compared with a dollar in common stocks. Figures 10.5 to 10.8 plot each year-to-year

[1]The most recent update of this work is *Stocks, Bonds, Bills and Inflation: 2010 Yearbook*™ (Chicago: Morningstar). All rights reserved.

FIGURE 10.4

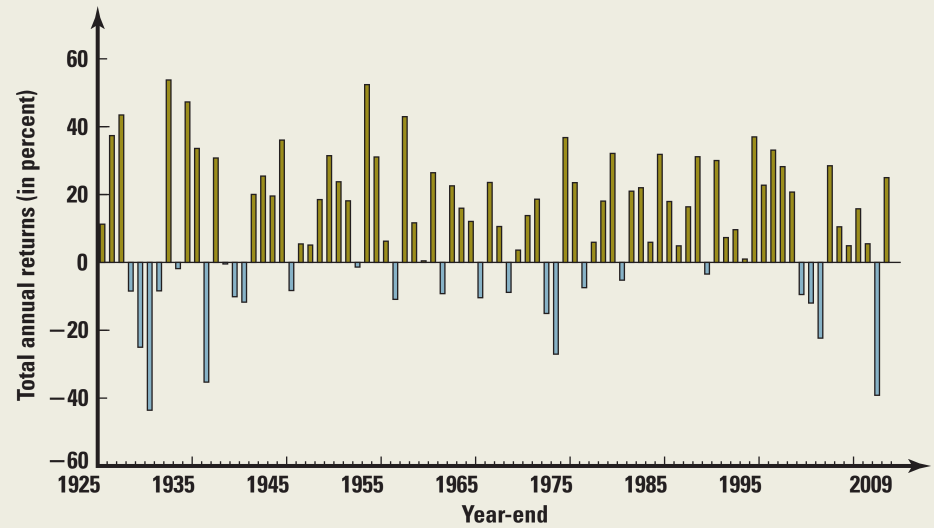
Wealth Indexes of Investments in the U.S. Capital Markets (Year-End 1925 = $1.00)



Redrawn from ***Stocks, Bonds, Bills and Inflation: 2010 Yearbook,*™ annual updates work by Roger G. Ibbotson and Rex A. Sinquefield (Chicago: Morningstar). All rights reserved.**

percentage return as a vertical bar drawn from the horizontal axis for large-company common stocks, small-company stocks, long-term government bonds and Treasury bills, and inflation, respectively.

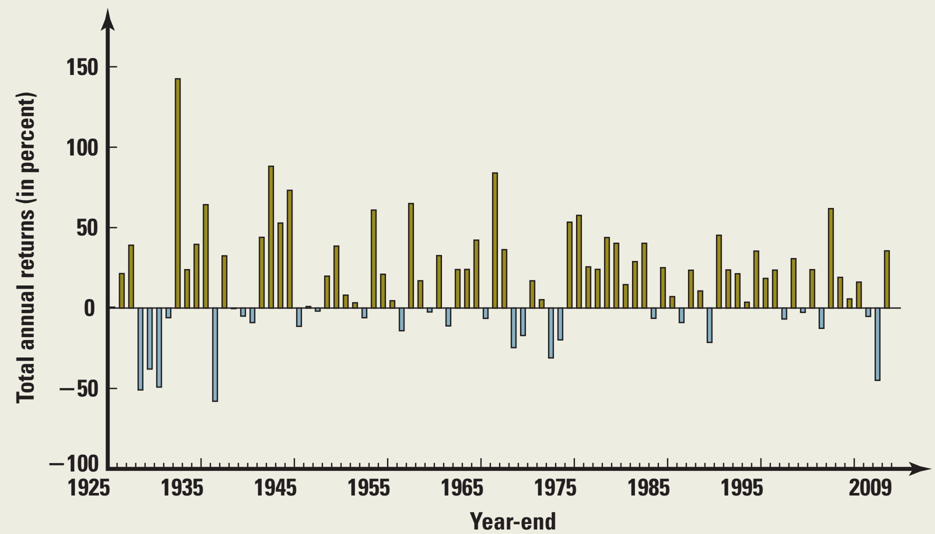
Figure 10.4 gives the growth of a dollar investment in the stock market from 1926 through 2009. In other words, it shows what the worth of the investment would have been if



Redrawn from *Stocks, Bonds, Bills and Inflation: 2010 Yearbook,*™ annual updates work by Roger G. Ibbotson and Rex A. Sinquefield (Chicago: Morningstar). All rights reserved.

FIGURE 10.5

Year-by-Year Total Returns on Large-Company Common Stocks



Redrawn from *Stocks, Bonds, Bills and Inflation: 2010 Yearbook,*™ annual updates work by Roger G. Ibbotson and Rex A. Sinquefield (Chicago: Morningstar). All rights reserved.

FIGURE 10.6

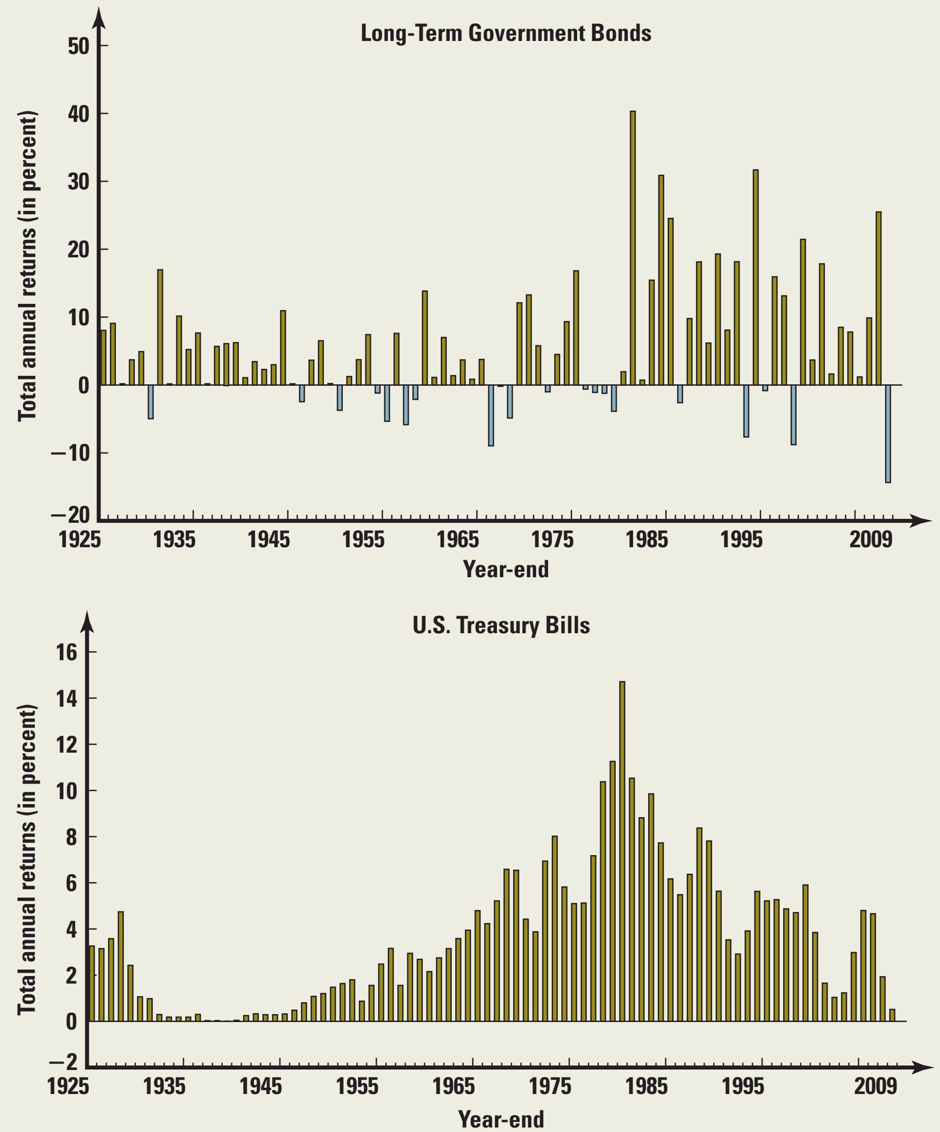
Year-by-Year Total Returns on Small-Company Stocks

the dollar had been left in the stock market and if each year the dividends from the previous year had been reinvested in more stock. If R_t is the return in year t (expressed in decimals), the value you would have at the end of year T is the product of 1 plus the return in each of the years:

$$(1 + R_1) \times (1 + R_2) \times \cdots \times (1 + R_t) \times \cdots \times (1 + R_T)$$

