

CHAPTER 5

Risk and Return

INSTRUCTOR'S RESOURCES

Overview

This chapter focuses on the fundamentals of the risk and return relationship of assets and their valuation. For the single asset held in isolation, risk is measured with the probability distribution and its associated statistics: the mean, the standard deviation, and the coefficient of variation. The concept of diversification is examined by measuring the risk of a portfolio of assets that are perfectly positively correlated, perfectly negatively correlated, and those that are uncorrelated. Next, the chapter looks at international diversification and its effect on risk. The Capital Asset Pricing Model (CAPM) is then presented as a valuation tool for securities and as a general explanation of the risk-return trade-off involved in all types of financial transactions.

PMF DISK

This chapter's topics are not covered on the *PMF Tutor* or *PMF Problem-Solver*.

PMF Templates

Spreadsheet templates are provided for the following problems:

<u>Problem</u>	<u>Topic</u>
Self-Test 1	Portfolio analysis
Self-Test 2	Beta and CAPM
Problem 5-7	Coefficient of variation
Problem 5-26	Security market line, SML

Study Guide

The following *Study Guide* examples are suggested for classroom presentation:

<u>Example</u>	<u>Topic</u>
4	Risk attitudes
6	Graphic determination of beta
12	Impact of market changes on return

ANSWERS TO REVIEW QUESTIONS

5-1 *Risk* is defined as the chance of financial loss, as measured by the variability of expected returns associated with a given asset. A decision maker should evaluate an investment by measuring the chance of loss, or risk, and comparing the expected risk to the expected return. Some assets are considered risk-free; the most common examples are U. S. Treasury issues.

5-2 The *return on an investment* (total gain or loss) is the change in value plus any cash distributions over a defined time period. It is expressed as a percent of the beginning-of-the-period investment. The formula is:

$$\text{Return} = \frac{[(\text{ending value} - \text{initial value}) + \text{cash distribution}]}{\text{initial value}}$$

Realized return requires the asset to be purchased and sold during the time periods the return is measured. *Unrealized return* is the return that could have been realized if the asset had been purchased and sold during the time period the return was measured.

- 5-3**
- a. The *risk-averse* financial manager requires an increase in return for a given increase in risk.
 - b. The *risk-indifferent* manager requires no change in return for an increase in risk.
 - c. The *risk-seeking* manager accepts a decrease in return for a given increase in risk.

Most financial managers are risk-averse.

5-4 *Sensitivity analysis* evaluates asset risk by using more than one possible set of returns to obtain a sense of the variability of outcomes. The range is found by subtracting the pessimistic outcome from the optimistic outcome. The larger the range, the more variability of risk associated with the asset.

5-5 The decision maker can get an estimate of project risk by viewing a plot of the probability distribution, which relates probabilities to expected returns and shows the degree of dispersion of returns. The more spread out the distribution, the greater the variability or risk associated with the return stream.

5-6 The *standard deviation* of a distribution of asset returns is an absolute measure of dispersion of risk about the mean or expected value. A higher standard deviation indicates a greater project risk. With a larger standard deviation, the distribution is more dispersed and the outcomes have a higher variability, resulting in higher risk.

5-7 The *coefficient of variation* is another indicator of asset risk, measuring relative dispersion. It is calculated by dividing the standard deviation by the expected value. The coefficient of variation may be a better basis than the standard deviation for comparing risk of assets with differing expected returns.

5-8 An *efficient portfolio* is one that maximizes return for a given risk level or minimizes risk for a given level of return. *Return of a portfolio* is the weighted average of returns on the individual component assets:

$$\hat{k}_p = \sum_{j=1}^n w_j \times \hat{k}_j$$

Where n = number of assets, w_j = weight of individual assets, and \hat{k}_j = expected Returns.

The *standard deviation of a portfolio* is not the weighted average of component standard deviations; the risk of the portfolio as measured by the standard deviation will be smaller. It is calculated by applying the standard deviation formula to the portfolio assets:

$$\sigma_{kp} = \sqrt{\sum_{i=1}^n \frac{(k_i - k)^2}{(n-1)}}$$

5-9 The *correlation* between asset returns is important when evaluating the effect of a new asset on the portfolio's overall risk. Returns on different assets moving in the same direction are *positively correlated*, while those moving in opposite directions are *negatively correlated*. Assets with high positive correlation increase the variability of portfolio returns; assets with high negative correlation reduce the variability of portfolio returns. When negatively correlated assets are brought together through diversification, the variability of the expected return from the resulting combination can be less than the variability or risk of the individual assets. When one asset has high returns, the other's returns are low and vice versa. Therefore, the result of diversification is to reduce risk by providing a pattern of stable returns.

Diversification of risk in the asset selection process allows the investor to reduce overall risk by combining negatively correlated assets so that the risk of the portfolio is less than the risk of the individual assets in it. Even if assets are not negatively correlated, the lower the positive correlation between them, the lower the resulting risks.

5-10 The inclusion of foreign assets in a domestic company's portfolio reduces risk for two reasons. When returns from foreign-currency-denominated assets are translated into dollars, the correlation of returns of the portfolio's assets is reduced. Also, if the foreign assets are in countries that are less sensitive to the U.S. business cycle, the portfolio's response to market movements is reduced.

When the dollar *appreciates* relative to other currencies, the dollar value of a foreign-currency-denominated portfolio *declines* and results in lower returns in dollar terms. If this appreciation is due to better performance of the U.S. economy, foreign-currency-denominated portfolios generally have lower returns in local currency as well, further contributing to reduced returns.

Political risks result from possible actions by the host government that are harmful to foreign investors or possible political instability that could endanger foreign assets. This form of risk is particularly high in developing countries. Companies diversifying internationally may have assets seized or the return of profits blocked.

5-11 The *total risk* of a security is the combination of nondiversifiable risk and diversifiable risk. *Diversifiable risk* refers to the portion of an asset's risk attributable to firm-specific, random events (strikes, litigation, loss of key contracts, etc.) that can be eliminated by diversification. *Nondiversifiable risk* is attributable to market factors affecting all firms (war, inflation, political events, etc.). Some argue that nondiversifiable risk is the only relevant risk because diversifiable risk can be eliminated by creating a portfolio of assets which are not perfectly positively correlated.

5-12 *Beta* measures nondiversifiable risk. It is an index of the degree of movement of an asset's return in response to a change in the market return. The beta coefficient for an asset can be found by plotting the

asset's historical returns relative to the returns for the market. By using statistical techniques, the "*characteristic line*" is fit to the data points. The slope of this line is beta. Beta coefficients for actively traded stocks are published in Value Line Investment Survey and in brokerage reports. The beta of a portfolio is calculated by finding the weighted average of the betas of the individual component assets.

5-13 The equation for the Capital Asset Pricing Model is: $k_j = R_F + [b_j \times (k_m - R_F)]$,

Where:

k_j = the required (or expected) return on asset j.

R_F = the rate of return required on a risk-free security (a U.S. Treasury bill)

b_j = the beta coefficient or index of nondiversifiable (relevant) risk for asset j

k_m = the required return on the market portfolio of assets (the market return)

The security market line (SML) is a graphical presentation of the relationship between the amount of systematic risk associated with an asset and the required return. Systematic risk is measured by beta and is on the horizontal axis while the required return is on the vertical axis.

5-14 a. If there is an increase in inflationary expectations, the security market line will show a parallel shift upward in an amount equal to the expected increase in inflation. The required return for a given level of risk will also rise.

b. The slope of the SML (the beta coefficient) will be less steep if investors become less risk-averse, and a lower level of return will be required for each level of risk.

5-15 The CAPM provides financial managers with a link between risk and return. Because it was developed to explain the behavior of securities prices in efficient markets and uses historical data to estimate required returns, it may not reflect future variability of returns. While studies have supported the CAPM when applied in active securities markets, it has not been found to be generally applicable to real corporate assets. However, the CAPM can be used as a conceptual framework to evaluate the relationship between risk and return.

