Business Risk, Financial Risk, and Default Risk: Theory and Empirical Results (I)

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I. Introduction

Since the emergence of the capital asset pricing model, most empirical studies have concentrated on the risks associated with the rate of return on common stocks, and very few empirical studies are available on the risks associated with the business and financial conditions of the firm.(1) It may be argued that such business and financial risks of the firm should be necessarily reflected on the risks associated with the rate of return on common stocks. However, there is no empirical data to support such a hypothesis.(2)

If the risks associated with common stocks do not necessarily reflect the risks

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Part II of this paper, "Multivariate Analysis of the Empirical Data," will appear in the next issue [*Ed.*].

(1) For the the development of the capital market theory and the capital asset pricing model, see Markowitz (1952, 1959), Sharpe (1963, 1964, 1965), Lintner (1965), Fama (1968, 1973), Mossin (1966), Jensen (1972), and Black (1972). For empirical studies see references in footnote (27).

(2) On the contrary, Brigham and Crum (1977) found that "the firms involved in the three largest U.S. bankruptcies—Penn Central, W.T. Grant, and Franklin National Bank—all had declining betas and poor earnings prospects as they approached bankruptcy."

associated with the business and financial conditions of the firm, the modern portfolio theory must consider additional factors, namely, the risks associated with the business and financial conditions of the firm.

This paper consists of three major parts: In the first part (Sections II～IV), the methods and formulas are derived to calculate the risks associated with the business and financial conditions of the firm, and the risks associated with the rate of return on common stocks. In the second part (Sections V～VI), the data are explained and the empirical results are presented. In the third part (Sections VI～X), the statistical relationships among the risks and returns are examined. Also, a summary and conclusions are provided in the final Section.

II. Business Risk and Financial Risk

The risks associated with the business and financial conditions of the firm may be divided into three types: business risk, financial risk and default risk. The first two risks are discussed in this section, and the third risk is discussed in Section III.

(1) Business Risk. Business risk is defined as the variability of earnings before interest and taxes (EBIT) or net operating income. It is usually measured by the coefficient of variation of net operating income.(3) Net operating income is given by

$$Y = pQ - vQ - F$$
$$= (p-v)Q - F \qquad (1)$$

where Y=net operating income or EBIT, p=price, Q=quantity of produ-

(3) For definitions of business risk and financial risk, see Bierman and Haas (1973, pp. 93-107), and Tinic and West (1979, pp. 160-166).

We have to recognize two types of risks or risk measures: The risk that is measured in terms of volatility of gains or losses, and the risk that is measured in terms of probability of incurring losses or gains.

Strictly speaking, net operating income is different from EBIT in that EBIT=net operating income+net non-operating income such as dividend and interest income received.

ction, v=the average variable cost, where taxes are not included, F=the total fixed cost, where interest payments are not included. Equation (1) suggests that net operating income depends upon price, the average variable cost, output, and the total fixed cost. These variables, in turn, depend upon product mix, the scale of production, marketing efforts, management policy, technology of production, the degree of monopoly power, etc.

If we assume that output is the only random variable, Equation (1) can be rewritten in terms of variances:

$$V(Y)=(p-v)^2V(Q) \tag{2}$$

where $V(Y)$=the variance of annual EBIT and $V(Q)$=the variance of annual output. And the standard deviation is given by

$$\hat{s}(Y)=(p-v)\hat{s}(Q) \tag{3}$$

where $\hat{s}(Y)$=the standard deviation of EBIT, and $\hat{s}(Q)$=the standard deviation of output.

However, the variance or the standard deviation of net operating income is not useful to compare business risks of two firms when the expected net operating income is significantly different between the firms. In such a case, the coefficient of variation is more useful. It is obtained by dividing the standard deviation by the expected value of net operating income.

$$\begin{aligned}\hat{s}(Y)/E(Y)&=(p-v)\hat{s}(Q)/E(Y)\\&=(p-v)\hat{s}(Q)/[(p-v)E(Q)-F]\end{aligned} \tag{4}$$

where $E(Y)$=the expected or mean net operating income, and $\hat{s}(Y)/E(Y)$= $\hat{s}/Y$=the coefficient of variation of net operating income. It is defined as business risk in this paper.

(2) Financial Risk. Financial risk is defined as the variability of earnings after tax (EAT) or net income. It is usually measured by the standard deviation of net income per dollar value of stock equity capital. Net income is given by

$$NY=(Y-iB)(1-a) \tag{5}$$

where NY=net income, Y=EBIT, i=the market rate of interest, B=the market value of debt, a=the effective tax rate.

Equation (5) states that net income depends upon net operating income, the market rate of interest, the market value of bonds, and the effective corporate tax rate. If we assume that net operating income is the only random variable, holding $i, B,$ and a constant, the variance of net income is

$$V(NY)=(1-a)^2V(Y). \tag{6}$$

The standard deviation of net income is

$$\hat{s}(NY)=(1-a)\hat{s}(Y). \tag{7}$$

However, the variance or the standard deviation of net income is not useful to compare financial risks of two firms with different sizes of stock equity capital. In order to express financial risk per dollar value of stocks, dividing Equation (5) by the market value of the equity capital,

$$\frac{NY}{S}=\frac{(Y-iB)(1-a)}{S}=\frac{(Y-iB)(1-a)/N}{S/N}=\frac{E}{P} \tag{8}$$

where S=the market value of stock equity capital, N=the number of shares of stock, E=earnings per share, E/P=the earnings/price ratio. Equation (8) states that net income per dollar value of stock is nothing but the earnings/price ratio. The variance and the standard deviation of the earnings/price ratio are given by

$$V(E/P)=\left(\frac{1-a}{S}\right)^2V(Y) \tag{9}$$

$$\hat{s}(E/P)=\left(\frac{1-a}{S}\right)\hat{s}(Y) \tag{10}$$

where $V(E/P)$=the variance of the earnings/price ratio, and $\hat{s}(E/P)$=the standard deviation of the earnings/price ratio. In this paper $\hat{s}(E/P)$ is defined as financial risk.

In order to compare the sizes of business risk and fiancial risk, by substituting Equation (3) in (10), we obtain

$$\hat{s}(E/P)=(1-a)(p-v)\hat{s}(Q)/S. \tag{11}$$

But, business risk is given by Equation (4),

$$\hat{s}(Y)/E(Y)=(p-v)\hat{s}(Q)/E(Y).$$

Usually, $1-a<1.0$, and $S>E(Y)$, so we can tell that in general financial risk should be smaller than business risk.

Also, Equation (10) can be rewritten as

$$\hat{s}(E/P)=(1-a)\frac{\hat{s}(Y)}{E(Y)}\frac{E(Y)}{S}. \qquad (12)$$

So,

$$\hat{s}(Y)/E(Y)=\frac{\hat{s}(E/P)}{(1-a)}\frac{S}{E(Y)}. \qquad (13)$$

The above two equations suggest that business risk and financial risk should be linearly and positively correlated to each other, if the stock/income ratio and the tax rate are constant.

III. Measurement of Default Risk

Default risk is defined as the probability that the firm is unable to pay the contractual cost of debt because of shortage of cash flow.(4) Under certainty, default takes place when

$$W<(W-D-iB)a+iB+B/m \qquad (14)$$

where W=earnings before depreciation, interest, and taxes (EBDIT), D=dep-

(4) A simple method of measuring default risk is to use various financial ratios such as the debt/asset ratio, the times interest earned, and the fixed charge coverage. For discussion of such ratios, see Findlay and Williams (1975), and Findlay, Williams and Gordon (1975). The method of measuring default risk in terms of normal distribution is discussed in Donaldson (1961, 1962, 1969), Hong and Rapport (1978), and Martin and Scott (1976). In the last two papers, default risk is discussed in connection with capital budgeting problems.

Financial ratio analysis and discriminant analysis are used to predict corporate bankruptcies. See Beaver (1966, 1968), Altman (1968), Altman, Haldeman, and Narayanan (1977). Recent studies in discriminant analysis are summarized in Van Horne (1980, pp. 690-694). Also see references cited in Chen and Shimerda (1981).

The failure of a firm may be divided into four types: Default takes place when the firm cannot pay the cost of debt. Technical insolvency takes place when the firm cannot pay current obligations. Bankruptcy takes place when the firm is liquidiating the firm itself to cease to exist. Reorganization is when the firm is reconstructing the financial and debt structures as a result of default or technical insolvency, but the firm continues to exist.

reciation, i=the market rate of interest, B=the market value of bonds, a=the effective corporate tax rate, m=the years to maturity of bonds, and B/m=the annual principal payments. It is assumed that the bonds are sinking fund bonds, and the redemption is based on the straight line schedule. It should be noted that depreciation cost and interest payments are tax deductable in the U.S. tax law, while the annual principal payments are not.

Assume that EBDIT is the only random variable. Then its confidence interval is given by

$$E(W) - t\hat{s}/\sqrt{n} \leq W \leq E(W) + t\hat{s}/\sqrt{n} \qquad (15)$$

where $E(W)$=the expected value of EBDIT, t=the t-ratio of the Student's t-distribution, $\hat{s}=\hat{s}(W)=\hat{s}(Y)$=the sample standard deviation of EBDIT(=W) or EBIT(=Y), where $Y=W-D$, and n=the sample size to calculate the standard deviation $\hat{s}$.

In Equation (15), instead of the t-distribution, a normal distribution may be assumed and the z-value may be used in place of the t-value. However, in calculating the standard deviation of EBDIT, usually the sample size tends to be small, and thus the t-distribution is more appropriate.

The implications of Equations (14) and (15) are illustrated in Figures 1 and 2. First, in Figure 1, panel (a), the random variable EBDIT is assumed to follow the Student's t-distribution. The mean of EBDIT is $E(W)$, and its standard deviation is $\hat{s}$. Under certainty, the cost of debt and taxes are equal to the right hand side of Equation (14). Under uncertainty, i.e., when EBDIT is a random variable, the expected cost of debt and taxes are given by

$$K=[E(W) - t\hat{s}/\sqrt{n} - D - iB]a + iB + B/m. \qquad (16)$$

When the cost of debt and taxes are equal to t_1, the probability that EBDIT is less than t_1 is given by the shaded area of the t-distribution, and the probability is defined as the risk of default. When the cost of debt and taxes increase to t_2 in panel (b) and t_3 in panel (c), the risk of default also increases as shown by the shaded areas in panels (b) and (c).