FIGURE 10.7

Year-by-Year Total Returns on Bonds and Bills



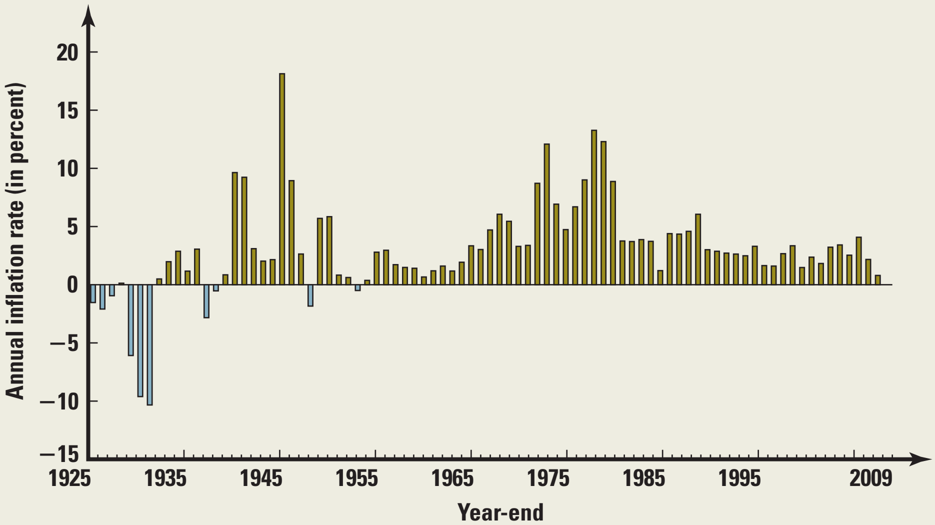
Redrawn from *Stocks, Bonds, Bills and Inflation: 2010 Yearbook,*™ annual updates work by Roger G. Ibbotson and Rex A. Sinquefield (Chicago: Morningstar). All rights reserved.

Go to bigcharts.marketwatch.com to see both intraday and long-term charts.

For example, if the returns were 11 percent, −5 percent, and 9 percent in a three-year period, an investment of $1 at the beginning of the period would be worth:

$$
\begin{aligned}
\$1 \times (1 + R_1) \times (1 + R_2) \times (1 + R_3) &= (1 + .11) \times (1 - .05) \times (1 + .09) \\
&= 1.11 \times .95 \times 1.09 \\
&= \$1.15
\end{aligned}
$$

at the end of the three years. Notice that .15 or 15 percent is the total return and that it includes the return from reinvesting the first-year dividends in the stock market for two more years and reinvesting the second-year dividends for the final year. The 15 percent is called a three-year **holding period return**. Table 10.1 gives the annual returns each year for selected investments from 1926 to 2009. From this table, you can determine holding period returns for any combination of years.



Redrawn from *Stocks, Bonds, Bills and Inflation: 2010 Yearbook,*™ annual updates work by Roger G. Ibbotson and Rex A. Sinquefield (Chicago: Morningstar). All rights reserved.

FIGURE 10.8

Year-by-Year Inflation

TABLE 10.1

Year-by-Year Total Returns, 1926–2009

Source: Global Financial Data (www.globalfinancialdata.com) copyright 2010.

YEAR	LARGE-COMPANY STOCKS	LONG-TERM GOVERNMENT BONDS	U.S. TREASURY BILLS	CONSUMER PRICE INDEX
1926	11.14%	7.90%	3.30%	−1.12%
1927	37.13	10.36	3.15	−2.26
1928	43.31	−1.37	4.05	−1.16
1929	−8.91	5.23	4.47	0.58
1930	−25.26	5.80	2.27	−6.40
1931	−43.86	−8.04	1.15	−9.32
1932	−8.85	14.11	0.88	−10.27
1933	52.88	0.31	0.52	0.76
1934	−2.34	12.98	0.27	1.52
1935	47.22	5.88	0.17	2.99
1936	32.80	8.22	0.17	1.45
1937	−35.26	−0.13	0.27	2.86
1938	33.20	6.26	0.06	−2.78
1939	−0.91	5.71	0.04	0.00
1940	−10.08	10.34	0.04	0.71
1941	−11.77	−8.66	0.14	9.93
1942	21.07	2.67	0.34	9.03
1943	25.76	2.50	0.38	2.96
1944	19.69	2.88	0.38	2.30
1945	36.46	5.17	0.38	2.25
1946	−8.18	4.07	0.38	18.13
1947	5.24	−1.15	0.62	8.84
1948	5.10	2.10	1.06	2.99
1949	18.06	7.02	1.12	−2.07

(*continued*)

TABLE 10.1
Year-by-Year Total Returns, 1926–2009 (*continued*)

YEAR	LARGE-COMPANY STOCKS	LONG-TERM GOVERNMENT BONDS	U.S. TREASURY BILLS	CONSUMER PRICE INDEX
1950	30.58%	−1.44%	1.22%	5.93%
1951	24.55	−3.53	1.56	6.00
1952	18.50	1.82	1.75	0.75
1953	−1.10	−0.88	1.87	0.75
1954	52.40	7.89	0.93	−0.74
1955	31.43	−1.03	1.80	0.37
1956	6.63	−3.14	2.66	2.99
1957	−10.85	5.25	3.28	2.90
1958	43.34	−6.70	1.71	1.76
1959	11.90	−1.35	3.48	1.73
1960	0.48	7.74	2.81	1.36
1961	26.81	3.02	2.40	0.67
1962	−8.78	4.63	2.82	1.33
1963	22.69	1.37	3.23	1.64
1964	16.36	4.43	3.62	0.97
1965	12.36	1.40	4.06	1.92
1966	−10.10	−1.61	4.94	3.46
1967	23.94	−6.38	4.39	3.04
1968	11.00	5.33	5.49	4.72
1969	−8.47	−7.45	6.90	6.20
1970	3.94	12.24	6.50	5.57
1971	14.30	12.67	4.36	3.27
1972	18.99	9.15	4.23	3.41
1973	−14.69	−12.66	7.29	8.71
1974	−26.47	−3.28	7.99	12.34
1975	37.23	4.67	5.87	6.94
1976	23.93	18.34	5.07	4.86
1977	−7.16	2.31	5.45	6.70
1978	6.57	−2.07	7.64	9.02
1979	18.61	−2.76	10.56	13.29
1980	32.50	−5.91	12.10	12.52
1981	−4.92	−0.16	14.60	8.92
1982	21.55	49.99	10.94	3.83
1983	22.56	−2.11	8.99	3.79
1984	6.27	16.53	9.90	3.95
1985	31.73	39.03	7.71	3.80
1986	18.67	32.51	6.09	1.10
1987	5.25	−8.09	5.88	4.43
1988	16.61	8.71	6.94	4.42
1989	31.69	22.15	8.44	4.65
1990	−3.10	5.44	7.69	6.11
1991	30.46	20.04	5.43	3.06
1992	7.62	8.09	3.48	2.90
1993	10.08	22.32	3.03	2.75
1994	1.32	−11.46	4.39	2.67
1995	37.58	37.28	5.61	2.54
1996	22.96	−2.59	5.14	3.32

(*continued*)

YEAR	LARGE-COMPANY STOCKS	LONG-TERM GOVERNMENT BONDS	U.S. TREASURY BILLS	CONSUMER PRICE INDEX
1997	33.36	17.70	5.19	1.70
1998	28.58	19.22	4.86	1.61
1999	21.04	−12.76	4.80	2.68
2000	− 9.10	22.16	5.98	3.39
2001	−11.89	5.30	3.33	1.55
2002	−22.10	14.08	1.61	2.38
2003	28.68	1.62	1.03	1.88
2004	10.88	10.34	1.43	3.26
2005	4.91	10.35	3.30	3.42
2006	15.79	0.28	4.97	2.54
2007	5.49	10.85	4.52	4.08
2008	−37.00	19.24	1.24	.09
2009	26.46	− 9.49	0.15	2.72

TABLE 10.1

Year-by-Year Total Returns, 1926–2009 (*concluded*)

10.3 RETURN STATISTICS

The history of capital market returns is too complicated to be handled in its undigested form. To use the history, we must first find some manageable ways of describing it, dramatically condensing the detailed data into a few simple statements.

This is where two important numbers summarizing the history come in. The first and most natural number is some single measure that best describes the past annual returns on the stock market. In other words, what is our best estimate of the return that an investor could have realized in a particular year over the 1926 to 2009 period? This is the *average return*.

Figure 10.9 plots the histogram of the yearly stock market returns. This plot is the **frequency distribution** of the numbers. The height of the graph gives the number of sample observations in the range on the horizontal axis.

Given a frequency distribution like that in Figure 10.9, we can calculate the **average**, or **mean**, of the distribution. To compute the average of the distribution, we add up all of the values and divide by the total (T) number (84 in our case because we have 84 years of data). The bar over the R is used to represent the mean, and the formula is the ordinary formula for the average:

$$\textbf{Mean} = \bar{R} = \frac{(R_1 + \cdots + R_T)}{T}$$

The mean return of the large-company stocks from 1926 to 2009 is 11.8 percent.

