c.1

TESTS OF DETERMINANTS OF OPTIMAL CAPITAL STRUCTURE

by

NICHOLAS FRANCIS PORTMAN

B.Comm.(Hons.), Dalhousie University, 1981

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE (BUSINESS ADMINISTRATION)

in

THE FACULTY OF GRADUATE STUDIES

Department Of Commerce And Business Administration

We accept this thesis as conforming

to the required standard

THE UNIVERSITY OF BRITISH COLUMBIA

April 1983

In presenting this thesis in partial fulfilment of the requirements for an advanced degree at the University of British Columbia, I agree that the Library shall make it freely available for reference and study. I further agree that permission for extensive copying of this thesis for scholarly purposes may be granted by the head of my department or by his or her representatives. It is understood that copying or publication of this thesis for financial gain shall not be allowed without my written permission.

Department of Commerce and Business Administration

The University of British Columbia
1956 Main Mall
Vancouver, Canada
V6T 1Y3

Date April 21st, 1983.

Abstract

This paper provides an examination of the relationship between capital structure and a number of firm characteristics. A synopsis of the theory and evidence on capital structure to date is provided. A model is developed which posits that capital structure is positively related to liquidity, firm size, the relative amounts of subordinated and priorized debt, and negatively related to operating leverage, sales variability, and bankruptcy costs.

Tests of the model were performed in a regression context, with the logarithm of the debt-to-equity ratio as the dependent variable. The characteristics used as independent variables were degree of operating leverage, variance of sales, industry class, firm size, the proportion of secured to unsecured debt, a liquidity measure (cash to total assets), and a number of proxies for operating leverage (accounts receivable, inventory and net plant, to total assets). Dummy variables were introduced to check for the influence of industry class, convertible debt and preferreds on capital structure.

Capital structure was found to be significantly negatively related to liquidity, industry class, operating leverage, and significantly positively related to the ratio subordinated to other long term debt. Size and sales variability were found to have no influence on financial leverage. Firms which had issued preferred stock had higher debt ratios. Convertible debt tended to act like equity.

Table of Contents

List of Tables

List of Figures

I. CAPITAL STRUCTURE: THEORY AND EVIDENCE TO DATE

In a world where capital markets are both complete and perfect, the relative amounts of risky debt and equity used for financing have no effect on firm value.[1] As financial leverage increases, stockholders demand higher returns to compensate them for bearing increased risk.

Hamada examined the effect of financial leverage on the systematic risk of equity.[2] Hamada assumed that the MM proposition held. He adjusted stock returns to what they would have been had the firm not been levered, and then regressed the estimates of returns (observed and adjusted) against estimates of the systematic risk of the levered and unlevered firms. The results showed that leverage explained between 21 and 24 percent of observed systematic risk.

Hamada measured the systematic risk of his observed and adjusted returns. He found the standard deviation of his systematic risk measure to be lower for the adjusted returns, for each industry. This suggested that within each industry, all equity financed firms tended to face the same levels of systematic risk, but firms could have chosen to have more systematic risk if they increased financial leverage. Chi-

---

[1] Joseph E. Stiglitz, "On the Irrelevance of Corporate Financial Policy," American Economic Review, December 1974.

[2] Robert S. Hamada, "The Effect of the Firm's Capital Structure on the Systematic Risk of Common Stocks," Journal of Finance, June 1966.

squared tests suggested that variation in systematic risk within risk classes was less than that in the whole sample. This again suggested similar underlying capitalization rates for firms within each industry, but differing amongst risk classes. Finally, Hamada found that the F-ratio of variance between industries was less for the observed systematic risk measures than for the adjusted ones. Between industries, systematic risk measures have similar variability, when compared to the variability of systematic risk measures of unlevered firms. These results tend to support the MM hypothesis.

The inclusion of corporate and personal income taxes leaves this conclusion unchanged for the individual firm.[3] Firms induce equityholders to switch to holding bonds by offering them higher yields. These higher yields compensate equityholders for their loss of tax savings from the reduction in their equity positions. There are some investors who are taxed at too high a rate for the tax savings from corporate borrowing to be sufficient to offset the increase in personal taxes resulting from the switch. Firms will be indifferent to issuing debt or equity when the increase in firm value from issuing debt equals zero. This occurs when the increase in corporate tax shield from debt issue is offset by the increased yield offered to the investor to induce him to switch drom equity to debt. Miller's theory suggests that there exists an optimal capital structure for all firms taken together, but the individual firm will find

---

[3] M.H. Miller, "Debt and Taxes", Journal of Finance, May 1977.

that debt structure does not matter.[4]

One argument that suggests firms do indeed face an optimal capital structure concerns information asymmetry.[5] Insiders engage in financial signalling in order to provide information to shareholders about the nature of the firm's business risk and profitability. By giving correct signals comprising positive information, managers ensure that firm value is maximized. This argument holds, given an appropriate incentive structure for managers. However, it may be in the interest of stockholders to make side payments to managers, thereby inducing them to make the wrong signals. This can lead to results which are inconsistent with firm value maximization.

A potentially important element in capital structure theory is bankruptcy costs. These deadweight losses will lead to the value of a bankrupt firm being less than the net present value of expected future cash flows to the firm. As a firm takes on more debt, the probability of bankruptcy increases. The firm will only issue debt until the marginal benefit from using more debt equals the increase in expected bankruptcy costs.

Bankruptcy costs can be classed as either direct or indirect, and the distinction set forth by Warner will be

---

[4] Richard Brealey and Stewart Myers, Principles of Corporate Finance, Mc-Graw Hill, Inc., Toronto, 1981, Chapter 18.

[5] Andrew H. Chen and E. Han Kim, "Theories of Corporate Debt Structure: A Synthesis", Journal of Finance, May 1979.

[6] Jerold B. Warner, "Bankruptcy Costs: Some Evidence", Journal of Finance, May 1977.

followed here.[6] Direct bankruptcy costs refer to legal, accounting, trustee, and other professional fees, the value of managerial time spent assessing the bankruptcy, court costs, and the disbursements by the trustee and other agents of the court. Indirect costs include lost sales, lost profits, loss of intangible assets, the opportunity cost of funds tied up due to legal proceedings, and the cost of creditors time.

An ideal examination of the effects of bankruptcy costs on the capital structure decision of the firm would include analysis of the ex ante expected costs of bankruptcy at the time when management is making the relevant decisions. Unfortunately, ex ante expected bankruptcy costs are not directly observable.

Two authors suggest that direct bankruptcy costs, as a percentage of firm value, are negatively related to firm size. Baxter found that for asset realizations under $50000, the ratio of administrative costs to total asset realization was 25.7%, whereas for realizations over $50000, the ratio was 19.9%.[7] In contrast to Baxter's examination of personal bankruptcies, concentrated on the liquidation costs of a sample of publicly traded railroad companies, and his study also suggested that the relative direct costs of bankruptcy decline as firm size increases.[8] For example, Warner found bankruptcy costs as a

---

[7] Nevins D. Baxter, "Leverage, Risk of Ruin and the Cost of Capital", Journal of Finance, 1967.

[8] Jerold B. Warner, Op. Cit. .

percent of market value at the date of bankruptcy to be 9.1% and 6.6% for the two smallest railroads, and 2.7% and 1.7% for the two largest.

In addition to bankruptcy costs, which may well be small, there are costs of financial distress, when the firm is on the verge of bankruptcy. The costs of financial distress include the reduction of firm value due to bondholder stockholder conflicts, and the bonding and monitoring costs associated with debt covenants.[9]

The inclusion of costs of bankruptcy and financial distress tends to support the traditional view that there is an optimal debt structure which minimizes the weighted average cost of capital.[10]

Schwartz and Aronson argued that without frictionless capital markets, firms would develop optimal capital structures which would appeal to various segments in the market for funds.[11] These optimal capital structures would be developed in light of the firm's operational and asset characteristics. They suggested that firms in the same industry would have similar asset structures and face similar levels of business risk, and

---

[9] M.H. Jensen and W. H. Meckling, "Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure", Journal of Financial Economics, October 1976.

[10] Richard Brealey and Stewart Myers, Op. Cit., p.396.

[11] Eli Schwartz and J. Richard Aronson, "Some Surrogate Evidence in Support of the Concept of Optimal Capital Structure", Journal of Finance, March 1967.

consequently would exhibit similar capital structures. Furthermore, firms in different industries would have differring capital structures.

In an effort to test this theory, they sampled four industries in 1928 and 1961. They took three samples of eight firms in each industry in each year. The industries examined were railroads, electric and gas utilities, mining, and industrials. They used a one way ANOVA test for differences in the mean equity to total assets ratio for all sample means. Common equity was seen as a residual claimant, and variation in common equity was felt to be more crucial than variation in prior claims. Schwartz and Aronson concluded that in neither 1961 or 1928 was there any statistical difference in financial structures within any class of firms. They did find significant inter-industry differences in both 1928 and 1961 for all samples.

Schwartz and Aronson maintained that industry financial structure does change in response to variation in the environment. For example, they suggested that over time, railroads became less leveraged. This was because of increased competition from other forms of transport and the susceptiblity of railroads to variation in business cycles. They implicitly assert that firms facing higher levels of business risk tend to reduce their degree of financial leverage. Nonetheless, it appeared to them that financial structures were stable over time. Unfortunately, they did not test this hypothesis statistically. Their examination was by inspection, which led

them to conclude that financial capital structures changed gradually in response to environmental change.[12]

Scott criticized Schwartz and Aronson on several grounds. He argued that Schwartz and Aronson only sampled four industries, and their choice of industries biased their results. Regulation of railroads and utilities may well have led to similar capital structures within each industry. Furthermore, they tested for equality amongst all group means, but did not conduct pairwise comparisons of means between industry groups.

Scott went on to perform tests similar to those of Schwartz and Aronson, using a larger sample of unregulated firms, and asked how many inter industry differences were significant. He explicitly assumed a relation between the business risk and the financial risk of firms, and that industry groupings corresponded to groupings by business risk. Using one way ANOVA tests, his conclusions gave the same results as those of Schwartz and Aronson. He argued that significant inter-industry variation in equity ratios was due to management adjusting financial structure in response to the the level of business risk faced by the firm,which differed among industries. No such differences in intra-industry equity ratios could be found, indicating that firms in the same industry face similar levels of business risk.

Remmers, Stonehill, Wright and Beekhuiser (RSWB) found that

---

[12] David F Scott, Jr., "Evidence on the Importance of Financial Structure", Financial Management, Summer 1972.

Scott's test was biased for two reasons.[13] First, they said that by increasing the number of industries in the sample, he added two groups which exhibited extreme equity ratios because of unusual profitability and growth. Unfortunately, they stated nothing further in this regard: the claim remains unsubstantiated. In the second instance, RSWB raise the issue of sample size again. Scott used 77 firms, with two industries comprised of four firms each, and two industries of five companies. RSWB calculated debt ratios in the same industries, using larger samples, and found that their ratios were considerably different from Scott's. However, they neither explain their comparison procedure, nor provide their results.