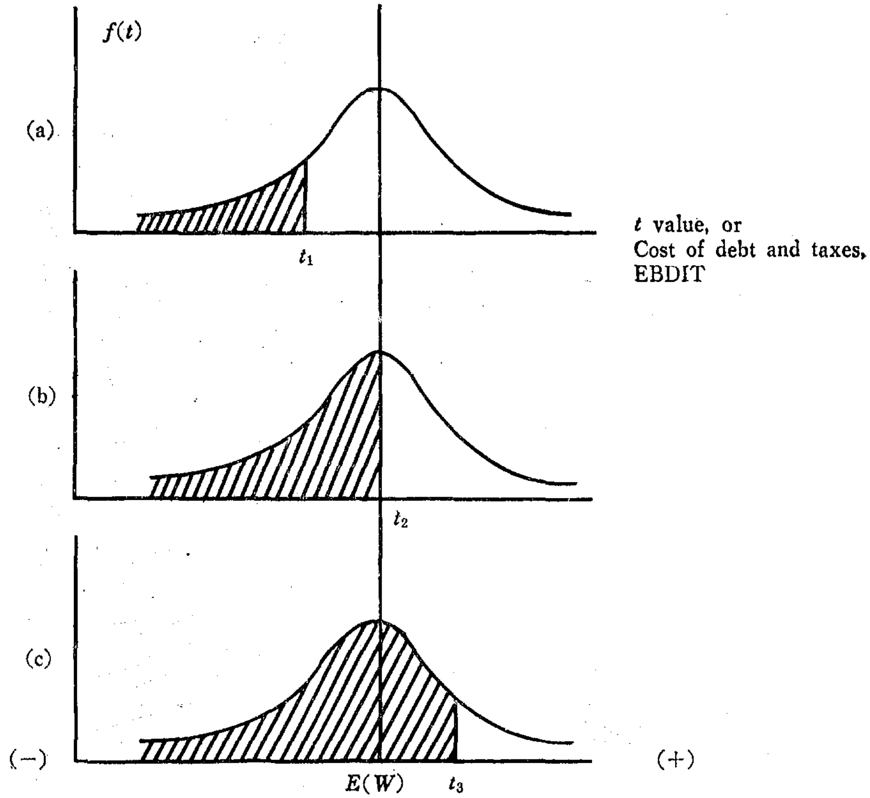

Fig. 1. Default Risk and the Cost of Debt

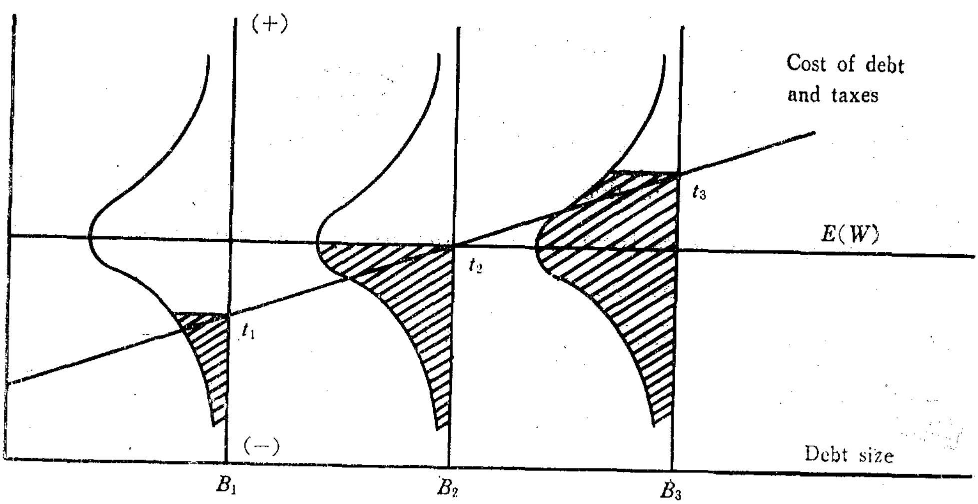

Fig. 2. Default Risk, the Cost of Debt, and Debt Size

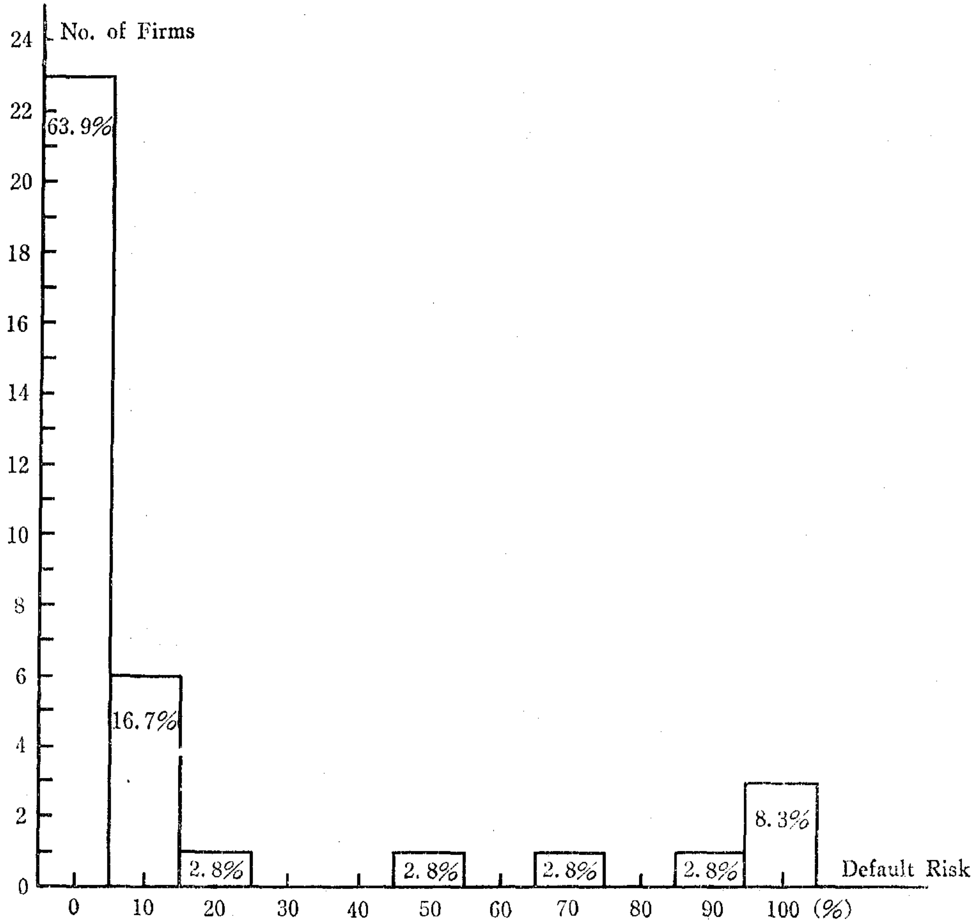

Fig. 3. Histogram of Default Risk

Figure 2 is more useful than Figure 1 in that it shows the relationships among the debt size, the cost of debt and taxes, and the risk of default all in one diagram. As the size of debt increases from B_1 to B_2, and to B_3, the cost of debt and taxes increases from t_1 to t_2, and to t_3, and the risk of default also increases, as shown by the shaded areas. (For Figure 3, see p. 96 [*Ed.*].)

Instead of measuring EBDIT, the cost of debt and taxes in terms of dollar values, it is more convenient to measure them in terms of t-ratios. In Figures 1 and 2, the critical t ratio must satisfy the following condition:

$$E(W)-t\hat{s}/\sqrt{n}=[E(W)-t\hat{s}/\sqrt{n}-D-iB]a+iB+B/m \qquad (17)$$

and thus

$$t=\frac{E(W)(1-a)+aD-B[i(1-a)+1/m]}{(1-a)\hat{s}/\sqrt{n}}$$

$$=\frac{E(W)+aD/(1-a)-B[i+1/m(1-a)]}{\hat{s}/\sqrt{n}}. \quad (18)$$

And the probability of default is given by the left-hand side integral of the Student's t-probability function:(5)

$$\alpha=\int_{-\infty}^{-t} f(t)dt=P(t<t_0) \quad (19)$$

where α is used to denote the risk of default.

In Equation (17) it is assumed that depreciation allowances can be used to pay off the cost of debt and taxes. If we assume that depreciation allowances are not allowed to be used to pay off the cost of debt and taxes, Equation (17) can be rewritten as

$$E(W)-t\hat{s}/\sqrt{n}=[E(W)-t\hat{s}/\sqrt{n}-D-iB]a+iB+B/m+D. \quad (20)$$

So,

$$t=\frac{[E(W)-D]-B[i+1/m(1-a)]}{\hat{s}/\sqrt{n}}$$

$$=\frac{E(Y)-B[i+1/m(1-a)]}{\hat{s}/\sqrt{n}} \quad (21)$$

where $E(W)-D=E(Y)$, i.e., EBDIT−D=EBIT.

Equation (20) assumes that the annual depreciation allowances and annual principal payments are independent, and depreciation allowances are not to be used to pay off any portion of the cost of debt and taxes. However, Equation (17) assumes that the annual depreciation allowances can be used to pay off any portion of the cost of debt and taxes. As a third possibility, we may

(5) The probability density function of the Student's t-distribution is given by

$$f(t|N)=\frac{\Gamma\left(\frac{N+1}{2}\right)}{\sqrt{N\pi}\,\Gamma\left(\frac{N}{2}\right)}\left(1+\frac{t^2}{N}\right)^{-(N+1)/2}$$

where $N=$ the degrees of freedom.

If Equation (18) is used to calculate the t-value, Equation (19) suggests that the greater the positive t value, the smaller is the risk of default, since the left-hand side area of the distribution represents the risk of default. Thus the greater a negative value of t, the greater will be default risk. For the Student's t-distribtuion, see Maksoudian (1969, p. 187).

If the sample size is large, we could use the normal probability function:

$$f(z)=\frac{1}{\sqrt{2\pi}}\exp[-z^2/2], \qquad \text{where } z=(X-\mu)/\sigma.$$

assume that the firm matches the depreciation schedule with the maturity structure of debt, and the annual depreciation allowances are used to pay off the exact amount of the annual principal payments. In such a case, $D=B/m$, and Equation (17) can be rewritten as

$$E(W)-t\hat{s}/\sqrt{n}=[E(W)-t\hat{s}/\sqrt{n}-D-iB]a+iB+D \tag{22}$$

and

$$t=\frac{[E(W)-D](1-a)-iB(1-a)}{(\hat{s}/\sqrt{n})(1-a)}$$

$$=\frac{E(Y)-iB}{\hat{s}/\sqrt{n}} \tag{23}$$

where $E(W)-D=E(Y)$ as defined previously. Equation (23) is useful when the corporate tax rate, depreciation allowances, and the maturity structure of debt are not available or unreliable.