EXAMPLE 10.2

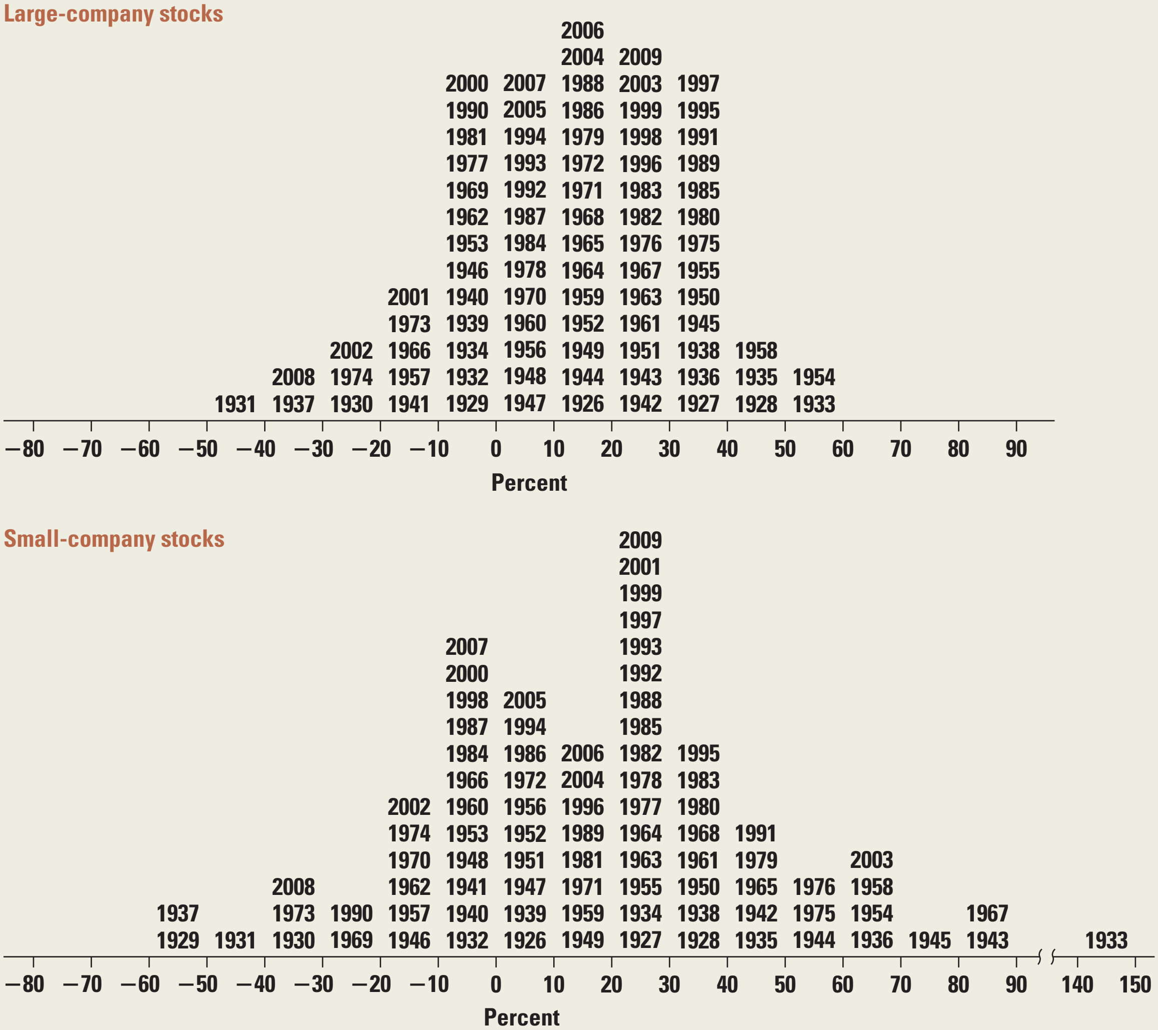
Calculating Average Returns

Suppose the returns on common stock over a four-year period are .1370, .3580, .4514, and −.0888, respectively. The average, or mean, return over these four years is:

$$\bar{R} = \frac{.1370 + .3580 + .4514 - .0888}{4} = .2144 \text{ or } 21.44\%$$

FIGURE 10.9

Histogram of Returns on Common Stocks, 1926–2009



Redrawn from ***Stocks, Bonds, Bills and Inflation: 2010 Yearbook,*™** annual updates work by Roger G. Ibbotson and Rex A. Sinquefield (Chicago: Morningstar). All rights reserved.

10.4 AVERAGE STOCK RETURNS AND RISK-FREE RETURNS

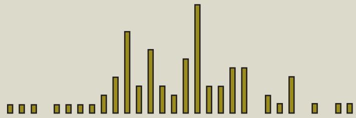
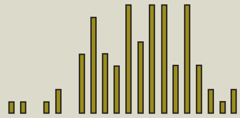
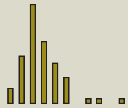
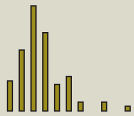
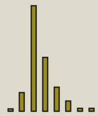
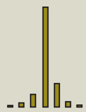
Now that we have computed the average return on the stock market, it seems sensible to compare it with the returns on other securities. The most obvious comparison is with the low-variability returns in the government bond market. These are free of most of the volatility we see in the stock market.

The government borrows money by issuing bonds, which the investing public holds. As we discussed in an earlier chapter, these bonds come in many forms, and the ones we will look at here are called *Treasury bills*, or *T-bills*. Once a week the government sells some bills at an auction. A typical bill is a pure discount bond that will mature in a year or less. Because the government can raise taxes to pay for the debt it incurs—a trick that many of

TABLE 10.2

Total Annual Returns, 1926–2009

Source: Modified from *Stocks, Bonds, Bills and Inflation: 2010 Yearbook,*™ annual updates work by Roger G. Ibbotson and Rex A. Sinquefield (Chicago: Morningstar).

SERIES	AVERAGE RETURN	STANDARD DEVIATION	DISTRIBUTION
Small-company stocks	16.6%	32.8%	 *
Large-company stocks	11.8	20.5	
Long-term corporate bonds	6.2	8.3	
Long-term government bonds	5.8	9.6	
Intermediate-term government bonds	5.5	5.7	
U.S. Treasury bills	3.7	3.1	
Inflation	3.1	4.2	

*The 1933 small-company stock total return was 142.9 percent.

us would like to be able to perform—this debt is virtually free of the risk of default. Thus we will call this the *risk-free return* over a short time (one year or less).

An interesting comparison, then, is between the virtually risk-free return on T-bills and the very risky return on common stocks. This difference between risky returns and risk-free returns is often called the *excess return on the risky asset*. It is called *excess* because it is the additional return resulting from the riskiness of common stocks and is interpreted as an equity **risk premium**.

Table 10.2 shows the average stock return, bond return, T-bill return, and inflation rate for the period from 1926 through 2009. From this we can derive excess returns. The average excess return from large-company common stocks for the entire period was 8.1 percent (11.8 percent − 3.7 percent).

One of the most significant observations of stock market data is this long-run excess of the stock return over the risk-free return. An investor for this period was rewarded for investment in the stock market with an extra or excess return over what would have been achieved by simply investing in T-bills.

Why was there such a reward? Does it mean that it never pays to invest in T-bills and that someone who invested in them instead of in the stock market needs a course in finance? A complete answer to these questions lies at the heart of modern finance, and Chapter 11 is devoted entirely to this. However, part of the answer can be found in the variability of the various types of investments. We see in Table 10.1 many years when an investment in T-bills achieved higher returns than an investment in large-company common stocks. Also, we note that the returns from an investment in common stocks are frequently negative whereas an investment in T-bills never produces a negative return. So, we now turn our attention to measuring the variability of returns and an introductory discussion of risk.

We first look more closely at Table 10.2. We see that the standard deviation of T-bills is substantially less than that of common stocks. This suggests that the risk of T-bills is less than that of common stocks. Because the answer turns on the riskiness of investments in common stock, we next turn our attention to measuring this risk.

10.5 RISK STATISTICS

For an easy-to-read review of basic stats, check out www.robertniles.com/stats.

The second number that we use to characterize the distribution of returns is a measure of the risk in returns. There is no universally agreed-upon definition of risk. One way to think about the risk of returns on common stock is in terms of how spread out the frequency distributions in Figure 10.9 are. The spread, or dispersion, of a distribution is a measure of how much a particular return can deviate from the mean return. If the distribution is very spread out, the returns that will occur are very uncertain. By contrast, a distribution whose returns are all within a few percentage points of each other is tight, and the returns are less uncertain. The measures of risk we will discuss are variance and standard deviation.

