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THE EFFECTS OF COMPLEX CAPITAL STRUCTURE
ON THE MARKET VALUES OF FIRMS

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Summary:

In this study, the familiar Modigliani and Miller risk class model provided the bas to test for a difference in value between simple and complex capital structure groups o firms in the same risk class. Cluster analysis, using market risk measures and debt-equ ratios as inputs, provided the method for obtaining the required risk class sample of firms. Cross sectional tests at the end of 1972, 1973, and 1974, for the sample of 26 complex capital structure firms, indicated that capital structure was a highly significa effect. For all periods examined, the complex capital structure firms were valued lowe than the simple capital structure firms. One explanation for the results is that most the convertible securities for the complex capital structure group were overhanging issu during the test period.

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The Effects of Complex Capital Structure on the Market Values of Firms

Thomas J. Frecka*

I. Introduction

Spurred by the seminal work of Modigliani and Miller [19], an issue of continuing concern and controversy in the field of finance has been the effect of the financing decision on firm market values. Despite the persistance of controversy, progress has been made at both theoretical and empirical levels. At the theoretical level, the MM arbitrage proofs have been extended and illustrated to hold in a variety of contexts by numerous authors.[1] And those theorists who continue to believe that capital structure matters have turned from ad hoc rationalization to more explicit consideration of the effects of certain market imperfections. At the empirical level, the main progress stems from the use of increasingly sophisticated econometric techniques to deal with a variety of measurement problems.[2] As a minimum, the result of continuing research during the last twenty years has been to raise the discussion to a higher plane.

Despite the plethora of research dealing with capital structure and value relationships, neither the theory nor empirical tests of the MM risk class model have explicitly considered the impact of convertible securities and warrants on firm market values.[3] This is somewhat surprising given the continuing interest[4] in these forms of financing and the sometimes confusing reasons given for their issuance, as explained below.

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*University of Illinois, Champaign-Urbana. This paper is a summary of my dissertation, completed at Syracuse University in 1978. Grateful acknowledgement is given to George M. Frankfurter, who served as chairman, and helped formulate the research question.

A major purpose of this study is to investigate empirically the effects of complex capital structure on firm market values. This is accomplished by testing for a difference in value between simple and complex capital structure groups of firms in the same risk class.

Despite the variety of analytic proofs showing that the existance of security types simply results in a fragmentation of the firm's total earnings stream among various security holders, suggestions that complex capital structure may impact on firm values are prevalent. These suggestions are evaluated in Part II. Related to this point, arbitrage proofs for the complex capital structure case within the two period risk class model are shown in Appendix 1.

An important assumption of the MM theory is that firms can be assigned to equivalent risk classes. Part III discusses limitations of previous risk class approaches and suggests the use of a new procedure based on cluster analysis.

Part IV discusses sample selection procedures, measurement procedures, statistical tests, and results.

A summary is provided in Part V, including limitations and suggestions for future research.

II. Reasons Complex Capital Structure May Impact on Firm Values

The traditional view concerning the effect of convertible securities on value is expressed by Johnson [15, p. 403] as follows.

> But the dilution of earnings per share is not necessarily equivalent to the dilution of price per share. Although conversion brings a drop of earnings per share ..., it does not follow that the market value

> of common stock will decline by the same percentage. Given the smaller financial risk attributable to the common stock because of the reduction of financial leverage, the price-earnings ratio may rise to offset in part the decline in earnings.

The above statement suggests that current shareholders react to a combined dilution and leverage effect associated with convertible securities. But the main concern is with dilution.

Dilution represents an expropriation of value without appropriate compensation.[5] In a perfect market,[6] it is assumed that security holders protect themselves from dilution by a variety of "me first" rules. With respect to convertible securities, while the firm and current shareholders do suffer an opportunity loss upon conversion, this loss is not without compensation. For in a perfect market, this opportunity loss should be exactly offset by the present value of accumulated savings in interest due to originally issuing the convertible security instead of straight debt.[7] But even if dilution in the above sense is possible, this only means that classes of security holders may not be indifferent to capital structure. Total firm value should be unaffected.[8]

Another set of arguments is based on the belief that management can more accurately estimate the firm's growth opportunities than the market. These arguments are based on the empirical fact that, on average, companies experience much higher stock price appreciation before issuing complex securities than occurs after the securities are issued.

It has been shown that investors are willing to pay a premium for past growth indicating their optimism that it will continue.[9] The implication is that managers believe they can successfully "fool the market" regarding growth, thus resulting in overvalued complex securities and firms.

A somewhat contrary explanation of how management might act if it perceived the market was unable to impound growth opportunities is as follows. If management believed its firm's common stock to be underpriced, perhaps due to nondisclosure of a recently developed growth opportunity or the market's failure to impound a disclosed growth opportunity in current stock prices, convertible securities could be issued to finance such opportunities. When the investment resulted in increased earnings, conversion would occur. The implication is that management seeks to protect current shareholders from the effects (if any) of current earnings dilution by issuing the convertible security rather than currently issuing stock.[10]

Although the difficulty of defining, measuring, and forecasting growth is admitted, it seems unlikely that the market is unable to make unbiased estimates of growth based on the information set available. The substantial empirical evidence concerning market efficiency in a variety of contexts might lead us to suspect that the market is also efficient regarding growth. But empirical tests will, hopefully, confirm or deny this suspicion.

A final suggestion as to why complex capital structure might affect market value is based on the leverage preferences of "gamblers." Although equity and debt markets are dominated by risk averse investors, this is less likely to be true in markets for convertible securities, warrants, and options. Given the well-known leverage opportunities associated with these latter securities, risk loving investors may bid up the price of these securities and firms in periods of high growth. Presumably the opposite effect would occur if anticipated growth was not forthcoming, e.g., the overhanging issue case.

Despite the above arguments to the contrary, the crux of capital structure theory, given perfect market assumptions, stresses the independence of total firm value and capital structure. Fama and Miller [9] analyze the issue first in a general equilibrium setting and then present the well-known arbitrage arguments using partial equilibrium states of the world and risk class approaches. Hamada [12, 13] has provided the analytic link between the risk class model and the capital asset pricing model. Finally, Merton [17] has provided the analytic link between the Black and Scholes [3] option pricing model and the risk class model.

Theory suggests that the separation principle should continue to hold for the complex capital structure case. While a strict independence will not hold given imperfections such as taxes[11] and assuming risky debt, these considerations are no more or less present for simple or complex capital structures and should not affect test results. Arbitrage proofs using a two period risk class model are illustrated for the complex capital structure case in Appendix 1.

III. The Risk Class Assumption

The null hypothesis examined in this study is that there is no difference in value between groups of simple versus complex capital structure firms in the same risk class. Before explaining the procedure used to obtain a risk class sample in this study, it would be useful to examine the nature and objectives of the risk class assumption.

In a theoretical sense, MM define a risk class as a group of firms whose net cash earnings before interest are perfectly correlated, and hence differ only by a scale factor. "In periods before t, earnings and investments at t are uncertain; but for two firms to be in the same class, investors must agree that whatever values earnings and investment outlays take in any period, for these two firms they are always proportional by the factor λ_i and hence perfectly correlated." [9, p. 161] However, the concept is an ex ante one and risk classes are not directly observable.

In a more pragmatic sense, the risk class assumption refers to firms with equivalent business or operating (as opposed to financial) risk. The objective is to hold operating risk constant so that the effects of financial risk can be observed. But in this study, it is desirable to hold both operating risk and leverage, as defined in the usual sense, constant to determine if complex capital structure impacts on value.

On a third level, the important objective is to obtain a sample that is homogeneous in a statistical sense. The need for sample homogeneity is summarized by Elton and Gruber [6, 7] who note three reasons for grouping in empirical studies:

(1) To isolate units that should in some sense act alike;

(2) To hold the effect of one or more omitted variable constant; or

(3) To obtain a homogeneous relationship between the variables included in the model. [6, p. 81]

All three of these objectives are necessary in a valuation study. But particularly the second objective is critical. Elton and Gruber show that the failure to hold business risk constant may result in (1) biased regression coefficients, (2) biased correlation coefficients, and (3) results that are extremely sample sensitive. The direction of the biases depends on the relationship between the omitted variable(s) and those included in the regression equation.

Previous researchers including MM [19, 21] and Barges [1] have used industry samples in an attempt to achieve homogeneity. But an industry approach is not possible in this study since no single industry or group of industries provides a large enough sample of simple and complex capital structure firms. Furthermore, several studies, including those of Wippern [30], Gonedes [11], Elton and Gruber [6], and more recently by Boness and Frankfurter [4] indicate that industry groups are heterogeneous with respect to business risk. The latter results are particularly striking in that firms in the assumed homogeneous electric utility industry do not pass statistical tests for homogeneity. Boness and Frankfurter conclude that more parsimonious methods should be used to obtain a risk class sample.

Due to limitations of the industry risk class approach, an alternate method of obtaining a sample is required. The objective of the sampling procedure is to select a sufficiently large and homogeneous group of firms from a population that is heterogeneous with respect to business risk. The set of algorithms commonly referred to as cluster analysis techniques seem particularly well suited to this purpose and are used in this study. Although several different clustering algorithms are available, the common objective of most methods is to separate a set of data into groups or clusters that can be viewed as contiguous elements of a statistical population. The hierarchical methods, a subset of cluster analytic techniques, combine objects into larger and larger groups by minimally increasing some generalized distance function. The Euclidean metric is frequently employed, where the distance between points i and j, d_{ij} is defined as:

$$d_{ij} = \{ \sum_{k=1}^{p} (X_{ik} - X_{jk}) \}^{1/2} \qquad (1) \quad [8, p. 56]$$

where X_{ik} and X_{jk} are the scores of objects i and j on variable k, with the summation over p variables. An algorithm that utilizes this Euclidean metric is used in this study.

