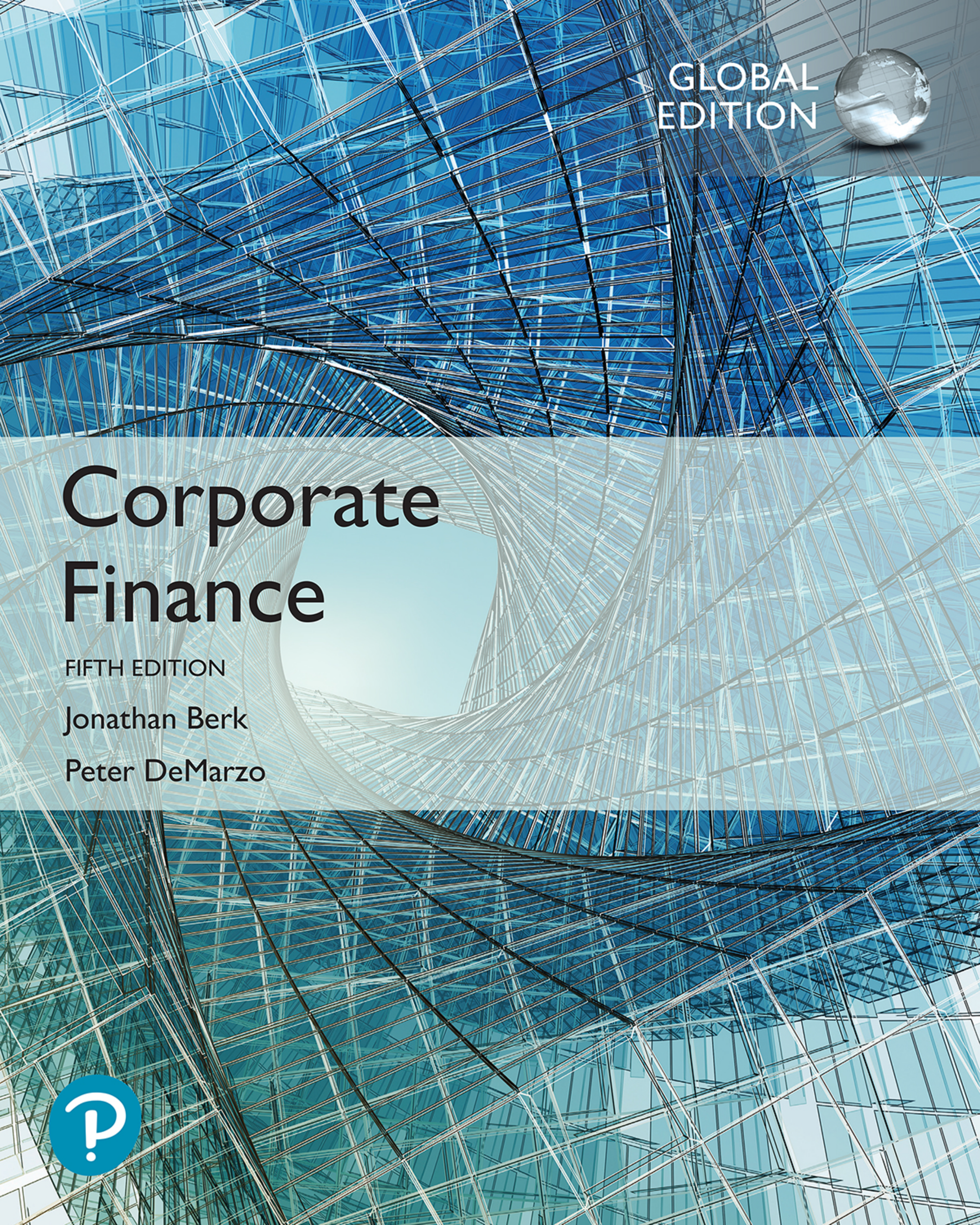

GLOBAL EDITION

Corporate Finance

FIFTH EDITION

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COMMON SYMBOLS AND NOTATION

A	market value of assets, premerger total value of acquirer
APR	annual percentage rate
B	risk-free investment in the replicating portfolio
C	cash flow, call option price
$Corr(R_i, R_j)$	correlation between returns of i and j
$Cov(R_i, R_j)$	covariance between returns of i and j
CPN	coupon payment
D	market value of debt
d	debt-to-value ratio
Div_t	dividends paid in year t
dis	discount from face value
E	market value of equity
EAR	effective annual rate
$EBIT$	earnings before interest and taxes
$EBITDA$	earnings before interest, taxes, depreciation, and amortization
EPS_t	earnings per share on date t
$E[R_i]$	expected return of security i
F, F_T	one-year and T-year forward exchange rate
FCF_t	free cash flow at date t
FV	future value, face value of a bond
g	growth rate
I	initial investment or initial capital committed to the project
Int_t	interest expense on date t
IRR	internal rate of return
K	strike price
k	interest coverage ratio, compounding periods per year
L	lease payment, market value of liabilities
ln	natural logarithm
MV_i	total market capitalization of security i
N	number of cash flows, terminal date, notational principal of a swap contract
N_i	number of shares outstanding of security i
$NPER$	annuity spreadsheet notation for the number of periods or dates of the last cash flow
NPV	net present value
P	price, initial principal or deposit, or equivalent present value, put option price
P_i	price of security i
P/E	price-earnings ratio
PMT	annuity spreadsheet notation for cash flow
PV	present value; annuity spreadsheet notation for the initial amount
q	dividend yield
p	risk-neutral probability
r	interest rate, discount rate of cost of capital
R_i	return of security i
R_{mkt}	return of the market portfolio
R_P	return on portfolio P
RATE	annuity spreadsheet notation for interest rate
r_E, r_D	equity and debt costs of capital
r_f	risk-free interest rate
r_i	required return or cost of capital of security i
r_U	unlevered cost of capital
r_{wacc}	weighted average cost of capital
S	stock price, spot exchange rate, value of all synergies
$SD(R_i)$	standard deviation (volatility) of return of security i
T	option expiration date, maturity date, market value of target
U	market value of unlevered equity
V_t	enterprise value on date t
