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The Determinants of Capital Structure Choice

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ABSTRACT

This paper analyzes the explanatory power of some of the recent theories of optimal capital structure. The study extends empirical work on capital structure theory in three ways. First, it examines a much broader set of capital structure theories, many of which have not previously been analyzed empirically. Second, since the theories have different empirical implications in regard to different types of debt instruments, the authors analyze measures of short-term, long-term, and convertible debt rather than an aggregate measure of total debt. Third, the study uses a factor-analytic technique that mitigates the measurement problems encountered when working with proxy variables.

IN RECENT YEARS, A number of theories have been proposed to explain the variation in debt ratios across firms. The theories suggest that firms select capital structures depending on attributes that determine the various costs and benefits associated with debt and equity financing. Empirical work in this area has lagged behind the theoretical research, perhaps because the relevant firm attributes are expressed in terms of fairly abstract concepts that are not directly observable.

The basic approach taken in previous empirical work has been to estimate regression equations with proxies for the unobservable theoretical attributes. This approach has a number of problems. First, there may be no unique representation of the attributes we wish to measure. There are often many possible proxies for a particular attribute, and researchers, lacking theoretical guidelines, may be tempted to select those variables that work best in terms of statistical goodness-of-fit criteria, thereby biasing their interpretation of the significance levels of their tests. Second, it is often difficult to find measures of particular attributes that are unrelated to other attributes that are of interest. Thus, selected proxy variables may be measuring the effects of several different attributes. Third, since the observed variables are imperfect representations of the attributes they are supposed to measure, their use in regression analysis introduces an errors-in-variable problem. Finally, measurement errors in the proxy variables may be correlated with measurement errors in the dependent variables, creating spurious correlations even when the unobserved attribute being measured is unrelated to the dependent variable.

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This study extends empirical work on capital structure theory in three ways.[1] First, it extends the range of theoretical determinants of capital structure by examining some recently developed theories that have not, as yet, been analyzed empirically. Second, since some of these theories have different empirical implications with regard to different types of debt instruments, we analyze separate measures of short-term, long-term, and convertible debt rather than an aggregate measure of total debt. Third, a technique is used that explicitly recognizes and mitigates the measurement problems discussed above.

This technique, which is an extension of the factor-analytic approach to measuring unobserved or latent variables, is known as linear structural modeling.[2] Very briefly, this method assumes that, although the relevant attributes are not directly observable, we can observe a number of indicator variables that are linear functions of one or more attributes and a random error term. There is, in this specification, a direct analogy with the return-generating process assumed to hold in the Arbitrage Pricing Theory. While the identifying restrictions imposed on our model are different, the technique for estimating it is very similar to the procedure used by Roll and Ross [29] to test the APT.

Our results suggest that firms with unique or specialized products have relatively low debt ratios. Uniqueness is categorized by the firms' expenditures on research and development, selling expenses, and the rate at which employees voluntarily leave their jobs. We also find that smaller firms tend to use significantly more short-term debt than larger firms. Our model explains virtually none of the variation in convertible debt ratios across firms and finds no evidence to support theoretical work that predicts that debt ratios are related to a firm's expected growth, non-debt tax shields, volatility, or the collateral value of its assets. We do, however, find some support for the proposition that profitable firms have relatively less debt relative to the market value of their equity.

I. Determinants of Capital Structure

In this section, we present a brief discussion of the attributes that different theories of capital structure suggest may affect the firm's debt-equity choice. These attributes are denoted asset structure, non-debt tax shields, growth, uniqueness, industry classification, size, earnings volatility, and profitability. The attributes, their relation to the optimal capital structure choice, and their observable indicators are discussed below.

[1] Recent cross-sectional studies include Toy et al. [40], Ferri and Jones [14], Flath and Knoeber [15], Marsh [24], Chaplinsky [11], Titman [38], Castanias [8], Bradley, Jarrell, and Kim [6], Auerbach [2], and Long and Malitz [23]. The papers by Titman [38], Bradley, Jarrell, and Kim [6], Auerbach [2], and Long and Malitz [23] examine variables that are similar to some of those examined here. The studies find a negative relation between both research and development and advertising and leverage but have mixed findings relating to the different measures of non-debt tax shields and leverage and volatility and leverage. Also see Schwartz and Aronson [30], Scott [31], and Scott and Martin [32] for evidence of industry effects in capital structure choice.

[2] References to linear structural modeling can also be found in the literature under the headings of analysis-of-covariance structures, path analysis, causal models, and content-variables models. A nontechnical introduction to the subject providing many references is Bentler and Bonett [4].

A. Collateral Value of Assets

Most capital structure theories argue that the type of assets owned by a firm in some way affects its capital structure choice. Scott [33] suggests that, by selling secured debt, firms increase the value of their equity by expropriating wealth from their existing unsecured creditors.[3] Arguments put forth by Myers and Majluf [28] also suggest that firms may find it advantageous to sell secured debt. Their model demonstrates that there may be costs associated with issuing securities about which the firm's managers have better information than outside shareholders. Issuing debt secured by property with known values avoids these costs. For this reason, firms with assets that can be used as collateral may be expected to issue more debt to take advantage of this opportunity.