In their own tests, RSWB attempted to expand on previous work by looking at capital structure as a function of both size and business risk, in an international context. They assumed that within an industry, firms face similar environments, and hence variation of sales and earnings amongst firms are correlated. This gave them grounds for proxying business risk by industry class. They posited that size is a determinant of financial structure because the diversification of product lines by large firms reduces firm risk, permitting the firm to increase financial leverage. RSWB pointed out that there may be

---

[13] Lee Remmers, Arthur Stonehill, Richard Wright and Theo Beekhuisen, "Industry and Size as Debt Ratio Determinants in Manufacturing Internationally", Financial Management, Summer 1974.

other reasons for the high correlation of intra-group equity ratios, such as similar technology and asset structures, for example.

RSWB's sample consisted of firms in the Fortune 500 (1971) list. A firm was included in the sample if it was in an industry which comprised at least twenty companies. They took sample debt ratios for the years 1966, 1970, and 1971, and using an F-test, they detected no differences among sample group means. They did say that some industries not reported on in their paper did have significantly different debt ratios, but these were not attributable to variation in business risk. The elimination of these unusual industries biased their results in favour af accepting the null hypothesis. Their international tests led to the conclusion of significant inter- industry differences in debt ratios for industries in France and Japan, but none in the United States, Norway, or the Netherlands. They postulated that the results for France were due to special conditions prevalent there.

In their tests for size as a determinant of financial structure, RSWB split an international sample into three groups of equal numbers, according to total sales. With one exception, they accepted the null hypothesis at the 95% confidence level.

In round four of this debate, Scott and Martin suggested that RSWB's choice of Fortune 500 firms was too limiting: it led

---

[14] David F. Scott, Jr., and John D. Martin, "Industry Influence on Financial Structure", Financial Management, Spring 1975.

to homogeneity in the sample.[14] Scott and Martin also asserted that RSWB's use of the debt to total assets ratio was inappropriate for measuring leverage because of the degree of subsitutability of prior claims for one another. This had also been pointed out by Schwartz and Aronson. This substitutability is especially notable in the case of preferred stock and debt. Another of the criticisms levelled against RSWB is that their results may have been erroneous due to the assumptions necessary for their tests. Specifically, the conditions of equality of variance across industries, and normality, may have been violated.

In their experiment, Scott and Martin used non parametric tests which did not require the assumptions of equal variance and normality. They asserted that an influential point which represents a "firm that is unusually highly levered or a firm not levered at all may materially distort the computation of the mean debt ratio [or equity ratio] for a particular industry".[15] So, they used a non-parametric ANOVA test for differences in equity ratios amongst industries, where equity ratio was defined as common equity divided by total assets.

The sample was composed of non-regulated industries. Scott and Martin found significant differences among industries' mean equity ratios for each of the years in the period 1967 to 1972. They also tested for differences based on the ranking of equity ratios, the results of which supported their previous findings.

---

[15] Ibid., p68.

They used both non-parametric and F tests in their examination of the relation between size and equity ratios. Like RSWB, they grouped firms into three equal classes, according to size. They found significant differences among the groups in all tests. Their test of size focussed on total assets, whereas RSWB size measure was total sales.

Ferri and Jones tested the effects of industry class, business risk, and operating leverage upon financial leverage.[16] They reasoned that operating leverage is important because it reflects earnings variability, which they felt should be negatively related to financial leverage. They used the debt to equity ratio because of "conceptual simplicity and the variable's ability to more completely reflect a firm's total reliance on borrowed funds".[17]

Ferri and Jones grouped firms into industries by using both SIC codes and product lines, and just by SIC codes. They tested for an industry effect using both methods of grouping. They measured size by total sales, total assets, average total assets and average total sales. Averages were computed using data from the most recent five year period. The coefficients of variation in sales, and in pre-tax income, as well as the standard deviations of standardized sales growth and standardized cash

---

[16] Michael G. Ferri and Wesley H. Jones, "Determinants of Financial Structure: A New Methodological Approach", Journal of Finance, June 1979.

[17] Ibid., p633.

flow growth were used to proxy business risk. To compute these measures of business risk, annual data for the most recent five years was used. Degree of operating leverage (DOL) was defined as the ratio of the percentage variance in EBIT to the percentage variance in sales. DOL was also proxied by the ratio of fixed assets to total assets and average fixed assets to total assets for a five year period.

In their examination of capital structure, Ferri and Jones grouped firms according to debt structure, using a clustering algorithm. They used an asymmetric uncertainty coefficient to test for industry effects, then used multivariate discriminant analysis to see if they could distinguish between the clusters, in examinations of the other hypotheses. Unfortunately, the nature of the clustering introduced bias into the second test. The discriminant test is biased by the somewhat arbitrary choice of boundaries for the groups of firms. For this reason, the Ferri and Jones technique is not employed in this paper.

Ferri and Jones found some support for the existence of relationships between financial structure and size, industry class, and operating leverage, but none between debt ratio and income variation. They found SIC codes to give stronger results in industry groupings than did SIC codes combined with product lines. Using 1976 data, they found that either historical or current data could be used in discriminating effectively amongst groups of debt ratios. However, using 1974 ratios, both historic and current data were necessary for effective discrimination amongst groups. They contended that this was due

to the differences in economic conditions during the two periods. In the expansion of 1976, debt was readily available to marginal firms, whereas in the 1974 recession, these same marginal firms were unable to finance through debt. Operating leverage discriminated amongst debt classes in both 1974 and 1976 when average fixed assets to average total assets was used as the discriminator, but the elasticity of EBIT with respect to sales was only an effective discriminator for the 1976 data.

The effect of the degree of operating leverage on risk, and hence on firm market value, was examined in an earlier study by Lev.[18] He defined operating leverage as the ratio of fixed to variable costs. Lev's model postulated that higher earnings volatility would occur for firms with lower variable costs per product. Within a risk class, such as a homogeneous industry, the higher the fixed costs, the higher the variability of returns to stockholders, hence the higher the total and systematic risk of common stocks. He noted that this was analagous to the argument that increased financial leverage leads to larger standard deviation of stock returns.

To test this hypothesis, Lev regressed total operating costs on sales, for the electric utility,steel, and oil producer industries, for the years 1949 to 1968. He used the slope of these regressions as estimates of average variable costs per

---

[18] Baruch Lev, "On the Association Between Operating Leverage and Risk", Journal of Financial and Quantitative Analysis, September 1974.

unit of output. He assumed no changes in the production functions over the sample period, and found the assumption to be borne out, in general, by cross validation tests. He then used the standard deviation of stock returns and the stock's beta as independent variables in a regression in which his average variable cost estimate was the dependent variable. His low R-squared statistics, which ranged from .05 to .38, suggested that the degree of operating leverage was not the only variable which affected risk. However, since all but one of his coefficients were significant at the .05 level, the relationship between risk and operating leverage was confirmed. The coefficients were negative in all cases. Lev argued that the only case of lack of significance was due to the heterogeneity of the firms in the industry in question, the oil industry.

In a recent study, Marsh focussed on the issuance of debt and equity by British firms between 1959 and 1970.[19] Target debt ratios were proxied by the average debt ratio over the sample period. Marsh explained and provided references for the arguments that treasurers tend to think in terms of book rather than market values, that covenants tend to be written in terms of book values, and that book values of debt and equity are more closely tied to assets already owned by the firm, and do not capitalize the future cash flows of assets the firm is expected

---

[19] Paul Marsh, "The Choice Between Equity and Debt: An Empirical Study", Journal of Finance, May 1977.

[20] Ibid., p131.

to acquire.[20] Using these reasons, he argued persuasively for the use of book values.

Marsh felt that size would be a factor influencing target debt ratios because of economies of scale in flotation costs of security issues. Measures of size, operating leverage, and asset composition were included to attempt to proxy the effect of variation in target ratios over time which had not been picked up by the historic average debt ratios.

Marsh found that the choice between issuance of debt or equity depended upon the state of the market and historical stock prices in such a way that firms appear to have target ratios of short and long term debt and equity to total assets. Furthermore, these target levels were found to be functions of company size, expected bankruptcy costs and asset structure.

In imperfect capital markets, with positive bankruptcy and distress costs, there appears to be justification for the arguments that size, asset structure, industry class, business risk, bankruptcy costs, distress costs, and operating leverage affect capital structure.

II. A SIMPLE MODEL OF CAPITAL STRUCTURE

The objective of this section is to derive a theoretical model of optimal capital structure. The model posits capital structure as a function of the liquidity of a firm's assets, it business risk, size, bankruptcy costs, and the levels of subordinated and priorized debt claims.

The model assumes risk neutral valuation with a probability density P(s), where s is defined to lie in the closed interval from $\underline{s}$ to $\bar{s}$. In an Arrow-Debreu context,

$$V=\int_{\underline{s}}^{\bar{s}} X(s)Q(s)ds,$$

where Q(s) is the vector of Arrow-Debreu prices, and X(s) is the vector of state contingent cash flows. This implies that

$$\int_{\underline{s}}^{\bar{s}} Q(s)ds=1/(1+Rf), \text{ or } \int_{\underline{s}}^{\bar{s}} (1/(1+Rf)Q(s)ds=1.$$

This is equivalent to stating that the price of a riskless security which provides a payoff of 1 in every state would be 1/(1+Rf), where Rf is the rate of return on a riskless asset. In the context of risk neutral valuation, (1+Rf)Q(s) is treated as a probability distribution, so that

$$(1+Rf)Q(s)=P(s) \text{ and } \int_{\underline{s}}^{\bar{s}} P(s)ds=1.$$

This provides

$$V=\int_{\underline{s}}^{\bar{s}} X(s)P(s)ds$$

which is equivalent to the Arrow-Debreu pricing model set out above.[21]

Suppose that the proceeds of a financing are placed into a riskless asset, L, such as cash, which earns no return, and a risky project which provides state contingent cash flows. Let cash flows from the risky project, denoted C, be defined as

(1) $C=X+g(s-e)$, where

(2) $e=\int_{\underline{s}}^{\bar{s}} sP(s)ds.$

In this case, $E(C)=X$, where X is a scale parameter reflecting the size of the firm (having no relation to X(s) defined above), and

$\sigma_c=g\sigma_s$, where g

is a parameter reflecting business risk. A more precise definition of business risk will be given later.

Let bankruptcy costs, denoted B , have the form

$B=ag+bX$ with $\partial B/\partial X=b>0$.

