RISK AND RATES OF RETURN *(Chapter 8)*

- <u>Defining and Measuring Risk</u>—in finance we define risk as the chance that something other than what is expected occurs—that is, variability of returns; risk can be considered "good"—that is, when the results are better than expected (higher returns)—or "bad"—that is, when the results are worse than expected (lower returns); when we examine how risky a single investment is by itself, we are examining *stand-alone risk*; when we examine how risky an investment is when it is combined in a portfolio with other investments, we are examining *portfolio risk*.
  - o Probability Distributions—a probability distribution gives all the possible outcomes with the chance, or probability, each outcome will occur

- <u>Expected Rate of Return</u>—the weighted average of the various possible outcomes; it is based on the probability that each outcome will occur; the expected rate of return is the average of the outcomes if the action—for example, an investment—was continued over and over again and the probability for each outcome remained the same—that is, the probability distribution does not change. Use the following equation to compute the expected rate of return:

$$\begin{aligned}\text{Expected rate of return} &= \hat{r} = Pr_1 r_1 + Pr_2 r_2 + \cdots + Pr_n r_n \\ &= \sum_{i=1}^{n} Pr_i r_i\end{aligned}$$

  where Pr_i is the probability that the i^{th} outcome, designated r_i, will occur.
  - o Continuous versus Discrete Probability Distributions
    - ▪ discrete outcomes—a limited, or finite, number of outcomes; for example, when picking a card from a standard deck of playing cards, there are exactly 52 possible outcomes.
    - ▪ continuous outcomes—unlimited, of infinite, number of outcomes; for example, the number of real numbers between 1 and 10 is infinite.
    - ▪ tightness of a probability distribution—because all of the possible outcomes are included in a probability distribution, the "tighter" the distribution, the more closely the outcomes are bunched together, and the more likely an outcome close to the expected value will occur; clearly, the more likely the expected outcome or a result near the expected outcome will occur, the less risk that is associated with the particular event (for example, an investment).
    - ▪ Measuring Stand-Alone Risk: The Standard Deviation—measures the tightness, or variability, of a set of outcomes—that is, a probability distribution; the tighter the distribution, the less the variability of the outcomes, and the less risk associated with the event; as a result, standard deviation is a measure of risk for a *single* investment—that is an investment held by itself (alone).
    - ▪ variance—the standard deviation squared; measures the variability of outcomes:

$$\text{Variance} = \sigma^2 = (r_1 - \hat{r})^2 Pr_1 + (r_2 - \hat{r})^2 Pr_2 + \cdots + (r_n - \hat{r})^2 Pr_n$$
$$= \sum_{i=1}^{n} (r_i - \hat{r})^2 Pr_i$$

- standard deviation—square root of variance:

$$\text{Standard deviation} = \sigma = \sqrt{\sigma^2} = \sqrt{\sum_{i=1}^{n} (r - \hat{r})^2 Pr_i}$$

  Because standard deviation measures variation, which is associated with risk, we generally say that an investment with a lower standard deviation is considered less risky than an investment with a higher standard deviation; all else equal, if two investments have the same return but different standard deviations, a rational investor would prefer the investment with the lower standard deviation—that is, lower risk is preferred to higher risk; all else equal, if two investments have the same standard deviation but different expected returns, a rational investor would prefer the investment with the higher expected return—that is, higher returns are preferred to lower returns.

- Coefficient of Variation—measures the relationship between risk and return; allows comparisons among various investments that have different risks and different returns.

$$\text{Coefficient of variation} = \text{CV} = \frac{\text{Risk}}{\text{Return}} = \frac{\sigma}{\hat{r}}$$

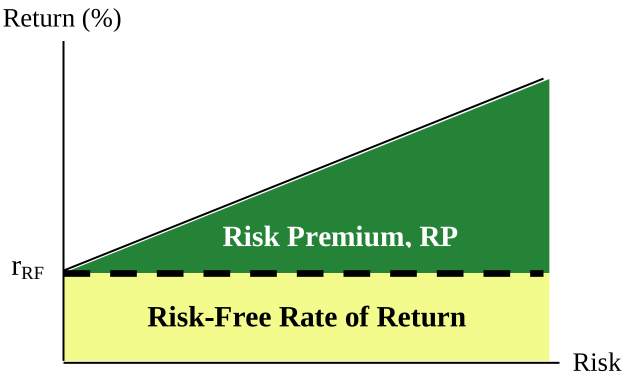
  Because lower risk is preferred to higher risk and higher return is preferred to lower return, an investment with a lower coefficient of variation, CV, is preferred to an investment with a higher CV.

