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The Impact of the Degrees of Operating and Financial Leverage on Systematic Risk of Common Stock

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I. Introduction

The capital asset pricing model postulates that the equilibrium return on any risky security is equal to the sum of the risk-free rate of return and a risk premium measured by the product of the market price of risk and the security's systematic risk. In the capital asset pricing model, beta as an index of systematic risk is the only security-specific parameter that affects the equilibrium return on a risky security.

The identification of the real determinants of the systematic risk of common stock has received a great deal of attention in the finance and accounting literature in recent years. A number of empirical studies have investigated the association between market-determined and accounting-determined risk measures (see [1], [2], [3], [12], [19], and [23]). These studies have increased our knowledge about correlations between betas of common stock and various accounting variables or accounting betas. The studies cited also have provided further insight into what forms of specification appear to best reduce the measurement errors in estimating accounting betas. In a review of their findings, Foster [10] concludes that the choice of accounting variables has not been guided by a theoretical model linking the firm's financing, investment, and production decisions with its common stock beta.

There have been limited efforts to utilize an empirical test design that is more consistent with the definition of beta in the framework of the capital asset pricing model. Under the presumption that the firm's asset structure and capital structure impact upon operating risk and financial risk, respectively, the separate effect of either financial leverage or operating leverage on beta of common stock has been examined. Hamada [13] reports that approximately one quarter of sys-

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tematic risk is explained by financial leverage while Lev [16] provides empirical evidence that operating leverage, as measured by variable cost, is one of the real determinants of systematic risk. Two recent studies by Hill and Stone [14] and Chance [6] represent more refined applications of the risk decomposition of Hamada [13] and Rubinstein [20]. Hill and Stone develop an accounting analogue to Hamada and Rubinstein's formula to investigate the joint impact of operating risk and financial structure on systematic risk. Chance conducts a direct test of the Hamada and Rubinstein formula by controlling operating risk to preserve the assumption of homogeneous risk class. Their findings provide considerable empirical support for Hamada and Rubinstein's formula.

Recent research efforts further explore the risk decomposition of Hamada and Rubinstein by introducing the degrees of operating and financial leverage into a model that explains betas of common stock. Although the degrees of the two types of leverage are extensively discussed in standard finance textbooks in relation to their impact on the volatility of stockholders' returns or of earnings per share, their relationship with the systematic risk of common stock has not been fully resolved. A recent work by Brenner and Schmidt [5] further extends Rubinstein's analysis of the relationship between the characteristics of the firm's real assets and its common stock beta. They demonstrate how unit sales, fixed costs, contribution margin, and the covariance of sales with returns on the market portfolio affect systematic risk. Gahlon and Gentry [11] show that the beta of a common stock is a function of the degrees of operating and financial leverages, the coefficient of variation of the total revenue, and the coefficient of correlation between earnings after interest and taxes and returns on the market portfolio. Unfortunately, it is difficult to investigate the impact of two types of leverage on operating risk and financial risk in the framework of Gahlon and Gentry. This is so because the degrees of two types of leverage are introduced by an expansion of the coefficient of variation of earnings after interest and taxes. Nonetheless, theoretical analyses of Brenner and Schmidt and Gahlon and Gentry show much promise of enhancing our knowledge of the real determinants of beta.

As the degrees of two types of leverage are recognized in a model that identifies the real determinants of beta, this study explores two important empirical issues. First, we examine the joint impact of the degrees of operating and financial leverage on the systematic risk of common stock. Although Hamada and Rubinstein demonstrate that operating risk and financial risk constitute systematic risk, it is not obvious how operating leverage and financial leverage are related to operating risk and financial risk, respectively, in their risk decomposition. We demonstrate how the two types of leverage contribute to systematic risk of common stock. Second, we address the issue of "trade-offs" between operating leverage and financial leverage, while investigating their combined effects on the systematic risk of common stock. The interrelationship between operating and financial leverage is widely discussed in the literature as a means of stabilizing the relative riskiness of stockholders' investment. For example, Van Horne ([24], p. 784) states that:

> Operating and financial leverage can be combined in a number of different ways to

obtain a desirable amount of risk of *common stock*. High operating *leverage* can be offset with low financial *leverage* and vice versa.[1]

The trade-off option enables the firm to make asset (capital) structure decisions irrespective of their impact on systematic risk since the resultant change in the degree of operating (financial) leverage can be offset by an adjustment in the degree of financial (operating) leverage. This trade-off hypothesis has remained a conjectural matter despite its practical implications for management since it has not been substantiated by empirical evidence. This study provides empirical evidence on this hypothesis.

