THE MORAL HAZARD THEORY
OF CORPORATE FINANCIAL STRUCTURE:
EMPIRICAL TESTS

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Structure: Empirical Tests

The development of the theory of optimal corporate financial structure has been based on the critical assumption that the value of the equity is maximized at the level of debt which maximizes the market value of the firm. Recently, however, Myers (1977) illustrated the breakdown of that assumption under very plausible conditions. Those conditions produce a conflict between bondholders and stockholders, leading to the application of the term moral hazard.

This paper is an attempt to use a large sample of firms to test the moral hazard theory against others found in the literature. Although the tests cannot conclusively prove one theory correct and the others incorrect, they will add information which may be of value in further theoretical development. Section I reviews the theory of optimal capital structure. Section II describes the moral hazard theory. Sections III and IV describe the tests and the results.

1. The Theory of Optimal Capital Structure

With the publication of their now famous paper (1958) Modigliani and Miller (MM) laid the traditional theory of optimal corporate capital structure open to inspection and criticism. Until that time, most discussion focused not on the value of the firm's securities at different levels of debt financing, but on which accounting items were capitalized to give that value. It was usually taken for granted that the value of the firm is a concave function of the degree of debt financing.

MM's models (1958 and 1963) employed the economic paradigm of the perfect and competitive market to analyze the capital structure problem. Proposition I (1958) disturbed people for a number of reasons, not the least of which was that it seemed to completely obviate the need to consider capital structure decisions. MM's addition of corporate income taxes to the model (1963) did little to convince casual empiricists that the basic model is a workable approximation to the interface between corporate finance and the capital markets. MM's propositions are the mathematically correct results of the assumptions they imposed on their model. Stiglitz (1974), however, proved that none of the other assumptions of the no-tax model are critical if capital markets are complete and perfect.

It appeared that the source of modifications to the MM theory must be based on imperfections in the capital markets. One of the first such imperfections to be identified was bankruptcy costs, or, more generally, the costs of financial distress.[1]

Robichek and Myers (1966) recognized that legal fees, the disruption of normal supplier-purchaser relationships, and other products of financial distress reduce expected cash flow, and that the expected value of these costs increases absolutely with the degree of financial leverage. With cash flows

related to capital structure in this way, the monotonically increasing market value curve of MM develops a negative slope at higher levels of debt financing. Note that this effect depends not only on the magnitude of the dead-weight loss given financial distress occurs, but also on the probability of occurence.

In the context of a mean-variance model of security valuation, Kim (1978) shows that corporate debt capacity (defined by Kim as the greatest present value of future debt obligations available to the firm) exists at a capital structure containing less than 100 percent debt. This result and the derivation of a firm value as a strictly concave function of the total debt obligations obtain from the author's assumption of corporate taxes and stochastic bankruptcy costs.

The empirical importance of costs of financial distress has not been conclusively determined. The direct costs of bankruptcies have been estimated by Stanley and Girth (1971). They found that close to 20 percent of the value is lost to expenses directly related to the bankruptcy. Van Horne's (1975) figures agree. Recently, Warner (1976), in examining the bankruptcies of U.S. railroad corporations, found the fractional loss to be close to one fourth that found in the earlier studies. Warner's data indicate that the marginal cost of bankruptcy is a decreasing function of firm size. This could help explain the large discrepancy between the studies when one considers that Stanly and Girth examined entities which, in general, were smaller than Warner's railroads.

Other costs of financial distress have not yet been measured. Loss of sales due to fears of the disruption of supply by a firm's customers is probably a significant expected cost. Similarly, the degree to which tax shields are lost by bankrupt and reorganized firms is unknown and may be significant.

Departure from the MM upward-sloping market value curve has been explained by a clientele hypothesis. Suggested by Black (1971 and 1973) and developed

by Miller (1977) the theory is an extension of the MM model, but allows for
1) personal income taxes, 2) personal capital gains taxes at a rate other
than that on income, and 3) the existence of tax-free bonds. Under certainty,
investors in a given tax bracket find it most profitable to hold taxable
corporate debt only if the yield differential between taxable and tax-free
bonds is sufficient to compensate the investors in that group for their added
tax liability. Firms will find that they can maximize their value if they
continue to substitute debt for equity as long as the additional interest tax
shield is large enough to offset the incremental amount of interest necessary
to induce the marginal investor group to hold the taxable bonds. Thus, under
certainty, there will exist some optimal aggregate level of corporate borrowing
given the distribution of investor tax brackets. The theory suggests that the
level of borrowing by a single firm is indeterminate, or determined entirely by
other unnamed factors.