Although cluster analysis provides a method for obtaining a risk class sample, it is not without problems. Issues such as variable selection, measurement procedures, and criteria for judging the results of clustering remain.

With respect to grouping variables, accounting risk measures, market risk measures, and combinations of accounting and market risk measures are possible choices. Accounting risk measures (financial ratios) have long been used by analysts in the security selection and evaluation process. In the present study, the objective is to use accounting measures to capture the basic risk characteristics of companies which should "behave alike" in the MM partial equilibrium framework. The main advantage of grouping based on accounting risk measures is that the approach focuses on company characteristics evaluated by the market in establishing relative security prices. To the extent variables can be selected that result in a homogeneous risk class, our knowledge of the risk determination process is enhanced.

But there are several limitations to the use of accounting risk measures. First, differences in accounting methods across industries and individual firms may affect the comparability of risk measures and result in inappropriate groupings. Second, there is a lack of theory concerning exactly what accounting measures to include. While a generally agreed upon list of risk measures could be obtained from research done in this area, there is always the danger that factors considered important by the market were not considered. A third disadvantage is that accounting measures lack certain desirable statistical properties.

A currently popular method of obtaining a risk class is to select firms with similar market risk measures. Typically, capital asset pricing theory is invoked which assumes that only systematic risk (beta) affects security prices since nonsystematic risk can be diversified away. Under the assumption that financial risk affects the systematic component of risk, Hamada [13] develops a method of unlevering security returns. While Hamada's approach is widely supported by theory [2, 16, 28], empirical results are mixed.

An appealing approach in this study is to cluster based on beta and similar debt-equity ratios. The approach, while equivalent to Hamada's and only slightly more restrictive, avoids an assumption concerning the financial risk and systematic risk relationship. To the extent nonsystematic risk is deemed important, it can be included as another grouping variable.

Regardless of what set of variables is employed, the distance metric employed in this study weights all sources of variation equally in computing a single distance index between groups. To the extent that some values are larger and fluctuate more than others due to scale differences, greater consideration will be given to them. However, standardization may result in dampening sources of variation that are particularly good discriminators. A more appropriate method of dealing with the weighting question may be to use factor analysis to account for correlations among variables. While the classification of firms into groups may be extremely sensitive to data, this is not considered a problem in this study since a unique risk class is not being sought; all that is sought is a sample that can be accepted as reasonably homogeneous.

In evaluating the success of a particular grouping procedure, the primary test concerns how well the sample satisfies the assumptions of the MM risk class model. Certain statistical tests for homogeneity can be done; but to be valid, the tests should be applied to the valuation model directly.[12] Clearly, the determination of a normative procedure for selecting risk classes would require the testing of all proposed methods in the valuation model. Such tests are beyond the scope of this study. An initial concern is the ability of a given set of variables to interact with the clustering algorithm so as to obtain relatively large groups with little within group variation. If several sets of grouping variables satisfy this requirement, then a choice will be made on theoretical grounds.

IV. Empirical Tests

Sample Selection

The population consisted of 515 calendar year-end industrial companies for which: (1) monthly returns could be calculated from the quarterly COMPUSTAT file for the period February 1967 through December

1972, and (2) required financial statement data was available from the annual COMPUSTAT file for use in the MM model and in clustering routines.

The grouping algorithm for this population was then applied to various sets of accounting and market risk measures.[13] The most important result was that all sets of variables examined in conjunction with the grouping algorithm resulted in some large clusters of firms while maintaining relatively little variation within groups. While there was little correspondence of groups based on different sets of variables, this result was not unexpected.

Somewhat aritrarily, three market risk measures and a leverage variable were finally selected as grouping variables. To obtain the market risk measures, monthly rates of return were computed for the Standard and Poor's Industrial Index for the 1967-1972 period and used as regressors in the equation:

$$r_{it} = a_i + b_i r_{mt} + e_{it} \qquad \begin{array}{l} i = 1, 2, \ldots, 515 \\ t = 1, 2, \ldots, 71 \end{array} \qquad (2)$$

where:

r_{it} is the rate of return of company i in period t,
a_i and b_i are constants,
r_{mt} is the index return in period t,
and e_{it} is a random disturbance.

The resulting parameter estimates and mean square error (nonsystematic risk) were used as the market risk measures. The leverage variable was computed as the ratio: (Current Liabilities + Long-term Debt + Preferred Stock) ÷ Common Equity, using the average of annual observations for 1963 through 1972, and is denoted LEV-3. In order to determine the dilution potential for the population, the ratio: shares reserved for conversion ÷ shares outstanding was also computed. The average values and standard deviations of the market risk measures, the above leverage variable plus two additional leverage variables, and dilution potential are shown in Table I.[14]

In 1972, the average dilution potential for the population averaged about ten percent. Table II further details the potential dilution from 1963 through 1975. The dilution ratio was generally increasing through 1970 and has remained fairly constant since that time. The fact that many companies had high dilution potential while others had relatively low dilution potential provides hope that a risk class sample containing both high and low dilution companies can be formed.

In order to avoid overweighting particular sources of variation and to account for corrections among the risk measures, factor scores[15] from the a_i, b_i, MSE, and LEV-3 measures were used as input to the clustering routine. Table III shows the factor analysis results. Three factors account for about 75 percent of the variability.

Using the first three factor scores as inputs, the clustering algorithm was run and then observed at the point where the 515 firms had been combined into 15 groups. Groups sizes ranged from 2 to 104 firms at this point. While several large clusters were evident, total variation within groups was only 14.613 as compared with total variation of 254.396 for the population based on the factor scores.

A group containing 82 firms was chosen as the cluster from which the sample was obtained. The firms were then classified into simple, intermediate, and complex categories as follows:

(1) simple: dilution potential < 6%

(2) intermediate: dilution potential 6% $\geq$ d. $\leq$ 11%

(3) complex: dilution potential > 11%.

Nine intermediate firms were discarded, leaving 36 complex and 37 simple firms.

An additional requirement was the availability of market values of convertible securities and warrants in published sources. Ten complex firms failed to satisfy this requirement, thus reducing the usable complex sample to 26 firms. Finally, 26 simple firms were randomly selected in obtaining a total sample of 52 firms. Due to the many restrictions placed on the population and on the sample, a caveat is in order when generalizing from the results of tests.

Table IV details the market risk leverage, dilution, and size characteristics of the simple and complex groups. There is no significant difference in the market risk measures for the two groups.[16] However, the attempt to obtain a sample that was equally levered for the two groups was not successful. The complex group's debt to equity ratio of 1.06 was significantly higher than the simple group's ratio of .902.[17] This result may indicate that complex capital structure firms are in general more highly levered than simple capital structure firms. The importance of this difference in leverage must be judged when evaluting the test results.

The most important result of the sample selection process was that a substantial difference in dilution potential was achieved. The complex group's dilution potential averaged about 25% compared with only 3% for the simple group.

One difference between the two groups is average firm size, as measured by total assets in 1972. The simple group's average total assets of $1.002 billion is about fifty percent larger than the complex group's average of $.667 billion. Further consideration is given to the effects of size later.

Comparing Table IV with Table I, note that the average risk measures for the sample are close to the population values. However, the variability of the sample risk measures is substantially less than that of the population. This provides evidence of the homogeneity resulting from the clustering procedure.

Model Selection

The familiar MM valuation model expresses total market value as:

$$V = \frac{1}{\rho}\,\overline{X}(1-\tau) + \tau D + k\overline{X}(1-\tau)\left[\frac{\rho^{*}-C}{C(1+C)}\right]T \qquad (3)\ [21, p. 344]$$

where:

V = total market value of the firm
$\frac{1}{\rho}$ = the appropriate capitalization rate for uncertain pure equity earning streams for the risk class
$\overline{X}$ = expected average annual earnings before interest and tax
τ = the marginal tax rate
D = the market value of debt
k = the earnings growth rate
ρ^{*} = the rate of return on growth opportunities
C = the cost of capital, and
T = the duration of growth.

Econometric analogs of model (3) provided the basis for the 1966 MM tests and are also used in this study for testing hypotheses concerning the effects of complex capital structure on value. The following three models are employed:

$$V-\tau D = a_0 + a_1\overline{X}^T + a_2G + u \quad (4)\ [21,\ p.\ 348]$$

$$\frac{\overline{X}^T}{(V-\tau D)} = a_1' + a_0\frac{1}{V-\tau D} + \frac{G}{V-\tau D} + u \quad (5)\ [21,\ p.\ 349]$$

$$\frac{V-\tau D}{A} = a_0\frac{1}{A} + a_1\frac{\overline{X}^T}{A} + a_2\frac{G}{A} + u \quad (6)\ [21,\ p.\ 350]$$

All three models are now expressed in the form of first order, normal error, multiple regression models. Model (4) is the econometric analog of model (3), with the growth term G simplified. Model (5) is the "yield" formulation of model (4), where $a_1' = \rho$. Model (6) is the deflated version of model (4), where A is the book value of assets. The model was suggested as a means of implementing the weighted least squares approach, under the assumption that the source of heteroscedasticity is firm size.

Dates of Tests

An objective was to test hypotheses at various points in the business cycle. Common stock prices were generally increasing in the early 1970's and reached a peak in December-January 1972-1973. Stock prices generally fell after 1973 and reached low levels at the end of 1974. In contrast, long-term bond prices were relatively flat in the early 1970's but then started to fall rapidly in 1973, reaching a low in the third quarter of 1974.