This is consistent with evidence to date, as discussed in Chapter 1, which suggests that relative, percentage bankruptcy costs decrease with increases in firm size. Furthermore, let

---

[21] For a discussion of contingent claims pricing, see Thomas E. Copeland and J. Fred Weston, Financial Theory and Corporate Policy, Addison Wesley, Don Mills, Ontario, 1979.

t=marginal corporate tax rate, F=the face value of debt outstanding, Vl=the value of the levered firm, Vu=the value of the unlevered firm, Ve=the value of equity, and Vd=the value of debt outstanding. In this context, the state contingent after (corporate) tax flows to various security holders are given below:

STATE CONTINGENT CASH FLOWS

SECURITY	STATE	
	$L+X+g(s-e)<F$	$L+X+g(s-e)>F$
BONDS	$L+(1-t)(X+g(s-e))-B$	F
EQUITY	0	$L+(1-t)(X+g(s-e))-(1-t)F$
TOTAL	$L+(1-t)(X+g(s-e))-B$	$L+(1-t)(X+g(s-e))+tF$

Define z as being that state for which $L+X+g(z-e)=F$, so that

(4) $z=(F-L-X)/g+e$

The values of debt, equity, and the levered firm are:

$$Vd=\int_{\underline{s}}^{z}[L+(1-t)(X+g(s-e))-B]P(s)ds + \int_{z}^{\bar{s}}FP(s)ds, \text{ or}$$

$$(5)\quad Vd=L\int_{\underline{s}}^{z}P(s)ds + (1-t)\int_{\underline{s}}^{z}(X+g(s-e))P(s)ds - B\int_{\underline{s}}^{z}P(s)ds + F\int_{z}^{\bar{s}}P(s)ds, \text{and}$$

$$Ve= [L+(1-t)(X+g(s-e))-(1-t)F]\int_{z}^{\bar{s}}P(s)ds, \text{ or}$$

$$(6)\quad Ve=(L-(1-t)F)\int_{z}^{\bar{s}}P(s)ds + (1-t)\int_{z}^{s}(X+g(s-e))P(s)ds, \text{ and}$$

$$(7)\quad Vl=L\int_{\underline{s}}^{\bar{s}}P(s)ds + (1-t)\int_{\underline{s}}^{\bar{s}}(X+g(s-e))P(s)ds + tF\int_{z}^{\bar{s}}P(s)ds - B\int_{\underline{s}}^{z}P(s)ds,$$

which is Ve + Vd.

Since $Vu=L\int_{\underline{s}}^{\bar{s}}P(s)ds + (1-t)\int_{\underline{s}}^{\bar{s}}(X+g(s-e))P(s)ds$, (7) can be written as

$$(8)\quad Vl=Vu-B\int_{\underline{s}}^{z}P(s)ds+tF\int_{z}^{\bar{s}}P(s)ds$$

which is the value of the unlevered firm, less expected bankruptcy costs, plus the tax shield of debt.

Noting that $\partial z/\partial F=1/g$, $\partial z/\partial L=-1/g$, $\partial z/\partial g=-(F-L-X)/g$, $\partial z/\partial X=-1/g$, and $\partial Vu/\partial F=0$, it can be shown that

$$\partial Vl/\partial F = -B(\partial z/\partial F)P(z) + t\int_{z}^{\bar{s}}P(s)ds - tF(\partial z/\partial F)P(z)$$

$$= t\int_{z}^{\bar{s}}P(s)ds - [(B+tF)/g]P(z)$$

This gives the first order condition for a maximum,

$$(9)\quad t\int_{z}^{\bar{s}}P(s)ds - [(B+tF)/g]P(z) = 0.$$

The second derivative is

$$\partial^2 Vl/\partial F^2 = -t(\partial z/\partial F)P(z) - [(B+tF)/g^2]P'(z) - (t/g)P(z)$$

$$= -(2t/g)P(z) - [(B+tF)/g^2]P'(z).$$

$= -(2t/g)P(z) - [(B+tF)/g^2]P'(z)$.

This provides the second order condition for a maximum,

(10) $-(2t/g)P(z) - (1/g^2)(P'(z))[B+tF] < 0$.

As an example, assume that s is defined to lie between $\underline{s}$ and $\bar{s}$, so that $P(s)=1/w$, where $w=\bar{s}-\underline{s}$. This is the uniform case, which satisfies the condition that $P'(z) \geq 0$.

The first order condition (9) becomes

$t(\bar{s}-z)1/w - [(B+tF)/g]/w = 0$ or (11) $\bar{s}-z - tF/g = B/tg$.

Substituting from (4) into (11) gives

$\bar{s} - [(F-L-X)/g)+e] - F/g = B/tg$, which reduces to

(12) $F^* = -B/2t + (g/2)(\bar{s}-e) + (L+X)/2$.

But $\bar{s}-e = \bar{s}-1/2(\bar{s}+\underline{s}) = 1/2(\bar{s}-\underline{s}) = 1/2w$, so that (12) can be rewritte

(13) $F^* = -B/2t + gw/4 + (L+X)/2$

and substituting from (3), the value of the levered firm is maximized when

(14) $F^* = -(ag+bX)/2t + gw/4 + (L+X)/2$, which is equivalent to

(15) $F^* = [(tL+(1/2)tgw-ag)+(t-b)X]/2t$, which reduces to

(16) $F^* = \{tL+g[(1/2)tw-a]+(t-b)X\}/2t$.

We assume $t>>b$, and $(1/2)tw<a$.

Equation (14) provides the comparative statics results given below.

(17) $\partial F^*/\partial L=1/2>0$.

Each dollar of liquidity , L, added, allows a fractional increase in F.

(18) $\partial F^*/\partial t=(ag+bX)/(2t\ )>0$,

which is consistent with the theory set forth is Chapter 1.

(19) $\partial F^*/\partial X = -b/2t+1/2 = (1/2)(t-b)>0$,

since $b<<t$ by assumption, again consistent with theory and evidence described in Chapter 1.

Ferri and Jones showed that the elasticity of F^* with respect to firm size is greater than unity. That is

$(\partial F^*/\partial X)(X/F^*)>1$ or

(20) $\partial F^*/\partial X>F^*/X$.

Substituting (19) into (20) gives $(1/2t)(t-b)>F^*/X$.

Using (15) gives

$(1/2t)(t-b)X > (1/2t)[tL+g((1/2)tw-a)] + (1/2t)(t-b)X$, or

$(1/2t)[tL+g((1/2)tw-a)] < 0$, or

$g((1/2)tw-a) < -tL$, hence

$(1/2)tw-a < -tL < 0$,

so that

(21) $\partial F^*/\partial g = -a/2t + w/4 = (1/2t)((1/2)wt-a)<0$

as is shown above. Firms facing more business risk issue less debt, again supported by the material presented in Chapter 1.

The rest of this chapter of the thesis deals with expanding the model, as set forth above, to include two levels of debt: subordinated and unsubordinated debt. Denote Ff as the face value of senior debt, and Fj as the face value of junior (unsubordinated) debt. Further, let bankruptcy costs be defined for senior debt as Bf=afg+bfX, and for junior debt as Bj=ajg+bjX The state contingent after (corporate) tax cash flows to the various security holders are as given below:

STATE CONTINGENT CASH FLOWS

SECURITY	STATE $L+X+g(s-e)<Ff$	$Ff\leq L+X+g(s-e)<Ff+Fj$	$Fj+Ff\leq L+X+g(s-e)$
SENIOR BONDS	$L+(1-t)(X+g(s-e))-Bf$	Ff	Ff
JUNIOR BONDS	0	$L+(1-t)(X+g(s-e)-(1-t)Ff-Bj$	Fj
EQUITY	0	0	$L+(1-t)(X+g(s-e)-(1-t)(Ff+Fj)$
TOTAL	$L+(1-t)(X+g(s-e))-Bf$	$L+(1-t)(X+g(s-e))+tFf-Bj$	$L+(1-t)(X+g(s-e))+t(Ff+Fj)$

Denoting Vf as the value of senior debt, Vj as the value of junior debt, $x=(Ff-L-X)/g+e$, and $y=(Ff+Fj-L-X)/g+e$, then it can be shown that

$$Vf=\int_{\underline{s}}^{x}[L+(1-t)(X+g(s-e))-Bs]P(s)ds + Ff\int_{x}^{\bar{s}}P(s)ds, \text{ or}$$

$$(22)\quad Vf=-Bf\int_{\underline{s}}^{x}P(s)ds + (L+(1-t))\int_{\underline{s}}^{x}P(s)ds + Ff\int_{x}^{\bar{s}}P(s)ds, \text{ and}$$

$$(23)\quad Vj=Bj\int_{y}^{Y}P(s)ds + (L+(1-t))\int_{x}^{Y}P(s)ds + Fj\int_{Y}^{\bar{s}}P(s)ds - (1-t)Ff\int_{x}^{Y}P(s)ds$$

and

$$(24)\quad Ve=(L+(1-t))\int_{Y}^{\bar{s}}(X+g(s-e))P(s)ds - (1-t)(Ff+Fj)\int_{Y}^{\bar{s}}P(s)ds.$$

In this case,

$$Vu=\int_{\underline{s}}^{\bar{s}}(L+(1-t))(X+g(s-e))P(s)ds, \text{ so that}$$

$$Vl=Vu + Ff\int_{X}^{\bar{s}}P(s)ds - Bf\int_{\underline{s}}^{X}P(s)ds + Fj\int_{Y}^{\bar{s}}P(s)ds - Bj\int_{X}^{Y}P(s)ds$$

$$-(1-t)Ff\int_{X}^{Y}P(s)ds - (1-t)(Ff+Fj)\int_{Y}^{\bar{s}}P(s)ds, \text{ or}$$

$$(25)\quad Vl=Vu - Bf\int_{\underline{s}}^{X}P(s)ds - Bj\int_{X}^{Y}P(s)ds + tFf\int_{X}^{\bar{s}}P(s)ds + tFj\int_{Y}^{\bar{s}}P(s)ds.$$

Equation (25) states that the value of the levered firm is equal to the value of the unlevered firm, less expected bankruptcy costs, plus the tax shields associated with junior and senior debt.

Note that $\partial x/\partial Ff=1/g, \partial x/\partial Fj=0, \partial y/\partial Ff=1/g, \partial y/\partial Fj=1/g,$ $\partial Vu/\partial Ff=\partial Vu/\partial Fj=0.$

$$\partial Vl/\partial Ff=-(Bf/g)P(x) + (Bj/g)P(y) + t\int_{X}^{\bar{s}}P(s)ds - (tFs/g)P(x)$$

$$- (tFj/g)P(y) - (Bj/g)P(y), \text{ and}$$

$$\partial Vl/\partial Fj=-(Bj/g)P(y) + t\int_{Y}^{\bar{s}}P(s)ds - tFjP(y)/g.$$

These give the first order conditions

(26) $t\int_{x}^{\bar{s}} P(s)ds - (P(x)/g)(Bf-Bj+tFf) - (P(y)/g)(Bj+tFj) = 0$, and

(27) $t\int_{y}^{\bar{s}} P(s)ds - (P(y)/g)(Bj+tFj) = 0$. The second order

derivatives are:

$\partial Vl/\partial Ff^2 = (1/g^2)P'(x)(-Bf+Bj-tFf) - (1/g^2)P'(y)(Bj+tFj)$
$-(2t/g)P(x)$

$\partial Vl/\partial Ff\ Fj = -(1/g^2)P'(y)(Bj+tFj) - (t/g)P(y)$

$\partial Vl/\partial Fj^2 = -(1/g^2)P'(y)(Bj+tFj) - (2t/g)P(y)$

The second order condition requires that the determinant of

$$\begin{bmatrix} \partial^2 Vl/\partial Ff^2 & \partial Vl/\partial Ff\partial Fj \\ \partial^2 Vl/\partial Ff\partial Fj & \partial^2 Vl/\partial Fj^2 \end{bmatrix} > 0.$$

Substitute $A=(1/g^2)P'(x)(-Bf+Bj-tFf)$,

$B=(-2t/g)P(x)$,

$C=(-1/g^2)P'(y)(Bj+tFj)$, and

$D=(-t/g)P(y)$.