- Risk Aversion and Required Returns
  - risk aversion—all else equal, risk averse investors prefer higher returns to lower returns as well as less risk to more risk; thus, risk averse investors demand higher returns for investments with higher risk.
  - risk premium—the part of the return on an investment that can be attributed to the risk of the investment; the total return on an investment is computed as follows:

$$\begin{aligned} \text{Return} &= \text{Risk-free return} + \text{Risk Premium} \\ &= r_{RF} + RP \end{aligned}$$

$$RP = \text{Return} - r_{RF}$$

Graphically,



- <u>Portfolio Risk--Holding Combinations of Assets</u>--by combining investments to form a portfolio, or collection of investments, diversification can be achieved; when evaluated in a portfolio, whether a single investment's actual return is above or below its expected return is not very important; rather the performance of the portfolio as a whole is important--some investments will perform better than expected while others will perform worse than expected.
  - Portfolio Return--the expected return on a portfolio is the weighted average of the expected returns of the individual investments included in the portfolio; the computation is:

$$\hat{r}_P = w_1\hat{r}_1 + w_2\hat{r}_2 + \cdots + w_N\hat{r}_N$$

$$= \sum_{j=1}^{N} w_j\hat{r}_j$$

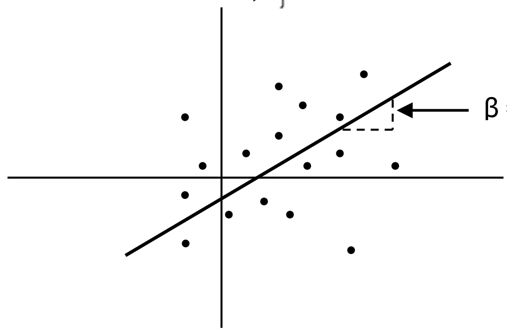
    where w_j is the percent of the total funds invested in Investment j and $\hat{r}_j$ is the expected return associated with Investment j. The realized, or actual, rate of return for any stock, $\ddot{r}_j$, generally differs somewhat from the expected rate of return, $\hat{r}_j$; thus, the actual return earned on a portfolio, $\ddot{r}_P$, generally differs from the expected return on the portfolio, $\hat{r}_P$.
  - Portfolio Risk—by combining more and more investments that are not perfectly correlated—that is, do not mirror each others' movements on a relative basis—to form a portfolio, the risk of the portfolio can be reduced; the amount of the risk reduction depends on how the investments in a portfolio are related—risk can be eliminated if two investments that are perfectly negatively related are combined to form a portfolio; the smaller the relationship among the various investments included in a portfolio, the greater the reduction of risk, or diversification; to manage, thus reduce, risk investors should diversify; "putting all your eggs into one basket"—that is, investing in a single stock—is much riskier than using more than one basket to carry your eggs—that is, investing in many stocks.
  - Firm-Specific Risk versus Market Risk—generally, we can divide the total risk associated with an investment into two components, or sources—one risk component results from the actions of the firm, thus it is called *firm-specific risk*, whereas the other

risk component results from factors relating to the economy, and it is called *market risk*—such that

Total risk = Firm-specific risk + Market risk.

- firm-specific risk—caused by actions that are specific to the firm, such as management decisions, labor characteristics, and so forth; the impact of this type of risk on the expected return associated with an investment is generally fairly random because many of the factors that cause firm-specific risk result from unpredictable outcomes of such events as labor strikes, lawsuits, and so forth; this risk component is often called *unsystematic risk* because its impact is not felt throughout the economic system (that is, it is not system wide); therefore, in a portfolio of investments, the effect of the firm-specific risk of one firm tends to offset the effect of the firm-specific risk(s) of some other firm(s); in effect, then the firm-specific risk associated with investments can be diversified away by holding a combination, or portfolio, of investments; thus, this risk is also called *diversifiable risk.*
- market risk—results from movements in factors that affect the economy as a whole, such as interest rates, unemployment, and so forth; this risk affects all companies, thus all investments; it is a system wide risk that cannot be diversified away; as a result, this risk is called *systematic, or nondiversifiable, risk*; even though all investments are affected by systematic risk, they are not all affected to the same degree; for example, if interest rates increase dramatically, sales of products for which consumers rely on financing to make their purchases (houses, automobiles, and other durable goods) will suffer more than sales of products that are considered necessities (food, electricity, and so forth).
- capital asset pricing model—a model developed to determine the required rate of return for an investment that considers the fact that some of the total risk associated with the investment can be diversified away; in essence, the model suggests that the risk premium associated with an investment should only be based on the risk that cannot be diversified away rather than the total risk; investors should not be rewarded for not diversifying—that is, they should not be paid for taking on risk that can be eliminated through diversification.
- relevant risk—risk that cannot be diversified away—that is, systematic risk.