II. The Moral Hazard Theory

Much recent work has been concerned with the conflicting interests of the
bondholders and the stockholders. Jensen and Meckling (1976) argued that bond-
holders should require an indenture to eliminate opportunities for the stockholders
and managers to shift wealth from bonds to stock. Costs of surveillance to moni-
tor the firm's compliance with the indenture is an agency cost which is passed
to the shareholders or managers. The more restrictive the indenture and the
larger the potential transfer, the higher agency costs are likely to be. Jensen
and Meckling suggest that these costs outweigh the present value of the interest
tax shields at some level of debt financing.

Galai and Masulis (1976) focused on a specific method of effecting the

transfer of value from debt to equity. Merton (1974) had shown, using a contingent claims analysis, that the value of a firm's bonds is inversely related to the total risk of its assets. The authors, using Merton's results, showed that since equity is in effect a call option on those assets, the acquisition of risky assets may reduce the value of the bonds while greatly increasing the value of the stock.[2] Thus, unlike the MM model, separation interms of the investment and financing decisions no longer obtains.

Myers (1977) took the idea one step farther. Not only are the managers of a financially levered firm induced to invest in riskier assets than their counterparts in an unlevered firm, but a moral hazard is created, leading them to reject some assets which have positive net present value![3] In this section I will show first that a partially debt-financed firm may reject some discretionary investment having positive net present value. This result will then be used to show that such a firm may employ less debt financing than a similar firm having no opportunities for discretionary investment.

A. Growth Opportunities and the Dependence of Investment on Financial Structure

It is extremely difficult to structure an indenture which forces managers, acting in the interests of the shareholders, to accept all assets having positive net present values. Even if such an indenture could be created, the costs of monitoring compliance would be enormous. Since, in the analysis of Jensen and Meckling, the owners would ultimately bear these agency costs, they will find that the optimal level of debt will fall below the level which would be optimal in the absence of the growth opportunities.

In this section shall employ a two-period, state preference model to investigate the phenomenon which I wish to explore. At t=0 the firm consists of

a set of assets financed either entirely with equity or with a mix of debt and equity. At t=1 the state of nature q is revealed. Its distribution is given by F(q). The assets of the firm are assumed to produce no return at t=1. Firms which face growth opportunities, however, must at t=1 either invest I_1 to capture the opportunities or forego investment, thereby giving up the option. Both the original assets and investment in growth opportunities produce their after-tax returns, $A(I_0,s)$ and $G(I_1,s)$, respectively, at t=2. As indicated, those returns are functions of the state of nature revealed at that time. Finally, risk neutrality is assumed with p the one-period rate of interest in the flat term structure. The asset which can be obtained by investing I_1 is a growth opportunity in the sense described by Myers (1977). The growth opportunity is a contingent claim - an option - on the underlying project. Like a stock option it may have positive value at t=0. The opportunity expires at t=1 and, based on the information state q, the expected net present value of the project must be estimated using F(s/q).

One can imagine a pharmaceutical firm conducting research to develop a new drug. The results are expected next year. If the drug is developed, and no similar item has been patented by a competitor, then it will be patented and may be put into production by building a new plant. The value of this project to the stockholders next year will depend on the results of the research and the decision whether to build the plant. The expected present value at t=0 may be positive.

The net present value of the all-equity firm at t=1 is given by

$$V_1^e = \int_0^\infty \frac{A(I_0,s)}{1+\rho} dF(s|q) + \int_0^\infty \frac{G(I_1,s)}{1+\rho} dF(s|q) - I_1 \qquad (1)$$

For the firm having issued debt with face value B_0, there may be some states in [S] in which the after-tax return from I_0 and I_1, $A(I_0,S)+G(I_1,S)$ is not large enough to cover the after-tax debt service, $(1+r_b)^2 B_0(1-T)-B_0T$. T is the tax rate. Imag without loss of generality, that the states in [S] are ordered so that they correspond to increasing levels of after-tax return.[4] Call the state for which $A(I_0,s)+G(I_1,s)=(1+r)^2 B_0(1-T)-B_0T$, s^*. Then for the net present value of the equity of such a firm at t=1 we can write

$$V_1^l = \int_{s^*}^{\infty} \frac{A(I_0,s) + G(I_1,s) - (1+r)^2 B_0(1-T) - B_c T}{1+\rho} \, dF(s|q) - I_1 \qquad (2)$$