SOLUTIONS TO PROBLEMS

5-1 LG 1: Rate of Return: $k_t = \frac{(P_t - P_{t-1} + C_t)}{P_{t-1}}$

a.

Investment X: $\text{Return} = \frac{(\$21,000 - \$20,000 + \$1,500)}{\$20,000} = 12.50\%$

Investment Y: $\text{Return} = \frac{(\$55,000 - \$55,000 + \$6,800)}{\$55,000} = 12.36\%$

b. Investment X should be selected because it has a higher rate of return for the same level of risk.

5-2 LG 1: Return Calculations: $k_t = \frac{(P_t - P_{t-1} + C_t)}{P_{t-1}}$

Investment	Calculation	k_t (%)
A	$(\$1,100 - \$800 - \$100) \div \800	25.00
B	$(\$118,000 - \$120,000 + \$15,000) \div \$120,000$	10.83
C	$(\$48,000 - \$45,000 + \$7,000) \div \$45,000$	22.22
D	$(\$500 - \$600 + \$80) \div \600	-3.33
E	$(\$12,400 - \$12,500 + \$1,500) \div \$12,500$	11.20

5-3 LG 1: Risk Preferences

- a. The risk-indifferent manager would accept Investments X and Y because these have higher returns than the 12% required return and the risk doesn't matter.
- b. The risk-averse manager would accept Investment X because it provides the highest return and has the lowest amount of risk. Investment X offers an increase in return for taking on more risk than what the firm currently earns.
- c. The risk-seeking manager would accept Investments Y and Z because he or she is willing to take greater risk without an increase in return.
- d. Traditionally, financial managers are risk-averse and would choose Investment X, since it provides the required increase in return for an increase in risk.

5-4 LG 2: Risk Analysis

a.	<u>Expansion</u>	<u>Range</u>
	A	24% - 16% = 8%
	B	30% - 10% = 20%

- b. Project A is less risky, since the range of outcomes for A is smaller than the range for Project B.

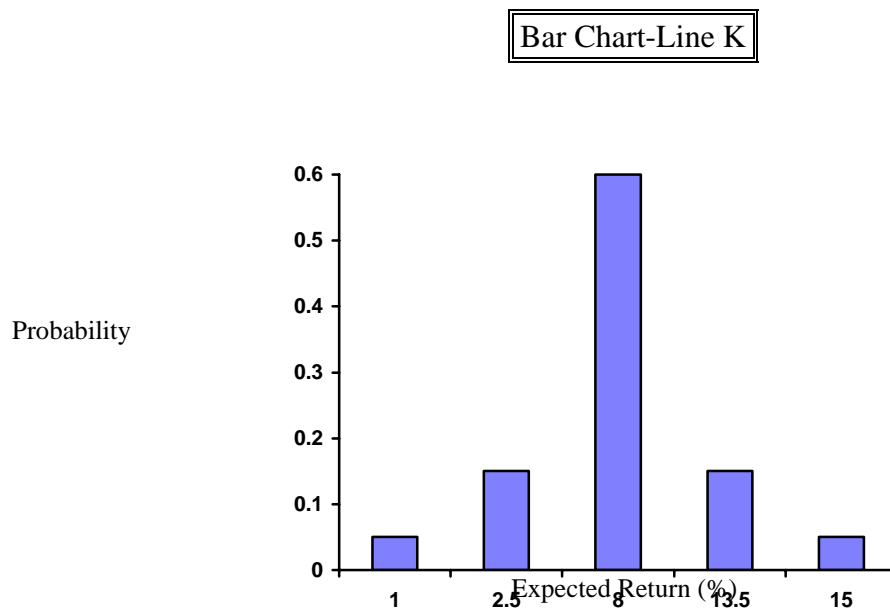
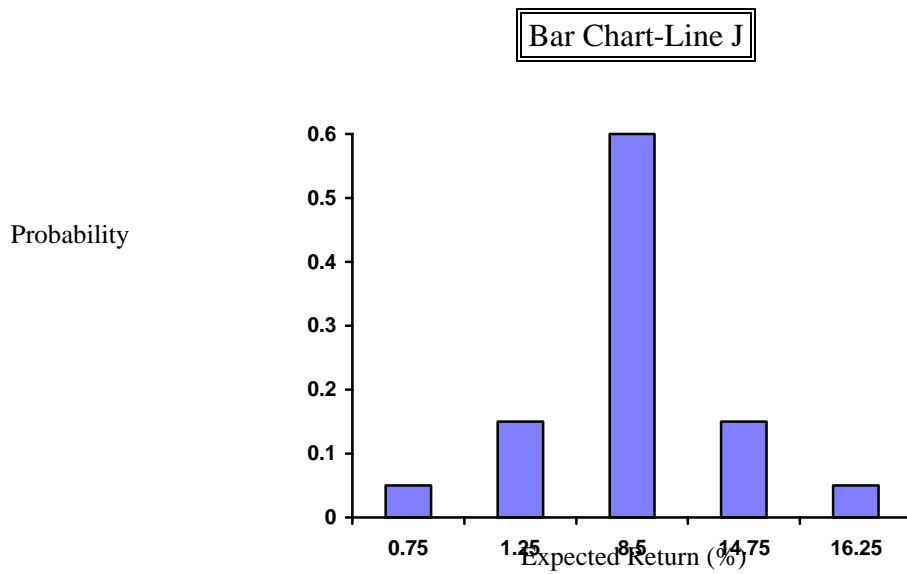
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- c. Since the most likely return for both projects is 20% and the initial investments are equal, the answer depends on your risk preference.
- d. The answer is no longer clear, since it now involves a risk-return trade-off. Project B has a slightly higher return but more risk, while A has both lower return and lower risk.

5-5 LG 2: Risk and Probability

- a.
- | <u>Camera</u> | <u>Range</u> |
|---------------|-----------------|
| R | 30% - 20% = 10% |
| S | 35% - 15% = 20% |
- b.
- | | Possible Outcomes | Probability P_{ri} | Expected Return k_i | Weighted Value (%)
($k_i \times P_{ri}$) |
|-----------------|-------------------|----------------------|-----------------------|---|
| Camera R | Pessimistic | 0.25 | 20 | 5.00 |
| | Most likely | 0.50 | 25 | 12.50 |
| | Optimistic | <u>0.25</u> | 30 | <u>7.50</u> |
| | | 1.00 | Expected Return | <u>25.00</u> |
| | | | | |
| Camera S | Pessimistic | 0.20 | 15 | 3.00 |
| | Most likely | 0.55 | 25 | 13.75 |
| | Optimistic | <u>0.25</u> | 35 | <u>8.75</u> |
| | | 1.00 | Expected Return | <u>25.50</u> |
| | | | | |
- c. Camera S is considered more risky than Camera R because it has a much broader range of outcomes. The risk-return trade-off is present because Camera S is more risky and also provides a higher return than Camera R.

a.



b.

	Market Acceptance	Probability P_{ri}	Expected Return k_i	Weighted Value ($k_i \times P_{ri}$)
Line J	Very Poor	0.05	.0075	.000375
	Poor	0.15	.0125	.001875
	Average	0.60	.0850	.051000
	Good	0.15	.1475	.022125
	Excellent	<u>0.05</u>	.1625	<u>.008125</u>
		1.00	Expected Return	<u>.083500</u>

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Line K	Very Poor	0.05	.010	.000500
	Poor	0.15	.025	.003750
	Average	0.60	.080	.048000
	Good	0.15	.135	.020250
	Excellent	<u>0.05</u>	.150	<u>.007500</u>
		1.00	Expected Return	<u>.080000</u>

- c. Line K appears less risky due to a slightly tighter distribution than line J, indicating a lower range of outcomes.