Now, we will examine the relationships between default risk, business risk, and financial risk. For this purpose, we may use any of the three default risk formulas. First, in order to see the relationship between default risk and business risk, we may use Equation (23) for its simplicity:

$$t=\frac{E(Y)-iB}{\hat{s}/\sqrt{n}}.$$

Dividing both the numerator and the denominator by $E(Y)$,

$$t=\frac{1-iB/E(Y)}{\frac{\hat{s}}{E(Y)}\,\frac{1}{\sqrt{n}}} \tag{24}$$

$$\frac{\partial t}{\partial \hat{s}/E(Y)}<0$$

where $\hat{s}/E(Y)=$business risk. Equation (24) suggests that as business risk increases, t-ratio falls, and default risk increases.(6)

Second, in order to see the relationship between default risk and financial risk, we substitute Equation (13) in Equation (24):

$$t=\frac{1-iB/E(Y)}{\frac{\hat{s}(E/P)}{(1-a)}\,\frac{S}{E(Y)}\,\frac{1}{\sqrt{n}}} \tag{25}$$

(6) As t-value decreases, default risk increases. See footnote (5).

$$\frac{\partial t}{\partial \hat{s}(E/P)} < 0$$

where $\hat{s}(E/P)$=financial risk. Eqvation(25) suggests that as financial risk rises, t-ratio falls, and default risk rises.

Third, in order to see the relationship between default risk and financial leverage, namely, B/V or B/S, we divide the numerator and the denominator of Equation (23) by S or V to obtain the following two equations:

$$t = \frac{E(Y)/S - iB/S}{\frac{\hat{s}}{E(Y)} \frac{E(Y)}{S} \frac{1}{\sqrt{n}}} \tag{26}$$

or,

$$t = \frac{E(Y)/V - iB/V}{\frac{\hat{s}}{E(Y)} \frac{E(Y)}{V} \frac{1}{\sqrt{n}}} \tag{27}$$

$$\frac{\partial t}{\partial B/S} < 0, \quad \frac{\partial t}{\partial B/V} < 0$$

where B/S=the debt/equity ratio, B/V=financial leverage or debt/value ratio, $\hat{s}/E(Y)$=business risk, $E(Y)/V$=the income/value ratio or the average rate of return on capital (before interest and taxes), and n=the sample size.

The above two equations suggest that default risk depends upon the income/equity ratio $E(Y)/S$, the debt/equity ratio B/S, and business risk $\hat{s}/E(Y)$; or the income/value ratio $E(Y)/V$, the debt/value ratio B/V, and business risk $\hat{s}/E(Y)$, given other constants such as the tax rate, the rate of interest, the years to maturity and the sample size.

IV. Total Risk, Systematic Risk, and Unsystematic Risk

Thus far, we have examined definitions and methods of measuring the risks associated with the business and financial conditions of the firm. Now we may briefly discuss the risks associated with the rate of return on common stocks of the firm.

The rate of return on common stocks, or the holding period return is defined as

$$R_i = D/P_i + \Delta P/P_i \qquad (28)$$

where R= the rate of return on common stock per share or the one year holding period return, D/P=the dividend yield, and $\Delta P/P$=the rate of increase in stock price or the rate of capital gain. Equation (28) simply defines that the holding period return is the sum of dividend yield and the rate of capital gain.

Assume that both the holding period return of i-th firm and the holding period return on the market portfolio are random variables, and that the firm's holding period return is a linear function of the rate of return on the market portfolio:

$$R_i = a_i + \beta_i R_m + e_i \qquad (29)$$

where a_i= the intercept of the regression equation, β_i= the slope, R_m=the rate of return on the market portfolio or market return, and e_i= the error term. The two constants of the above regression equation, or what is often called the characteristic line of the common stock, are estimated by

$$\beta_i = \frac{\text{Cov}(R_i, R_m)}{V(R_m)} \qquad (30)$$

and

$$a_i = \bar{R}_i - \beta_i \bar{R}_m$$

where $\text{Cov}(R_i, R_m)$= the convariance of R_i and R_m, $V(R_m)$= the variance of R_m, $\bar{R}_i$= the mean value of R_i, and $\bar{R}_m$= the mean value of R_m.

The expected value of the holding period return on common stock is

$$E(R_i) = a_i + \beta_i E(R_m) \qquad (31)$$

where $E(e_i)=0$.

From Equation (29), we can derive the variance and the standard deviation of the holding period return:

$$V(R_i) = \beta_i^2 V(R_m) + V(e_i) \qquad (32)$$

and

$$\sigma(R_i) = \sqrt{\beta_i^2 V(R_m) + V(e_i)} \qquad (33)$$

were $V(e_i)=0$, $\text{Cov}(\beta_i, e_i)=0$, $V(R_i)$= the variance of the holding period return or total risk of common stock, $\beta_i^2 V(R_m)$=systematic risk or undiversifiable risk,

$V(e_i)=$ unsystematic risk or diversifiable risk, and $\sigma(R_i)=$ the standard deviation of the holding period return or a measure of total risk.

In the above equations, $V(R_m)$ is the same for all firms in cross sectional analysis, and thus the size of β determines the size of systematic risk $\beta^2 V(R_m)$. Thus, β alone is often regarded as systematic risk, just as $V(R_i)$ or $\sigma(R_i)$ is alternatively regarded as total risk.

An application of risk concepts is found in the modern theories of capital markets. The modern theories of capital markets consist of two hypotheses. First, the capital market theory (CMT) or the capital market line (CML) hypothesis maintains that the *ex ante* expected return on common stock $E(R_i)$ is a linear positive function of total risk $\hat{s}(R_i)$. Second, the capital asset pricing model (CAPM) or the security market line (SML) hypothesis maintains that the *ex ante* expected return on common stock $E(R_i)$ is a linear positive function of systematic risk β_i. The two hypotheses are listed below:

$$E(R_i)=R_F+\left[\frac{E(R_m)-R_F}{\sigma_m}\right]\sigma_i \tag{34}$$

$$E(R_i)=R_F+[E(R_m)-R_F]\beta_i \tag{35}$$

where $E(R_i)$=the expected return on security i, $R_F=$ the risk-free rate or the rate of return on the risk-free asset, $E(R_m)=$ the expected return on the market portfolio, $\sigma_m=$ total risk of the return on the market portfolio, $\sigma_i=$ total risk of security i, and $\beta_i=$ systematic risk of security i. Equation (34) states the capital market line hypothesis, and Equation (35) states the security market line hypothesis.(7)

In order to complete the review of risk concepts, now we may briefly examine the concepts of portfolio risks.

Assume there are two securities. The holding period returns are given by the following characteristic lines:

$$R_1=a_1+\beta_1 R_m+e_1, \tag{36}$$

(7) For the capital market line and the security market line hypotheses, see references in footnotes (1) and (27). Also see Copeland and Weston (1979, pp. 163-164, 187-190) and Tinic and West (1979, pp. 273-321).

$$R_2 = a_2 + \beta_2 R_m + e_2. \tag{37}$$

If we assume that X_1 and X_2 are the percents of total investment allocated on each security, the weighted average return, i.e., the portfolio return is given by

$$(X_1 R_2 + X_2 R_2) = (X_1 a_1 + X_2 a_2) + (X_1 \beta_1 + X_2 \beta_2) R_m + (X_1 e_1 + X_2 e_2). \tag{38}$$

And the variance is

$$V(R_p) = (X_1 \beta_1 + X_2 \beta_2)^2 V(R_m) + [X_1^2 V(e_1) + X_2^2 V(e_2)]$$

$$= \beta_p^2 V(R_m) + \sum_{i=1}^{2} X_i^2 V(e_i). \tag{39}$$

The standard deviation is

$$\sigma_p = \sqrt{\beta_p^2 V(R_m) + \sum_{i=1}^{2} X_i^2 V(e_i)} \tag{40}$$

where $X_1 R_1 + X_2 R_2 = R_p$, $X_1 \beta_1 + X_2 \beta_2 = \beta_p$, $V(X_1 a_1 + X_2 a_2) = 0$, $\mathrm{Cov}(R_m, e_i) = 0$, $V(R_p) =$ the variance of the portfolio return or total risk of the portfolio p, $\sigma_p =$ the standard deviation of the return on the portfolio, $\beta_p^2 V(R_m) =$ systematic risk of the portfolio, and $\sum_{i=1}^{n} X_i^2 V(e_i) = V(e_p) =$ unsystematic risk of the portfolio.

If the portfolio is well diversified, unsystematic risk approaches zero, and total risk depends entirely upon systematic risk.[8]

$$V(R_p) = \beta_p^2 V(R_m), \tag{41}$$

$$\sigma_p = \beta_p \sigma_m. \tag{42}$$

The capital market line and the security market line applied to the case of portfolio will take the following equations:

$$E(R_p) = R_F + \left[\frac{E(R_m) - R_F}{\sigma_m} \right] \sigma_p, \tag{43}$$

$$E(R_p) = R_F + [E(R_m) - R_F] \beta_p. \tag{44}$$

Equation (43) is the capital market line for the portfolio p, and Equation (44) is the security market line for the portfolio p.

Thus far we have reviewed the risk measures associated with the rate of

(8) In Equation (39), assume $X_i = 1/n$, where $n =$ the number of securities. Then

$$V(e_p) = \sum_{i=1}^{n} X_i^2 V(e_i) = \left(\frac{1}{n}\right)^2 \sum V(e_i) = \frac{1}{n} \frac{\sum V(e_i)}{n} \to 0 \quad \text{as } n \to \infty.$$

return on common stocks. Now the remaining task is to examine a possible link between the risks on common stocks and the risks on the business and financial conditions of the firm, namly, business risk, financial risk, and default risk.

According to the Modigliani-Miller model (1958, 1963) on the cost of capital, the cost of stock equity capital is given by

$$k_e=\frac{(\mathrm{NOI}-iB)(1-a)/N}{S/N}=\frac{E}{P} \tag{45}$$

where k_e=the cost of stock equity capital, NOI=net operating income or EBIT, i=the market rate of interest, B=the market value of bonds, a=the effective corporate tax rate, N=the number of shares of common stock, S=the market value of stock equity capital, and E/P=the earnings/price ratio.