Variance

The **variance** and its square root, the **standard deviation**, are the most common measures of variability or dispersion. We will use Var and σ^2 to denote the variance and SD and σ to represent the standard deviation. σ is, of course, the Greek letter sigma.

EXAMPLE 10.3

Volatility

Suppose the returns on common stocks over a four-year period are (in decimals) .1370, .3580, .4514, and −.0888, respectively. The variance of this sample is computed as:

$$\text{Var} = \frac{1}{T-1}[(R_1 - \overline{R})^2 + (R^2 - \overline{R})^2 + (R_3 - \overline{R})^2 + (R_4 - \overline{R})^2]$$

$$.0582 = \frac{1}{3}[(.1370 - .2144)^2 + (.3580 - .2144)^2$$
$$+ (.4514 - .2144)^2 + (-.0888 - .2144)^2]$$

$$\text{SD} = \sqrt{.0582} = .2413 \text{ or } 24.13\%$$

This formula tells us just what to do: Take the T individual returns ($R_1, R_2, \ldots$) and subtract the average return $\overline{R}$, square the result, and add them up. Finally, this total must be divided by the number of returns less one ($T - 1$). The standard deviation is always just the square root of the variance.

Using the stock returns for the 84-year period from 1926 through 2009 in the above formula, the resulting standard deviation of large-company stock returns is 20.5 percent. The standard deviation is the standard statistical measure of the spread of a sample, and it will be the measure we use most of the time. Its interpretation is facilitated by a discussion of the normal distribution.

Standard deviations are widely reported for mutual funds. For example, the Fidelity Magellan Fund is one of the largest mutual funds in the United States. How volatile is it? To find out, we went to www.morningstar.com, entered the ticker symbol FMAGX, and hit the "Risk/Measures" link. Here is what we found:

Volatility Measurements	Trailing 3-Yr through 02-28-10 | *Trailing 5-Yr through 02-28-10		
Standard Deviation	26.46	Sharpe Ratio	-0.17
Mean	-2.76	Bear Market Decile Rank*	---

Modern Portfolio Theory Statistics		Trailing 3-Yr through 02-28-10
	Standard Index S&P 500 TR	Best Fit Index Russell Mid Cap Growth TR USD
R-Squared	90	97
Beta	1.25	1.06
Alpha	2.44	-1.29

Over the last three years, the standard deviation of the return on the Fidelity Magellan Fund was 26.46 percent. When you consider the average stock has a standard deviation of about 50 percent, this seems like a low number, but the Magellan Fund is a relatively well-diversified portfolio, so this is an illustration of the power of diversification, a subject we will discuss in detail later. The mean is the average return, so, over the last three years, investors in the Magellan Fund lost a 2.76 percent return per year. Also under the Volatility Measurements section, you will see the Sharpe ratio. The Sharpe ratio is calculated as the risk premium of the asset divided by the standard deviation. As such, it is a measure of return to the level of risk taken (as measured by standard deviation). This ratio is −0.17 for the period covered. The "beta" for the Fidelity Magellan Fund is 1.25. We will have more to say about this number—lots more—in the next chapter.

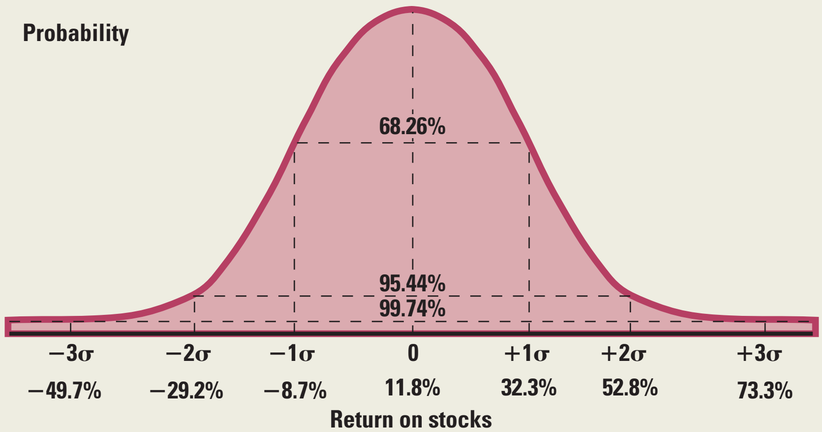
Normal Distribution and Its Implications for Standard Deviation

A large enough sample drawn from a **normal distribution** looks like the bell-shaped curve drawn in Figure 10.10. As you can see, this distribution is *symmetric* about its mean, not *skewed*, and has a much cleaner shape than the actual distributions of yearly returns drawn in Figure 10.9. Of course, if we had been able to observe stock market returns for 1,000 years, we might have filled in a lot of the jumps and jerks in Figure 10.9 and had a smoother curve.

In classical statistics, the normal distribution plays a central role, and the standard deviation is the usual way to represent the spread of a normal distribution. For the normal distribution, the probability of having a return that is above or below the mean by a certain amount depends only on the standard deviation. For example, the probability of having a return that is within one standard deviation of the mean of the distribution is approximately .68, or 2/3, and the probability of having a return that is within two standard deviations of the mean is approximately .95.

FIGURE 10.10

The Normal Distribution



In the case of a normal distribution, there is a 68.26 percent probability that a return will be within one standard deviation of the mean. In this example, there is a 68.26 percent probability that a yearly return will be between −8.7 percent and 32.3 percent.

There is a 95.44 percent probability that a return will be within two standard deviations of the mean. In this example, there is a 95.44 percent probability that a yearly return will be between −29.2 percent and 52.8 percent.

Finally, there is a 99.74 percent probability that a return will be within three standard deviations of the mean. In this example, there is a 99.74 percent probability that a yearly return will be between −49.7 percent and 73.3 percent.

The 20.5 percent standard deviation we found for large-company stock returns from 1926 through 2009 can now be interpreted in the following way: If stock returns are roughly normally distributed, the probability that a yearly return will fall within 20.5 percent of the mean of 11.8 percent will be approximately 2/3. That is, about 2/3 of the yearly returns will be between −8.7 percent and 32.3 percent. (Note that −8.7% = 11.8% − 20.5% and 32.3% = 11.8% + 20.5%.) The probability that the return in any year will fall within two standard deviations is about .95. That is, about 95 percent of yearly returns will be between −29.2 percent and 52.8 percent.

10.6 THE U.S. EQUITY RISK PREMIUM: HISTORICAL AND INTERNATIONAL PERSPECTIVES

So far, in this chapter, we have studied the United States in the period from 1926 to 2009. As we have discussed, the historical U.S. stock market risk premium has been substantial. Of course, anytime we use the past to predict the future, there is a danger that the past period isn't representative of what the future will hold. Perhaps U.S. investors got lucky over this period and earned particularly large returns. Data from earlier years for the United States is available, though it is not of the same quality. With that caveat in mind, researchers have tracked returns back to 1802, and the U.S. equity risk premium in the pre-1926 era was smaller. Using the U.S. return data from 1802, the historical equity risk premium was 5.2 percent.[2]

[2]Jeremy J. Seigel has estimated the U.S. equity risk premium with data from 1802. As can be seen in the following table, from 1802 to 2008 the historical equity risk premium was 5.2 percent, or:

	AVERAGE RETURNS 1802–2008 (%)
Common stock	9.5
Treasury bills	4.3
Equity risk premium	5.2

Adopted and updated from J. Seigel, *Stocks for the Long Run,* 4th ed. (New York: McGraw-Hill, 2008).

COUNTRY	$ IN TRILLIONS	PERCENT
United States	$10.1	45%
Europe (excluding U.K.)	5.4	24
Japan	3.1	14
United Kingdom	1.8	8
Pacific (excluding Japan)	1.1	5
Canada	.9	4
	$22.4	100%

TABLE 10.3

World Stock Market Capitalization, 2008

Source: *Ibbotson SBBI 2009 Classic Yearbook,* Morningstar, p. 216.

COUNTRY	HISTORICAL EQUITY RISK PREMIUMS (%) (1)	STANDARD DEVIATION (%) (2)	THE SHARPE RATIO (1)/(2)
Australia	8.49%	17.00%	.50
Belgium	4.99	23.06	.22
Canada	5.88	16.71	.35
Denmark	4.51	19.85	.23
France	9.27	24.19	.38
Germany*	9.07	33.49	.27
Ireland	5.98	20.33	.29
Italy	10.46	32.09	.33
Japan	9.84	27.82	.35
Netherlands	6.61	22.36	.30
Norway	5.70	25.90	.22
South Africa	8.25	22.09	.37
Spain	5.46	21.45	.25
Sweden	7.98	22.09	.36
Switzerland	5.29	18.79	.28
United Kingdom	6.14	19.84	.31
United States	7.41	19.64	.38
Average	**7.14**	**22.75**	**.31**

*Germany omits 1922–1923.