II. The Association between Systematic Risk and the Degrees of Operating and Financial Leverage

Hamada [13] and more recently Rubinstein [20] deserve credit for their efforts of decomposing systematic risk into operating risk and financial risk as indicated below

$$\beta = \beta^* + \beta^*(1 - \tau)D/E , \tag{1}$$

where β = the levered firm's common stock beta,
β^* = the unlevered firm's common stock beta,
τ = the corporate income tax rate,
D = the market value of debt, and
E = the market value of common equity.

β^* measures operating risk while $\beta^*(1 - \tau)D/E$ represents the financial risk of common stock. Rubinstein suggests that operating risk reflects the combined effects of the degree of operating leverage, the pure systematic influence of economy-wide events, and the uncertainty associated with the firm's operating efficiency. Financial leverage magnifies this operating risk to produce financial risk.

For an investigation of the association between systematic risk and the degrees of operating and financial leverage, an alternative to the Hamada and Rubinstein formula is necessary for the following reasons. First, equation (1) does not explicitly introduce the degrees of two types of leverage in its expression. Second, Hill and Stone [14] ably document various econometric problems caused by a nonlinear multiplicative effect of financial structure on operating risk as measured by β^*. Third, equation (1) assumes that corporate debt is risk free. Although this assumption is consistent with Modigliani and Miller's [18] tax correction model, equation (1) must be modified to allow risky debt. With the introduction of risky debt, equation (1) is rewritten as

$$\beta = [1 + (1 - \tau)D/E]\beta^* - (1 - \tau)(D/E)\beta_d \tag{2}$$

[1] The words printed in italics are changed from the original statement.

where β_d denotes beta of risky corporate debt.[2] After a slight rearrangement, we write equation (2) as

$$\beta = \beta^* + (1 - \tau)\left(\beta^* - \beta_d\right)D/E \,. \tag{3}$$

Financial risk as measured by $(1 - \tau)(\beta^* - \beta_d)D/E$ causes additional econometric problems associated with a multiplicative effect of financial structure on the beta of risky debt. Although it is not an impossible task to resolve these problems when investigating the real determinants of beta using equation (3), an alternative beta formula is derived to serve our purpose. This formula explicitly incorporates the degrees of operating leverage and financial leverage. By definition, the beta of common stock j is

$$\beta_j = \mathrm{Cov}\left(\tilde{R}_{jt}, \tilde{R}_{mt}\right) / \sigma^2\left(\tilde{R}_{mt}\right) \tag{4}$$

where $\tilde{R}_{jt}$ = the rate of return on common stock j for the period from $t - 1$ to t,

$\tilde{R}_{mt}$ = the rate of return on the market portfolio for the period from $t - 1$ to t,

$\mathrm{Cov}(\cdot)$ and $\sigma^2(\cdot)$ denote the covariance and variance operators, respectively.

Suppose that $\tilde{R}_{jt} = (\tilde{\Pi}_{jt}/E_{jt-1}) - 1$ where $\tilde{\Pi}_{jt}$ denotes earnings after interest and taxes at t and E_{jt-1} represents the market value of common equity at $t - 1$. Substitution of this definition of $\tilde{R}_{jt}$ into equation (4) yields

$$\begin{aligned} \beta_j &= \mathrm{Cov}\left[\left(\tilde{\Pi}_{jt}/E_{jt-1}\right) - 1, \tilde{R}_{mt}\right] / \sigma^2\left(\tilde{R}_{mt}\right) \\ &= \mathrm{Cov}\left(\tilde{\Pi}_{jt}/E_{jt-1}, \tilde{R}_{mt}\right) / \sigma^2\left(\tilde{R}_{mt}\right) . \end{aligned} \tag{5}$$