If we assume that net operating income (NOI) is a random variable, the variance and the standard deviation of the cost of stock equity capital are given by

$$V(k_e)=V(E/P) \tag{46}$$

$$\hat{s}(k_e)=\hat{s}(E/P) \tag{47}$$

where $V(k_e)$= the variance of the equity capital, $\hat{s}(k_e)$= the standard deviation of the equity capital, $V(E/P)$=the variance of the earnings/price ratio, and $\hat{s}(E/P)$=the standard deviation of the earnings/price ratio. Recall that $\hat{s}(E/P)$ is the same as financial risk as was defined by Equation (10).

On the other hand, according to the capital asset pricing model, the rate of return on common stocks is a linear function of the market rate of return as was shown by Equation (29):

$$R_i=a_i+\beta_i R_m+e_i. \tag{29}$$

The variance and the standard deviation were given by Equations (32) and (33) respectively:

$$V(R_i)=\beta^2 V(R_m)+V(e_i), \tag{32}$$

$$\alpha(R_i)=\sqrt{\beta^2 V(R_m)+V(e_i)}. \tag{33}$$

In equilibrium, the cost of stock equity capital should be equal to the holding period return on common stocks, i.e., (29)=(45),[9]

$$k_e = R_i \tag{48}$$

and thus (32)=(46), and (33)=(47):

$$V(E/P) = V(R_i) = \beta^2 V(R_m) + V(e_i), \tag{49}$$

$$\hat{s}(E/P) = \sigma(R_i) = \sqrt{\beta^2 V(R_m) + V(e_i)}. \tag{50}$$

(9) The holding period return is

$$R = D/P + \Delta P/P. \qquad \text{(a)}$$

The earnings/price ratio can be written as

$$E/P = (D + bE)/P = D/P + bE/P \qquad \text{(b)}$$

where D=dividend payment, and b=retention rate of earnings per share. The two equations will be equal if

$$\Delta P/P = bE/P, \text{ or } \Delta P = bE.$$

When the retained earnings are reinvested, future income stream will increase:

$$rbE = \Delta E \qquad \text{(c)}$$

where r=the rate of return on reinvestment. To convert the future income stream into the present value, we divide Equation (d) by the stock capitalization rate k_e

$$rbE/ke = \Delta E/k_e. \qquad \text{(d)}$$

Further assume that the market price of stock is equal to the present value of the future income stream:

$$P = E/k_e. \qquad \text{(e)}$$

Then the increase in stock price is equal to the increase in the future income stream:

$$\Delta P = \Delta E/k_e. \qquad \text{(f)}$$

From Equations (c) and (f),

$$\Delta P = \Delta E/k_e = rbE/k_e. \qquad \text{(g)}$$

Substituting Equation (g) in (a),

$$R = D/P + (rbE/k_e)/P. \qquad \text{(h)}$$

Now compare Equations (h) and (b).

If $r = k_e$, then $rbE/k_e = \Delta P$ and $R = E/P$, i.e., (h)=(b).

If $r > k_e$, then $rbE/k_e > \Delta P$ and $R > E/P$, i.e., (h)>(b).

If $r < k_e$, then $rbE/k_e < \Delta P$ and $R < E/P$, i.e., (h)<(b).

If $r > k_e$, then reinvestment will increase, and r tends to fall. If $r < k_e$, then retention will fall, and r tends to rise. Thus in equilibrium $r = k_e$ and $R = E/P$.

Solomon (1963, pp. 59-67) derives the following valuation formula for a simple firm (Eq. 5. 5).

$$V = \frac{D'}{k_e} + \frac{bmE'}{k_e} \qquad \text{(i)}$$

where V=value of the firm, D'=aggregate dividend payments, E'=aggregate earnings after tax, b=retention rate of earnings, k_e=the cost of stock equity capital, $m = r/k_e$, r=the rate of return on reinvestment, and k_e=the cost of existing stock equity capital. Rewriting (i)

$$k_e = \frac{D'}{V} + \frac{bmE'}{V}. \qquad \text{(j)}$$

Dividing by the number of shares of stocks, N,

$$k_e = \frac{D}{P} + \frac{bmE}{P} \qquad \text{(k)}$$

where D'/N=dividend per share, $E = E'/N$=earnings per share, and $P = V/N$=the price of stock per share. In Equation (k), $m = r/k_e$. So Equation (k) can be rewritten

$$k_e = \frac{D}{P} + \frac{brE/k_e}{P}. \qquad \text{(l)}$$

We note that Equations (l) and (h) are the same.

The above equations suggest that there are indeed theoretical relationships between the risks associated with common stocks and the risks associated with the business and financial conditions of the firm. Equations (45)～(50) suggest that in equilibrium, financial risk is equal to the total risk of common stocks. However, it should be noted that the relationship between financial risk $\hat{s}(E/P)$ and systematic risk β depends upon unsystematic risk. In other words, if the capital market is not efficient, $V(e_i)\neq 0$, and thus there is no unique relationship between financial risk and systematic risk.

V. The Data and the Empirical Methods

In the previous Sections, we have reviewed the formulas to calculate risks and returns. In this Section, we aim to achieve three objectives. The first is to apply the risk and return formulas to empirical data. The second is to examine the statistical significance of correlations among the various risk measures. The third objective is to observe the statistical relationships between risk and return measures. However, before we discuss the empirical results, it is useful to explain about the basic statistical data and the empirical methods used. For this purpose we will summarize all the formulas we have discussed in the previous Sections:

Also, in the theory of the cost of capital, $k_e=E/P$. So Equation (h) can be reduced to

$$R=D/P+rb. \quad \text{(m)}$$

From Equation (c), $rb=\Delta E/E=g$. Thus, Equation (m) can be rewritten as

$$R=D/P+g. \quad \text{(n)}$$

Also we note that

$$P_o=\frac{D_1+P_o(1+g)}{(l+k_e)}, \quad \text{(o)}$$

and

$$k_e=D_1/P_o+g. \quad \text{(p)}$$

Since (n)=(p), $R=k_e=E/P$.

Also see Hamada (1969, 1972) and Rubinstein (1973). They linked the CAPM and the Modigliani-Miller model based on the assumption that $k_e=E(R_i)$

$$k_e=R_F+[E(R_m)-R_F]\beta_u[1+(1-a)]B/S \quad \text{(q)}$$

where $\beta_u[1+(1-a)]B/S=\beta_L$, β_u=the unlevered firm's beta, and β_L=the levered firm's beta. See Copeland and Weston (1979, p. 294).

Risk measures:

Business risk$=\hat{s}/E(Y)=\hat{s}/Y$.

Financial risk$=\hat{s}(E/P)$.

Default risk$=\int_{-\infty}^{-t*} f(t)dt=\alpha$

where $t*=\dfrac{E(Y)-B[i+1/m(1-a)]}{\hat{s}/\sqrt{n}}$.

Total risk$=\sigma(R)=\hat{s}(R)$

$$=\sqrt{\frac{\sum(R_i-\bar{R}_i)^2}{n-1}}.$$

Systematic risk (beta)$=\dfrac{\sum(R_i-\bar{R}_i)(R_m-\bar{R}_m)^2}{\sum(R_m-\bar{R}_m)^2}=\beta$.

Systematic risk$=\beta^2V(R_m)$.

Unsystematic risk$=V(e)=V(R)-\beta^2V(R_m)$.

Debt/equity ratio (bond/stock ratio)$=B/S$.

Debt/value ratio (debt/asset ratio)$=B/V=B/(S+B)$.

Standard deviation of the rate of change in stock price (risk of stock price)

$=\hat{s}(\varDelta P/P)$.

Standard deviation of the dividend yield (risk of dividend yield)$=\hat{s}(D/P)$.

Systematic risk of the portfolio (portfolio beta)$=\sum_{i=1}^{n} X_i\beta_i=\beta_p$.

Systematic risk of the portfolio$=\beta_p{}^2V(R_m)$.

Unsystematic risk of the portfolio$=V(e_p)=\sum_{i=1}^{n}X_iV(e_i)=V(R_p)-\beta_p{}^2V(R_m)$.

Return measures:

Holding period return$=R=\varDelta P/P+D/P$.

Expected return$=E(R)=E(\varDelta P/P+D/P)$.

Earnings/price ratio (cost of equity capital)$=E/P$.

Average rate of return on capital (before interest and taxes)$=Y/V$.

Portfolio return$=\sum_{i=1}^{n}X_iR_i=R_p$.

Expected portfolio return$=E(R_p)$.

Since the portfolio risks and returns are not relevant in this paper, excluding them, we have calculated the following risks and returns: business risk, financial risk, default risk, the debt/equity ratio, the debt/value ratio, the expected return, and the earnings/price ratio. The systematic risk β was taken from the *Value Line Investment Survey*. The other basic statistical data were taken from the *Moody's Handbook of Common Stocks*, Summer 1979, unless otherwise specified. The variables are defined below:

$\hat{s}/E(Y)=\hat{s}/Y$=business risk. $\hat{s}=\hat{s}(Y)$=the standard deviation of EBIT is caculated with the EBIT data for 1976~78. EBIT is obtained by gross revenue × operating profit margin (%).

$$\hat{s}=\sqrt{\sum(Y-\bar{Y})^2/(n-1)}$$

where $n=3$. The expected income $E(Y)=\bar{Y}$ is the 3 year average of EBIT. (%)

$\hat{s}(E/P)$=financial risk. The earnings/price ratio (E/P) is obtained as the reciprocal of the price/earnings ratio (P/E). The standard deviation of E/P is obtained from the 3 year data for 1976~78. (%)

$\hat{s}(R)$=total risk of common stock. It is the standard deviation of the holding period return for 1976~78. The annual holding period return is given by $\Delta P/P+D/P=R$. To calculate the rate of change in stock prices ($\Delta P/P$), the average of high and low prices of the year is used. D/P=the dividend yield. (%)

β=the index of systematic risk. Since the annual data in the *Moody*'s *Handbook* is not sufficient, we have taken it from the *Value Line Investment Survey*. It is obtained by using the weekly percentage changes in the price of a stock and the weekly percentage changes in the NYSE average over a period of 5 years.