o The Concept of Beta—market, or systematic, risk can be measured by comparing the return on an investment with the return on the market in general, or an average stock; the resulting measure is called the beta coefficient, and is identified using the Greek symbol β; graphically, β can be determined as follows:



The beta coefficient shows how the returns associated an investment move with respect to the returns associated the market; because the market is very well diversified, its returns should be affected by systematic risk only—unsystematic risk should be completely diversified away in a portfolio that contains all investments in the market; thus, the beta coefficient is a measure of systematic risk because it gives an indication of the degree of movement in returns associated with an investment relative to the market, which contains only systematic risk; for example, an investment with β = 2.0 generally is considered twice as risky as the market, such that the risk premium associated with the investment should be twice the risk premium on the market.

- Portfolio Beta Coefficients—the beta coefficient associated with a portfolio is based on the betas of the individual investments in the portfolio; if the portfolio contains investments with low beta coefficients, then the portfolio beta will be low, and vice versa; the portfolio beta is determined by computing the weighted average of the betas associated with the individual investments contained in the portfolio:

$$\beta_P = w_1\beta_1 + w_2\beta_2 + \cdots + w_N\beta_N$$

$$= \sum_{j=1}^{N} w_j\beta_j$$

where β represents the beta coefficients and w_j is the percent of the total amount invested in the portfolio that is invested in Investment j.

Example: Consider the following portfolio:

Investment	Beta	Amount Invested
Stock A	2.5	$ 10,000
Stock B	1.2	25,000
Stock C	1.8	35,000
Stock D	0.5	30,000
		$100,000

$$\beta_P = 2.5\left(\frac{\$10,000}{\$100,000}\right) + 1.2\left(\frac{\$25,000}{\$100,000}\right) + 1.8\left(\frac{\$35,000}{\$100,000}\right) + 0.5\left(\frac{\$30,000}{\$100,000}\right)$$

$$= 2.5(0.10) + 1.2(0.25) + 1.8(0.35) + 0.5(0.30) = 1.33$$

- The Relationship between Risk and Rates of Return—the *market* risk premium is the return associated with the riskiness of a portfolio that contains all the investments available in the market; it is the return earned by the market in excess of the risk-free rate of return; thus it is defined as follows:

  $$\text{Market risk premium} = RP_M = r_M - r_{RF}$$

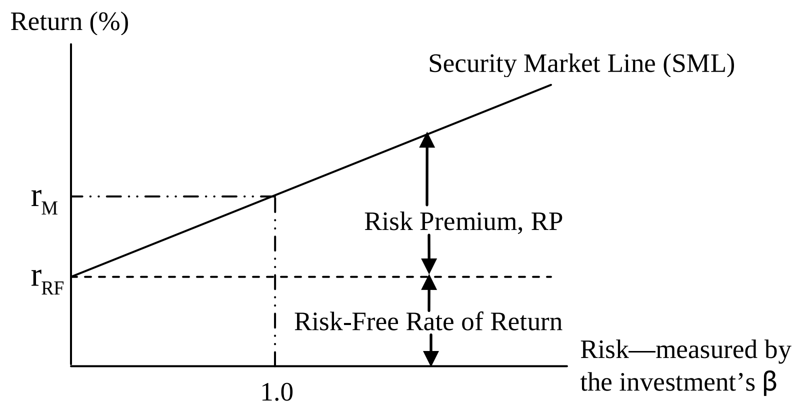
  The market risk-premium is based on how risk averse investors are on average; because we know that the beta coefficient of an investment indicates the volatility of the investment relative to the market, we can use β to determine the risk premium for an individual investment as follows:

  $$\text{Investment risk premium} = RP_{\text{Investment}} = RP_M \times \beta_{\text{Investment}}$$

  And, because the total return associated with an investment equals the risk-free rate plus a return to compensate for the risk associated with the investment, the return on an individual investment can be stated as:

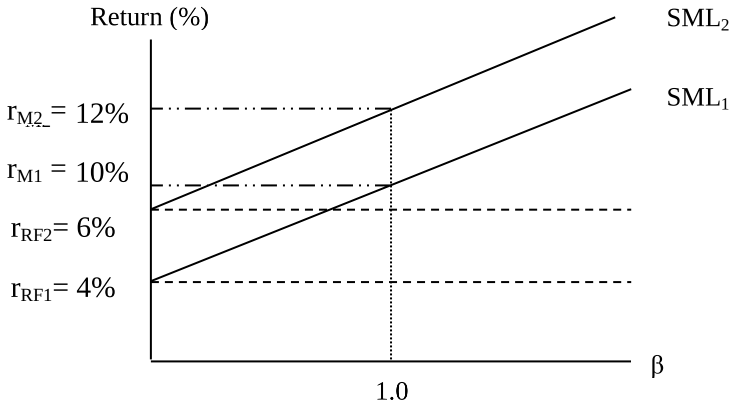
  $$r_j = r_{RF} + RP_{\text{Investment}} = r_{RF} + (RP_M)\beta_j$$

