Chapter 2
Risk and Return: Part I
ANSWERS TO BEGINNING-OF-CHAPTER QUESTIONS

Our students have had an introductory finance course, and many have also taken
a course on investments and/or capital markets. Therefore, they have seen the
Chapter 2 material previously. However, we use the Beginning of Chapter (BOC)
Questions to review it because our students need a refresher.

With some groups of students it is best to go through the chapter on a point-
by-point basis, using the PowerPoint slides. With other groups, this would
involve repeating too much of the intro course. In the latter situation, we
tell our students that the chapter is a review and that we will call on them
to discuss the BOC questions in class. We supplement their answers to make
sure the key points are covered.

Our students have mainly taken multiple-choice exams, so they are
uncomfortable with essay tests. Also, we cover the chapters quickly, so the
assignments cover a lot of pages. We explain that much of the material is a
review, and that if they can answer the BOC questions they will do OK on the
exams. We also tell them, partly for motivation and partly to reduce anxiety,
that our exams will consist of 5 slightly modified BOC questions, and they
must answer 3. We also tell them that they can use a 4-page "cheat sheet,"
two sheets of paper, front and back. They can put anything they want on it-
formulas, definitions, outlines of answers to the questions, or complete
answers. All this helps them focus and get better prepared. Writing out
answers is a good way to study, and outlining answers to fit them on the cheat
sheet (in really small font!) also helps them learn.

We try to get students to think in a more integrated manner, relating topics
covered in different chapters to one another. Studying all of the BOC
questions in a fairly compressed period before the exams helps in this regard.

We expected really excellent exams, given that they had the questions and
could use cheat sheets. Some of the exams were indeed excellent, but we were
surprised and disappointed at the poor quality of many of the papers. Part of
the problem is that they were not used to taking essay exams. Also, they
would have done better if they had taken the exam after we covered cases (in
the second half of the semester), where we apply the text material to real-
world cases. While both points are true, but it's also true that some
students are just better than others. Finally, since our students are all
graduating seniors, we graded rather easily.

Answers

2-1 Stand-alone risk is the risk faced by an investor who holds just one
asset, versus the risk inherent in a diversified portfolio.

Stand-alone risk is measured by the standard deviation (SD) of
expected returns or the coefficient of variation (CV) of returns =
SD/expected return.

Answers and Solutions: 2-1
A portfolio's risk is measured by the SD of its returns, and the risk of the individual stocks in the portfolio is measured by their beta coefficients. Note that unless returns on all stocks in a portfolio are perfectly positively correlated, the portfolio's SD will be less than the average of the SD's of the individual stocks. Diversification reduces risk.

In theory, investors should be concerned only with portfolio risk, but in practice many investors are not well diversified, hence are concerned with stand-alone risk. Managers who have large stockholdings in their companies are an example. They get stock (or options) as incentive compensation or else because they founded the company, and they are often constrained from selling to diversify. Note too that years ago brokerage costs and administrative hassle kept people from diversifying, but today mutual funds enable small investors to diversify efficiently.

2-2 Diversification can eliminate unsystematic risk, but market risk will remain. See Figure 2-8 for a picture of what happens as stocks are added to a portfolio. The graph shows that the risk of the portfolio as measured by its SD declines as more stocks are added. This is the situation if randomly selected stocks are added, but if stocks in the same industry are added, the benefits of diversification will be loosened.

Conventional wisdom says that about 40 stocks from a number of different industries is sufficient to eliminate most unsystematic risk, but in recent years the markets have become increasingly volatile, so now it takes somewhat more, perhaps 50 or 60. Of course, the more stocks, the closer the portfolio will be to having zero unsystematic risk. Again, this assumes that stocks are randomly selected.

Different diversified portfolios can have different amounts of risk. First, if the portfolio concentrates on a given industry or sector (as sector mutual funds do), then the portfolio will not be well diversified even if it contains 100 stocks. Second, the betas of the individual stocks affect the risk of the portfolio. If the stock with the highest beta in each industry is selected, then the portfolio may not have much unsystematic risk, but it will have a high beta and thus have a lot of market risk. (Note: The market risk of a portfolio is measured by the beta of the portfolio, and that beta is a weighted average of the betas of the stocks in the portfolio.)

2-3 Note: This question is covered in more detail in Chapter 5, but students should remember this material from their first finance course, so it is a review.

Expected: The rate of return someone expects to earn on a stock. Typically measured as \( \frac{D_t}{P_0} + g \) for a constant growth stock.

Required: The minimum rate of return that an investor must expect on a stock to induce him or her to buy or hold the stock. Typically measured as \( k_e = k_f + b(MRP) \), where MRP is the market risk premium or the risk premium required for an average stock.

