The following exam questions are organized according to the text's sections. Within each section, questions follow the order of the text's chapters and are organized as multiple choice, true-false with discussion, problems, and essays. The correct answers and the corresponding chapter(s) are indicated below each question.

PART 2: PORTFOLIO ANALYSIS

PART 2 – Section 1: Mean Variance Portfolio Theory

Multiple Choice

1. The risk on a portfolio of assets:
   a. is different from the risk on the market portfolio.
   b. is not influenced by the risk of individual assets.
   c. is different from the risk of individual assets.
   d. is negatively correlated to the risk of individual assets.

   Answer: C
   Chapter: 4

2. Which of the following is correct of how the returns on assets move together?
   a. Positive and negative deviations between assets at similar times give a
negative covariance.
b. Positive and negative deviations between assets at dissimilar times give a
c. Positive and negative deviations between assets give a zero covariance.
d. Positive and negative deviations between assets at dissimilar times give a
positive covariance.
Answer: B
Chapter: 4

3. An efficient frontier is:
a. a combination of securities that have the highest expected return for each
level of risk.
b. the combination of two securities or portfolios represented as a convex
function.
c. a combination of securities that lie below the minimum variance portfolio and
the maximum return portfolio.
d. a combination of securities that have an average expected return for each
level of risk.
Answer: A
Chapter: 5

4. Two companies Amber and Bolt are manufacturers of glass. The securities of the
companies are listed and traded in the New York Stock Exchange. An investor’s
portfolio consists of these two securities in the proportion of 5/6 and 1/6 respectively.
Amber’s security has an expected return of 20% and a standard deviation of 8%. Bolt
has an expected return of 15% and a standard deviation of 5%. The correlation
coefficient between the two securities is 0.6. Calculate the expected return and the
standard deviation of the investor’s portfolio.
a. \( \bar{R}_p = 19.17\%; \sigma_p = 7.20\% \)
b. \( \bar{R}_p = 20.19\%; \sigma_p = 8.20\% \)
c. \( \bar{R}_p = 17\%; \sigma_p = 7.0\% \)
d. \( \bar{R}_p = 18.19\%; \sigma_p = 8.0\% \)
Answer: A
Chapter: 6

Problems

1. Consider the probability distribution below. (Note that the expected returns of A
and B have already been computed for you.)

<table>
<thead>
<tr>
<th>State</th>
<th>p(s)</th>
<th>( r_A )</th>
<th>( r_B )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recession</td>
<td>0.3</td>
<td>-0.11</td>
<td>0.16</td>
</tr>
<tr>
<td>Normal</td>
<td>0.4</td>
<td>0.13</td>
<td>0.06</td>
</tr>
</tbody>
</table>
a. Calculate the standard deviations of A and B.
b. Calculate the covariance and correlation between A and B.
c. Calculate the expected return of the portfolio that invests 30% in stock A and the rest in stock B.
d. Calculate the standard deviation of the portfolio in part b.

Answer:

a. \( \sigma_A^2 = (0.3 \times (-0.11 - 1))^2 + (0.4 \times (0.13 - 1))^2 + (0.3 \times (0.27 - 1))^2 = 0.02226 \)
   \[ \sigma_A = \sqrt{0.02226} = 14.92\% \]

   \( \sigma_B^2 = (0.3 \times (0.16 - 0.06))^2 + (0.4 \times (0.06 - 0.06))^2 + (0.3 \times (0.27 - 0.06))^2 = 0.006 \)
   \[ \sigma_B = \sqrt{0.006} = 7.75\% \]

b. \( \text{Cov}(r_A, r_B) = (0.3 \times (-0.11 - 1)(0.16 - 0.06)) + (0.4 \times (0.13 - 1)(0.06 - 0.06)) + (0.3 \times (0.27 - 0.06))(-0.04 - 0.06) = -0.0114 \)
   \[ \text{Corr}(r_A, r_B) = -0.0114 / (0.1492 \times 0.0775) = -0.9859 \]

c. \( E(r_p) = 0.3(0.1) + 0.7(0.06) = 0.072 \)

d. Using the standard deviation of each of the assets A and B computed in part a and covariance between the two assets computed in part b:

   \( \sigma_p^2 = [(0.3 \times 0.1492)^2 + (0.7 \times 0.0775)^2 + 2 \times 0.3 \times 0.7 \times (-0.0114)] = 0.0001554 \)
   \[ \sigma_p = \sqrt{0.0001554} = 1.25\% \]

Chapter: 4

2. Stock A has an expected return of 8% and a standard deviation of 40%. Stock B has an expected return of 13% and standard deviation of 60%. The correlation between A and B is -1 (i.e., they are perfectly negatively correlated). Show that you can form a zero risk portfolio by investing \( w_A = \frac{\sigma_B}{\sigma_A + \sigma_B} \) in A and the rest in B.