$Var(R)$	variance of return R
x_i	portfolio weight of investment in i
YTC	yield to call on a callable bond
YTM	yield to maturity
α_i	alpha of security i
β_D, β_E	beta of debt or equity
β_i	beta of security i with respect to the market portfolio
β_s^P	beta of security i with respect to portfolio P
β_U	beta of unlevered firm
Δ	shares of stock in the replicating portfolio; sensitivity of option price to stock price
σ	volatility
τ	tax rate
τ_c	marginal corporate tax rate

CHAPTER

10

Capital Markets and the Pricing of Risk

NOTATION

p_R	probability of return R
$Var(R)$	variance of return R
$SD(R)$	standard deviation of return R
$E[R]$	expectation of return R
Div_t	dividend paid on date t
P_t	price on date t
R_t	realized or total return of a security from date $t-1$ to t
$\overline{R}$	average return
β_s	beta of security s
r	cost of capital of an investment opportunity

OVER THE TEN-YEAR PERIOD 2008 THROUGH 2017, INVESTORS IN the consumer products firm Procter & Gamble (PG) earned an average return of 6% per year. Within this period, there was some variation, with the annual return ranging from −14% in 2008 to 24% in 2013. Over the same period, investors in the computer networking firm Netgear (NTGR) earned an average return of 14% per year. These investors, however, lost 68% in 2008 and gained over 90% in 2009. Finally, investors in three-month U.S. Treasury bills earned an average annual return of 0.4% during the period, with a high of 2.0% in 2008 and a low of 0.04% in 2014. Clearly, these three investments offered returns that were very different in terms of their average level and their variability. What accounts for these differences?

In this chapter, we will consider why these differences exist. Our goal is to develop a theory that explains the relationship between average returns and the variability of returns and thereby derive the risk premium that investors require to hold different securities and investments. We then use this theory to explain how to determine the cost of capital for an investment opportunity.

We begin our investigation of the relationship between risk and return by examining historical data for publicly traded securities. We will see, for example, that while stocks are riskier investments than bonds, they have also earned higher average returns. We can interpret the higher average return on stocks as compensation to investors for the greater risk they are taking.