5-7 LG 2: Coefficient of Variation: $CV = \frac{\sigma_k}{k}$

a. A $CV_A = \frac{7\%}{20\%} = .3500$

B $CV_B = \frac{9.5\%}{22\%} = .4318$

C $CV_C = \frac{6\%}{19\%} = .3158$

D $CV_D = \frac{5.5\%}{16\%} = .3438$

- b. Asset C has the lowest coefficient of variation and is the least risky relative to the other choices.

5-8 LG 2: Standard Deviation versus Coefficient of Variation as Measures of Risk

- a. Project A is least risky based on range with a value of .04.

- b. Project A is least risky based on standard deviation with a value of .029. Standard deviation is not the appropriate measure of risk since the projects have different returns.

c. A $CV_A = \frac{.029}{.12} = .2417$

B $CV_B = \frac{.032}{.125} = .2560$

C $CV_C = \frac{.035}{.13} = .2692$

D $CV_D = \frac{.030}{.128} = .2344$

In this case project A is the best alternative since it provides the least amount of risk for each percent of return earned. Coefficient of variation is probably the best measure in this instance since it provides a standardized method of measuring the risk/return trade-off for investments with differing returns.

5-9 LG 2: Assessing Return and Risk**a. Project 257**

1. **Range:** $1.00 - (-.10) = 1.10$

2. **Expected return:** $\bar{k} = \sum_{i=1}^n k_i \times P_{ri}$

Rate of Return	Probability	Weighted Value	Expected Return
k_i	P_{ri}	$k_i \times P_{ri}$	$\bar{k} = \sum_{i=1}^n k_i \times P_{ri}$
-.10	.01	-.001	
.10	.04	.004	
.20	.05	.010	
.30	.10	.030	
.40	.15	.060	
.45	.30	.135	
.50	.15	.075	
.60	.10	.060	
.70	.05	.035	
.80	.04	.032	
1.00	.01	.010	
	<u>1.00</u>		<u>.450</u>

3. **Standard Deviation:** $\sigma = \sqrt{\sum_{i=1}^n (k_i - \bar{k})^2 \times P_{ri}}$

k_i	\bar{k}	$k_i - \bar{k}$	$(k_i - \bar{k})^2$	P_{ri}	$(k_i - \bar{k})^2 \times P_{ri}$
-.10	.450	-.550	.3025	.01	.003025
.10	.450	-.350	.1225	.04	.004900
.20	.450	-.250	.0625	.05	.003125
.30	.450	-.150	.0225	.10	.002250
.40	.450	-.050	.0025	.15	.000375
.45	.450	.000	.0000	.30	.000000
.50	.450	.050	.0025	.15	.000375
.60	.450	.150	.0225	.10	.002250
.70	.450	.250	.0625	.05	.003125
.80	.450	.350	.1225	.04	.004900
1.00	.450	.550	.3025	.01	.003025
					<u>.027350</u>

$$\sigma_{\text{Project 257}} = \sqrt{.027350} = .165378$$

4. $CV = \frac{.165378}{.450} = .3675$

Project 432

1. **Range:** $.50 - .10 = .40$

2. **Expected return:** $\bar{k} = \sum_{i=1}^n k_i \times P_{ri}$

Rate of Return	Probability	Weighted Value	Expected Return
----------------	-------------	----------------	-----------------

k_i	P_{ri}	$k_i \times P_{ri}$	$\bar{k} = \sum_{i=1}^n k_i \times P_{ri}$
.10	.05	.0050	
.15	.10	.0150	
.20	.10	.0200	
.25	.15	.0375	
.30	.20	.0600	
.35	.15	.0525	
.40	.10	.0400	
.45	.10	.0450	
.50	.05	.0250	
	<u>1.00</u>		<u>.300</u>

3. Standard Deviation: $\sigma = \sqrt{\sum_{i=1}^n (k_i - \bar{k})^2 \times P_{ri}}$

k_i	\bar{k}	$k_i - \bar{k}$	$(k_i - \bar{k})^2$	P_{ri}	$(k_i - \bar{k})^2 \times P_{ri}$
.10	.300	-.20	.0400	.05	.002000
.15	.300	-.15	.0225	.10	.002250
.20	.300	-.10	.0100	.10	.001000
.25	.300	-.05	.0025	.15	.000375
.30	.300	.00	.0000	.20	.000000
.35	.300	.05	.0025	.15	.000375
.40	.300	.10	.0100	.10	.001000
.45	.300	.15	.0225	.10	.002250
.50	.300	.20	.0400	.05	.002000
					<u>.011250</u>

$$\sigma_{\text{Project 432}} = \sqrt{.011250} = .106066$$

4. $CV = \frac{.106066}{.300} = .3536$

b. Bar Charts

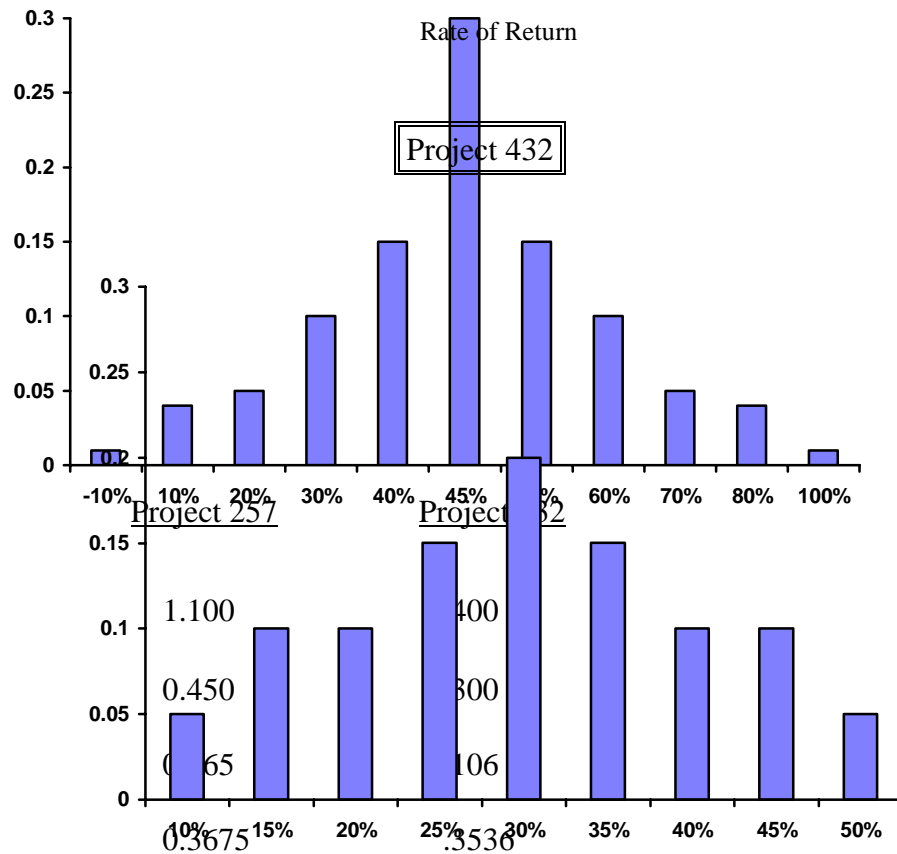
Project 257

Probability

c.

Summary Statistics

Probability
Range
Expected
Return (\bar{k})
Standard
Deviation (σ_k)
Coefficient of
Variation (CV)



Since Projects 257 and 432 have differing expected values, the coefficient of variation should be the criterion by which the risk of the asset is judged. Since Project 432 has a smaller CV, it is the opportunity with lower risk.