Answer:
\[ w_A = \frac{0.6}{0.6 + 0.4} = 0.6 \]  Thus, \( w_B = 0.4 \).

The variance of the portfolio is given by:

\[ \sigma_p^2 = 0.6^2 \cdot 0.4^2 + 0.4^2 \cdot 0.6^2 + 2 \cdot 0.6 \cdot 0.4 \cdot 0.4 \cdot 0.6 \cdot (-1) = 0 \]

This portfolio has zero variance; hence, it is riskless. This confirms what we learned in class—when two securities are perfectly negatively correlated, it is possible to form a zero-risk portfolio by combining them.

Chapter 5

3. The following diagram shows the investment opportunity set for portfolios containing stocks A and B. You need to know that:
- Point A on the graph represents a portfolio with 100% in stock A
- Point B represents a portfolio with 100% in stock B
a. Is the correlation between A and B greater than, equal to, or less than 1. How do you know?
b. Which labeled point on the graph represents the minimum variance portfolio?
c. Which labeled point on the graph represents a portfolio with 88% invested in stock A and the rest in B?
d. If A and B are the only investments available to an investor, which of the labeled portfolios are efficient?
e. Suppose a risk-free asset exists, allowing an investor to invest or borrow at the risk-free rate of 3%. If the above graph is drawn perfectly to scale, which labeled point represents the optimal risky portfolio.
f. Under the assumptions in part (e), would it be wise for an investor to invest all of his or her money in stock A? Why or why not?

Answer:

a. Less than 1. Correlation can’t be greater than 1, and if correlation equaled 1 (meaning that A and B were perfectly positively correlated), then the IOS between A and B would be a straight line.

b. x

c. z. This should be obvious, since a portfolio with 88% in A will be much closer to A than B on the curve. You can also confirm mathematically by noting from the graph that $E(r_A) \approx 8.5\%$ and $E(r_B) \approx 4.5\%$. Thus, a portfolio with 87% in A will have $E(r_P) \approx 0.88(0.085) + 0.12(0.045) = 0.0802$, which is approximately the expected return of portfolio z in the graph.

d. x, y, z, and A

e. y. Note on the graph that the tangency line from the risk-free asset intercepts the IOS at y.
f. No. When the investor has the ability to borrow or lend at the risk-free rate, only the portfolios on the tangency line are efficient. Note in the graph above that by borrowing at the risk-free rate and investing everything in the optimal risky portfolio (y, in this case), the investor can create portfolios that that dominate A. Chapter: 5 and 6

**Essay**

1. Describe what is semivariance? Give reasons why semivariance is not used as a measure of dispersion.

Answer:
Semivariance is a measure of dispersion that considers only the deviations of the returns which are below the average desired returns. This may be useful as the only returns that alarm an investor are the returns that are below the desired level.

For a well-diversified equity portfolio, symmetrical distribution is a reasonable assumption and hence, variance is also an appropriate measure of downside risk.

Furthermore, since empirical evidence shows that most of the assets existing in the market have returns that are reasonably symmetrical, semivariance is not needed because if returns on an asset are symmetrical; the semivariance is proportional to the variance. Thus, in most of the cases, not the semivariance, but the variance, is used as
a measure of dispersion.
Chapter: 4

2. Under what condition will adding a security with a high standard deviation decrease the risk of a portfolio?
Answer: The risk of a combination of assets is different from a simple average of the risk of individual assets. The standard deviation of a combination of two assets may be less than the variance of either of the assets themselves.

Adding a security with a high standard deviation to a portfolio can reduce the overall risk of the portfolio if the security is negatively correlated to the bulk of securities in the portfolio. In this condition where two securities are perfectly negatively correlated, the securities will move together but in opposite directions. The standard deviation of such a portfolio will be smaller than a portfolio whose securities are positively correlated. If two securities are perfectly negatively correlated, it should always be possible to find some combination of these two securities that has zero risk. A zero risk portfolio will always involve positive investment in both the securities.
Chapter: 5

3. With the help of a diagram show, how would you identify a ray with the greatest slope as an efficient frontier where riskless lending and borrowing is present?
Answer: We understand that the existence of riskless lending and borrowing implies that there is a single portfolio of risky assets that is preferred to all other portfolios. In the return standard deviation space, this portfolio plots on the ray connecting the riskless asset and the risky portfolio that lies farthest in the counter-clockwise direction. We can judge from the below given graph that the ray $R_f \rightarrow B$ is preferred by the investors to any other portfolio or rays like $R_f \rightarrow A$. The efficient frontier is the entire length of the ray extending through $R_f$ and $B$. 

