CHAPTER 1

A Brief History of Risk and Return

Anyone can retire as a millionaire! Consider this: If you invest $2,500 per year while earning 12 percent annual returns, then after 35 years you will have accumulated $1,079,159. But with annual returns of only 8 percent you will have just $430,792. Are these investment returns realistic over a long period of time? Based on the history of financial markets, the answer appears to be yes. For example, over the last 75 years the Standard and Poor's index of large company common stocks has yielded almost a 13 percent average annual return.

The study of investments could begin in many places. After thinking it over, we decided that a brief history lesson is in order, so we start our discussion of risk and return by looking back at what has happened to investors in U.S. financial markets since 1925. In 1931, for example, the stock market lost 43 percent of its value. Just two years later, the market reversed itself and gained 54 percent. In more recent times, the stock market lost about 25 percent of its value on October 19, 1987, alone, and it gained almost 40 percent in 1995. What lessons, if any, should investors learn from such shifts in the stock market? We explore the last seven decades of market history to find out.

The primary goal in this chapter is to see what financial market history can tell us about risk and return. One of the most important things to get out of this discussion is a perspective on the numbers. What is a high return? What is a low return? More generally, what returns should we expect from financial assets such as stocks and bonds, and what are the risks from such investments? Beyond this, we hope that by studying what *did* happen in the past, we will at least gain some insight into what *can* happen in the future.

The history of risk and return is made day by day in global financial markets. The internet is an excellent source of information on financial markets. Visit our website (at www.mhhe.com/~finance /cjlinks) for suggestions on where to find information on recent financial market events.

Not everyone agrees on the value of studying history. On the one hand, there is philosopher George Santayana's famous comment, “Those who do not remember the past are condemned to repeat it.” On the other hand, there is industrialist Henry Ford's equally famous comment, “History is more or less bunk.” These extremes aside, perhaps everyone would agree with Mark Twain who observed, with remarkable foresight (and poor grammar), that “October. This is one of the peculiarly dangerous months to speculate in stocks in. The others are July, January, September, April, November, May, March, June, December, August, and February.”

Two key observations emerge from a study of financial market history. First, there is a reward for bearing risk, and, at least on average, that reward has been substantial. That's the good news. The bad news is that greater rewards are accompanied by greater risks. The fact that risk and return go together is probably the single most important fact to understand about investments, and it is a point to which we will return many times.

1.1 Returns

We wish to discuss historical returns on different types of financial assets. First, we need to know how to compute the return from an investment. We will consider buying shares of stock in this section, but the basic calculations are the same for any investment.

(*marg. def.* **total dollar return** The return on an investment measured in dollars that accounts for all cash flows and capital gains or losses.)

Dollar Returns

If you buy an asset of any type, your gain (or loss) from that investment is called the *return* on your investment. This return will usually have two components. First, you may receive some cash directly while you own the investment. Second, the value of the asset you purchase may change. In this case, you have a capital gain or capital loss on your investment.[1]

To illustrate, suppose you purchased 100 shares of stock in Harley-Davidson on January 1. At that time, Harley was selling for $37 per share, so your 100 shares cost you $3,700. At the end of the year, you want to see how you did with your investment.

The first thing to consider is that over the year, a company may pay cash dividends to its shareholders. As a stockholder in Harley, you are a part owner of the company, and you are entitled to a portion of any money distributed. So, if Harley chooses to pay a dividend, you will receive some cash for every share you own.

[1] As a practical matter, what is and what is not a capital gain (or loss) is determined by the Internal Revenue Service. Even so, as is commonly done, we use these terms to refer to a change in value.

In addition to the dividend, the other part of your return is the capital gain or loss on the stock. This part arises from changes in the value of your investment. For example, consider these cash flows:

	Ending Stock Price	
	$40.33	$34.78
January 1	$3,700	$3,700
December 31	4,033	3,478
Dividend income	185	185
Capital gain or loss	333	-222

At the beginning of the year, on January 1, the stock is selling for $37 per share, and, as we calculated above, your total outlay for 100 shares is $3,700. Over the year, Harley pays dividends of $1.85 per share. By the end of the year, then, you received dividend income of

$$\text{Dividend income} = \$1.85 \times 100 = \$185$$

Suppose that as of December 31, Harley was selling for $40.33, meaning that the value of your stock increased by $3.33 per share. Your 100 shares are now worth $4,033, so you have a capital gain of

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

On the other hand, if the price had dropped to, say, $34.78, you would have a capital loss of

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

Notice that a capital loss is the same thing as a negative capital gain.

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

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

In our first example here, the total dollar return is thus given by

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

Overall, between the dividends you received and the increase in the price of the stock, the value of your investment increased from $3,700 to $3,700 + $518 = $4,218.

A common misconception often arises in this context. Suppose you hold on to your Harley-Davidson stock and don't sell it at the end of the year. Should you still consider the capital gain as part of your return? Isn't this only a “paper” gain and not really a cash gain if you don't sell it?

The answer to the first question is a strong yes, and the answer to the second is an equally strong no. The capital gain is every bit as much a part of your return as the dividend, and you should certainly count it as part of your return. That you decide to keep the stock and don't sell (you don't “realize” the gain) is irrelevant because you could have converted it to cash if you had wanted to. Whether you choose to do so is up to you.

After all, if you insist on converting your gain to cash, you could always sell the stock and immediately reinvest by buying the stock back. There is no difference between doing this and just not selling (assuming, of course, that there are no transaction costs or tax consequences from selling the stock). Again, the point is that whether you actually cash out and buy pizzas (or whatever) or reinvest by not selling doesn't affect the return you actually earn.

(*marg. def.* **total percent return** The return on an investment measured as a percent of the originally invested sum that accounts for all cash flows and capital gains or losses.)

Percentage Returns

It is usually more convenient to summarize information about returns in percentage terms than in dollar terms, because that way your return doesn't depend on how much you actually invested. With percentage returns the question we want to answer is: How much do we get for each dollar we invest?

To answer this question, let P_t be the price of the stock at the beginning of the year and let D_{t+1} be the dividend paid on the stock during the year. The following cash flows are the same as those shown earlier, except that we have now expressed everything on a per share basis:

	Ending Stock Price	
	$40.33	$34.78
January 1	$37.00	$37.00
December 31	40.33	34.78
Dividend income	1.85	1.85
Capital gain or loss	3.33	-2.22

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. If we express this dividend as a percentage of the beginning stock price, the result is the *dividend yield*:

$$\text{Dividend yield} = D_{t+1} / P_t$$

$$= \$1.85 / \$37 = .05 = 5\%$$

This says that, for each dollar we invested, we received 5 cents in dividends.

The second component of our percentage return is the *capital gains yield*. This yield is calculated as the change in the price during the year (the capital gain) divided by the beginning price. With the $40.33 ending price, we get:

$$\text{Capital gains yield} = (P_{t+1} - P_t) / P_t$$
$$= (\$40.33 - \$37) / \$37$$
$$= \$3.33 / \$37 = .09 = 9\%$$

This 9 percent yield means that for each dollar invested we got 9 cents in capital gains.

Putting it all together, per dollar invested, we get 5 cents in dividends and 9 cents in capital gains for a total of 14 cents. Our *total percentage return* is 14 cents on the dollar, or 14 percent. When a return is expressed on a percentage basis, we often refer to it as the *rate of return* on the investment.

To check our calculations, notice that we invested $3,700 and ended up with $4,218. By what percentage did our $3,700 increase? As we saw, we picked up $4,218 - $3,700 = $518. This is an increase of $518 / $3,700, or 14 percent.

Example 1.1 Calculating Percentage Returns Suppose you buy some stock for $25 per share. After one year, the price is $35 per share. During the year, you received a $2 dividend per share. What is the dividend yield? The capital gains yield? The percentage return? If your total investment was $1,000, how much do you have at the end of the year?

Your $2 dividend per share works out to a dividend yield of

$$\text{Dividend yield} = D_{t+1} / P_t$$
$$= \$2 / \$25$$
$$= 8\%$$

The per share capital gain is $10, so the capital gains yield is

$$
\begin{aligned}
\text{Capital gains yield} &= (P_{t+1} - P_t) / P_t \\
&= (\$35 - \$25) / \$25 \\
&= \$10 / \$25 \\
&= 40\%
\end{aligned}
$$

The total percentage return is thus 8% + 40% = 48%.

If you had invested $1,000, you would have $1,480 at the end of the year. To check this, note that your $1,000 would have bought you $1,000 / $25 = 40 shares. Your 40 shares would then have paid you a total of 40 × $2 = $80 in cash dividends. Your $10 per share gain would give you a total capital gain of $10 × 40 = $400. Add these together and you get $480, which is a 48 percent total return on your $1,000 investment.

CHECK THIS

1.1a What are the two parts of total return?

1.1b Why are unrealized capital gains or losses included in the calculation of returns?

1.1c What is the difference between a dollar return and a percentage return? Why are percentage returns usually more convenient?

1.2 The Historical Record

We now examine year-to-year historical rates of return on three important categories of financial investments. These returns can be interpreted as what you would have earned if you had invested in portfolios of the following asset categories:

1. Large capitalization stocks (large-caps). The large company stock portfolio is the Standard and Poor's index of the largest companies (in terms of total market value of outstanding stock) in the United States. This index is known as the S&P 500, since it contains 500 large companies.

2. Long-term U.S. Treasury bonds. This is a portfolio of U.S. government bonds with a 20-year life remaining until maturity.

3. U.S. Treasury bills. This a portfolio of Treasury bills (T-bills for short) with a three-month investment life.

If you are now not entirely certain what these investments are, don't be overly concerned. We will have much more to say about each in later chapters. For now, just take it as given that these are some of the things that you could have put your money into in years gone by. In addition to the year-to-year returns on these financial instruments, the year-to-year percentage changes in the Consumer Price Index (CPI) are also computed. The CPI is a standard measure of consumer goods price inflation.

Figure 1.1 about here

A First Look

Before examining the different portfolio returns, we first take a look at the "big picture." Figure 1.1 shows what happened to $1 invested in these three different portfolios at the beginning of 1926 and held over the 72-year period ending in 1997.

To fit all the information on a single graph, some modification in scaling is used. As is commonly done with financial time series, the vertical axis is scaled so that equal distances measure equal percentage (as opposed to dollar) changes in value. Thus, the distance between $10 and $100 is the same as that between $100 and $1,000, since both distances represent the same 900 percent increases.