Work by Galai and Masulis [16], Jensen and Meckling [20], and Myers [26] suggests that stockholders of leveraged firms have an incentive to invest suboptimally to expropriate wealth from the firm's bondholders. This incentive may also induce a positive relation between debt ratios and the capacity of firms to collateralize their debt. If the debt can be collateralized, the borrower is restricted to use the funds for a specified project. Since no such guarantee can be used for projects that cannot be collateralized, creditors may require more favorable terms, which in turn may lead such firms to use equity rather than debt financing.

The tendency of managers to consume more than the optimal level of perquisites may produce the opposite relation between collateralizable capital and debt levels. Grossman and Hart [18] suggest that higher debt levels diminish this tendency because of the increased threat of bankruptcy. Managers of highly levered firms will also be less able to consume excessive perquisites since bondholders (or bankers) are inclined to closely monitor such firms. The costs associated with this agency relation may be higher for firms with assets that are less collateralizable since monitoring the capital outlays of such firms is probably more difficult. For this reason, firms with less collateralizable assets may choose higher debt levels to limit their managers' consumption of perquisites.

The estimated model incorporates two indicators for the collateral value attribute. They include the ratio of intangible assets to total assets (INT/TA) and the ratio of inventory plus gross plant and equipment to total assets (IGP/TA). The first indicator is negatively related to the collateral value attribute, while the second is positively related to collateral value.

B. Non-Debt Tax Shields

DeAngelo and Masulis [12] present a model of optimal capital structure that incorporates the impact of corporate taxes, personal taxes, and non-debt-related corporate tax shields. They argue that tax deductions for depreciation and investment tax credits are substitutes for the tax benefits of debt financing. As a result, firms with large non-debt tax shields relative to their expected cash flow include less debt in their capital structures.

Indicators of non-debt tax shields include the ratios of investment tax credits over total assets (ITC/TA), depreciation over total assets (D/TA), and a direct

[3] See Smith and Warner [35] for a comment on Scott's model.

estimate of non-debt tax shields over total assets (NDT/TA). The latter measure is calculated from observed federal income tax payments (T), operating income (OI), interest payments (i), and the corporate tax rate during our sample period (48%), using the following equation:

$$NDT = OI - i - \frac{T}{0.48},$$

which follows from the equality

$$T = 0.48(OI - i - NDT).$$

These indicators measure the current tax deductions associated with capital equipment and, hence, only partially capture the non-debt tax shield variable suggested by DeAngelo and Masulis. First, this attribute excludes tax deductions that are not associated with capital equipment, such as research and development and selling expenses. (These variables, used as indicators of another attribute, are discussed later.) More important, our non-debt tax shield attribute represents tax deductions rather than tax deductions net of true economic depreciation and expenses, which is the economic attribute suggested by theory. Unfortunately, this preferable attribute would be very difficult to measure.

C. Growth

As we mentioned previously, equity-controlled firms have a tendency to invest suboptimally to expropriate wealth from the firm's bondholders. The cost associated with this agency relationship is likely to be higher for firms in growing industries, which have more flexibility in their choice of future investments. Expected future growth should thus be negatively related to long-term debt levels. Myers, however, noted that this agency problem is mitigated if the firm issues short-term rather than long-term debt. This suggests that short-term debt ratios might actually be positively related to growth rates if growing firms substitute short-term financing for long-term financing. Jensen and Meckling [20], Smith and Warner [36], and Green [17] argued that the agency costs will be reduced if firms issue convertible debt. This suggests that convertible debt ratios may be positively related to growth opportunities.

It should also be noted that growth opportunities are capital assets that add value to a firm but cannot be collateralized and do not generate current taxable income. For this reason, the arguments put forth in the previous subsections also suggest a negative relation between debt and growth opportunities.

Indicators of growth include capital expenditures over total assets (CE/TA) and the growth of total assets measured by the percentage change in total assets (GTA). Since firms generally engage in research and development to generate future investments, research and development over sales (RD/S) also serves as an indicator of the growth attribute.[4]

[4] We also considered using price/earnings ratios as an indicator of growth. However, this variable is determined in part by the firm's leverage ratio and, hence, is subject to bias due to reverse causality.

D. Uniqueness

Titman [39] presents a model in which a firm's liquidation decision is causally linked to its bankruptcy status. As a result, the costs that firms can potentially impose on their customers, suppliers, and workers by liquidating are relevant to their capital structure decisions. Customers, workers, and suppliers of firms that produce unique or specialized products probably suffer relatively high costs in the event that they liquidate. Their workers and suppliers probably have job-specific skills and capital, and their customers may find it difficult to find alternative servicing for their relatively unique products. For these reasons, uniqueness is expected to be negatively related to debt ratios.

Indiators of uniqueness include expenditures on research and development over sales (RD/S), selling expenses over sales (SE/S), and quit rates (QR), the percentage of the industry's total work force that voluntarily left their jobs in the sample years. It is postulated that RD/S measures uniqueness because firms that sell products with close substitutes are likely to do less research and development since their innovations can be more easily duplicated. In addition, successful research and development projects lead to new products that differ from those existing in the market. Firms with relatively unique products are expected to advertise more and, in general, spend more in promoting and selling their products. Hence, SE/S is expected to be positively related to uniqueness. However, it is expected that firms in industries with high quit rates are probably relatively less unique since firms that produce relatively unique products tend to employ workers with high levels of job-specific human capital who will thus find it costly to leave their jobs.