The test dates were chosen as January 31, 1973, 1974, and 1975 to reflect stock price peaks, midpoints, and troughs respectively. The January 31st dates were chosen to avoid any possible year-end price aberations and so that the previous year's earnings number would be better known by the market. Dates close to year-ends were chosen to avoid measurement errors resulting from post year-end capital structure changes.[18]

Variable Definition

The details of the capital structures of the 52 firms comprising the sample were obtained as of 1972, 1973, and 1974 year-ends. The variables in model (4) were then operationally measured as follows:

V_{it} represents the total market value of firm i at the time t and consists of the market value of all securities and other claims against the assets of the firm. Market prices of common stock, warrants, most convertible securities and preferred stock issues were obtained from published sources.[19]

Based on a pilot study on a smaller sample of 28 firms, it was determined that all non-convertible long-term debt could be measured at book value without significantly affecting the results.[20] Convertible securities and warrants were measured at market values. All other liabilities, primarily current liabilities and deferred taxes, were included at their book values.

The expected cash savings due to the tax deductibility of interest payments, τD, was computed at 48% of the book value of long-term debt. It should be noted that to the extent the market views the issuance of a convertible security as an expectation that the firm will unlever, the operational definition of the tax savings is upward biased for the complex group.

The tax-adjusted earnings term, $\overline{X}^T$, was computed from COMPUSTAT data as operating earnings less taxes (COMPUSTAT variable numbers (13-14)

- 16). The current year's earnings was used under the assumption that the process generating the annual accounting earnings number approximates a random walk [32, 33].

Finally the growth term, G, was measured as in the 1966 MM study using the 4-year linear growth rate of assets times the current year's assets. While this operational definition is not a good proxy for growth in the true sense, the election was made to follow MM due to lack of a better measure.[21]

Hypothesis Testing

Using models (4), (5), and (6) a variety of approaches are available for testing for differences in value between the simple and complex groups. One approach is to add a dummy variable or series of dummy variables representing complex capital structure to the models and test the coefficient(s) for significance. A second approach is to run separate regressions for the simple and complex groups and test for differences in regression lines. A third approach is to test for differences in the average residuals of the two groups using an analysis of variance approach. Essentially, these techniques are equivalent and will be subject to the same econometric problems.

Due to its ability to examine several effects simultaneously, and because of its relative parsimony with respect to theory, an analysis of variance model, using residuals from the two groups as data, was preferred in this study.

Consider the following model:

$$Y_{ijk} = \mu_{..} + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \varepsilon_{ijk} \qquad (7)\ [25, p. 568]$$

$i = 1, 2, 3$
$j = 1, 2$
$k = 1, 2, ..., 26$

where:

$\mu_{..}$ is an overall constant
α_i is the time effect (years 1972, 1973, and 1974)
β_j is the capital structure effect (simple or complex)
$(\alpha\beta)_{ij}$ is the interaction effect
k is the number of replicates.

The Y_{ijk}'s are residuals from the regressions and are assumed independent $N(\mu_{..} + a_i + B_j + (\alpha\beta)_{ij})\sigma^2$ [25, p. 569].[22]

Using model (7), it is possible to test for differences in value between the simple and complex groups by examining the following operational hypotheses:

H_1^1 There is no difference in average residuals over the three year period.

H_2^1 There is no difference in the average residuals of the simple versus complex groups.

H_3^1 There is no interaction between time and capital structure effects.

Note that the use of least squares estimators in models (4), (5), and (6) rules out rejecting H_1^1 since the residuals must sum to zero in any one time period. But the use of the two-way design provides a convenient accuracy check on the data, and more importantly, allows for testing interactions.

<u>Results</u>

Table V summarizes the estimates obtained using model (4) for the combined 52-firm sample. The earnings and growth coefficients are significant in all three years while the constant is not significantly different from zero. The values of the coefficients seem reasonably consistent with the underlying theory.

Plots of residuals on the estimated values of the dependent variable appear in Table VI. The plots show evidence of heteroscedasticity, but there is little evidence that a linear regression function is not appropriate. A possible concern is the presence of some outliers. Standardizing residuals in terms of the residual standard deviation ($\sqrt{M.S.E.}$) from model (4), and treating deviations in excess of 2.5 standard deviations as outliers, several outliers are noted each year. In 1972 and 1973, Phillips Petroleum (+4 s.d.), Texas Instruments (+3 s.d.) and Goodyear (-2.5 s.d.) are outliers. In 1974, Phillips Petroleum and Texas Instruments again appear, along with Bristol Myers and Union Carbide. The outliers all belong to the simple group and are some of the larger firms in the sample.

To assure that a few large firms were not influencing the results, model (4) was rerun, using a reduced sample of the twenty smallest companies from each of the two groups. This procedure had the added advantage of eliminating the previous noted average size difference of the two groups. The regression results are shown in Table VII. It is evident that the estimates are not unduly influenced by the large firms. The earnings and growth coefficients are consistent with the previous results. But the fit is somewhat better as evidenced by smaller standard deviations, generally higher T-statistics and higher R^2 values.

Models (5) and (6) were suggested variance-stabilizing transformations of the basic valuation model. Estimates for these models are shown in Tables VIII and IX respectively.

Model (5) is the "yield" formulation of model (4), where the constant a_1' provides the estimate of ρ. The reciprocal of the constant term is equivalent to the estimated earnings capitalization rate in model (4). Compared with Tables V and VII, the reciprocal values are all higher, but the direction of change over time is consistent with the previous results. As in the MM study, the explanatory power of model (5) applied to this sample is much lower than for the non-deflated model.

The residual plots for model (5) are presented in Table X. The residuals appear particularly well-behaved with an apparent random distribution about zero and no evidence of heteroscedasticity. Only one outlier is noted, Stone Container, in 1974.

Model (6) is the deflated form of model (4), where the deflater is book value of assets. The explanatory power of this model when employed by MM, using a utility sample, was relatively high. But this is not the case in the present study and there is other evidence of model misspecification. This is clear from the residual plots, shown in Table XI. There is a noticeable downward drift in the residuals for higher values of the dependent variable. This effect is especially noticeable in the 1974 plot and may indicate a violation of the linearity assumption, the effect of an omitted variable, or some other misspecification.

The following conclusions seem warranted concerning the adequacy of the sample and models examined. It seems that a relatively homogeneous sample has been obtained using the clustering procedure. This is evidenced by high explanatory power of model (4), coefficients that are consistent with the theory, and evidence that the estimators are not very sample sensitive. Sample homogeneity implies that the average results of the cross-sectional tests are due to the entire sample, rather than due to the influence of just a few firms.

A concern was the average size difference between the simple and complex firms. In the presence of heteroscedasticity, the size difference is important, since it could lead to rejecting the null hypothesis for this reason alone. The use of the reduced sample for model (4) and the deflated model (5) have apparently purged the results of the effect of size differences, but model (6) may be misspecified.

The results of hypothesis testing using the analysis of variance model (7) appear in Tables XII and XIII. Note that time is not a significant effect and that there is no significant interaction.[24] However, for all models tested, capital structure is a highly significant effect. Note the direction of the difference between groups. Except for the deflator, models (4) and (6) are equivalent. The residuals using these models are consistently negative for the complex group and positive for the simple group. In other words, the observed market values for the complex firms consistently fell below the estimated value and the simple firms above. The results from model (5) are consistent with the other models. Since model (5) is the yield formulation of model (4), consistency requires that complex firms sell at higher yields (lower values) than the simple firms, as the results indicate.[25]

Discussion

The test results indicating that complex capital structure firms were valued lower by the market than risk equivalent simple capital structure firms was a surprising result and one that is contrary to the underlying theory and conventional wisdom. For this reason, a variety of additional steps were taken to assure that the results were not due to using different measurement procedures for the two groups or due to perceived risk differences.

In regard to possible measurement differences, the following steps were taken. Off balance sheet financing (leases) were valued and included in measuring the dependent variable. Four simple and five complex firms had substantial amounts of leases. Another concern was a possible overstatement of the tax savings from convertible debt.[26] The dependent variable was recalculated for the complex group under the assumption that the tax savings from convertible debt was zero. Finally, convertible debt was originally computed at market value, while all other debt was computed at book value. Now measuring convertible debt at book value, and along with the other changes, the models were rerun. Conclusions based on the revised measures were unchanged.

A second concern was the procedure used to calculate the market risk measures. These were calculated using historical return series under the assumption of stationarity. Perhaps the risk characteristics of the simple and complex groups differed on an ex post basis which would account for the observed difference in value. To investigate this possibility, the market risk measures were recalculated at the end of 1973, 1974, and 1975 using the seventy-one most recent monthly observations prior to the respective year-ends. Although there were a few anomalies in the results, a general conclusion is that the two groups did not differ significantly in terms of market risk measures for the ex post periods.[27]

There are several possible explanations for the difference in value. One conclusion is that the difference is evidence of market inefficiency. Based on test results, investors should have sold their portion of the more highly valued simple capital structure firms, reinvesting in complex capital structure firms, to obtain the same expected earnings stream at a lower cost. But while market inefficiency is a possible explanation, it seems unlikely that such large and significant differences in value could have persisted over the three year period observed.

To assist in providing an alternate explanation, Tables XIV and XV summarize, as of January 31, 1973, valuation data for convertible bonds and convertible preferred stock included in the sample. Although January 31, 1973 was near a stock market peak, few of the convertible securities were selling at premiums. In fact, most of the convertible debt issues were selling below book values. Although not shown, this disparity between book values and market values became much greater in 1973 as interest rates continued to rise.

