SYSTEMATIC AND UNSYSTEMATIC RISK OF RATES OF RETURN ASSOCIATED WITH SELECTED FOREST PRODUCTS COMPANIES

James E. Hotvedt and Philip L. Tedder

The objective of most investors in stocks or other assets is to maximize the expected returns in a given risk class; in other words, to minimize risk for a given level of expected returns [6]. Although "risk" may connote the chance of injury or loss, the term is not defined so narrowly in this article. Rather, it is used to reflect volatility in stock or other assets' rates of return and should not be confused with risk and uncertainty in the production process. Risk, as approached herein, equals the variance of historical rates of return about the average rate of return [6].

Total risk of an investor's investment portfolio can be reduced through investment diversification, that is, by the purchase of different kinds of assets (stocks, bonds, securities, real estate, etc.) and by the purchase of stocks or bonds from more than one company or industry. However, risk cannot be reduced in this way beyond a certain limit because changes in over-all market conditions affect price variations in all stocks and other assets and this variability cannot be eliminated completely by diversification [4].

As a result, it is desirable to separate total risk, or variation in rates of return, into two components—one reflecting that portion of an asset's price movements caused by changes in the market as a whole and a second reflecting that portion of an asset's price movements caused by factors or variables unique to the company or industry itself. The former is called "systematic risk" (and is nondiversifiable) and the latter "unsystematic risk" [5]. Unsystematic risk, related to such factors as labor strikes, inventions, research and developments, and the like is diversifiable.

A stock is said to be more desirable for portfolio diversification purposes if only a small proportion of its volatility can be attributed to the impact of the market [4], unless, of course, an investor wishes to invest in assets whose rates of return follow those of the market as a whole. A measurement of systematic and unsystematic risk is needed from which the percentage of total risk accounted for by each can be calculated.

The purpose of this article is to measure total, systematic, and unsystematic risk of the rates of return of a select group of forest products firms.

In measuring risk it is desirable to determine that portion associated with the market and that portion associated with the company itself. Are rates of return of forest products companies relatively volatile? Or do they generally follow market changes and trends? Unsystematic risk will measure the former and unsystematic risk the latter.

MODEL

A statistical model is used to separate total risk into its components. The expected rate of return on an asset is considered to be a linear function of a risk-free rate and the expected return on a market factor. Because such a function cannot be observed in practice, the expected rate of return is estimated by considering rate of return as a function of an overall market rate of return [8]. Thus a means is provided for measuring an asset's sensitivity to market changes.

The statistical model commonly used is [8]:

$$i_t = a + bm_t + e_t$$

where

i_t = rate of return of a particular company's assets in time period t

James E. Hotvedt is a Graduate Research Assistant in Forestry Economics, Virginia Polytechnic Institute and State University, and Philip L. Tedder is Assistant Professor of Forest Management, Oregon State University. This article was completed while the authors were Instructor and Assistant Professor, respectively, at the University of Arkansas at Monticello.

a = y-intercept
b = slope of the regression line
M_t = market rate of return in time period t and
e_t = random error about the regression line in time period t.

For the five forest products companies, the assets to be evaluated are their common stocks. The rate of return (i_t) on each company's common stocks is calculated as follows [6]:

$$i_t = \frac{D_t + P_{t+1} - P_t}{P_t}$$

where

D_t = cash dividend for time period t
P_{t+1} = common stock price at end of time period t and
P_t = common stock price at beginning of time period t.

The market rate of return (M_t) is reflected by Standard and Poor's (SP) market index [4, 6]. The market rate of return is calculated as:

$$M_t = \frac{SP_{t+1} - SP_t}{SP_t}$$

where

SP_{t+1} = value of the SP index at the end of the time period t and
SP_t = value of the SP index at the beginning of time period t.

Dividends are excluded purposely from the market rate of return calculations and thus the resulting index is downward biased. Provided that dividends are excluded consistently, comparisons of statistical results and of risk are valid [6].

The model results in a regression line, often termed a "characteristic line," and the characteristic line reflects the "nature of systematic and unsystematic risks; it shows the relationships of some asset with the market" [6]. Indeed, the hypothesis is that the rate of return of an asset (i_t) is a linear function of a market factor common to all assets (M_t) and of an independent factor unique to the particular asset (e_t) [3].