But we will also find that not all risk needs to be compensated. By holding a portfolio containing many different investments, investors can eliminate risks that are specific to individual securities. Only those risks that cannot be eliminated by holding a large portfolio determine the risk premium required by investors. These observations will allow us to refine our definition of what risk is, how we can measure it, and thus, how to determine the cost of capital.

10.1 Risk and Return: Insights from 92 Years of Investor History

We begin our look at risk and return by illustrating how risk affects investor decisions and returns. Suppose your great-grandparents invested $100 on your behalf at the end of 1925. They instructed their broker to reinvest any dividends or interest earned in the account until the beginning of 2018. How would that $100 have grown if it were placed in one of the following investments?

1. Standard & Poor's 500 (S&P 500): A portfolio, constructed by Standard and Poor's, comprising 90 U.S. stocks up to 1957 and 500 U.S. stocks after that. The firms represented are leaders in their respective industries and are among the largest firms, in terms of market value, traded on U.S. markets.
2. Small Stocks: A portfolio, updated quarterly, of U.S. stocks traded on the NYSE with market capitalizations in the bottom 20%.
3. World Portfolio: A portfolio of international stocks from all of the world's major stock markets in North America, Europe, and Asia.[1]
4. Corporate Bonds: A portfolio of long-term, AAA-rated U.S. corporate bonds with maturities of approximately 20 years.[2]
5. Treasury Bills: An investment in one-month U.S. Treasury bills.

Figure 10.1 shows the result, through the start of 2018, of investing $100 at the end of 1925 in each of these five investment portfolios, ignoring transactions costs. During this 92-year period in the United States, small stocks experienced the highest long-term return, followed by the large stocks in the S&P 500, the international stocks in the world portfolio, corporate bonds, and finally Treasury bills. All of the investments grew faster than inflation, as measured by the consumer price index (CPI).

At first glance the graph is striking—had your great-grandparents invested $100 in the small stock portfolio, the investment would be worth nearly $5.8 million at the beginning of 2018! By contrast, if they had invested in Treasury bills, the investment would be worth only about $2,000. Given this wide difference, why invest in anything other than small stocks?

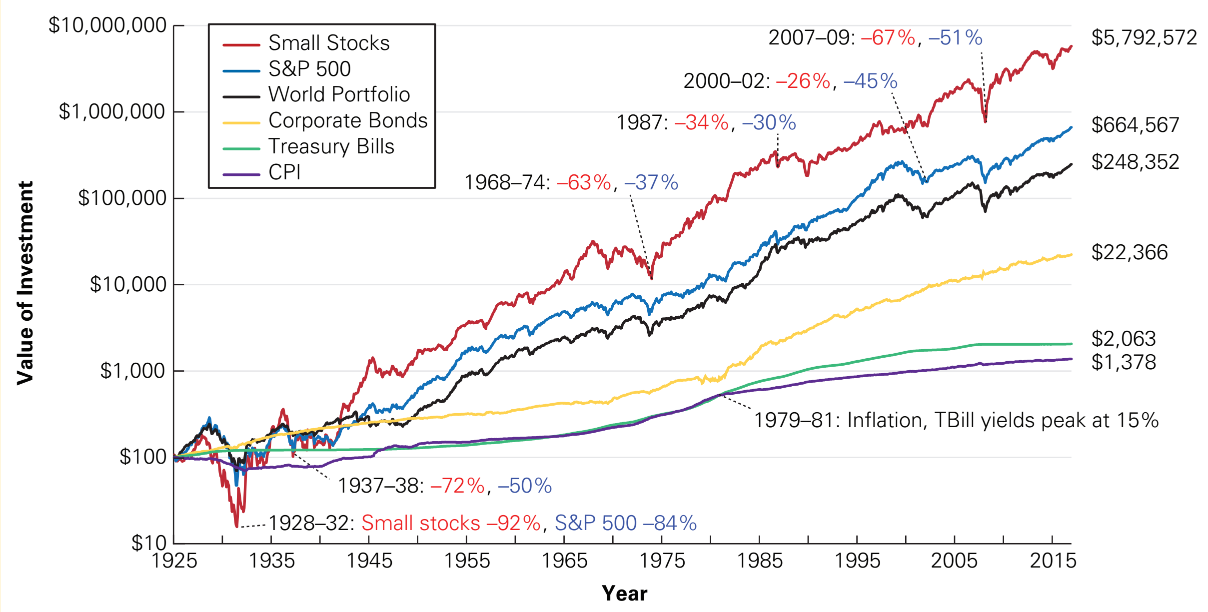
But first impressions can be misleading. While over the full horizon stocks (especially small stocks) did outperform the other investments, they also endured periods of significant losses. Had your great-grandparents put the $100 in a small stock portfolio during the Depression era of the 1930s, it would have grown to $181 in 1928, but then fallen to only $15 by 1932. Indeed, it would take until World War II for stock investments to outperform corporate bonds.