We can rearrange equation (5) by multiplying the first argument of the covariance by Π_{jt-1}/Π_{jt-1} and subtracting a constant from it

$$\beta_j = \left(\Pi_{jt-1}/E_{jt-1}\right) \mathrm{Cov}\left[\left(\tilde{\Pi}_{jt}/\Pi_{jt-1}\right) - 1, \tilde{R}_{mt}\right] / \sigma^2\left(\tilde{R}_{mt}\right) . \tag{6}$$

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[2] Proposition II of Modigliani and Miller [17], [18] can be expressed as indicated below in the presence of corporate income taxes and risky debt

$$E(\tilde{R}) = E(\tilde{R}^*) + (1 - \tau)\left[E(\tilde{R}^*) - E(\tilde{R}_d)\right]D/E \,, \tag{a}$$

where $\tilde{R}$ = the rate of return on the levered firm's common stock,
$\tilde{R}^*$ = the rate of return on the unlevered firm's common stock, and
$\tilde{R}_d$ = the rate of return on risky debt.

According to the capital asset pricing model, $E(\tilde{R}) = R_f + [E(\tilde{R}_m) - R_f]\beta$, $E(\tilde{R}^*) = R_f + [E(\tilde{R}_m) - R_f]\beta^*$, and $E(\tilde{R}_d) = R_f + [E(\tilde{R}_m) - R_f]\beta_d$, where R_f = the rate of return on a risk-free asset. Substitution of these expressions into (a) yields

$$\beta = [1 + (1 - \tau)D/E]\,\beta^* - (1 - \tau)(D/E)\beta_d \,.$$

The degree of financial leverage (DFL) is defined as the percentage change in Π that results from a percentage change in X, where X denotes earnings before interest and taxes. Thus,

$$\text{DFL} = \left[\left(\tilde{\Pi}_{jt}/\Pi_{jt-1}\right)-1\right]/\left[\left(\tilde{X}_{jt}/X_{jt-1}\right)-1\right]. \tag{7}$$

Solving for $(\tilde{\Pi}_{jt}/\Pi_{jt-1})-1$, we have

$$\left(\tilde{\Pi}_{jt}/\Pi_{jt-1}\right)-1 = (\text{DFL})\left[\left(\tilde{X}_{jt}/X_{jt-1}\right)-1\right]. \tag{8}$$

The degree of operating leverage (DOL) is measured by the percentage change in X that is associated with a given percentage change in the units produced and sold.[3] Let Q denote the number of units. Thus,

$$\text{DOL} = \left[\left(\tilde{X}_{jt}/X_{jt-1}\right)-1\right]/\left[\left(\tilde{Q}_{jt}/Q_{jt-1}\right)-1\right]. \tag{9}$$

Solving for $(\tilde{X}_{jt}/X_{jt-1})-1$, we obtain

$$\left(\tilde{X}_{jt}/X_{jt-1}\right)-1 = (\text{DOL})\left[\left(\tilde{Q}_{jt}/Q_{jt-1}\right)-1\right]. \tag{10}$$

Successive substitution of (10) into (8) and (8) into (6) yields

$$\beta_j = (\text{DOL})\ (\text{DFL})\ \text{Cov}\left[\left(\Pi_{jt-1}/Q_{jt-1}\right)\left(\tilde{Q}_{jt}/E_{jt-1}\right), \tilde{R}_{mt}\right]/\sigma^2\left(\tilde{R}_{mt}\right). \tag{11}$$

Let S denote sales in dollars. Thus, $S = pQ$ where p is the price per unit. By multiplying the first argument of the covariance in (11) by p/p, we obtain the desired result

$$\beta_j = (\text{DOL})(\text{DFL})\beta_j^0, \tag{12}$$

where $\beta_j^0 = \text{Cov}[(\Pi_{jt-1}/S_{jt-1})(\tilde{S}_{jt}/E_{jt-1}), \tilde{R}_{mt}]/\sigma^2(\tilde{R}_{mt})$.[4] Note that Π_{jt-1}/S_{jt-1} represents the net profit margin at $t-1$ while $\tilde{S}_{jt}/E_{jt-1}$ measures the

[3] When the units produced and the units sold differ due to an uncertain demand for the products, stochastic cost-volume-profit analysis is introduced. (See [15] and [21].)