By substitution, the second order condition may be rewritten

$(A+B+C)(C+2D)-(C+D)(C+D)>0$

$(A+B)(C+2D)>DD$

Again, if the uniform case is used, $P'(x)=P'(y)=0$, so that $A=C=0$, and $2BD>DD$ or $2B<D$ since $D<0$. Expanding the last inequality, $-(4t/g)P(x)<-(t/g)P(y)$ or $4P(x)>P(y)$, which holds in the uniform case.

Continuing the uniform case further, equation (26) can be rewritten as

(28) $t(\bar{s}-x)1/w - (1/gw(Bf-Bj+tFf) - (1/gw)(Bj+tFj) = 0$.

Recalling that $x=(Ff-L-X)/g+e$ and $\bar{s}-e=(1/2)w$, (28) is equivalent to

$tFf= -Bf - tFj + g[(1/2)tw-t(Ff-L-X)/g]$

which reduces to

(29) $Fj^*=gw/2 - 2Ff + L + X - Bf/t$

Similarly, equation (27) can be written as

$t(\bar{s}-y)1/w - (1/gw)(Bj+tFj) =0$, which reduces to

(30) $Fj^* =(1/2)(L+X+(1/2)gw) - (1/2t)Bj.$

Solving simultaneously, it can be shown that

(31) $Fj^* =(1/3)(L+X+(1/2)gw) + (1/3t)(Bf-2Bj).$

For ease of exposition, define $M=1/3(L+X+(1/2)gw)$. Suppose that $Bf=Bj=B$, then $Ff^*=Fj^*=M-B/3t$, with $\partial Ff^*/\partial(.)=\partial Fj^*/\partial(.)$. Assuming equal bankruptcy costs for junior and senior debt gives the following comparative statics results for (31) and (32):

(33) $\partial Ff^*/\partial X =1/3 - (1/3t)X =(1/3)[1-(t/X)] >0$

which implies that larger firms have more of both forms of debt.

(34) $\partial Ff^*/\partial L =1/3 >0,$

which implies that more liquid firms have more of both types of debt.

(35) $\partial Ff^*/\partial g =(1/3)w - a/3t =(1/3t)[(wt/2)-a] <0$

since $(wt/2)-a<0$, as shown above. Firms with more cash flow volatility have less of both kinds of debt.

(36) $\partial Ff^*/\partial t= B/3t >0$

which shows that more heavily taxed firms have more of both types of debt. These are all consistent with the predictions of the model in its simpler form.

Now assume that $Bj=2Bf$. This assumption is not

unreasonable, at least in Canadian courts. Trustees get paid a maximum percentage rate of the cash or cash equivalents paid to unsecured creditors. Essentially, the secured creditors have an opportunity to get their security back before the trustee can take a share of the pie. This maximum can be overruled by the courts. Under this assumption, (31) and (32) can be rewritten as

(37) $Fj^* = (1/3)(L+X+(1/2)gw) - Bf/t$, and

(38) $Ff^* = (1/3)(L+X+(1/2)gw)$.

These give the following comparative statics results:

(40) $\partial Ff^*/\partial X = 1/3 > 0$ and

(41) $\partial Fj^*/\partial X = 1/3 - bf/t = (1/3)[1-(3bf/t)] \gtrless 0$.

Larger firms are expected to have more senior debt, but will only issue more junior debt if s is less than 1/3 of the tax rate, or very small. This is consistent with evidence presented in Chapter 1.

(42) $\partial Ff^*/\partial L = Fj^*/L = 1/3 > 0$, as before.

(43) $\partial Ff^*/\partial g = w/6 > 0$ and

(44) $\partial Fj/\partial g = w/6 - af/t = (1/3t)[(wt/2)-3as] < 0$ since $wt/2 < as$ as shown above. Riskier firms issue more senior debt and less junior debt.

Riskier firms issue more senior debt and less junior debt.

(45) $\partial Ff^*/\partial t = 0$ and

(46) $\partial Fj^*/\partial t = Bf/t > 0$,

so that as the tax rate increases, there is an increasing incentive for firms to issue more junior debt.

To examine the effects of X,g,t and L on capital structure as a whole, the partial derivatives for Ff* and Fj* must be added together. Under the assumption of constant bankruptcy costs, the results are simply twice those given for Ff*. That is, larger firms, more liquid firms, and firms facing higher tax brackets all issue more debt, ceteris paribus. Increased operating leverage decreases the relative reliance on debt financing. Furthermore, by adding (29) and (30), it can be shown that the partials of Ff* with respect to Fj* are identical to the partials of Fj* with respect to Ff*.

If we now examine the partials for Bj=2Bf,

(47) $\partial(Ff^*+Fj^*)/\partial X = 2/3 - bs/t = (2/3)[1-(3bs/2t) \gtrless 0$. Size effect is once again linked to the tax rate, and will be positive if bankruptcy costs are small.

(48) $\partial(Ff^*+Fj^*)/\partial L = 2/3 > 0$, which is consistent with previous results.

(49) $\partial(Ff^*+Fj^*)/\partial g = (1/3t)(wt-3as) < 0$ since $tw<3as$, as shown abov

Once again, as business risk increases, financial leverage declines.

(50) $\partial(Ff^*+Fj^*)/\partial t = Bf/t > 0$.

This is consistent with results to date. If the tax rate for junior debt is positive, then the marginal value of issuing more debt declines as the tax rate increases.

Business risk will now be defined more carefully, as comprising:

(51) Industry risk: the risk inherent in the environment in which

the firm is operating, and variability of earnings before interes and taxes (EBIT).

The variance of EBIT has two components:

(52) Sales variability and

(53) Elasticity of EBIT with respect to sales.

To show that VAR(EBIT) has two components, assume EBIT=Revenue-Fixed Costs-Variable Costs. Suppose the firm sells Q units of product at price P. Variable per unit cost of production is denoted V, while F represents fixed production costs.

$$\begin{aligned} VAR(EBIT) &= VAR(PQ-VQ-F) \\ &= VAR[(P-V)Q] \\ &= (P-V)(P-V)VAR(Q) \end{aligned}$$

$$DOL=(P\partial Q-V\partial Q)/P\partial Q=(P-V)/P$$

These final results are consistent with evidence to date. The next chapter sets out the hypotheses generated by the model, and the results of the tests of those hypotheses.

III. METHODOLOGY AND RESULTS

The model in chapter two implies that a number of factors influence the capital structure of the firm. The null hypotheses to be tested are listed below:

H1: Liquidity has no effect on the firm's financing decision, from (48).

H2: Operating leverage is not related to financial leverage, from (49) and (53).

H3: Firms issuing junior debt do not have larger debt-to-equity ratios, from (40), (41), (43), and (44). The model implied that some firms may have increased incentives to issue either junior or senior debt. Doing so would enable them to have higher debt-to-equity ratios than otherwise.

H4: The degree of financial leverage is not affected by firm size, from (47).

H5: Sales variance is unrelated to financial structure, from (49) and (52).

H6: Preferred stock has the same influence on capital structure as that of common stock, to be discussed below.

H7: Convertible debt has the same effect on capital structure as does common stock, to be discussed below.

H8: Firms' capital structures are not affected by time, to be discussed below.

H9: Capital structure is not influenced by the industry in which a firm operates, from (49) and (51).

Cross sectional regression was used to attempt to fit the model DEBTEQ=A+BiXi, where A is the intercept term, Xi is the

ith independent variable, and Bi is the regression coefficient corresponding to the ith independent variable. The decision variables are:

1. CMTA=(Cash+ Marketable Securities)/ Total Assets.
2. ARTA=Accounts Receivable/ Total Asets.
3. INVTA=Inventory/ Total Asets.
4. NTPTA=Net Plant/ Total Asets. This includes all physical assets used for production.
5. SUBSEC=Subordinated Debt/Other Long Term Debt.
6. SIZE= Total Assets.
7. DOL=Elasticity of EBIT with respect to sales.
8. VAR=Standardized variance of sales.
9. PFDDUM=Dummy variable, for preferred shares outstanding.
10. CONVDUM=Dummy variable, for convertible debt.
11. YRDUM=Dummy variable for sample year.

12-25. D1-D14=Dummy variables for industry classes.

The hypotheses as listed above can be restated in terms of the regression coefficients, and these are given below.

H1: B1=0.

H2: B2=B3=B4=B7=0.

H3: B5=0.

H4: B6=0.

H5: B8=0.

H6: B9=0.

H7: B10=0.

H8: B11=0.

H9: B12=B13=B14=B15=B16=B17=B18=B19=B20=B21=B22=B23=B24=B25=0.

Ranking of the industry SIC numbers was felt to have been meaningless, so the use of SIC codes as an independent variable in a regression setting would have been inappropriate. Dummy variables were created for fourteen of the fifteen industries. Using fifteen dummy variables would have led to an ill-conditioned X-matrix which could have been partitioned into an identity matrix, hence their inclusion would have provided no more information than if they had not been used at all.

Homogeneity amongst firms in a given industry is necessary if the industry class methodology is to work well. However, sampling industries on the the basis of homogeneity, using some a priori specified rationale, would have introduced bias into the sample. Furthermore, if tests taken over a random sample of industries do not show a strong relationship between capital structure and industry class, then industry class will not be useful in predicting or determining optimal capital structure. If industry groupings are to provide management and investors with useful information, then the group into which any particular firm falls must be readily identified. SIC codes provide this ease of grouping and identification. So the industries used were those for which sufficient data was available within SIC groupings.

Data for the sample was drawn from the Compustat Annual and Quarterly tapes of 1982. Bearing in mind that industry class was to be used as an independent variable, firms were chosen if they were in an industry which had more than eleven entries on the quarterly tape. There were 15 of these industries,

consisting of 212 companies, in the sample. A list of firms and industries is included in the appendix.

Firms which became bankrupt before February 28, 1983, were excluded from the sample. Observations for which DEBTEQ<0 were dropped from the sample. These firms could have introduced considerable unreasonable noise into the data. For example, consider two firms with positive debt outstanding, but one of which has slightly negative equity, while the other has slightly positive equity. Their debt ratios would appear at opposite ends of the real line, whereas in an absolute sense they had almost identical capital structures.

It has been shown that financial ratios deteriorate as firms approach bankruptcy.[22] To attempt to control for impending bankruptcy by the introduction of another dummy variable would require the determination of some cutoff point. This cutoff point would be set at some time before bankruptcy when the firm's financial ratios began to deteriorate, which would have been when the impending bankruptcy would have begun to have had an effect on the firm's balance sheet. The cutoff point would be arbitrary, and a source of bias. So all firms which have become bankrupt before February 28 1983 were deleted from the

---

[22] Edward I. Altman, "Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy", Journal of Finance, September, 1978 and William H. Beaver, "Market Prices, Financial Ratios, and the Prediction of Failure", Journal of Accounting Research, Autumn 1968.

sample.