5-10 LG 2: Integrative–Expected Return, Standard Deviation, and Coefficient of Variation

a. **Expected return:** $\bar{k} = \sum_{i=1}^n k_i \times P_{ri}$

	Rate of Return	Probability	Weighted Value	Expected Return
	k_i	P_{ri}	$k_i \times P_{ri}$	$\bar{k} = \sum_{i=1}^n k_i \times P_{ri}$
Asset F	.40	.10	.04	<u>.04</u>
	.10	.20	.02	
	.00	.40	.00	
	-.05	.20	-.01	
	-.10	.10	-.01	

Asset G	.35	.40	.14	
	.10	.30	.03	
	-.20	.30	-.06	
				<u>.11</u>
Asset H	.40	.10	.04	
	.20	.20	.04	
	.10	.40	.04	
	.00	.20	.00	
	-.20	.10	-.02	
				<u>.10</u>

Asset G provides the largest expected return.

b. **Standard Deviation:** $\sigma_k = \sqrt{\sum_{i=1}^n (k_i - \bar{k})^2 \times P_{ri}}$

	$(k_i - \bar{k})$	$(k_i - \bar{k})^2$	P_{ri}	σ^2	σ_k
Asset F	.40 - .04 = .36	.1296	.10	.01296	
	.10 - .04 = .06	.0036	.20	.00072	
	.00 - .04 = -.04	.0016	.40	.00064	
	-.05 - .04 = -.09	.0081	.20	.00162	
	-.10 - .04 = -.14	.0196	.10	.00196	
				.01790	<u>.1338</u>

	$(k_i - \bar{k})$	$(k_i - \bar{k})^2$	P_{ri}	σ^2	σ_k
Asset G	.35 - .11 = .24	.0576	.40	.02304	
	.10 - .11 = -.01	.0001	.30	.00003	
	-.20 - .11 = -.31	.0961	.30	.02883	
				.05190	<u>.2278</u>

Asset H	.40 - .10 = .30	.0900	.10	.009	
	.20 - .10 = .10	.0100	.20	.002	
	.10 - .10 = .00	.0000	.40	.000	
	.00 - .10 = -.10	.0100	.20	.002	
	-.20 - .10 = -.30	.0900	.10	.009	
				.022	<u>.1483</u>

Based on standard deviation, Asset G appears to have the greatest risk, but it must be measured against its expected return with the statistical measure coefficient of variation, since the three assets have differing expected values. An incorrect conclusion about the risk of the assets could be drawn using only the standard deviation.

c. **Coefficient of Variation** = $\frac{\text{standard deviation } (\sigma)}{\text{expected value}}$

Asset F: $CV = \frac{.1338}{.04} = 3.345$

Asset G: $CV = \frac{.2278}{.11} = 2.071$

Asset H: $CV = \frac{.1483}{.10} = 1.483$

As measured by the coefficient of variation, Asset F has the largest relative risk.

5-11 LG 2: Normal Probability Distribution

a. Coefficient of variation: $CV = \sigma_k \div \bar{k}$

Solving for standard deviation: $.75 = \sigma_k \div .189$
 $\sigma_k = .75 \times .189 = .14175$

b. 1. 58% of the outcomes will lie between ± 1 standard deviation from the expected value:

$$+1\sigma = .189 + .14175 = .33075$$

$$-1\sigma = .189 - .14175 = .04725$$

2. 95% of the outcomes will lie between ± 2 standard deviations from the expected value:

$$+2\sigma = .189 + (2 \times .14175) = .4725$$

$$-2\sigma = .189 - (2 \times .14175) = -.0945$$

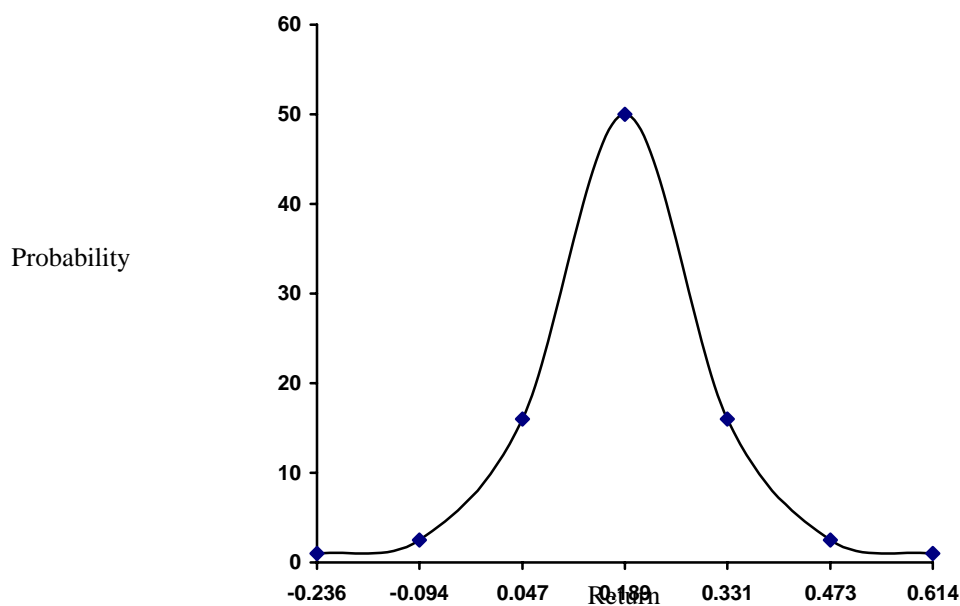
3. 99% of the outcomes will lie between ± 3 standard deviations from the expected value:

$$+3\sigma = .189 + (3 \times .14175) = .61425$$

$$-3\sigma = .189 - (3 \times .14175) = -.23625$$

c.

Probability Distribution



5-12 LG 3: Portfolio Return and Standard Deviation

a. **Expected Portfolio Return for Each Year:** $k_p = (w_L \times k_L) + (w_M \times k_M)$

Year	Asset L ($w_L \times k_L$)	+	Asset M ($w_M \times k_M$)	Expected Portfolio Return k_p
2004	(14% x .40 = 5.6%)	+	(20% x .60 = 12.0%)	= 17.6%
2005	(14% x .40 = 5.6%)	+	(18% x .60 = 10.8%)	= 16.4%
2006	(16% x .40 = 6.4%)	+	(16% x .60 = 9.6%)	= 16.0%
2007	(17% x .40 = 6.8%)	+	(14% x .60 = 8.4%)	= 15.2%
2008	(17% x .40 = 6.8%)	+	(12% x .60 = 7.2%)	= 14.0%
2009	(19% x .40 = 7.6%)	+	(10% x .60 = 6.0%)	= 13.6%

b. **Portfolio Return:** $k_p = \frac{\sum_{j=1}^n w_j \times k_j}{n}$

$$k_p = \frac{17.6 + 16.4 + 16.0 + 15.2 + 14.0 + 13.6}{6} = 15.467 = 15.5\%$$

c. **Standard Deviation:** $\sigma_{kp} = \sqrt{\frac{\sum_{i=1}^n (k_i - \bar{k})^2}{(n-1)}}$

$$\sigma_{kp} = \sqrt{\frac{(17.6\% - 15.5\%)^2 + (16.4\% - 15.5\%)^2 + (16.0\% - 15.5\%)^2 + (15.2\% - 15.5\%)^2 + (14.0\% - 15.5\%)^2 + (13.6\% - 15.5\%)^2}{6-1}}$$

$$\sigma_{kp} = \sqrt{\frac{(2.1\%)^2 + (.9\%)^2 + (0.5\%)^2 + (-0.3\%)^2 + (-1.5\%)^2 + (-1.9\%)^2}{5}}$$

$$\sigma_{kp} = \sqrt{\frac{(4.41\% + 0.81\% + 0.25\% + 0.09\% + 2.25\% + 3.61\%)}{5}}$$

$$\sigma_{kp} = \sqrt{\frac{11.42}{5}} = \sqrt{2.284} = 1.51129$$

- d. The assets are negatively correlated.
- e. Combining these two negatively correlated assets reduces overall portfolio risk.