[4] It is important to note that both DOL and DFL are not random variables. For example, DOL as defined by (9) can be modified as

$$\begin{aligned}\text{DOL} &= \left[\left(\tilde{X}_{jt}/X_{jt-1}\right)-1\right]/\left[\left(\tilde{Q}_{jt}/Q_{jt-1}\right)-1\right] \\ &= (p-v)Q_{jt-1}/\left[(p-v)Q_{jt-1}-F_{jt-1}\right],\end{aligned} \tag{a}$$

where p = the price per unit,
v = the variable cost per unit, and
F = the total fixed costs.

Equation (a) represents another definition of DOL that indicates its nonrandomness. Likewise, DFL as defined by (7) can be rewritten as

$$\begin{aligned}\text{DFL} &= \left[\left(\tilde{\Pi}_{jt}/\Pi_{jt-1}\right)-1\right]/\left[\left(\tilde{X}_{jt}/X_{jt-1}\right)-1\right] \\ &= \left[(p-v)Q_{jt-1}-F_{jt-1}\right]/\left[(p-v)Q_{jt-1}-F_{jt-1}-I_{jt-1}\right],\end{aligned} \tag{b}$$

where I denotes interest expenses.

turnover of the firm's common equity for the period from $t - 1$ to t. The covariability of the product of these two terms with returns on the market portfolio represents the intrinsic business risk of common stock as measured by β_j^0. Further note that the unlevered firm, both operationally and financially, would have DOL $= 1$ and DFL $= 1$.[5] Therefore, this intrinsic business risk represents the systematic risk of common stock when the firm is completely unlevered. When the firm is only financially unlevered, its common stock beta, denoted by β^* in Hamada and Rubinstein's formula, is equivalent to (DOL) β_j^0. The role of DOL and DFL is clearly indicated by equation (12). Both DOL and DFL magnify intrinsic business risk of common stock.

Equation (12) is an alternative formula to the risk decomposition of Hamada and Rubinstein. Because it explicitly introduces the degrees of two types of leverage, its usefulness is obvious for an empirical investigation of the impact of DOL and DFL on systematic risk. A nonlinear multiplicative effect of financial structure on operating risk as well as on the beta of risky corporate debt can be avoided by a logarithmic transformation of equation (12). This formula remains valid regardless of whether coporate debt is risky or not.

III. Empirical Test Design and Results

A. Data and Estimation Procedures

This study is based on a sample of 255 manufacturing firms during the period from 1957 to 1976. When selecting these firms, we require that their financial data be on the Standard and Poor's Compustat Annual Data tape and that monthly stock price data be available on the Center for Research in Security Prices (CRSP) tape. Moody's Industrial Manuals (1957-1976) are used to verify some ambiguous or missing financial data.

The first stage of the analysis involves the estimation of the degrees of operating and financial leverage of the sample firms. Since the degree of leverage is built on the familiar concept of elasticity, we use the following time-series regressions

$$\text{(13)} \qquad \mathrm{Ln}\tilde{X}_{jt} = a_j + c_j \, \mathrm{Ln}\tilde{S}_{jt} + \tilde{u}_{jt} \qquad \begin{array}{l} j = 1\text{-}255 \\ t = 1957\text{-}1976 \end{array}$$

$$\text{(14)} \qquad \mathrm{Ln}\tilde{\Pi}_{jt} = b_j + d_j \, \mathrm{Ln}\tilde{X}_{jt} + \tilde{\epsilon}_{jt} \qquad \begin{array}{l} j = 1\text{-}255 \\ t = 1957\text{-}1976 \end{array}$$

where $\tilde{u}_{jt}$ and $\tilde{\epsilon}_{jt}$ are disturbance terms. The estimated regression coefficients, c_j and d_j, represent the degrees of operating leverage and financial leverage, respectively.[6] In estimating c_j, the independent variable should be the number of