TABLE 10.4

Annualized Equity Risk Premiums and Sharpe Ratios for 17 Countries, 1900–2005

Source: Elroy Dimson, Paul Marsh, and Michael Staunton, "The Worldwide Equity Premium: A Smaller Puzzle," in *Handbook of the Equity Risk Premium,* Rajnish Mehra, ed. (Elsevier, 2007).

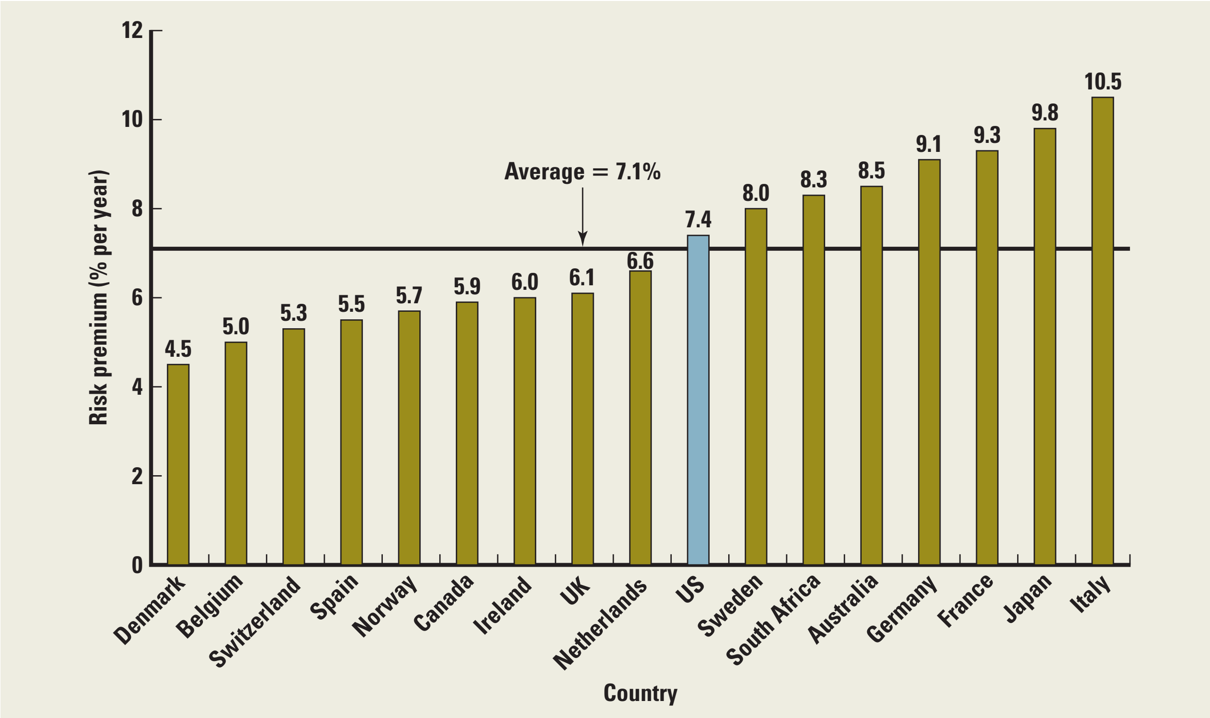
Also, we have not looked at other major countries. Actually, more than half of the value of tradable stock is not in the United States. From Table 10.3, we can see that while the total world stock market capitalization was $22.4 trillion in 2008, only about 45 percent was in the United States. Thanks to Dimson, Marsh, and Staunton, data from earlier periods and other countries are now available to help us take a closer look at equity risk premiums. Table 10.4 and Figure 10.11 show the historical stock market risk premiums for 17 countries around the world in the period from 1900 to 2005. Looking at the numbers, the U.S. historical equity risk premium is the 8th highest at 7.4 percent (which differs from our earlier estimate because of the different time periods examined). The overall world average risk premium is 7.1 percent. It seems clear that U.S. investors did well, but not exceptionally so relative to many other countries. The top-performing countries according to the Sharpe ratio were the United States, Australia, and France, while the worst performers were Belgium, Norway, and Denmark. Germany, Japan, and Italy might make an interesting case study because they have the highest stock returns over this period (despite World Wars I and II), but also the highest risk.

So what is a good estimate of the U.S. equity risk premium going forward? Unfortunately, nobody can know for sure what investors expect in the future. If history is a guide,

FIGURE 10.11

Stock Market Risk Premiums for 17 Countries: 1900–2005

Source: Elroy Dimson, Paul Marsh, and Michael Staunton, "The Worldwide Equity Premium: A Smaller Puzzle," in *Handbook of the Equity Risk Premium*, Rajnish Mehra, ed. (Elsevier, 2007).



the expected U.S. equity risk premium could be 7.4 percent based upon estimates from 1900–2005. We should also be mindful that the average world equity risk premium was 7.1 percent over this same period. On the other hand, the more recent periods (1926–2008) suggest higher estimates of the U.S. equity risk premium, and earlier periods going back to 1802 suggest lower estimates.

The standard error (SE) helps with the issue of how much confidence we can have in our historical average of 7.4 percent. The SE is the standard deviation of the historical risk premium and is given the following formula:

$$\text{SE} = \text{SD}(\bar{R}) = \frac{\text{SD}(R)}{\sqrt{\text{The number of observations}}}$$

If we assume that the distribution of returns is normal and that each year's return is independent of all the others, we know there is a 95.4 percent probability that the true mean return is within two standard errors of the historical average.

More specifically, the 95.4 percent confidence interval for the true equity risk premium is the historical average return ± (2 × standard error). From 1900 to 2005, the historical equity risk premium of U.S. stocks was 7.4 percent and the standard deviation was 19.6 percent. Therefore 95.4 percent of the time the true equity risk premium should be within 3.6 and 11.2 percent:

$$7.4 \pm 2\left(\frac{19.6\%}{\sqrt{106}}\right) = 7.4 \pm 2\left(\frac{19.6}{10.3}\right) = 7.4 \pm 3.8$$

In other words, we can be 95.4 percent confident that our estimate of the U.S. equity risk premium from historical data is in the range from 3.6 percent to 11.2 percent.

Taking a slightly different approach, Ivo Welch asked the opinions of 226 financial economists regarding the future U.S. equity risk premium, and the median response was 7 percent.[3]

We are comfortable with an estimate based on the historical U.S. equity risk premium of about 7 percent, but estimates of the future U.S. equity risk premium that are somewhat higher or lower could be reasonable if we have good reason to believe the past is not representative of the future.[4] The bottom line is that any estimate of the future equity risk premium will involve assumptions about the future risk environment as well as the amount of risk aversion of future investors.

10.7 2008: A YEAR OF FINANCIAL CRISIS

2008 entered the record books as one of the worst years for stock market investors in U.S. history. How bad was it? The widely followed S&P 500 Index, which tracks the total market value of 500 of the largest U.S. corporations, decreased 37 percent for the year. Of the 500 stocks in the index, 485 were down for the year.

Over the period 1926–2008, only the year 1931 had a lower return than 2008 (−43 percent versus −37 percent). Making matters worse, the downdraft continued with a further decline of 25.1 percent through March 9, 2009. In all, from November 2007 (when the decline began) through March 9, 2009, the S&P 500 lost 56.8 percent of its value. Fortunately for investors, things turned around dramatically for the rest of the year. From March 9, 2009, to December 31, 2009, the market gained about 65 percent!

Figure 10.12 shows the month-by-month performance of the S&P 500 decline during 2008. As indicated, returns were negative in eight of the twelve months. Most of the decline occurred in the fall, with investors losing almost 17 percent in October alone. Small stocks fared no better. They also fell 37 percent for the year (with a 21 percent drop in October), their worst performance since losing 58 percent in 1937.