5-13 LG 3: Portfolio Analysis

a. Expected portfolio return:

Alternative 1: 100% Asset F

$$k_p = \frac{16\% + 17\% + 18\% + 19\%}{4} = 17.5\%$$

Alternative 2: 50% Asset F + 50% Asset G

Year	Asset F ($w_F \times k_F$)	+	Asset G ($w_G \times k_G$)	=	Portfolio Return k_p
2001	(16% x .50 = 8.0%)	+	(17% x .50 = 8.5%)	=	16.5%
2002	(17% x .50 = 8.5%)	+	(16% x .50 = 8.0%)	=	16.5%
2003	(18% x .50 = 9.0%)	+	(15% x .50 = 7.5%)	=	16.5%
2004	(19% x .50 = 9.5%)	+	(14% x .50 = 7.0%)	=	16.5%

$$k_p = \frac{66}{4} = 16.5\%$$

Alternative 3: 50% Asset F + 50% Asset H

Year	Asset F ($w_F \times k_F$)	+	Asset H ($w_H \times k_H$)	=	Portfolio Return k_p
2001	(16% x .50 = 8.0%)	+	(14% x .50 = 7.0%)	=	15.0%
2002	(17% x .50 = 8.5%)	+	(15% x .50 = 7.5%)	=	16.0%
2003	(18% x .50 = 9.0%)	+	(16% x .50 = 8.0%)	=	17.0%
2004	(19% x .50 = 9.5%)	+	(17% x .50 = 8.5%)	=	18.0%

$$k_p = \frac{66}{4} = 16.5\%$$

b. Standard Deviation: $\sigma_{kp} = \sqrt{\sum_{i=1}^n \frac{(k_i - \bar{k})^2}{(n-1)}}$

(1)

$$\sigma_F = \sqrt{\frac{[(16.0\% - 17.5\%)^2 + (17.0\% - 17.5\%)^2 + (18.0\% - 17.5\%)^2 + (19.0\% - 17.5\%)^2]}{4-1}}$$

$$\sigma_F = \sqrt{\frac{[(-1.5\%)^2 + (-0.5\%)^2 + (0.5\%)^2 + (1.5\%)^2]}{3}}$$

$$\sigma_F = \sqrt{\frac{(2.25\% + 0.25\% + 0.25\% + 2.25\%)}{3}}$$

$$\sigma_F = \sqrt{\frac{5}{3}} = \sqrt{1.667} = 1.291$$

(2)

$$\sigma_{FG} = \sqrt{\frac{[(16.5\% - 16.5\%)^2 + (16.5\% - 16.5\%)^2 + (16.5\% - 16.5\%)^2 + (16.5\% - 16.5\%)^2]}{4-1}}$$

$$\sigma_{FG} = \sqrt{\frac{[(0)^2 + (0)^2 + (0)^2 + (0)^2]}{3}}$$

$$\sigma_{FG} = 0$$

(3)

$$\sigma_{FH} = \sqrt{\frac{[(15.0\% - 16.5\%)^2 + (16.0\% - 16.5\%)^2 + (17.0\% - 16.5\%)^2 + (18.0\% - 16.5\%)^2]}{4-1}}$$

$$\sigma_{FH} = \sqrt{\frac{[(-1.5\%)^2 + (-0.5\%)^2 + (0.5\%)^2 + (1.5\%)^2]}{3}}$$

$$\sigma_{FH} = \sqrt{\frac{[(2.25 + .25 + .25 + 2.25)]}{3}}$$

$$\sigma_{FH} = \sqrt{\frac{5}{3}} = \sqrt{1.667} = 1.291$$

c. **Coefficient of variation: CV** = $\sigma_k \div \bar{k}$

$$CV_F = \frac{1.291}{17.5\%} = .0738$$

$$CV_{FG} = \frac{0}{16.5\%} = 0$$

$$CV_{FH} = \frac{1.291}{16.5\%} = .0782$$

d. **Summary:**

	k_p : Expected Value of Portfolio	σ_{kp}	CV_p
Alternative 1 (F)	17.5%	1.291	.0738
Alternative 2 (FG)	16.5%	-0-	.0
Alternative 3 (FH)	16.5%	1.291	.0782

Since the assets have different expected returns, the coefficient of variation should be used to determine the best portfolio. Alternative 3, with positively correlated assets, has the highest coefficient of variation and therefore is the riskiest. Alternative 2 is the best choice; it is perfectly negatively correlated and therefore has the lowest coefficient of variation.

5-14 LG 4: Correlation, Risk, and Return

- a.
 1. Range of expected return: between 8% and 13%
 2. Range of the risk: between 5% and 10%
- b.
 1. Range of expected return: between 8% and 13%
 2. Range of the risk: $0 < \text{risk} < 10\%$
- c.
 1. Range of expected return: between 8% and 13%
 2. Range of the risk: $0 < \text{risk} < 10\%$

5-15 LG 1, 4: International Investment Returns

a. $\text{Return}_{\text{pesos}} = \frac{24,750 - 20,500}{20,500} = \frac{4,250}{20,500} = .20732 = 20.73\%$

b. $\text{Purchase price} = \frac{\text{Price in pesos}}{\text{Pesos per dollar}} = \frac{20.50}{9.21} = \$2.22584 \times 1,000 \text{ shares} = \$2,225.84$

Chapter 5 Risk and Return

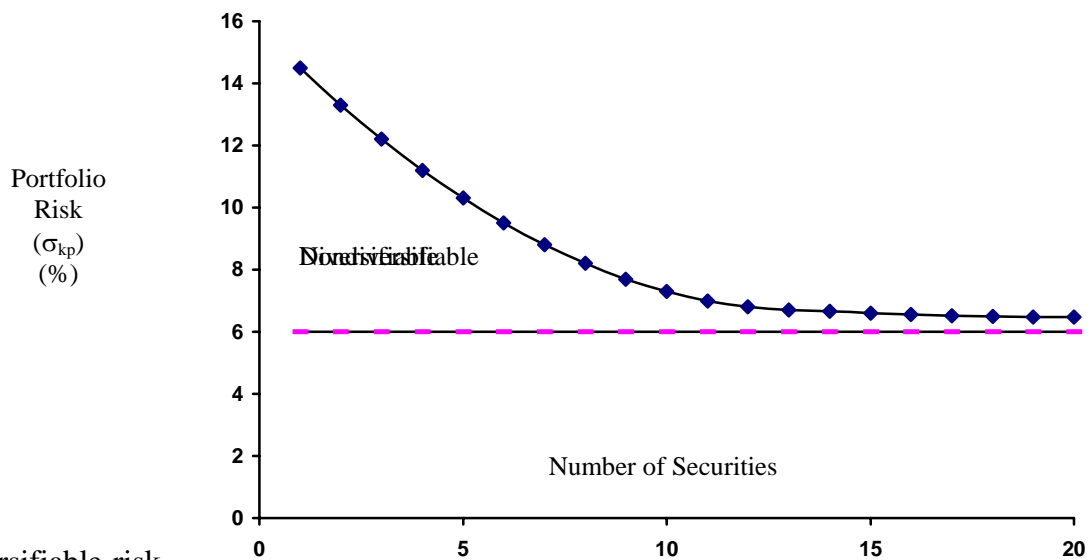
$$\text{Sales price} \frac{\text{Price in pesos}}{\text{Pesos per dollar}} = \frac{24.75}{9.85} = \$2.51269 \times 1,000 \text{ shares} = \$2,512.69$$

c. $\text{Return}_{\text{pesos}} = \frac{2,512.69 - 2,225.84}{2,225.84} = \frac{286.85}{2,225.84} = .12887 = 12.89\%$

- d. The two returns differ due to the change in the exchange rate between the peso and the dollar. The peso had depreciation (and thus the dollar appreciated) between the purchase date and the sale date, causing a decrease in total return. The answer in part c is the more important of the two returns for Joe. An investor in foreign securities will carry exchange-rate risk.

5-16 LG 5: Total, Nondiversifiable, and Diversifiable Risk

a. and b.



- c. Only nondiversifiable risk is relevant because, as shown by the graph, diversifiable risk can be virtually eliminated through holding a portfolio of at least 20 securities which are not positively correlated. David Talbot's portfolio, assuming diversifiable risk could no longer be reduced by additions to the portfolio, has 6.47% relevant risk.