Analysis of the issue dates of the complex securities indicated that a high majority were issued in the middle to late 1960's. Empirically, it is known that conversion generally occurs within five to seven years from issue date, or not at all. By the end of 1973, or perhaps earlier, it became obvious that any hoped for conversion was not forthcoming. Thus, for the test period, the market generally viewed the complex securities as overhanging issues.

To the extent there is a cost to the firm associated with overhanging issues, this cost would explain the observed difference in value. The complex firms were already more highly levered than the simple firms and may seek a lower debt/equity ratio in the future. If equity is issued in an attempt to move toward a lower target debt level, the issue may only be marketable at a relatively high cost to the firm. If the target is achieved by calling the convertible securities, the cost of the required funds may also be high. In summary, there are real costs associated with the loss of financing flexibility due to overhanging issues. The market is not ignoring these costs.

Another anomaly in the results is the leverage difference between groups without a corresponding difference in market risk measures. This relationship is inconsistent with Hamada's argument that beta is a function of leverage. The difference in leverage tended to increase from 1973 to 1975. As an explanation of the difference in value, the higher levered complex firms may offer a higher risk of bankruptcy. But this suggestion is not appealing, since ex ante bankruptcy costs are believed to be small [18].

In concluding this section, a statement seems necessary concerning possible measurement error in the independent variables. Since observations on true earnings and growth are not available, it is known that parameter estimates for the valuation equations are biased and the measurement error will be impounded in the residuals. However, parameter estimation was not a primary objective in this study. Unless there is a difference in bias between the simple and complex groups, and there is no reason to expect this to occur, the test results should be unaffected by the presence of measurement error.

V. Conclusion

This study has attempted to extend previous tests of the risk class model by examining the effects of complex capital structure. The major research finding was that, within a risk class sample, a group of complex capital structure companies was valued lower than a group of simple capital structure companies. This occurred over a three-year cross sectional test period when there was little expectation that complex securities would be converted.

Assuming the theory is correct, the sample can be accepted as a homogeneous risk class, and assuming that the always present danger of measurement errors did not affect the results, two possible explanations for the results were suggested. One explanation, market inefficiency, is unlikely to have persisted over the test period. The other explanation, future costs associated with correcting capital structure to a lower target debt/equity ratio for the complex group, is a more likely explanation.

A limitation of the study is that convertible securities were evaluated in a period when conversion was not expected. It would be interesting to repeat the tests in periods when convertible securities are selling at substantial premiums.

Methodologically, cluster analysis seems to provide a useful procedure for obtaining a homogeneous risk class sample. The method provides a useful alternative to the well-known industry and beta adjustment approaches.

TABLE I

Average Market Risk, Leverage, and Degree of Complexity Statistics
515 Industrial, Calendar Year-End Companies

	$\bar{a}_i$*	$\bar{b}_i$*	EXPECTED MONTHLY RETURN***	MSE*	STD DEV OF RETURNS	LEV-1 L.T.D. ÷ COMMON EQUITY	LEV-2 L.T.D. + P.S. ÷ COMMON EQUITY	LEV-3 L.T.D. + P.S. + C.L. ÷ COMMON EQUITY*	SHARES RESERVED FOR CONVERSION ÷ SHARES OUTSTANDING
MEAN	.192	1.194	1.183	72.812	9.415	.402	.466	.923	.101**
STD. DEV.	.971	.446		51.571	2.766	.463	.529	.783	.138

* Variables used in factor analysis

** Average percentage for year 1972

*** Based on index mean = .830

Note: The market risk measures are based on 71 monthly rate of returns observations for the period February 1967 through December 1972. The leverage measures are averages for the 10-year period 1963 through 1972.

TABLE II

Shares Reserved for Conversion As a Per Cent of Outstanding Shares
515 Industrial Firms

		≥50%	≥40%	≥30%	≥20%	≥10%	TOTAL
1963	Number	1	6	7	17	49	515
	Per Cent of Total	.02	1.1	1.4	3.3	8.0	
1964	Number	1	6	8	16	51	515
	Per Cent of Total	.02	1.2	1.6	3.1	9.9	
1965	Number	2	6	8	20	50	515
	Per Cent of Total	.04	1.2	1.6	3.9	9.7	
1966	Number	3	9	11	24	57	515
	Per Cent of Total	.06	1.7	2.1	4.7	11.1	
1967	Number	5	15	22	43	90	515
	Per Cent of Total	1.0	2.9	4.3	8.3	17.5	
1968	Number	8	18	29	53	112	515
	Per Cent of Total	1.6	3.5	5.6	10.3	21.7	
1969	Number	8	17	28	57	127	515
	Per Cent of Total	1.6	3.3	5.4	11.6	24.7	
1970	Number	12	21	44	83	162	515
	Per Cent of Total	2.3	4.1	8.5	16.2	31.5	
1971	Number	14	22	39	76	172	515
	Per Cent of Total	2.7	4.3	7.6	14.8	33.4	
1972	Number	9	22	38	75	167	515
	Per Cent of Total	1.7	4.3	7.4	14.6	32.4	
1973	Number	9	20	39	78	175	515
	Per Cent of Total	1.7	3.9	7.6	15.1	34.0	
1974	Number	9	20	36	82	170	515
	Per Cent of Total	1.7	3.9	7.0	15.9	33.1	
1975	Number	9	21	34	74	171	515
	Per Cent of Total	1.7	4.1	6.6	14.4	33.2	

TABLE III

Summary Factor Analysis Statistics
Alpha, Beta, M.S.E., and LEV-3

Correlation Matrix

	ALPHA 1	BETA 2	M.S.E. 3	LEV-3 4
1	1.00000			
2	-0.35347	1.00000		
3	0.01813	0.40788	1.00000	
4	-0.12980	0.30460	0.18031	1.00000

Eigenvalues

1.44159	0.82411	0.70545	0.00114

Cumulative Proportion of Total Variance

0.36040	0.56642	0.74279	0.74307

VARIABLE	ESTIMATED COMMUNALITY	FINAL COMMUNALITY
1	0.823072	0.822938
2	0.404411	0.403622
3	0.762258	0.762050
4	0.982558	0.982537

TABLE IV

Market Risk and Other Characteristics of Sample

COMPLEX GROUP FIRM NAME	GROUPING VARIABLES a_i	b_i	MSE	LEV-3	DIL. %	SIZE*
Amax	-.025	.711	38.8	.883	.13	1408
Greyhound	-.281	1.136	28.4	1.069	.35	1444
National Distillers	-.377	.708	30.3	.951	.12	966
Cluett Peabody	-.324	1.246	47.2	1.190	.15	316
Wayne Gossard	-.273	1.119	63.3	1.180	.57	40
Fibreboard	-.029	1.194	73.8	1.450	.51	182
Monsanto	-.216	1.126	31.9	.750	.13	2236
Stauffer Chemical	-.275	1.210	36.3	.660	.14	578
Witco Chemical	-.389	1.636	48.2	1.253	.25	229
Lone Star Industries	-.072	1.640	55.9	.747	.18	449
Medusa Corp.	.085	1.369	51.6	.640	.17	148
Interpace Corp.	-.504	1.402	53.8	1.340	.37	158
Armco Steel	-.349	.987	30.5	.720	.15	2082
Crane Co.	-.208	1.234	44.2	1.540	.41	578
Cooper Industries	.007	1.511	80.7	1.160	.43	214
Otis Elevator	-.112	.691	29.8	.740	.18	572
Scovill Mft.	-.191	1.488	44.3	1.160	.43	318
Singer	-.003	1.128	28.3	1.520	.26	1608
Fruehauf	-.118	1.255	48.7	1.150	.19	556
Eaton	-.078	1.549	40.3	.810	.13	947
Amfac	.715	1.294	57.9	1.280	.20	560
Host International	.399	1.445	64.1	1.080	.15	82
GAF Corp.	-.544	1.223	63.5	1.202	.50	610
Copperweld Corp.	-.036	1.109	64.2	.718	.12	83
Interstate Brands	-.069	.524	68.8	.937	.14	98
GATX	.004	1.028	76.5	1.468	.11	864
Average	-.126	1.191	50.5	1.06	.25	667
Standard Deviation	.264	.291	15.96	.282	.14	620

* Book value of total assets for 1972.

TABLE IV

Market Risk and Other Characteristics of Sample

SIMPLE GROUP FIRM NAME	GROUPING VARIABLES a_i	b_i	MSE	LEV-3	DIL. %	SIZE *
Eastern Gas	.014	1.428	84.8	1.415	.03	482
Sante Fe International	.525	1.885	83.4	1.189	.04	185
Domtar Ltd.	.016	1.057	57.7	.876	.00	503
Stone Container	.192	.880	69.4	.649	.00	73
Union Carbide	-.432	1.073	16.9	.763	.00	3718
Koppers Co.	.080	1.028	44.1	.832	.01	470
Bristol Myers	-.175	.948	29.3	1.241	.05	2560
Ansul Co.	.310	1.054	97.8	1.061	.06	48
Marathon Oil	-.220	1.243	46.9	.655	.02	1514
Phillips Petroleum	.503	1.141	62.0	.647	.00	3269
Robertson	-.174	1.050	75.4	.915	.03	133
Goodyear	.080	1.066	28.3	.953	.03	3980
American Can	-.541	.714	25.6	.831	.05	1491
Continental Can	-.186	.880	34.5	.702	.05	1574
Carborundum	.102	1.188	52.8	.565	.06	308
Owens Corning	-.001	1.107	45.3	.588	.04	533
Houdaille	-.007	1.448	52.8	.993	.02	159
Honeywell	-.199	1.932	152.7	1.259	.06	2240
Texas Instruments	.037	1.240	41.6	.741	.06	634
A. O. Smith	.335	1.314	41.7	.700	.06	302
ACF Industries	.182	.692	78.8	1.015	.03	179
Pullman	-.190	.917	35.1	.855	.03	509
H. K. Porter	-.340	.588	42.6	1.245	.00	151
G. C. Murphy	-.088	1.035	45.7	.464	.02	188
Kroger	-.349	1.062	43.4	1.117	.00	811
Servisco	.301	.834	102.4	1.172	.03	36
Average	-.009	1.108	57.346	.902	.03	1002
Standard Deviation	.273	.313	29.629	.253	.02	1191

* Book value of total assets for 1972.