Looking at Figure 1.1, we see that among these three asset categories the large-cap common stock portfolio did the best. Every dollar invested in the S&P 500 index at the start of 1926 grew to $1,659.03 at the end of 1997. At the other end of the return spectrum, the T-bond portfolio grew to just $36.35, and the T-bill portfolio grew to only $17.43. This bond and bill performance is even less impressive when we consider inflation over this period. As illustrated, the increase in the price level was such that $9.01 was needed in 1997 just to replace the purchasing power of the original $1 in 1926. In other words, an investment of $9.01 in T-bonds (measured in today's dollars) grew to only $36.35 over 72 years.

Given the historical record, why would any investor buy anything other than common stocks? If you look closely at Figure 1.1, you will see the answer - risk. The long-term government bond portfolio grew more slowly than did the stock portfolio, but it also grew much more steadily. The common stocks ended up on top, but as you can see, they grew more erratically much of the time. We examine these differences in volatility more closely later.

Figure 1.2 about here

A Look Overseas

It is instructive to compare the American financial experience since 1926 with the experience of some major foreign financial markets. Figure 1.2 graphically compares stock market index levels for the United Kingdom (England), Germany and Japan over the 72-year period 1926 through 1997. Notice that the stock markets in Germany and Japan were devastated at the end of World War II in 1945 and recovered steadily after the war and through most of the postwar era.

If you compare the $7.94 for the United States in Figure 1.2 to the S&P 500 in Figure 1.1, there is an obvious (and very large) difference. The reason for the difference is that, in Figure 1.1, we assume that all dividends received are reinvested, meaning that they are used to buy new stock. In contrast, in Figure 1.2, we assume that all dividends are not reinvested. Thus one thing we learn is that whether or not we reinvest can have a big impact on the future value of our portfolio.

Figure 1.3 about here

A Longer Range Look

The data on stock returns before 1925 are not as comprehensive, but it is nonetheless possible to trace reasonably accurate returns in U.S. financial markets as far back as 1802. Figure 1.3 shows the values, in 1992, of $1 invested in stocks, long-term bonds, short-term bills, and gold. The CPI is also included for reference.

Inspecting Figure 1.3, we see that $1 invested in stocks grew to an astounding $7.47 million over this 195-year period. During this time, the returns from investing in stocks dwarf those earned on other investments. Notice also in Figure 1.3 that, after almost two centuries, gold has managed to keep up with inflation, but that is about it.

What we see thus far is that there has been a powerful financial incentive for long-term investing. The real moral of the story is this: Get an early start!

Figures 1.4 - 1.6 about here

A Closer Look

To illustrate the variability of the different investments, Figures 1.4 through 1.6 plot year-to-year percentage returns in the form of vertical bars drawn from the horizontal axis. The height of each bar tells us the return for a particular year. For example, looking at the long-term government bonds (Figure 1.5), we see the largest historical return (44.44 percent) occurred not so long ago (in 1982). This was a good year for bonds. In comparing these charts, notice the differences in the vertical axis scales. With this in mind, you can see how predictably the Treasury bills (Figure 1.6) behaved compared to the S&P 500 index of large-cap stocks (Figure 1.4).

Table 1.1 about here

The actual year-to-year returns used to draw these bar graphs are displayed in Table 1.1. Looking at this table, we see, for example, that the largest single-year return is an impressive 53.12 percent for the S&P 500 index of large company stocks in 1933. In contrast, the largest Treasury bill return was merely 15.23 percent (in 1981).

CHECK THIS

1.2a Why doesn't everyone just buy common stocks as investments?

1.2b What was the smallest return observed over the 72 years for each of these investments? When did each occur?

1.2c How many times did large stocks (common stocks) return more than 30 percent? How many times did they return less than -20 percent?

1.2d What was the longest "winning streak" (years without a negative return) for large stocks? For long-term government bonds?

1.2e How often did the T-bill portfolio have a negative return?

1.3 Average Returns: The First Lesson

As you've probably begun to notice, the history of financial market returns in an undigested form is complicated. What we need are simple measures to accurately summarize and describe all these numbers. Accordingly, we discuss how to go about condensing detailed numerical data. We start out by calculating average returns.

Calculating Average Returns

The obvious way to calculate average returns on the different investments in Table 1.1 is to simply add up the yearly returns and divide by 72. The result is the historical average of the individual values. For example, if you add the returns for common stocks for the 72 years, you will get about 923.63 percent. The average annual return is thus 923.63 / 72 = 12.83%. You can interpret this 12.83 percent just like any other average. If you picked a year at random from the 72-year history and you had to guess the return in that year, the best guess is 12.83 percent.

Table 1.2 Annual Returns Statistics (1926-1997)

Asset category	Average	Maximum	Minimum
Large-Cap Stocks	12.83%	53.12%	-43.76%
U.S. Treasury Bonds	5.41%	44.44%	-7.55%
U.S. Treasury Bills	4.10%	15.23%	0.01%
Inflation	3.20%	18.13%	-10.27%

Average Returns: The Historical Record

Table 1.2 shows the average returns computed from Table 1.1. These averages don't reflect the impact of inflation. Notice that over this 72-year period the average inflation rate was 3.20 percent per year, while the average return on U.S. Treasury bills was 4.10 percent per year. Thus, the average return on Treasury bills exceeded the average rate of inflation by only 0.90 percent per year! At the other extreme, the return on large-cap common stocks exceeded the rate of inflation by a whopping 12.83% - 3.20% = 9.63%!

(*marg. def.* **risk-free rate** The rate of return on a riskless investment.)

(*marg. def.* **risk premium** The extra return on a risky asset over the risk-free rate; the reward for bearing risk.)

Risk Premiums

Now that we have computed some average returns, it seems logical to see how they compare with each other. Based on our discussion above, one such comparison involves government-issued securities. These are free of much of the variability we see in, for example, the stock market.

The government borrows money by issuing debt securities, which come in different forms. The ones we will focus on here are Treasury bills. Because these instruments have a very short investment life and because the government can always raise taxes or print money to pay its bills, at least in the short run, there is essentially no risk associated with buying them. Thus, we call the rate of return on such debt the **risk-free rate**, and we will use it as a kind of investing benchmark.

A particularly interesting comparison involves the virtually risk-free return on T-bills and the risky return on common stocks. The difference between these two returns can be interpreted as a measure of the **risk premium** on the average risky asset (assuming that the stock of a large U.S. corporation has about average risk compared to all risky assets). We call this the risk premium because it is the additional return we earn by moving from a risk-free investment to a typical risky one, and we interpret it as a reward for bearing risk.

Risk Premiums: An International Perspective

We've seen that U.S. stock market investors earned significant risk premiums over the last few decades. It is natural to wonder whether this experience is unique to the United States, or is a common feature of financial markets worldwide. To gain some perspective on this issue, look back at Figure 1.2 comparing U.S. stock market performance with that of stock markets in England, Germany, and Japan. As in Figure 1.1, what is shown is how the value of a $1 investment made in 1926 performed through the year 1997.

Unlike our previous Figure 1.1, the values in Figure 1.2 do not include dividends, so we are considering only the capital gains portion of stock market returns. In examining Figure 1.2, two things seem apparent. First, investors in all four countries made money, but the amounts differ quite a bit. Surprisingly, although the German stock market was nearly wiped out in World War II, an investment in German stocks is actually worth a little more than a similar U.S. investment. Investors in England lagged behind the United States and Germany, while investors in Japan did much worse.

Figure 1.7 about here

In fact, the recent Japanese experience provides some insight into how risky stocks can be. Figure 1.7 focuses on the recent performance of the Nikkei 225, a widely followed index of large Japanese stocks. As shown, from 1984 to 1989 the Nikkei rocketed to almost 40,000 from just over 10,000. At its peak, the Tokyo Stock Exchange (TSE) surpassed even the New York Stock Exchange (NYSE) and was the largest market in the world based on the total value of traded stocks. From its peak, however, the Nikkei slid dramatically. By 1998, it had fallen to its lowest levels since 1986, thus wiping out more than a decade's gains.

Almost any country, including the United States, has suffered from periods of substantial stock market declines. Nonetheless, the historical evidence from markets around the globe is surprisingly consistent. There does appear to be a risk premium as over the long run stocks have done better than bonds or bills. But the "over the long run" part of this message is very important because the long run may be very long indeed!

Table 1.3 Risk Premiums (1926-1997)

Asset category	Average
Large-Cap Stocks	8.73%
U.S. Treasury Bonds	1.31%
U.S. Treasury Bills	0.00%

The First Lesson

From the data in Table 1.2, we can calculate risk premiums for the three different categories of investments. The results are shown in Table 1.3. Notice that the risk premium on T-bills is shown as zero in the table because they are our riskless benchmark. Looking at Table 1.3, we see that the average risk premium earned by the large-cap common stock portfolio is 12.83% - 4.10% = 8.73%. This is a significant reward. The fact that it exists historically is an important observation, and it is the basis for our first lesson: Risky assets, on average, earn a risk premium. Put another way, there is a reward, on average, for bearing risk.

Why is this so? Why, for example, is the risk premium for stocks so much larger than the risk premium for bonds? More generally, what determines the relative sizes of the risk premiums for the different assets? These questions speak to the heart of the modern theory of investments, and we will discuss the issues involved many times in the chapters ahead. For now, part of the answer can be found by looking at the historical variability of returns of these different investments. So, to get started, we now turn our attention to measuring variability in returns.

CHECK THIS

1.3a What is a risk premium?

1.3b What was the historical risk premium on common stocks? On U.S. Treasury bonds?

1.3c What is the first lesson from financial market history?

1.4 Return Variability: The Second Lesson

We have already seen that year-to-year returns on common stocks tend to be more volatile than returns on, say, long-term government bonds. We now discuss how to measure this variability so we can begin examining the important subject of risk.

Figure 1.8 about here

Frequency Distributions and Variability

To get started, we can draw a *frequency distribution* for common stock returns like the one in Figure 1.8. What we have done here is to count the number of times that an annual return on the common stock portfolio falls within each 10-percent range. For example, in Figure 1.8, the height of 11 for the bar within the interval 32 percent to 42 percent means that 11 of the 72 annual returns are in that range. Notice also that the range from 22 percent to 32 percent is the most frequent return interval since the bar in this interval is the highest representing 16 of 72 returns.

What we need to do now is to actually measure the spread in these returns. We know, for example, that the return on the S&P 500 index of common stocks in a typical year was 12.83 percent. We now want to know by how much the actual return differs from this average in a typical year. In other words, we need a measure of returns volatility. The **variance** and its square root, the **standard deviation,** are the most commonly used measures of volatility. We briefly review how to calculate these next. If you've already studied basic statistics, you should notice that we are simply calculating an ordinary sample variance and standard deviation, just as you may have done many times before.

