$1.85 xerox

Faculty Working Papers

TOTAL CORPORATE RISK VERSUS MARKET-RELATED RISK

James M. Gahlon and James A. Gentry

#439

College of Commerce and Business Administration
University of Illinois at Urbana-Champaign

FACULTY WORKING PAPERS

College of Commerce and Business Administration

University of Illinois at Urbana-Champaign

October 7, 1977

TOTAL CORPORATE RISK VERSUS MARKET-RELATED RISK

James M. Gahlon and James A. Gentry

#439

ABSTRACT

A primary contribution of this article is the development of a model that allows the measurement of the contribution of each financial component of total corporate risk. These three components are sales volatility, operating leverage and financial leverage. A second contribution is the derivation of a model that integrates the corporate risk components with the market-determined risk measure.

Data from 23 SIC industries and 385 of the Fortune 500 companies are used to measure the percent of total corporate risk due to sales volatility, operating leverage and financial leverage. The data shows sales volatility composes between 60 and 80 percent of total corporate risk; operating leverage represents 20-40 percent and the remainder is financial leverage. In measuring the relationship between market-determined risk and the corporate risk measures, financial leverage was significant and sales volatility was very close to being significant at the 5 percent level.

TOTAL CORPORATE RISK VERSUS MARKET-RELATED RISK

JAMES M. GAHLON*
JAMES A. GENTRY**

The type of risk facing a firm can profoundly affect the objectives and decisions that managers make in the fundamental direction in which a company grows. Risk has been defined at various levels--market, firm and project. Portfolio theory has shown there is a linear relationship between the rate of return on a specific asset and the rate of return on a portfolio of all assets [6, 10, 12]. The degree these two rates of return move together is a measure of the corporation's systematic risk, commonly referred to as Beta or market-determined risk. While Beta has become the dominant risk measure when evaluating the total risk of a corporation, it has several restrictive assumptions with one of the most important being that the market accurately reflects the total risk of the firm.

Inside the corporation, management evaluates the risk and return expectations of individual projects and appraises their relationship to the corporation's total risk-return mix. In theory, firm risk is related to the market-determined risk [16, Chapter 7] [18], but there are practical measurement problems interwoven into this relationship [9, 14]. With the best available information investors determine the market value of a company's common stock. Management is interested in the market's appraisal of their company because of its impact on future financing decisions. However, management's interpretation of the total risk facing the corporation is based on an insider's view and this perspective may or may not be in agreement with the market place. Investors can misassess the value of a corporation

*Assistant Professor of Finance, University of Minnesota
**Professor of Finance, University of Illinois, Urbana-Champaign

which results in a misallocation of resources. Because of market imperfections and measurement problems, there is a need to design a model that specifies the financial components of *total corporate risk*. There are fundamental relationships existing between total corporate risk and market-determined risk; therefore relating the components of total corporate risk to market-determined risk would be a valuable contribution to the financial management literature. That is the overall objective of this paper.

Several authors have evaluated the relationship between the market determined risk of a company and its financial variables [1, 2, 3, 4, 5, 7, 8, 11, 15]. In these studies the theoretical relationships have not been well defined, which has resulted in a variety of variables to explain Beta. The use of *ad hoc* relationships has, not surprisingly, produced a mixed assortment of findings. The intent of this study is not to extend this type of research, but rather to model a set of theoretical relationships that underly total corporate risk and market-determined risk. The model will utilize income statement relationships which focus on the valuation of a firm's net cash flow.

The objectives of this paper are to develop theoretically the primary financial components of total corporate risk; to integrate these components with the market-determined risk measure; to measure empirically the relative contribution that each financial component makes to total corporate risk and business risk; and finally, to analyze the relationship between the total corporate risk components and the market-determined risk measure.

TOTAL CORPORATE RISK MODEL

Total corporate risk is defined in this study as the uncertainty of common stock earnings and, therefore, will be examined in this section in terms of the *ex ante* probability distribution of common stock earnings. Obtained by dividing the standard deviation by the expected value, the coefficient of variation of common stock earnings will be used as the measure of total corporate risk. It has been selected rather than the standard deviation because total corporate risk is not variability per se; a relative measure is required to allow for the expected level of common stock earnings, particularly when comparing total corporate risk among firms.

As discussed in the introduction, there is a need to develop a model that identifies the specific variables which affect total corporate risk. Generally, total corporate risk is viewed as a function of both business risk and financial risk. The former is determined by both operating leverage and sales variability and affects the variability of earnings before interest and taxes. The latter is the additional risk that is induced by the firm's decision to use debt to finance a portion of its assets. Holding business risk constant, the greater the use of financial leverage, the greater the relative variability of common stock earnings. Given this discussion of total corporate risk, the model derived below shows how operating leverage, financial leverage, and sales variability interact to determine total corporate risk. Specifically, a firm's coefficient of variation of common stock earnings is proved to be equal to the product of its degree of operating leverage, degree of financial leverage and coefficient of variation of sales.

In the analysis that follows, these assumption apply: (1) The firm produces a single product with price per unit (P), variable costs per unit (V), and fixed operating expenses (F) known with certainty. (2) The number of units produced and sold (Q) is a random variable with an expected value of E(Q) and a standard deviation of σ(Q) in the next period. (3) The firm will pay interest expenses equal to I on its outstanding debt in the next period. (4) The corporate income tax rate equals t.