The y-intercept (a) is the asset's rate of return when the market is stationary ($M_t = 0$).

The beta coefficient (b) is a measure of the slope of the characteristic line; it measures the volatility of an asset's rate of return in relation to the market rate of return [1] and therefore is an index of systematic, nondiversifiable risk. It indicates how the return for a given asset varies with the market. If the coefficient is greater than one, an asset's rate of return increases (decreases) at a faster rate than the market's. This value indicates what Francis [6] calls an "aggressive asset." A coefficient less than one indicates that an asset's rate of return moves counter to that of the market as a whole [3].

The statistic representing random error (e_t) about the characteristic line cannot be estimated in practice. Theoretically, however, it represents that portion of total risk affected by characteristics unique to the company or industry itself.

The coefficient of determination (r^2) is a measure of the percentage of total risk (variation in the rate of return of the asset) explained by changes in the market index. Thus, the coefficient of determination is that statistic used to measure the percentage of total risk accounted for by systematic, nondiversifiable risk [6].

EXAMPLE

Total, systematic, and unsystematic risk associated with the rates of return of five forest products companies are calculated to illustrate how the model is used. The firms analyzed are Crown Zellerbach, Potlatch, International Paper, Westvaco, and Weyerhaeuser. Each firm is large, having landholdings and processing plants in more than one region of the country. The analysis allows total risk and its components for each of the companies to be compared. In addition, the results of such an analysis aid in determining whether large forest products companies are more or less susceptible than companies in other industries to factors that affect the market as a whole, or to factors which are inherent or unique to the particular companies or industries themselves.

TABLE 1. RESULTS OF CHARACTERISTIC LINE ANALYSIS

Company	Characteristic Line	r^2	F-Value[a]
Crown Z.	$i_t = 0.0527 + 1.549\ m_t$	.356	14.4
Potlatch	$i_t = 0.0131 + 0.929\ m_t$	.312	11.8
Int. Pap.	$i_t = 0.0631 + 1.0292\ m_t$	.242	8.3
Westvaco	$i_t = 0.0523 + 1.2406\ m_t$	.279	10.1
Weyco	$i_t = 0.0732 + 0.9071\ m_t$	.123	3.6

[a]All equations and beta coefficients are significant at the .05 level except those for Weyerhaeuser which are significant at the .10 level.

Table 1 shows the results of the characteristic line analysis for each of the five companies. The time series used included seven years (1970-1976), each observation being one quarter. Thus 28 observations were used.

The portion of total risk accounted for by systematic, nondiversifiable risk ranges from 12.3 to 35.6 percent. The former figure is somewhat suspect because the value for each of the other four companies is greater than 24 percent. The beta coefficients range from 0.9071 to 1.549, indicating that the rates of return of the companies are relatively stable, except that of Crown Zellerbach. Indeed, the returns of the four companies closely follow changes in the overall market.

The high beta value for Crown Zellerbach indicates volatility in its rate of return in relation to market changes. For example, if the market index (as measured by SP) were increasing, the rate of return of Crown Zellerbach's common stock would increase 154.9 percent of the increase in the market index. Conversely, a decrease in the market index would result in a decrease equivalent to 154.9 percent of the decrease in the market rate. Although a substantial return is possible in an advancing market, the prospects for heavy losses in a declining market are equally probable.

TABLE 2. TOTAL, UNSYSTEMATIC, AND SYSTEMATIC RISK ASSOCIATED WITH EACH OF THE FIVE FOREST PRODUCTS COMPANIES

Company	TR[a]	SR[b]	UR[c]
Crown Z.	.0657	.0234	.0423
Potlatch	.0270	.0084	.0186
Int. Pap.	.0428	.0104	.0324
Westvaco	.0538	.0150	.0388
Weyco	.0652	.0080	.0572

[a]Total risk = Variance (i_t) t = 1,28.

[b]Systematic risk = $[b^2 (\text{Variance } (m_t))] = [r^2 (\text{Variance } (i_t))]$.