(*marg. def.* **variance** A common measure of volatility)

(*marg. def.* **standard deviation** The square root of the variance)

The Historical Variance and Standard Deviation

Variance measures the average squared difference between the actual returns and the average return. The bigger this number is, the more the actual returns tend to differ from the average return. To illustrate how we calculate historical variance, suppose a particular investment had returns of 10 percent, 12 percent, 3 percent, and -9 percent over the last four years. The average return is (10% + 12% + 3% - 9%) / 4 = 4%.

Notice that the return is never actually equal to 4 percent. Instead, the first return deviates from the average by 10% - 4% = 6%, the second return deviates from the average by 12% - 4% = 8%, and so on. To compute the variance, we square each of these deviations, add them up, and divide the result by the number of returns less one, or three in this case. These calculations are summarized immediately below:

$$
\begin{array}{lcrlll}
(10 - 4)^2 & = & 36 & & & \\
(12 - 4)^2 & = & 64 & & & \\
(3 - 4)^2 & = & 1 & & & \\
(-9 - 4)^2 & = & \underline{169} & & & \\
 & & 270 & \rightarrow & \rightarrow & 270 / 3 = 90
\end{array}
$$

To recap, we first calculate the differences between actual returns and their average by subtracting out 4 percent. Second, we square each difference. Third, we sum all squared deviations to get 270. Finally, we divide the sum of the squared deviations by 4 - 1 = 3.[2]

[2] The reason for dividing by N-1 rather than simply N is based on statistical sampling theory, which is beyond the scope of this book. Just remember that to calculate a variance about a sample average divide the sum of squared deviations from the average by N-1.

By these calculations we get *Var*(*R*) or σ^2 (read this as "sigma squared") which is the variance of the return:

$$Var(R) = \sigma^2 = 270 / (4 - 1) = 90$$

The standard deviation is the square root of the variance. So, if *SD*(*R*) or σ stands for the standard deviation of return:

$$SD(R) = \sigma = \sqrt{90} = 9.487\%$$

The square root of the variance is used because the variance is measured in "squared" percentages and is hard to interpret. The standard deviation is an ordinary percentage, which here is 9.487 percent.

In general, if we have *N* historical returns, where *N* is some number, we can write the historical variance as

$$Var(R) = [(R_1 - \bar{R})^2 + (R_2 - \bar{R})^2 + . . . + (R_N - \bar{R})^2] / (N - 1)$$

This formula tells us to do just what we did above: Take each of the *N* individual returns $(R_1, R_2, . . . ,R_N)$ and subtract the average return, $\bar{R}$; then square the results, and add them all up; finally, divide this total by the number of returns less one (*N* - 1). The standard deviation is always the square root of *Var*(*R*).

Example 1.2 Calculating the variance and standard deviation Calculate return averages, variances, and standard deviations for S&P 500 large-cap stocks and T-bonds using data for the first five years in Table 1.1, 1926-1930.

First, calculate return averages as follows:

S&P 500 large-cap stocks	T-bonds
13.70	6.50
35.78	4.52
45.15	0.05
-8.86	5.77
-25.22	4.18
60.55	21.02
60.55 / 5 = 12.11	21.02 / 5 = 4.20
average return	average return

Using the averages above, calculate the squared deviations from the average returns and sum the squared deviations as follows:

S&P 500 large-cap stocks	T-bonds
$(13.70 - 12.11)^2 = 2.53$	$(6.50 - 4.20)^2 = 5.29$
$(35.78 - 12.11)^2 = 560.27$	$(4.52 - 4.20)^2 = .10$
$(45.15 - 12.11)^2 = 1{,}091.64$	$(0.05 - 4.20)^2 = 17.22$
$(-8.86 - 12.11)^2 = 439.74$	$(5.77 - 4.20)^2 = 2.46$
$(-25.22 - 12.11)^2 = 1{,}393.53$	$(4.18 - 4.20)^2 = .00$
3,487.71	25.07

Calculate return variances by dividing the sums of squared deviations by four, the number of returns less one.

3,487.71 / 4 = 871.93	25.07 / 4 = 6.27
S&P 500	T-bonds

Standard deviations are then calculated as the square root of the variance.

$\sqrt{871.93} = 29.53$	$\sqrt{6.27} = 2.50$
S&P 500	T-bonds

Notice that the large-cap stock portfolio had a volatility more than 10 times greater than the T-bond portfolio, which is not unusual during periods of market turbulence.

Table 1.4 Annual Returns Statistics (1926-1997)

Asset category	Average	Standard deviation
Large-Cap Stocks	12.83%	20.38%
U.S. Treasury Bonds	5.41%	8.35%
U.S. Treasury Bills	4.10%	3.25%
Inflation	3.20%	4.52%

The Historical Record

Table 1.4 summarizes much of our discussion of financial markets history so far. It displays average returns and standard deviations for the three asset category portfolios. Notice that the standard deviation for the stock portfolio (20.38 percent per year) is more than six times larger than the T-bill portfolio's standard deviation (3.25 percent per year).

A useful thing about the distribution shown in Figure 1.8 is that it roughly approximates a normal distribution. Because of this, a good rule of thumb is that the probability that we end up within plus-or-minus one standard deviation of the average is about 2/3. The probability that we end up within plus-or-minus two standard deviations of the average is about 95 percent. Finally, the probability of being more than three standard deviations away from the average is less than 1 percent.[3]

To see why this is useful, notice that Table 1.4 reports that the standard deviation of returns on the large-cap common stocks is 20.38 percent. The average return is 12.83 percent. So the probability that the return in a given year is in the range -7.55 percent to 33.21 percent [12.83% ± 1 SD (20.38%)] is about 2/3.

[3]As many of you recognize, these probabilities are based on the normal distribution. The returns on most types of assets are in fact only roughly normal.

In other words, there is about one chance in three that the return will be *outside* this range. This literally tells you that if you invest in the S&P 500 index of large company stocks, you should expect to be outside this range in one year out of every three. This reinforces our earlier observations about stock market volatility. However, there is only a 5 percent chance (approximately) that we would end up outside the range -27.93 percent to 53.59 percent [12.83% ± (2 × 20.38%)].

The Second Lesson

Our observations concerning year-to-year variability in returns are the basis for our second lesson from financial market history. On average, bearing risk is handsomely rewarded, but in a given year, there is a significant chance of a dramatic change in value. Thus our second lesson is: The greater the potential reward, the greater the risk.

An excellent example of this second lesson is provided by the history of returns on small capitalization stocks, often called small-caps. A small-cap portfolio of stocks from the smallest size quintile (20 percent) of stocks traded on the New York Stock Exchange (NYSE) earned an average return of 17.21 percent over the 72-year period 1926 through 1997. This average return yields a risk premium of 13.11 percent. Thus, the historical average return and risk premium on a small-cap stock portfolio was almost 5 percent more than the average return and risk premium on the S&P 500 index. However, this extra return came with substantial extra risk; the small-caps return standard deviation was 34.34 percent, or almost double the risk of the S&P 500 portfolio of large-cap stocks.

Example 1.3 Investing in Growth Stocks As a practical matter, the phrase *growth stock is* frequently a euphemism for small-company stock. Are such investments suitable for "widows and orphans"? Before answering, you should consider historical volatility. For example, from the historical record, what is the approximate probability that you will actually lose 17 percent or more of your money in a single year if you buy stocks from a group of such companies?

The historical average return on a small-cap stock portfolio is 17.21 percent, with an annual standard deviation of 34.34 percent. From our rule of thumb, there is about a 1/3 probability that you will experience a return outside the range -17.13 percent to 51.55 percent (17.21% ±34.34%).

The odds of being above or below this range are about equal. There is thus about a 1/6 chance (half of 1/3) that you will lose more than 17 percent. So you should expect this to happen once in every six years, on average. Such investments can thus be *very* volatile, and they are not well-suited for those who cannot afford to bear the risk.

CHECK THIS

1.4a In words, how do we calculate a variance? A standard deviation?

1.4b What is the first lesson from financial market history? The second lesson?

1.5 Risk and Return

In previous sections, we explored financial market history to see what we could learn about risk and return. In this section, we summarize our findings and then conclude our discussion by looking ahead at the subjects we will be examining in later chapters.

Figure 1.9 about here

The Risk/Return Tradeoff

Figure 1.9 is a way of putting together our findings on risk and return. What it shows is that there is a risk/return tradeoff. At one extreme, if we are unwilling to bear any risk at all, but we are willing to forego the use of our money for a while, then we can earn the risk-free rate. Because the risk-free rate represents compensation for just waiting, it is often called the *time value of money*.

If we are willing to bear risk, then we can expect to earn a risk premium, at least on average. Further, the more risk we are willing to bear, the greater is that risk premium. Investment advisors like to say that an investment has a "wait" component and a "worry" component. In our figure, the time value of money is the compensation for waiting, and the risk premium is the compensation for worrying.

There are two important caveats to this discussion. First, risky investments do not *always* pay more than risk-free investments. Indeed, that's precisely what makes them risky. In other words, there is a risk premium *on average*, but, over any particular time interval, there is no guarantee. Second, we've intentionally been a little imprecise about what we mean exactly by risk. As we will discuss in the chapters ahead, not all risks are compensated. Some risks are cheaply and easily avoidable, and there is no expected reward for bearing them. It is only those risks that cannot be easily avoided that are compensated (on average).

A Look Ahead

In the remainder of this text, we focus exclusively on financial assets. An advantage of this approach is that it is limited to four major types: stocks, bonds, options, and futures, in the order that we cover them. This means that we won't be discussing collectibles such as classic automobiles, baseball cards, coins, fine art, or stamps. We also won't be discussing real estate or precious metals such as gold and platinum. It's not that these are unimportant; rather, they are very specialized. So, instead of treating them superficially, we leave a discussion of them for another day (and another book).

As we've indicated, to understand the potential reward from an investment, it is critical to first understand the risk involved. There is an old saying that goes like this: it's easy to make a small fortune investing in _____ (put your favorite investment here), just start with a large fortune! The moral is that the key to successful investing is to make informed, intelligent decisions about risk. For this reason, we are going to pay particular attention to the things that determine the value of the different assets we discuss and the nature of the associated risks.

One common characteristic that these assets have is that they are bought and sold around the clock and around the world in vast quantities. The way they are traded can be very different, however. We think it is important and interesting to understand exactly what happens when you buy or sell one of these assets, so we will be discussing the different trading mechanisms and the way the different markets function. We will also describe actual buying and selling at various points along the way to show you the steps involved and the results of placing buy and sell orders and having them executed.

1.7 Summary and Conclusions

This chapter explores financial market history. Such a history lesson is useful because it tells us what to expect in the way of returns from risky assets. We summarized our study of market history with two key lessons:

1. Risky assets, on average, earn a risk premium. There is a reward for bearing risk.
2. The greater the potential reward from a risky investment, the greater is the risk.