Based on these assumptions, the firm's expected value of common stock earnings, E(π), in the next period is

$$E(\pi) = (1 - t) [P - V) E(Q) - F - I], \tag{1}$$

with a standard deviation, σ(π), equal to

$$\sigma(\pi) = (1 - t) (P - V) \sigma(Q). \tag{2}$$

The measure of total corporate risk is CV(π), the coefficient of variation of common stock earnings. Therefore, dividing Equation 2 by Equation 1 gives

$$CV(\pi) = \frac{(P - V) \sigma(Q)}{(P - V) E(Q) - F - I} . \tag{3}$$

Multiplying and dividing Equation 3 by E(Q) results in

$$CV(\pi) = [\frac{(P - V) E(Q)}{(P - V) E(Q) - F - I}] [\frac{\sigma(Q)}{E(Q)}] \tag{4}$$

The first bracketed term on the right-hand side of Equation 4 represents the firm's degree of combined leverage at its expected sales level and equals the product of the degree of operating leverage (DOL) and the degree of financial leverage (DFL) [17, p. 582]. The second bracketed

term equals CV(Q), the coefficient of variation of sales. Thus, an alternate expression for total corporate risk is

$$CF(\pi) = DOL \times DFL \times CV(Q) \quad . \tag{5}$$

If the coefficient of variation of common stock earnings is the relevant measure of total corporate risk, the above equation expresses the specific function relating total corporate risk to operating leverage, financial leverage, and sales variability. The functional form is multiplicative with DOL and DFL magnifying the relative variability of sales into a greater relative variability of common stock earnings.

Equation 5 shows the separate effects of the elements of business risk, DOL and CV(Q), on total corporate risk. Adopting the coefficient of variation of earnings before interest and taxes, CV(EBIT), as the appropriate measure of business risk, it is easy to show that under the assumptions stated earlier

$$CV(EBIT) = DOL \times CV(Q) \quad , \tag{6}$$

the product of the degree of operating leverage and the coefficient of variation of sales. Thus, another expression for total corporate risk is

$$CV(\pi) = DFL \times CV(EBIT) \quad , \tag{7}$$

the product of the degree of financial leverage and the coefficient of variation of earnings before interest and taxes.

Equation 5 indicates that a firm's total corporate risk differs from its relative sales variability as a result of its use of operating and financial leverage; if it employs neither operating nor financial leverage (DOL = DFL = 1), its total corporate risk would equal its relative sales variability. Similarly, Equation 7 indicates that a firm's

total corporate risk differs from its business risk. Finally, Equation 6 shows that a firm's business risk will equal its relative sales variability if it has no operating leverage. Thus, Equations 5, 6, and 7 together afford the opportunity for examining on an ex post basis the percentage of total corporate risk that results from operating leverage, financial leverage, and relative sales variability. Likewise Equations 5, 6, and 7 make it possible to solve for the percentage of business risk that is due solely to operating leverage and relative sales variability. The methodology and an example are outlined in Appendix A and the results when applied to both industry data and a sample of firms from the Fortune 500 are discussed in a subsequent section.

MARKET RISK MODEL

In the context of the capital asset pricing model, the relevant measure of a firm's risk is the covariance between the return on the firm's shares and the return on a portfolio of all assets. Many studies have demonstrated that the market-based estimate of systematic risk is empirically associated with certain financial variables, but few have developed explicit theoretical models that depict specifically which variables should affect systematic risk and what the appropriate functional form should be. Thus, in this section a theoretical equilibrium model is derived which suggests that total corporate risk, as discussed in the previous section, is an important differentiating factor among the systematic risk of common stocks.

The assumptions made to derive the model include the following: (1) Conditions of market equilibrium are adequately described by the capital

asset pricing model with all its attendant assumptions. (2) The firm produces a single product with price per unit (P), variable costs per unit (V), and fixed operating expenses (F) known with certainty. (3) The number of units produced and sold (Q) is a random variable with an expected value of E(Q) and a standard deviation of $\sigma(Q)$ in all future periods. (4) The firm is assumed to be able to borrow at the risk-free rate of interest (R_F), and with the amount of debt in its capital structure assumed constant in all future periods, its total interest expense (I) in each period equals $R_F D$. (5) The corporate tax rate equals t. (6) The firm pays out 100 percent of its earnings as dividends with depreciation reinvested to keep total assets constant in all future periods.

Assumptions 2, 3, 4, 5, and 6 mean that the firm's expected dividend payout is a perpetuity equal to the expected value of its common stock earnings:

$$E(\pi) = (1 - t) [P - V) E(Q) - F - I] . \qquad (8)$$

Together, assumptions 4 and 6 imply that the firm is not growing. Thus, there are no capital gains and the present value of the firm's shares, S, in equilibrium equals

$$S = E(\pi)/E(R) , \qquad (9)$$

where E(R) is the equilibrium expected rate of return on the firm's shares. From assumption 1, E(R) may be expressed as

$$E(R) = R_F + \lambda \ \mathrm{cov}(R,R_M), \qquad (10)$$

where R_F is the risk-free rate of interest, λ equals $[E(R_M) - R_F]/\sigma^2(R_M)$, $E(R_M)$ is the expected return on the market portfolio, $\sigma^2(R_M)$ is the variance of return on the market portfolio, and $\mathrm{cov}(R,R_M)$ is the covariance between the return on the firm's shares and the return on the market portfolio.

In the context of the capital asset pricing model, $\mathrm{cov}(R,R_M)$ is the appropriate measure of the risk of the firm. With

$$R = \pi/S \ , \tag{11}$$

evaluating $\mathrm{cov}(R,R_M)$ gives

$$\mathrm{cov}(R,R_M) = \mathrm{cov}(\pi,R_M)/S \ . \tag{12}$$

Substituting Equation 12 into Equation 10 yields

$$E(R) = R_F + \lambda[\mathrm{cov}(\pi,R_M)/S] \ . \tag{13}$$

Replacing E(R) in Equation 9 by Equation 13 and rearranging gives the certainty-equivalent formula for the equilibrium value of the firm's shares:

$$S = [E(\pi) - \lambda\ \mathrm{cov}(\pi,R_M)]/R_F \ . \tag{14}$$

When Equation 14 is substituted for S in both Equations 12 and 13, it can be shown that the covariance between the return on the firm's shares and the return on the market portfolio becomes

$$\mathrm{cov}(R,R_M) = \frac{R_F\ \mathrm{cov}(\pi,R_M)/E(\pi)}{1 - \lambda\ \mathrm{cov}(\pi,R_M)/E(\pi)} \tag{15}$$

and that the firm's expected return becomes

$$E(R) = [\frac{1}{1 - \lambda\ \mathrm{cov}\ (\pi,R_M)/E(\pi)}]\ R_F \ . \tag{16}$$