[5] Alternative expressions for DOL and DFL as defined by (a) and (b) in footnote 4 become useful to show that the unlevered firm, both financially and operationally, would have DOL $= 1$ and DFL $= 1$. The operationally unlevered firm will have $F = 0$ and DOL becomes unity from (a). The financially unlevered firm will have $I = 0$ and DFL becomes unity from (b).

units produced and sold rather than annual sales in dollars. Because the quantity produced and sold is not available from the income statement, following Lev [16], we use annual sales as a proxy as indicated by (13).[7] Estimation procedures based on (13) and (14) rest on the restrictive, *ceteris paribus*, assumption of stationary elasticity over the estimation period. To examine the assumption of stationarity, the Chow [7] and Fisher [9] test is conducted for each firm based on regressions over two subperiods, t_I = 1957-1966 and t_{II} = 1967-1976. The test results indicate that we cannot reject the hypothesis that the degrees of two types of leverage are stable for approximately 90 percent of the firms at $\alpha = 5$ percent. One possible option available would be to choose only those firms that pass the Chow-Fisher test but this would reduce the size of the sample. Since we employ a portfolio-grouping approach that should lessen the degree of nonstationarity of the coefficients, we decided not to eliminate any of the firms in our sample.[8,9]

The following market model is used to estimate the beta of each common stock. The measurement of monthly rates of return on the market portfolio is based on a value-weighted index of the New York Stock Exchange stocks compiled by CRSP.

$$(15) \qquad \tilde{R}_{jt} = \alpha_j + \beta_j \tilde{R}_{mt} + \tilde{\nu}_{jt}, \quad \begin{array}{l} j = 1\text{-}255 \\ t = 1\text{-}240 \end{array}$$

where $\tilde{\nu}_{jt}$ denotes a disturbance term. Table 1 summarizes estimates of beta, the degree of operating leverage, and the degree of financial leverage for 255 firms in the sample by industry. The 255 firms are distributed over 10 different industries under the 2-digit SIC Industry Code.

B. Regression Results

We investigate the combined effects of the degrees of two types of leverage on systematic risk by using the following equation

$$(16) \qquad \mathrm{Ln}\beta_p = \gamma_0 + \gamma_1 \,\mathrm{Ln DOL}_p + \gamma_2 \,\mathrm{Ln DFL}_p + e_p \quad (p = 1\text{-}51)$$

where β_p, DOL_p, and DFL_p are portfolio means of beta, the degree of operating leverage, and the degree of financial leverage. A portfolio-grouping approach is

[6] When negative earnings are observed for either X or Π, the following regressions are run without a logarithmic transformation

$$\tilde{X}_{jt} = \phi_1 + \phi_2 \tilde{S}_{jt} + \tilde{\delta}_{jt}, \quad \text{and}$$

$$\tilde{\Pi}_{jt} = \psi_1 + \psi_2 x_{jt} + \tilde{\zeta}_{jt}.$$

After ϕ_2 and ψ_2 are estimated, $\hat{c}_j$ in (13) is approximated by $\phi_2(\bar{S}_j/\bar{X}_j)$ and $\hat{d}_j$ in (14) is approximated by $\psi_2(\bar{X}_j/\bar{\Pi}_j)$ where $\bar{S}_j$, $\bar{X}_j$, and $\bar{\Pi}_j$ denote the 20-year average values of $\tilde{S}_{jt}$, $\tilde{X}_{jt}$, and $\tilde{\Pi}_{jt}$.

[7] Lev [16] uses the annual sales as a proxy for the units produced and sold.

[8] In his examination of the assumption of stationarity, Lev [16] compares the estimates from regressions for the whole period and a subperiod and concludes that the differences in estimated coefficients are minimal. He does not use any statistical test to support his findings.

[9] When those firms that did not pass the Chow-Fisher test were excluded from our sample, we found that the overall results did not improve much from what is reported in the empirical portion of this paper.