It is apparent from two of the indicators of uniqueness, RD/S and SE/S, that this attribute may also be related to non-debt tax shields and collateral value. Research and development and some selling expenses (such as advertising) can be considered capital goods that are immediately expensed and cannot be used as collateral. Given that our estimation technique can only imperfectly control for these other attributes, the uniqueness attribute may be negatively related to the observed debt ratio because of its positive correlation with non-debt tax shields and its negative correlation with collateral value.

E. Industry Classification

Titman [39] suggests that firms that make products requiring the availability of specialized servicing and spare parts will find liquidation especially costly. This indicates that firms manufacturing machines and equipment should be financed with relatively less debt. To measure this, we include a dummy variable equal to one for firms with SIC codes between 3400 and 4000 (firms producing machines and equipment) and zero otherwise as a separate attribute affecting the debt ratios.

F. Size

A number of authors have suggested that leverage ratios may be related to firm size. Warner [41] and Ang, Chua, and McConnell [1] provide evidence that suggests that direct bankruptcy costs appear to constitute a larger proportion of a firm's value as that value decreases. It is also the case that relatively large firms tend to be more diversified and less prone to bankruptcy. These arguments suggest that large firms should be more highly leveraged.

The cost of issuing debt and equity securities is also related to firm size. In particular, small firms pay much more than large firms to issue new equity (see Smith [34]) and also somewhat more to issue long-term debt. This suggests that small firms may be more leveraged than large firms and may prefer to borrow short term (through bank loans) rather than issue long-term debt because of the lower fixed costs associated with this alternative.

We use the natural logarithm of sales (*LnS*) and quit rates (*QR*) as indicators of size.[5] The logarithmic transformation of sales reflects our view that a size effect, if it exists, affects mainly the very small firms. The inclusion of quit rates, as an indicator of size, reflects the phenomenon that large firms, which often offer wider career opportunities to their employees, have lower quit rates.

G. Volatility

Many authors have also suggested that a firm's optimal debt level is a decreasing function of the volatility of earnings.[6] We were only able to include one indicator of volatility that cannot be directly affected by the firm's debt level.[7] It is the standard deviation of the percentage change in operating income (*SIGOI*). Since it is the only indicator of volatility, we must assume that it measures this attribute without error.

H. Profitability

Myers [27] cites evidence from Donaldson [13] and Brealey and Myers [7] that suggests that firms prefer raising capital, first from retained earnings, second from debt, and third from issuing new equity. He suggests that this behavior may be due to the costs of issuing new equity. These can be the costs discussed in Myers and Majluf [28] that arise because of asymmetric information, or they can be transaction costs. In either case, the past profitability of a firm, and hence the amount of earnings available to be retained, should be an important determinant of its current capital structure. We use the ratios of operating income over sales (*OI/S*) and operating income over total assets (*OI/TA*) as indicators of profitability.

[5] An unreported model was estimated that included the natural logarithm of total assets (*LnTA*) as a third indicator of size. The very high correlation between *LnTA* and *LnS* (about 0.98) created a near singularity in the covariance matrix, causing problems in estimating the model. However, parameter estimates of the structural model are not sensitive to the choice between *LnS* or *LnTA* as an indicator for size.

[6] Counter-examples to this basic hypothesis have been demonstrated. (See, for example, Castanias and DeAngelo [9], Jaffe and Westerfield [19], and Bradley, Jarrell, and Kim [6].)

[7] Other possible indicators, such as a firm's stock beta or total volatility, are of course partially determined by the firm's debt ratio. Calculating "unlevered betas" and "unlevered volatilities" requires accurate measurements of the market value of the firm's debt ratio as it evolves over time and of the tax gain to leverage. The potential for spurious correlation arises if the impact of leverage and taxes is not completely purged from these volatility estimates.

II. Measures of Capital Structure

Six measures of financial leverage are used in this study. They are long-term, short-term, and convertible debt divided by market and by book values of equity.[8] Although these variables could have been combined to extract a common "debt ratio" attribute, which could in turn be regressed against the independent attributes, there is good reason for not doing this. Some of the theories of capital structure have different implications for the different types of debt, and, for the reasons discussed below, the predicted coefficients in the structural model may differ according to whether debt ratios are measured in terms of book or market values. Moreover, measurement errors in the dependent variables are subsumed in the disturbance term and do not bias the regression coefficients.

Data limitations force us to measure debt in terms of book values rather than market values. It would, perhaps, have been better if market value data were available for debt. However, Bowman [5] demonstrated that the cross-sectional correlation between the book value and market value of debt is very large, so the misspecification due to using book value measures is probably fairly small. Furthermore, we have no reason to suspect that the cross-sectional differences between market values and book values of debt should be correlated with any of the determinants of capital structure suggested by theory, so no obvious bias will result because of this misspecification.

There are, however, some other important sources of spurious correlation. The dependent variables used in this study can potentially be correlated with the explanatory variables even if debt levels are set randomly. Consider first the case where managers set their debt levels according to some randomly selected target ratio measured at book value.[9] This would not be irrational if capital structure were in fact irrelevant. If managers set debt levels in terms of book value rather than market value ratios, then differences in market values across firms that arise for reasons other than differences in their book values (such as different growth opportunities) will not necessarily affect the total amount of debt they issue. Since these differences do, of course, affect the market value of their equity, this will have the effect of causing firms with higher market/book value ratios to have lower debt/market value ratios. Since firms with growth opportunities and relatively low amounts of collateralizable assets tend to have relatively high market value/book value ratios, a spurious relation might exist between debt/market value and these variables, creating statistically significant coefficient estimates even if the book value debt ratios are selected randomly.[10]

[8] We also examined these debt levels divided by total assets and market value of equity plus book value of debt and preferred stock. The results using these dependent variables were very similar to those reported here.