B/S=the debt/equity ratio or the bond/stock ratio. The senior capital is divided by the market value of the stock. B=the 3 year average of the senior capital, and S=the 3 year average of the stock value. The market value of the stock is obtained by the number of shares outstanding × the average price of the stock. The average price of the stock is the average of the high and low prices of the year. (%)

B/V=the debt/value ratio, or financial leverage. A simple 3 year average of

$B/(S+B)$ for 1976～78. (%)

$\hat{s}(\Delta P/P)$=the risk of stock price. The standard deviation of the rate of change in stock prices for 1976～78. (%)

$\hat{s}(D/P)$=the risk of dividend. The standard deviation of the dividend yield for 1976～78. (%)

As for the return concepts, we have calculated the following five types:

$E(R)$=the expected return on the stock. A simple 3 year average of the holding period return, which is equal to $\Delta P/P+D/P=R$. As previously explained, the average price of the high and low prices of the year is used to calculate the annual rate of change in stock prices. D/P=the dividend yield. (%)

E/P=the earnings/price ratio. It is regarded as the cost of equity capital in the Modigliani-Miller model (1958, 1963). It is the reciprocal of the price/earnings ratio. A simple 3 year average for 1976～78. (%)

Y/V=the average rate of return on capital. EBIT (earnings before interest and taxes) is divided by the total capital ($V=S+B$). (%)

$\Delta P/P$=the rate of change in stock prices. A simple 3 year average for 1976～78. For the average of the high and low prices of each year is taken as the stock price of the year. (%)

D/P=the dividend yield. A simple 3 year average for 1976～78. (%)

The above risk-return concepts are easy to calculate. However, for default risk calculation, we need a little more detailed explanation. As we have seen before, there are three t-ratio equations, (18), (21) and (23). Out of these three, we have selected Equation (21) on the assumption that it measures default risk under the normal condition under which the firm does not use depreciation allowances to pay off the cost of debt and taxes.

$$\alpha=\int_{-\infty}^{-t} f(t)\,dt=\text{default risk}$$

where

$$t=\frac{E(Y)-B[i+1/m(1-a)]}{\hat{s}/\sqrt{n}}.$$

$E(Y)$=the expected income, or the 3 year average of EBIT for 1976～78.

B=the long-term debt. Since we have selected corporations without preferred stocks, senior capital is regarded as the long term debt. It is a simple 3 year average for 1976~78. (In millions of dollars)

$\hat{s}$=the standard deviation of EBIT for 1976~78.

$$\hat{s}=\sqrt{\sum(Y-\bar{Y})/(n-1)}$$

n=the sample size, 3 years.

i=the rate of interest, 0.094. We have used the uniform rate of interest. The simple average rate of interest on the Moody's Baa corporate bond was 0.094 for 1976~78. (*Economic Report of the President*, 1980, p. 278.)

m=years to maturity, 7 years. We have used the uniform years to maturity for all corporations in the sample. Silvers (1976) calculates that the "long term debt duration" fluctuated between 8 and 6 years during 1961~75. For the concept of debt duration, see Bierman and Hass (1973, pp. 34-35.)

a=the effective corporate tax rate, 0.43. Holland and Myers (1980) estimate that the effective tax rate for the U.S. manufacturing industries was 0.428 during 1975~78.

By substituting these data into the t-ratio equation, we obtain the critical value of t. Given the t-value, the next step is to find the probability of the Student's t-distribution.[10]

VI. Empirical Results and Some Related Hypotheses

For the purpose of empirical measurement of risks and returns, we have selected 36 U.S. corporations listed in the *Moody's Handbook of Common Stocks*, Summer 1978, in the alphabetical order. However, we dropped those corpora-

(10) To see a numerical example, assume $E(Y)=183.989$, $B=189.30$, $\hat{s}(Y)=38.95$, $i=0.094$, $m=7$, $a=0.43$, so $[i+1/m(1-a)]=0.344$, and $n=3$. Substituting these data,

$$t=\frac{183.989-189.30[0.10+1/7(1-0.43)]}{38.95/\sqrt{2}}=5.286.$$

And the default risk is

$$\alpha=\int_{-\infty}^{-5.286} f(t)dt=P(t<-0.5286)=0.01524 \text{ or } 1.524\%$$

where the degrees of freedom=3-1=2.

This is the probability of default for Abbot Corporation as shown in Table 1. Since statistics textbooks do not provide detailed probabilities of the Student's t-distribution, we have used a simple computer program to calculate the t-probabilities.

tions with insufficient data or with preferred stocks. Since preferred stocks are a hybrid of debts and stocks, by eliminating them, the effects of "pure" debts may be more clearly measured.

The empirical results of risk-return measurement are summarized in Appendix Tables 1~3, together with the basic statistical data for the 36 corporations. In the below, we will discuss briefly three major findings in the empirical results: (1) the general characteristics of risks and returns, (2) the relationships among the risk measures, and (3) the relationships between risks and returns.

(1) General Characterisits. The descriptive statistics of the 14 risk and return variables are summarized in Table 1. For instance, as to default risk (α), the maximum risk for the 36 corporations is 99.07%, and the minimum risk is 0.06%. The median is 2.90% and the mean is 17.24%. As shown in Figure 3 (*see p. 82*), 80% of the firms have default risk less than 90%, but 8.3% have default risk greater than 90%. The normality test coefficient indicates that default risk is not normally distributed.

As to business risk ($\hat{s}/Y$), the maximum risk is 75.75%, and the minimum risk is 1.58%. The median is 21.38%, and the mean is 26.65%. The distribution is not normal. Financial risk $\hat{s}(E/P)$ has a much smaller range of variation. The maximum financial risk is 12.35%, and the minimum financial risk is 0.26%. This result is consistent with Equations (11) and (4). As to the risks on common stocks, total risk $\hat{s}(R)$ has a maximum value of 55.05%, and a minimum value of 2.62%. The median is 17.85% and the mean is 20.37%. The distribution is not normal. Systematic risk (β) has a maximum value of 1.63%, and a minimum value of 0.7%. The median is 1.03% and the mean is 1.04%. This is very close to the mean value 1.05% which is obtained by Modigliani and Pogue (1974) using the monthly data for 30 corporations. The normality test coefficient indicates that systematic risk is normally distributed. Other variables which are normally distributed include the debt/value ratio (B/V), the risk of dividend yield $\hat{s}(D/P)$, the earnings/price ratio (E/P), the income/value ratio (Y/V), and the dividend yield (D/P).

Table 1. Descriptive Statistics of Risk and Return Measures

	(1) Busi. risk $\hat{s}/Y$	(2) Finan. risk $\hat{s}(E/P)$	(3) Default risk α	(4) Total risk $\hat{s}(R)$	(5) Systematic risk β	(6) B/S	(7) B/V	(8) $\hat{s}(\Delta P/P)$	(9) $\hat{s}(D/P)$	(10) E/P	(11) Y/V	(12) $E(R)$	(13) $\Delta P/P$	(14) D/P
1. Mean	26.648	2.719	17.235	20.370	1.040	42.447	25.795	20.509	0.463	12.153	18.406	21.121	17.561	0.344
2. Median	21.380	1.853	2.900	17.845	1.025	28.410	22.135	17.945	0.361	11.140	17.550	18.760	15.715	3.430
3. Mode	1.580	0.260	0.058	22.010	0.900	1.630	1.600	23.180	0.666	15.390	4.260	21.121	−9.660	0.000
4. Stand. devi.	18.680	2.602	31.743	12.694	0.200	6.050	16.524	12.760	0.327	4.855	7.420	20.506	20.521	1.774
5. Kurtosis	0.575	4.928	2.487	1.588	0.808	−0.161	−1.072	1.436	−0.359	−0.246	0.174	1.840	2.508	−0.641
6. Skewness	1.115	2.141	2.000	1.319	0.788	0.923	0.296	1.282	0.675	0.578	0.697	1.137	1.314	−0.340
7. Maximum	75.750	12.346	99.071	55.050	1.600	129.490	56.640	54.640	1.266	24.800	36.960	86.590	86.280	9.170
8. Minimum	1.580	0.260	0.058	2.620	0.700	1.630	1.600	2.490	0.000	4.960	4.260	−6.630	−9.660	0.000
9. Normality	0.946	0.863	0.753	0.934	0.979*	0.947	0.979*	0.936	0.973*	0.972*	0.977*	0.948	0.940	0.983*

Note: All variables are measured in percents except for β.

The normality test scores are the correlation coefficients between the original values and their normal deviates, and the test is equivalent to the Shapiro-Wilk test. If the correlation coefficient is significant, the distribution is consistent with normality. The critical value of the correlation coefficient for the 5% level with the sample size 36 is 0.9685. *indicates the normality coefficient is significant at the 5% level. See T.A. Ryan, Jr., B.L. Joiner, and B.F., Ryan, *Minitab Reference Manual*, Jan. 1980, p. 49. Except for the normal coefficient, all descriptive statistics are calculated by SPSS, 7.05, Frequencies. *SPSS* (1975), pp. 181-202.

(2) In order to examine the statistical relationships among the risk variables, simple correlation coefficients are calculated. They are summarized in Table 2. First, as to the relationships among business risk, financial risk and default risk, Equations (12) and (13) suggest that if the income/stock ratio and the tax rate are the same for all firms, we should expect a linear positive correlation between business risk and financial risk. And as Equations (24) and (25) suggest, we should expect non-linear positive relationships between default risk and business risk and between default risk and financial risk. In Table 2, we find business risk and financial risk are indeed highly correlated ($r=0.583$). However, the linear simple correlation coefficients of default risk are not significant for business risk and financial risk. These results are not necessarily inconsistent with Equations (24) and (25) since these equations define non-linear

Table 2. Correlation Coefficients between Risks and between Returns

A. Correlation between Risk Variables

	(1) $\hat{s}/Y$	(2) $\hat{s}(E/P)$	(3) α	(4) $\hat{s}(R)$	(5) β	(6) B/S	(7) B/V	(8) $\hat{s}(\Delta P/P)$	(9) $\hat{s}(D/P)$
(1) $\hat{s}/Y$ (Business)	1.000	0.583*	0.255	0.214	−0.077	0.245	0.269	0.195	0.138
(2) $\hat{s}(E/P)$ (Financial)		1.000	0.245	0.325	−0.242	0.515*	0.520*	0.312	0.351*
(3) α (Default)			1.000	0.327	0.060	0.780*	0.706*	0.317	0.037
(4) $\hat{s}(R)$ (Total)				1.000	0.117	0.371*	0.295	0.999*	0.111
(5) β (Systematic)					1.000	−0.171	−0.236	0.118	−0.232
(6) B/S (Debt/equity)						1.000	0.977*	0.360*	0.075
(7) B/V (Debt/value)							1.000	0.286	0.124
(8) $\hat{s}(\Delta P/P)$ (Capital gain)								1.000	0.121
(9) $\hat{s}(D/P)$ (Dividend yield)									1.000

B. Correlation between Return Variables

	(1) E/P	(2) $E(R)$	(3) Y/V	(4) $\Delta P/P$	(5) D/P
(1) E/P (Earnings/price ratio)	1.000	0.401*	0.352*	0.366*	0.542*
(2) $E(R)$ (Expected return)		1.000	0.023	0.996*	0.127
(3) Y/V (Income/value ratio)			1.000	0.006	0.161
(4) $\Delta P/P$ (Rate of capital gain)				1.000	0.049
(5) D/P (Dividend yield)					1.000

Note: *Significant at 5% level (two-tail test). Sample size=36, d.f.=34. The critical value of r is 0.3296 for the 5% level, and 0.2789 for the 10% level.

relations while the simple correlations measure linear relationships.