Because Equations 15 and 16 set forth equilibrium conditions, the risk-free rate of interest, R_F, and the market price of risk, λ, in the equations are economy-wide constants. Therefore, the variable which accounts for differences in systematic risk and expected return among firms is

$$\phi = \mathrm{cov}(\pi,R_M)/E(\pi) \ . \tag{17}$$

In Appendix B it is demonstrated that under the assumptions listed at the beginning of this section ϕ equals

$$\phi = DOL \times DFL \times CV(Q) \times \rho(Q,R_M) \times \sigma(R_M) \quad . \tag{18}$$

With DOL equal to the degree of operating leverage, DFL equal to the degree of financial leverage, and CV(Q) equal to the coefficient of variation of sales, the product of these terms in the above equation equals the coefficient of variation of common stock earnings--total corporate risk. The fourth term equals the correlation coefficient between sales and market return, while the last term equals the standard deviation of market return and is constant across all firms.

At first glance, $\rho(Q,R_M)$ may appear to lack a plausible economic interpretation. However, this measure becomes intuitively appealing when it is remembered that the market portfolio in theory is comprised of many kinds of capital assets [13, p. 143]. Therefore, the return on the market portfolio can be viewed as being comparable to an index of general business conditions, and the correlation coefficient between sales and market return becomes a measure of the responsiveness of sales to general business conditions. Furthermore, since a correlation coefficient always lies between minus one and plus one, $\rho(Q,R_M)$ may be interpreted as the percent of total corporate risk that is important to market risk.

Showing that systematic risk and expected return vary among firms due to differences in both total corporate risk and the responsiveness of sales to general business conditions, Equation 18 has two important implications for financial managers. First, if management seeks to influence the market risk of the firm and therefore its cost of equity capital, they may do so in

a number of ways. For example, they may adjust the firm's operating leverage (DOL) and financial leverage (DFL), or more fundamentally they may alter the line of business in order to affect CF(Q) and $\rho(Q,R_M)$. Second, when used to assess the impact of their decisions on market risk, the equation clearly shows that it is not enough that financial managers examine how such decisions affect only total corporate risk. They must also be aware of how their decisions will affect the sensitivity of the firm to general business conditions. While total corporate risk may change, there may be an offsetting change in $\rho(Q,R_M)$.

Given that Equations 15 and 16 show ϕ to be nonlinearly related to systematic risk and expected return respectively, neither lends itself to empirical testing. However, when Equation 15 is divided by Equation 16, systematic risk relative to expected return equals

$$\begin{aligned} \mathrm{cov}(R,R_M)/E(R) &= \mathrm{cov}(\pi,R_M)/E(\pi) \\ &= \mathrm{DOL} \times \mathrm{DFL} \times \mathrm{CV}(Q) \times \rho(Q,R_M) \times \sigma(R_M) \end{aligned} \tag{19}$$

The above equation is linear in the natural logarithms of the variables. Thus, an appropriate empirical test of the model would be to use ex post data and the multiple regression technique to estimate the coefficients of the following equation:

$$Y = B_0 + B_1X_1 + B_2X_2 \times B_3X_3 + B_4X_4, \tag{20}$$

where $Y = \log[\mathrm{cov}(R,R_M)/E(R)]$, $X_1 = \log[\mathrm{DOL}]$, $X_2 = \log[\mathrm{DFL}]$, $X_3 = \log[\mathrm{CV}(Q)]$, $X_4 = \log[\rho(Q,R_M)]$ and the theoretical values of the coefficients are $B_0 = \log[\sigma(R_M)]$ and $B_1 = B_2 = B_3 = B_4 = 1$. The results of a test of this nature using a sample of firms from the Fortune 500 are reported in a subsequent section.

TESTING THE TOTAL CORPORATE RISK MODEL

The objective of this segment of the paper is to measure empirically the relative contribution of sales volatility, operating leverage, and financial leverage to the total corporate risk. The methodology for the test is presented in Appendix A.

We have used two separate data samples to measure the contribution of each component to total corporate risk. The first sample is composed of the twenty-three SIC industries reported in the Federal Trade Commission's Quarterly Financial Report for Manufacuturing, Mining and Trade Corporations. The data are quarterly and over the period 1961-1973. This segment of the study is broken down into three time periods--1961-1965, 1966-1970, and 1971-1973. The second sample is composed of 385 companies from the Fortune 500. These 385 companies were all listed on the COMPUSTAT Annual Industrial Tape and had the necessary annual data for the period 1966-1975.

The percentages of total corporate risk due to sales volatility, operating leverage and financial leverage for each of the 23 SIC industries in each of the three time periods are presented in Appendices C, D, and E. The means and standard deviations are found in Table 1 and the Appendices. Several observations emerge from a careful study of Table 1 and the Appendices.

Sales volatility is always the greatest contributor to total corporate risk. The mean (standard deviation) for the percent of total corporate risk explained by sales volatility is 65% (11%) in the first period, 82% (56%) in the second and 59% (18%) in the third. Operating leverage is always second most important with the means (standard

TABLE 1

MEANS AND STANDARD DEVIATIONS OF
THE PERCENT OF TOTAL CORPORATE RISK DUE TO EACH
COMPONENT WHEN THE SAMPLE EQUALS 23 SIC INDUSTRIES

Period		Percent Due to Sales Volatility	Percent Due to Operating Leverage	Percent Due to Financial Leverage
1961-1965	$\bar{X}$	65.49%	20.75%	13.76%
	σ	10.56%	101.63%	13.04%
1966-1970	$\bar{X}$	81.85%	46.23%	28.08%
	σ	55.61%	144.33%	12.54%
1971-1973	$\bar{X}$	58.63%	34.64%	6.73%
	σ	18.39%	20.81%	15.23%

deviations) for the three periods being 21% (102%), 46% (144%) and 35% (21%). The percent of total corporate risk due to sales volatility was highest in 12 of the 23 industries for the 1961-1965 period. During the 1966-1970 period it was highest in 16 of the 23 industries, and it was highest in 19 of the 23 in the last period, 1971-1973. These data indicate that sales volatility has been increasing in importance during the three time periods.