5-17 LG 5: Graphic Derivation of Beta

a.

b. To estimate beta, the "rise over run" method can be used:

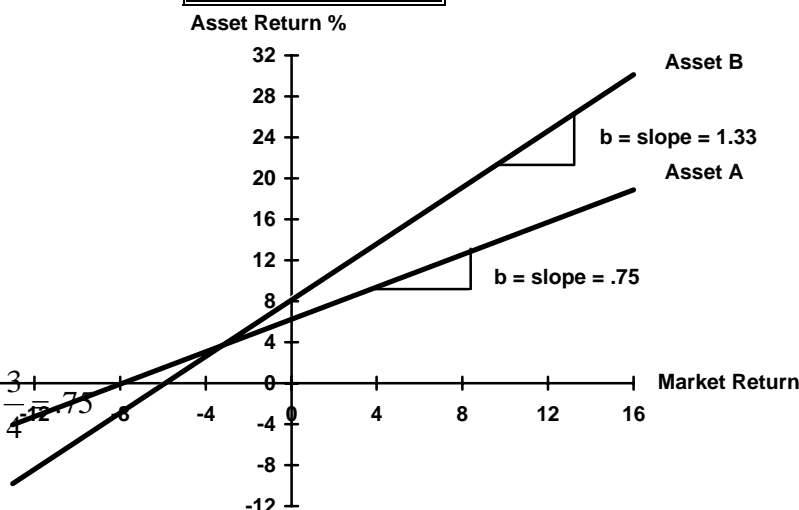
$$\text{Beta} = \frac{\text{Rise}}{\text{Run}} = \frac{\Delta Y}{\Delta X}$$

Taking the points shown on the graph:

$$\text{Beta A} = \frac{\Delta Y}{\Delta X} = \frac{12 - 9}{8 - 4} = \frac{3}{4} = .75$$

$$\text{Beta B} = \frac{\Delta Y}{\Delta X} = \frac{26 - 22}{13 - 10} = \frac{4}{3} = 1.33$$

Derivation of Beta



A financial calculator with statistical functions can be used to perform linear regression analysis. The beta (slope) of line A is .79; of line B, 1.379.

c. With a higher beta of 1.33, Asset B is more risky. Its return will move 1.33 times for each one point the market moves. Asset A's return will move at a lower rate, as indicated by its beta coefficient of .75.

5-18 LG 5: Interpreting Beta

Effect of change in market return on asset with beta of 1.20:

a. 1.20 x (15%) = 18.0% increase

b. 1.20 x (-8%) = 9.6% decrease

c. 1.20 x (0%) = no change

d. The asset is more risky than the market portfolio, which has a beta of 1. The higher beta makes the return move more than the market.

5-19 LG 5: Betas

a. and b.

Asset	Beta	Increase in Market Return	Expected Impact on Asset Return	Decrease in Market Return	Impact on Asset Return
A	0.50	.10	.05	-.10	-.05
B	1.60	.10	.16	-.10	-.16
C	-0.20	.10	-.02	-.10	.02
D	0.90	.10	.09	-.10	-.09

c. Asset B should be chosen because it will have the highest increase in return.

d. Asset C would be the appropriate choice because it is a defensive asset, moving in opposition to the market. In an economic downturn, Asset C's return is increasing.

5-20 LG 5: Betas and Risk Rankings

a.	Stock	Beta
Most risky	B	1.40
	A	0.80

b. and c.

- d. In a declining market, an investor would choose the defensive stock, stock C. While the market declines, the return on C increases.
- e. In a rising market, an investor would choose stock B, the aggressive stock. As the market rises one point, stock B rises 1.40 points.

a.

b. Portfolio A is slightly less risky than the market (average risk), while Portfolio B is more risky than the market. Portfolio B's return will move more than Portfolio A's for a given increase or decrease in market return. Portfolio B is the more risky.

Case	k _j	=	R _F + [b _j x (k _m - R _F)]
A	8.9%	=	5% + [1.30 x (8% - 5%)]
B	12.5%	=	8% + [0.90 x (13% - 8%)]
C	8.4%	=	9% + [- 0.20 x (12% - 9%)]
D	15.0%	=	10% + [1.00 x (15% - 10%)]
E	8.4%	=	6% + [0.60 x (10% - 6%)]

To solve this problem you must take the CAPM and solve for beta. The resulting model is:

a.
$$\text{Beta} = \frac{10\% - 5\%}{16\% - 5\%} = \frac{5\%}{11\%} = .4545$$

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c.
$$\text{Beta} = \frac{18\% - 5\%}{16\% - 5\%} = \frac{13\%}{11\%} = 1.1818$$

d.
$$\text{Beta} = \frac{20\% - 5\%}{16\% - 5\%} = \frac{15\%}{11\%} = 1.3636$$

e. If Katherine is willing to take a maximum of average risk then she will be able to have an expected return of only 16%. ($k = 5\% + 1.0(16\% - 5\%) = 16\%$.)

5-24 LG 6: Manipulating CAPM: $k_j = R_F + [b_j \times (k_m - R_F)]$

a.
$$\begin{aligned} k_j &= 8\% + [0.90 \times (12\% - 8\%)] \\ k_j &= 11.6\% \end{aligned}$$

b.
$$\begin{aligned} 15\% &= R_F + [1.25 \times (14\% - R_F)] \\ R_F &= 10\% \end{aligned}$$

c.
$$\begin{aligned} 16\% &= 9\% + [1.10 \times (k_m - 9\%)] \\ k_m &= 15.36\% \end{aligned}$$

d.
$$\begin{aligned} 15\% &= 10\% + [b_j \times (12.5\% - 10\%)] \\ b_j &= 2 \end{aligned}$$

5-25 LG 1, 3, 5, 6: Portfolio Return and Beta

a.
$$b_p = (.20)(.80) + (.35)(.95) + (.30)(1.50) + (.15)(1.25) = .16 + .3325 + .45 + .1875 = 1.13$$

b.
$$k_A = \frac{(\$20,000 - \$20,000) + \$1,600}{\$20,000} = \frac{\$1,600}{\$20,000} = 8\%$$

$$k_B = \frac{(\$36,000 - \$35,000) + \$1,400}{\$35,000} = \frac{\$2,400}{\$35,000} = 6.86\%$$

$$k_C = \frac{(\$34,500 - \$30,000) + 0}{\$30,000} = \frac{\$4,500}{\$30,000} = 15\%$$

$$k_D = \frac{(\$16,500 - \$15,000) + \$375}{\$15,000} = \frac{\$1,875}{\$15,000} = 12.5\%$$

c.
$$k_P = \frac{(\$107,000 - \$100,000) + \$3,375}{\$100,000} = \frac{\$10,375}{\$100,000} = 10.375\%$$