The slope of the line connecting a riskless asset and a risky portfolio is the expected return on the portfolio minus the risk-free rate divided by the standard deviation of the return on the portfolio. Thus, the efficient set is determined by finding a portfolio with the greatest ratio of excess return to standard deviation that satisfies the constraint that the sum of the proportions invested in the assets equals 1.

Chapter: 6

**PART 2 – Section 2: Simplifying the Portfolio Selection Process**

**Multiple Choice**

1. If the returns on different assets are uncorrelated:
   a. an increase in the number of assets in a portfolio may bring the standard deviation of the portfolio close to zero.
   b. there will be little gain from diversification.
   c. diversification will result in risk averaging but not in risk reduction.
   d. the expected return on a portfolio of such assets should be zero.

   Answer: A
   Chapter: 4

2. Using the Sharpe single-index model with a random portfolio of U.S. common stocks, as one increases the number of stocks in the portfolio, the total risk of the portfolio will:
   a. approach zero.
   b. approach the portfolio’s systematic risk.
   c. approach the portfolio’s non-systematic risk.
   d. not be affected.

   Answer: B
   Chapter: 7

Part 2 - 8
3. What is the concept behind the indexes used in the Fama and French Model?
   a. Form portfolios with standard deviations that mimic the impact of the variables.
   b. Form portfolios with returns that are opposite to the impact of the variables.
   c. Form portfolios with returns that mimic the impact of the variables.
   d. Form portfolios with standard deviations that are opposite to the impact of the variables.

Answer: C
Chapter: 8

4. Which of the following is true of a cutoff rate?
   a. The cutoff rate is determined by dividing the Beta with the difference between average return and return on the riskfree rate of the securities.
   b. All securities whose return is above the cutoff rate are selected in the market portfolio.
   c. The cutoff rate is computed from the characteristics of all securities in the optimum portfolio.
   d. All securities whose risk is below the cutoff rate are selected in the optimum portfolio.

Answer: C
Chapter: 9

**True-False With Discussion**

1. Discuss whether the following statement is true or false:
   One can always construct a multi-index model that explains more of the returns on a security than a single-index model does.

   Answer: True
   The single-index model assumes that the stock prices move together only because of common movement in the market. Hence, the single index-model derives returns on securities with the help of the market movement in which the securities are being traded. Although, according to many researchers, there are influences beyond the market that cause stocks to move together. The multi-index model includes two different types of schemes that have been put forth for handling additional influences. Hence, the multi-index model takes into consideration the return on securities by introducing additional sources of covariance. By adding these additional influences, the multi-index model explains more of the returns to the general return equation of the single-index model.

   Chapter: 8

2. Discuss whether the following statement is true or false:
   A multi-index model will predict returns better than a single-index model.

   Answer: False
   The multi-index model lies in an intermediate position between the full historical
correlation matrix and the single-index model in its ability to reproduce the historical correlation matrix. Adding more indexes complicates things but result in a more accurate representation of the historical correlation matrix. However, this does not imply that future correlation matrices will be forecast more accurately.

Chapter: 8

Problems

1. Consider the following data for assets A and B:
   \( \bar{R}_A = 10\% ; \bar{R}_B = 19\% ; \sigma_A = 3\% ; \sigma_B = 5\% ; \beta_A = 0.6 ; \beta_B = 1.4 ; \rho_{AB} = 0.4 \).

   a. Calculate the expected return, variance, and beta of a portfolio constructed by investing 1/3 of your funds in asset A and 2/3 in asset B.

   b. If only the riskless asset and assets A and B are available, find the optimum risky-asset portfolio if the risk-free rate is 8%.

