

## APPENDIX 8A: The Capital Asset Pricing Model

The capital asset pricing model (CAPM), developed in the early 1960s, is a model that predicts the relationship between the risk and equilibrium required returns on risky assets. Knowledge and an understanding of the CAPM are increasingly important for corporate managers as well as investors. The CAPM is built on the theory that the appropriate risk premium on an asset will be determined by its contribution to the risk of an investor's overall portfolio. That is, if an investor holds a large portfolio of stocks, some of the stocks in the portfolio will go up in value because of positive company-specific events and some will go down in value because of negative events. The net effect on the overall value of the portfolio will be relatively small, however, as these effects will tend to cancel each other out. Thus, with portfolio formation, some of the variability associated with individual stocks is eliminated by diversification. When investors combine stocks into portfolios, the unique, or unsystematic, events (both positive and negative) tend to cancel out once the investor has more than just a few stocks. This risk, which affects a single stock or a small group of stocks, is called unsystematic (or firm-specific) risk.

However, not all risk can be diversified away through portfolio formation. For example, uncertainties about general economic conditions, such as GDP, interest rates, or inflation, affect nearly all stock values to some degree. An unanticipated increase in inflation, for example, affects wages and the costs of supplies that companies buy; it affects the value of assets that companies own; and it affects the value of companies' stock. This risk, which affects a large number of stocks, is called systematic (or market) risk. Since systematic risk affects almost all stock prices to some degree, no matter how many stocks an investor puts into his portfolio, the systematic risk does not go away.

Since unsystematic risk can be eliminated at virtually no cost (through diversification), no reward accrues for bearing it. However, the systematic risk present in a stock cannot be eliminated by diversification. Thus, only the systematic portion of the risk of a stock is relevant in determining the equilibrium required return on that stock. The specific measure used in CAPM to measure the level of systematic risk for different investments is called the beta coefficient, or beta. A beta measures the amount of systematic risk a stock has relative to an average stock in the market (e.g., the S&P 500 Index). A beta is measured by the covariance in the movement of a stock's return with the market in general, divided by the variance of the return on the market. Both are measured over some historic period when data are available. Technically, beta ( $\beta_a$ ) =  $\text{cov}(R_a, R_M) / \text{var}(R_M)$ , where  $R_a$  = the return on the stock,  $a$ , and  $R_M$  = the return on the market, or average stock (e.g., the S&P 500 Index). A stock with a beta of 0.5 has half as much systematic risk as the S&P 500 Index; a stock with a beta of 2.0 has twice as much.

In the CAPM the risk premium component of the required return on a stock is proportional to its beta, where the risk premium is the required return on the stock,  $E(R_a)$ , minus the return on a risk-free asset,  $R_f$ . For example, if you double a stock's systematic risk, you must double its risk premium for investors still to be willing to hold the stock. Thus, the ratio of risk premium to beta should be the same for any two securities or portfolios. For example, if an investor compares the ratio of risk premium of systematic risk for a market portfolio, which has a beta of 1.0, with the corresponding ratio of a particular stock,  $a$ , the investor will conclude that:

$$\frac{E(R_M) - R_f}{1} = \frac{E(R_a) - R_f}{\beta_a}$$

where  $E(R_M)$  = the required return on the average stock or market portfolio (e.g., the S&P 500 Index). Rearranging this relationship results in the CAPM's required or expected return-risk relationship:

$$E(R_a) = R_f + \beta_a [E(R_M) - R_f]$$

Notice that according to the CAPM the expected return on a stock  $E(R_i)$ , depends on three factors:

1. *Pure time value of money*, measured by the risk-free rate,  $R_f$ . This is the reward for merely saving (forgoing consumption) without taking any risk. The risk-free rate in the CAPM is often measured by the return on a one-year Treasury security,  $R_f$ .
2. *Reward for bearing risk*, measured by the market risk premium or the risk premium on an investment in the “market” in general (e.g., the S&P 500 Index),  $[E(R_M) - R_f]$ . This is the reward the market offers for bearing an average amount of systematic risk in addition to the risk-free rate. The market portfolio in the CAPM is often measured by the return on the S&P 500 Index.
3. *Amount of systematic risk*, measured by the beta,  $\beta_a$ . This is the amount of systematic risk present in a particular stock (e.g., stock  $a$ ) relative to the market index.