TABLE 1
Estimates of Average Beta, DOL, and DFL by Industry

Industry Code		Number of Firms	Beta	DOL*	DFL*
2000	(Food and Kindred)	32	0.94	0.96	1.02
2600	(Paper & Allied Products)	13	1.05	0.91	1.06
2800	(Chemical)	36	1.13	0.91	1.01
2900	(Petro-Chemical)	20	0.96	1.08	0.79
3200	(Glass & Cement Gypsum)	10	1.04	0.91	1.05
3300	(Steel)	21	1.11	0.73	1.03
3500	(Machinery)	40	1.20	1.01	1.00
3600	(Appliances)	24	1.34	1.09	0.99
3700	(Auto)	24	1.09	0.99	1.02
4900	(Utilities)	35	0.72	0.85	0.87

* DOL = the Degree of Operating Leverage.
* DFL = the Degree of Financial Leverage.

employed to reduce the errors-in-variables bias.[10] Under this grouping procedure, we rank the sample firms on the basis of the size of DOL in ascending order. We place the first five securities in portfolio 1, the next five in portfolio 2, and the last five securities in portfolio 51. The average β, DOL, and DFL are calculated for each portfolio, respectively. The same procedures are used to form 51 portfolios based upon the size of DFL. We also group the sample firms on the basis of the size of β to investigate whether or not firms with higher betas show greater trade-offs between DOL and DFL than firms with lower betas.

One has to recognize a potential selection bias because the grouping and cross-sectional regressions are performed in the same study period. To correct this bias, we introduce instrumental variables which should be highly correlated with the two independent variables but which can be observed independently of the two.[11] The natural candidates for our purpose would be operating leverage and financial leverage measured in book values. Out of several proxies available, we choose the 20-year average of the ratio of net fixed assets to total assets and the ratio of total debt to total assets as appropriate instrumental variables for DOL and DFL, respectively.

Table 2 presents test results of the hypothesis that both DOL and DFL have positive effects on the beta of common stock. The table presents the cross-sectional regression estimates based on three sets of data. Each data set has 51 portfolios that are formed from rankings of two instrumental variables for DOL and DFL, and beta, respectively. For each set of data, three regression results are reported. The coefficients in the first lines in each panel show the association between the portfolio's beta and both DOL and DFL. The second and third lines report the results when either DOL or DFL is suppressed.

The empirical results are consistent with the hypothesized relationship: regression coefficients of DOL and DFL are consistently positive, suggesting that both are positively associated with the relative riskiness of common stock. The explanatory power of both operating and financial leverage is quite high, ranging

[10] See [4], [8], and [2] for details about such grouping procedures and their statistical merits.
[11] See [22], p. 445.

from 38 percent to 48 percent. The bottom two panels of Table 2 present a summary of results of the regressions without introducing instrumental variables. The estimates of DOL and DFL from (13) and (14) are used for ranking common stocks in the sample, as discussed earlier. Observe that the overall results are similar to those obtained by using instrumental variables. The values of R^2 are smaller than those reported in the top two panels.