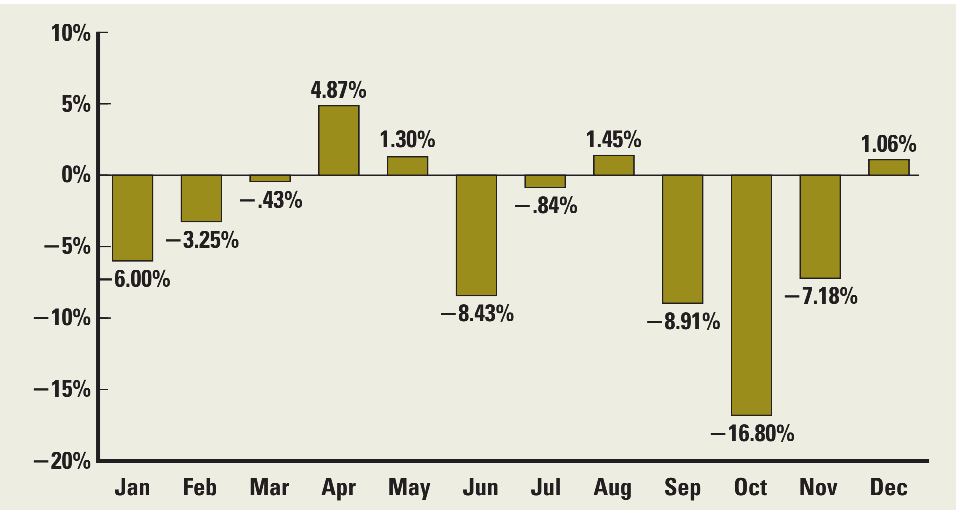


FIGURE 10.12
S&P 500 Monthly Returns, 2008

[3]For example, see I. Welch, "Views of Financial Economists on the Equity Risk Premium and Other Issues," *Journal of Business*, 73 (2000), pp. 501–537.

[4]In Elroy Dimson, Paul Marsh, and Mike Staunton, "The Worldwide Equity Premium: A Smaller Puzzle," from *Handbook of the Equity Risk Premium*, R. Mehra, ed., the authors argue that a good estimate of the world equity risk premium going forward should be about 5 percent, largely because of nonrecurring factors that positively affected worldwide historical returns. However, it could be argued that the global financial crisis of 2008–2009 was a negative shock to the stock market that has increased the equity risk premium from its historical levels.

As Figure 10.12 suggests, stock prices were highly volatile at the end the year—more than has been generally true historically. Oddly, the S&P had 126 up days and 126 down days (remember the markets are closed weekends and holidays). Of course, the down days were much worse on average.

The drop in stock prices was a global phenomenon, and many of the world's major markets declined by much more than the S&P. China, India, and Russia, for example, all experienced declines of more than 50 percent. Tiny Iceland saw share prices drop by more than 90 percent for the year. Trading on the Icelandic exchange was temporarily suspended on October 9. In what has to be a modern record for a single day, stocks fell by 76 percent when trading resumed on October 14.

Did any types of securities perform well in 2008? The answer is yes because, as stock values declined, bond values increased, particularly U.S. Treasury bonds. In fact, long-term Treasury bonds *gained* 20 percent, while shorter-term Treasury bonds were up 13 percent. Higher quality long-term corporate bonds did less well, but still managed to achieve a positive return of about 9 percent. These returns were especially impressive considering that the rate of inflation, as measured by the CPI, was very close to zero.

What lessons should investors take away from this very recent bit of capital market history? First, and most obviously, stocks have significant risk! But there is a second, equally important lesson. Depending on the mix, a diversified portfolio of stocks and bonds probably would have suffered in 2008, but the losses would have been much smaller than those experienced by an all-stock portfolio. Finally, because of increased volatility and heightened risk aversion, many have argued that the equity risk premium going forword is probably (at least temporarily) somewhat higher than has been true historically.

10.8 MORE ON AVERAGE RETURNS

Thus far in this chapter, we have looked closely at simple average returns. But there is another way of computing an average return. The fact that average returns are calculated two different ways leads to some confusion, so our goal in this section is to explain the two approaches and also the circumstances under which each is appropriate.

Arithmetic versus Geometric Averages

Let's start with a simple example. Suppose you buy a particular stock for $100. Unfortunately, the first year you own it, it falls to $50. The second year you own it, it rises back to $100, leaving you where you started (no dividends were paid).

What was your average return on this investment? Common sense seems to say that your average return must be exactly zero since you started with $100 and ended with $100. But if we calculate the returns year-by-year, we see that you lost 50 percent the first year (you lost half of your money). The second year, you made 100 percent (you doubled your money). Your average return over the two years was thus (−50 percent + 100 percent)/2 = 25 percent!

So which is correct, 0 percent or 25 percent? The answer is that both are correct; they just answer different questions. The 0 percent is called the **geometric average return**. The 25 percent is called the **arithmetic average return**. The geometric average return answers the question, *"What was your average compound return per year over a particular period?"* The arithmetic average return answers the question, *"What was your return in an average year over a particular period?"*

Notice that, in previous sections, the average returns we calculated were all arithmetic averages, so we already know how to calculate them. What we need to do now is (1) learn how to calculate geometric averages and (2) learn the circumstances under which one average is more meaningful than the other.

Calculating Geometric Average Returns

First, to illustrate how we calculate a geometric average return, suppose a particular investment had annual returns of 10 percent, 12 percent, 3 percent, and −9 percent over the last four years. The geometric average return over this four-year period is calculated as $(1.10 \times 1.12 \times 1.03 \times .91)^{1/4} - 1 = 3.66$ percent. In contrast, the average arithmetic return we have been calculating is $(.10 + .12 + .03 - .09)/4 = 4.0$ percent.

In general, if we have T years of returns, the geometric average return over these T years is calculated using this formula:

$$\textbf{Geometric average return} = [(1 + R_1) \times (1 + R_2) \times \cdots \times (1 + R_T)]^{1/T} - 1 \qquad [10.1]$$

This formula tells us that four steps are required:

1. Take each of the T annual returns $R_1, R_2, \ldots, R_T$ and add 1 to each (after converting them to decimals!).
2. Multiply all the numbers from step 1 together.
3. Take the result from step 2 and raise it to the power of $1/T$.
4. Finally, subtract 1 from the result of step 3. The result is the geometric average return.

EXAMPLE 10.4

Calculating the Geometric Average Return

Calculate the geometric average return for S&P 500 large-cap stocks for a five-year period using the numbers given here.

First, convert percentages to decimal returns, add 1, and then calculate their product:

S&P 500 RETURNS	PRODUCT
13.75%	1.1375
35.70	×1.3570
45.08	×1.4508
− 8.80	× .9120
−25.13	× .7487
	1.5291

Notice that the number 1.5291 is what our investment is worth after five years if we started with a one dollar investment. The geometric average return is then calculated as:

Geometric average return $= 1.5291^{1/5} - 1 = .0887$, or 8.87%

Thus, the geometric average return is about 8.87 percent in this example. Here is a tip: If you are using a financial calculator, you can put $1 in as the present value, $1.5291 as the future value, and 5 as the number of periods. Then, solve for the unknown rate. You should get the same answer we did.

One thing you may have noticed in our examples thus far is that the geometric average returns seem to be smaller. It turns out that this will always be true (as long as the returns are not all identical, in which case the two "averages" would be the same). To illustrate, Table 10.5 shows the arithmetic averages and standard deviations from Table 10.2, along with the geometric average returns.

As shown in Table 10.5, the geometric averages are all smaller, but the magnitude of the difference varies quite a bit. The reason is that the difference is greater for more volatile

TABLE 10.5

Geometric versus Arithmetic Average Returns: 1926–2009

Source: Modified from *Stocks, Bonds, Bills and Inflation: 2010 Yearbook,*™ annual updates work by Roger G. Ibbotson and Rex A. Sinquefield (Chicago: Morningstar).

SERIES	GEOMETRIC AVERAGE	ARITHMETIC AVERAGE	STANDARD DEVIATION
Small-company stocks	11.9%	16.6%	32.8%
Large-company stocks	9.8	11.8	20.5
Long-term corporate bonds	5.9	6.2	8.3
Long-term government bonds	5.4	5.8	9.6
Intermediate-term government bonds	5.3	5.5	5.7
U.S. Treasury bills	3.7	3.7	3.1
Inflation	3.0	3.1	4.2

investments. In fact, there is useful approximation. Assuming all the numbers are expressed in decimals (as opposed to percentages), the geometric average return is approximately equal to the arithmetic average return minus half the variance. For example, looking at the large-company stocks, the arithmetic average is 11.8 and the standard deviation is .205, implying that the variance is .042. The approximate geometric average is thus $11.8 - 4.02 = 9.8$, which is quite close to the actual value.

EXAMPLE 10.5

More Geometric Averages

Take a look back at Figure 10.4. There, we showed the value of a $1 investment after 84 years. Use the value for the small-company stock investment to check the geometric average in Table 10.5.

In Figure 10.4, the small-company investment grew to $12,230.87 over 84 years. The geometric average return is thus:

$$\text{Geometric average return} = 12{,}230.87^{1/84} - 1 = .119, \text{ or } 11.9\%$$

This 11.9% is the value shown in Table 10.5. For practice, check some of the other numbers in Table 10.5 the same way.

Arithmetic Average Return or Geometric Average Return?

When we look at historical returns, the difference between the geometric and arithmetic average returns isn't too hard to understand. To put it slightly differently, the geometric average tells you what you actually earned per year on average, compounded annually. The arithmetic average tells you what you earned in a typical year. You should use whichever one answers the question you want answered.