In order to ensure a large enough sample, each firm was used twice, data was taken from both 1981 and 1976. This assumed that over a period of five years, firms were able to change their capital structures. A statistical test for independence of the 1981 and 1976 data was considered to be inappropriate. If a firm was at its optimal debt ratio in 1976, then it may well be that it was at the same optimal capital structure in 1981. YRDUM, a dummy variable, which was set equal to 1 if the observation was made in 1976, and 0 otherwise, was included as a check for the influence of sample date.

All the variables used in these tests were book values, as reported on the Compustat tapes. Book values were used for the reasons given in Chapter 1: treasurers tend to think in terms of book values; book values of debt and equity are more closely tied to the book value of assets since they do not capitalize expected cash flows from assets that will be acquired in the future; covenants are written in terms of book values.

Any noise introduced by the use of book values was assumed to be random. No expectation of direction of bias could be formulated. For instance, management may choose measures of determining sales, or the reported book value of marketable securities, to minimize income taxes, or maximize accounting earnings, or to portray some desired level of assets or

---

[23] Jack Clark Francis, Investments: Analysis and Management, Third Edition, McGraw Hill Book Company, Toronto, 1980.

liabilities.[23] So there may be incentives for management to manipulate book values.

It was beyond the scope of this thesis to construct market values for debt and equity. Furthermore, for many of the other assets, it would have been extremely difficult to measure market values. Indeed, for practical purposes, book values of many of the variables were the only reasonable proxies for market values. Adequate descriptions of these assets, such as plant, would not have been available from which to derive market values. Also, the uniqueness of certain assets would have made them especially difficult to price, either directly or by proxy.

The first independent variable, CMTA, was a measure of liquidity of the firm's asset structure. Financial leverage was expected to increase as a result of increases in liquidity.

The less liquid assets, especially NTPTA, may have had a reverse effect on liquidity, and hence be associated with a negative coefficient. ARTA, INVTA and NTPTA were used as proxies for operating leverage, since they represent fixed costs. This also led to the expectation of negative coefficients for these variates. ARTA,INVTA,NTPTA, DOL, and VAR were examined to see if they were independent. As is shown below, they are non-collinear.

SUBSEC was a measure of subordinated to other long term debt. The model posited that it should have a positive coefficient, under the assumption of small bankruptcy costs which were the same for both senior and subordinated debt.

The simpler model predicted that SIZE would be positively

related to financial leverage. The more complicated model predicted the coefficient of SIZE to be either positive or negative, depending upon the relative magnitude of bankruptcy costs. Previous studies found SIZE to be positively related to the financial leverage, so larger firms were expected to assume more financial leverage.

DOL was first measured as the simple average of the percentage change in earnings before interest and taxes to the percentage change in sales. It was taken over all the quarters in the five years prior to the date associated with the balance sheet data, excepting those cases where there were no sales.

The resultant DOL measure showed a coefficient of variation over 1,000,000 due to tremendous variability in the data, and not just a few exceptional observations. Some firms had miniscule change in sales, but relatively large changes in earnings, which led to some very large numbers. Consequently, DOL was redefined as the slope of the simple regression of EBIT on sales over the relevant five year period. This is the measure that appears in the results given below.

VAR was taken to be the sample standard deviation of sales divided by the sample mean of sales, again over a five year period. The sample sizes varied from 22 to 50 across industries. Since variance is underestimated for small samples, it was felt that sample variance was a more appropriate measure than population variance. Dividing by the sample mean made allowance for differences in the average level of sales amongst companies. The definitions chosen for DOL and VAR are standard

financial ratios.[24]

PFDDUM and CONVDUM were dummy variables used as checks on the definition of DEBTEQ. The coefficients of both variables were expected to be zero. Preferreds and convertibles were included because they can act like both debt and equity. Both convertibles and preferreds are like debt in that they require fixed interest payments. Convertibles are like equity in that convertible bondholders have the option of turning their securities into residual claims. Preferred stockholders are residual claimants in that they do not receive dividends until after debtholders have been paid.

The dependent variable was defined as total assets less equity divided by equity. Debt-to-equity was used rather than debt-to-total assets because it was felt to encompass more information. Ferri and Jones recognized that it satisfies both sides in the dispute about whether capital structure is more properly measured using debt or equity divided by total assets.[25] Equity was the sum of common stock, preferred stock, and convertible debt. This definition of DEBTEQ was chosen so that the variable would contain as much information as possible about capital structure.

Preliminary regression runs were examined to see which of three definitions of DEBTEQ gave the smallest t-statistics for the coefficients of PFDDUM and CONVDUM. The other possible

---

[24] Richard Brealey, and Stewart Myers, Op. Cit., pp 586-587.

[25] M. G. Ferri and Wesley H. Jones, Op. Cit.

definitions for equity were common stock, and common stock less preferred stock. The chosen definition was felt to contain the most information about preferreds and convertibles and their relation to capital structure.

All the non-dummy independent variables were standardized. This was to reduce the possibility of roundoff errors when inverting the X'X matrix. If the determinant of the X'X matrix is near zero, or the variables differ considerably in scale, there is a serious danger of roundoff errors.[26]

So that the results could be easily interpreted, the dependent variable was not standardized. For example, unstandardized data should not lead to an intercept term which is significantly negative, since this is not observable in firms which are going concerns. Because the magnitude of DEBTEQ was relatively close to that of the standardized independent variates, it was felt that the use of standardized independent varibles would aid in the interpretation of the results.

Preliminary results suggested that the assumption of constant variance necessary in a regression setting was being violated. From a statistical point of view, heteroscedasticity was observed and had to be corrected. In particular, the size of the residuals increased with DEBTEQ, and the expected normal probability plot of residuals was a steep curve of positive and decreasing slope. The ideal expected normal plot is a forty-

---

[26] John Neter and William Wasserman, Applied Linear Statistical Models, Richard D. Irwin Inc., Homewood, Illinois, 1974, p347.

five degree straight line. To compensate for these violations of normality, DEBTEQ was transformed. The new dependent variable, LNDE, was taken to be the logarithm to base e, of DEBTEQ.

A decrease in equity both decreases the denominator and increases the numerator, so that a change in financing policy has a double effect. DEBTEQ is concave to the origin, with respect to equity. The derivative of the logarithm of the debt-to-equity ratio as defined, with respect to preferred stock, is negative if the average equity to total assets ratio is greater that 1/2. For the sample, the ratio was .48.

An examination of the correlation matrix indicated that SIZE and VAR were highly correlated (.7946). An auxiliary regression showed that VAR=.79458(SIZE). Average sales and sales variance were not significantly correlated. The intercept was not forced to zero, but the regression results gave an intercept term of nil. This regression was highly significant, with a R-squared statistic of .63 and a F-ratio of 75.19. A new variable, NEWVAR, was formed, which equalled VAR-.79548(SIZE),so as to separate the effects of size and sales variance.

The regression results are given in Table 1. Each column gives the coefficients for a different regression. The first column corresponds to the output from the full set of data from 1976 and 1981.

Table I - Regression Results

	1981, 1976 DATA			1971, 1966 DATA	
	All Cases	All Cases	Cases 69,241 Deleted	All Cases	Cases 38,236 Deleted
Intercept	.46	-.04	.44	.04	.04
CMTA	-.22***	-.21***	-.24***	-.24***	-.25***
ARTA	-.07	-.17***	-.07	-.06	-.07
INVTA	-.12	-.17***	-.11	-.22**	-.23**
NTPTA	-.31***	-.17*	-.31***	-.23**	-.19
SUBSEC	.12***	.13***	.12***	.11***	.11***
SIZE	-.02	.03	-.01	-.05	-.04
DOL	-.03	-.06	-.05		
NEWVAR	.03	.04	.01		
PFDDUM	.13***	.26***	.12***	.40***	.38***
CONVDUM	.00	.08	.00	.15	.15
YRDUM	-.05	-.07	-.05	.10	.10
D1	-.52***		-.49**	-.60**	-.57***
D2	-.83***		-.83***	-.69***	-.59***
D3	-.75***		-.74***	-.36	-.27
D4	-.48***		-.47***	-.73***	-.75***
D5	-.38*		-.37*	-.56***	-.56***
D6	-.64***		-.57***	-.61***	-.56***
D7	-.02		.00	-.49*	-.53**
D8	-.44***		-.47***	-.45**	-.54***
D9	-.89***		-.88***	-.89***	-.84***
D10	-.73***		-.70***	-.68***	-.63***
D11	-.74***		-.71***	-.62**	-.57***
D12	.01		.06	.46	.43
D13	.49*		.52**	.39	.31
D14	-.47***		-.46***	-.34	-.30
F-RATIO	14.676	16.11	15.745	11.751	12.574
P(TAIL)	.000	.000	.000	.000	.000

*INDICATES BONFERRONI SIGNIFICANCE AT .10 LEVEL
**INDICATES BONFERRONI SIGNIFICANCE AT .05 LEVEL
***INDICATES BONFERRONI SIGNIFICANCE AT .01 LEVEL

Bonferroni joint confidence intervals were used to enable simultaneous testing of all the regression coefficients. In essence, the probability associated with the Bonferroni interval requires taking the two tail probability derived from the t-statistic for each coefficient, and dividing that t-statistic by the number of regression coefficients.

The first hypothesis cannot be supported: it appears that firms with more liquidity do not have higher debt ratios. The significantly negative coefficient of CMTA implies this surprising result. This may have been due to firms experiencing downturns in earnings, which would have led to decreased retained earnings, hence lower equity, while at the same time cash flows would have decreased.

If this were the case, then one would expect the coefficient to be closer to zero, or less significant, or both, during periods of economic growth. During expansionary periods, firms would face growing cash flows, in general. Retained earnings would not be expected to decrease during these times, nor would cash be drawn down due to reduced cash flows. To see if economic climate might be inducing the negative cefficient for CMTA, similar regressions were run on 1971 and 1966 data. These results indicate that that the inverse relationship between CMTA and LNDE is permanent.

The coefficient of CMTA may have been due to collinearity. However, when all the variables with which CMTA had an absolute value of simple correlation of more than .20 were deleted from

the model, the coefficient for CMTA remained significantly negative. Furthermore, in an all subsets context, CMTA was always among the first variables included in the regression (using the BMDP package P:9R), and the sign of its coefficient was always negative.

In a further effort to test for collinearity, especially among three or more variates, the Belsley, Kuh and Welsh technique of variance decomposition was used. This procedure requires standardizing the X-matrix to unit column length. Principle components analysis is then used to break the X-matrix down into eigenvalues and corresponding orthogonal eigenvectors. The eigenvectors are then decomposed as shown in Table 2.

Table II - Variance Decomposition

	Variance(Bi)											
Lj	1	2	3	4	5	6	7	8	9	10	11	Nj
1.88	.01	.05	.03	.30	.00	.02	.02	.01	.00	.00	.00	1.0
1.32	.02	.12	.17	.27	.00	.09	.02	.07	.00	.03	.05	1.4
1.27	.13	.21	.06	.08	.00	.06	.03	.10	.01	.01	.11	1.5
1.04	.15	.31	.26	.14	.00	.01	.05	.04	.03	.00	.01	1.8
1.01	.31	.10	.19	.12	.04	.02	.19	.08	.03	.04	.09	1.9
.95	.08	.05	.06	.01	.03	.03	.11	.04	.02	.02	.06	2.0
.88	.08	.02	.04	.01	.03	.10	.37	.07	.07	.09	.31	2.1
.81	.10	.07	.01	.02	.15	.09	.07	.12	.27	.17	.24	2.3
.77	.01	.03	.15	.01	.02	.42	.02	.34	.09	.06	.07	2.4
.73	.00	.10	.02	.01	.06	.14	.01	.08	.32	.36	.06	2.6
.65	.04	.00	.01	.00	.66	.01	.10	.04	.15	.21	.00	2.9

Lj is the square root of the jth eigenvalue.