TABLE 2

Regression Results at Portfolio Level

$$\ln \beta_p = \gamma_0 + \gamma_1 \ln DOL_p + \gamma_2 \ln DFL_p + e_p$$

	γ_0	γ_1	γ_2	R^2	F-statistic
I. Portfolios Formed Based upon Rankings of Instrumental Variable for DOL	.09 (4.23)†	.32 (2.50)†	1.30 (5.47)†	.43	18.70†
	.06 (2.35)*	.35 (2.17)*	–	.09	4.72*
	.07 (3.37)†	–	1.33 (5.31)†	.36	28.15†
II. Portfolios Formed Based upon Rankings of Instrumental Variable for DFL	.09 (4.58)†	.37 (3.37)†	.94 (4.10)†	.38	15.33†
	.07 (3.21)†	.41 (3.25)†	–	.17	10.56†
	.06 (3.29)†	–	1.00 (3.99)†	.24	15.96†
III. Portfolios Formed Based upon Rankings of Beta	.12 (3.87)†	.73 (3.80)†	1.98 (5.62)†	.48	22.28†
	.07 (1.87)*	.69 (2.82)†	–	.14	7.97†
	.07 (2.23)†	–	1.93 (4.86)†	.33	23.66†
IV. Portfolios Formed Based upon Rankings of DOL	.07 (4.53)†	.14 (3.06)†	.37 (1.71)*	.17	4.99*
	.06 (4.12)†	.11 (2.61)†	–	.12	6.81†
	.05 (3.35)†	–	.16 (.73)	.01	.53
V. Portfolios Formed Based upon Rankings of DFL	.07 (4.26)†	.14 (1.15)†	4.32 (4.93)†	.34	12.26†
	.04 (2.32)*	−.05 (.37)	–	.003	.13
	.06 (4.25)†	–	.40 (4.80)†	.32	23.05†

Figures in parentheses are t-values.
† Statistically significant at α = 1 percent.
* Statistically significant at α = 5 percent.

From Panel IV of Table 2, we note that DOL shows a higher explanatory power relative to DFL, 12 percent versus 1 percent, when the magnitude of DOL is used for rankings of common stocks to form portfolios. On the other hand, the regression results in the last panel show that DFL demonstrates much higher explanatory power than does DOL, 32 percent versus 0.3 percent, when the magnitude of DFL is used for rankings of common stocks to form portfolios. Considering the ranking method employed, it is not surprising. For example, when ranking is done according to DFL, we have 51 portfolios, each with various levels of DOL. Therefore, when DOL is used as an independent variable in the regression, we would indeed expect it to have a small explanatory power. A similar phenomenon would be observed when ranking is done on the basis of DOL while DFL is used as an independent variable in the regression. As reported in the top two panels of Table 2, however, the same phenomena do not occur when instrumental variables are used for rankings of common stocks. When regression coefficients are estimated using 51 portfolios formed based upon rankings of beta, we find that DFL alone can explain as much as 33 percent of cross-sectional variation of betas and DOL alone explains 14 percent.[12] Because of limited data, we have not included an independent variable representing the intrinsic business risk of common stock. The estimates of the intercept that are significant in all regressions appear to capture the influence of this omitted variable. Furthermore, the intercept's estimates seem to be stable from one regression to another.

C. Tests of the Trade-Off Hypothesis between Operating Leverage and Financial Leverage

The second hypothesis to be examined is the relationship between DOL and DFL. It has been proposed in the literature that management tries to stabilize the level of the beta of common stock. Frequent changes in the beta of common stock, so it is argued, impose transaction costs on stockholders because they have to rebalance their portfolios to maintain them at a desired level of risk. The degree of operating leverage is an important factor to be considered in the firm's asset structure decisions. By changing from a labor-intensive manufacturing process to a capital-intensive one, a significant change would occur in the cost structure of the firm. A rise in fixed costs and a simultaneous decline in variable cost per unit increase the degree of operating leverage and thereby increase the relative riskiness of common stocks. However, the firm's decision on the operating leverage can be offset by its decision on its financial leverage. To save portfolio revision costs to the stockholders, the two types of leverage can be chosen so that changes in the level of beta are minimized. If the level of intrinsic business risk is constant, a change in DOL can be offset by a change in DFL and vice versa. Therefore, one would expect a cross-sectional negative correlation between DOL and DFL.

[12] When the cross-sectional regression is performed at the level of the individual firm, the following results are obtained

$$\underset{}{Ln\,\beta_i} = \underset{(3.30)}{.05} + \underset{(3.13)}{.14\,Ln\,DOL_i} + \underset{(4.92)}{.44\,Ln\,DFL_i} \quad R^2 = .1081$$

where figures in parentheses are t-values. They are statistically significant at α = 1 percent. The smaller R^2 reported for the regression can be attributed to measurement errors of variables at the level of the individual firm.