A somewhat trickier question concerns forecasting the future, and there's a lot of confusion about this point among analysts and financial planners. The problem is this. If we have *estimates* of both the arithmetic and geometric average returns, then the arithmetic average is probably too high for longer periods and the geometric average is probably too low for shorter periods.

The good news is that there is a simple way of combining the two averages, which we will call *Blume's formula*.[5] Suppose we calculated geometric and arithmetic return averages from N years of data and we wish to use these averages to form a T-year average return forecast, $R(T)$, where T is less than N. Here's how we do it:

$$R(T) = \frac{T-1}{N-1} \times \text{Geometric average} + \frac{N-T}{N-1} \times \text{Arithmetic average} \qquad [10.2]$$

[5]This elegant result is due to Marshall Blume ("Unbiased Estimates of Long-Run Expected Rates of Return," *Journal of the American Statistical Association*, September 1974, pp. 634–638).

For example, suppose that, from 25 years of annual returns data, we calculate an arithmetic average return of 12 percent and a geometric average return of 9 percent. From these averages, we wish to make 1-year, 5-year, and 10-year average return forecasts. These three average return forecasts are calculated as follows:

$$R(1) = \frac{1-1}{24} \times 9\% + \frac{25-1}{24} \times 12\% = 12\%$$

$$R(5) = \frac{5-1}{24} \times 9\% + \frac{25-5}{24} \times 12\% = 11.5\%$$

$$R(10) = \frac{10-1}{24} \times 9\% + \frac{25-10}{24} \times 12\% = 10.875\%$$

Thus, we see that 1-year, 5-year, and 10-year forecasts are 12 percent, 11.5 percent, and 10.875 percent, respectively.

This concludes our discussion of geometric versus arithmetic averages. One last note: In the future, when we say "average return," we mean arithmetic average unless we explicitly say otherwise.

SUMMARY AND CONCLUSIONS

1. This chapter presents returns for a number of different asset classes. The general conclusion is that stocks have outperformed bonds over most of the twentieth century, though stocks have also exhibited more risk.
2. The statistical measures in this chapter are necessary building blocks for the material of the next three chapters. In particular, standard deviation and variance measure the variability of the return on an individual security and on portfolios of securities. In the next chapter, we will argue that standard deviation and variance are appropriate measures of the risk of an individual security if an investor's portfolio is composed of that security only.
3. Both arithmetic and geometric averages are commonly reported. The chapter explains how both are calculated and interpreted.

CONCEPT QUESTIONS

1. **Investment Selection** Given that Human Genome Sciences was up by almost 1,342 percent for 2009, why didn't all investors hold Human Genome Sciences?
2. **Investment Selection** Given that RHI Entertainment was down by 96 percent for 2009, why did some investors hold the stock? Why didn't they sell out before the price declined so sharply?
3. **Risk and Return** We have seen that over long periods of time stock investments have tended to substantially outperform bond investments. However, it is not at all uncommon to observe investors with long horizons holding their investments entirely in bonds. Are such investors irrational?
4. **Stocks versus Gambling** Critically evaluate the following statement: Playing the stock market is like gambling. Such speculative investing has no social value, other than the pleasure people get from this form of gambling.
5. **Effects of Inflation** Look at Table 10.1 and Figure 10.7 in the text. When were T-bill rates at their highest over the period from 1926 through 2009? Why do you think they were so high during this period? What relationship underlies your answer?
6. **Risk Premiums** Is it possible for the risk premium to be negative before an investment is undertaken? Can the risk premium be negative after the fact? Explain.
7. **Returns** Two years ago, General Materials' and Standard Fixtures' stock prices were the same. During the first year, General Materials' stock price increased by 10 percent while Standard Fixtures' stock price decreased by 10 percent. During the second year, General

Materials' stock price decreased by 10 percent and Standard Fixtures's stock price increased by 10 percent. Do these two stocks have the same price today? Explain.

8. **Returns** Two years ago, the Lake Minerals and Small Town Furniture stock prices were the same. The average annual return for both stocks over the past two years was 10 percent. Lake Minerals's stock price increased 10 percent each year. Small Town Furniture's stock price increased 25 percent in the first year, and lost 5 percent last year. Do these two stocks have the same price today?
9. **Arithmetic versus Geometric Returns** What is the difference between arithmetic and geometric returns? Suppose you have invested in a stock for the last 10 years. Which number is more important to you, the arithmetic or geometric return?
10. **Historical Returns** The historical asset class returns presented in the chapter are not adjusted for inflation. What would happen to the estimated risk premium if we did account for inflation? The returns are also not adjusted for taxes. What would happen to the returns if we accounted for taxes? What would happen to the volatility?

QUESTIONS AND PROBLEMS

connect
Basic
(Questions 1–20)

1. **Calculating Returns** Suppose a stock had an initial price of $84 per share, paid a dividend of $1.40 per share during the year, and had an ending share price of $96. Compute the percentage total return.
2. **Calculating Yields** In Problem 1, what was the dividend yield? The capital gains yield?
3. **Calculating Returns** Rework Problems 1 and 2 assuming the ending share price is $71.
4. **Calculating Returns** Suppose you bought a 7.5 percent coupon bond one year ago for $1,030. The bond sells for $970 today.
   a. Assuming a $1,000 face value, what was your total dollar return on this investment over the past year?
   b. What was your total nominal rate of return on this investment over the past year?
   c. If the inflation rate last year was 3 percent, what was your total real rate of return on this investment?
5. **Nominal versus Real Returns** What was the arithmetic average annual return on large-company stocks from 1926 through 2009.
   a. In nominal terms?
   b. In real terms?
6. **Bond Returns** What is the historical real return on long-term government bonds? On long-term corporate bonds?
7. **Calculating Returns and Variability** Using the following returns, calculate the average returns, the variances, and the standard deviations for X and Y.

	RETURNS	
YEAR	X	Y
1	21%	31%
2	2	11
3	13	8
4	−19	−35
5	8	16

8. **Risk Premiums** Refer to Table 10.1 in the text and look at the period from 1973 through 1978.
   - **a.** Calculate the arithmetic average returns for large-company stocks and T-bills over this time period.
   - **b.** Calculate the standard deviation of the returns for large-company stocks and T-bills over this time period.
   - **c.** Calculate the observed risk premium in each year for the large-company stocks versus the T-bills. What was the arithmetic average risk premium over this period? What was the standard deviation of the risk premium over this period?
9. **Calculating Returns and Variability** You've observed the following returns on Yasmin Corporation's stock over the past five years: 19 percent, −13 percent, 24 percent, 31 percent, and 8 percent.
   - **a.** What was the arithmetic average return on Yasmin's stock over this five-year period?
   - **b.** What was the variance of Yasmin's returns over this period? The standard deviation?
10. **Calculating Real Returns and Risk Premiums** In Problem 9, suppose the average inflation rate over this period was 2.8 percent and the average T-bill rate over the period was 3.6 percent.
    - **a.** What was the average real return on Yasmin's stock?
    - **b.** What was the average nominal risk premium on Yasmin's stock?
11. **Calculating Real Rates** Given the information in Problem 10, what was the average real risk-free rate over this time period? What was the average real risk premium?
12. **Holding Period Return** A stock has had returns of −17.62 percent, 15.38 percent, 10.95 percent, 26.83 percent, and 5.31 percent over the past five years, respectively. What was the holding period return for the stock?
13. **Calculating Returns** You purchased a zero coupon bond one year ago for $215.81. The market interest rate is now 8 percent. If the bond had 20 years to maturity when you originally purchased it, what was your total return for the past year?
14. **Calculating Returns** You bought a share of 5.5 percent preferred stock for $92.73 last year. The market price for your stock is now $95.89. What is your total return for last year?
15. **Calculating Returns** You bought a stock three months ago for $32.81 per share. The stock paid no dividends. The current share price is $37.53. What is the APR of your investment? The EAR?
16. **Calculating Real Returns** Refer to Table 10.1. What was the average real return for Treasury bills from 1926 through 1932?
17. **Return Distributions** Refer back to Table 10.2. What range of returns would you expect to see 68 percent of the time for long-term corporate bonds? What about 95 percent of the time?
18. **Return Distributions** Refer back to Table 10.2. What range of returns would you expect to see 68 percent of the time for large-company stocks? What about 95 percent of the time?
19. **Blume's Formula** Over a 30-year period an asset had an arithmetic return of 13.4 percent and a geometric return of 11.7 percent. Using Blume's formula, what is your best estimate of the future annual returns over 5 years? 10 years? 20 years?
20. **Blume's Formula** Assume that the historical return on large-company stocks is a predictor of the future returns. What return would you estimate for large-company stocks over the next year? The next 5 years? 20 years? 30 years?