Answer: a. Expected return on a portfolio = \( \sum X_i \bar{R}_i \).

   \[
   \bar{R}_p = \left( \frac{1}{3} \times 10 \right) + \left( \frac{2}{3} \times 19 \right) = 16.0
   \]

   \( \bar{R}_p = 16\% \)

   To construct the portfolio with investments A and B, the variance of the portfolios will have to be calculated as:

   \[
   \sigma^2_p = \sum_{i=1}^{N} X_i^2 \sigma_i^2 + \sum_{i=1}^{N} \sum_{j=1}^{N} X_i X_j \sigma_{ij}
   \]

   \[
   \sigma^2_p = \left( \frac{1}{3} \right)^2 \times 3^2 + \left( \frac{2}{3} \right)^2 \times 5^2 + \left\{ 2 \times \frac{1}{3} \times \frac{2}{3} \times 3 \times 5 \times 0.4 \right\}
   \]

   \( \sigma^2_p = 14.78\% \)

   The Beta of a portfolio can be calculated by the following method:

   \[
   \beta_p = \sum_{i=1}^{N} X_i \beta_i
   \]

   \[
   \beta_p = \frac{1}{3} \times 0.6 + \frac{2}{3} \times 1.4
   \]

   \( \beta_p = 1.13 \)

   b. Calculating for market variance we get,

   \[
   \rho_{ij} = \frac{\beta_i \times \beta_j \times \sigma_m^2}{\sigma_i \sigma_j}
   \]
0.4 = \frac{0.6 \times 1.4 \times \sigma_m^2}{3 \times 5}

Hence,
\sigma_m^2 = 7.14

Now,
\sigma_{e_i}^2 = \sigma_i^2 - (\sigma_m^2 \times \beta_i^2)
\sigma_{e_A}^2 = 6.43
\sigma_{e_B}^2 = 11.01

<table>
<thead>
<tr>
<th>Security</th>
<th>Mean Return</th>
<th>Excess Return</th>
<th>Beta</th>
<th>Excess Return Over Beta</th>
<th>\frac{(R_i - R_F)\beta_i}{\sigma_{e_i}^2}</th>
<th>\frac{\beta_i^2}{\sigma_i^2}</th>
<th>\sum_j \frac{(R_j - R_F)\beta_j}{\sigma_{e_j}^2}</th>
<th>\sum_j \frac{\beta_j^2}{\sigma_{e_j}^2}</th>
<th>\frac{\beta_i^2}{\sigma_i^2}</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>19</td>
<td>11</td>
<td>1.4</td>
<td>7.86</td>
<td>1.399</td>
<td>0.178</td>
<td>1.399</td>
<td>0.178</td>
<td>0.127</td>
</tr>
<tr>
<td>A</td>
<td>10</td>
<td>2</td>
<td>0.6</td>
<td>3.33</td>
<td>0.1866</td>
<td>0.033</td>
<td>1.586</td>
<td>0.211</td>
<td>0.093</td>
</tr>
</tbody>
</table>

\[ C_i = \frac{1}{1 + \sigma m^2 \sum_{j=1}^{n} \left( \frac{\beta_j^2}{\sigma_{e_j}^2} \right)} \]
\[ C_A = 4.520 \]
\[ C_B = 4.398 \ (C^*) \]
(As \( C_B \) is lower than the excess return over risk, we consider \( C_B \) as the cutoff rate \( C^* \))
\[ Z_i = \frac{\beta_i^2}{\sigma_{e_i}^2} \left( \frac{R_i - R_F}{\beta_j} - C^* \right) \]
\[ Z_A = -0.099 \]
\[ Z_B = 0.440 \]

Therefore, the optimum portfolio will have its proportion of \( X_A = -29.17\% \) \( X_B = 129.17\% \).

Chapter: 7 and 9

2. Consider the following data for assets A, B, and C
\[ R_A = 12\% ; \ R_B = 8\% ; \ R_C = 6\% ; \ \beta_A = 1.1 ; \ \beta_B = 0.8 ; \ \beta_C = 0.9 ; \ \sigma_{e_A}^2 = 10 ; \ \sigma_{e_B}^2 = 15 ; \ \sigma_{e_C}^2 = 5. \]

Assume the variance of the market portfolio is 20 and that a riskless asset exists. Set up the
first-order conditions for the optimum risky-asset portfolio.

Answer:
Assuming a risk free rate of 5%, we get the following values for the optimum portfolio:

<table>
<thead>
<tr>
<th>Security</th>
<th>Mean Return</th>
<th>Excess Return</th>
<th>Beta</th>
<th>Excess Return over Beta</th>
<th>( \frac{(R_j - R_F)\beta_j}{\sigma_{ij}} )</th>
<th>( \frac{\beta_j^2}{\sigma_{ei}^2} )</th>
<th>( \sum_{j=1}^{2} (R_j - R_F)\beta_j )</th>
<th>( \sum_{j=1}^{2} \frac{(R_j - R_F)^2}{\sigma_{ij}^2} )</th>
<th>( \frac{\beta_j}{\sigma_{ei}} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>12</td>
<td>7</td>
<td>1.1</td>
<td>6.36</td>
<td>0.77</td>
<td>0.121</td>
<td>0.77</td>
<td>0.121</td>
<td>0.11</td>
</tr>
<tr>
<td>B</td>
<td>8</td>
<td>3</td>
<td>0.8</td>
<td>3.75</td>
<td>0.16</td>
<td>0.043</td>
<td>0.93</td>
<td>0.164</td>
<td>0.053</td>
</tr>
<tr>
<td>C</td>
<td>6</td>
<td>1</td>
<td>0.9</td>
<td>1.11</td>
<td>0.18</td>
<td>0.162</td>
<td>1.11</td>
<td>0.326</td>
<td>0.18</td>
</tr>
</tbody>
</table>

The cutoff rate \( C_i \) of for an optimum portfolio can be found by the following equation:

\[
C_i = \frac{\sigma_m^2 \sum_{j=1}^{2} (R_j - R_F)\beta_j}{\sigma_{ei}^2} \left( 1 + \sigma_m^2 \sum_{j=1}^{2} \frac{\beta_j^2}{\sigma_{ej}^2} \right)
\]

\[
C_A = \frac{20 \times 0.77}{1 + (20 \times 0.121)} \quad C_B = \frac{20 \times 0.93}{1 + (20 \times 0.164)} \quad C_C = \frac{20 \times 1.11}{1 + (20 \times 0.326)}
\]

\( C_A = 4.50 \quad C_B = 4.35 \quad C_C = 2.95 \)

The ratio of excess return over Beta is higher than the cutoff rate of 4.50 for only security A. Hence, we conclude that only security A is included in the first order equation of the optimal risky portfolio.

Chapter: 9

3. Consider the following historical data for the returns on assets A and B and the market portfolio:

<table>
<thead>
<tr>
<th>Period</th>
<th>Asset A</th>
<th>Asset B</th>
<th>Market Portfolio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10%</td>
<td>6%</td>
<td>4%</td>
</tr>
<tr>
<td>2</td>
<td>3%</td>
<td>6%</td>
<td>1%</td>
</tr>
<tr>
<td>3</td>
<td>5%</td>
<td>2%</td>
<td>5%</td>
</tr>
<tr>
<td>4</td>
<td>2%</td>
<td>4%</td>
<td>2%</td>
</tr>
<tr>
<td>5</td>
<td>1%</td>
<td>2%</td>
<td>1%</td>
</tr>
</tbody>
</table>

a. What is the covariance between asset A and asset B?
b. If the beta of asset B is 0.5, what is the systematic return and non-systematic return for asset B in each period?

Answer: a.
Hence, the Covariance \((A, B)\) = \(2 ÷ 5 = 0.4\)

b. From the given information, we know that the average return on asset B is 4%, average return on market is 2.6% and the Beta of asset B is 0.5. Based on this information, we can find the value of systematic return \(\alpha_B\) and unsystematic return \(e_i\).

\[
\alpha_B = \bar{R}_B - \beta_B \bar{R}_M \quad \alpha_B = 4 - (0.5 \times 2.6) \quad \text{Hence,} \quad \alpha_B = 2.7
\]

To find the value of the unsystematic risk for all periods, we used the following formula:

\[
R_B = \alpha_B + \beta_B R_M + e_B
\]

<table>
<thead>
<tr>
<th>Period</th>
<th>(\alpha_B)</th>
<th>(\beta_B)</th>
<th>(R_M)</th>
<th>(R_B)</th>
<th>(\beta_B R_M)</th>
<th>(\alpha_B + \beta_B R_M)</th>
<th>(e_B = R_B - \alpha_B + \beta_B R_M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.7</td>
<td>0.5</td>
<td>4</td>
<td>6</td>
<td>2</td>
<td>4.7</td>
<td>1.3</td>
</tr>
<tr>
<td>2</td>
<td>2.7</td>
<td>0.5</td>
<td>1</td>
<td>6</td>
<td>0.5</td>
<td>3.2</td>
<td>2.8</td>
</tr>
<tr>
<td>3</td>
<td>2.7</td>
<td>0.5</td>
<td>5</td>
<td>2</td>
<td>2.5</td>
<td>5.2</td>
<td>-3.2</td>
</tr>
<tr>
<td>4</td>
<td>2.7</td>
<td>0.5</td>
<td>2</td>
<td>4</td>
<td>1.0</td>
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<td>2.7</td>
<td>0.5</td>
<td>1</td>
<td>2</td>
<td>0.5</td>
<td>3.2</td>
<td>-1.2</td>
</tr>
</tbody>
</table>

Hence, the systematic return will remain 2.7% for all periods. The unsystematic return will be 1.3% for period 1, 2.8% for period 2, -3.2% for period 3, 0.3% for period 4 and -1.2% for period 5.