Even more importantly, your great-grandparents would have sustained losses at a time when they likely needed their savings the most—in the depths of the Great Depression. A similar story held during the 2008 financial crisis: All of the stock portfolios declined by more than 50%, with the small stock portfolio declining by almost 70% (over $1.5 million!) from its peak in 2007 to its lowest point in 2009. Again, many investors faced a double whammy: an increased risk of being unemployed (as firms started laying off employees)

[1] Based on a World Market Index constructed by Global Financial Data, with approximate initial weights of 44% North America, 44% Europe, and 12% Asia, Africa, and Australia.

[2] Based on Global Financial Data's Corporate Bond Index.

FIGURE 10.1 **Value of $100 Invested in 1925 in Stocks, Bonds, or Bills**



The chart shows the growth in value of $100 invested in 1925 if it were invested in U.S. large stocks, small stocks, world stocks, corporate bonds, or Treasury bills, with the level of the consumer price index (CPI) shown as a reference. Returns were calculated at year-end assuming all dividends and interest are reinvested and excluding transactions costs. Note that while stocks have generally outperformed bonds and bills, they have also endured periods of significant losses (numbers shown represent peak to trough decline, with the decline in small stocks in red and the S&P 500 in blue).

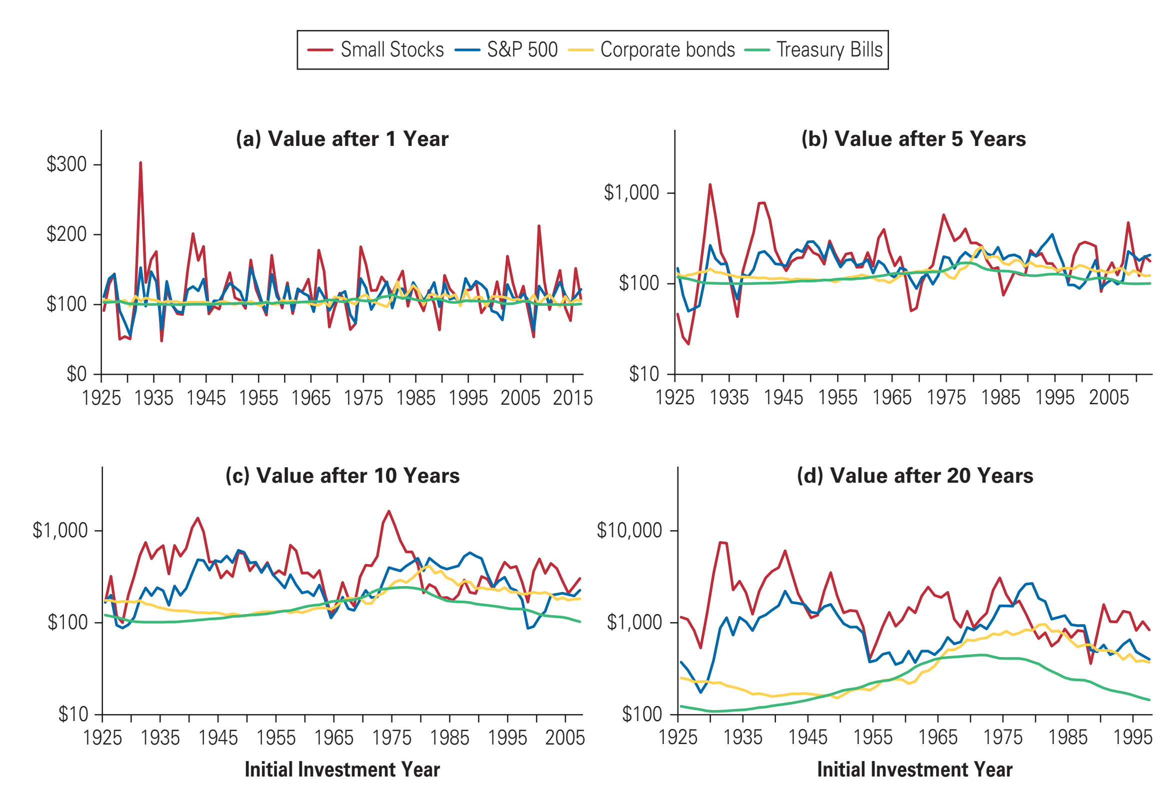
Source: Chicago Center for Research in Security Prices, Standard and Poor's, MSCI, and Global Financial Data