TABLE V

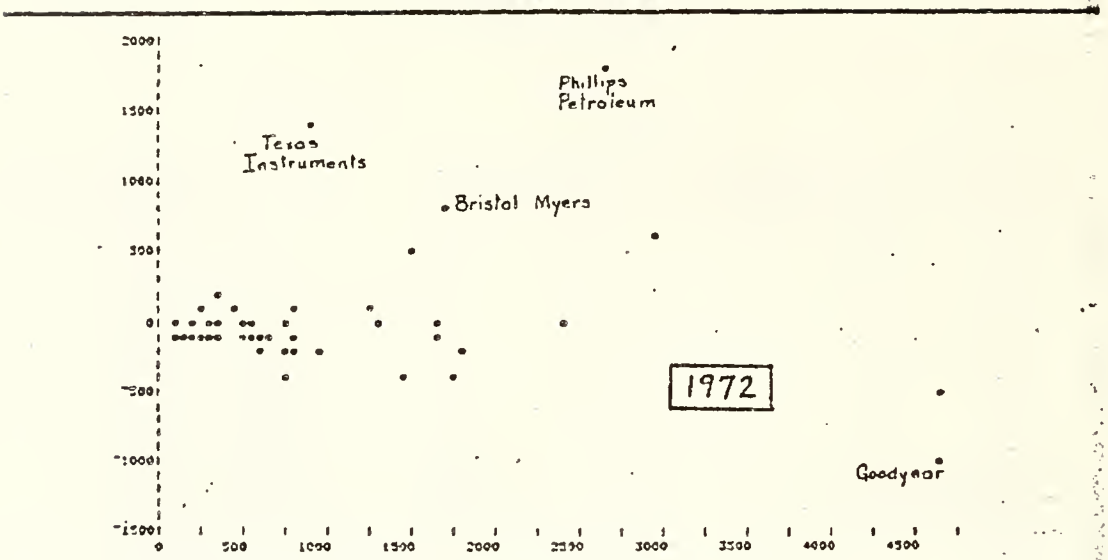
Estimates From Model (4)
52-Firm Combined Sample

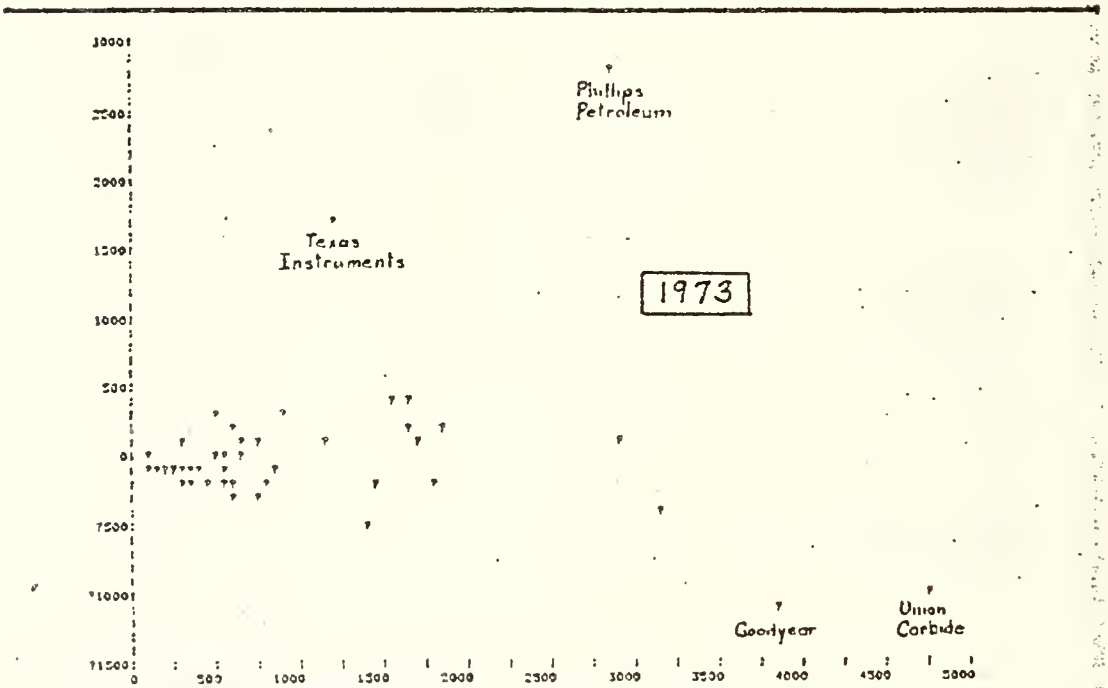
Year		a_0	a_1	a_2
1972		64.078	16.138*	1.477*
	Standard deviation	78.116	1.273	.577
	T statistic	.82	12.67	2.56
	R^2	.85		
1973		76.801	12.269*	1.616*
	Standard deviation	98.911	1.285	.815
	T statistic	.45	9.54	1.98
	R^2	.78		
1974		68.933	7.685*	2.695*
	Standard deviation	54.666	.581	.623
	T statistic	1.26	13.21	4.32
	R^2	.92		

* significant at $\leq$ .05

TABLE VI

Model (4)
Plot Residuals vs. Estimated Y





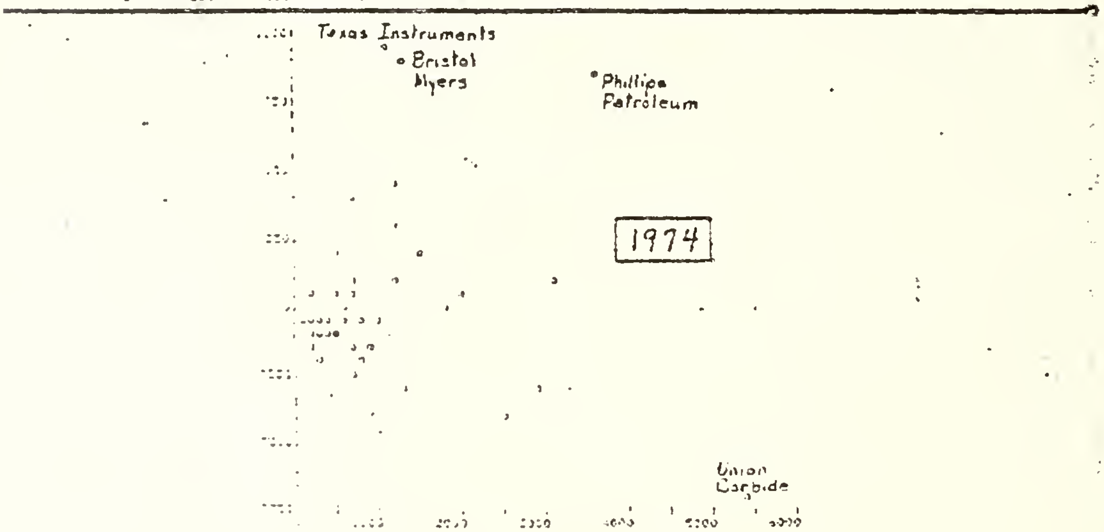


TABLE VII

Estimates From Model (4)
Reduced 40-Firm Sample

Year		a_0	a_1	a_2
1972		19.160	15.671*	.986*
	standard deviation	24.179	.878	.451
	T statistic	.79	17.83	2.19
	R^2	.93		
1973		-17.370	12.536*	2.381*
	standard deviation	33.477	1.088	1.026
	T statistic	.52	11.52	2.32
	R^2	.91		
1974		-22.654	7.807*	3.437*
	standard deviation	29.228	.677	.581
	T statistic	.78	11.53	5.91
	R^2	.93		

* significant at $\leq .05$

TABLE VIII

Estimates From Model (5)
Combined 52-Firm Sample
Dependent Variable: $(X^T/V-\tau D)$

Year		Coefficients of Constant $a'_1=\rho$	Size $a'_0= -a_0\rho$	Growth $a'_2= -a_2\rho$	Reciprocal of Constant
1972		.049*	1.006*	.045	20.408
	std. dev.	.004	.339	.033	
	T stat.	12.36	2.97	1.35	
	R^2	.169			
1973		.069*	1.105*	- .003	14.493
	std. dev.	.008	.435	.075	
	T stat.	9.09	2.54	- .04	
	R^2	.117			
1974		.088*	.749	.046	11.363
	std. dev.	.010	.484	.076	
	T stat.	8.73	1.55	.60	
	R^2	.049			

* significant at $\leq$ .05

TABLE IX

Estimates From Model (6)
Combined 52-Firm Sample

Year		a_0	a_1	a_2
1972		.306	11.693*	1.285
	standard deviation	.247	3.966	.942
	T statistic	1.24	2.95	1.36
	R^2	.188		
1973		.244	8.836*	1.609
	standard deviation	.228	3.245	1.041
	T statistic	1.07	2.72	1.55
	R^2	.179		
1974		.398*	4.533*	1.138
	standard deviation	.135	1.384	.804
	T statistic	2.94	3.28	1.42
	R^2	.204		