[9] There is evidence that managers do think in terms of book values. See, for example, the survey evidence presented in Stonehill et al. [37].

[10] It may be easier to understand how this spurious correlation arises in the case where all firms have the same book debt ratios. In this case, the cross-sectional variation in debt/market value will be determined entirely by the variation in the differences between book and market values across firms. Variables that are related to this difference will, therefore, also be related to debt/market value.

One should note that the previously cited empirical work shares this potential for spurious results. Clearly, the different measures of firm size and industry classifications used in past studies are correlated with their market value/book value ratios.

Similar spurious relations will be induced between debt ratios measured at book value and the explanatory variables if firms select debt levels in accordance with market value target ratios. If some firms use book value targets while others use market value targets, both dependent variables will be spuriously correlated with the independent variables. Fortunately, the book and market value debt ratios induce spurious correlation in opposite directions. Using dependent variables scaled by both book values and market values may then make it possible to separate the effects of capital structure suggested by theory, which predicts coefficient estimates of the same sign for both dependent variable groups, from these spurious effects.

III. Data

The variables discussed in the previous sections were analyzed over the 1974 through 1982 time period. The source of all the data except for the quit rates is the Annual Compustat Industrial Files. The quit-rate data are from the U.S. Department of Labor, Bureau of Labor Statistics, "Employment and Earnings" publication. These data are available only at the four-digit (SIC code) industry level for manufacturing firms.

From the total sample, we deleted all the observations that did not have a complete record on the variables included in our analysis. Furthermore, since many of the indicator variables are scaled by total assets or average operating income, we were forced to delete a small number of observations that included negative values for one of these variables. These requirements may bias our sample toward relatively large firms. In total, 469 firms were available.

The sampling period was divided into three subperiods of three years each, over which sample averages of the variables were calculated. Averaging over three years reduces the measurement error due to random year-to-year fluctuations in the variables. The dependent variables were measured during the 1977 through 1979 subperiod. Two of the indicators of expected future growth, the growth rate of total assets (GTA) and capital expenditures over total assets (CE/TA), were measured over the period 1980 through 1982. By doing this, we are using the realized values as (imperfect) proxies of the values expected when the capital structure decision was made. The variables used to measure uniqueness, non-debt tax shields, asset structure, and the industry classification were measured contemporaneously with the dependent variables, i.e., during the period 1977 through 1979. The variables used as indicators of size and profitability were taken from the 1974 through 1976 period. Measuring the profitability attribute during the earlier period allows us to determine whether profitability has more than just a short-term effect on observed leverage ratios. Measuring size in the earlier periods avoids creating a spurious relation between size and debt ratios that arises because of the relation between size and past profitability (profitable firms become larger) and the short-term relation between profitability and leverage (profitable firms increase their net worth). Finally, the standard deviation of the change in operating income was measured using all nine years in the sample in order to obtain as efficient a measure as possible.

In comparing our results with results from previous research, it should be noted that our sample is somewhat more restricted than others. Our sample reflects the fact that most of the theories were developed with the knowledge that regulated and unregulated firms have very different capital structures. Given this and other well-known capital structure differences between broad industry groups, we think that it is more appropriate to test the capital structure theories on a sample restricted only to those firms in the manufacturing sector of the economy. Of course, the drawback to limiting the sample is the loss in power associated with reducing the variation in the independent variables.

IV. The Model Specification

Section II discussed a number of attributes and their indicators that may in theory affect a firm's capital structure choice. Unfortunately, the theories do not specify the functional forms describing how the attributes relate to the indicators and the debt ratios. The statistical procedures used to estimate the model require that these relations be linear.

The model we estimate is an application of the LISREL system developed by K. Jöreskog and D. Sörbom.[11] It can be conveniently thought of as a factor-analytic model consisting of two parts: a measurement model and a structural model that are estimated simultaneously. In the measurement model, unobservable firm-specific attributes are measured by relating them to observable variables, e.g., accounting data. In the structural model, measured debt ratios are specified as functions of the attributes defined in the measurement model.

The measurement model can be specified as follows:

$$x = \Lambda \xi + \delta, \tag{1}$$

where x is a $q \times 1$ vector of observable indicators, ξ is an $m \times 1$ vector of unobservable attributes, and Λ is a $q \times m$ matrix of regression coefficients of x on ξ. Errors of measurement are represented by the vector δ. In our model, we have fifteen indicator variables for eight attributes—thus, x is 15×1 and Λ is 15×8.

The structural model can be specified as the following system of equations:

$$y = \Gamma \xi + \varepsilon, \tag{2}$$

where y is a $p \times 1$ vector of debt ratios, Γ is a $p \times m$ matrix of factor loadings, and ε is a $p \times 1$ vector of disturbance terms. The model is estimated for two separate 3×1 vectors of debt: short-term, long-term, and convertible debt scaled by book value and market value of equity.

Equation (1) simply states that, although the firm-specific attributes that supposedly determine capital structures cannot be observed, a number of other variables denoted as indicators, that are imperfect measures of the attributes, are observable. These indicator variables can be expressed as linear functions of one or more of the unobservable attributes and a random measurement error.