Answers and Solutions: 2-2
Historical: The average rate of return earned on a stock during some past period. The historical return on an average large stock varied from -5% to +3% during the 1990s, and it was about -15% in 2000. The variations for individual stocks were much greater—the best performer on the NYSE in 2000 gained 413% and the worst performer lost 99.8% of its value.

Are they Equal?
1) Expected and required. For market equilibrium, the expected and required rate of return as seen by "the marginal investor" must be equal for any given stock and therefore for the entire market. If the expected return exceeds the required return, then investors will buy, push the price up and the expected return down, and thus produce an equilibrium. Of course, any individual investor may believe that a given stock's expected and required returns differ, so individuals may think there are bargains to be had or dogs to be sold. Also, new information is constantly hitting the market and changing the opinions of marginal investors, and this leads to swings in the market. Now technology is causing new information to be disseminated more rapidly, and that is leading to more rapid and violent market swings.

2) Historical. There is no reason whatever to think that the expected and/or required rate of return, for any given year for either one stock or for all stocks on average, will be equal to the historical performance to continue. On the other hand, people do argue that investors expect to earn returns in the future that approximate average past returns. For example, if stocks returned 10% on average in the past (from 1926 to 2000, which is as far back as good data exist), then they may expect to earn about 10% on stocks in the future. Note, though, that this is a controversial issue—the period 1926-2000 covers a lot of very different economic environments, and investors may not expect the future to replicate the past. Certainly investors didn't expect future returns to equal distant past returns during the height of the 1999 bull market.

Risk aversion means that someone doesn't like risk, so if Securities A and B both have an expected return of say 10%, but Security A has less risk than B, then investors will prefer A. As a result, A's price will be bid up, and B's price bid down, and in the resulting equilibrium A's expected rate of return will be below that of B. Of course, A's required rate of return will also be less than B's, and in equilibrium the expected and required returns will be equal. One issue here is the type of risk investors are averse to—unsystematic, market, or both? According to CAPM theory, only market risk as measured by beta is relevant and thus requires a premium. However, empirical tests indicate that investors also require a premium for bearing unsystematic risk as measured by the stock's SD.
2-5 CAFM - Capital Asset Pricing Model. The CAFM establishes a metric for measuring the market risk of a stock (beta), and it specifies the relationship between risk as measured by beta and the required rate of return on a stock. Its principal developers (Sharpe, Merton, and Markowitz) won the Nobel Prize for their work.

The key assumptions are spelled out in Chapter 3, but they include (1) all investors focus on a single holding period, (2) investors can lend or borrow unlimited amounts at the risk-free rate, (3) there are no brokerage cost, and (4) there are no taxes. The assumptions are not realistic, so the CAFM may be incorrect. Empirical tests have neither confirmed nor refuted the CAFM with any degree of confidence, so it may or may not provide a valid formula for measuring the required rate of return.

The SML, or Security Market Line (see Figure 2-12), specifies the relationship between risk as measured by beta and the required rate of return, \( R = R_f + \beta (R_M - R_f) \). The data requirements are beta, the risk-free rate, and the rate of return expected on the market. Betas are easy to get (by calculating them or from some source such as Value Line or Yahoo!), but a beta show how volatile a stock was in the past, not how volatile it will be in the future, so historical betas may not reflect investors perceptions about the stock's risk. The risk-free rate is based on either T-bonds or T-bills; these rates are easy to get, but it is not clear which should be used, and there can be a big difference between bill and bond rates, depending on the shape of the yield curve. Finally, it is difficult to determine the rate of return investors expect on an average stock. Some argue that investors expect to earn the same average return in the future that they earned in the past, hence use historical MRCs, but as noted above, that may not reflect investors' true expectations.

The bottom line is that we cannot be sure that the CAFM-derived estimate of the required rate of return is actually correct.

2-6 a. We used an Excel model to calculate betas for X and Y, and the SML required returns for these stocks:

\[ b_X = 0.69; \quad b_Y = 1.66 \quad \text{and} \quad k_X = 10.7\%; \quad k_Y = 14.6\%. \]

Since Y has the higher beta, it has the higher required return.

Note that the points all fall on the trend line. Thus, the two stocks have essentially no diversifiable, unsystematic risk—all of their risk is market risk. If these were real companies, they might have the indicated trend line and betas, but the points would be scattered about the trend line. See Figure 3-3 in Chapter 3, where data for Wal-Mart are plotted. Although the situation for our Stocks X and Y would never occur for individual stocks, it would occur (approximately) for index funds, if Stock X were an index fund that held stocks with betas that averaged 0.69 and Stock Y were an index fund with \( b = 1.66 \) stocks.

b. Here we drop Year 1 and add Year 6, then calculate new betas and k's.

For Stock X, the beta and required return are stable. However, Y's
beta falls from 1.66 to 0.19, and its required return as calculated with the SML falls to 8.8%.