To find the optimal level of investment in growth opportunities at t=1 set the derivative of (1) to zero:

$$\frac{dV_1^e}{dI_1} = 0 = \int_0^{\infty} \frac{\frac{\partial G(I_1,s)}{\partial I_1}}{1+\rho} \, dF(s|q) - 1 \qquad (3)$$

Similarly for the levered firm[5]

$$\frac{dV_1^l}{dI_1} = 0 = \int_{s^*}^{\infty} \frac{\frac{\partial G(I_1,s)}{\partial I_1}}{1+\rho} - 1 \qquad (4)$$

If $\{s \mid s < s^*\}$ is not empty, then for the level of I_1 defined by $\frac{dV_1^l}{dI_1} = 0$, $\frac{dV_1^e}{dI_1} > 0$.

Thus the optimal level of investment at t=1, I_1^*, is greater for the all equity firm.[6] This result is not dependent on assumptions on the tax structure. Finally, note that since at I_1^* from equation (4) the expected present value of the growth opportunity is still increasing, the expected present value, V_1^e, will be greater for the all-equity firm.

B.   The Trade-Off Between Growth Opportunities and Tax Shields

Having investigated the investment decision at t=1 we must now look at the

financing decision at t=0. I shall first determine the effect of debt financing on the net present value of the stockholders' investment in a firm having no growth opportunities. Then growth opportunities will be introdu ed, and the effect of the financing decision analyzed.

Consider a firm having no growth opportunities. Assume, as in the previous section, that all cash flows and debt payments occur in period two. The net present value of the equity investment is given by the difference between the present value of the cash inflows less debt payments and the equity investment in period zero:

$$N_0^e = \int_0^\infty \int_{s^*}^\infty \frac{A(I_o, s) - (1+r)^2 B_o (1-T) - B_o T}{(1+\rho)^2} \, dF(s|q) \, dF(q) - E_0 \qquad (5)$$

Given risk neutrality and a flat term structure, the expected period two payment to the bondholders must equal the square of one plus the riskless rate times the face value of the bonds:

$$\int_0^\infty \int_{s^*}^\infty (1+r)^2 B_c \, dF(s|q) \, dF(q) + \int_0^\infty \int_0^{s^*} \frac{A(I_o, s)}{1-T} \, dF(s|q) \, dF(q) = (1+\rho)^2 B_0 \qquad (6)$$

Equation (6) implies that in the event of default (s < s*) the bondholders receive the cash flow $A(I_0, s)$, which is untaxed. Thus, it is assumed that for [s|s < s*] the value of the interest tax shield is zero.[7]

Subtracting the second integral from both sides of (6) and substituting the result into (5), we get

$$N_0^e = \int_0^\infty \int_0^\infty \frac{A(I_o, s)}{(1+\rho)^2} \, dF(s|q) \, dF(q) - I_0 + B_o T \left[1 - \int_0^\infty \int_0^{s^c} \frac{1}{(1+\rho)^2} \, dF(s|q) \, dF(q) \right] \qquad (7)$$

I_0 is the initial investment and is equal to $(B_0 + E_0)$. To find the optimal level

of debt financing, take the derivative of the present value of the stockholders' investment holding I_0 constant:[8]

$$\frac{dN_0^e}{dB_0} = T\left[1 - \int_0^\infty \int_{s^*}^\infty \frac{1}{(1+\rho)^2} dF(s|q) dF(q)\right] + \frac{B_0 T}{(1+\rho)^2} \frac{ds^*}{dB_0} \qquad (8)$$

Setting the derivative equal to zero defines B_0^*, the optimal level of debt. The first term is the reduced expected after-tax interest payment and part of the reduced expected principal repayment due to the greater probability of default. The second term corresponds to the remainder of the reduced expected principal repayment. Since both terms are positive, the optimal level of debt financing is an infinite amount of debt.[9] This result corresponds with the MM (1963) model with taxes.