Chapter: 7

4. The annual returns of Wonder Widgets, Inc. and the S&P 500 Composite Index over the last ten years were as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Wonder Widgets</th>
<th>S&amp;P 500</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-15%</td>
<td>-8.5%</td>
</tr>
<tr>
<td>2</td>
<td>10%</td>
<td>4.0%</td>
</tr>
<tr>
<td>3</td>
<td>12%</td>
<td>14.0%</td>
</tr>
<tr>
<td>4</td>
<td>20%</td>
<td>15.0%</td>
</tr>
<tr>
<td>5</td>
<td>-20%</td>
<td>-14.0%</td>
</tr>
</tbody>
</table>
Find the following for Wonder Widgets:

a. Beta ($\beta_W$, slope of regression line)

b. Alpha ($\alpha_W$, intercept of regression line)

c. Unsystematic variance ($\sigma^2_{W} - \beta^2_W \sigma^2_m$)

d. Correlation coefficient ($\rho$)

Answer:

<table>
<thead>
<tr>
<th>Year</th>
<th>$R_t$</th>
<th>$R_m$</th>
<th>$R_t - R_m$</th>
<th>$R_{mt} - R_{mt}$</th>
<th>$(R_{mt} - R_{mt})^2$</th>
<th>$[R_{mt} - (\alpha + \beta R_m)]^2$</th>
<th>$(R_t - \bar{R_t})^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-15</td>
<td>-8.5</td>
<td>-19</td>
<td>-13</td>
<td>247</td>
<td>169</td>
<td>55.29</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>4</td>
<td>-19</td>
<td>-3</td>
<td>0.25</td>
<td>169</td>
<td>41.54</td>
</tr>
<tr>
<td>3</td>
<td>12</td>
<td>14</td>
<td>-6</td>
<td>9.5</td>
<td>0.25</td>
<td>76</td>
<td>90.25</td>
</tr>
<tr>
<td>4</td>
<td>20</td>
<td>15</td>
<td>16</td>
<td>10.5</td>
<td>168</td>
<td>110.25</td>
<td>44.26</td>
</tr>
<tr>
<td>5</td>
<td>-20</td>
<td>-14</td>
<td>-24</td>
<td>-18.5</td>
<td>444</td>
<td>342.25</td>
<td>56.80</td>
</tr>
<tr>
<td>6</td>
<td>-15</td>
<td>-26</td>
<td>-30.5</td>
<td>287.5</td>
<td>930.25</td>
<td>66.31</td>
<td>631</td>
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<tr>
<td>7</td>
<td>25</td>
<td>37</td>
<td>-19</td>
<td>-30.5</td>
<td>579.5</td>
<td>1056.25</td>
<td>62.84</td>
</tr>
<tr>
<td>8</td>
<td>30</td>
<td>24</td>
<td>26</td>
<td>19.5</td>
<td>207</td>
<td>380.25</td>
<td>74.70</td>
</tr>
<tr>
<td>9</td>
<td>-10</td>
<td>-7</td>
<td>-14</td>
<td>-11.5</td>
<td>161</td>
<td>132.25</td>
<td>14.19</td>
</tr>
<tr>
<td>10</td>
<td>3</td>
<td>6.5</td>
<td>-1</td>
<td>2</td>
<td>-2</td>
<td>4</td>
<td>7.74</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>45</td>
<td>45</td>
<td>2860</td>
<td>3215</td>
<td>423.88</td>
<td>2968</td>
</tr>
<tr>
<td>Mean</td>
<td>4</td>
<td>4.5</td>
<td>4.5</td>
<td>2860</td>
<td>3215</td>
<td>423.88</td>
<td>2968</td>
</tr>
</tbody>
</table>

a. Beta: $\beta = \frac{\sigma_{\text{err}}}{\sigma^2_m} = \sum_{i=1}^{10} \frac{\left( R_{it} - \bar{R}_t \right) \left( R_{mt} - \bar{R}_m \right)}{\sum_{i=1}^{10} \left( R_{mt} - \bar{R}_m \right)^2} = \frac{2860}{3215} = 0.89$

b. Alpha: $\alpha = \bar{R}_m - \beta \bar{R}_{mt} = 4 - (0.89 \times 4.5) = -0.0031$

c. Unsystematic Variance: $\sigma^2_{e_i} = \frac{1}{10} \sum_{i=1}^{10} \left[ R_{it} - (\alpha_i + \beta_i R_{mt}) \right]^2$