As to the relationships between the risks on common stocks and the risks on conditions of the firm, Equations (48)~(50) suggest that in an efficient market equilibrium, total risk $\hat{s}(R)$ should be equal to financial-risk $\hat{s}(E/P)$, and systematic risk (β) should be equal to financial risk. In Table 2, we note that the correlation coefficient of total risk is 0.325 for financial risk, 0.327 for default risk, and 0.255 for business risk.(11) The first two coefficients are significant only at the 10% level (two-tail test), and the last coefficient is not significant. The simple correlation coefficients of systematic risk are −0.08, −0.24, and 0.06 for business risk, financial risk and default risk, respectively. These coefficients are not significant. The above results do not support the efficient capital market hypothesis, but support the hypothesis that the risks on common stocks do not necessarily accurately reflect the risks on the business and financial conditions of the firm.

(3) In order to examine the statistical relationships between the risk and return variables, simple correlation coefficients are calculated, and these are summarized in Table 3. As a matter of fact, the risk-return relationships are the central topics of the modern finance theories. Thus far we have four major propositions on the risk and return relationships:

(a) The Modigliani-Miller hypotheses (1958, 1963):

$$E/P=\rho+(\rho-i)(1-t_c)B/S \qquad (51)$$

$$Y(1-t_c)/V=\rho(1-t_cB/V) \qquad (52)$$

---

(11) For the empirical data, the mean of $E/P=12.15$, its standard deviation $\hat{s}(E/P)=4.86$, the mean of the holding period return $E(R)=21.12$, its standard deviation $\hat{s}(R)=20.5$.

Thus the t score for the difference between the two sample means of paired data is:

$$t=\frac{\bar{X}_1-\bar{X}_2}{\hat{s}_d/\sqrt{n}}=-2.819$$

where $\bar{X}_1$=the mean of E/P, and $\bar{X}_2$=the mean of R. $\hat{s}_d$=the standard deviation of the differences between the two variables. The t score for the difference between the two sample means of unpaired data is:

$$t=\frac{\bar{X}_1-\bar{X}_2}{\hat{s}_p\sqrt{\frac{1}{n_1}+\frac{1}{n_2}}}=-2.553$$

where $\hat{s}_p$=the pooled standard deviation of the two sample means. $t=-2.819$ is significant at the 0.79% level, and $t=-2.553$ is significant at the 1.28% level.

Table 3. Correlation Coefficients between Risk and Return

	(1) E/P	(2) $E(R)$	(3) Y/V	(4) $\Delta P/P$	(5) D/P
(1) $\hat{s}/Y$ (Business)	0.314	0.300	0.085	0.299	−0.032
(2) $\hat{s}(E/P)$ (Financial)	0.358*	−0.031	0.132	−0.035	0.082
(3) α (Default)	−0.153	−0.075	−0.354*	−0.072	−0.153
(4) $\hat{s}(R)$ (Total)	−0.008	0.285	−0.061	0.312	−0.337*
(5) β (Systematic)	−0.346*	0.133	−0.350*	0.183	−0.611*
(6) B/S (Debt/equity)	0.290	0.034	0.018	0.024	0.089
(7) B/V (Debt/value)	0.352*	0.023	0.064	0.006	0.161
(8) $\hat{s}(\Delta P/P)$ (Capital gain)	−0.014	0.279	−0.065	0.306	−0.335*
(9) $\hat{s}(D/P)$ (Dividend yield)	0.165	−0.160	−0.100	−0.188	0.348*

Note: *Significant at the 5% level (two-tail test). Sample size=36, d.f.=34. The critical value of r is 0.3296 for the 5% level, and 0.2789 for the 10% level.

where $\rho>i$, and $0\leq t_c<1$

(b) The Miller market equilibrium model (1977):

$$E(1-t_{ps})/P=\rho+(\rho-i)\frac{(1-t_c)(1-t_{ps})}{(1-t_{pB})}\frac{B}{S}, \text{ or} \tag{53}$$

$$E/P=\rho+(\rho-i)B/S$$

$$\frac{Y(1-t_c)(1-t_{ps})}{V}=\rho-\rho\left[1-\frac{(1-t_c)(1-t_{ps})}{(1-t_{pB})}\right]\frac{B}{V}, \text{ or} \tag{54}$$

$$Y(1-t_c)/V=\rho$$

where in the Miller's market equilibrium, $t_{ps}=0$, $t_c=t_{pB}$, and $\rho>i$

(c) The capital market line hypothesis (Markowitz-Sharpe-Lintner-Mossin):

$$E(R_i)=R_F+\frac{E(R_m)-R_F}{V(R_m)}\hat{s}(R_i) \tag{55}$$

(d) The security market line hypothesis(Markowitz-Sharpe-Lintner-Mossin):

$$E(R_i)=R_F+[E(R_m)-R_F]\beta_i \tag{56}$$

where E/P=the cost of equity capital, measured by the earnings/price ratio, $Y(1-t_c)/V$=the average cost of capital, Y=EBIT, t_c=the corporate tax rate, ρ=the cost of equity capital of the unlevered firm, i=the market rate of interest on debts, B/S=the debt/equity ratio, B/V=the debt/value ratio, t_{ps}=the personal tax on income from stock holdings, t_{pB}=the personal tax on income from bond holdings, $E(R_i)$= the expected return on common stock i, $E(R_m)$= the expected return on the market portfolio, R_F=the risk-free rate, $\hat{s}(R_i)$=the standard deviation of the rate of return on common stock or total risk, and β_i=the systematic risk of the return on common stock.

First, the Modigliani-Miller model (1958, 1963) states that the cost of equity capital (E/P) is a linear positive function of the debt/equity ratio (B/S), but the average cost of capital, $Y(1-t_c)/V$, is a linear decreasing function of the debt/value ratio (B/V). Second, the Miller model (1977) states that in the market equilibrium, the cost of equity capital increases with the debt/equity ratio, but the average cost of capital is independent of financial leverage.(12) The Miller model is different from the Modigliani-Miller model in that the Miller model includes personal taxes on incomes from stocks and bonds, and assumes in the market $t_{ps}=0$, $t_{pB}=t_c$, $(1-t_c)(1-t_{ps})/(1-t_{pB})=1.0$.

Third, the capital market line hypothesis states that the expected return on common stock is a linear and positive function of its total risk, or its standard deviation. Fourth, the security market line hypothesis, or the capital asset pricing model, states that the expected return is a linear and positive function of its systematic risk, if the capital market is efficient.

As a first step to test the above hypothese, we have calculated again the simple correlation coefficients between various risks and returns. In Table 3, the correlation matrix is presented. First, according to the Modigliani-Miller model, B/S should be positively correlated with E/P, and B/V should be

(12) Instead of $Y(1-t_c)/V$, $E(1-t_{ps})/P$, and $Y(1-t_c)(1-t_{ps})/V$, we have taken pre-tax cost of equity capital and pre-tax average cost of capital. That is, Equations (52), (53) and (54) can be rewritten as

$$Y/V=\rho/(1-t_c)-\rho t_c/(1-t_c)B/V, \qquad (52)'$$

$$E/P=\rho/(1-t_{ps})+\left[\frac{(\rho-i)(1-t_c)(1-t_{ps})}{(1-t_{ps})(1-t_{pB})}\right]\frac{B}{V}, \qquad (53)'$$

$$Y/V=\rho/[(1-t_c)(1-t_{ps})]-\rho\left[\frac{1}{(1-t_c)(1-t_{ps})}-\frac{1}{(1-t_{pB})}\right]\frac{B}{V}. \qquad (54)'$$

In the Miller market equilibrium model, $t_{ps}=0$, and $t_c=t_{pB}$. So the second terms on the right hand sides of Equations (53)′ and (54)′ drop out. The assumption $t_{ps}=0$ implies that the personal tax rate on income from stock holding is equal to zero. See Miller (1977), and Kim, Lewellen and McConell (1979).

Steurle (1980) states that "dividing tax revenue of $30.6 billion on net income from capital by the amount of net capital income in the economy yields an effective average marginal rate of Federal individual income tax of 10% on all capital income" (pp. 11-12).

negatively correlated with Y/V. In Table 3, indeed B/S has a positive sign, but it is significant only at the 10% level (5% at each tail). B/V is not significant for Y/V at the 10% level. These results suggest that Equation (51) is weakly supported, but Equation (52) is not.

Second, as to Miller model, as in the above case, Equation (53) is weakly supported. But B/V is not significant for Y/V, and this result is consistent with his hypothesis or Equation (54), though his assumptions on the personal tax rates are not consistent with the factual statistical data.

Third, as to the capital market line hypothesis, we note that total risk $\hat{s}(R)$ is positive and significant at the 10% level (two-tail) for the expected return on common stocks $E(R)$. This result is consistent with the capital market line hypothesis.

Fourth, as to the security market line hypothesis, systematic risk β is positive, but not significant at the 10% level for the expected return $E(R)$. This result does not support the security market line hypothesis.

However, simple correlation analysis is not necessarily an appropriate method of testing a hypothesis. That is, the simple correlation coefficient does not measure a net relationship but a gross linear relationship between two variables. In the following Sections, we will apply multivariate analysis to test the above and some other related hypotheses.

References

Altman, E.I., "Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy," *Journal of Finance*, Sept. 1968, pp. 589-609.

Altman, E.I., R.G. Haldeman, and P. Narayanan, "Zeta Analysis: A New Model to Identify Bankruptcy Risk of Corporations," *Journal of Banking and Finance*, June 1977, pp. 29-54.

Barges, A., *The Effects of Capital Structure on the Cost of Capital*, 1963.

Beaver, W.H., "Financial Ratios and Prediction of Failure," *Empirical Research in Accoun-*

ting: Selected Studies, supplement to *Journal of Accounting Research*, 1966, pp. 71-111.

Beaver, W.H., "Market Prices, Financial Ratios, and the Prediction of Failure," *Journal of Accounting Research*, Autumn 1968, pp. 179-192.

Bierman, H., Jr., and J.E. Hass, *An Introduction to Managerial Finance*, 1973, pp. 96-98.