  This is called the Capital Asset Pricing Model, or the CAPM, which can be illustrated as follows:

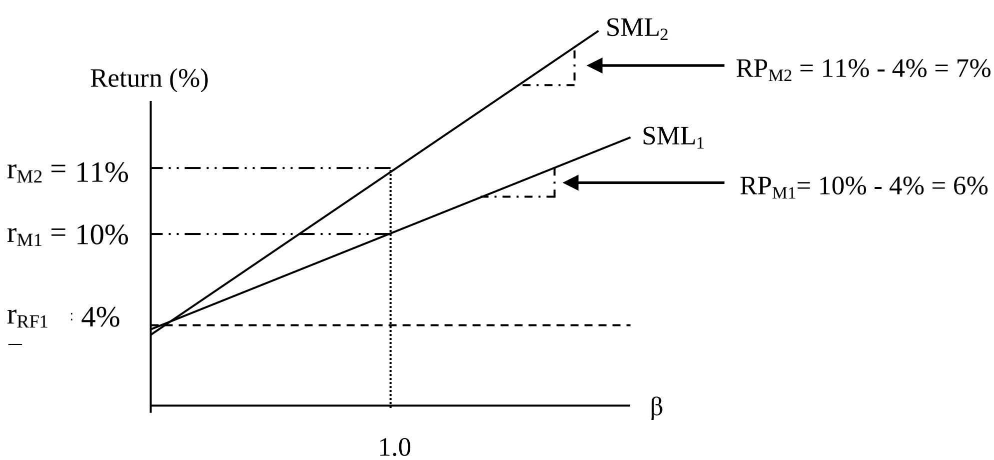


  The slope of the line in the graph, called the Security Market Line (SML), indicates how risk averse investors are on average.

  - The Impact of Inflation—inflation affects the risk-free rate of return; thus, when inflation expectations change the SML shifts; if inflation is expected to be higher (lower), the market return should be higher (lower) because r_{RF} increases; when r_{RF} increases (decreases), the intercept increases (decreases). The following graph shows what happens when inflation expectations increase such that the risk-free rate increases from 4 percent to 6 percent causing the market return to increase from 10 percent to 12 percent (risk attitudes remain constant):

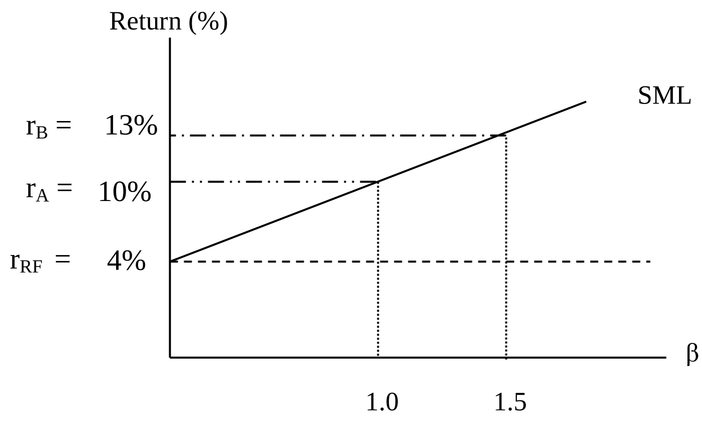


- Changes in Risk Aversion—if investors demand a higher (lower) return for the same amount of risk, they are considered more (less) risk averse, and the SML will be steeper (flatter)—that is, Slope = $(r_M - r_{RF})/(1.0 - 0) = r_M - r_{RF} = RP_M$ increases. The following graph shows what happens when investors become more risk averse, thus demand more return to take on the same amount of risk (inflation expectations are constant):



- Changes in a Stock's Beta—if the beta coefficient associated with an investment changes, then, according to the CAPM, so does the investment=s expected return; $r_j = r_{RF} + (RP_M)\beta_j$; thus,

$$r_j = r_{RF} + (RP_M)1.25 > r_{RF} + (RP_M)1.00$$



- Chapter 8 Summary Questions—You should answer these questions as a summary for the chapter and to help you study for the exam.
  - What is the cost of money?
  - What is the yield on an investment, and how is it computed?
  - How are interest rates determined in general and what factors affect interest rates?
  - What are the basic risks that are included in the risk premium associated with a debt instrument?
  - What is the term structure of interest rates? What theories have been developed to help explain the shape of the yield curve? What is a yield curve?
  - How are expected interest rates computed?