Nj is the jth condition index. This is equal to the square root of the largest eigenvalue divided by the square root of the jth eigenvalue.

Each row of Table 2 corresponds to an eigenvalue. The final column on the right side of the table gives the condition index associated with each eigenvalue. Each of the other columns corresponds to one of the original X-variates.

The ith condition index is the ratio of the square root of the largest eigenvalue to the square root of the ith eigenvalue. A high condition index is associated with collinearity. Belsley, Kuh and Welsh suggest that weak dependencies are found when indices read between 5 and 10, whereas measures of 30 to 100 indicate severe ill-conditioning. The largest condition index in this case is 2.9, which gives no indication of collinearity.

In the rest of the table, the i,jth entry gives the amount of variance of the jth X-variate described by the ith eigenvector. Collinearity is diagnosed if a large portion of the variance of two or more X-variates is associated with the same eigenvector. Put another way, if two or more variance decomposition proportions in the same row are large, then the same eigenvector is explaining the variance of the non-orthogonal X-variates corresponding to the large variance decomposition proportions. Belsley, Kuh and Welsh suggest that a good cutoff point for the variance- decomposition proportions is .50, and that discrepencies usually show up with proportions being about .80 or so. In Table 2, there is no case in which two proportions associated with any one condition index exceed .35, so that there is little or no collinearity in the data; the columns of the X-matrix are orthogonal. This supports the

contention that VAR and DOL are independent as postulated in (52) and (53).

The proxies for degree of operating leverage, ARTA, INVTA, and NTPTA, all have negative coefficients. This is consistent with lower financial leverage for firms with high operating leverage, so the second null hypothesis is rejected. The individual coefficients are not all significant.

The lack of significance of ARTA and INVTA could be due to different industries having different types of receivables and inventories. different firms. Write-off procedures for accounts receivable will vary amongst industries, as will accounts receivable and inventory turnover. Consequently, the extent to which these variables measure fixed costs will vary amongst industries. Plant is a fixed cost for all the firms, so it should be a better proxy for operating leverage than ARTA or INVTA.

SUBSEC has a significant and positive coefficient, which is consistent with the theory that firms which satisfy certain conditions have higher debt ratios. The extent to which junior debt will be used depends on taxes, bankruptcy costs, and operating leverage. Tax rates were not examined in this experiment, so that the influences on SUBSEC cannot be properly determined.

SUBSEC was regressed against ARTA, INVTA, NTPTA, SIZE, DOL, and NEWVAR. The R-squared statistic was less than .01, and each t-statistic was less than 1.0. The data was extremely skewed, with only 68 cases being non-zero, so regression was perhaps an

inappropriate way to test the relationship in question. Transformations indicated by the expected normal plot to correct the error variance were the logarithmic or the square root transformations. The first was impossible since many of the observations was 0.0, and the second was shown to be inappropriate.

In Chapter 2, firms were shown to be indifferent to issuing senior or subordinated debt if each kind of debt had similar bankruptcy costs. However, if junior debtholders faced higher bankruptcy costs, junior debt would be issued if taxes were significantly positive.

The insignificant coefficient of SIZE leads to rejection of the fourth null hypothesis, that larger firms have larger debt-to-equity ratios. Other studies consistently found SIZE to be positively related to financial leverage. This unexpected result could be due to sampling bias: the Compustat Quarterly Industrial Tape comprises firms on the Standard and Poor's 400 Industrial Index, and some other large firms. It could be that once firms reach a certain size, there is no longer any effect of size on the financing decision. It may also be that the size effect was swamped by the industry effect. If there are optimal scales within industries, then the size effect may be part of the industry effect.

The coefficient for DOL is insignificant, causing acceptance of the null hypothesis. However, with the deletion of outliers, this variable does become significant at the level of .10, using Bonferroni confidence limits.

The coefficient of NEWVAR is insignificant, leading to acceptance of the hypothesis that sales variance has no relation to financial leverage. This is contrary to the prediction of the model developed in Chapter 2. It may be that sales variability was measured imperfectly. For example, suppose two firms had identical sales of 50, 100, and 150 over three periods. Further, assume that one firm grew over the period, with total assets of 100, 200 and 300 over the three periods. The second firm is assumed to have constant size of 200 over the three periods. The measures of variability will be the same for both firms, that is, they have the same standard deviations and same average sales. The firm which grows over the period has sales which are a constant percentage of size.

One measure of variability which would compensate for the scale effect would be the standard deviation of the ratio of sales to total assets (the total assets turnover ratio). This value would be 0 for the growth firm, and .125 for the constant size firm. Unfortunately, Compustat does not provide balance sheet data on a quarterly basis. However, the measure was computed on the basis of annual data. The coefficients for all the variables were unchanged in sign from previous regressions. The coefficient for the standard deviation of sales turnover was insignificant, having a t-statistic of less than one. When influential points had been deleted, the coefficient remained insignificant.

The insignificance of CONVDUM in the regression indicates that the dependent variable is well specified with respect to

convertible debt acting like equity. However, PFDDUM is significantly positive, even though preferreds are already being treated like equity. Perhaps the reason for this lies in the nature of preferred dividends.

Preferred shareholders are only entitled to dividends after debtholders' claims have been settled. However, their claims have an upper bound. If earnings are more than enough to make interest payments and preferred dividends, then the excess must either be paid to common shareholders or be retained. Earnings that are retained are subject to first claim by debtholders during the next period. In this context, debtholders would prefer that equity be issued solely in the form of preferreds and not at all in the form of common stock. It may be that lenders feel that future interest payments are more secure when preferred equity is issued, so that firms who issue preferreds are able to issue more debt.

YRDUM is not significant, as predicted.

Twelve of fourteen industry coefficients are significant. The regression results are consistent with an industry class effect, which contradicts the Modigliani-Miller hypothesis. Debt ratios are similar within risk classes, indicating that there are factors which influence firms' capital structure decisions.

Three expected normal probability plots are provided in Figures 1, 2 and 3. These correspond respectively to the full sample with no deletions, with case 241 deleted, and with cases 241 and 69 deleted, respectively. Case 241 is identified in

Figure 1 as the case with the largest positive standardized residual. Case 69 has the largest negative standardized residual in Figures 1 and 2. Cases 69 and 241 are arguably outliers and should be deleted from the sample. When these cases are deleted, the expected normal plot of Figure 3 is close to the ideal, which is a positively sloped forty-five degree straight line.

Case 69 was Kaiser Steel, which has large holdings in Kaiser Resources. Kaiser Resources was petitioned for bankruptcy in British Columbia in 1982. Case 241 is Bowater Corp., whose financial statements have been translated from pounds to dollars. Bankruptcy and currency translation are exceptional occurances, and support the contention that these two observations should be deleted from the sample.