Table 3 presents the estimated correlation coefficients for the 51 portfolios formed from rankings of operating leverage, financial leverage, and beta, respectively. As expected, we observe consistent negative correlations between DOL and DFL. Negative correlations are particularly pronounced when either operating leverage or financial leverage is used for ranking. The respective correlations are $\rho(DOL_p, DFL_p) = -.30$ and $-.32$ for the whole sample. These correlations are significant at $\alpha = 1$ percent. When portfolios are formed on the basis of the rankings of beta, we observe a negative and nonsignificant correlation between the two types of leverage, $\rho(DOL_p, DFL_p) = -.05$, for the whole sample. To investigate why this happens, we divide the portfolios into two subgroups, one group with low betas and another with high betas. It appears that firms with high betas engage in trade-offs more actively than do firms with low betas.

TABLE 3
Test Results of the Trade-off Hypothesis

		Number of Portfolios	Beta	DOL	DFL	$\rho(DOL_p, DFL_p)$
Operating Leverage	Low	25	1.02 [.10]	.73 [.17]	.99 [.07]	−.26 (1.26)
	High	26	1.09 [.11]	1.16 [.21]	.97 [.06]	−.23 (1.18)
	Whole	51	1.06 [.11]	.95 [.28]	.98 [.06]	−.30 (2.19)†
Financial Leverage	Low	25	1.00 [.12]	.97 [.10]	.88 [.13]	−.32 (1.61)#
	High	26	1.10 [.10]	.93 [.13]	1.08 [.08]	−.31 (1.59)#
	Whole	51	1.06 [.12]	.95 [.11]	.98 [.14]	−.32 (2.39)†
Beta	Low	25	.85 [.14]	.89 [.10]	.94 [.06]	−.08 (.37)
	High	26	1.25 [.17]	1.00 [.14]	1.01 [.06]	−.49 (2.73)†
	Whole	51	1.06 [.25]	.95 [.13]	.98 [.07]	−.05 (.35)

Figures in parentheses are t-values.
† Statistically significant at $\alpha = 1$ percent.
# Statistically significant at $\alpha = 10$ percent.
Figures in brackets are cross-sectional standard deviations.

The average DOL and DFL of the two subgroups also provide some evidence of balancing activities between the degrees of two types of leverage. For portfolios formed based upon rankings of DOL, it appears that low DOL is combined with high DFL, .73 versus .99, and vice versa, 1.16 versus .97. The same trend can be observed for portfolios formed from rankings of DFL. Low DFL is combined with high DOL, .88 versus .97, and vice versa, 1.08 versus .93.

III. Summary

The unique aspect of this study is its explicit introduction of the degrees of operating leverage and financial leverage in investigating the joint impact of both asset structure and capital structure on systematic risk. In this study, we recognize the role of DOL and DFL in magnifying the intrinsic business risk of common stock. This study isolates the degree of operating leverage from operating risk to highlight the joint impact of DOL and DFL on the systematic risk of common stock and to test the trade-off hypothesis between the two.

Our empirical findings suggest that the degrees of operating and financial leverage explain a large portion of the variation in beta. The conjecture that firms engage in trade-offs between DOL and DFL seems to have gained strong empirical evidence in our study. We found a significant correlation between the two types of leverage.

If corroborated by future studies, these findings may help us in prediction of corporate behavior. For example, a new technological breakthrough that requires new capital investment, shifting the firm to a higher degree of operating leverage, may signal an offsetting shift in the degree of financial leverage. The findings of this study also may clarify to management that indeed such a policy is widely followed and may help it understand why it is so. Corporate managers then will have to sacrifice less of their time pondering it. Another practical merit of this study is that it can help us in formulating prediction models for the betas of common stock and the firm. Given the significant joint impact of the two types of leverage, beta forecasting models can be improved in accuracy.

There are many issues to which this study and follow-up studies in this direction may contribute to our understanding of corporate financing and investment decisions. We are engaged in examining further aspects of the issues. One direction we are pursuing is to introduce the instrinsic business risk of common stock into the empirical model along with DOL and DFL. Another direction is an investigation of changes over time in both DOL and DFL and the relationship between the two changes. A further investigation is warranted on changes of beta over time and corresponding changes in the degrees of operating and financial leverage.

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