When we put these two lessons together, we concluded that there is a risk-return trade-off: the only way to earn a higher return is to take on greater risk.

Key Terms

total dollar return	**total percent return**
risk-free rate	**variance**
risk premium	**standard deviation**

Get Real!

This chapter took you through some basic, but important, investment-related calculations. We then walked through the modern history of risk and return, both in the United States and elsewhere. How should you, as an investor or investment manager, put this information to work?

The answer is that you now have a rational, objective basis for thinking about what you stand to make from investing in some important broad asset classes. For the stock market as a whole, as measured by the performance of large company stocks, you know that you can realistically expect to make 13 percent or so per year on average.

Equally important, you know that you won't make 13 percent in any one year; instead, you'll make more or less. You know that the standard deviation is about 20 percent per year, and you should know what that means in terms of risk. In particular, you need to understand that in one year out of every six, you should expect to lose more than 7 percent (13 percent minus one standard deviation), so this will be a relatively common event. The good news is that, in one year out of six, you can realistically expect to earn more than 33 percent (13 percent plus one standard deviation).

The other important, practical thing to understand from this chapter is that a strategy of investing in very low risk assets (such as T-bills) has historically barely kept up with inflation. This might be sufficient for some investors, but if your goal is to do better than that, then you will have to bear some amount of risk to achieve it.

STOCK-TRAK FAST TRACK

PORTFOLIO TRADING SIMULATIONS WITH STOCK-TRAK

Stock-Trak provides an effective, low cost way to learn the basics of securities trading on the internet. With a Stock-Trak account, you can trade stocks, bonds, options, and futures through the Stock-Trak website (www.stocktrak.com). Stock-Trak trading is conducted in much the same way as you would trade through your own brokerage account with a broker that supports trading on the internet. With the Stock-Trak Portfolio Trading Simulation you gain valuable experience trading securities at actual market prices. However, you can't lose real money since Stock-Trak is a simulation.

This textbook contains several sections intended to provide specialized instructions on trading securities through Stock-Trak. We recommend that you start by reading the section *TRADING COMMONS STOCKS WITH STOCK-TRAK* at the end of Chapter 2. This section will bring you up to speed on the mechanics of trading common stocks on the internet Similar Stock-Trak sections are dispersed throughout the textbook. For example, the section *TRADING STOCK OPTIONS WITH STOCK-TRAK* at the end of Chapter 14 explains how ticker symbols for stock options must be constructed before submitting an order to trade stock options on the internet through Stock-Trak. Similarly, the section *TRADING FUTURES CONTRACTS WITH STOCK-TRAK* at the end of Chapter 16 discusses the intricacies of submitting orders to trade futures contracts. These sections are designed to supplement instructions provided by Stock-Trak in its brochure and at the Stock-Trak website (www.stocktrak.com). Remember, you can't lose real money with Stock-Trak, so feel free to experiment.

STOCK-TRAK EXERCISES

1. Log on to the Stock-Trak website at www.stocktrak.com.
2. While logged on to the Stock-Trak website, review the most current rules and regulations pertaining to Stock-Trak accounts.
3. Explore some of the Internet links to stock market research tools provided by Stock-Trak.

Chapter 1
A Brief History of Risk and Return

End of Chapter Questions and Problems

Review Problems and Self-Test

1. **Calculating Returns** You bought 400 shares of Metallica Heavy Metal, Inc., at \$30 per share. Over the year, you received \$0.75 per share in dividends. If the stock sold for \$33 at the end of the year, what was your dollar return? Your percentage return?

2. **Calculating Returns and Variability** Using the following returns, calculate the average returns, the variances, and the standard deviations for the following stocks:

Year	Michele, Inc.	Janicek Co.
1	12%	5%
2	-4	-15
3	0	10
4	20	38
5	2	17

Answers to Self-Test Problems

1. Your dollar return is just your gain or loss in dollars. Here, we receive \$.75 in dividends on each of our 400 shares, for a total of \$300. In addition, each share rose from \$30 to \$33, so we make \$3 × 400 shares = \$1,200 there. Our total dollar return is thus \$300 + 1,200 = \$1,500.

Our percentage return (or just “return” for short) is equal to the \$1,500 we made divided by our initial outlay of \$30 × 400 shares = \$12,000; so \$1,500/12,000 = .125 = 12.5%. Equivalently, we could have just noted that each share paid a \$.75 dividend and each share gained \$3, so the total dollar gain per share was \$3.75. As a percentage of the cost of one share (\$30), we get \$3.75/30 = .125 =12.5%.

2. First, calculate return averages as follows:

Michele, Inc.	Janicek Co.
12%	5%
-4	-15
0	10
20	38
2	17
30%	55%
30/ 5 = 6%	55/5 = 11%
average return	average return

Using the averages above, calculate the squared deviations from the average returns and sum the squared deviations as follows:

Michele, Inc.	Janicek Co.
$(12 - 6)^2 = 36$	$(5 - 11)^2 = 36$
$(-4 - 6)^2 = 100$	$(-15 - 11)^2 = 676$
$(0 - 6)^2 = 36$	$(10 - 11)^2 = 1$
$(20 - 6)^2 = 196$	$(38 - 11)^2 = 729$
$(2 - 6)^2 = 16$	$(17 - 11)^2 = 36$
384	1,478

Calculate return variances by dividing the sums of squared deviations by four, which is the number of returns less one.

384 / 4 = 96	1,478 / 4 = 369.5
Michele	Janicek

Standard deviations are then calculated as the square root of the variance.

$\sqrt{96} = 9.8\%$	$\sqrt{369.5} = 19.22\%$
Michele	Janicek

Test Your IQ (Investment Quotient)

1. **Stock Returns** A stock pays a $1.50 dividend and falls in price from $56.25 to $52.75. What is the stockholder's total dollar return?

    a. -$1.50
    b. -$2.00
    c. -$2.50
    d. -$3.00

2. **Stock Returns** A stock pays a $1 dividend and rises in price from $50 to $53. What is the stockholder's total percentage return?

    a. 8%
    b. 4%
    c. 5%
    d. -2%

3.. **Prices and Returns** Over a one-year period, a bond pays 7 percent interest and its price falls from $100 to $98. What is the bondholder's total realized one-year return?

    a. 9%
    b. 7%
    c. 5%
    d. -2%

4. **Prices and Returns** You plan to buy common stock and hold it for one year. You expect to receive both $1.50 in dividends and $26 from the sale of stock at the end of the year. If you wanted to earn a 15 percent return, what is the maximum price you would pay for the stock today? (*1994 CFA exam*)

    a. $22.61
    b. $23.91
    c. $24.50
    d. $27.50

5. **Return Components** The total dollar return on an investment is conventionally said to have two components. What are these two components?

    a. a cash payment and a capital gain or loss
    b. a dollar return and a percentage return
    c. a taxable component and a tax-exempt component
    d. principal and interest

6. **Investment Returns** Suppose the value of an investment doubles in a one-year period. In this case, the rate of return on this investment over that one-year period is what amount?

a. 100 percent even if the gain is not actually realized
b. 200 percent even if the gain is not actually realized
c. 100 percent only if the gain is actually realized
d. 200 percent only if the gain is actually realized

7.. **Investment Returns** Suppose the value of an investment decreases by half in a one-year period. In this case, the rate of return on this investment over that one-year period is what amount?

a. -100 percent even if the loss is not actually realized
b. -50 percent even if the loss is not actually realized
c. -100 percent only if the loss is actually realized
d. -50 percent only if the loss is actually realized

8. **Historical Returns** Which of the following asset categories has an annual returns history most closely linked to historical annual rates of inflation?

a. U,S. Treasury Bills
b. Corporate bonds
c. Large company stocks
d. Small company stocks

9. **Historical Returns** Based on the annual returns history since 1926, which asset category on average has yielded the highest risk premium?

a. U.S. government Bonds
b. Corporate bonds
c. Large company stocks
d. Small company stocks

10. **Financial Markets' Lessons** The first lesson of financial markets history is

a. don't put all your eggs in one basket
b. put all your eggs in one basket and watch that basket
c. buy low and sell high
d. risky assets on average earn a risk premium

11. **Stat 101** Over a four year period, an investment in T-Rex common stock yields returns of 30 percent, 0 percent, -10 percent, and 20 percent. What is the standard deviation of return for T-Rex stock over this four year period?

a. 10 percent
b. 21.6 percent
c. 20 percent
d. 18.3 percent

12. **Stat 101** You calculate an average historical return of 10 percent and a standard deviation of return of 10 percent for an investment in Stonehenge Construction Co. You believe these values represent well the future distribution of returns. Assuming that returns are normally distributed, what is the probability that Stonehenge Construction will yield a negative return?

a. 17 percent
b. 33 percent
c. 50 percent
d. 20 percent

13. **Stat 101** Given a data series that is normally distributed with a mean of 100 and a standard deviation of 10, about 95 percent of the numbers in the series will fall within which of the following ranges? (*1994 CFA exam*)

a. 60 to 140
b. 70 to 130
c. 80 to 120
d. 90 to 110

14. **Stat 101** For a given set of returns data, in addition to the mean you calculate these three risk measures: range (maximum minus minimum), variance, and standard deviation. Which of the following statements about these three risk measures is correct?

a. the variance is always larger than the standard deviation
b. the mean always lies between the minimum and the maximum
c. the range is always larger than the mean
d. the range is sometimes smaller than the standard deviation

15. **Stat 101** Which of the following statements about a normal distribution is incorrect?

a. a normal distribution is symmetrically centered on its mean
b. the probability of being within one standard deviation from the mean is about 33 percent
c. the probability of being within two standard deviations from the mean is about 5 percent
d. the probability of a negative value is always one-half

Questions and Problems

Core Questions

1. **Calculating Returns** Suppose you bought 200 shares of stock at an initial price of $42 per share. The stock paid a dividend of $2.40 per share during the following year, and the share price at the end of the year was $31. Compute your total dollar return on this investment. Does your answer change if you keep the stock instead of selling it? Why or why not?

2. **Calculating Yields** In the previous problem, what is the capital gains yield? The dividend yield? What is the total rate of return on the investment?

3. **Calculating Returns** Rework Problems 1 and 2 assuming that you buy 750 shares of the stock and the ending share price is $60.