[11] For a lucid introduction to the system and its many applications, see Jöreskog and Sörbom [23]; for a critical review see Bentler [3]; a detailed description of the technical procedures of LISREL is given in Jöreskog [21].

Table I

The Structure of the Measurement Model

$$
\begin{bmatrix} NDT/TA \\ ITC/TA \\ D/TA \\ RD/S \\ SE/S \\ CE/TA \\ INT/TA \\ IGP/TA \\ LnS \\ GTA \\ QR \\ OI/TA \\ OI/S \\ SIGOI \\ IDUM \end{bmatrix}
=
\begin{bmatrix}
0 & 0 & \lambda_{1,3} & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & \lambda_{2,3} & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & \lambda_{3,3} & 0 & 0 & 0 & 0 & 0 \\
\lambda_{4,1} & \lambda_{4,2} & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & \lambda_{5,2} & 0 & 0 & 0 & 0 & 0 & 0 \\
\lambda_{6,1} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & \lambda_{7,4} & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & \lambda_{8,4} & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & \lambda_{9,5} & 0 & 0 & 0 \\
\lambda_{10,1} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & \lambda_{11,2} & 0 & 0 & \lambda_{11,5} & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & \lambda_{12,6} & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & \lambda_{12,7} & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 1
\end{bmatrix}
\times
\begin{bmatrix} \xi_1 \\ \xi_2 \\ \xi_3 \\ \xi_4 \\ \xi_5 \\ \xi_6 \\ \xi_7 \\ \xi_8 \end{bmatrix}
+
\begin{bmatrix} \delta_1 \\ \delta_2 \\ \delta_3 \\ \delta_4 \\ \delta_5 \\ \delta_6 \\ \delta_7 \\ \delta_8 \\ \delta_9 \\ \delta_{10} \\ \delta_{11} \\ \delta_{12} \\ \delta_{13} \\ 0 \\ 0 \end{bmatrix}
$$

The principal advantage of this estimation procedure over standard regression models is that it explicitly specifies the relation between the unobservable attributes and the observable variables. However, in order to identify the estimated equations, additional structure must be added. In most factor-analysis models, the common factors are constrained to be orthogonal and scaled to have unit variances, and the residuals are assumed to be uncorrelated. However, since the common factors in this study are given definite interpretations by identifying them with specific attributes, the assumption that the common factors are uncorrelated is untenable since many firm-specific attributes are likely to be related (e.g., size and growth). For this reason, the correlations among the unobservable attributes (the matrix Ψ) are estimated within the model. Of course, in order to achieve identification, additional restrictions on the parameters of the model must be imposed.

In total, we have imposed 105 restrictions on the matrix Λ of factor loadings. These are shown in Table I as the factor loadings that are exogenously specified to equal either one or zero. For example, since *RD/S* is not assumed to be an indicator of size, its factor loading on the size attribute is set to zero and is not estimated within the model. In addition, we have also constrained the measurement error in the equation of indicator variables *SIGOI* and *IDUM* to be zero, implying that the factor loadings of these variables on their respective attributes are constrained to equal one. Also, we have assumed that the measurement errors, δ, are uncorrelated with each other, with the attributes, and with the errors in the structural equations.

Since the restrictions may not all be appropriate, interpretations of the estimates should be made with caution. It is quite likely, for example, that some of the measurement errors may in fact be correlated. It is unfortunate that there is an arbitrary element in the choice of identifying restrictions; however, similar restrictions must be made implicitly in order to interpret a standard regression model that uses proxy variables.

In contrast to the measurement model, the structural model is totally unrestricted. The model estimates the impact of each of the attributes on each of the different debt ratios. In other words, none of the factor loadings in the structural equations is fixed exogenously. In addition, the correlations between the residual errors in the structural equations are estimated within the model. This allows for the possibility that there exist additional attributes, not considered in the model, that are determinants of each of the debt ratios.

V. Estimates of the Parameters

The parameters of our model can be estimated by fitting the covariance matrix of observable variables implied by the specification of the model (Σ) to the covariance matrix (S) of these variables observed from the sample. In the LISREL system, this is done by minimizing the function,

$$F = \log(\det \Sigma) + \mathrm{tr}(S\Sigma^{-1}) - \log(\det S) - (p + q), \tag{3}$$

with respect to the vector of parameters of the matrices referred to above. This fitting function is derived from maximum-likelihood procedures and assumes that the observed variables are conditionally multinormally distributed.

Our estimates of the parameters of the measurement model are presented in Tables II and III. The estimates are generally in accord with our a priori ideas about how well the indicator variables measure the unobserved attributes. Both the direction and the magnitude, as well as the statistical significance, of the estimates suggest that these indicators capture the concepts we wish to consider as determinants of capital structure choice.[12]

The estimates of the structural coefficients are presented in Table IV. These coefficients specify the estimated impact of the unobserved attributes on the observed debt ratios. For the most part, the coefficient estimates for the long-term and short-term debt ratios were of the predicted sign. However, many of the estimated coefficients are fairly small in magnitude and are statistically insignificant. In particular, the attributes representing non-debt tax shields, asset structure, and volatility do not appear to be related to the various measures of leverage. Moreover, the estimated models explain virtually none of the cross-sectional variation in the convertible debt ratios.