$\sigma^2_{e_i} = \frac{1}{10} \times 423.88 = 42.388$

d. Correlation Coefficient: $\rho_{im} = \frac{\sigma_{im}}{\sigma_i \sigma_m} = \beta \frac{\sigma_m}{\sigma_i}$

$= 0.89 \times \frac{\sqrt{321.5}}{\sqrt{296.8}} = 0.93$
Chapter: 7

5. You are the pension fund manager for a major university with $100 million in an index fund that invests in the S&P 500 stocks. (The fund holds all the stocks in the index in proportion to their market values.) Due to recent pressure from student groups, the regents have decided to divest themselves of the stocks of firms that invest in South Africa. You estimate that this will eliminate 100 of the 500 stocks in your portfolio. You have been asked to evaluate the effect of the divestiture decision. You estimate that the correlation between acceptable and eliminated stocks is 0.6. You also have the following data:

<table>
<thead>
<tr>
<th></th>
<th>Acceptable Stocks</th>
<th>Eliminated Stocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Firms</td>
<td>400</td>
<td>100</td>
</tr>
<tr>
<td>Total Market Value</td>
<td>$3 billion</td>
<td>$2 billion</td>
</tr>
<tr>
<td>Average Beta</td>
<td>1.0</td>
<td>1.25</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>25%</td>
<td>30%</td>
</tr>
</tbody>
</table>

a. What will the effect of the divestment be on the beta of your portfolio? (Report the beta before and after the divestment.)

b. How will divestment affect the standard deviation of your portfolio? (Report the standard deviation before and after the divestment.)

c. Assume that the standard deviation of the overall market is 20%. What is the effect of divestment on the proportion of your portfolio’s risk that is unsystematic? (Report the proportion before and after the divestment.)

Answer:

a. \[ \sum X_i \beta_i = \left( \frac{3}{5} \times 1 \right) + \left( \frac{2}{5} \times 1.25 \right) = 1.1 \] (Before divestment)

After divestment, the Beta is given as 1.

b. \[ \sigma_p^2 = \sum_{i=1}^{N} X_i^2 \sigma_i^2 + \sum_{i=1}^{N} \sum_{j=1}^{N} X_i X_j \sigma_{ij} \]

\[ \sigma_p = \sqrt{\left( \frac{3}{5} \times 0.25 \right)^2 + \left( \frac{2}{5} \times 0.3 \right)^2 + \left( 2 \times \frac{3}{5} \times \frac{2}{5} \times 0.25 \times 0.3 \times 0.6 \right)} = 24.19\% \] (Before divestment).

After divestment, the standard deviation is given as 25%.

c. If the standard deviation of the overall market is 20%, and the standard deviation of the portfolio before divestment was 24.19%.

\[ \sigma_p^2 = \beta_p^2 \sigma_m^2 + \left[ \sum_{i=1}^{n} X_i^2 \sigma_{ei}^2 \right] \]

\[ 0.0585 = 1.1 \times 0.20 + \left[ \sum_{i=1}^{n} X_i^2 \sigma_{ei}^2 \right] \]

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\[
\left[ \sum_{i=1}^{n} X_i^2 \sigma^2_{ei} \right] = 1.01\% \text{ (unsystematic risk before elimination)}
\]

\[
(0.25)^2 = 1 \times 0.20 + \left[ \sum_{i=1}^{n} X_i^2 \sigma^2_{ei} \right]
\]

\[
\left[ \sum_{i=1}^{n} X_i^2 \sigma^2_{ei} \right] = 2.25\% \text{ (unsystematic risk after elimination)}
\]

Chapter: 7

6. A security analyst works for a large institution that uses the single-index model as part of its portfolio-management scheme. The security analyst believes the following values are relevant for the four stocks she follows:

- \( \bar{R}_A = 14\% \)
- \( \bar{R}_B = 12\% \)
- \( \bar{R}_C = 8\% \)
- \( \bar{R}_D = 11\% \)
- \( \beta_A = 2.0 \)
- \( \beta_B = 1.5 \)
- \( \beta_C = 1.0 \)
- \( \beta_D = 1.0 \)
- \( \sigma^2_{eA} = 15 \)
- \( \sigma^2_{eB} = 7.5 \)
- \( \sigma^2_{eC} = 9 \)
- \( \sigma^2_{eD} = 10 \)