Figure 1 - Expected Normal Plot, All Cases, 1981 & 1976 Data

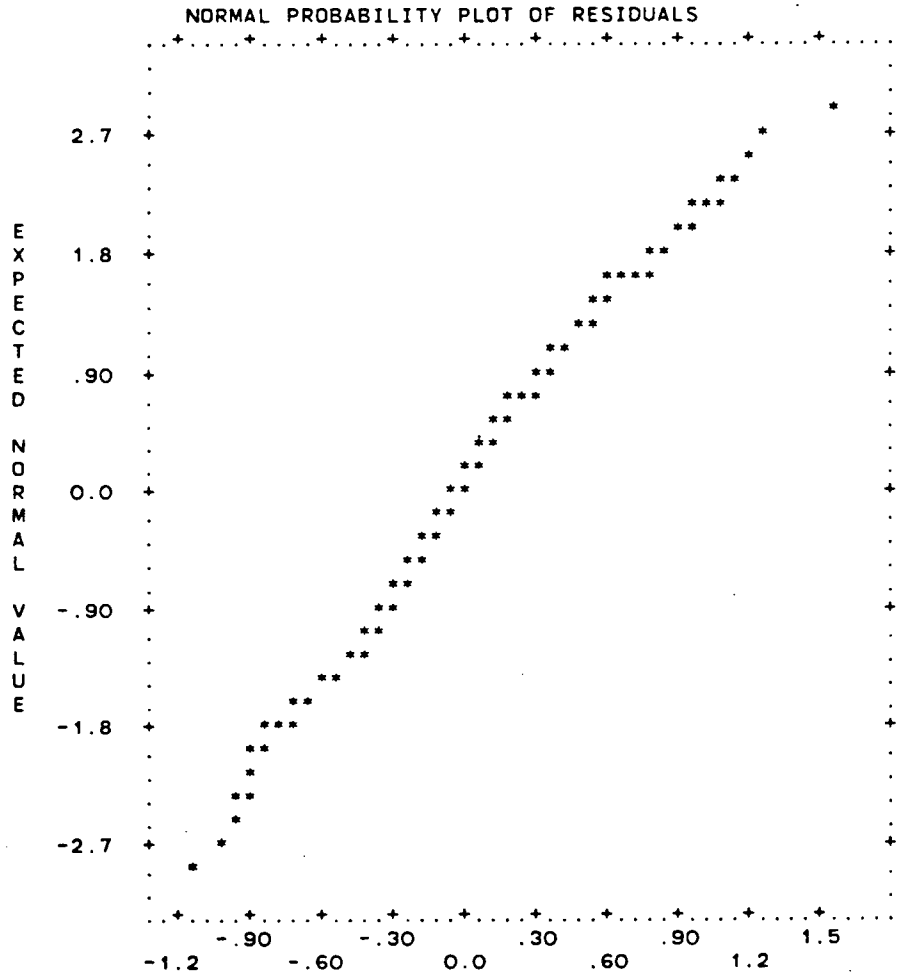


Figure 2 - Expected Normal Plot, Cases 69 & 241 Deleted, 1981 & 1976 Data

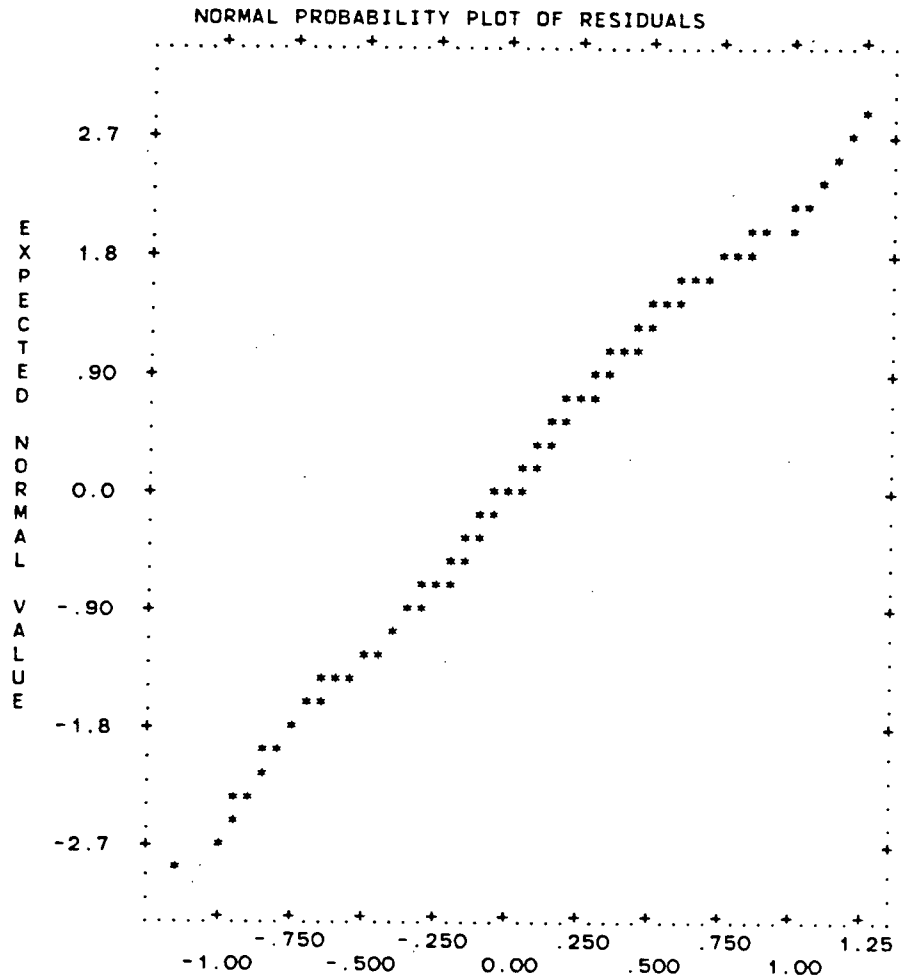
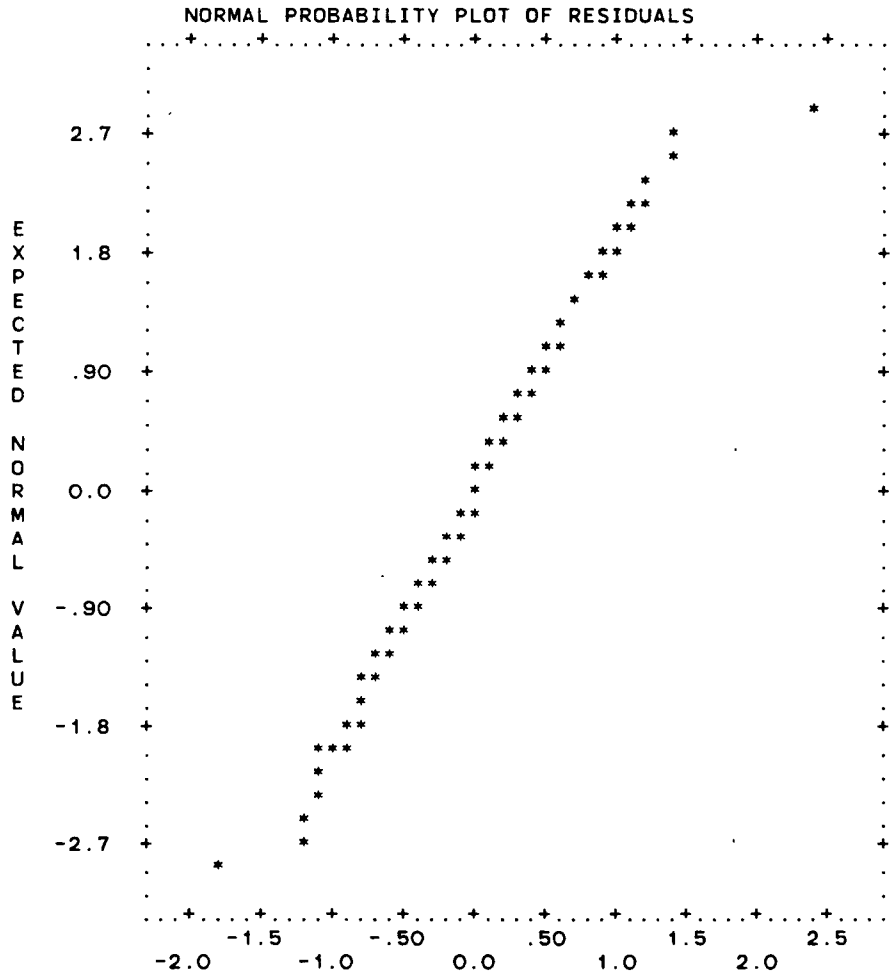


Figure 3 - Expected Normal Plot, All Cases, 1971 & 1966 Data



The regression results for the revised sample are given in the second column of Table 1. In no cases do the signs of the coefficients change, but the DOL becomes significant, and takes the sign predicted by the model. The outliers did introduce a slight distortion of the coefficients, but they appear to be stable with or without the outliers.

A variable selection technique was employed to see if the model had been correctly specified. The subset of variables which had the Cp statistic which was closest, in absolute terms, to the number of variables in the subset, was that selected as the best subset. To calculate the Cp statistic, first take the ratio of the residual sum of squares from the reduced model (using a subset of variables) to the residual mean square for the full model. Subtract from this the difference between the number of variables in the full model less twice the number of variables in the subset. The expected value of Cp is the number of variables in the reduced equation.

The chosen equation had nineteen variables, including the intercept. The full model had twenty-six. The Cp statistic for the best subset was 18.81. Three coefficients, for the variables INVTA, DOL, and YRDUM, were insignificant at the Bonferroni joint confidence level of .05. More importantly, the signs of all the coefficients were consistent with those of Table 1. Furthermore, in the computer output, for all subsets examined, the coefficients of all the significant variables in Table 1 had the same signs. This is consistent with the earlier findings that there is no collinearity in the data.

Regressions were next run for each industry, using all cases. The results are given in Table 3 and Table 4. The tables list the coefficients for each regression, followed by a * if the coefficient had a t-statistic which was significant at the .05 level.

Table III - Industry Regressions

	D1	D2	D3	D4	D5	D6	D7	D8
INTERCEPT	-.52	-.79	-1.63	-.49	-.15	-.39	.42	.03
CMTA	-.78	-.09	-.13	-.19	-.24	-.15*	-.33	-.25
ARTA	-.97	.24	-.29	.24	-.04	.07	.09	-.46*
INVTA	-.47	.31	.13	-.43	-.70*	-.49	-.21	-.21
NTPTA	-1.00	.09	-.39	-.14	-.50	-.24	-.30	-.81*
SUBSEC	.61	.46	.22*	.18	N.A.	.21*	.58*	.14*
SIZE	-.85	-.26	-2.82	-.78	.09	.21	-.01	-.09
DOL	.03	-.03	-.09	-.03	-.05	-.06	-.05	.12
NEWVAR	-.90	-1.31	4.51	.07	-.03	-.10	-.03	-.31
PFDDUM	1.18*	.23	.19	.34*	.17	.19	.46*	.36
CONVDUM	.23	.18	-.28	.03	-.28*	.11	-.20	-.36
YRDUM	-.83	-.25	-.06	.00	.14	.13	.12	-.24
R-SQUARED	.91	.51	.69	.54	.36	.69	.56	.52
F-RATIO	3.60	1.31	2.38	2.60	1.42	4.38	4.17	2.77
DF	11,4	11,4	11,12	11,24	10,25	11,22	11,36	11,28
P(TAIL)	.11	.31	.08	.02	.23	.00	.00	.01
EXPECTED NORMAL PLOT	GOOD	VERY POOR	OK	OK	OK	POOR	POOR	GOOD
OUTLIERS	NO	YES	YES	YES	YES	YES	YES	YES
CASES	16	26	24	36	36	34	48	40

N.A.:No variability in the data.

* Indicates t-statistic significant at .05 level.

Table IV - Industry Regressions Continued

	D9	D10	D11	D12	D13	D14	D15
INTERCEPT	-.44	-.43	-.73	3.12	.69	-.14	.64
CMTA	-.53	-.03	-.27	.23*	-.13	N.A.	-.52*
ARTA	-.42	.25	-.05	.42	.04	.13	-.39
INVTA	-.42	-.12	.45	-.58	.42	.42	-.39
NTPTA	-.62	-.06	-.23	-.44	.05	.35	-.59
SUBSEC	.27	.20	.05	.35	.33	-.24	.04
SIZE	-1.74	.21	-.85	8.89*	-1.04	.07	.31
DOL	-.06	.00	.05	-.25	-1.03*	.14	-.25
NEWVAR	-10.35	.37	-2.02	-4.54*	-3.18	-.72	-.34
PFDDUM	.41	.53	-.40	N.A.	.15	.35*	-.14
CONVDUM	.04	.14	.57	.10	.21	.01	.10
YRDUM	-.19	-.12	.02	.79*	-.66	-.27	-.38
R-SQUARED	.83	.62	.67	.92	.74	.76	.47
F-RATIO	3.63	1.48	2.17	7.77	3.12	3.40	1.77
DF	11,8	11,10	11,12	10,7	11,12	10,11	11,22
P(TAIL)	.04	.27	.10	.01	.03	.03	.12
EXPECTED NORMAL PLOT	POOR	VERY POOR	OK	OK	POOR	POOR	OK
OUTLIERS	NO	NO	YES	YES	YES	YES	YES
CASES	20	22	24	18	24	22	34

N.A. means no variability in the data.

* Indicates t-statistic significant at .05 level.

The bottom row of the table shows that most of the regressions violate the normality assumption, and have coefficients which are determined by a few outliers. There were nineteen significant coefficients, out of a possible total of 165. The signs of the significant coefficients are consistent with those in Table 1, with the exception of YRDUM in D12, the trucking industry. The coefficient for SIZE was 8.89, and that for NEWVAR -4.54, in D12, and both were highly significant. In this case, the normal probability plot indicated the presence of outliers, one with a very large negative residual, and the other with a very large positive residual. Furthermore, there were only eleven independent variables to be determined by only eighteen cases. In the context of so few cases and the influence of outliers, The regression results provide little information in the case of D12. These results can be generalized to all the industry regressions, to each of which at least one of the following criticisms apply: the assumption of constant error variance was violated, the sample consisted of relatively few observations, or there were influential points in the data. Consequently, little faith can be attached to the industry by industry results.

When regressions were run without the industry dummies, the resultant equation was that shown in the second column of Table 1. Coefficients were identical in sign to those of earlier regressions, and ARTA and DOL are both significant in Bonferroni tests at the .05 level.