Some of the coefficient estimates are both large in magnitude and statistically significant. The large negative coefficient estimate for the uniqueness attribute (ξ_2) indicates that firms characterized as having relatively large research and development expenditures and high selling expenses, and that have employees with relatively low quit rates, tend to have low debt ratios. The coefficient

[12] The goodness of fit of the measurement model was evaluated by testing the model against two alternatives. (See Bentler and Bonett [4].) The first alternative model is one in which the observed variables are assumed to be mutually uncorrelated—the χ^2-statistic equals 1893, with 42 degrees of freedom, which for this test is highly significant. The second alternative model specifies that the covariance matrix is totally unrestricted. The χ^2-statistic equals 378, with 63 degrees of freedom; this result is also highly significant, indicating that, although our model captures a significant part of the information in the sample covariance matrix, relaxing one or more of the imposed restrictions could improve the fit of the model.

Table II

Measurement Model: Factor Loadings for Independent Variables[a]

	Attributes								
Variable	ξ_1 (Growth)	ξ_2 (Uniqueness)	ξ_3 (Non-Debt) Tax Shields	ξ_4 (Collateral Value)	ξ_5 (Size)	ξ_6 (Profitability)	ξ_7 (Volatility)	ξ_8 (*IDUM*)	σ^2_δ
NDT/TA			0.779						0.393
			(26.7)						
ITC/TA			0.606						0.744
			(19.2)						
D/TA			0.848						0.280
			(30.1)						
RD/S	0.246	0.781							0.401
	(6.6)	(21.6)							
SE/S		0.681							0.536
		(19.7)							
CE/TA	0.951								0.095
	(26.4)								
INT/TA				−0.331					0.891
				(−8.7)					
IGP/TA				1.180					−0.392
				(15.7)					
LnS					0.938				0.120
					(7.9)				
GTA	0.471								0.778
	(13.9)								
QR		−0.228			−0.273				0.896
		(−5.6)			(−5.5)				
OI/TA						0.641			0.589
						(18.8)			
OI/S						0.998			0.005
						(27.8)			
SIGOI							1.000		0.000
IDUM								1.000	0.000

[a] Reported *t*-statistics are in parentheses.

Table III

Estimated Correlations between Attributes

Attribute	ξ_1	ξ_2	ξ_3	ξ_4	ξ_5	ξ_6	ξ_7	ξ_8
ξ_1 (Growth)	1.00							
ξ_2 (Uniqueness)	−0.18	1.00						
ξ_3 (Non-Debt Tax Shields)	0.72	−0.04	1.00					
ξ_4 (Asset Structure)	0.27	−0.39	0.47	1.00				
ξ_5 (Size)	0.15	−0.18	0.19	0.28	1.00			
ξ_6 (Profitability)	0.53	0.12	0.46	0.12	−0.02	1.00		
ξ_7 (Volatility)	−0.08	−0.01	−0.02	0.03	−0.11	−0.04	1.00	
ξ_8 (Industry Dummy)	−0.14	0.38	−0.13	−0.22	−0.24	−0.10	−0.05	1.00

Table IV

Estimates of Structural Coefficients[a]

Debt Measures	Attributes							
	ξ_1 (Growth)	ξ_2 (Uniqueness)	ξ_3 (Non-Debt Tax Shields)	ξ_4 (Asset Structure)	ξ_5 (Size)	ξ_6 (Profitability)	ξ_7 (Volatility)	ξ_8 (Industry Dummy)
1. *LT/MVE*	−0.068	−0.263	−0.058	0.041	−0.033	−0.213	−0.031	−0.106
	(−0.7)	(−3.7)	(−0.6)	(0.8)	(−0.6)	(−3.7)	(−0.7)	(−2.1)
ST/MVE	−0.112	−0.260	−0.041	−0.046	−0.183	−0.179	−0.017	−0.063
	(−1.2)	(−3.7)	(−0.4)	(−0.9)	(−3.2)	(−3.1)	(−0.4)	(−1.2)
C/MVE	−0.067	−0.076	−0.050	0.004	0.055	−0.108	−0.027	0.026
	(−0.7)	(−1.0)	(−0.5)	(0.1)	(1.0)	(−1.8)	(−0.6)	(0.5)
2. *LT/BVE*	0.230	−0.281	−0.113	−0.076	−0.132	−0.052	−0.043	−0.066
	(2.4)	(−3.6)	(−1.1)	(−1.4)	(−2.3)	(−0.9)	(−0.9)	(−1.2)
ST/BVE	0.140	−0.185	−0.079	−0.096	−0.284	−0.044	−0.038	−0.051
	(1.5)	(−2.4)	(−0.8)	(−1.7)	(−4.1)	(−0.7)	(−0.8)	(−0.9)
C/BVE	0.028	−0.065	−0.156	−0.019	0.050	0.026	−0.016	0.074
	(0.3)	(−0.8)	(−1.5)	(−0.3)	(0.9)	(0.4)	(0.3)	(1.3)

[a] The coefficient estimates are scaled to represent the estimated change in the dependent variable, relative to its variance, with respect to a change in an attribute, relative to its variance. Reported t-statistics are in parentheses.

estimate of −0.263 in the equation with *LT/MVE* indicates that firms that differ in "uniqueness" by one variance are expected to have long-term debt ratios that differ by 0.263 variances. This evidence, along with the estimated coefficients of the industry dummy variable, are consistent with the implications of Titman [39]. As mentioned previously, a negative relation between uniqueness and the debt ratios could also be due to the relation between this attribute and non-debt tax shields and collateral values.

