CHAPTER 7

Framework for Investing: The Capital Asset Pricing Model (CAPM)

Although finance and investing have existed as long as there have been markets to connect suppliers of capital (savers) with those who need capital (businesses), the beginnings of a rigorous framework for appraising and designing portfolios did not really come into being until the mid-twentieth century. The Capital Assets Pricing Model (CAPM) is one of the most influential models developed to address this. Merton Miller, Franco Modigliani, and William Sharpe shared a Nobel Prize in Economics in 1990 for their development of the CAPM.

To jump ahead for a moment, one of the core implications of CAPM when combined with the Efficient Markets Hypothesis (EMH), which will be described in the next chapter, is that very few investors can produce sustained returns superior to market averages. Therefore, CAPM and EMH adherents asserted, buying "the market," such as a stock market index, would produce superior results to most other strategies. Burton Malkiel's *A Random Walk Down Wall Street* was the first popular book on *indexing*; first published in 1973, it has now appeared in over a dozen new editions. John Bogle founded Vanguard Funds in the early 1970s to make *index investing* available to retail customers.

Hedge funds are premised on the belief that it is in fact possible to outperform a long-only market indexing strategy. So why spend a chapter on a framework that seems to contradict this? Because CAPM has been hugely influential in the investment community. And because it presents a framework that allows us to break down investing performance into component parts.

An Overview of CAPM

FIgure 7.1 shows daily price movements of a stock, ExxonMobil (ticker symbol XOM) and an index, the S&P 500 (ticker symbol SPX), for about 1 year from late 2011 to late 2012.

You can see that prices of these two assets *mostly* move in tandem. But there are periods where one moves by more, or less, than the other. This suggests two things:

- There appears to be a strong relationship (positive correlation) between XOM and SPX—that is, most events seem to affect both assets in the same general way.
- Changes in XOM do not appear (for the most part) to be quite as pronounced as changes in SPX.

Clearly, relative price movements for a given stock—in this case XOM—compared to the overall market—captured in the S&P 500 index, SPX—deserve attention. But there may also be a systematic difference in a stock's returns, aside from the portion of its returns that seem to relate to broader market movements. That is the core of CAPM: distinguishing

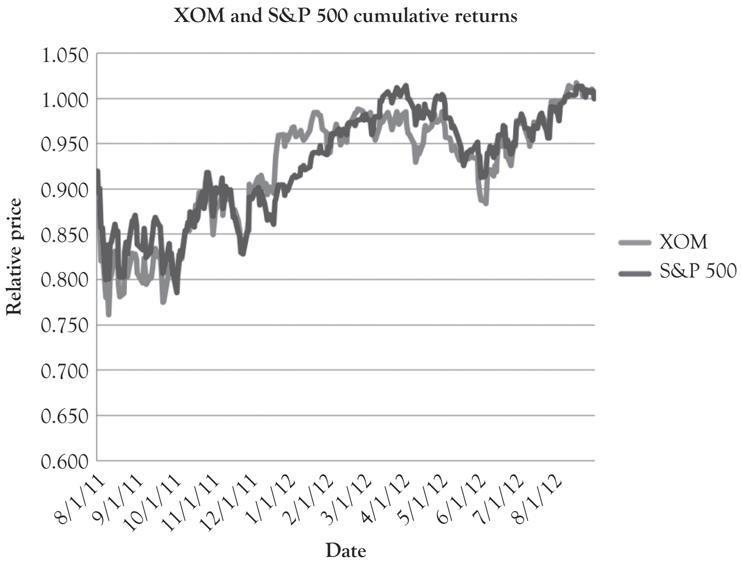

Figure 7.1 Daily price movements for XOM and SPX

between stock returns that derive from broad market movements and those that do not.

The ABCs of CAPM: Alphas, Betas, and Correlations

Figure 7.2 shows the price *changes* (i.e., the daily returns in percent) in XOM and SPX. In many instances, the two series are indistinguishable, a sign that whatever affects the overall market (SPX) is also affecting ExxonMobil (XOM). Recall that returns are simply

$$[(\text{Price at time } t/\text{Price at time } t - 1) - 1].$$

The most basic measure of the relationship between movements in XOM's price and SPX is *correlation*. In a simple form, a correlation coefficient measures the frequency with which prices of two assets move in the same direction. Correlation coefficients can be as follows:

- –1.0—a perfect negative relationship. Whenever the S&P rises, XOM falls, and vice versa.
- 0—no visible relationship.
- +1.0—a perfect positive relationship. Whenever the S&P rises, XOM rises, and vice versa.