Now consider a firm having the opportunity to invest in growth opportunities at $t=1$. The net present value of the equity investment at $t=0$ will be the present value of the cash flows less debt payments from period zero investment minus the equity investment, plus the present value of the cash inflows from the growth opportunities minus the period one investment.[10]

$$N_0^1 = \int_0^\infty \int_{s^*}^\infty \frac{A(I_0,s) - (1+r)^2 B_0(1-T) - B_0 T}{(1+\rho)^2} dF(s|q) dF(q) - E_0$$

$$+ \int_0^\infty \left[\left\{\int_{s^*}^\infty \frac{G(I_{1,w}^* s)}{1+\rho} dF(s|q)\right\} - I_1^*(q)\right] dF(q) \qquad (9)$$

As before, the bondholders' required expected return can be written

$$\int_0^\infty \int_{s^*}^\infty (1+r)^2 B_0 \, dF(s|q) \, dF(q) + \int_0^\infty \int_0^{s^*} \left[A(I_0, s) + G(I_1^*(q), s) \right] dF(s|q) \, dF(q) = (1+\rho)^2 B_0 \quad (10)$$

Rearranging (10) and substituting the first term for the debt term in equation (9) gives

$$N_0^1 = \int_0^\infty \int_0^\infty \frac{A(I_0, s)}{(1+\rho)^2} dF(s|q) \, dF(q) + \int_0^\infty \int_0^\infty \frac{G(I_1^*(q), s)}{(1+\rho)^2} dF(s|q) \, dF(q) - I_0$$

$$+ B_0 T \left[1 - \int_0^\infty \int_{s^*}^\infty \frac{1}{(1+\rho)^2} dF(s|q) \, dF(q) \right] - \int_0^\infty \frac{I_1^*(q)}{1+\rho} dF(q) \qquad (11)$$

Taking the derivative of N_0 with respect to B_0 gives[11]

$$\frac{dN_0^1}{dB_0} = T \left[1 - \int_0^\infty \int_{s^*}^\infty \frac{1}{(1+\rho)^2} dF(s|q) \, dF(q) \right] + \frac{B_0 T}{(1+\rho)^2} \frac{ds^*}{dB_0}$$

$$+ \int_0^\infty \int_0^\infty \frac{\frac{\partial G(I_1^*(q), s)}{\partial I_1^*(q)} \frac{\partial I_1^*(q)}{\partial B_0}}{(1+\rho)^2} dF(s|q) \, dF(q) - \int_0^\infty \frac{\frac{\partial I_1^*}{\partial B_0}}{1+\rho} dF(q) \qquad (12)$$

The first two terms of equation (12) are the same as in equation (8) and are positive. From the results presented earlier, $\partial I_1^*/\partial B_0$ is negative. Thus the last term is positive. In order for the marginal dollar of I_1^* to be invested, we know that

$$\int_0^\infty \left(\partial G(I_1^*(q), s) / \partial I_1^*(q) \right) dF(s|q) = 1 + \rho$$

and is consequently positive. Since $\partial I_1^*/\partial B_0$ is negative, then the third term must be negative. For some distributions $F(q)$ and $F(s|q)$, functions G and $I_1^*(B_0, q)$, and for some B_0, $\frac{dN_0^1}{dB_0} < 0$. Thus, in contrast to the case in which

the firm has no growth opportunities, here a financial structure with a positive amount of equity may be optimal. The optimal structure depends simultaneously on the nature of the growth opportunities and on the distributions of the states. As Bodie and Taggart (1978) point out, projects having positive net present values may prove unattractive to a firm since the shareholders are not able to capture all of the cash inflows of the project. The bondholders benefit because, although their investment remains constant, the present value of their expected cash inflows rises. The bond holders cannot compensate the shareholders for this shift of value in this simple model.

A number of methods of reducing the wealth transfer are available to the stockholders. Myers (1977) discusses the use of short-term debt and restrictions on dividend payout. In practice, neither of these is likely to eliminate the moral hazard problem completely. Bodie and Taggart (1978) show that call provisions on the bonds may reduce the problem, but will not eliminate it. [12]

Finally, it must be determined whether the existence of growth opportunities will unambiguously reduce the optimal level of firm borrowing. I shall use the present value of growth opportunities defined by

$$PVGO = \int_0^\infty \frac{1}{1+\rho} \left\{ \int_0^\infty \frac{G(I_1, s)}{1+\rho} dF(s|q) - I_1 \right\} dF(q)$$

to measure growth opportunities. We want to know how B_0^* changes with changes in PVGO.

We assume that $G(I_1, S)$ is a monotonically increasing then decreasing function of I_1. As an example of such a function, I shall use a quadratic

$G(I_1, S) = \alpha(S)I_1^2 + \beta(S)I_1 + \gamma(S)$, where $\alpha < 0$ and $\beta, \gamma > 0$. Then from the definition of PVGO above, a sufficient condition for higher growth opportunities is a higher value in some state S for $\beta(S)$ or $\gamma(S)$ or both, if these are not accompanied by a reduction in $\alpha(S)$ for the same S. Another sufficient condition is a reduction in $\alpha(S)$ without an offsetting reduction in $\beta(S)$ or $\gamma(S)$.