d.
$$k_A = 4\% + [0.80 \times (10\% - 4\%)] = 8.8\%$$

$$k_B = 4\% + [0.95 \times (10\% - 4\%)] = 9.7\%$$

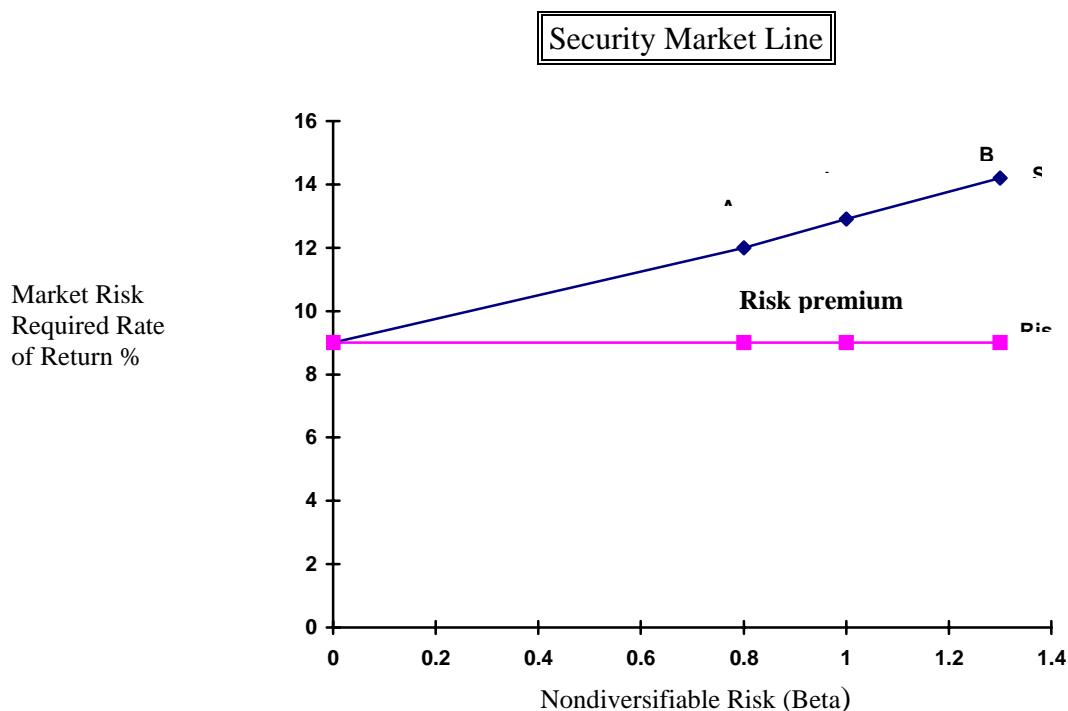
$$k_C = 4\% + [1.50 \times (10\% - 4\%)] = 13.0\%$$

$$k_D = 4\% + [1.25 \times (10\% - 4\%)] = 11.5\%$$

- e. Of the four investments, only C had an actual return which exceeded the CAPM expected return (15% versus 13%). The underperformance could be due to any unsystematic factor which would have caused the firm not to do as well as expected. Another possibility is that the firm's characteristics may have changed such that the beta at the time of the purchase overstated the true value of beta that existed during that year. A third explanation is that beta, as a single measure, may not capture all of the systematic factors that cause the expected return. In other words, there is error in the beta estimate.

5-26 LG 6: Security Market Line, SML

a., b., and d.



c. $k_j = R_F + [b_j \times (k_m - R_F)]$

Asset A

$$k_j = .09 + [0.80 \times (.13 - .09)]$$

$$k_j = .122$$

Asset B

$$k_j = .09 + [1.30 \times (.13 - .09)]$$

$$k_j = .142$$

- d. Asset A has a smaller required return than Asset B because it is less risky, based on the beta of 0.80 for Asset A versus 1.30 for Asset B. The market risk premium for Asset A is 3.2% (12.2% - 9%), which is lower than Asset B's (14.2% - 9% = 5.2%).

5-27 LG 6: Shifts in the Security Market Line

a., b., c., d.

$$b. \quad k_j = R_F + [b_j \times$$

$$k_A = 8\% +$$

Required
Return
(%)

$$12.4\%$$

$$c. \quad k_A = 6\% +$$

$$k_A = 6\% +$$

$$k_A = 10.4\%$$

$$d. \quad k_A = 8\% +$$

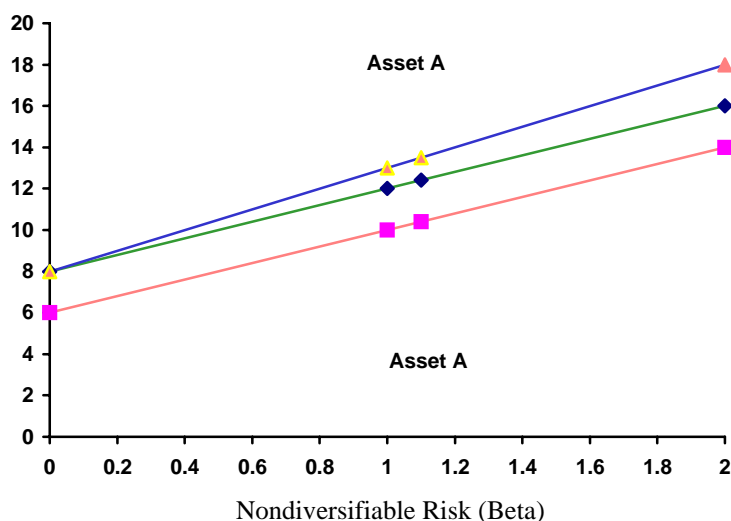
$$k_A = 8\% + 5.5\%$$

$$k_A = 13.5\%$$

e. 1. A decrease in inflationary expectations reduces the required return as shown in the parallel downward shift of the SML.

2. Increased risk aversion results in a steeper slope, since a higher return would be required for each level of risk as measured by beta.

Security Market Lines



$$(k_m - R_F)]$$

$$SML_d \quad [1.1 \times (12\% -$$

$$SML_a$$

$$SML_c \quad k_A = 8\%$$

$$+ 4.4\%$$

$$k_A =$$

$$[1.1 \times (10\% - 6\%)]$$

$$4.4\%$$

$$[1.1 \times (13\% - 8\%)]$$

5-28 LG 5, 6: Integrative-Risk, Return, and CAPM

$$a. \quad \text{Project} \quad k_j = R_F + [b_j \times (k_m - R_F)]$$

$$A \quad k_j = 9\% + [1.5 \times (14\% - 9\%)] = 16.5\%$$

$$B \quad k_j = 9\% + [.75 \times (14\% - 9\%)] = 12.75\%$$

$$C \quad k_j = 9\% + [2.0 \times (14\% - 9\%)] = 19.0\%$$

$$D \quad k_j = 9\% + [0 \times (14\% - 9\%)] = 9.0\%$$

$$E \quad k_j = 9\% + [(-.5) \times (14\% - 9\%)] = 6.5\%$$

b. and d.

Security Market Line

$$SML_b$$

$$SML_d$$

Chapter 5 Risk and Return

c. Project A is as the market.

Project B is the market.

Project C is as the market.

Project D is movement.

Project E is responsive as moves in the the market.

d. See graph for

$$k_A = 9\%$$

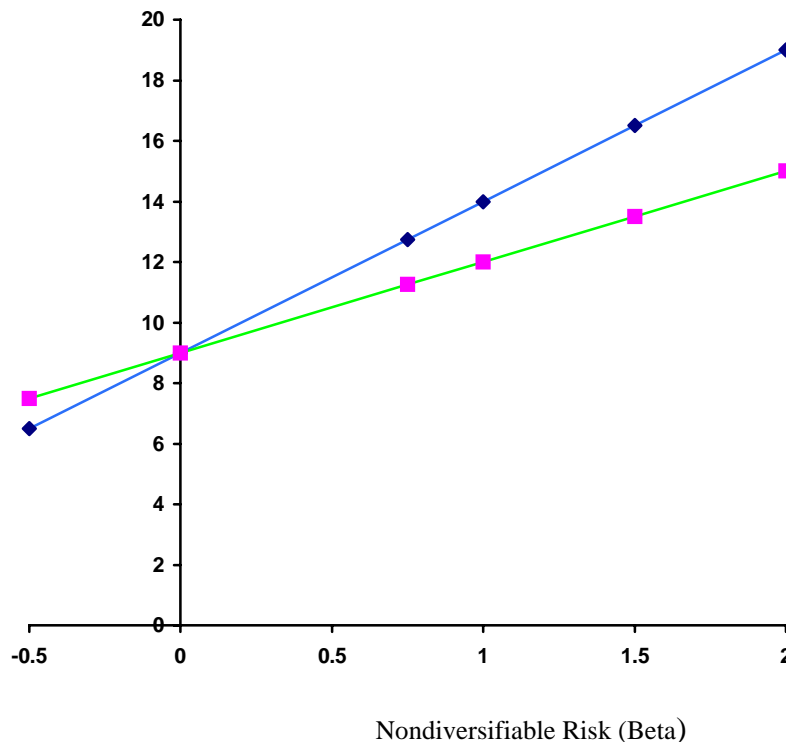
$$k_B = 9\%$$

$$k_C = 9\%$$

$$k_D = 9\%$$

$$9\%)] =$$

$$k_E = 9\%$$



150% as responsive

75% as responsive as

twice as responsive

unaffected by market

only half as the market, but opposite direction as

new SML.

$$+ [1.5 \times (12\% - 9\%)]$$

$$+ [.75 \times (12\% - 9\%)]$$

$$+ [2.0 \times (12\% - 9\%)]$$

$$+ [0 \times (12\% -$$

$$9.00\%$$

$$+ [-.5 \times (12\% - 9\%)]$$

e. The steeper slope of SML_b indicates a higher risk premium than SML_d for these market conditions. When investor risk aversion declines, investors require lower returns for any given risk level (beta).