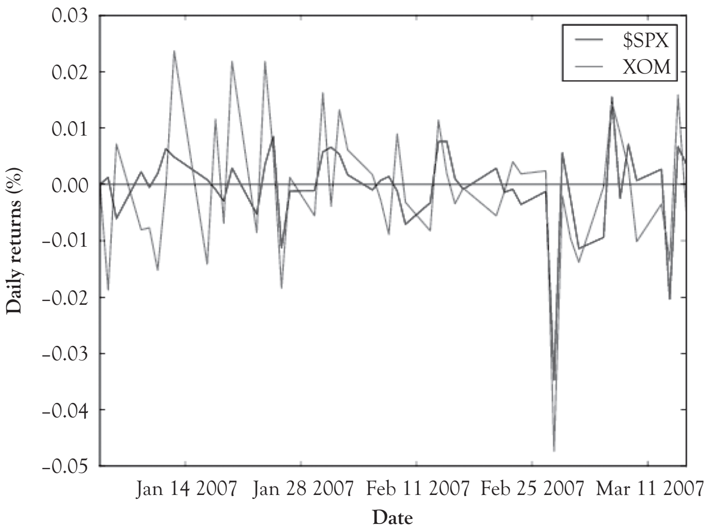

Figure 7.2 Daily percentage change in price for SPX and XOM

Correlations among financial instruments will be essential elements of portfolio construction, discussed in a later chapter. In general, combining assets with low or negative correlations to each other—that is, correlation coefficients that are near zero, or even negative—dampens a portfolio's volatility (i.e., lowers risk).

The essence of CAPM is illustrated in Figure 7.3. This is a scatter plot of XOM's daily returns versus those of SPX. Each dot represents one day of data—the horizontal location indicates the change in SPX, while the vertical location is the change in XOM. This pattern of a generally upward-sloping oval-shaped scatter is very common: On days when the overall market is driven upward (i.e., when there are more buyers than sellers), the same is true of XOM. This implies the correlation coefficient is positive (between 0 and 1). If XOM benefitted from events that hurt the overall market (or vice versa), the general shape of the scatter would be downward, and the SPX and XOM correlation coefficient would be negative (between –1 and 0).

As shown in Figure 7.3, we can fit a regression line through this scatter to find the linear equation that best captures its pattern. All linear equations have the general form $Y = b \times X + a$; in this example:

$$\text{Return (XOM)} = \text{beta} \times \text{Return (SPX)} + \text{alpha}$$

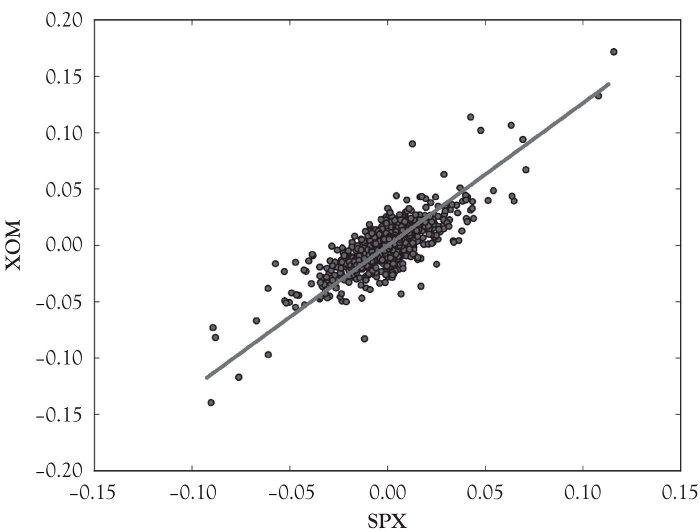

Figure 7.3 Scatter graph of XOM return versus market return, with regression line

where alpha is the *Y*-intercept of the regression line, and beta is its slope.

We can interpret these ABCs—alphas, betas, and correlations—as follows:

- *Alpha* is the systematic difference in performance (return) of a stock over and above the market. Positive alpha could come from superior management, production technology, or product design; or from having a dominant position in the company's market that provides it pricing power (the ability to raise prices without losing many customers). Alpha is the intercept of the regression line in Figure 4.3. Since collectively all stocks cannot beat the market because together they *are* the market, alpha is assumed to be zero on average. (Any stock with positive alphas is counterbalanced by other stocks with negative alphas.)
- *Beta* represents the stock's price volatility relative to the overall market. Simply put, a stock with a beta of, say, 1.5 will rise on average 1.5 times as much, and fall 1.5 times as much, as the overall market, in percentage terms. Small, speculative companies usually have betas well above 1.0, while large companies with very stable earnings usually have betas well under 1.0. XOM's beta is 0.77; it isn't surprising that a large company whose fortunes are so intertwined with other companies (through oil supplier relationships) would see its stock move almost as much as the overall market. The market's beta is by definition 1.0. Beta is the slope of the regression line as shown in Figure 7.3. You can find a stock's beta on many investing websites, such as Google Finance or Yahoo Finance.
- *Correlation coefficients* capture the "tightness" of the scatter around the regression line, which summarizes the pattern in that scatter. The higher (closer to 1.0) the correlation between XOM and SPX, the more that XOM's price movements are explained by movements in SPX. Said differently, a high correlation coefficient suggests that events that affect prices in the overall market have similar effects on the price of XOM.

Implications of CAPM

A fund manager can derive return from beta and alpha: When returns are based primarily on an upward general market we call this *buying beta.* On the other hand, returns resulting from investment skill are known as *seeking alpha*. As noted earlier, extensive study of the mutual fund industry finds little evidence of persistent alpha among fund managers.