Operating leverage tends to be the second highest contributor to total corporate risk among the 23 SIC industries for the three separate time periods. Table 1 shows that the relative contribution of operating leverage to total corporate risk has increased modestly from 21 percent in 1961-1965 to approximately 35 percent in the 1971-1973 period. Operating leverage was the greatest contributor in 11 of the 23 industries in 1961-65, but decreased to only 7 of 23 in the 1966-70 period and 4 of 23 in the 1971-73 period.

Financial leverage always contributed the least to total corporate risk. It has been erratic and of decreasing importance across the periods studied. The means (standard deviations) of the percent of total corporate risk due to financial leverage for the three periods are 14% (13%), -28% (13%) and 7% (15%). Appendix D shows that the negative value for financial leverage in 1966-70 is attributed to the large negative value in the lumber and wood products industry.

The stability of the contribution of each component across the three time periods was rather mixed. A rank correlation test was made to determine the stability of the ranking of a specific industry among the three periods. The results are presented in Table 2. The percent of total corporate risk

TABLE 2

RANK CORRELATION COEFFICIENTS FOR THE THREE COMPONENTS OF TOTAL CORPORATE RISK FOR COMBINATIONS OF THREE PERIODS

	Spearman's Correlation Coefficient (r_s) between periods...		
	1961-65 vs 1966-70	1961-65 vs 1971-73	1966-70 vs 1971-73
Percent of Total Corporate Risk due to...			
Sales volatility	.5267***	.3923*	.4753**
Operating leverage	.4546**	.3162	-.0030
Financial leverage	.1779	.6265***	.2609

* significant at the .10 level
** significant at the .05 level
*** significant at the .01 level

due to sales volatility is the most consistent of the three variables in each of the three periods tested. This variable is significant at the .05 level or better for two of the combinations and significant at the 10 percent level for the third. The rank correlation coefficient for the percent of total risk resulting from operating leverage is only significant at the 5 percent level for the 1961-65 period compared to the 1966-70 period. The rank correlation for financial leverage is significant between the first and third period at the 1 percent level. The conclusion to be drawn from these statistics is that there is substantial shifting in the relative importance of the components of total corporate risk between the different time periods. A good example of the shifting is evidenced in the motor vehicle and equipment industry as shown in Appendices C, D, and E. In 1961-65 operating leverage accounted for 47 percent of total corporate risk. It increased to 80 percent in 1966-70 and decreased to 68 percent in 1971-73. Sales volatility for the same periods accounted for 30 percent, 58 percent and 38 percent of total corporate risk. Another good example is industry number 8, printing and publishing. The proportion of total corporate risk due to operating leverage for the three periods was respectively, 56%, 11% and 46% and that due to sales volatility was 28%, 97% and 40%. These two examples illustrate the significant shifting occurring between the relative importance of operating leverage and sales volatility across these three time periods.

Table 3 shows the means and standard deviations of the percent of total corporate risk due to the three components for the 385 industrial companies from the Fortune 500. This table shows that sales volatility makes the largest contribution to total corporate risk with a mean of

of 87 percent, and a standard deviation of 43 percent. Operating leverage and financial leverage make almost identical contributions. Their respective means (standard deviations) are 7% (31%) and 7% (24%). These data reinforce the importance of sales volatility as the major contributor to total corporate risk. Operating leverage is of less importance for the 23 SIC industries, but it is also quite volatile. Financial leverage generally assumes the same level of importance as for the 23 SIC industries.

TESTING THE BUSINESS RISK MODEL

Theoretically financial risk is dependent on business risk. We found for the 23 SIC industries that the contribution of business risk to total corporate risk is substantially greater than than of financial risk. Therefore it is important to determine the contribution of operating leverage and sales volatility to business risk.

The theory underlying the components of total corporate risk is also directly applicable to the determination of business risk. In equation form business risk is defined as

$$CV(EBIT) = DOL \times CV(Q) \quad , \qquad (21)$$

where CV(EBIT) is the coefficient of variation of earnings before interest and taxes, DOL is the degree of operating leverage and CV(Q) is the coefficient of variation of sales, a measure of sales variability. Data from the same 23 SIC industries and for the same three time periods were used to measure the contribution of sales variability and operating leverage to business risk. In addition, the data for the 385 companies from the Fortune 500 were used to test the model. Appendices F, G, and H present the contribution of the two variables to business risk for the

23 industries. These data indicate that sales volatility accounts for a greater proportion of business risk than operating leverage for all industries in all three periods. The means for the percent of business risk due to sales volatility for the three separate time periods are 70%, 79%, and 64%. The respective standard deviations are 92%, 52%, and 22%.

Rank correlation was used to test the stability of the contribution of sales volatility and operating leverage between the three different time periods. The correlation coefficient was .432 for operating leverage between the first and second period, .359 between the first and third period and .089 between the second period and the third period. The correlation coefficients for sales volatility were the same quantity, but with a negative sign. The only significant correlation coefficient at the 5 percent level was between the first and second period. This indicates during the third period there was shifting in the contribution of sales volatility and operating leverage to business risk.

In using the 385 companies from the Fortune 500, it was found the sales volatility accounted for 91 percent of business risk while operating leverage accounted for 9 percent. The standard deviation in both cases was 35 percent. Thus, the individual company annual data covering a ten year period show the same relationship that existed among the 23 SIC industries. However, this relationship is even more pronounced for the individual company data.