* significant at $\leq .05$

TABLE X

Model (5)
Plot Residuals vs. Estimated Y

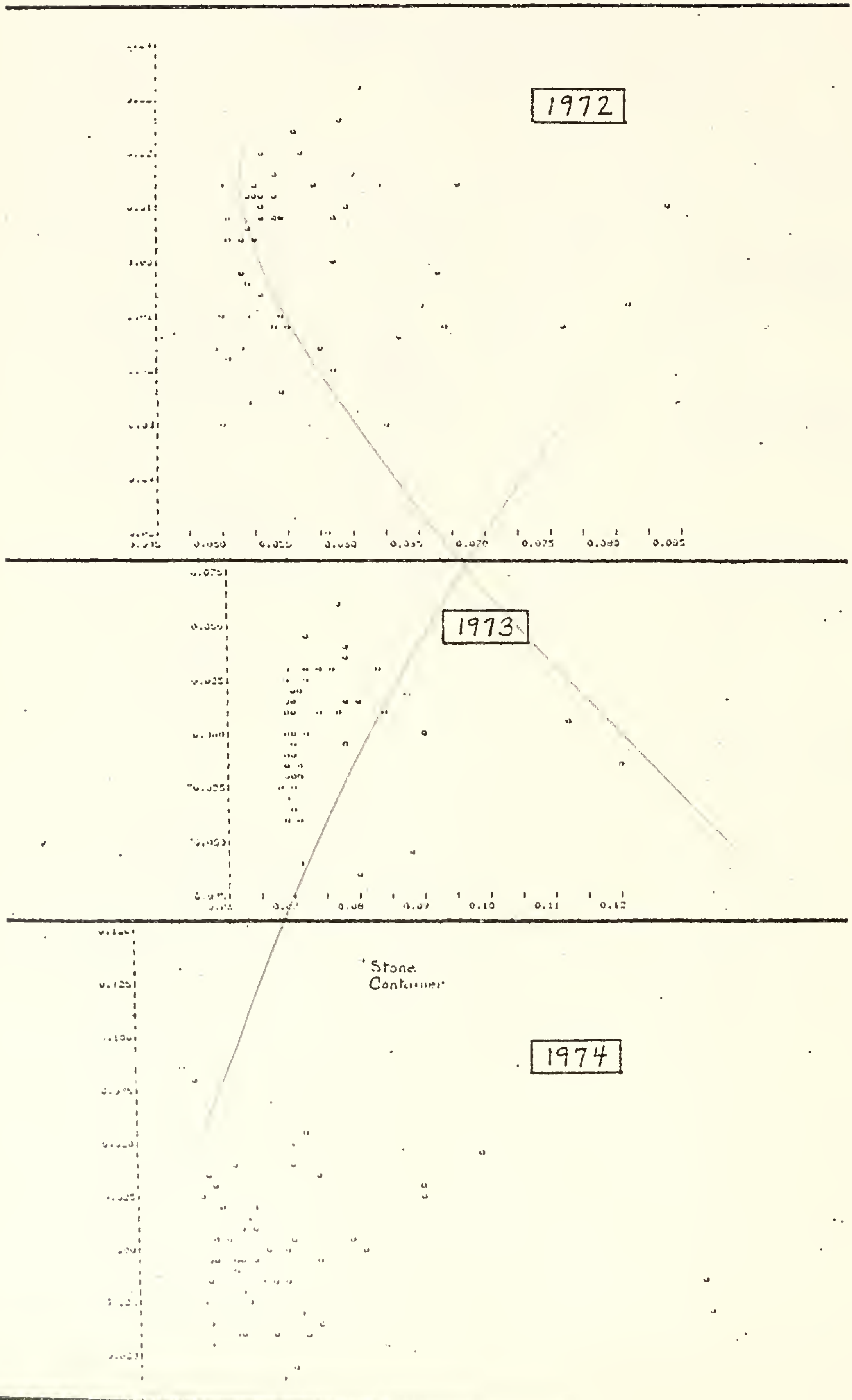


TABLE X

Model (5)
Plot Residuals vs. Estimated Y

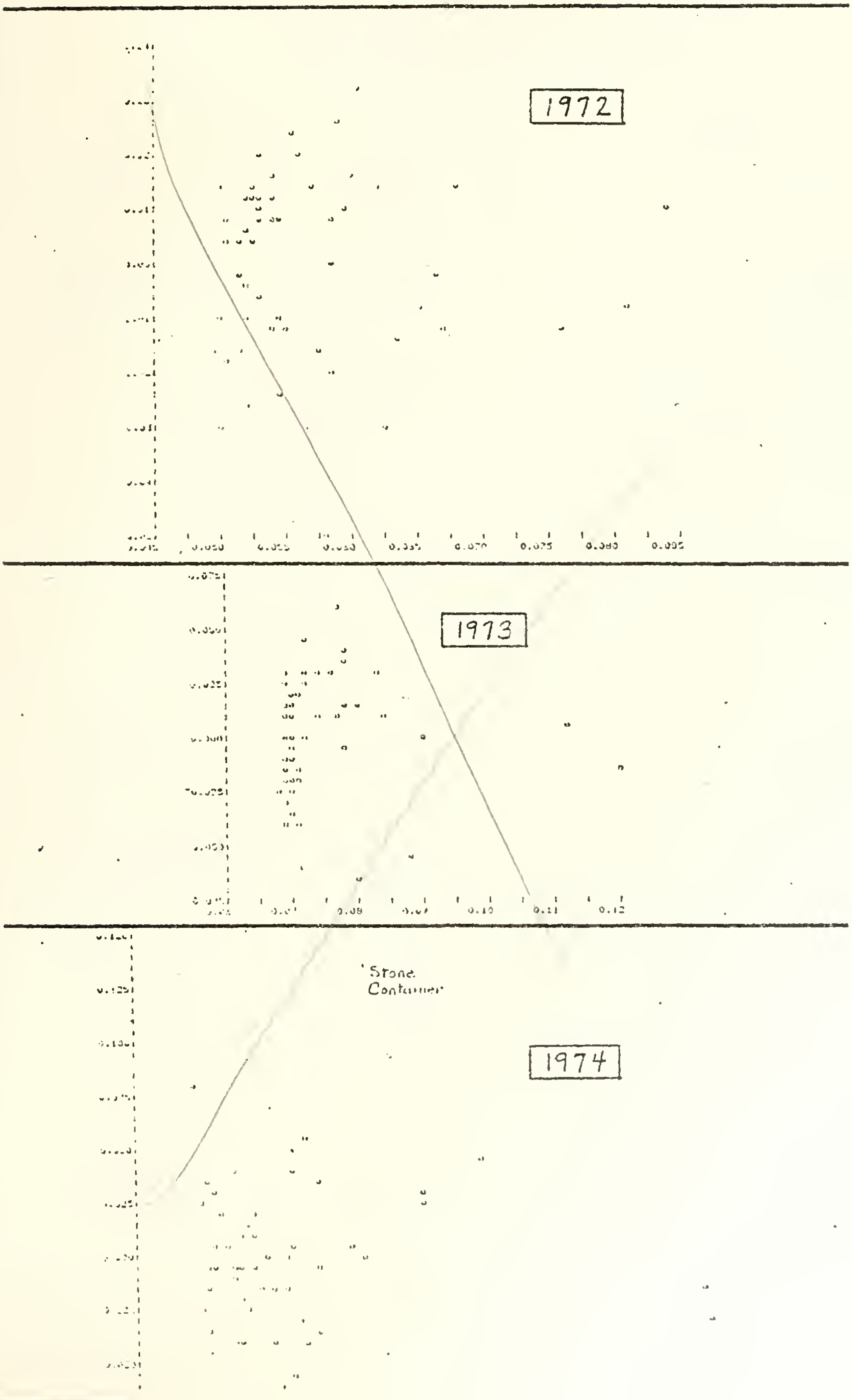


TABLE XI

Model (6)
Plot Residuals vs. Estimated Y

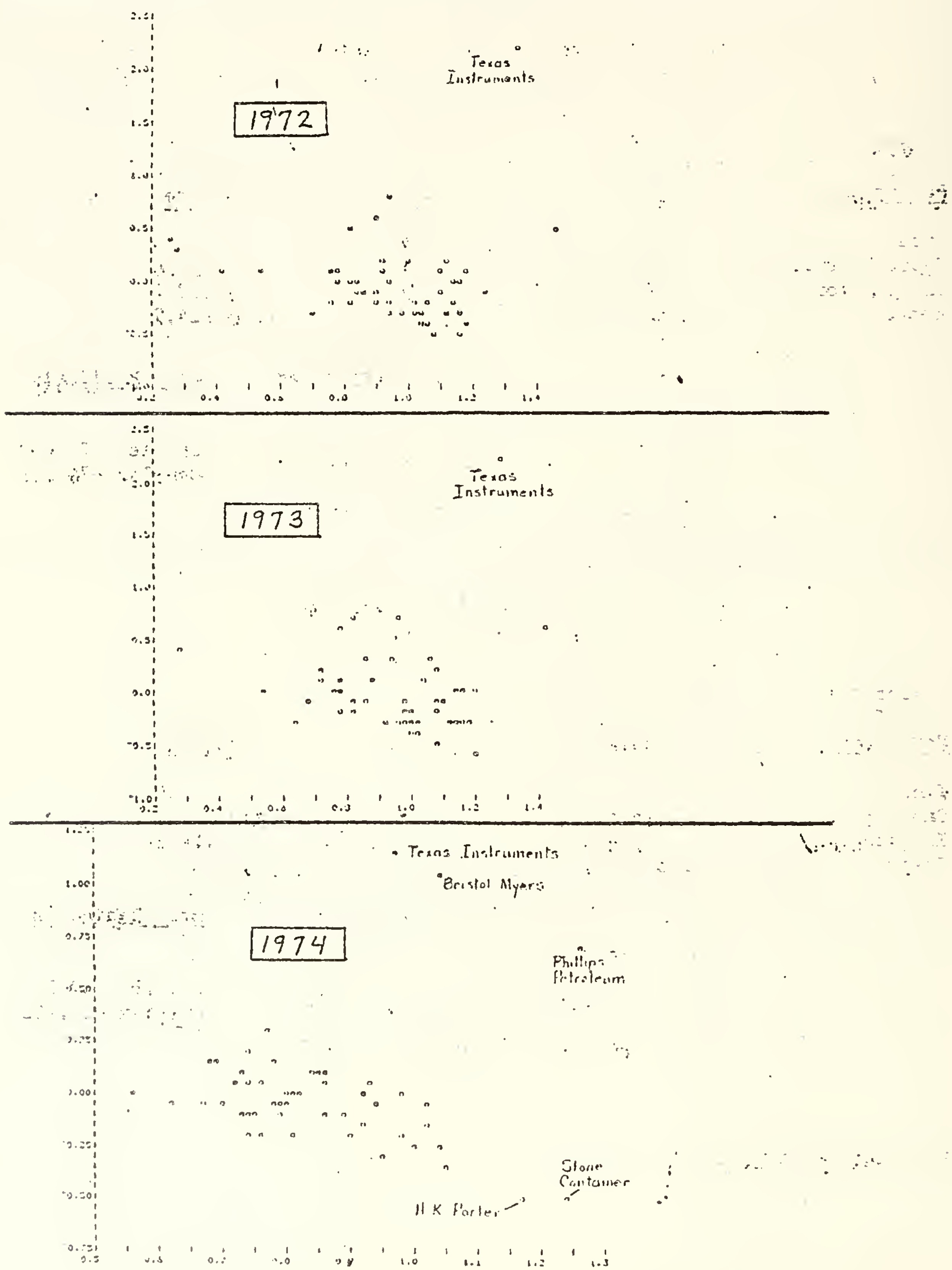


TABLE XII

Test for Difference in Mean Residuals
Model (4) - 52 Firms

Source of Variation	Sum of Squares	D.F.	Mean Square
Time	.0	2	.0
Capital Structure	910,586.6	1	910,586.6
Interaction	41,304.1	2	20,652.1
Error	2,680,720.5	150	178,714.7

		Probability of F*	Mean Residuals
H_1^1	$F^*_{2,150} = 0$	.9999	
H_2^1	$F^*_{1,150} = 5.095$	.0241**	Simple 76.403 Complex -76.399
H_3^1	$F^*_{2,150} = .116$	.8909	

Test for Difference in Mean Residuals
Model (4) - 40 Firms

Source of Variation	Sum of Squares	D.F.	Mean Square
Time	.0	2	.0
Capital Structure	113,114.2	1	113,114.2
Interaction	2,853.6	2	1,426.8
Error	1,525,467.2	114	13,381.3

		Probability of F*	Mean Residuals
H_1^1	$F^*_{2,114} = 0$	.9999	
H_2^1	$F^*_{1,114} = 8.453$	.0045**	Simple 30.702 Complex -30.702
H_3^1	$F^*_{2,114} = .107$	.8987	

** Significant at $\leq .05$

TABLE XIII

Test for Difference in Mean Residuals
Model (5) - 52 Firms

Source of Variation	Sum of Squares	D.F.	Mean Square
Time	.0006	2	.0003
Capital Structure	.0063	1	.0063
Interaction	.0010	2	.0005
Error	.1508	150	.0010

		Probability of F*	Mean Residuals
H_1^1	F* 2,150	.7210	
H_2^1	F* 1,150 = 6.3	.0128**	Simple -.007 Complex .005
H_3^1	F* 2,150	.6253	

Test for Difference in Mean Residuals
Model (6) - 52 Firms

Source of Variation	Sum of Squares	D.F.	Mean Square
Time	.0	2	.0
Capital Structure	1.705	1	1.705
Interaction	.116	2	.058
Error	23.308	150	.155

		Probability of F*	Mean Residuals
H_1^1	F* 2,150	.9999	
H_2^1	F* 1,150 = 10.0	.0013**	Simple .105 Complex -.105
H_3^1	F* 2,150	.6936	

** Significant at $\leq$ .05
*** Yield formulation

TABLE XIV

Convertible Debt

		Book Value*	Market Value*	Conversion Price	Common Price	Conversion Value*
Greyhound						
6 1/2's	1990	$68.1	$68.6	$18.375	$17	$63.0
Nat'l Distillers						
4 1/2's	1992	$60.1	$45.2	$25.02	$15.75	$37.8
Fibreboard						
4 3/4's	1993	$19.7	$14.6	$31.25	$17.375	$11.0
Stauffer Chemical						
4 1/2's	1991	$35.2	$32.4	$53.50	$44.125	$29.0
Witco Chemical						
4 1/2's	1993	$15.0	$14.0	$50.00	$22.75	$ 6.8
Lone Star						
5 1/8's	1993	$28.7	$28.4	$26.00	$20.875	$23.0
Medusa						
5 3/4's	1998	$ 4.9	$ 4.9	$35.00	$33.50	$ 4.7
Crane Co.						
5's	1993	$18.1	$16.8	$25.00	$20.50	$14.8
5's	1994	$34.8	$32.3	$28.75	$20.50	$24.8
Otis Elevator						
6 1/2's	1995	$50.0	$52.5	$46.50	$42.50	$45.7
Fruehauf						
5 1/2's	1994	$60.0	$49.9	$46.25	$31.25	$40.5
Amfac						
5's	1989	$15.1	$13.1	$35.7143	$26.625	$11.3
5 1/4's	1994	$35.0	$30.5	$43.67	$26.625	$21.3

* Millions of dollars

TABLE XV

Convertible Preferred Stock
(Millions of dollars)

	Total Market	Conversion Value
Amax $1 preferred	$ 73.2	$ 58.9
Cluett Peabody $1 preferred	$ 21.8	$ 14.2
Wayne Gossard	$ 7.3	$ 7.0
Monsanto	$140.2	$128.1
Stauffer Chemical $1.80 preferred	$ 17.2	$ 17.3
Witco Chemical $2.65 preferred	$ 15.6	$ 15.5
Interpace 5% preferred	$ 23.3	$ 15.7