So CAPM allows the most basic disaggregation of an investment's performance into two parts: based on market return (which could be achieved simply by buying an index)—beta; and based on company-specific factors—alpha. Since there are extremely inexpensive ways to guarantee a beta of 1.0 by buying index funds or ETFs, outperforming the market entails investing in stocks more volatile than the index (buying beta), or finding stocks that systematically outperform (buying alpha). Buying beta means, by definition, buying increased risk, since high beta stocks not only rise faster than the index on "up" days, but also fall farther on "down" days. Buying alpha is the oft-sought, but rarely achieved goal.

Basic Hedge Fund Strategies in the CAPM Framework

Hedge funds are so called because the first hedge fund, Albert Winslow Jones' fund formed in 1949, strove for absolute positive returns through hedging—making contrary bets that would pay off if their main bet failed. These hedges would at a minimum reduce losses, and in the best case could produce absolute positive returns (i.e., returns above zero even if the general market direction was downward). In exchange, these hedges posed a drag on returns when the market headed upward.

In CAPM terms, a hedge works as follows. (We will retain the XOM and SPX example from the previous figures.)

A portfolio's return is the weighted average of the returns of its constituent assets. (Portfolio construction will be treated at length in later chapters.) So if an investor holds a portfolio that constitutes a long position in XOM for 60 percent of its holdings and in SPY (SPY is a publicly traded ETF that tracks SPX) for 40 percent, the portfolio's return would be calculated as follows:

XOM weight: 60 percent; XOM return: 8 percent

SPY weight: 40 percent; SPY return: 10 percent

Portfolio return: 60% × 8% + 40% × 10% = 4.8% + 4% = 8.8%.
(XOM) (SPY) (Portfolio)

As you would expect, the portfolio's return falls between that of its two constituents, shaded toward XOM, which has a larger share of the overall portfolio.

In CAPM terms, a portfolio's return is likewise an amalgam of the returns on each stock within it:

return (portfolio) = weight (XOM) × return (XOM) + weight (SPY) × return (SPY), where each stock's return is as follows:

return (XOM) = beta (XOM) × return (market) + alpha (XOM)

and

return (SPY) = beta (SPY) × return (market) + alpha (SPY)

Note: We assume beta for SPY is 1.0 and that SPY's alpha is 0 because its performance is equivalent to the market's.

Let's move on now to a hedge example: Assume that the investor has some reason to believe that Exxon will experience positive developments and will rise faster than the overall market. A long-only investor would simply buy XOM. If it performs as expected, the investor will do well; however, if the market drops substantially, XOM will drop with it and he will lose money.

To hedge against this possibility—that XOM may decline because the overall market declines—when a hedge fund buys a long position in XOM, it can short the SPX. Accordingly, suppose the manager takes a 50 percent positive position in XOM, and a negative 50 percent position in SPY: The portfolio return is the weighted average of the two positions:

0.5 × [beta (XOM) × return (market) + alpha (XOM)] +
–0.5 × [beta (SPY) × return (market) + alpha (SPY)]

The portfolio weight for SPY has a negative sign because the fund is shorting the SPX. Again note that the alpha for SPY—the market—is by definition 0.

If the investor's forecast is incorrect and XOM falls (not rises as he expected), the tumble may be because of a general fall in the market, in which case his short would make money that would at least partly compensate for his loss in the long XOM position. At the same time, if his forecast is correct and both XOM and the overall market rise, his XOM gains will be at least partly offset (dragged down) by his losses on the short SPX position.

Note that this portfolio (50 percent XOM, –50 percent SPY) is dollar balanced, meaning that there is an equivalent investment on the long side as on the short side. But the portfolio is not beta balanced. The two positions do not quite cancel each other out—the portfolio will still be skewed long or short by the respective alphas and betas of its two positions. In this instance, it's because XOM's beta (0.77) is lower than SPY's (1.0). If the market goes up the portfolio will only be net long if XOM's alpha is sufficiently greater than the market's to counteract the 0.23 difference in betas (1.0 – 0.77). However, if the betas of the two issues were very close, the positive return would be 0.5 × the long position's alpha (in this case, XOM's).

Most hedge funds seek beta-balanced portfolios so that they are precisely protected against market-wide moves. That means, essentially

Sum(beta_i * w_i) = 0, and
Sum(|w_i|) = 1.0

where beta_i is the beta for stock I, and w_i is its weight in the portfolio. In this case, because XOM's beta is 0.77, we must hold a larger portion of XOM to offset its lower beta. A beta-balanced portfolio of these two issues would contain 56 percent XOM, and –44 percent in SPY. (We leave the algebra as an exercise.)

Such excess returns are quite small, which is why hedge funds need to trade in very large volumes, and often use leverage (borrowing) to expand the magnitude of their trades. Many financial institutions like hedge funds leverage 20 or 30 times their invested capital. Leverage magnifies both gains *and* losses. This is why high degrees of leverage are often combined with hedged (long/short) strategies.