Chapter 5 Case

Analyzing Risk and Return on Chargers Products' Investments

This case requires students to review and apply the concept of the risk-return trade-off by analyzing two possible asset investments using standard deviation, coefficient of variation, and CAPM.

a.

$$\text{Expected rate of return: } k_t = \frac{(P_t - P_{t-1} + C_t)}{P_{t-1}}$$

Asset X:

Year	Cash Flow (C_t)	Ending Value (P_t)	Beginning Value (P_{t-1})	Gain/Loss	Annual Rate of Return
1994	\$1,000	\$22,000	\$20,000	\$2,000	15.00%
1995	1,500	21,000	22,000	- 1,000	2.27
1996	1,400	24,000	21,000	3,000	20.95
1997	1,700	22,000	24,000	- 2,000	- 1.25
1998	1,900	23,000	22,000	1,000	13.18
1999	1,600	26,000	23,000	3,000	20.00
2000	1,700	25,000	26,000	- 1,000	2.69
2001	2,000	24,000	25,000	- 1,000	4.00
2002	2,100	27,000	24,000	3,000	21.25
2003	2,200	30,000	27,000	3,000	19.26

Average expected return for Asset X = 11.74%

Asset Y:

Year	Cash Flow (C_t)	Ending Value (P_t)	Beginning Value (P_{t-1})	Gain/Loss	Annual Rate of Return
1994	\$1,500	\$20,000	\$20,000	\$0	7.50%
1995	1,600	20,000	20,000	0	8.00
1996	1,700	21,000	20,000	1,000	13.50
1997	1,800	21,000	21,000	0	8.57
1998	1,900	22,000	21,000	1,000	13.81
1999	2,000	23,000	22,000	1,000	13.64
2000	2,100	23,000	23,000	0	9.13
2001	2,200	24,000	23,000	1,000	13.91
2002	2,300	25,000	24,000	1,000	13.75
2003	2,400	25,000	25,000	0	9.60

Average expected return for Asset Y = 11.14%

b.

$$\sigma_k = \sqrt{\sum_{i=1}^n (k_i - \bar{k})^2 \div (n-1)}$$

Asset X:

Year	Return k_i	Average Return, \bar{k}	$(k_i - \bar{k})$	$(k_i - \bar{k})^2$
------	--------------	---------------------------	-------------------	---------------------

Chapter 5 Risk and Return

1994	15.00%	11.74%	3.26%	10.63%
1995	2.27	11.74	- 9.47	89.68
1996	20.95	11.74	9.21	84.82
1997	- 1.25	11.74	-12.99	168.74
1998	13.18	11.74	1.44	2.07
1999	20.00	11.74	8.26	68.23
2000	2.69	11.74	- 9.05	81.90
2001	4.00	11.74	- 7.74	59.91
2002	21.25	11.74	9.51	90.44
2003	19.26	11.74	7.52	<u>56.55</u>
				<u>712.97</u>

$$\sigma_x = \sqrt{\frac{712.97}{10-1}} = \sqrt{79.22} = 8.90\%$$

$$CV = \frac{8.90}{11.74\%} = .76$$

Asset Y-

Year	Return k_i	Average Return, k	$(k_i - \bar{k})$	$(k_i - \bar{k})^2$
1994	7.50%	11.14%	- 3.64%	13.25%
1995	8.00	11.14	- 3.14	9.86
1996	13.50	11.14	2.36	5.57
1997	8.57	11.14	- 2.57	6.60
1998	13.81	11.14	2.67	7.13
1999	13.64	11.14	2.50	6.25
2000	9.13	11.14	- 2.01	4.04
2001	13.91	11.14	2.77	7.67
2002	13.75	11.14	2.61	6.81
2003	9.60	11.14	-1.54	<u>2.37</u>
				<u>69.55</u>

$$\sigma_Y = \sqrt{\frac{69.55}{10-1}} = \sqrt{7.73} = 2.78\%$$

$$CV = \frac{2.78}{11.14\%} = .25$$

c. Summary Statistics:

	<u>Asset X</u>	<u>Asset Y</u>
Expected Return	11.74%	11.14%
Standard Deviation	8.90%	2.78%
Coefficient of Variation	.76	.25

Comparing the expected returns calculated in part **a**, Asset X provides a return of 11.74 percent, only slightly above the return of 11.14 percent expected from Asset Y. The higher standard deviation and coefficient of variation of Investment X indicates greater risk. With just this information, it is difficult to

determine whether the .60 percent difference in return is adequate compensation for the difference in risk. Based on this information, however, Asset Y appears to be the better choice.

- d. Using the capital asset pricing model, the required return on each asset is as follows:

Capital Asset Pricing Model: $k_j = R_F + [b_j \times (k_m - R_F)]$

Asset	$R_F + [b_j \times (k_m - R_F)]$	=	k_j
X	$7\% + [1.6 \times (10\% - 7\%)]$	=	11.8%
Y	$7\% + [1.1 \times (10\% - 7\%)]$	=	10.3%

From the calculations in part a, the expected return for Asset X is 11.74%, compared to its required return of 11.8%. On the other hand, Asset Y has an expected return of 11.14% and a required return of only 10.8%. This makes Asset Y the better choice.

- e. In part c, we concluded that it would be difficult to make a choice between X and Y because the additional return on X may or may not provide the needed compensation for the extra risk. In part d, by calculating a required rate of return, it was easy to reject X and select Y. The required return on Asset X is 11.8%, but its expected return (11.74%) is lower; therefore Asset X is unattractive. For Asset Y the reverse is true, and it is a good investment vehicle.

Clearly, Charger Products is better off using the standard deviation and coefficient of variation, rather than a strictly subjective approach, to assess investment risk. Beta and CAPM, however, provide a link between risk and return. They quantify risk and convert it into a required return that can be compared to the expected return to draw a definitive conclusion about investment acceptability. Contrasting the conclusions in the responses to questions c and d above should clearly demonstrate why Junior is better off using beta to assess risk.

- f. (1) **Increase in risk-free rate to 8 % and market return to 11 %:**

Asset	$R_F + [b_j \times (k_m - R_F)]$	=	k_j
X	$8\% + [1.6 \times (11\% - 8\%)]$	=	12.8%
Y	$8\% + [1.1 \times (11\% - 8\%)]$	=	11.3%

- (2) **Decrease in market return to 9 %:**

Asset	$R_F + [b_j \times (k_m - R_F)]$	=	k_j
X	$7\% + [1.6 \times (9\% - 7\%)]$	=	10.2%
Y	$7\% + [1.1 \times (9\% - 7\%)]$	=	9.2%

In situation (1), the required return rises for both assets, and neither has an expected return above the firm's required return.

With situation (2), the drop in market rate causes the required return to decrease so that the expected returns of both assets are above the required return. However, Asset Y provides a larger return compared to its required return ($11.14 - 9.20 = 1.94$), and it does so with less risk than Asset X.