precisely when the value of their savings eroded. Thus, while the stock portfolios had the best performance over this 92-year period, that performance came at a cost—the risk of large losses in a downturn. On the other hand, Treasury bills enjoyed steady—albeit modest—gains each year.

Few people ever make an investment for 92 years, as depicted in Figure 10.1. To gain additional perspective on the risk and return of these investments, Figure 10.2 shows the results for more realistic investment horizons and different initial investment dates. Panel (a), for example, shows the value of each investment after one year and illustrates that if we rank the investments by the volatility of their annual increases and decreases in value, we obtain the same ranking we observed with regard to performance: Small stocks had the most variable returns, followed by the S&P 500, the world portfolio, corporate bonds, and finally Treasury bills.

Panels (b), (c), and (d) of Figure 10.2 show the results for 5-, 10-, and 20-year investment horizons, respectively. Note that as the horizon lengthens, the relative performance of the stock portfolios improves. That said, even with a 10-year horizon there were periods during which stocks underperformed Treasuries. And while investors in small stocks most often came out ahead, this was not assured even with a 20-year horizon: For investors in

FIGURE 10.2 **Value of $100 Invested in Alternative Assets for Differing Horizons**



Each panel shows the result of investing $100, in each investment opportunity, for horizons of 1, 5, 10, or 20 years, plotted as a function of the year when the investment was initially made. Dividends and interest are reinvested and transaction costs are excluded. Note that small stocks show the greatest variation in performance at the one-year horizon, followed by large stocks and then corporate bonds. For longer horizons, the relative performance of stocks improved, but they remained riskier.

Source Data: Chicago Center for Research in Security Prices, Standard and Poor's, MSCI, and Global Financial Data

the early 1980s, small stocks did worse than both the S&P 500 *and* corporate bonds over the subsequent 20 years. Finally, stock investors with long potential horizons might find themselves in need of cash in intervening years, and be forced to liquidate at a loss relative to safer alternatives.

In Chapter 3, we explained why investors are averse to fluctuations in the value of their investments, and that investments that are more likely to suffer losses in downturns must compensate investors for this risk with higher expected returns. Figures 10.1 and 10.2 provide compelling historical evidence of this relationship between risk and return, just as we should expect in an efficient market. Given this clear evidence that investors do not like risk and thus demand a risk premium to bear it, our goal in this chapter is to quantify this relationship. We want to explain *how much* investors demand (in terms of a higher expected return) to bear a given level of risk. To do so, we must first develop tools that will allow us to measure risk and return. That is our objective in the next section.

CONCEPT CHECK

1. For an investment horizon from 1926 to 2017, which of the following investments had the highest return: the S&P 500, small stocks, world portfolio, corporate bonds, or Treasury bills? Which had the lowest return?
2. For an investment horizon of just one year, which of these investments was the most variable? Which was the least variable?

10.2 Common Measures of Risk and Return

When a manager makes an investment decision or an investor purchases a security, they have some view as to the risk involved and the likely return the investment will earn. Thus, we begin our discussion by reviewing the standard ways to define and measure risks.

Probability Distributions

Different securities have different initial prices, pay different cash flows, and sell for different future amounts. To make them comparable, we express their performance in terms of their returns. The return indicates the percentage increase in the value of an investment per dollar initially invested in the security. When an investment is risky, there are different returns it may earn. Each possible return has some likelihood of occurring. We summarize this information with a **probability distribution**, which assigns a probability, p_R, that each possible return, R, will occur.