The figures for Y make little sense. The stock fell sharply because investors became worried about its future prospects, which means that it fell because it became riskier. Yet its beta fell. As a riskier stock, its required return should rise, yet the calculated return fell from 14.6% to 8.8%, just above the riskless rate.

The problem is that Y’s low return tilted the regression line down—the point for Year 6 is in the lower right quadrant of the Excel graph. The low R² and the large standard error as seen in the Excel regression make it clear that the beta, and thus the calculated required return, are not to be trusted.

Note that in April 2001, the same month that PG&E declared bankruptcy, its beta as reported by Finance.Yahoo was only 0.05, so PG&E actually had the same experience as Stock Y. The moral of the story is that the CARM, like other cost of capital estimating techniques, can be dangerous if used without care and judgment.

One final point on all this. The utilities are regulated, and regulators estimate their cost of capital and use it as a basis for setting electric rates. If the estimated cost of capital is low, then the companies are only allowed to earn a low rate of return on their invested capital. At times, utilities like PG&E become overly risky, have resulting low betas, and are then in danger of having some squirellish finance “expert” argue that they should be allowed to earn an improper CARM rate of return. In the industrial sector, a badly trained financial analyst could make the same mistake, estimate the cost of capital to be below the true cost, and cause the company to make investments that it should not have made.
We use BOC Q2-6 to illustrate some points about the CAPM, the SML, and Excel. For a more complete treatment of Excel, see the Tool Kit for Chapter 2 and also those for the other chapters.

We provide some instructions for creating the Excel model below on the tab labeled Inst.

We print out this sheet, then follow it when we go through the Excel model in class. We often delete some of the prepared materials below and then re-create it in class.

**Question 6.**

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<th>Market</th>
<th>Stock X</th>
<th>Stock Y</th>
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<td>1</td>
<td>20%</td>
<td>16%</td>
</tr>
<tr>
<td>2</td>
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<td>8%</td>
<td>8%</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>15%</td>
<td>12%</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>-6%</td>
<td>-2%</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>23%</td>
<td>18%</td>
</tr>
<tr>
<td>6</td>
<td>Average</td>
<td>12.0%</td>
<td>10.4%</td>
</tr>
</tbody>
</table>

**Beta Graph**

**SML Analysis:**

Risk-free rate: 8.0%

Market return: 12.0%

\[ k(X) = k(r_f) + b(k(Market) - k(r_f)) \]

\[ = 8.0\% + 2.7\% = 10.7\% = Predicted return for X. \]

\[ k(Y) = k(r_f) + b(k(Market) - k(r_f)) \]

\[ = 8.0\% + 6.6\% = 14.6\% = Predicted return for Y. \]

**New Beta Y:** 0.19

**New beta:** 8.5%

Note that the R-square for the regression dropped from 0.99 to 0.0029, and the standard error rose sharply. This indicates that the beta, and the CAPM required return, are being measured with a lot of error.

So, we cannot trust the accuracy of the estimated required return.

**Answers and Solutions:** 2 - 6
ANSWERS TO END-OF-CHAPTER QUESTIONS

2-1  a. Stand-alone risk is only a part of total risk and pertains to the risk an investor takes by holding only one asset. Risk is the chance that some unfavorable event will occur. For instance, the risk of an asset is essentially the chance that the asset’s cash flows will be unfavorable or less than expected. A probability distribution is a listing, chart or graph of all possible outcomes, such as expected rates of return, with a probability assigned to each outcome. When in graph form, the tighter the probability distribution, the less uncertain the outcome.

b. The expected rate of return (\( \bar{r} \)) is the expected value of a probability distribution of expected returns.

c. A continuous probability distribution contains an infinite number of outcomes and is graphed from \(-\infty\) and \(+\infty\).

d. The standard deviation (\( \sigma \)) is a statistical measure of the variability of a set of observations. The variance (\( \sigma^2 \)) of the probability distribution is the sum of the squared deviations about the expected value adjusted for deviation. The coefficient of variation (CV) is equal to the standard deviation divided by the expected return; it is a standardized risk measure which allows comparisons between investments having different expected returns and standard deviations.

e. A risk averse investor dislikes risk and requires a higher rate of return as an inducement to buy riskier securities. A realized return is the actual return an investor receives on their investment. It can be quite different than their expected return.

f. A risk premium is the difference between the rate of return on a risk-free asset and the expected return on Stock I which has higher risk. The market risk premium is the difference between the expected return on the market and the risk-free rate.

g. CAPM is a model based upon the proposition that any stock’s required rate of return is equal to the risk free rate of return plus a risk premium reflecting only the risk remaining after diversification.

h. The expected return on a portfolio, \( \bar{r}_p \), is simply the weighted-average expected return of the individual stocks in the portfolio, with the weights being the fraction of total portfolio value invested in each stock. The market portfolio is a portfolio consisting of all stocks.

i. Correlation is the tendency of two variables to move together. A correlation coefficient (r) of +1.0 means that the two variables move