Lone Star $14.50 preferred	$ 13.6	$ 12.0
Armco Steel $2.10 preferred	$123.6	$ 79.5
Cooper Ind. $5 preferred	$ 16.8	$ 14.6
$2.50 preferred	$ 27.7	$ 22.2
Scovill	$ 59.2	$ 60.1
Eaton	$30.1	$30.5
Amfac $1.00 B preferred	$ 17.7	$ 14.7
GAF $1.20 preferred	$ 74.1	$ 69.4
GATX $2.50 preferred	$ 38.7	$36.9

Footnotes

1. For example, see Hamada (12, 13), Stiglitz (27), Rubinstein (24), Merton (17), and Miller (18).

2. For instance, see Boness and Frankfurter (4).

3. MM explain in both (19, fnt. 37) and in (21, p. 357) that this issue was avoided in their empirical tests since they had few convertible issues in their samples.

4. Soldofsky (26) estimated \$12.4 billion of convertible bonds and \$17.8 billion of convertible preferred stock was outstanding in 1969. From 1970 to 1977 new issues of convertible bonds ranged from a high of \$3.7 billion in 1971 to a low of \$.5 billion in 1974. New issues of nonconvertible bonds ranged from a low of \$20.1 billion in 1973 to a high of \$40.4 billion in 1975. New issues of preferred and common stock ranged from lows of \$1.4 billion and \$4.0 billion in 1970 and 1974 respectively and highs of \$3.7 billion and \$10.7 billion in 1971 and 1972 respectively. Standard and Poor's <u>Trade and Securities, Statistics, Banking and Finance</u>, July, 1978, p. 27.

5. For a good discussion of the concept, see Hubbard (14).

6. Following Fama and Miller (9, Chp. 4), a frictionless market is assumed in terms of infinitely divisible securities, costless information, the absence of transaction costs and taxes. Further, all financial arrangements are equally available to individuals and firms; individuals and firms are price takers. Finally, investors are assumed to protect themselves from dilution (expropriation without compensation) by means of subordination rules, pre-emptive issues, and other "me first" rules.

7. This tradeoff is explained by Onsi and Frankfurter (22) who also develop a new method of calculating earnings per share based on the opportunity loss concept.

8. This point is discussed using the states of the world model in (9, pp. 178-181).

9. See Poensgen (23, pp. 91-94) for these empirical results.

10. Modigliani and Miller (19, p. 291) and Soldofsky (26, p. 61) offer this explanation.

11. The tax savings from interest on convertible debt will be lower than that from interest on straight debt.

12. An example of a direct test is that of Boness and Frankfurter (4), where the vector of disturbances for each firm is tested for homogeneity.

13. The market risk measures are explained below. The nineteen accounting variables listed in Appendix 2 were used. Both raw scores and factor scores were examined. Further details concerning the clustering procedures can be found in (10).

14. On average, the 515 firms are more risky than firms included in the Standard and Poor's index, as evidenced by an average beta of 1.194, but the average monthly return is also higher than the index. In regard to leverage, the most prevalent feature is the importance of current liabilities as a contributor to total debt, a fact noted by MM in (21).