Consider again equation (12), which implicitly defines B_0^*. The negative (third) term contains $\dfrac{\partial G(I_1^*, S)}{\partial I_1^*}$. For the quadratic, the partial is

$2\alpha(S)I_1^* + \beta(S)$. A rise in growth opportunities due to a higher value of $\beta(S)$ will make the third term in (12) more negative. The same is true for a larger (negative) $\alpha(S)$. Note that changes in $\gamma(S)$ do not affect equation (12).

Since none of the changes in the parameters of $G(I_1, S)$ raise $\dfrac{dN_0^1}{dB_0}$, none raise B_0^*. Since some reduce $\dfrac{dN_0^1}{dB_0^*}$, they reduce B_0^*. Thus we can say that for two otherwise identical firms the one with a lower level of PVGO will have an optimal debt level below or equal to the other firm.

III. Empirical Tests of the Model

The traditional theory of corporate capital structure holds that the optimal level of debt financing is some fraction of the value of the firm's assets. The degree to which a firm's optimal debt-to-asset ratio deviates from the average from all firms is usually thought to be related to the firm's industry - presumably a proxy for bankruptcy risk.

The MM theory states that, in an environment with corporate taxes, all firms should use 100% debt financing to make maximum use of the tax shield. Thus all firms, regardless of industry and risk, should finance all of their assets with debt. Adding positive expected bankruptcy costs to the MM model

means that asset risk must be included as a factor. As before, riskless assets should still be financed entirely with debt. Risky assets, though, may raise the expected dead weight loss due to bankruptcy costs if those assets are financed by debt. Expected bankruptcy costs are a positive function of asset risk. Thus the MM theory with bankruptcy costs (MMB) says that the degree to which assets should be financed by equity is directly related to the risk of the assets.

The recent tax arbitrage theory of Miller's states that at the firm level, under certainty no optimal capital structure exists. Taggart (1978), in some preliminary work, extends the Miller model to uncertainty and finds that firms should finance their assets either entirely with equity or entirely with debt. In equilibrium one of these capital structures is optimal for each firm regardless of the risk of its assets.

Finally, the moral hazard (MH) theory distinguishes between two types of assets. Assets in place (AIP) are those which are generating or will generate earnings without further investment. Growth opportunities are technologies, patents, etc. which, because they may generate future earnings, have a positive present value (PVGO). In order to realize those earnings, funds must be invested. It is these growth opportunities which create the moral hazard problem. They may reduce the optimal level of debt financing.

A.   The Structure of the Tests

Imagine the balance sheet of a firm expressed in market values

SA	STL
ASSETS	B
	PFD
	CS
V	V

Where   SA   is current assets

ASSETS is long-term assets

STL   is current liabilities

B   is long-term debt including current maturities and financing leases

PFD   is preferred stock

CS   is common stock

V   is the market value of the firm.

Now net current liabilities against current assets and against the right hand side of the balance sheet. Move inventories from current assets to long-term assets. Finally, divide ASSETS into physical assets in place, AIP, and present value of growth opportunities, PVGO. Calling the net current asset less inventory entry, STA, the balance sheet looks like

STA	B
AIP	PFD
PVGO	CS
\	V

Consider the hypotheses to be tested. The MM theory predicts that B=V, or B=STA+AIP+PVGO. The MMB theory adds a term which measures expected bankruptcy costs. That term should appear with a negative sign. Finally the MH theory predicts that B should be a function not only of V and possibly risk, but also of the relative proportions of PVGO and (AIP+STA) in V.

In order to test the hypotheses empirically, I shall use the following equation:

$$B = a_1 AIP + a_2 PVGO + a_3 STA + a_4 R \cdot V + e \tag{13}$$

Where

K is a measure of bankruptcy risk

e is a stochastic error term.

We could fit this equation to try to distinguish between the theories of capital
structure. First a number of changes must be made. Fitting the equation to the
levels of the variables would probably cause heteroskedasticity, reducing the
efficiency of the estimates. One expedient would be to divide (13) by the level
of AIP. This gives

$$\frac{B}{AIP} = a_1 + a_2 \frac{PVGO}{AIP} + a_3 \frac{STA}{AIP} + a_4 \frac{V \cdot R}{AIP} + \frac{e}{AIP} \qquad (14)$$

To allow for the testing of the traditional theory and to allow for signifi-
cant differences between accounting and tax treatment between industries,
industry dummy variables will be used to adjust the intercept.