4. **Historical Returns** What is the historical rate of return on each of the following investments? What is the historical risk premium on these investments?
a. Long-term government bonds
b. Treasury bills
c. Common stocks
d. Small stocks

5. **Calculating Average Returns** The rate of return on Jurassic Jalopies, Inc., stock over the last five years was 25 percent, 17 percent, -22 percent, 29 percent, and 8 percent. Over the same period, the return on Stonehenge Construction Company's stock was 9 percent, 13 percent, 3 percent, 16 percent, and 6 percent. What was the average return on each stock over this period?

6. **Calculating Returns and Variability** Using the following returns, calculate the average returns, the variances, and the standard deviations for stocks A and B.

Year	A	B
1	14%	22%
2	3	- 5
3	-6	-15
4	11	28
5	9	17

7. **Risk versus Return** Based on the historical record, rank the following investments in increasing order of risk. Rank the investments in increasing order of average returns. What do you conclude about the relationship between the risk of an investment and the return you expect to earn on it?

a. Common stocks
b. Treasury bills
c. Long-term government bonds
d. Small stocks

8. **Returns and the Bell Curve** An investment has an expected return of 10 percent per year with a standard deviation of 20 percent. Assuming that the returns on this investment are a least roughly normally distributed, how frequently do you expect to earn between -10 percent and +30 percent?

9. **Returns and the Bell Curve** An investment has an expected return of 6 percent per year with a standard deviation of 3 percent. Assuming that the returns on this investment are at least roughly normally distributed, how frequently do you expect to lose money?

10. **Using Returns Distributions** Based on the historical record, if you invest in U.S. Treasury bonds, what is the approximate probability that your return will be less than -2.94 percent in a given year? What range of returns would you expect to see 95 percent of the time? 99 percent of the time?

<u>Intermediate Questions</u>

11. **Using Returns Distributions** Based on the historical record, what is the approximate probability that an investment in small stocks will double in value in a single year? How about triple in a single year?

12. **More Returns Distributions** In the previous problem, what is the probability that the return on small stocks will be less than -100 percent in a single year (think about it)? What are the implications for the distribution of returns?

13. Risk Premiums Consider the following common stock and T-bill returns for the period 1980-1986:

Year	Common Stocks	T-Bills
1980	32.6%	12.0%
1981	-5.0	15.2
1982	21.7	11.3
1983	22.6	8.9
1984	6.2	10.0
1985	31.9	7.7
1986	18.7	6.2

a. Calculate the observed risk premium in each year for the common stocks.
b. Calculate the average returns and the average risk premium over this period.
c. Calculate the standard deviation of returns and the standard deviation of the risk premium.
d. Is it possible that the observed risk premium can be negative? Explain how this can happen and what it means.

14. Inflation and Returns Look at Table 1.1 and Figure 1.6. When were T-bill rates at their highest? Why do you think they were so high during this period?

15. Inflation and Returns The returns we have examined are not adjusted for inflation. What do you suppose would happen to our estimated risk premiums if we did account for inflation?

16. Taxes and Returns The returns we have examined are not adjusted for taxes. What do you suppose would happen to our estimated returns and risk premiums if we did account for taxes? What would happen to our volatility measures?

17. Taxes and Treasury Bills As a practical matter, most of the return you earn from investing in Treasury bills is taxed right away as ordinary income. Thus, if you are in a 40 percent tax bracket and you earn 5 percent on a Treasury bill, your aftertax return is only $.05\times(1 - .40) = .03$ or 3 percent. In other words, 40 percent of your return goes to pay taxes, leaving you with just 3 percent. Once you consider inflation and taxes, how does the long-term return from Treasury bills look?

18. The Long Run Given your answer to the last question and the discussion in the chapter, why would any rational person do anything other than load up on 100 percent small stocks?

Chapter 1
A Brief History of Risk and Return
Answers and solutions

Answers to Multiple Choice Questions

1. **B**
2. **A**
3. **C**
4. **B**
5. **A**
6. **A**
7. **B**
8. **A**
9. **D**
10. **D**
11. **D**
12. **A**
13. **C**
14. **B**
15. **D**

Answers to Questions and Problems

Core Questions

1. Dollar return = 200($31 – $42) + 200($2.40) = –$1,720. No, whether you choose to sell the stock or not does not affect the gain or loss for the year; your stock is worth what it would bring if you sold it. Whether you choose to do so or not is irrelevant (ignoring taxes).

2. Capital gains yield = ($31 – $42)/$42 = –26.19%
Dividend yield = $2.40/$42 = +5.71%
Total rate of return = –26.19% + 5.71% = –20.48%

3. Dollar return = 750($60 – $42) + 750($2.40) = $15,300
Capital gains yield = ($60 – $42)/$42 = 42.86%
Dividend yield = $2.40/$42 = 5.71%
Total rate of return = 42.86% + 5.71% = 48.6%

4. *a.* average return = 5.41%, average risk premium = 1.31%
b. average return = 4.10%, average risk premium = 0%
c. average return = 12.83%, average risk premium = 8.73%
d. average return = 17.21%, average risk premium = 13.11%

5. Jurassic average return = 11.4%; Stonehenge average return = 9.4%

6. A: average return = 6.20%, variance = 0.00627, standard deviation = 7.92%
B: average return = 9.40%, variance = 0.03413, standard deviation = 18.47%

7. For both risk and return, increasing order is *b, c, a, d*. On average, the higher the risk of an investment, the higher is its expected return.

8. That's plus or minus one standard deviation, so about two-thirds of time or two years out of three.

9. You lose money if you have a negative return. With a 6 percent expected return and a 3 percent standard deviation, a zero return is two standard deviations below the average. The odds of being outside (above or below) two standard deviations are 5 percent; the odds of being below are half that, or 2.5 percent. You should expect to lose money only 2.5 years out of every 100. It's a pretty safe investment.

10. Prob(Return < –2.94 or Return > 13.76) ≈ $^1/_3$, but we are only interested in one tail; Prob(Return < –2.94) ≈ $^1/_6$.
95% level: 5.41 ± 2σ = 5.41 ± 2(8.35) = –11.29% to 22.11%
99% level: 5.41 ± 3σ = 5.41 ± 3(8.35) = –19.64% to 30.46%

Intermediate Questions

11. Expected return = 17.21% ; σ = 34.34%. Doubling your money is a 100% return, so if the return distribution is normal, "*z*" = (100–17.21)/34.31 = 2.41 standard deviations; this is in between two and three standard deviations, so the probability is small, somewhere between .5% and 2.5% (why?). (Referring to the nearest "*z*" table, the actual probability is ≈ 1%, or once every 100 years.) Tripling your money would be "*z*" = (200–17.21)/34.31 = 5.32 standard deviations; this corresponds to a probability of (much) less than 0.5%, or once every 200 years. (The actual answer is less than once every 1 million years; don't hold your breath).

12. It is impossible to lose more than –100 percent of your investment. Therefore, return distributions are cut off on the lower tail at –100 percent; if returns were truly normally distributed, you could lose much more.

13.

Year	Common stocks	T-bill return	Risk premium
1980	32.6%	12.0%	21.6%
1981	–5.0	15.2	–20.2
1982	21.7	11.3	10.4
1983	22.6	8.9	13.7
1984	6.2	10.0	– 3.8
1985	31.9	7.7	24.2
1986	18.7	6.2	12.5
	128.7	71.3	57.4

a. Annual risk premium = common stock return – T-bill return (see table above).

b. Average returns: Common stocks = 128.7 / 7 = 18.4% ; T-bills = 71.3 / 7 = 10.2%, Risk premium = 57.4 / 7 = 8.2%

c. Common stocks: Var = 1/6{ $(.326–.184)^2$ + $(–.05–.184)^2$ + $(.217–.184)^2$ + $(.226–.184)^2$ + $(.062–.184)^2$ + $(.319–.184)^2$ + $(.187–.184)^2$ } = 0.01848

Standard deviation = $(0.01848)^{1/2}$ = 0.1359 = 13.59%

T-bills: Var = 1/6{ $(.120–.102)^2$ + $(.152–.102)^2$ + $(.113–.102)^2$ + $(.089–.102)^2$ + $(.100–.102)^2$ + $(.077–.102)^2$ + $(.062–.102)^2$ } = 0.00089

Standard deviation = $(0.00089)^{1/2}$ = 0.02984 = 2.98%

Risk premium: Var = 1/6{ $(.206–.082)^2$ + $(–.202–.082)^2$ + $(.104–.082)^2$ + $(.137–.082)^2$ + $(–.038–.082)^2$ + $(.242–.082)^2$ + $(.125–.082)^2$ } = 0.02356

Standard deviation = $(0.02356)^{1/2}$ = 0.1528 = 15.35%

d. Before the fact, the risk premium will be positive; investors demand compensation over and above the risk-free return to invest their money in the risky asset. After the fact, the observed risk premium can be negative if the asset's nominal return is unexpectedly low, the risk-free return is unexpectedly high, or any combination of these two events.

14. T-bill rates were highest in the early eighties; inflation at the time was relatively high. As we discuss in our chapter on interest rates, rates on T-bills will almost always be slightly higher than the rate of inflation.

15. Risk premiums are about the same whether or not we account for inflation. The reason is that risk premiums are the difference between two returns, so inflation essentially nets out.

16. Returns, risk premiums, and volatility would all be lower than we estimated because aftertax returns are smaller than pretax returns.

17. We've seen that T-bills barely kept up with inflation before taxes. After taxes, investors in T-bills actually lost ground (assuming anything other than a very low tax rate). Thus, an all T-bill strategy will probably lose money in real dollars for a taxable investor.

18. It's important not to lose sight of the fact that the results we have discussed cover well over 70 years, well beyond the investing lifetime for most of us. There have been extended periods during which small stocks have done terribly. Thus, one reason most investors will chose not to pursue a 100 percent stock strategy is that many investors have relatively short horizons, and high volatility investments may be very inappropriate in such cases. There are other reasons, but we will defer discussion of these to later chapters.