The institution assumes that the risk-free rate is 6%, and short selling is not allowed. The institution accepts the Sharpe single-index model and uses the procedure described by Elton, Gruber and Padberg (EGP) to determine the optimum risky-asset portfolio for the institution to hold. The procedure is to compute

\[
Z_i = \frac{\beta_i}{\sigma_{ei}^2} \times \left[ \text{(ranking criterion for asset } i \text{)} - C^* \right]
\]

where the ranking criterion is as described by EGP and where \( C^* \) depends on all risky assets the institution holds. The institution’s management has determined that \( C^* = 3 \).

a. Which stocks that the analyst follows will be held in the institution’s optimum portfolio?

b. If the sum of the \( Z \)'s for all the institution’s stocks in the optimum portfolio is equal to 4, what fraction of the institution’s optimum portfolio will each of the stocks that the analyst follows represent?

c. Why should \( \sigma^2_{ei} \) (diversifiable risk) enter into the optimal solution?

Answer:

<table>
<thead>
<tr>
<th>Security</th>
<th>Mean Return</th>
<th>Excess Return ( (R_i - R_F) )</th>
<th>Beta</th>
<th>Excess Return over Beta</th>
<th>( \frac{\beta_i}{\sigma_{ei}^2} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>14</td>
<td>8</td>
<td>2</td>
<td>4</td>
<td>0.1333</td>
</tr>
<tr>
<td>B</td>
<td>12</td>
<td>6</td>
<td>1.5</td>
<td>4</td>
<td>0.2000</td>
</tr>
<tr>
<td>C</td>
<td>8</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>0.1111</td>
</tr>
<tr>
<td>D</td>
<td>11</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>0.1000</td>
</tr>
</tbody>
</table>

a. if \( C^* = 3 \), the stocks A, B, and D can be held in the optimum portfolio, as their
excess return over Beta is higher than the cutoff rate.

b. If the sum of \( Z_i \)'s for all the institution's stocks in the optimum portfolio equals 4, the fraction of the institution's optimum portfolio will be represent as \( Z_A/4, Z_B/4, \) and \( Z_D/4. \)

Hence, in this case, the fraction of the institution's optimum portfolio can be found by using the following equation:

\[
Z_i = \frac{\beta_i}{\sigma_i^2} \left( \frac{R_i - R_F}{\beta_i} - C^* \right)
\]

\[
Z_A = 0.1333 \times (4 - 3) = 0.13
\]

\[
Z_B = 0.20 \times (4 - 3) = 0.20
\]

\[
Z_D = 0.10 \times (5 - 3) = 0.20
\]

Therefore, the fraction of the portfolio is \( Z_A = 0.13/4, Z_B = 0.20/4, \) and \( Z_D = 0.20/4. \)

Therefore, Stock A has a proportion of 3%, Stock B has a 5% proportion and Stock D has a proportion of 5%.

c. \( \sigma_{e_i}^2 \) is denoted as the variance of a stock’s movement that is not associated with the movement of market index. The residual variance plays an important role in determining how much to invest in each security.

Chapter: 9

**Essays**

1. What is a stock's own variance and what is the covariance between two stocks if one accepts the Sharpe single-index model? Explain why each is what it is.

Answer:

In a single-index model for expected return, a security's variance has two parts, unique risk and market-related risk. The covariance depends only on the market risk. That is why the single-index model implies that the only reason securities move together is a common response to market movements.

The model's basic equation is \( R_i = \alpha_i + \beta_i R_m + e_i. \) Where, \( \alpha_i \) denotes the expected value of the component of return insensitive to the return on the market, \( e_i \) represents the random element of the component, and \( \beta_i \) is the constant Beta used to measure the expected change in return on the security in comparison to the return on markets. The variance of return on any security is \( \sigma_i^2 = E(R_i - \overline{R_i})^2. \) From this we understand that the variance of \( e_i = E(e_i)^2 = \sigma_{e_i}^2. \) The covariance between any two securities is described as \( \sigma_{ij} = E[(R_i - \overline{R_i})(R_j - \overline{R_j})]. \) After substituting the returns and average returns of the securities with the single-index model, we get the stock's variance and the covariance between two stocks. We can hence find that the variance of a security’s return is...
\[ \sigma^2_i = \beta_i^2 \sigma^2_m + \sigma^2_{ei} \] and the covariance of two securities is \[ \sigma_{ij} = \beta_i \beta_j \sigma^2_m . \]

Chapter: 7

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