Although the reported t-statistics for the coefficients of the uniqueness attribute are quite high, we feel that their statistical significance should be interpreted cautiously. The reported t-statistics are based on the assumptions of independent, identical, and normally distributed error terms—assumptions that are surely violated by our data. To provide further evidence about the statistical significance of the relation between uniqueness, the industry dummy, and the measured debt ratios, we compared the estimated likelihood function for the reported model with the likelihood function of the model with the coefficients of uniqueness and the industry dummy constrained to equal zero. The difference in these likelihood functions has a χ^2 distribution with six degrees of freedom. The estimated χ^2 for the debt ratios scaled by market values equals forty, which is statistically significant at well beyond the 0.005 level. With the debt ratios scaled by book value of equity, this statistic equals seventeen, which is significant at the 0.01 level. Given these results, we feel comfortable in asserting that the evidence supports the implication of Titman [39] that firms that can potentially impose high costs on their customers, workers, and suppliers in the event of liquidation tend to choose lower debt ratios.

The evidence also indicates that small firms tend to use significantly more short-term financing than large firms. This difference in financing practice probably reflects the high transaction costs that small firms face when they issue long-term debt or equity. Our finding that small firms use more short-term financing may also provide some insights about possible risk factors underlying the "small-firm effect." By borrowing more short term, these firms are particularly sensitive to temporary economic downturns that have less of an effect on larger firms that are less leveraged and use longer term financing. (See Chan, Chen, and Hsieh [10] for a similar argument and evidence relating to this.)

The results also suggest that size is related to *LTD/BVE* but not *LTD/MVE*. This finding may be due to the positive relation between our size attribute and the total market value of the firm. Firms with high market values relative to their book values have higher borrowing capacities and hence have higher debt levels relative to their book values. Thus, rather than indicating a size effect, we think that this evidence suggests that many firms are guided by the market value of their equity when selecting their long-term debt levels.

Coefficient estimates for the "profitability" attribute are large and have high t-statistics in the equations with debt over market value of equity-dependent variables, but they are not statistically significant in the equations with the debt measures scaled by book value of equity. This suggests that increases in the market value of equity, due to an increase in operating income, are not completely offset by an increase in the firm's borrowing. This provides additional evidence supporting the importance of transaction costs and is consistent with the observation of Myers [27] regarding what he calls "the pecking order theory" that firms prefer internal to external financing. However, the evidence suggests that borrowing is increased to the extent that the higher operating income leads to an increase in the book value of equity (through increases in retained earnings). This suggests that many firms do in fact use book value target debt-to-equity ratios.

It should be emphasized that the significant coefficient estimates for profitability and size are not necessarily inconsistent with the hypothesis of capital structure irrelevance. As we mentioned in Section III, significant coefficient estimates for either (but not both) the market value or book value equations are consistent with debt ratios being chosen randomly. Similarly, we should not view the positive coefficient estimate of the growth attribute in the long-term debt over book value of the equity equation as necessarily being inconsistent with the agency- and tax-based theories that predict a negative coefficient for this attribute. The observed positive coefficient simply implies that, since growth opportunities add value to a firm, they increase the firm's debt capacity and, hence, the ratio of debt to book value, since this additional value is not reflected in the firm's book value.

VI. Robustness

An examination of the correlation matrix of the sample data (Table V) provides some insights about the robustness of our results. Particularly noteworthy is the high negative simple correlation between *OI/TA* and the various debt ratios. This relation can potentially create a problem in interpreting the correlation between variables scaled by either *OI* or *TA* and the debt ratio measures.

The best examples of this are the indicators of non-debt tax shields. For instance, the simple correlation between *NDT/TA* and the different measures of leverage is strongly negative. While this correlation is predicted by the DeAngelo and Masulis [12] model, it should be noted that the large negative correlation may be due to the large positive correlation between *OI/TA* and *NDT/TA* caused by their common denominators. In the estimated structural model, where we control for the profitability attribute that is measured by *OI/TA* and *OI/S*, the coefficient estimate for the non-debt tax shield attribute is not statistically significant. Moreover, if we replace the denominators of the non-debt tax shield indicators with *OI*, the simple correlations are still just as strong but are reversed. For example, *NDT/OI* is strongly negatively correlated with *OI/TA* and strongly positively correlated with the measures of leverage. Using indicators scaled by *OI* for the non-debt tax shield attribute leads to positive coefficient estimates that are sometimes marginally statistically significant in the structural equations. While this result is inconsistent with the DeAngelo and Masulis model, it is most likely caused by the way the variables used as indicators are scaled.

We expect that similar changes in coefficient estimates caused by scaling indicator variables by *OI* rather than *TA* would be found for other attributes. For example, *IGP/OI* is very highly correlated with the inverse of *OI/TA* and is therefore probably strongly positively correlated with leverage. This positive correlation could be put forth as evidence in support of the hypothesis that firms