Table 1.1 Annual Returns 1926-1961

Year	S&P 500	T-Bonds	T-Bills	CPI
1926	13.70%	6.50%	4.41%	-1.12%
1927	35.78%	4.52%	4.21%	-2.26%
1928	45.15%	0.05%	4.87%	-1.16%
1929	-8.86%	5.77%	6.03%	0.58%
1930	-25.22%	4.18%	3.75%	-6.40%
1931	-43.76%	0.32%	2.62%	-9.32%
1932	-8.40%	5.63%	2.91%	-10.27%
1933	53.12%	6.02%	1.69%	0.76%
1934	-2.42%	5.94%	1.06%	1.52%
1935	46.98%	3.29%	0.26%	2.99%
1936	32.33%	1.67%	0.14%	1.45%
1937	-35.68%	4.69%	0.45%	2.86%
1938	32.26%	4.79%	0.05%	-2.78%
1939	-1.55%	2.26%	0.02%	0.00%
1940	-10.50%	4.31%	0.01%	0.71%
1941	-12.14%	1.54%	0.09%	9.93%
1942	20.98%	1.80%	0.32%	9.03%
1943	25.50%	2.01%	0.37%	2.96%
1944	19.48%	2.27%	0.38%	2.30%
1945	36.33%	5.29%	0.38%	2.25%
1946	-8.48%	0.54%	0.38%	18.13%
1947	4.96%	-1.02%	0.57%	8.84%
1948	4.93%	2.66%	1.04%	2.99%
1949	17.76%	4.58%	1.12%	-2.07%
1950	30.03%	-0.98%	1.21%	5.93%
1951	23.88%	-0.20%	1.54%	6.00%
1952	18.44%	2.43%	1.74%	0.75%
1953	-1.11%	2.28%	1.95%	0.75%
1954	52.43%	3.08%	0.96%	-0.74%
1955	31.64%	-0.73%	1.70%	0.37%
1956	6.90%	-1.72%	2.68%	2.99%
1957	-10.53%	6.82%	3.30%	2.90%
1958	43.73%	-1.72%	1.81%	1.76%
1959	12.02%	-2.02%	3.34%	1.73%
1960	0.45%	11.21%	3.13%	1.36%
1961	26.89%	2.20%	2.35%	0.67%

Table 1.1 Annual Returns 1962-1997

Year	S&P 500	T-Bonds	T-Bills	CPI
1962	-8.79%	6.04%	2.80%	1.33%
1963	22.72%	1.39%	3.16%	1.64%
1964	16.43%	3.87%	3.59%	0.97%
1965	12.38%	1.00%	3.98%	1.92%
1966	-10.10%	4.79%	4.93%	3.46%
1967	24.04%	-2.48%	4.49%	3.04%
1968	11.04%	1.57%	5.39%	4.72%
1969	-8.47%	-4.98%	6.81%	6.20%
1970	4.00%	18.31%	6.70%	5.57%
1971	14.35%	11.49%	4.50%	3.27%
1972	18.99%	2.44%	4.06%	3.41%
1973	-14.85%	3.43%	6.98%	8.71%
1974	-26.58%	3.75%	8.09%	12.34%
1975	37.42%	5.60%	6.03%	6.94%
1976	23.76%	15.32%	5.15%	4.86%
1977	-7.38%	0.45%	5.28%	6.70%
1978	6.54%	-1.15%	7.23%	9.02%
1979	18.59%	0.37%	10.30%	13.29%
1980	32.61%	-0.80%	12.04%	12.52%
1981	-4.97%	2.46%	15.23%	8.92%
1982	21.67%	44.44%	11.27%	3.83%
1983	22.57%	1.90%	8.90%	3.79%
1984	6.19%	16.00%	10.04%	3.95%
1985	31.85%	30.67%	7.70%	3.80%
1986	18.68%	23.13%	6.18%	1.10%
1987	5.22%	-3.43%	5.86%	4.43%
1988	16.58%	6.83%	6.73%	4.42%
1989	31.75%	18.81%	8.49%	4.65%
1990	-3.13%	7.23%	7.84%	6.11%
1991	30.53%	18.70%	5.71%	3.06%
1992	7.62%	8.54%	3.57%	2.90%
1993	10.07%	13.59%	3.08%	2.75%
1994	1.27%	-7.55%	4.15%	2.67%
1995	37.80%	25.21%	5.64%	2.54%
1996	22.74%	1.54%	5.12%	3.32%
1997	33.43%	10.97%	5.22%	1.70%

Figure 1.1 Investment Returns

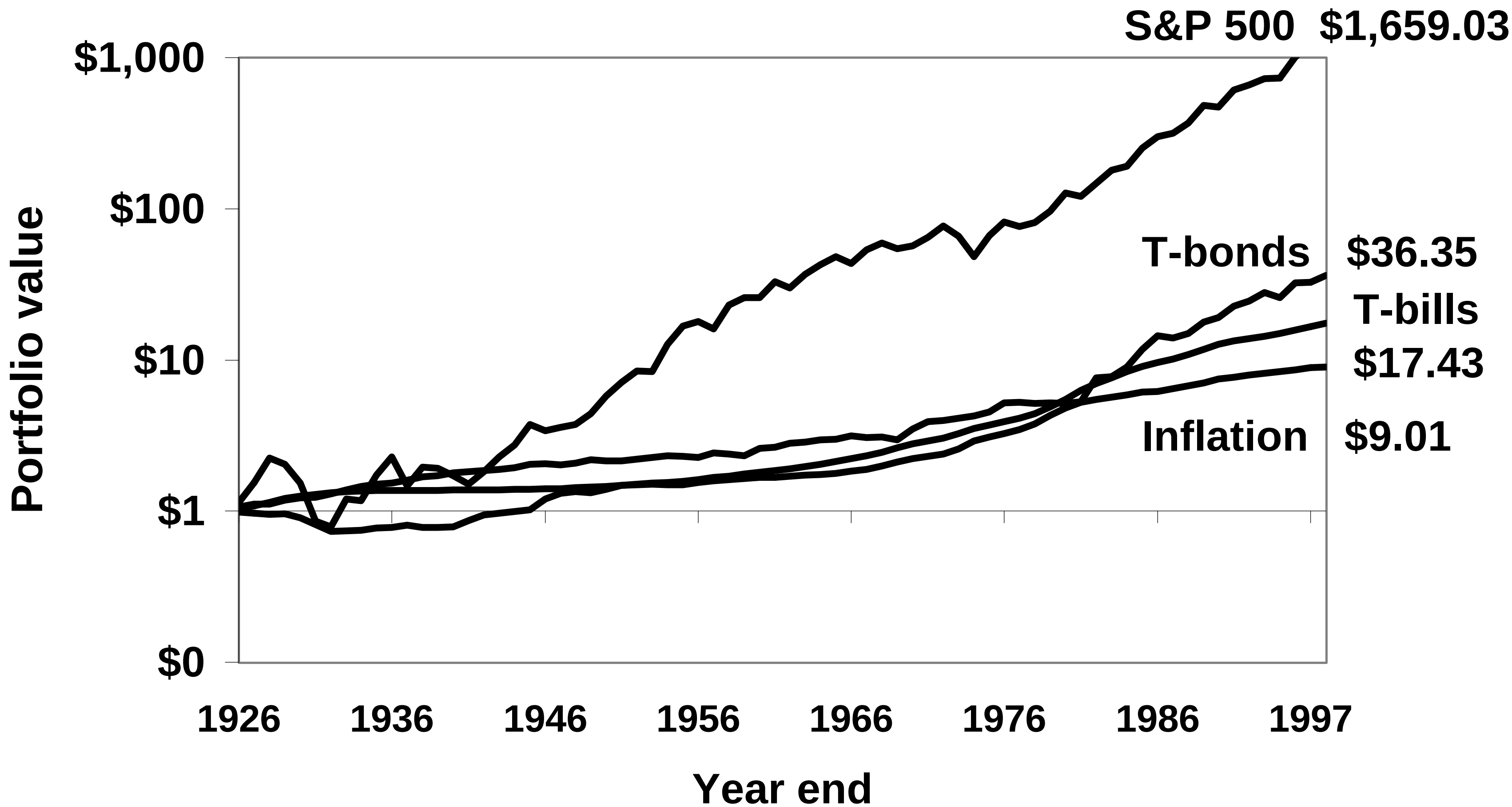

Figure 1.2 International Stock Indexes

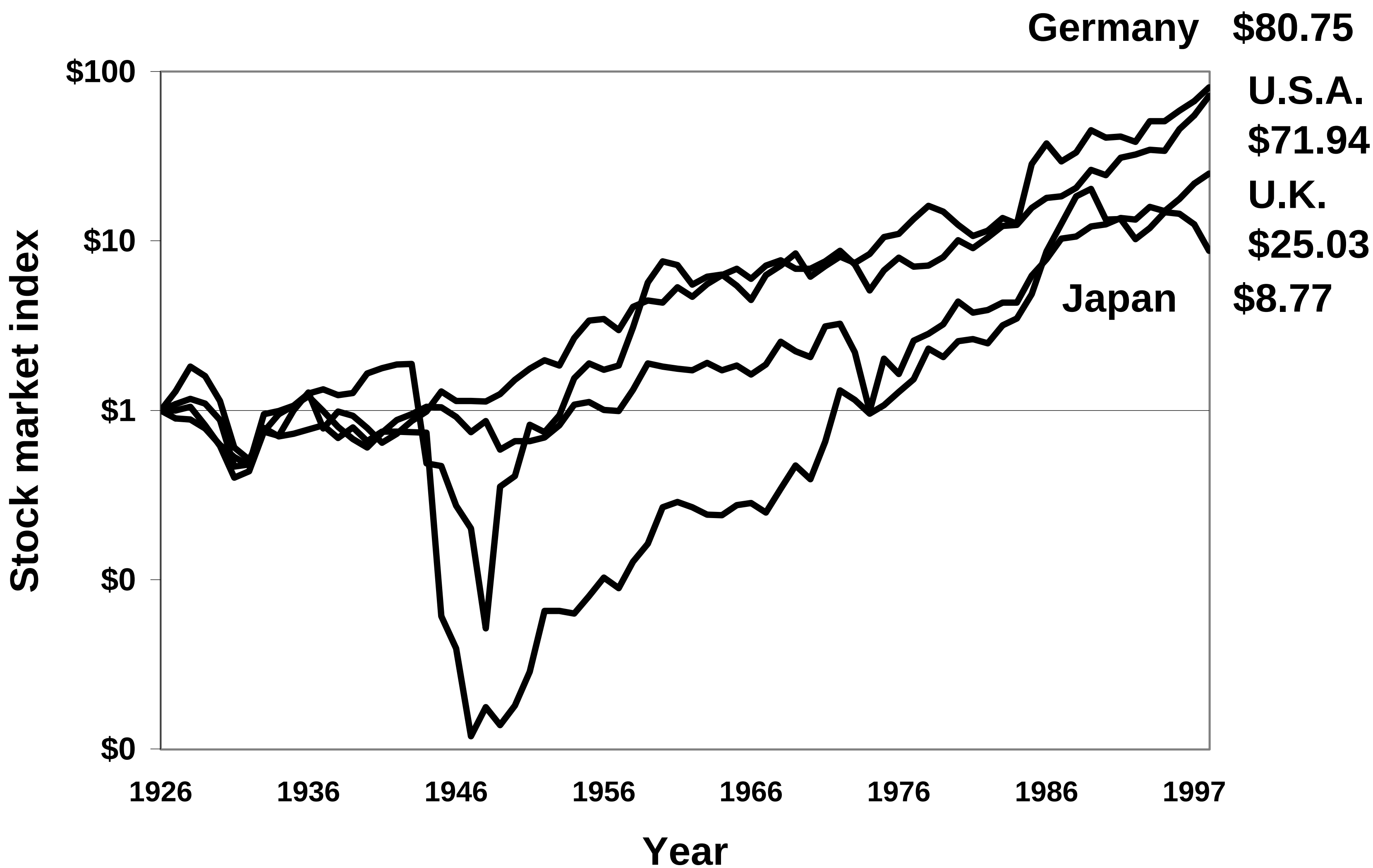

Figure 1.3. Financial Market History

Total Return Indexes (1802-1997)