Black, F., "Capital Market Equilibrium with Restricted Borrowing," *Journal of Business*, July 1972, pp. 444-455.

Black, F., M.C. Jensen, and M. Scholes, "The Capital Asset Pricing Model: Some Empirical Tests," in *Studies in the Theory of Capital Markets*, ed. by M.C. Jensen, 1972, pp. 79-124.

Brealey, R., and S. Myers, *Principles of Corporate Finance*, 1980.

Brigham, E.F., and R.C. Crum, "On the Use of the CAPM in Public Utility Rate Cases," *Financial Management*, Summer 1977, pp. 7-15.

Brigham, E.F., and M.J. Gordon, "Leverage, Dividend, and the Cost of Capital," *Journal of Finance*, March 1968, pp. 85-104.

Chen, K.H., and T.A. Shimerda, "An Empirical Analysis of Useful Financial Ratios," *Financial Management*, Spring 1981, pp. 51-60.

Comrey, A.L., *A First Course in Factor Analysis*, 1973.

Cooley, W.W., and P.R. Lohnes, *Multivariate Data Analysis*, 1971.

Copeland, T.E., and J.F. Weston, *Financial Theory and Corporate Policy*, 1979.

Donaldson, G., *Corporate Debt Capacity*, 1961.

Donaldson, G., "New Framework for Corporate Debt Policy," *Harvard Business Review*, March/April 1962, pp. 117-131.

Donaldson, G., "Financial Goals: Management vs. Stockholders," *Harvard Business Review*, May/June 1963, pp. 116-129.

Donaldson, G., "Strategy for Financial Emergencies," *Harvard Business Review*, November/December 1969, pp. 67-79.

Douglas, G., "Risk in the Equity Markets: An Empirical Appraisal of Market Efficiency," *Yale Economic Essays*, No. 1, 1968, pp. 3-45.

Durand, D., "Cost of Debt and Equity Funds for Business: Trends and Problems of Measurement," in *Conference on Research in Business Finance*, NBER, N.Y., 1952, repr. in E. Solomon, ed., *The Management of Corporate Capital*, 1959, pp. 91-116, and in S.H. Archer and C.A. D'Ambrosio, eds., *The Theory of Business Finance: A Book of Read-*

ings, 2nd ed., 1976, pp. 420-452.

Fama, E.F., "Risk, Return and Equilibrium: Some Clarifying Comments," *Journal of Finance*, March 1968, pp. 29-40.

Fama, E.F., "Efficient Capital Markets: A Review of Theory and Empirical Work," *Journal of Finance*, May 1970, pp. 383-417.

Fama, E.F., and J.D. MacBeth, "Risk, Return and Equilibrium: Empirical Tests," *Journal of Political Economy*, May 1973, pp. 607-636.

Findlay, M.C., and E.E. Williams, "Towards More Adequate Debt Service Coverage Ratios," *Financial Analysts Journal*, Autumn 1975, pp. 54-61.

Findlay, M.C., E.E. Williams, and L.A. Gordon, "Towards More Adequate Measures of Lender Protection," *Financial Management*, Autumn 1975, pp. 54-61.

Friend, I., and M. Blume, "Measurement of Portfolio Performance under Uncertainty," *American Economic Review*, Sept. 1970, pp. 561-575.

Gonedes, N.J., "A Test of the Equivalent-Risk Class Hypothesis," *Journal of Financial and Quantitative Analysis*, June 1969, pp. 159-177.

Gordon, M.J., "Some Estimates of the Cost of Capital to the Electric Utility Industry, 1954-57: Comment," *American Economic Review*, 1967, pp. 1267-77.

Grauer, R.R., "Generalized Two Parameter Asset Pricing Models: Some Empirical Evidence," *Journal of Financial Economics*, March 1978, pp. 11-32.

Grauer, R.R, "Investment Policy Implications of the Capital Asset Pricing Model," *Journal of Finance*, March 1981, pp. 127-141.

Hair, J.F., R.E. Anderson, R.L. Tatham, and B.J. Grablowsky, *Multivariate Data Analysis with Readings*, 1979.

Hakansson, N.H., "Optimal Investment and Consumption Strategies under Risk for a Class of Utility Functions," *Econometrica*, Sept. 1970, pp. 587-607.

Hakansson, N.H., "Capital Growth and the Mean Variance Approach to Portfolio Selection," *Journal of Financial and Quantitative Analysis*, Jan. 1971, pp. 517-557.

Haley, C.W., and L.D Schall, *The Theory of Financial Decisions*, 2nd ed., 1979.

Hamada, R.S., "Portfolio Analysis, Market Equilibrium and Corporation Finance," *Journal of Finance*, March 1969, pp. 13-31.

Hamada, R.S., "The Effect of the Firm's Capital Structure on the Systematic Risk of Common Stocks," *Journal of Finance*, May 1972, pp. 435-452.

Harman, H.H., *Modern Factor Analysis*, 1976.

Hoel, P.G., *Introduction to Mathematical Statistics*, 1971.

Holland, D. M., "Profitability and Capital Costs for Manufacturing Corporations and All Nonfinancial Corporations," *American Economic Review*, May 1980, pp. 320-325.

Hong, H., and A. Rapport, "Debt Capacity, Optimal Capital Structure, and Capital Budgeting," *Financial Management*, Autumn 1978, pp. 7-11.

Jensen, M.C., "Capital Markets: Theory and Evidence," *The Bell Journal of Economics and Management Science*, Autumn 1972, pp. 357-398.

Kim, J., and C.W. Mueller, *Introduction to Factor Analysis*, 1978.

Kim, J., and C.W. Mueller, *Factor Analysis*, 1978.

Kim, E.H., W.G. Lewellen, and J.J. McConnell, "Financial Leverage Clienteles: Theory and Evidence," *Journal of Financial Economics*, No. 7, 1979, pp. 83-109.

Klecka, W.R., *Discriminant Analysis*, 1980.

Lewellen, W.G., "Management and Ownership in the Large Firm," *Journal of Finance*, May 1969, pp. 299-322.

Lintner, J., "The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets," *Reveiw of Economics and Statistics*, Feb. 1965, pp. 13-47.

Mao, J.C.T., *Quantitative Analysis of Financial Decisions*, 1969, pp. 432-452.

Maksoudian, Y.L., *Probability and Statistics with Application*, 1969.

Markowitz, H.M., "Portfolio Selection," *Journal of Finance*, March 1952, pp. 77-91.

Markowitz, H.M., *Portfolio Seletion: Efficient Diversification of Investment*, 1959.

Martin, J.D., and D.F. Scott, Jr., "Debt Capacity and the Capital Budgeting Decision," *Financial Management*, Summer 1976, pp. 7-14.

Mayers,D., and E.M. Rice, "Measuring Portfolio Performance and the Empirical Content of Asset Pricing Models," *Journal of Financial Economics*, No. 7, 1979, pp. 3-28.

Melnyk, Z. Lew, "Cost of Capital as a Function of Financial Leverage," *Decision Science*, July/August 1970, pp. 327-356.

Miller, M., "Debt and Taxes," *Journal of Finance*, May 1977, pp. 261-275.

Miller, M., and M. Scholes, "Rates of Relation to Risk: A Reexamination of Some Recent Findings," in *Studies in the Theory of Capital Markets*, ed. by M. Jensen, 1972, pp. 47-78.

Modigliani, F., and M.H. Miller, "The Cost of Capital, Corporation Finance and the Theory of Investment," *American Economic Review*, June 1958, pp. 261-297.

Modigliani, F., and M.H. Miller, "Corporate Income Taxes and the Cost of Capital: A Correction," *American Economic Review*, June 1963, pp. 433-443.

Modigliani, F., and M.H. Miller, "Reply," *American Economic Review*, June 1965, pp. 524-527.

Modigliani, F., and M.H. Miller, "Some Estimates of the Cost of Capital to the Electric Utility Industry," *American Economic Review*, June 1966, pp. 333-391.

Modigliani, F., and G.A. Pogue, "An Introduction to Risk and Return," *Financial Analysts Journal*, March/April 1974, pp. 68-80; May/June 1974, pp. 69-88.

Mossin, J., "Equilibrium in a Capital Asset Market," *Econometrica*, Oct. 1966, pp. 768-783.

Nie, N.H. and others, eds., *SPSS: Statistical Package for the Social Sciences*, 2nd ed., 1975.

O'Connor, M.C., "On the Usefulness of Financial Ratios to Investors in Common Stock," *Accounting Review*, April 1973, pp. 339-352.

Pinches, G.E., and K.A. Mingo, "A Multivariate Analysis of Industrial Bond Ratings," *Journal of Finance*, March 1973, pp. 1-18.

Pogue, T.F., and R.M. Soldofsky, "What's in a Bond Rating," *Journal of Financial and Quantitative Analysis*, June 1969, pp. 201-228.

Reinganum, M.R., "Abnormal Returns in Small Firm Portfolios," *Financial Analysts Journal*, March/April 1981, pp. 52-56.

Roll, R., "Evidence on the Growth Optimum Model," *Journal of Finance*, June 1973, pp. 551-566.

Roll, R., "A Critique of the Asset Pricing Theory's Tests: Part I," *Journal of Financial Economics*, March 1977, pp. 129-176.

Roll, R., "Ambiguity When Performance Is Measured by the Securities Market Line," *Journal of Finance*, Sept. 1978, pp. 1051-1069.

Rubinstein, M.E., "A Mean Variance Synthesis of Corporate Financial Theory," *Journal of Finance*, March 1973, pp. 167-181.

Rubinstein, M., "An Aggregation Theorem for Securities Markets," *Journal of Financial Economics*, Sept. 1974, pp. 225-244.

Rubinstein, M., "The Strong Case for the Generalized Logarithmic Utility Model as the Premier Model of Financial Markets," *Journal of Finance*, May 1976, pp. 551-571.

Sharpe, W.F., "Simplified Model for Portfolio Analysis," *Management Science*, Jan. 1963, pp. 277-293.

Sharpe, W.F., "Capital Asset prices: A Theory of Market Equilibrium under Conditions of Risk," *Journal of Finance*, Sept. 1964, pp.425-442.

Sharpe, W.F, "Risk Aversion in the Stock Market: Some Empirical Evidence," *Journal of Finance*, Sept. 1965, pp. 416-422.

Silvers, J.B., "Liquidity, Risk, and Duration Patterns in Corporate Financing," *Financial Management*, Autumn 1976, pp. 54-64.

Soldofsky, R.M., and D.F. Max, *Holding Period Yields and Risk-Premium Curves for Long-Term Marketable Securities: 1910-1976*, New York University Monograph Series in Finance and Economics, 1977.