[c]Unsystematic risk = total risk − systematic risk.

Table 2 shows total risk and its components, systematic and unsystematic risk, for the five companies. Although Crown Zellerbach has the greatest volatility in its rates of return in comparison with changes in the market, its total risk (.0657 or 6.57 percent) is not out of line with that of the other companies. Indeed, the total risk values for Crown Zellerbach and Weyerhaeuser are nearly equal.

In comparison with the systematic risk associated with stocks of hundreds of other companies listed on the NYSE, the values for Crown Zellerbach and Potlatch are apparently higher and that for Weyerhaeuser lower, whereas the values for International Paper and Westvaco conform fairly well to those tested. Blume [3] found an average coefficient of determination (r^2) to be .25 which indicates that about 25 percent of total risk is systematic risk. Independent studies do not appear to complement each other, however, because King [7] found average systematic risk to be about 50 percent of the total. Brealey [4] found the proportion of earnings movements associated with market movements to be 27 percent (about equal to the conclusion by Blume). In addition, Brealey's results indicated that approximately 27 percent of total risk in the paper industry was related to movements in the market. This value conforms to those of International Paper and Westvaco, both of which are multiproduct companies but which derive most of their income from pulp, paper, and paper product sales.

DISCUSSION

The time span used may have had an influence on the statistical results of the characteristic line analysis. For example, one might expect the beta coefficient to stabilize or become stationary as the time series increases [2, 5]. However, too long a period allows dilution of the influence or effect that changes in a company might have on changes in its rate of return. For example, management may become more or less conservative, management might introduce modern technological developments into its manufacturing or administrative functions, the company may increase the diversification of its products or mergers, and so on.

The validity of results in risk analysis has been questioned when single assets are analyzed rather than a portfolio. Indeed, it may be difficult to determine changes in the rate of return of one stock on the basis of market changes because other factors may have an effect [4]. Brealey [4] states that if individual stocks are aggregated into a portfolio these other factors may be diversified away. If so, then market changes can be assumed to be the major determinant of changes in the value of group stocks, and market changes can be used with greater assurance in predicting changes in the rate of return from a portfolio than in predicting changes in the price of any individual stock.

Thus, it may have been more appropriate to compare risks of alternative well-diversified portfolios by comparing their beta values.

With such an approach, however, the comparisons of risks associated with the selected group of forest products firms would have been precluded.

Future work involves isolating those factors which contribute to the unsystematic risk portion of the rates of returns to forest product companies.

If the relative volatility of an asset's rate of return does tend to persist over time then this pattern might continue in the future. If so, then risk analysis may provide an investor with a means of estimating the likely degree of fluctuation or variation of his investments in relation to the market and the risk that their value may, at any time, be below his expectations [4].

REFERENCES

[1] Babcock, Guilford C. "A Note on Justifying Beta as a Measure Risk," *Journal of Finance,* Volume 27, No. 3, 1972, pp. 699-702.

[2] Baesel, Jerome B. "On the Assessment of Risk: Some Further Considerations," *Journal of Finance,* Volume 29, No. 5, 1974, pp. 1491-1494.

[3] Blume, Marshall E. "On the Assessment of Risk," *Journal of Finance,* Volume 26, No. 1, 1971, pp. 1-10.

[4] Brealey, Richard A. *An Introduction to Risk and Return from Common Stocks,* Cambridge: The MIT Press, Massachusetts Institute of Technology, 1969.

[5] Cohen, Jerome B., Edward D. Zinbarg, and Arthur Zeikel. *Investment Analysis and Portfolio Management,* Homewood, Illinois: Dow Jones—Irwin Inc., 1973.

[6] Francis, Jack Clark. *Investments: Analysis and Management,* New York: McGraw-Hill Book Company, 1972.

[7] King, B. F. "Market and Industry Factors in Stock Price Behavior," *Journal of Business,* Volume 39, No. 2, 1966, pp. 139-190.

[8] Schwendiman, Carl J. and George E. Pinches. "An Analysis of Alternative Measures of Investment Risk," *Journal of Finance,* Volume 30, No. 1, 1975, pp. 193-200.