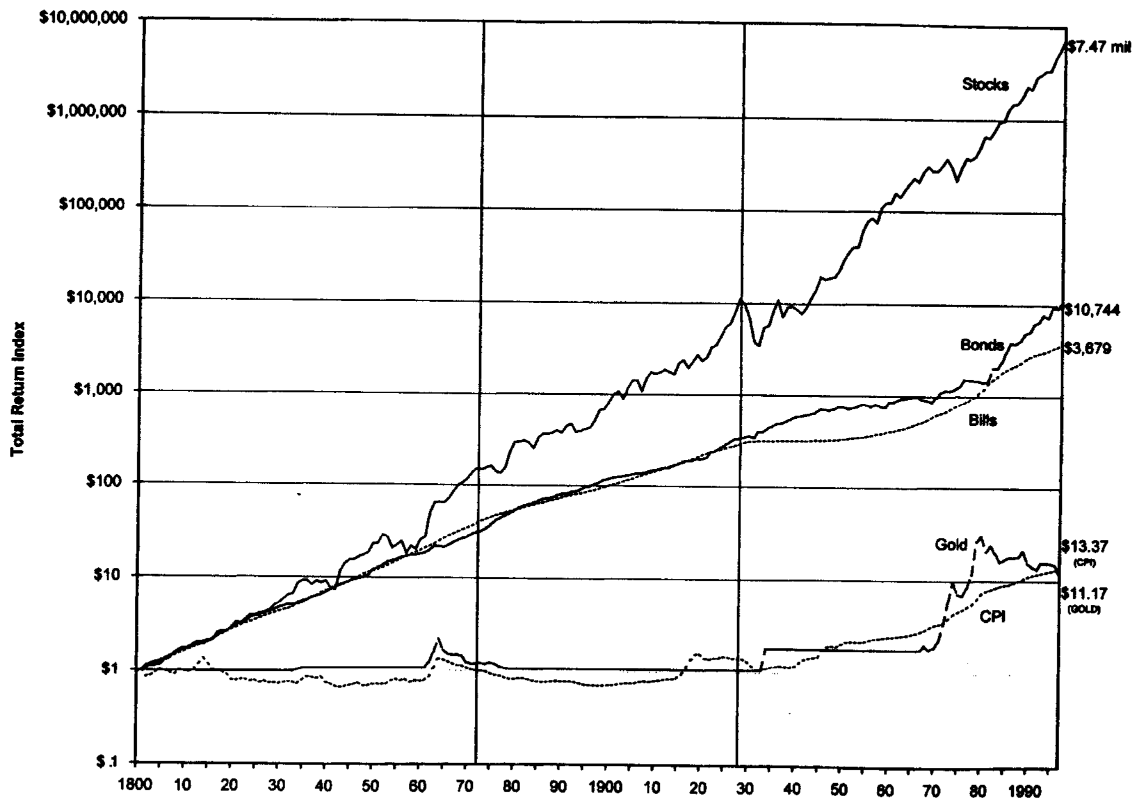

Figure 1.4 S&P 500 Annual Returns

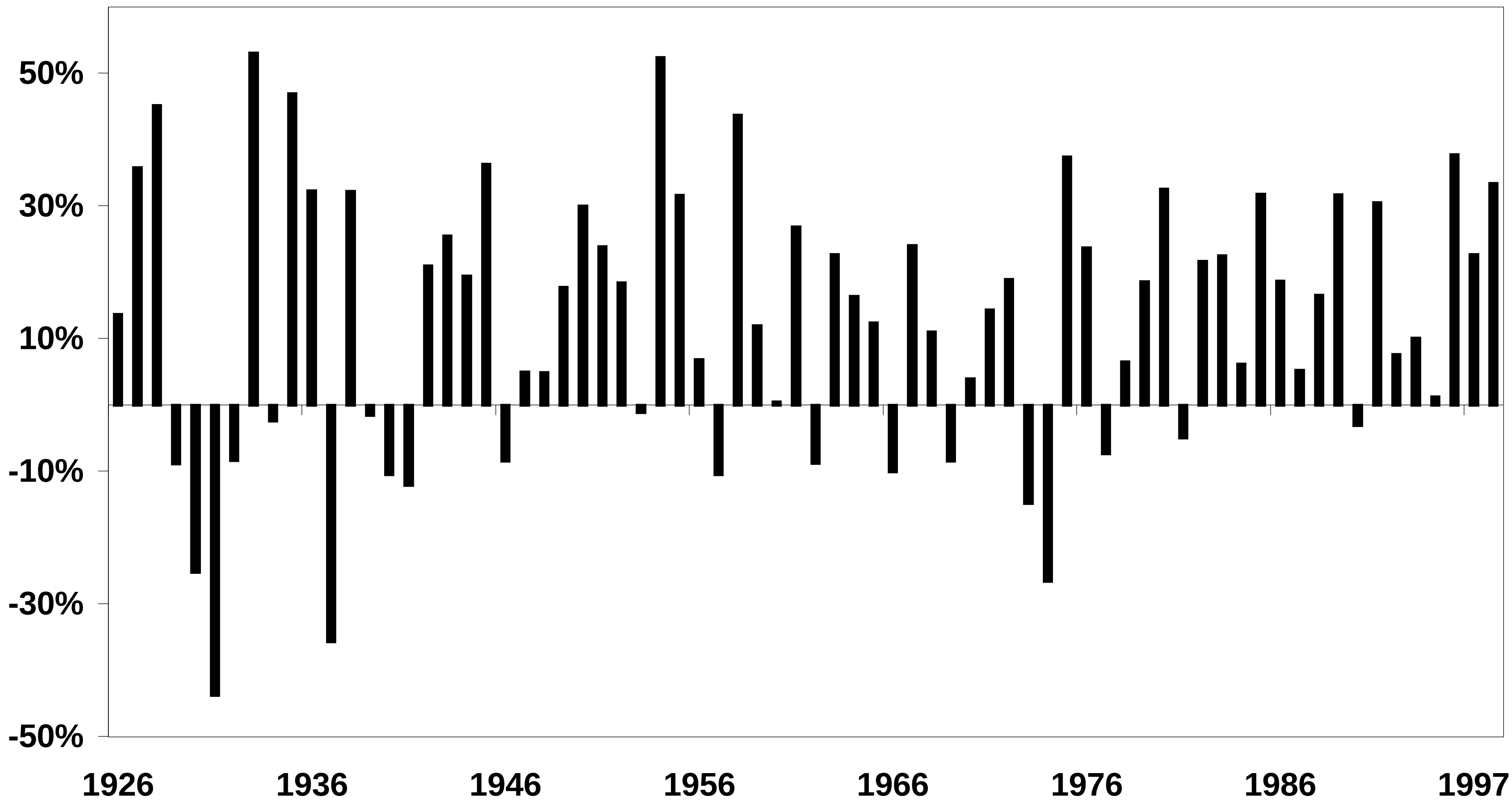

Figure 1.5 U.S. Treasury Bond Annual Returns

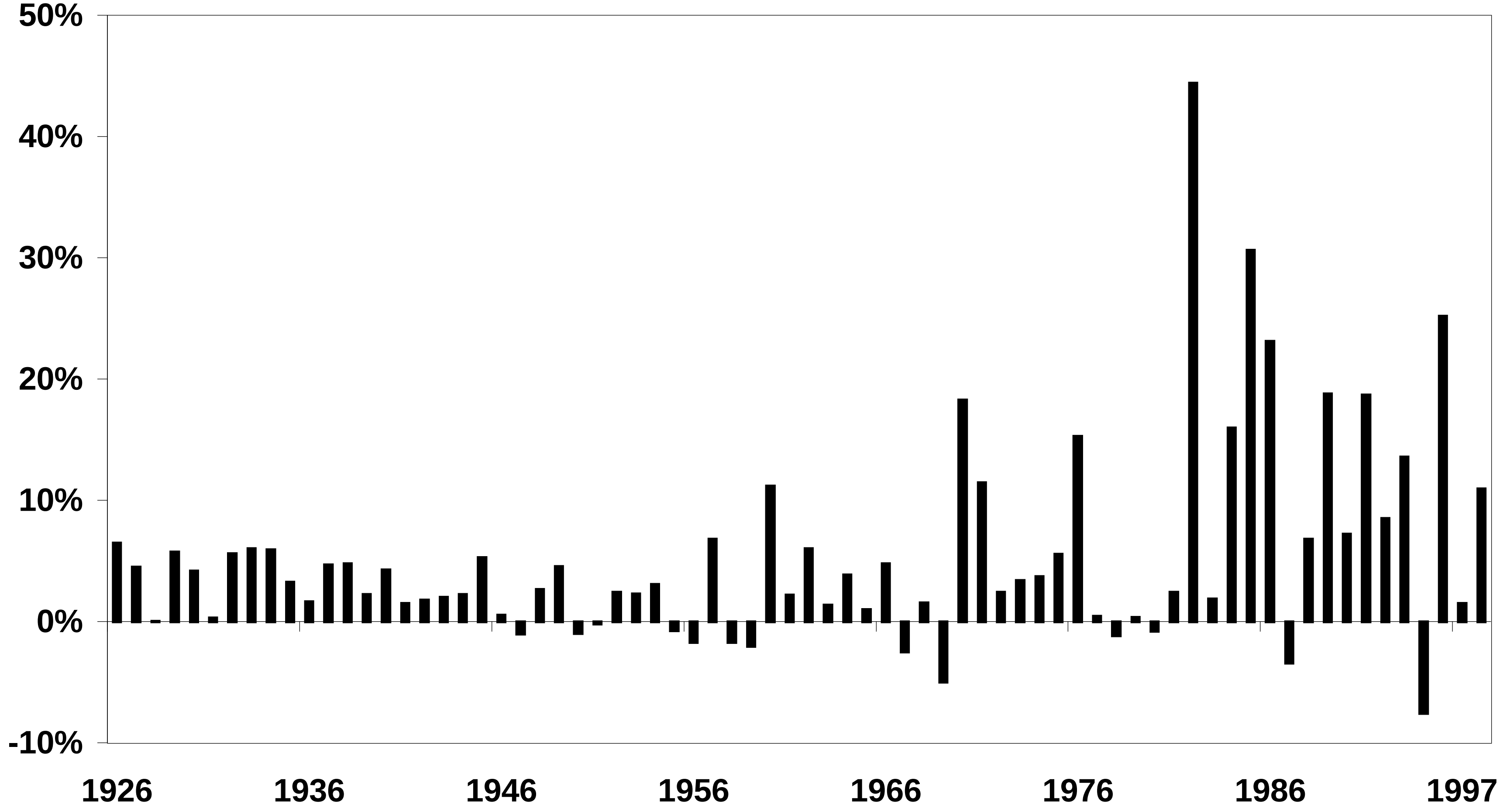

Figure 1.6 U.S. Treasury Bill Annual Returns