TABLE 3

MEANS AND STANDARD DEVIATIONS OF THE PERCENT OF TOTAL CORPORATE RISK DUE TO EACH COMPONENT WHEN SAMPLE EQUALS 385 COMPANIES FROM FORTUNE 500 1966-1975

	Percent Due to Sales Volatility	Percent Due to Operating Leverage	Percent Due to Financial Leverage
Mean	.8671	.0674	.0655
Standard Deviation	.4220	.3145	.2357

TEST OF MARKET RISK MODEL

The test of the market risk model is to estimate the coefficients of Equation 20 using a sample of 243 firms from the Fortune 500. The 243 companies selected contained complete annual data on all of the necessary variables on the COMPUSTAT file for the period 1966-1975 and monthly rates of return from the CRSP tapes. The Fisher index on the CRSP files was used as the market index (R_M). For each firm, the necessary variables (prior to taking the natural logarithms) were computed as follows: (1) $cov(R,R_M)/E(R)$: Using the CRSP Tapes, cov (R,R_M) was computed for the period 1966-1975. Because many of the firms exhibited a negative average return over the period, the average holding period return was used in the demonimator. (2) DOL was estimated from Equation 6 by dividing the firm's actual coefficient of variation of EBIT by its actual coefficient of variation of sales for the 1966-1975 period. (3) DFL was estimated from Equation 7 by dividing the firm's actual coefficient of variation of common stock earnings by its actual coefficient of variation of EBIT over the 1966-1975 period. (4) CV(Q) was estimated as the actual coefficient of variation of sales over the 1966-1975 period. (5) $\rho(Q,R_M)$ was proxied by the actual correlation coefficient over 1966-1975 between the firm's annual sales and the unadjusted annual sales of manufacturing and trade firms obtained from the Survey of Current Business.

The results of the test are recorded in Table 4. An examination of the table reveals several interesting points. The intercept has the correct negative sign and the coefficients associated with log[DOL] and log[DFL] have the correct positive sign. The coefficients associated with log[CV(Q)] and log $[\rho(Q,R_M)]$ have incorrect, negative signs. The only coefficients

TABLE 4

SUMMARY STATISTICS FOR MULTIPLE REGRESSION EQUATION:

$$\mathrm{Log}[\mathrm{cov}(R,R_M)/E(R)] = B_0 + B_1\ \mathrm{Log}[DOL] + B_2\ \mathrm{Log}[DFL] + B_3\ \mathrm{Log}[CV(Q)] + B_4\ \mathrm{Log}[\rho(Q,R_M)]$$

Coefficient	Estimated Value	Standard Error	T-Ratio	Probability in Tail
B_0	-5.930	0.063	-94.486	0.000
B_1	0.018	0.048	0.378	0.053
B_2	0.483	0.065	7.462	0.000
B_3	-0.091	0.059	-1.534	0.063
B_4	-0.254	0.159	-1.601	0.055

Standard Error of Estimate = 0.299

$F(4,238) = 24.940$

F Probability = 0.000

$R^2 = 0.295$

that are statistically significant at the 5 percent level or better are the intercept and that associated with log[DFL]. The coefficient associated with log[DOL] is not statistically different from zero, while the coefficients for log[CF(Q)] and $\log[\rho(Q,R_M)]$ are almost statistically significant at the 5 percent level.

The following observations are offered as interpretations of the regression findings. The data in Table 4 show financial leverage is significantly related to the market-determined risk-return measure. One interpretation of this finding is that investors are able to evaluate accurately the impact of financial leverage on the risk-return tradeoff of a company's common stock. Perhaps this is a result of the emphasis financial literature has placed on financial structure and its impact on the total value of the firm. Also the components of financial structure are externally visible and easily analyzed by investors. Finally, during this period the financial leverage component was relatively stable compared to the other variables in the regression.

Turning to the insignificant relationship between the risk-return measure and DOL, the company data, plus the SIC industry data, indicate the instability of operating leverage during the period studied. Operating leverage is a mixture of internal investment, financing and operational decisions by management and is often more affected by short-run decisions than financial leverage. More than likely the nuances of changes in operating leverage are not as visible to external investors as changes in financial leverage. Finally the market model is cast in a static time dimension while the components of operating leverage are dynamic and constantly changing. Thus these data may be showing the

insensitivity of the market-determined risk-return measure to short-run operating changes. In summary, the complexity of the short-run dynamic interactions between investment, financing and operating decisions are better evaluated by internal management than external investors.

In the regression test sales volatility and the relationship between company and market sales were negatively related to the market-determined risk-return variable. Although this theoretical relationship was hypothesized to be positive, a negative sign may be appropriate for the period 1966-1975. The following background is offered as the rationale for the observed negative relationship. Throughout this period the rate of inflation increased substantially. Directly related to the inflationary trend there was a market decline in corporate liquidity and profitability, and a substantial increase in financial leverage. With this background it is reasonable to assume the market evaluated companies with relatively stable sales, a low CV(Q) measure, as being more risky than companies with rising but more volatile sales over time, a higher CV(Q). The company with rising sales will have a higher coefficient of variation of sales than the company with relationship stable sales. The interpretation is that growth in sales offsets part or all of the rising costs due to inflation, while companies with relatively stable sales are more risky because it is more difficult for them to offset rising costs. Thus a negative relationship between CV(Q) and the risk-return measure seems quite acceptable for this time period.

An explanation for the negative relationship between $r(Q_i,Q_m)$ and the risk-return measure is not as logically clear as the explanation concerning CV(Q) and the dependent variable. Using the preceding logic concerning

inflation, it is reasonable to expect a company with sales increasing more rapidly than the average and having a lower coefficient of correlation to be less risky than a company with a sales performance closely related to the average. However, companies with sales growth below average or negatively related to the average compose the riskiest set. This set of companies should be positively associated with the risk-return measure which is contrary to the actual findings. Thus the explanation of the negative relationship between $r(Q_i,Q_m)$ and the market risk-return measure is not complete and is a result of other unexplained factors.

CONCLUSIONS

A primary contribution of this article is the development of a model that allows the measurement of the contribution of each financial component of total corporate risk. These three components are sales volatility, operating leverage and financial leverage. A second contribution is the derivation of a model that integrates the corporate risk components with the market-determined risk measure.

Measuring the relative contribution of each component of total financial risk shows sales volatility composes between 60 and 80 percent, operating leverage between 20-40 percent and the remainder by financial leverage. The relative contribution of each component varies significantly between time periods and among industries and companies. Operating leverage had substantially greater instability than the other two components. This occurs because operating leverage is a mixture of short and long-run investment, financing and operating decisions and is direclty affected by business risk.