Intermediate
(Questions 21–26)

21. **Calculating Returns and Variability** You find a certain stock that had returns of 14 percent, 8 percent, −17 percent, and 19 percent for four of the last five years. If the average return of the stock over this period was 10.35 percent, what was the stock's return for the missing year? What is the standard deviation of the stock's returns?

22. **Arithmetic and Geometric Returns** A stock has had returns of −17 percent, 42 percent, 31 percent, −24 percent, 17 percent, and 21 percent over the last six years. What are the arithmetic and geometric returns for the stock?

23. **Arithmetic and Geometric Returns** A stock has had the following year-end prices and dividends:

YEAR	PRICE	DIVIDEND
1	$30.06	—
2	29.63	$0.88
3	32.40	1.00
4	33.27	1.12
5	15.32	1.24
6	15.04	0.40

What are the arithmetic and geometric returns for the stock?

24. **Calculating Returns** Refer to Table 10.1 in the text and look at the period from 1973 through 1980.
    - **a.** Calculate the average return for Treasury bills and the average annual inflation rate (consumer price index) for this period.
    - **b.** Calculate the standard deviation of Treasury bill returns and inflation over this time period.
    - **c.** Calculate the real return for each year. What is the average real return for Treasury bills?
    - **d.** Many people consider Treasury bills to be risk-free. What do these calculations tell you about the potential risks of Treasury bills?

25. **Calculating Investment Returns** You bought one of Bergen Manufacturing Co.'s 7 percent coupon bonds one year ago for $979. These bonds make annual payments and mature eight years from now. Suppose you decide to sell your bonds today, when the required return on the bonds is 6.8 percent. If the inflation rate was 3.4 percent over the past year, what would be your total real return on the investment?

26. **Using Return Distributions** Suppose the returns on long-term government bonds are normally distributed. Based on the historical record, what is the approximate probability that your return on these bonds will be less than −3.8 percent in a given year? What range of returns would you expect to see 95 percent of the time? What range would you expect to see 99 percent of the time?

Challenge (Questions 27–30)

27. **Using Return Distributions** Assuming that the returns from holding small-company stocks are normally distributed, what is the approximate probability that your money will double in value in a single year? Triple in value?

28. **Distributions** In the previous problem, what is the probability that the return is less than −100 percent? (Think.) What are the implications for the distribution of returns?

29. **Using Probability Distributions** Suppose the returns on large-company stocks are normally distributed. Based on the historical record, use the NORMDIST function in Excel® to determine the probability that in any given year you will lose money by investing in common stock.

30. **Using Probability Distributions** Suppose the returns on long-term corporate bonds and T-bills are normally distributed. Based on the historical record, use the NORMDIST function in Excel® to answer the following questions:
    - **a.** What is the probability that in any given year, the return on long-term corporate bonds will be greater than 10 percent? Less than 0 percent
    - **b.** What is the probability that in any given year, the return on T-bills will be greater than 10 percent? Less than 0 percent?

c. In 1979, the return on long-term corporate bonds was −4.18 percent. How likely is it that such a low return will recur at some point in the future? T-bills had a return of 10.56 percent in this same year. How likely is it that such a high return on T-bills will recur at some point in the future?

WHAT'S ON THE WEB?

1. **Market Risk Premium** You want to find the current market risk premium. Go to money.cnn.com and find current interest rates. What is the shortest maturity interest rate shown? What is the interest rate for this maturity? Using the large-company stock return in Table 10.5, what is the current market risk premium? What assumption are you making when calculating the risk premium?
2. **Historical Interest Rates** Go to the St. Louis Federal Reserve Web site at www.stls.frb.org and search "Treasury." You will find a list of links for different historical interest rates. Follow the "10-Year Treasury Constant Maturity Rate" link and you will find the monthly 10-year Treasury note interest rates. Calculate the average annual 10-year Treasury interest rate for 2008 and 2009 using the rates for each month. Compare this number to the long-term government bond returns and the U.S. Treasury bill returns found in Table 10.2. How does the 10-year Treasury interest rate compare to these numbers? Do you expect this relationship to always hold? Why or why not?

CLOSING CASE

A JOB AT EAST COAST YACHTS, PART 1

You recently graduated from college, and your job search led you to East Coast Yachts. Since you felt the company's business was seaworthy, you accepted a job offer. The first day on the job, while you are finishing your employment paperwork, Dan Ervin, who works in Finance, stops by to inform you about the company's 401(k) plan.

A 401(k) plan is a retirement plan offered by many companies. Such plans are tax-deferred savings vehicles, meaning that any deposits you make into the plan are deducted from your current pretax income, so no current taxes are paid on the money. For example, assume your salary will be $50,000 per year. If you contribute $3,000 to the 401(k) plan, you will only pay taxes on $47,000 in income. There are also no taxes paid on any capital gains or income while you are invested in the plan, but you do pay taxes when you withdraw money at retirement. As is fairly common, the company also has a 5 percent match. This means that the company will match your contribution up to 5 percent of your salary, but you must contribute to get the match.

The 401(k) plan has several options for investments, most of which are mutual funds. A mutual fund is a portfolio of assets. When you purchase shares in a mutual fund, you are actually purchasing partial ownership of the fund's assets. The return of the fund is the weighted average of the return of the assets owned by the fund, minus any expenses. The largest expense is typically the management fee, paid to the fund manager. The management fee is compensation for the manager, who makes all of the investment decisions for the fund.

East Coast Yachts uses Bledsoe Financial Services as its 401(k) plan administrator. The investment options offered for employees are discussed below.

Company Stock One option in the 401(k) plan is stock in East Coast Yachts. The company is currently privately held. However, when you interviewed with the owner, Larissa Warren, she informed you the company stock was expected to go public in the next three to four years. Until then, a company stock price is simply set each year by the board of directors.

Bledsoe S&P 500 Index Fund This mutual fund tracks the S&P 500. Stocks in the fund are weighted exactly the same as the S&P 500. This means the fund return is approximately the return on the S&P 500, minus expenses. Since an index fund purchases assets based on the composition of the index it is following, the fund manager is not required to research stocks and make investment decisions. The result is that the fund expenses are usually low. The Bledsoe S&P 500 Index Fund charges expenses of .15 percent of assets per year.

Bledsoe Small Cap Fund This fund primarily invests in small capitalization stocks. As such, the returns of the fund are more volatile. The fund can also invest 10 percent of its assets in companies based outside the United States. This fund charges 1.70 percent in expenses.

Bledsoe Large Company Stock Fund This fund invests primarily in large capitalization stocks of companies based in the United States. The fund is managed by Evan Bledsoe and has outperformed the market in six of the last eight years. The fund charges 1.50 percent in expenses.

Bledsoe Bond Fund This fund invests in long-term corporate bonds issued by U.S. domiciled companies. The fund is restricted to investments in bonds with an investment grade credit rating. This fund charges 1.40 percent in expenses.

Bledsoe Money Market Fund This fund invests in short-term, high credit quality debt instruments, which include Treasury bills. As such, the return on the money market fund is only slightly higher than the return on Treasury bills. Because of the credit quality and short-term nature of the investments, there is only a very slight risk of negative return. The fund charges .60 percent in expenses.

1. What advantages do the mutual funds offer compared to the company stock?
2. Assume that you invest 5 percent of your salary and receive the full 5 percent match from East Coast Yachts. What EAR do you earn from the match? What conclusions do you draw about matching plans?
3. Assume you decide you should invest at least part of your money in large capitalization stocks of companies based in the United States. What are the advantages and disadvantages of choosing the Bledsoe Large Company Stock Fund compared to the Bledsoe S&P 500 Index Fund?
4. The returns on the Bledsoe Small Cap Fund are the most volatile of all the mutual funds offered in the 401(k) plan. Why would you ever want to invest in this fund? When you examine the expenses of the mutual funds, you will notice that this fund also has the highest expenses. Does this affect your decision to invest in this fund?
5. A measure of risk-adjusted performance that is often used is the Sharpe ratio. The Sharpe ratio is calculated as the risk premium of an asset divided by its standard deviation. The standard deviation and return of the funds over the past 10 years are listed below. Calculate the Sharpe ratio for each of these funds. Assume that the expected return and standard deviation of the company stock will be 15 percent and 65 percent, respectively. Calculate the Sharpe ratio for the company stock. How appropriate is the Sharpe ratio for these assets? When would you use the Sharpe ratio?

	10-YEAR ANNUAL RETURN	STANDARD DEVIATION
Bledsoe S&P 500 Index Fund	10.15%	23.85%
Bledsoe Small Cap Fund	14.83	29.62
Bledsoe Large Company Stock Fund	11.08	26.73
Bledsoe Bond Fund	8.15	10.34

6. What portfolio allocation would you choose? Why? Explain your thinking carefully.