Solomon, E., *The Theory of Financial Management*, 1963.

Stuerle, E., *Is Income from Capital Subject to Income Taxation?*, OTA Paper 42, U.S. Department of the Treasury, Oct. 1980.

Tatsuoka, M.M., *Multivariate Analysis*, 1971.

Tinic, S.M., and R.R. West, *Investing in Securities: An Efficient Markets Approach*,1979.

U.S. Council of Economic Advisers, *Economic Report of the President*, Jan. 1980.

Van de Geer, J.P., *Introduction to Multivariate Analysis for the Social Sciences*, 1971.

Van Horne, J.C., *Financial Management and Policy*, 5th ed., 1980.

West, R.R., "An Alternative Approach to Predicting Corporate Bond Ratings," *Journal of Accounting Research*, Spring 1970, pp. 15-21.

Weston, J.F., "A Test of Cost of Capital Propositions," *Southern Economic Journal*, Oct. 1963, pp. 105-112.

Weston, J.F., and E.F. Brigham, *Managerial Finance*, 7th ed., 1981.

Wippern, R.F., "A Note on the Equivalent Risk Class Assumption," *Engineering Economist*, Spring 1966, pp. 13-22.

Appendix Table 1. Risk and Return Variables (Empirical Data and Results)

Company	(1) $\hat{s}/Y$ (Business risk)	(2) $\hat{s}(E/P)$ (Financial risk)	(3) t-ratio	(4) α (Default risk)	(5) $\hat{s}(R)$ (Total risk)	(6) β (Systematic risk)
1. Abbot	20.95	.665	5.2860	1.524	24.19	1.20
2. ACF	1.58	.518	−.7260	72.821	2.62	.90
3. Akzona	51.95	5.892	−3.2946	96.004	22.01	.95
4. Alpha	56.83	12.346	1.4928	13.737	15.07	.80
5. Am. Broadca.	32.48	.727	3.8897	2.889	16.45	1.15
6. Am. Cyanamid	15.30	.615	3.2391	4.126	5.13	1.05
7. Am. Hospital	9.50	1.702	9.8386	.376	13.21	1.20
8. Am. Motor	58.52	8.315	1.0889	19.546	22.01	.90
9. Am. Steril.	13.99	2.188	6.1037	1.108	17.84	.90
10. Amtek	17.36	1.665	7.4427	.707	23.09	1.05
11. AMP	28.21	2.081	5.4958	1.399	15.16	1.20
12. Anheuser	26.34	3.541	1.9042	9.906	15.39	1.20
13. Asarco	66.85	2.173	−6.5965	99.071	10.16	.95
14. Ball	22.32	2.213	3.2561	4.086	21.76	.85
15. Bally	30.87	1.280	3.4818	3.600	23.04	1.50
16. Bard (CR)	6.50	.536	25.5620	.058	12.63	1.35
17. Barnes	15.83	.260	7.8630	.624	12.66	.80
18. Belco	34.12	1.391	4.0848	2.627	19.86	1.05
19. Belden	17.64	2.773	1.4524	14.211	23.10	.70
20. Berkey	3.80	2.634	−2.7867	94.593	54.17	1.00
21. Bliss	14.90	1.749	6.4604	.975	11.46	.85
22. Boeing	62.84	1.961	2.3479	7.202	37.14	1.10
23. Braniff	21.34	4.158	−4.2712	97.603	42.53	1.60
24. Brockway	9.73	4.592	7.8467	.627	33.88	.90
25. Brown-Sharpe	75.75	8.440	.1312	45.163	55.05	1.00
26. Bucyrus	7.52	2.945	12.6657	.217	19.47	1.05
27. Burndy	18.81	1.768	7.3481	.728	43.84	.85
28. Burns	28.58	6.236	2.9717	4.828	18.90	.90
29. Burroughs	16.47	1.858	8.7758	.486	17.85	1.20
30. Cabot	24.75	1.206	2.5231	6.404	4.50	1.15
31. Campbell-Sou.	9.42	.864	17.8147	.109	7.12	.75
32. Capital Citi.	23.15	.983	5.5150	1.388	22.15	1.25
33. Carlisle	40.79	2.916	2.6395	5.937	13.36	.95
34. Carpenter	32.15	1.337	5.1770	1.595	7.32	.95
35. Caterpillar	29.22	1.848	3.3750	3.820	17.37	1.10
36. Chesebrough	12.98	1.513	10.1222	.353	11.82	1.15

Note: All variables are measured in % except the following: t-ratio and β are measured in the natural units. Y,B,S, $\hat{s}(Y)$ are measured in millions of dollars.

Appendix Table 2. Risk and Return Variables (Empirical Data and Results)

Co.	(7) B/S (Debt/equity)	(8) B/V (Dept/value)	(9) $E(R)$ (Expected return)	(10) E/P (Earnings/Price)	(11) Y/V (Income/value)	(12) g (Growth rate of EBIT)
1. Abbot	11.74	10.5075	31.62	7.50	10.2127	22.90
2. ACF	86.08	46.2601	18.71	12.11	14.9267	17.06
3. Akzona	93.58	48.3427	1.52	6.03	8.3643	86.89
4. Alpha	99.71	49.9271	31.00	24.80	33.6644	−34.22
5. Am. Broadca.	26.62	21.0256	38.45	14.31	26.7224	40.55
6. Am. Cyanamid	36.59	26.7908	8.82	11.13	12.9083	14.36
7. Am. Hospital	16.70	14.3079	−2.41	7.12	10.6973	9.87
8. Am. Motor	59.47	37.2929	2.13	14.41	20.2970	80.76
9. Am. Steril.	28.40	22.1169	4.93	7.79	15.0045	14.70
10. Amtek	17.02	14.5476	32.52	12.00	19.6844	19.48
11. AMP	3.99	3.8404	2.35	6.77	12.5963	34.19
12. Anheuser	32.81	24.7052	−6.63	8.11	11.9635	32.02
13. Asarco	78.17	43.8735	5.81	8.51	4.2562	1.36
14. Ball	60.95	37.8680	20.13	15.92	22.4421	26.31
15. Bally	14.60	12.7399	86.59	5.89	11.5472	39.09
16. Bard (CR)	1.83	1.7953	3.11	8.02	15.4384	6.08
17. Barnes	31.58	23.9981	31.92	16.13	29.3190	25.16
18. Belco	26.58	20.9980	31.00	20.48	36.9628	39.85
19. Belden	93.60	48.2256	22.72	16.02	19.4700	19.88
20. Berkey	129.49	56.4247	15.69	4.96	18.2930	0.85
21. Bliss	42.38	29.7665	27.55	16.16	23.0477	22.00
22. Boeing	7.95	7.3610	68.42	15.39	17.0905	49.93
23. Braniff	124.83	55.5219	32.38	15.79	12.5139	23.48
24. Brockway	48.10	32.4783	21.17	17.26	19.9800	4.41
25. Brown-Sharpe	95.10	48.7435	44.70	15.94	17.7881	161.58
26. Bucyrus	22.50	18.3651	2.63	11.35	14.0262	7.33
27. Burndy	12.39	11.0249	33.20	10.75	18.7599	19.29
28. Burns	35.10	25.9812	12.82	8.98	17.5342	33.76
29. Burroughs	5.96	5.6274	−2.84	6.87	11.7169	18.11
30. Cabot	68.12	40.5188	43.65	17.01	21.7976	29.03
31. Campbell-Sou.	1.63	1.5997	7.26	9.43	17.8306	9.71
32. Capital Citi.	25.57	20.3615	1.66	10.48	26.6315	26.86
33. Carlisle	52.71	34.5182	31.82	21.09	31.3841	41.31
34. Carpenter	3.45	3.3304	41.10	15.39	29.2762	43.15
35. Caterpillar	21.11	17.8382	14.02	9.89	14.2520	34.04
36. Chesebrough	11.07	9.9705	.83	7.71	14.2111	13.61

Appendix Table 3. Risk and Return Variables (Empirical Data and Results)

Co.	(13) Y (EBIT)	(14) B (Bond)	(15) S (Stock)	(16) $\hat{s}(Y)$ (Stand. dev.)	(17) Moody's ratings
1. Abbot	183.989	189.30	1612.27	38.95	B
2. ACF	84.647	262.33	304.75	13.35	C
3. Akzona	32.107	185.57	198.29	16.68	C
4. Alpha	18.475	27.40	27.48	10.50	C−
5. Am. Broadca.	245.716	193.33	726.18	79.80	C
6. Am. Cyanamid	221.700	460.13	1257.37	33.91	B
7. Am. Hospital	133.830	179.00	1072.06	12.72	B
8. Am. Motor	50.235	92.30	155.20	29.40	D
9. Am. Steril.	13.297	19.60	69.02	1.86	C
10. Amtek	35.090	25.93	152.53	6.09	C
11. AMP	143.988	43.90	1099.20	40.62	B
12. Anheuser	178.446	368.50	1123.09	47.01	B
13. Asarco	36.576	377.03	482.33	24.45	C
14. Ball	36.250	61.17	100.36	8.09	C
15. Bally	40.304	44.47	304.57	12.44	C−
16. Bard (CR)	21.215	2.47	134.95	1.38	C
17. Barnes	32.416	26.53	84.03	5.13	C
18. Belco	96.054	54.57	205.30	32.77	C−
19. Belden	17.118	42.40	45.52	3.02	C
20. Berkey	11.066	34.13	26.36	0.42	D
21. Bliss	23.693	30.60	72.20	3.53	C
22. Boeing	242.392	104.40	1313.88	152.32	C
23. Braniff	64.851	287.73	230.50	13.84	D
24. Brockway	43.575	70.83	147.26	4.24	C
25. Brown-Sharpe	8.211	22.50	23.66	6.22	D
26. Bucyrus	76.374	100.00	444.51	5.74	C+
27. Burndy	24.673	14.50	117.02	4.64	C
28. Burns	6.929	10.27	29.25	1.98	C
29. Burroughs	407.749	195.83	3284.18	67.18	A
30. Cabot	83.187	154.63	227.00	20.59	C
31. Campbell-Sou.	210.665	18.90	1162.58	19.85	A
32. Capital Citi.	95.653	73.13	286.04	22.14	C
33. Carlisle	20.518	22.57	42.81	8.37	C
34. Carpenter	51.575	5.87	170.30	16.58	C
35. Caterpillar	815.768	1021.03	4702.84	238.40	A
36. Chesebrough	127.566	89.50	808.15	16.56	B