Financial leverage was found to be closely related to a market-determined risk-return measure during the period 1966-1975 for a set of larger industrial companies. This may be because financial leverage is relatively stable over time and is also highly visible and easily measured by external investors. Sales votatility was second in importance, but not statistically significant at the 5 percent level. Operating leverage was not significantly related to the market-determined risk-return measure nor was a market-related sales variable. The short-run and dynamic nature of operating leverage cause it to vary widely among industries and to be quite unstable over time.

In summary, the models and the empirical findings indicate the need for building financial theory that incorporates the operational dynamics of financial management. General financial theory will be advanced substantially as the network of operational decisions are more rigorously developed. In our judgment this is a new frontier for theoretical research.

REFERENCES

[1] William Beaver, Paul Kettler and Myron Scholes, "The Association Between Market Determined and Accounting Determined Risk Measures," The Accounting Review, Vol. 45, No. 4 (October, 1970), pp. 654-82.

[2] Uri Ben-Zion and Sol. S. Shalit, "Size, Leverage, and Dividend Record as Determinants of Equity Risk," Journal of Finance, Vol. 30, No. 4 (September, 1975), pp. 1015-1026.

[3] John S. Bildersee, "The Association Between Market-Determined Measures of Risk and Alternative Measures of Risk," The Accounting Review, Vol. 50, No. 1 (January, 1975), pp. 81-98.

[4] William J. Breen and Eugene M. Lerner, "Corporate Financial Strategies and Market Measures of Risk and Return," Journal of Finance, Vol. 28, No. 2 (May, 1973), pp. 339-351.

[5] Baruch Lev, "On the Association Between Operating Leverage and Risk," Journal of Financial and Quantitative Analysis, Vol. 9, No. 4 (September, 1974), pp. 627-642.

[6] John Lintner, "The Valuation of Risky Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets," Review of Economics and Statistics, (February, 1965), pp. 13-37.

[7] Dennis E. Logue and Larry J. Merville, "Financial Policy and Market Expectations," Financial Management, Vol. 1, No. 2 (Summer, 1972), pp. 37-44.

[8] Ronald W. Melicher and David F. Rush, "Systematic Risk, Financial Data, and Bond Rating Relationships in a Regulated Industry Environment," Journal of Finance, Vol. 29, No. 2 (May, 1974), pp. 537-544.

[9] Stewart C. Myers and Stuart M. Turnbull, "Capital Budgeting and the Capital Asset Pricing Model: Good News and Bad News," Journal of Finance, Vol. 32, No. 2 (May, 1977), pp. 321-332.

[10] Jan Mossin, "Equilibrium in a Capital Asset Market," Econometrica, (October, 1966), pp. 7[illegible]-782.

[11] Frank K. Reilly and Roger Bent, "A Specification, Measurement and Analysis of Operating Leverage," Faculty Working Paper No. 257, University of Illinois at Urbana-Champaign (June, 1975).

[12] William F. Sharpe, "A Simplified Model for Portfolio Analysis," Management Science (January, 1963), pp. 277-293.

[13] William F. Sharpe, Portfolio Theory and Capital Markets (New York, McGraw-Hill Book Company, 1970).

[14] R. C. Stapleton and M. G. Subrahmanyaw, "Market Imperfections, Capital Market Equilibrium, and Corporation Finance," Journal of Finance, Vol. 32, No. 2 (May, 1977), pp. 307-320.

[15] Donald J. Thompson III, "Sources of Systematic Risk in Common Stocks," Journal of Business, Vol. 49, No. 2 (April, 1976), pp. 173-188.

[16] James C. Van Horne, Financial Management and Policy, 4th Edition, (Englewood Cliffs, Prentice-Hall, Inc., 1977).

[17] J. Fred Weston and Eugene F. Brigham, Managerial Finance (Hinsdale, Illinois, Dryden Press, 1975).

[18] J. Fred Weston, "Investment Decisions Using the Capital Asset Pricing Model," Financial Management, Vol. 2 (Summer, 1971), pp. 25-33.

APPENDIX A

I. Definitions of symbols

a. Q = sales ($)

b. EBIT = earnings before interest and taxes

c. π = common stock earnings

d. CV = coefficient of variation

e. DOL = degree of operating leverage

f. DFL = degree of financial leverage

II. Basic equations

a. Business risk: CV(EBIT) = DOL x CV(Q)

b. Total corporate risk: $CV(\pi)$ = DFL x CV(EBIT)
= DOL x DFL x CV(Q)

III. Methodology

a. Measure a firm's actual CV(Q), CV(EBIT), and $CV(\pi)$ for a given time period.

b. Compute the following statistics:

1. Percent of total corporate risk due to sales variability: $X_1 = CV(Q)/CV(\pi)$

2. Percent of total corporate risk due to financial leverage: $X_2 = [CV(\pi - CV(EBIT)]/CV(\pi)$

3. Percent of total corporate risk due to operating leverage: $X_3 = [CV(EBIT) - CV(Q)]/CV(\pi)$

4. Percent of business risk due to sales variability: $X_4 = CV(Q)/CV(EBIT)$

5. Percent of business risk due to operating leverage: $X_5 = [CV(EBIT) - CV(Q)]/CV(EBIT)$

IV. Example

DOL = 2, DFL = 4, CV(Q) = .5

CV(EBIT) = 2 x .5 = 1

$CV(\pi) = 2 \times 4 \times .5 = 4$

$X_1 = .5/4 = .25$

$X_2 = (4 - 1)/4 = .75$

$X_3 = (1 - .5)/4 = .125$

$X_4 = .5/1 = .5$

$X_5 = (1 - .5)/1 = .5$

APPENDIX B

$$\begin{aligned}
cov(\pi, R_M) &= E[(\pi - E(\pi))(R_M - E(R_M))] \\
&= E[((1 - t)((P - V)Q - F - I) - (1 - t)((P - V)E(Q) - F - I)) \\
&\quad (R_M - E(R_M))] \\
&= (1 - t)(P - V)E[(Q - E(Q))(R_M - E(R_M))] \\
&= (1 - t)(P - V)cov(Q, R_M)
\end{aligned}$$

$$\begin{aligned}
cov(\pi, R_M)/E(\pi) &= [(1 - t)(P - V)cov(Q, R_M)]/[(1 - t)((P - V)E(Q) - F - I)] \\
&= [(P - V)cov(Q, R_M)]/[(P - V)E(Q) - F - I] \\
&= [((P - V)E(Q))/((P - V)E(Q) - F - I)]\ [cov(Q, R_M)/E(Q)] \\
&= DOL \times DFL \times [cov(Q, R_M)/E(Q)] \\
&= DOL \times DFL \times [(\pi(Q, R_M)\sigma(Q)\sigma(R_M))/E(Q)] \\
&= DOL \times DFL \times CV(Q) \times \rho(Q, R_M) \times \sigma(R_M)
\end{aligned}$$