Table V

Correlation Matrix

	LT/ MVE	*ST/ MVE*	*C/ MVE*	*LT/ BVE*	*ST/ BVE*	*C/ BVE*	*NDT/ TA*	*ITC/ TA*	*D/ TA*	*RD/ S*	*SE/ S*	*CE/ TA*	*INT/ TA*	*IGP/ TA*	*LnS*	*GTA*	*QR*	*OI/ TA*	*OI/ S*	*SIGOI*	*IDUM*
LT/MVE	1.																				
ST/MVE	0.66	1.																			
C/MVE	0.29	0.19	1.																		
LT/BVE	0.73	0.47	0.15	1.																	
ST/BVE	0.43	0.75	0.10	0.66	1.																
C/BVE	0.15	0.10	0.89	0.14	0.11	1.															
NDT/TA	−0.25	−0.32	−0.15	−0.11	−0.17	0.14	1.														
ITC/TA	−0.06	−0.14	−0.06	0.09	−0.02	−0.07	0.46	1.													
D/TA	−0.08	−0.12	−0.10	0.02	−0.02	−0.09	0.66	0.52	1.												
RD/S	−0.27	−0.24	−0.07	−0.19	−0.12	−0.03	0.30	−0.04	0.11	1.											
SE/S	−0.25	−0.14	−0.08	−0.20	−0.06	−0.04	0.06	−0.24	−0.10	0.50	1.										
CE/TA	−0.14	−0.20	−0.13	0.14	0.04	−0.06	0.51	0.47	0.58	0.09	−0.13	1.									
INT/TA	0.03	0.02	0.13	0.00	−0.01	0.12	−0.13	−0.11	−0.17	−0.03	0.23	−0.09	1.								
IGP/TA	0.09	0.06	0.03	0.01	0.11	0.08	0.37	0.39	0.51	−0.22	−0.43	0.31	−0.39	1.							
LnS	0.04	−0.14	0.05	−0.07	−0.24	0.01	0.18	−0.01	0.17	−0.01	−0.25	0.14	−0.09	0.31	1.						
GTA	−0.20	−0.22	−0.17	0.04	−0.01	−0.10	0.24	0.26	0.27	0.18	0.07	0.45	−0.03	−0.01	−0.18	1.					
QR	0.11	0.19	0.06	0.10	0.14	0.02	−0.13	0.03	−0.01	−0.23	−0.01	−0.04	0.07	−0.13	−0.22	0.07	1.				
OI/TA	−0.38	−0.34	−0.23	−0.24	−0.19	−0.17	0.31	0.18	0.29	0.03	0.07	0.25	−0.04	0.09	−0.01	0.20	−0.06	1.			
OI/S	−0.29	−0.28	−0.18	−0.02	−0.03	−0.05	0.41	0.20	0.39	0.19	0.12	0.50	−0.06	0.14	−0.02	0.29	−0.13	0.64	1.		
SIGOI	0.00	0.03	−0.02	−0.04	−0.01	−0.02	−0.02	−0.02	−0.01	0.02	−0.05	−0.07	0.04	−0.04	−0.10	−0.09	−0.04	−0.02	−0.04	1.	
IDUM	−0.17	−0.07	0.01	−0.13	−0.04	0.06	−0.08	−0.16	−0.11	0.32	0.16	−0.14	−0.04	−0.25	0.23	−0.03	−0.18	−0.11	−0.10	−0.06	1.

with assets that have high collateral value choose high debt levels. However, we feel that such a variable would actually be measuring profitability and therefore thought it more appropriate to scale the variable by *TA*.

The above discussion suggests that one should be cautious when interpreting variables scaled by operating income (*OI*) that are positively correlated with debt ratios and to a lesser extent variables scaled by total assets (*TA*) that are negatively related to the debt ratios. Fortunately, the indicators of "uniqueness", the attribute that appears to do the best job explaining debt ratios, are not scaled by either *TA* or *OI*. Research and development expenditures could conceivably have been scaled by *OI* or *TA*; however, the correlation between debt and this variable is not nearly as sensitive to its scaling as, for example, *NDT*. The other indicators of "uniqueness", *SE/S* and *QR*, suggest no alternative scaling variable; hence, the robustness of the correlation between these variables and the debt ratios is not a serious issue.

VII. Summary and Conclusion

This paper introduced a factor-analytic technique for estimating the impact of unobservable attributes on the choice of corporate debt ratios. While our results are not conclusive, they serve to document empirical regularities that are consistent with existing theory. In particular, we find that debt levels are negatively related to the "uniqueness" of a firm's line of business. This evidence is consistent with the implications of Titman [39] that firms that can potentially impose high costs on their customers, workers, and suppliers in the event of liquidation have lower debt ratios.

The results also indicate that transaction costs may be an important determinant of capital structure choice. Short-term debt ratios were shown to be negatively related to firm size, possibly reflecting the relatively high transaction costs small firms face when issuing long-term financial instruments. Since transaction costs are generally assumed to be small relative to other determinants of capital structure, their importance in this study suggests that the various leverage-related costs and benefits may not be particularly significant. In this sense, although the results suggest that capital structures are chosen systematically, they are in line with Miller's [25] argument that the costs and benefits associated with this decision are small. Additional evidence relating to the importance of transaction costs is provided by the negative relation between measures of past profitability and current debt levels scaled by the market value of equity. This evidence also supports some of the implications of Myers and Majluf [28] and Myers [27].

Our results do not provide support for an effect on debt ratios arising from non-debt tax shields, volatility, collateral value, or future growth. However, it remains an open question whether our measurement model does indeed capture the relevant aspects of the attributes suggested by these theories. One could argue that the predicted effects were not uncovered because the indicators used in this study do not adequately reflect the nature of the attributes suggested by theory. If stronger linkages between observable indicator variables and the relevant attributes can be developed, then the methods suggested in this paper can be used to test more precisely the extant theories of optimal capital structure.

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