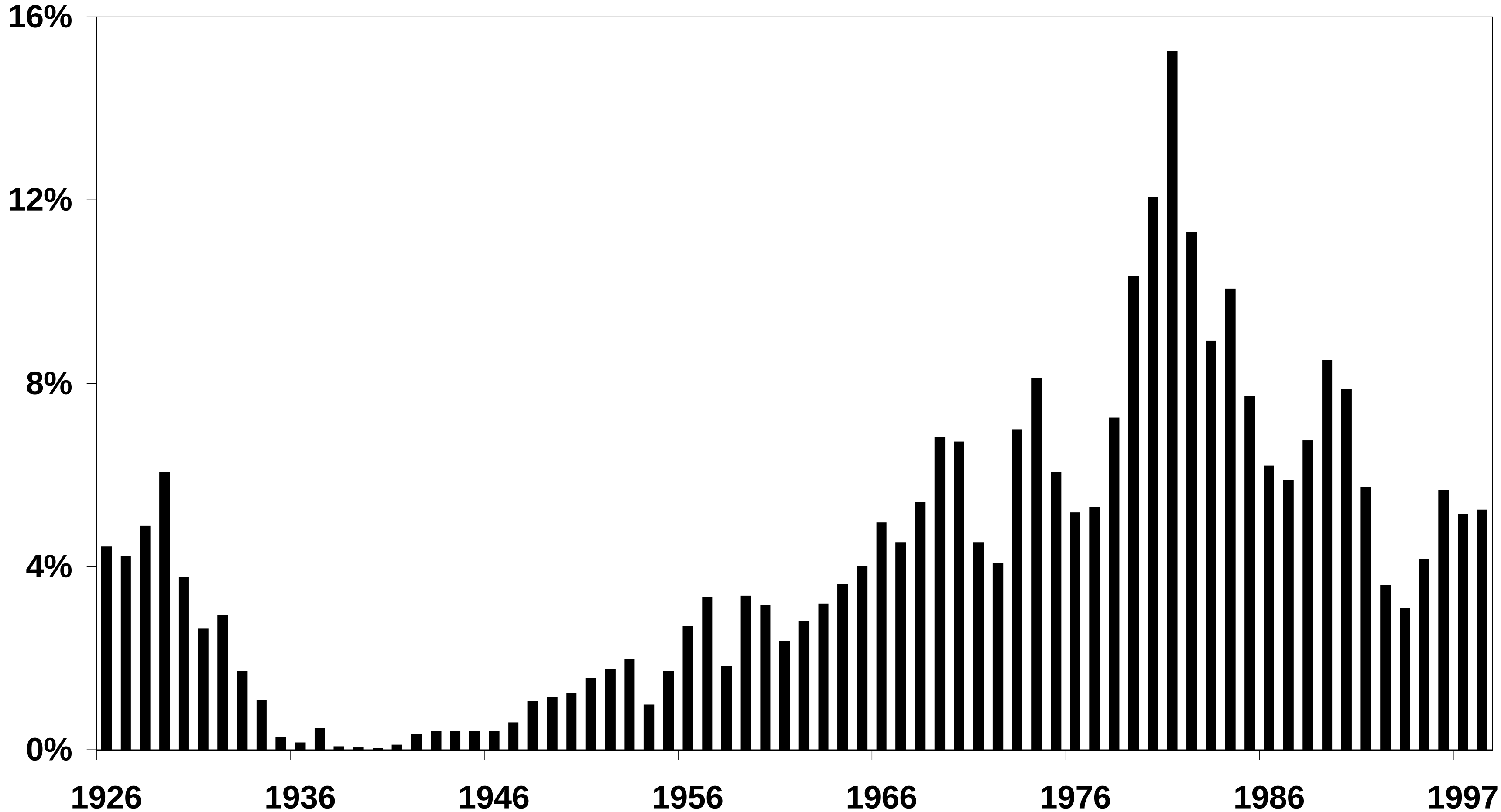

Figure 1.7 Nikkei 225

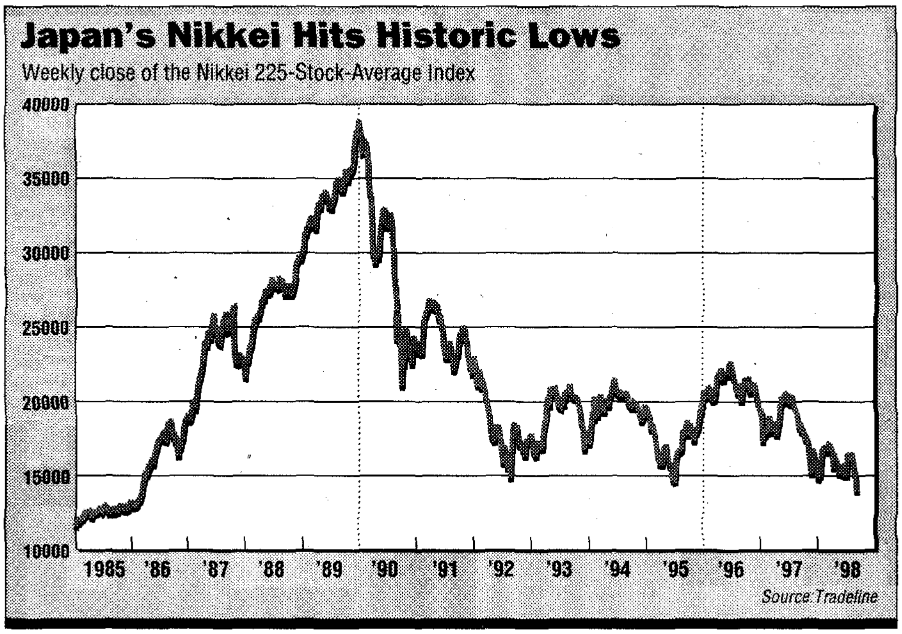

Figure 1.8 S&P 500 Return Frequencies

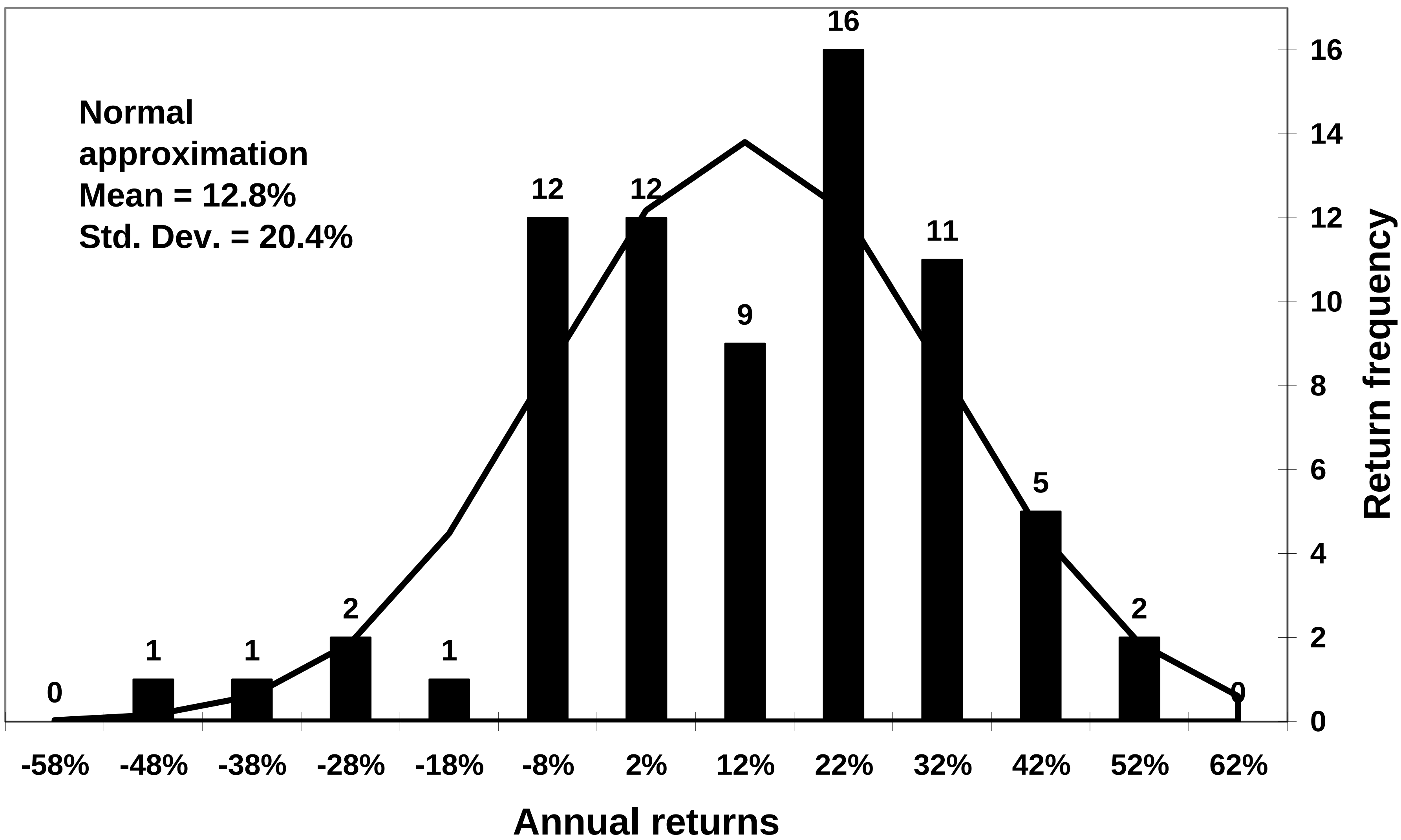

Figure 1.9 Risk / Return Tradeoff