Let's consider a simple example. Suppose BFI stock currently trades for \$100 per share. You believe that in one year there is a 25% chance the share price will be \$140, a 50% chance it will be \$110, and a 25% chance it will be \$80. BFI pays no dividends, so these payoffs correspond to returns of 40%, 10%, and −20%, respectively. Table 10.1 summarizes the probability distribution for BFI's returns.

We can also represent the probability distribution with a histogram, as shown in Figure 10.3.

Expected Return

Given the probability distribution of returns, we can compute the expected return. We calculate the **expected (or mean) return** as a weighted average of the possible returns, where the weights correspond to the probabilities.[3]

Expected (Mean) Return

$$\text{Expected Return} = E[R] = \sum_R p_R \times R \qquad (10.1)$$

TABLE 10.1 Probability Distribution of Returns for BFI

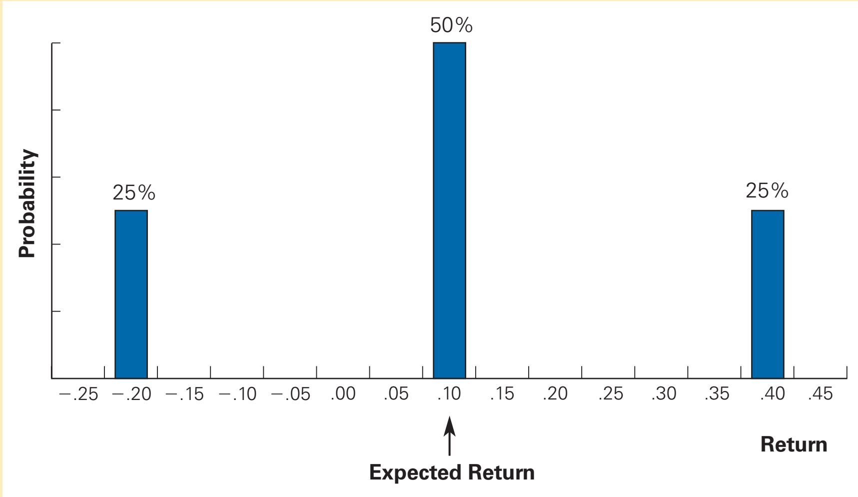
		Probability Distribution	
Current Stock Price (\$)	**Stock Price in One Year (\$)**	**Return, R**	**Probability, p_R**
	140	0.40	25%
100	110	0.10	50%
	80	−0.20	25%

[3] The notation Σ_R means that we calculate the sum of the expression (in this case, $p_R \times R$) over all possible returns R.

FIGURE 10.3

Probability Distribution of Returns for BFI

The height of a bar in the histogram indicates the likelihood of the associated outcome.



The expected return is the return we would earn on average if we could repeat the investment many times, drawing the return from the same distribution each time. In terms of the histogram, the expected return is the "balancing point" of the distribution, if we think of the probabilities as weights. The expected return for BFI is

$$E[R_{BFI}] = 25\%(-0.20) + 50\%(0.10) + 25\%(0.40) = 10\%$$

This expected return corresponds to the balancing point in Figure 10.3.

Variance and Standard Deviation

Two common measures of the risk of a probability distribution are its *variance* and *standard deviation*. The **variance** is the expected squared deviation from the mean, and the **standard deviation** is the square root of the variance.

Variance and Standard Deviation of the Return Distribution

$$Var(R) = E[(R - E[R])^2] = \sum_R p_R \times (R - E[R])^2$$

$$SD(R) = \sqrt{Var(R)} \tag{10.2}$$

If the return is risk-free and never deviates from its mean, the variance is zero. Otherwise, the variance increases with the magnitude of the deviations from the mean. Therefore, the variance is a measure of how "spread out" the distribution of the return is. The variance of BFI's return is

$$\begin{aligned} Var(R_{BFI}) &= 25\% \times (-0.20 - 0.10)^2 + 50\% \times (0.10 - 0.10)^2 + 25\% \times (0.40 - 0.10)^2 \\ &= 0.045 \end{aligned}$$

The standard deviation of the return is the square root of the variance, so for BFI,

$$SD(R) = \sqrt{Var(R)} = \sqrt{0.045} = 21.2\% \tag{10.3}$$