APPENDIX C

PERCENT OF TOTAL CORPORATE RISK DUE TO FINANCIAL AND OPERATING LEVERAGE AND SALES VOLATILITY FOR 23 SIC INDUSTRIES, 1961-65

	Industry	Financial Leverage	Operating Leverage	Sales Volatility
1.	Food and Kindred Products	.2737	.3176	.4087
2.	Tobacco Manufacturers	.2336	.1480	.6185
3.	Textile Mill Products	.1736	.5216	.3048
4.	Apparel and Other Finished Products	.2726	.4505	.2769
5.	Lumber and Wood Products Except Furniture	.0666	.6144	.3190
6.	Furniture and Fixtures	.2137	.5067	.2796
7.	Paper and Allied Products	.3755	.1252	.4994
8.	Printing and Publishing	.1626	.5611	.2763
9.	Chemical and Allied Products	.0387	.2034	.7579
10.	Petroleum Refining and Related Industries	-.1414	.4935	.6479
11.	Rubber and Miscellaneous Plastic Products	.2251	.1520	.6229
12.	Leather and Leather Products	.2460	.5422	.2112
13.	Stone, Glass, and Clay Products	.2040	.4302	.3658
14.	Primary Nonferrous Metals	.0463	.4684	.4854
15.	Primary Iron and Steel Products	.0744	.4905	.4351
16.	Other Fabricated Metal	.2123	.4176	.3701
17.	Machinery, Except Electrical	.0826	.4150	.5024
18.	Electrical Machinery, Equipment, and Supplies	.1424	.4034	.4542
19.	Transportation Equipment, Except Motor Vehicles and Equipment	.1811	.5541	.2648
20.	Motor Vehicles and Equipment	-.0536	.4721	.5815
21.	Instruments and Related Products	.0997	.4360	.4644
22.	Miscellaneous Manufacturing and Ordinance	.1868	.4602	.3530
23.	Petroleum Refining	-.1517	-4.4118	-5.5635
	Mean	.1376	.2075	.6549
	Standard Deviation	.1304	1.0163	.1056

APPENDIX D

PERCENT OF TOTAL CORPORATE RISK
DUE TO FINANCIAL AND OPERATING LEVERAGE AND SALES VOLATILITY
FOR 23 SIC INDUSTRIES, 1966-1970

	Industry	Financial Leverage	Operating Leverage	Sales Volatility
1.	Food and Kindred Products	-.1739	.2722	.9017
2.	Tobacco Manufacturers	-.1023	.1506	.9517
3.	Textile Mill Products	.2156	.4317	.3527
4.	Apparel and Other Finished Products	-.3757	1.1771	.1986
5.	Lumber and Wood Products Except Furniture	-5.9468	6.6286	.3481
6.	Furniture and Fixtures	.0791	.5345	.3864
7.	Paper and Allied Products	.0042	.2914	.7044
8.	Printing and Publishing	-.0794	.1101	.9692
9.	Chemical and Allied Products	-.5375	-.2962	1.8336
10.	Petroleum Refining and Related Industries	.0644	-.7511	1.6867
11.	Rubber and Miscellaneous Plastic Products	.0616	.4043	.5342
12.	Leather and Leather Products	.1386	.4198	.4415
13.	Stone, Glass, and Clay Products	.1327	.4798	.3875
14.	Primary Nonferrous Metals	-.0498	.2701	.7797
15.	Primary Iron and Steel Products	.1096	.8453	.2643
16.	Other Fabricated Metal	.1401	.1559	.7040
17.	Machinery, Except Electrical	.0000	.1787	.8213
18.	Electrical Machinery, Equipment, and Supplies	-.0707	-1.1279	2.1986
19.	Transportation Equipment, Except Motor Vehicles and Equipment	.0623	.4368	.5009
20.	Motor Vehicles and Equipment	-.0953	.7951	.3002
21.	Instruments and Related Products	-.0589	-.1298	1.1887
22.	Miscellaneous Manufacturing and Ordinance	.2239	.1096	.6665
23.	Petroleum Refining	.0479	-.7535	1.7056
	Mean	-.2808	.4623	.8185
	Standard Deviation	.1254	1.4433	.5561

APPENDIX E

PERCENT OF TOTAL CORPORATE RISK DUE TO FINANCIAL AND OPERATING LEVERAGE AND SALES VOLATILITY FOR 23 SIC INDUSTRIES, 1971-73

	Industry	Financial Leverage	Operating Leverage	Sales Volatility
1.	Food and Kindred Products	.0703	.1242	.8056
2.	Tobacco Manufacturers	.2115	-.3381	1.1266
3.	Textile Mill Products	.1529	.3641	.4830
4.	Apparel and Other Finished Products	.2350	.2953	.4697
5.	Lumber and Wood Products Except Furniture	-.0120	.3995	.6124
6.	Furniture and Fixtures	.1018	.2331	.6651
7.	Paper and Allied Products	.0099	.3169	.6732
8.	Printing and Publishing	.1297	.4679	.4024
9.	Chemical and Allied Products	.0596	.1961	.7444
10.	Petroleum Refining and Related Industries	-.3252	.5440	.7811
11.	Rubber and Miscellaneous Plastic Products	.1362	.2142	.6496
12.	Leather and Leather Products	.3338	.2122	.4540
13.	Stone, Glass, and Clay Products	.1441	.4266	.4293
14.	Primary Nonferrous Metals	.0604	.5771	.3625
15.	Primary Iron and Steel Products	.0212	.6187	.3601
16.	Other Fabricated Metal	.1589	.3116	.5295
17.	Machinery, Except Electrical	.1080	.2998	.5922
18.	Electrical Machinery, Equipment, and Supplies	.0792	.3962	.5246
19.	Transportation Equipment, Except Motor Vehicles and Equipment	.0092	.3125	.6784
20.	Motor Vehicles and Equipment	-.0677	.6860	.3818
21.	Instruments and Related Products	.1369	.3320	.5311
22.	Miscellaneous Manufacturing and Ordinance	.1275	.4296	.4430
23.	Petroleum Refining	-.3338	.5477	.7862
	Mean	.0673	.3464	.5863
	Standard Deviation	.1523	.2081	.1839