In conclusion, there seems to be an industry effect where

firms in the same industry face similar capital structures. Liquidity was found to be negatively related to the degree of operating leverage, contrary to expectations. Operating leverage had a negative effect on the dependent variable, when measured directly as the elasticity of EBIT to sales, or through proxies such as the inventory to total assets ratio or the net plant to total assets ratio. Firms which issued subordinated debt issued more debt relative to equity. SIZE was found to have no relation to the debt-to-equity ratio. This may have been due to the sampling technique, or the industry effect. Sales variance did not affect capital structure, contratry to expectations. Firms which issued preferred debt had more financial leverage, which may be due to the fixed and residual nature of preferred dividends. Convertible debt was seen to have behaved like equity. These results tend to support the concept of an optimal capital structure.

LITERATURE CITED

1. Altman, Edward I. "Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy." Journal of Finance, September 1978.

2. Baxter, Nevins D. "Leverage, Risk of Ruin and the Cost of Capital." Journal of Finance, September 1967.

3. Beaver, William H. "Market Prices, Financial Ratios, and the Prediction of Failure." Journal of Accounting Research, Autumn 1968.

4. Belsley, David A.; Kuh, Edwin; and Welsh, Roy E. Regression Diagnostics. Toronto: John Wiley & Sons, 1980.

5. Brealey, Richard; and Myers, Stewart. Principles of Corporate Finance. Toronto: Mc-Graw Hill,Inc., 1981.

6. Chatterjee, Samprit; and Price, Bertram. Regression Analysis By Example. Toronto: John Wiley & Sons, 1977.

7. Chen, Andrew H.; and Kim, E. Han. "Theories of Corporate Debt Structure: A Synthesis." Journal of Finance, May 1979.

8. Copeland, Thomas E.; and Weston, J. Fred. Financial Theory and Corporate Policy. Don Mills, Ontario: Addison Wesley, 1979.

9. Dixon, W.J.; and Brown, M.B., eds., BMDP-79: Biomedical

10. Computer Programs P-Series. Berkely, California: University of California, 1979.

11. Draper, Norman; and Smith, Harry. Applied Regression Analysis, 2nd ed. Toronto: John Wiley & Sons, 1981.

12. Ferri, Michael G.; and Jones, Wesley H. "Determinants of Financial Structure: A New Methodological Approach." Journal of Finance, June 1979.

13. Francis, Jack Clark. Investments: Analysis and Management, 3rd ed. Toronto:McGraw Hill Book Company, 1980.

14. Hamada, Robert S. "The Effect of the Firm's Capital Structure on the Systematic Risk of Common Stocks." Journal of Finance, June 1966.

15. Jensen, M.C.; and Meckling, W.H. "Theory of the Firm:Managerial Behavior, Agency Costs and Ownership Structure." Journal of Financial Economics, October 1976.

16. Lev, Baruch. "On The Association Between Operating Leverage and Risk." Journal of Financial and Quantitative Analysis, September 1974.

17. Marsh, Paul. "The Choice Between Equity and Debt: An Empirical Study." Journal of Finance, March 1982.

18. Miller, M.H. "Debt and Taxes." Journal of Finance, May 1977.

19. Modigliani, Franco; and Miller, Merton H. " The Cost of Capital, Corporate Finance, and the Theory of Investment." American Economic Review, June 1958.

20. Myers, Stewart C., ed. Modern Developments in Financial Management. Hillsdale, Illinois: Holt, Rinehart and Winston, 1976.

21. Neter, John; and Wasserman, William. Applied Linear Statistical Models. Homewood, Illinois: Richard D. Irwin Inc., 1974.

22. Remmers, Lee; Stonehill, Arthur; Wright, Richard; and Beekhuisen, Theo. "Industry and Size as Debt Ratio Determinants in Manufacturing Internationally." Financial Management, Summer 1974.

23. Schwartz, Eli; and Aronson, J. Richard. "Some Surrogate Evidence in Support of the Concept of Optimal Capital Structure." Journal of Finance, March 1967.

24. Scott, David F., Jr. "Evidence on the Importance of Financial Structure." Financial Management, Summer 1972.

25. Scott, David F., Jr.; and Martin, John D. "Industry Influence on Financial Structure." Financial Management, Spring 1975.

26. Scott, James H., Jr. "Bankruptcy, Secured Debt, and Optimal Capital Structure:Reply." Journal of Finance, March 1979.

27. Smith,Clifford W., Jr.; and Warner, Jerold B. "On Financial Contracting: An Analysis of Bond Covenants." Journal of Financial Economics, 7(1979) 117-161.

28. Standard and Poor's Compustat Services, Inc. Industrial Compustat. New York: Standard and Poor's Compustat Services, Inc., 1982.

29. Stiglitz, Joseph E. "On the Irrelevance of Corporate Financial Policy." American Economic Review, December, 1974.

30. Van Horne, James C.; Dipchand, cecil R.; and Hanrahan, J. Robert. Financial Management and Policy, Canadian 4th ed. Scarborough, Ontario: Prentice-Hall of Canada Ltd., 1977.

31. Warner, Jerold B. "Bankruptcy Costs: Some Evidence." Journal of Finance, May 1977.

APPENDIX A - LIST OF COMPANIES SAMPLED

This appendix lists the industries and firms included in the sample .

Food and Kindred Products: Anderson, Clayton & Co.; CPC International Inc.; Campbell Soup Co.; Consolidated Food Corp.; Kellog Co.; Nabisco Brands Inc.; Norton Simon Inc.; Quaker Oats Co.

Textile Mill Products: Belding Heminway; Burlington Industries Inc.; Collins and Aikman Corp.; Cone Mills Corp.; Dan River Inc.; Fieldcrest Mills; Graniteville Co.; M. Lowenstein Corp.; Reeves Brothers Inc.; Riegel Textile Corp.; Springs Industries Inc.; J.P. Stevens Inc.; West Point-Pepperell.

Apparell and Other Finished Products: BTK Industries Inc.; Blue Bell Inc.; Cluett, Peabody and Co.; Hart, Schaffner and Marx Co.; Interco Inc.; Jonathan Logan Inc.; Levi Strauss & Co.; Manhattan Industries Inc.; Phillips-Van Heusen; U.S. Industries; VF Corp.; Warnaco Inc.

Paper and Allied Products: Boise Cascade Corp.; Bowater Corp. Ltd.-ADR; Crown Zellerbach; Diamond International Corp.; Domtar Inc.; Federal Paper Board Co.; Fort Howard Paper; Great Northern Nakoosa Corp.; Hammermill Paper Co.; International Paper Co.; Kimberly-Clark Corp.; Mead Corp.; Potlach Corp.; St. Regis Paper Co.; Scott Paper Co.; Stone Container Corp.; Union Camp Corp.; Westvaco Corp.

Chemicals and Allied Products: Allied Corp.; American Cyanamid Co.; Diamond Shamrock Corp.; Dow Chemical; E.I. Du Pont De Nemours; FMC Corp.; W.R. Grace & Co.; Hercules Inc.; Monsanto Co.; Morton-Norwich Products; National Distillers and Chemical; Olin Corp.; PPG Industries Inc.; Pennwalt Corp.; Rohm and Haas Co.; Stauffer Chemical Co.; Thiokol Corp.; Union Carbide Corp.

Drugs: Abbott Laboratories; American Home Products Corp.; Bristol-Myers Co.; Iroquois Brands Ltd.; Eli Lilly & Co.; Merck and Co.; Pfizer Inc.; Richardson Vicks Inc.; Rorer Group; Schering-Plough; G.D. Searle & Co.; Smithkline Beckman Corp.; Squibb Corp.; Sterling Drug Inc.; Syntex Corp.; Upjohn Co.; Warner-Lambert Co.

Petroleum Refining: Amerada Hess Corp.; Ashland Oil Inc.; Atlantic Richfield Co.; British Petroleum Co. Ltd.-ADR; Cities Service Co.; Coastal Corp.; Exxon Corp.; Gulf Oil Corp.; Imperial Oil Ltd.-CL A; Kerr McGee Corp.; Louisiana Land & Exploration; Mobil Corp.; Murphy Oil Corp.; Phillips Petroleum Co.; Quaker State Oil Refining; Royal Dutch Petroleum-NY GLDR 10; Shell Oil Co.; Standard Oil Co. of California; Standard Oil Co. of Indiana; Sun Co. Inc.; Tenneco Inc.; Texaco Inc.; Union

Oil Co. of California; Witco Chemical Corp.

Blast Furnaces and Steel Works: Armco Inc.; Athlone Industries; Axia Inc.; Bethlehem Steel Corp.; Carpenter Technology; Colt Industries Inc.; Copperweld Corp.; Crane Co.; Inland Steel Co.; Interlake Inc.; Kaiser Steel Corp.; Keystone Construction Industries Inc.; LTV Corp.; Lukens Inc.; McLouth Steel Corp.; National-Standard Co.; Northwest Industries; Republic Steel Corp.; U.S. Steel Corp.; Wheeling-Pittsburg Steel.

Metalworking Machinery and Equipment: Acme-Cleveland Corp.; Black and Decker Manufacturing Co.; Brown and Sharpe Manufacturing Co.; Chicago Pneumatic Tool Co.; Cincinnati Millacron Inc.; Esterline Corp.; Ex-Cell-O Corp.; Giddings & Lewis Inc.; Kennametal Inc.; Monarch Machine Tool Co.

General Industrial Machinery and Equipment: Cooper Industries Inc.; Curtiss Wright Corp.; Figgie International Inc.; Ingersoll-Rand Co.; Midland-Ross Corp.; New Hampshire Ball Bearings; Rexnord Inc.; Scott and Fetzer Co.; Sta-Rite Industries; Sunstrand Corp; Timken Co.

Electronic Computing Equipment: Computervision Corp.; Control Data Corp.; Data General Corp.; Datapoint Corp.; Digital Equipment; Electronic Associates Inc.; Electronic Memories and Magnet; Hazeltine Corp.; Hewlett-Packard Co.; Honeywell Inc.; Storage Technology Corp.; Wang Laboratories-CL B.

Trucking- Local and Long Distance: Consolidated Freightways Inc.; Leaseway Transportation Corp.; McLean Trucking Co.; National City Lines; Overnite Transportation; Purolator Inc.; Roadway Express Inc.; Transcon Inc.-California; Yellow Freight System.

Air Transportation- Certified: American Airlines Inc.; Continental Air Lines Inc.; Delta Air Lines Inc.; Eastern Air Lines; Northwest Airlines Inc.; Pan American World Airways; Tiger International; Trans World Corp.; United Air Lines Inc.; U.S. Air Inc.; Western Air Lines Inc.; World Airways Inc.

Retail- Department Stores: Allied Stores; Associated Dry Goods Corp.; Carter Hawley Hale Stores; Federated Department Stores Inc.; R.H. Macy and Co.; Marshall Field & Co.; May Department Stores Co.; J.W. Mays Inc.; Mercantile Stores Co.; J.C. Penny Co.; Sears, Roebuck & Co.

Retail- Grocery Stores: A.J. Bayless Markets Inc.; Borman's Inc.; Dillon Companies; General Host Corp.; Great Atlentic and Pacific Tea Co.; Jewel Companies Inc.; Kroger Co.; Lucky Stores Inc.; Munford Inc.; Petrolane Inc.; Safeway Stores Inc.; Southland Corp.; Star Supermarkets; Stop & Shop Companies; Supermarkets General Corp.; Thorofare Markets; Winn-Dixie Stores Inc.