Thus, the rate of return on a stock exceeds the risk-free rate by a risk premium equal to the stock’s systematic risk measure (its beta) times the risk premium of the (benchmark) market portfolio. The expected return-risk relationship is the most familiar expression of the CAPM.

### EXAMPLE 8-7 Calculating the Expected Return on a Stock Using the CAPM

Suppose the expected return on a market portfolio (e.g., the S&P 500 Index) is 10 percent, the return on the risk-free asset (e.g., one-year Treasury bill) is 5 percent, and the beta on stock  $a$  is 1.25. According to the CAPM, the expected or required return on stock  $a$   $[E(R_a)]$  should be:

$$E(R_a) = 5\% + 1.25(10\% - 5\%) = 11.25\%$$

## APPENDIX 8B: Event Study Tests

Event studies use a model, called a market model, to identify the *normal* relationship between a stock’s return and the market’s return using a period of time prior to a news release (e.g., the year prior). The market model equation is represented as an ordinary least squares regression equation:

$$R_{it} = a_i + \beta_i R_{Mt} + e_{it}$$

where

$R_{it}$  = Return on firm  $i$  on day  $t$

$R_{Mt}$  = Return on a market portfolio (e.g., the S&P 500 Index) on day  $t$

$a_i$  = Regression coefficient representing the intercept term for stock  $i$ ; the stock’s return component that is not related to the market return

$\beta_i$  = Coefficient representing the slope of the regression, the expected change in stock  $i$ ’s return for a 1 percent change in the market return (often called the stock’s beta or  $\beta$ )<sup>9</sup>

$e_{it}$  = Error term on the regression (reflecting factors other than the stock market that impact the return on a stock  $i$ )

9. A stock’s beta is a measure of the sensitivity of its return to changes in the return on a market index.

On the day of the news release, the actual stock market return ( $R_{Mt}$ ) is applied to the market model to calculate the stock's expected return, or  $E(R_{it})$ , given the historically estimated values of  $a$  and  $\beta$  (noted  $a$  and  $\beta$ ):

$$E(R_{it}) = a_i + \beta_i R_{Mt}$$

An abnormal return on the announcement day,  $AR_{it}$ , is then calculated by subtracting the expected return on the stock,  $E(R_{it})$ , calculated as shown above, from the actual return,  $R_{it}$ , on the stock on the day of the announcement as follows:

$$AR_{it} = R_{it} - E(R_{it})$$

or:

$$AR_{it} = R_{it} - [a_i + \beta_i R_{Mt}]$$

Market inefficiencies are indicated if the abnormal return ( $AR_{it}$ ) is statistically different from zero.<sup>10</sup>

### EXAMPLE 8-8 Calculation of Abnormal Returns at a News Announcement

Suppose that early this morning, a firm in which you own stock released news that earnings for the past quarter increased by 10 percent more than expected. In response to this announcement, the stock price increased 5 percent during today's trading. The return on the S&P 500 Index increased by 2 percent during today's trading. You want to use the market model to determine the abnormal return on the stock resulting from this announcement. You have collected the following information on the stock using a simple regression of returns on the stock and the S&P 500 Index over the last year:

$$\begin{aligned} 1\% &= a_s = \text{Regression coefficient representing the intercept term for the stock} \\ 1.5 &= \beta_s = \text{Regression coefficient representing the slope of the regression} \\ &\quad (\text{i.e., the estimated } \beta \text{ of the stock}) \end{aligned}$$

or for this stock:

$$E(R_{it}) = 1\% + 1.5 (R_{Mt})$$

To calculate the abnormal return on the stock resulting from the earnings announcement, we use this equation, as follows:

$$\begin{aligned} AR_{it} &= R_{it} - E(R_{it}) \\ &= R_{it} - [1\% + 1.5 (R_{Mt})] \\ &= 5\% - [1\% + 1.5 (2\%)] \\ &= 5\% - 4\% = 1\% \end{aligned}$$

or you earned an abnormal return of 1 percent as a result of the news of increased earnings.

10. In actuality, since the timing of the exact release of the announcement of "news" is often imprecise, the  $AR$  may be calculated over longer periods of time (e.g., the day prior to, the day of, and the day following the event). In this case the  $AR$  is calculated over a three-day window.