APPENDIX F

PERCENT OF BUSINESS RISK DUE TO OPERATING LEVERAGE AND SALES VOLATILITY FOR 23 SIC INDUSTRIES, 1961-1965

	Industry	Operating Leverage	Sales Volatility
1.	Food and Kindred Products	.4373	.5627
2.	Tobacco Manufacturers	.1931	.8069
3.	Textile Mill Products	.6311	.3689
4.	Apparel and Other Finished Products	.6193	.3807
5.	Lumber and Wood Products Except Furniture	.6582	.3418
6.	Furniture and Fixtures	.6444	.3556
7.	Paper and Allied Products	.2004	.7996
8.	Printing and Publishing	.6701	.3299
9.	Chemical and Allied Products	.2116	.7884
10.	Petroleum Refining and Related Industries	.4324	.5676
11.	Rubber and Miscellaneous Plastic Products	.1962	.8038
12.	Leather and Leather Products	.7197	.2804
13.	Stone, Glass, and Clay Products	.5405	.4595
14.	Primary Nonferrous Metals	.4911	.5089
15.	Primary Iron and Steel Products	.5299	.4701
16.	Other Fabricated Metal	.5302	.4698
17.	Machinery, Except Electrical	.4524	.5476
18.	Electrical Machinery, Equipment, and Supplies	.4704	.5296
19.	Transportation Equipment, Except Motor Vehicles and Equipment	.6766	.3234
20.	Motor Vehicles and Equipment	.4481	.5519
21.	Instruments and Related Products	.4842	.5158
22.	Miscellaneous Manufacturing and Ordinance	.5659	.4341
23.	Petroleum Refining	-3.8308	4.8308
	Mean	.3031	.6969
	Standard Deviation	.9153	.9153

APPENDIX G

PERCENT OF BUSINESS RISK DUE TO OPERATING LEVERAGE AND SALES VOLATILITY FOR 23 SIC INDUSTRIES, 1966-1970

	Industry	Operating Leverage	Sales Volatility
1.	Food and Kindred Products	.2319	.7682
2.	Tobacco Manufacturers	.1366	.8634
3.	Textile Mill Products	.5503	.4497
4.	Apparel and Other Finished Products	.8557	.1444
5.	Lumber and Wood Products Except Furniture	.9501	.0499
6.	Furniture and Fixtures	.5804	.4196
7.	Paper and Allied Products	.2927	.7073
8.	Printing and Publishing	.1020	.8980
9.	Chemical and Allied Products	-.1926	1.1926
10.	Petroleum Refining and Related Industries	-.8028	1.8028
11.	Rubber and Miscellaneous Plastic Products	.4308	.5692
12.	Leather and Leather Products	.4874	.5126
13.	Stone, Glass, and Clay Products	.5532	.4468
14.	Primary Nonferrous Metals	.2573	.7427
15.	Primary Iron and Steel Products	.7618	.2382
16.	Other Fabricated Metal	.1813	.8187
17.	Machinery, Except Electrical	.1787	.8213
18.	Electrical Machinery, Equipment, and Supplies	-1.0534	2.0534
19.	Transportation Equipment, Except Motor Vehicles and Equipment	.4658	.5342
20.	Motor Vehicles and Equipment	.7259	.2741
21.	Instruments and Related Products	-.1226	1.1226
22.	Miscellaneous Manufacturing and Ordinance	.1413	.8587
23.	Petroleum Refining	-.7914	1.7914
	Mean	.2139	.7861
	Standard Deviation	.5234	.5234

APPENDIX H

PERCENT OF BUSINESS RISK DUE TO OPERATING LEVERAGE AND SALES VOLATILITY FOR 23 SIC INDUSTRIES, 1971-1973

	Industry	Operating Leverage	Sales Volatility
1.	Food and Kindred Products	.1335	.8665
2.	Tobacco Manufacturers	-.4288	1.4288
3.	Textile Mill Products	.2156	.7844
4.	Apparel and Other Finished Products	.3860	.6140
5.	Lumber and Wood Products Except Furniture	.3948	.6052
6.	Furniture and Fixtures	.2595	.7405
7.	Paper and Allied Products	.3201	.6799
8.	Printing and Publishing	-.5376	.4624
9.	Chemical and Allied Products	.2085	.7915
10.	Petroleum Refining and Related Industries	.4105	.5895
11.	Rubber and Miscellaneous Plastic Products	.2479	.7521
12.	Leather and Leather Products	.3185	.6815
13.	Stone, Glass, and Clay Products	.4984	.5016
14.	Primary Nonferrous Metals	.6142	.3858
15.	Primary Iron and Steel Products	.6321	.3679
16.	Other Fabricated Metal	.3705	.6295
17.	Machinery, Except Electrical	.3361	.6639
18.	Electrical Machinery, Equipment, and Supplies	.4303	.5697
19.	Transportation Equipment, Except Motor Vehicles and Equipment	.3154	.6846
20.	Motor Vehicles and Equipment	.6425	.3575
21.	Instruments and Related Products	.3846	.6154
22.	Miscellaneous Manufacturing and Ordinance	.4923	.5077
23.	Petroleum Refining	.4106	.5894
	Mean	.3628	.6372
	Standard Deviation	.2162	.2162