15. The model used is of the form:

$$z_j = a_{j1}F_1 + a_{j2}F_2 + \ldots + a_{jm}F_m + d_jV_j \quad (j = 1, 2, \ldots, n)$$

where each of the n variables is described linearly in terms of m common factors and a unique factor. See Harman (31, p. 15).

16. Test for differences in means were done using the ANOVA model at the 1% significance level.

17. However, if convertible securities are excluded from debt, the difference is not significant.

18. Test dates are subsequently referred to as 1972, 1973, and 1974. The 52-firm sample had no major capital structure changes during January for the three-year test period.

19. Sources of price data included:

    Moody's Bond Record, Moody's Investors Service, Inc.
    Bond Guide, Standard and Poor's Corporation
    Stock Guide, Standard and Poor's Corporation
    Barron's, Dow Jones and Company, and
    Daily Stock Price Record, Standard and Poor's Corporation

    Financial statement data was obtained from:

    Microfiche, by Disclosure, Inc.
    Moody's Industrial Manual, Moody's Investors Services, Inc.
    Moody's Transportation Manual, Moody's Investors Services, Inc., and
    COMPUSTAT.

20. This was true for several reasons. First, current liabilities comprise a substantial portion of total firm debt. Second, about one-half of all debt issues are privately placed and are not traded in the market. Third, the market prices of most debt issues did not deviate greatly from par during the test period.

21. A summary of the calculations is provided in (10), Exhibit 4-26.

22. Of the independence, normality and constant variance assumptions, the most important is independence. Given this design it is known that the test for differences in means is relatively robust to departures from normality and equal variance assumptions (25). In regard to independence, as possible concern is that residuals for the same firm observed at three points in time are correlated. To the extent this is true, the two-way design has the effect of artifically increasing the sample and the probability of Type-I error. While a more elegant design could be used to exploit any expected correlations, instead, simple one-way analyses for individual years will be used to supplement the two-way analysis. If inconsistencies result, alternate designs can be explored.

23. Residual plots for the reduced sample showed a reduction in the severity of both the heteroscedasticity and outlier problems. Only two possible outliers remained, Pullman (+3 s.d.) in 1972 and Amfac (-3.5 s.d.) in 1974.

24. The absence of interactions implies that the main effects are meaningful measures of the differences between groups.

25. One-way analyses were also run on residuals from model (4). For the 52-firm sample, capital structure was significant at 5% to 15% levels in the three years. For the 40-firm sample, significance level were from .5% to 5%. This provides evidence that the results of the two-way analysis are not greatly influenced by any correlations among a specific firm's residuals over time.

26. Miller (18) has suggested that the previously assumed tax savings from debt may be substantially overstated. This should not affect the results of the present study as long as there is no differential bias in the calculations for the simple versus complex groups.

27. The anomalies were significant b_0 differences for 1973 and 1974, and a difference in b_1 that was significant at the 9.3 percent level for 1973.

Appendix 1.

Arbitrage in the Two Period Risk Class Model
Complex Capital Structure Case

In the two period model,* the firm makes production decisions at period - 1 that will yield probability distributions of net cash earnings at period - 2 to be paid to security holders at that time. The role of the capital market is to establish prices for such securities at period - 1. Let us consider the market values of three firms—one unlevered, a second with straight debt as part of its capital structure, and a third whose debt can be converted into a specified percentage y of the number of common shares issued at period - 1 at the option of the holder at period - 2. It is presumed that the market at period - 1 anticipates the same period - 2 net cash earnings for the three firms such that $X_{c(2)} = X_{b(2)} = X_{u(2)} = X_{(2)}$, where the subscripts mean complex, levered and unlevered respectively. In the ensuing discussion, the following notation is used, with subscripts as above:

V = total market value of the firm at period - 1.
S = total market value of common shares at period - 1.
B = total market value of debt at period - 1.
R = total paymentes to debtholders at period - 2.

Let us now consider the market value of α percent investments in each firm.

The market value of an α percent investment in the unlevered firm is:

$$\alpha V_{u(1)} = \alpha S_{u(1)} \quad (8)$$

*The example assumes a perfect market (see footnote 6.) and no taxes. Notation follows Fama and Miller [9, Chp. 4].

and the period - 2 return is:

$$\alpha X_{u(2)} = \alpha X_{(2)} \tag{9}$$

An investor could obtain the same return by purchasing α percent of the stocks and bonds of the levered firm. In this case, ignoring taxes, the market value of the investment would be

$$\alpha S_{b(1)} + \alpha B_{b(1)} \tag{10}$$

and the period - 2 return would be

$$\alpha[X_{(2)} - R_{b(2)}] + \alpha R_{b(2)} = \alpha X_{(2)} \tag{11}$$

Similarly, an investor in the complex firm could obtain the same return by purchasing α percent of that firm's stock and convertible bonds, and the period - 2 return will not depend on conversion.* The market value of this investment would be

$$\alpha S_{c(1)} + \alpha B_{c(1)} \tag{12}$$

If conversion does not occur, the period - 2 return will be computed as in (11) above and would be

$$\alpha[X_2 - R_{c(2)}] + \alpha R_{c(2)} = \alpha X_{(2)} \tag{13}$$

If conversion does occur, the investor will receive

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*Conversion will occur, if, after equilibrium prices are established, the price associated with the "option" portion of the security is such that the expected return from holding the "right" in the original form, rather than common stock form, vanishes.

$$\alpha[X_{(2)} - y\, X_{(2)}] + \alpha\, y\, X_{(2)} = \alpha\, X_{(2)} \quad (14)$$

The two components of the left side of (14) refer to the return applicable to the old shares plus the return applicable to shares received from conversion.

Now consider investor actions if the market value of the unlevered firm is higher than the other firms such that $V_u > V_b = V_c$. In this case, it is clear that no investor would want to hold shares in the unlevered firm because the same return could be obtained at less cost by purchasing a combination of debt and shares in either of the other firms. Thus, arbitrage opportunities would prevent the unlevered firm from selling at a higher price than the other firms.

The more important arbitrage arguments have centered around actions of $\alpha\, S_b$ shareholders in the levered firm where $V_b > V_u$. The shareholder's period - 2 return will be

$$\alpha[X_{(2)} - R_{b(2)}] \quad (15)$$

In this case, the shareholder owning $\alpha\, S_b$ has the opportunity to undo the leverage by selling his shares and purchasing α shares in the unlevered firm. The purchase would be made with funds obtained from the sale of the levered shares and personal borrowing. Since the capital market is perfect, the investor must be able to borrow $\alpha\, B_{b(1)}$ on personal account, by promising to pay lenders α times the levered firm's bond payments at period - 2. The period - 2 return will be $\alpha[X_{(2)} - R_{b(2)}]$, the same as (15) above. But since $V_b > V_u$, the return from $\alpha\, V_u$ can be obtained at less cost, and no investor would choose to own S_b.

Now consider the case of $V_c > V_b > V_u$ for an αS_c shareholder in the complex firm. A variety of options to achieve the same return at a lower cost are available to this investor; we will consider just one at this time.

One possible action for the complex firm's shareholder would be to sell his αS_c ownership and buy $\alpha S_u = \alpha V_u$ ownership in the unlevered firm, financing part of the purchase with personal borrowing. Again, since markets are perfect, the investor must be able to borrow $\alpha B_{c(1)}$ on personal account, promising to repay $\alpha R_{c(2)}$ or $\alpha y X_{(2)}$ at period - 2, depending on conversion. The net period - 1 cost to the investor is $\alpha[V_{u(1)} - B_{c(1)})$, and his return on V_u will be $\alpha[X_{(2)} - R_{c(2)}]$ or $\alpha[X_{(2)} - yX_{(2)}]$, depending on conversion. This is the same return that would be achieved by holding $\alpha S_{c(1)}$. But since $V_u < V_c$, this return can be achieved at a lower cost by investing in V_u. Thus, the independence of capital structure and value continues to hold for the complex capital structure case.

Appendix 2.

Accounting Risk Measures Used in Clustering Routines

Ratios	Calculation*
1. Dividend payout	Σ DATA (21, I) / Σ DATA (20, I)
2. Capital expenditures/Total Assets	Σ DATA (30, I) / Σ DATA (6, I)
3. Capital expenditures/Net Income	Σ DATA (30, I) / Σ DATA (18, I)
4. Average asset turnover	Σ DATA (12, I) / Σ DATA (6, I)
5. Average profit margin	Σ DATA (18, I) / Σ DATA (12, I)
6. Senior debt/Total Assets	Σ (DATA (9, I) + DATA (10, I)) / Σ DATA (6, I)
7. Long term debt/Common Equity	Σ DATA (9, I) / Σ DATA (11, I)
8. Return on Common Equity	Σ DATA (20, I) / Σ DATA (11, I)
9. Return on Invested Capital	Σ (DATA (18, I) + DATA (15, I)) / Σ (DATA (9, I) + DATA (10, I) + DATA (11, I))
10. Current Ratio	Σ DATA (4, I) / Σ DATA (5, I)

Growth Rates**	Variable Numbers
11. Total Assets	6
12. Operating Earnings	13 - 14
13. Net Income	18
14. Earnings Per Share (Primary)	58
15. Operating Earnings Per Share	13 - 14 / 25
16. Capital Expenditures	30
17. Return on Common Equity	20 / 11
18. Return on Invested Capital	18 + 15 / 9 + 10 + 11
19. Dividends Per Share	26

* Numbers refer to COMPUSTAT variable numbers

** Geometric growth rates were calculated as follows:

$$gmg = \text{antilog}\left[\frac{\sum_{t=1}^{n} \log(1 + g_t)}{n}\right] - 1$$

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