Referring back to equation (13), none of the theories except MH differ-
entiates between AIP and PVGO. Those theories would predict $a_1 = a_2 = a_3$. MM's
total debt financing prescription means that $a_1 = a_2 = a_3 = 1$. Risk of bankruptcy
doesn't matter, so $a_4 = 0$. As with all of the theories to be tested, it is
possible that institutional factors, such as accounting policies, cause indus-
tries to appear to behave differently. Thus, we cannot rule out the possibi-
lity that the dummy coefficients will be non-zero. Similarly for MMB, we
expect $a_1 = a_2 = a_3 = 1$. But $a_4 < 0$. Finally, the traditional theory says $a_1 = a_2 = a_3$,
but a_1, a_2, and a_3 could be less than one. If the relevant risk is not captured
by the industry dummies, $a_4 < 0$.

The MH theory states that PVGO supports less debt than an equal dollar value

of AIP or STA.[13] $a_1=a_3 > a_2$. and that $a_2 < 0$. The theory does not rule out positive bankruptcy costs, indicating $a_4 < 0$. Once again, industry factors may be relevant.

B. Description of the Variables

The variables described in this section were formed using stock and price data for the last day of each firm's fiscal year ending between December 1, 1976 and March 31, 1977. Flow data correspond to the same fiscal year. It is not possible to replicate the tests directly using earlier years because replacement cost information used in forming the AIP and PVGO variables was not reported prior to December 1976. The tests will be rerun using 1977 data when they are available.

The sample consists of 189 manufacturing firms in 24 three-digit S.I.C. industries and fall into 14 two-digit industries. A firm was excluded from the sample if a) its common stock was not listed on the NYSE, b) its fiscal year did not end in the specified time period, c) in its industry there were not at least four firms which met the requirements, or d) any data were unavailable. The last requirement eliminated a number of firms which were too small to be obliged to comply with the S.E.C.'s ASR-190, which requires the reporting of replacement cost information. Data are from various sources, primarily Compustat tapes, S.E.C.. Form 10-K, corporate annual reports, Moody's Industrial Manual, Standard and Poor's Reports, and Moody's Bond Record.

The debt variable, B, was formed in several different ways. The MH theory derives a firm's debt capacity and optimal borrowing in terms of the present value of future debt payments, both principal and interest. This seems to be a strong reason for using the market value of a firm's debt for B. In theory, corporate managers should make their financing decisions based on the market

values of the securities. There is, however, no convincing evidence that this is the case. Taggart (1977), for example, finds supporting evidence to be weak. To allow for this possibility and to give the traditional view, which is usually couched in terms of book values, a fair chance, I shall repeat the tests using book values for B.

To calculate the market value of a firm's debt, its outstanding debt issues were gathered from Moody's, Standard and Poor's, and Form 10-K along with the book value outstanding. For publicly traded issues the price listed in Moody's Bond Record was multiplied by the amount outstanding. The estimated payments for non-traded straight debt were discounted to find their present value. The rate used to discount the payments was found by referring to a yield curve constructed for bonds of the given rating. Financing leases were included by capitalizing payments at the Aaa rate. Bank loans were capitalized at the rates reported in the Federal Reserve Bulletin, April 1977. Where insufficient information was given, book values were used.[14]

For both listed and unlisted convertible issues, a second market value measure was calculated. Since convertible debt is analogous to a bond with an attached warrant, the market value of such debt will usually overstate the true market value of the debt component. To attempt to remove the equity component I capitalized the stream of interest and principal payments at the estimated market yield for bonds of similar time to maturity and rating. For issues for which information was not sufficient to allow the calculation, book values were used. In all cases only debt with a term to maturity at issue of one year or more was used. One would not expect the level of short-term debt to be affected by the level of growth opportunities in the MH model.[15] These short-term items were netted against current assets in forming the STA variable.

Present value of financing leases was included in the debt variable.

For the equity components, market price on the last day of the fiscal year was multiplied by the number of shares outstanding on that date to arrive at the market value. For unlisted preferred, the infinite dividend stream was capitalized at the Moody's index rate. [16]

V is the unlevered market value of the securities on the right side of the balance sheet after netting current liabilities from both sides. In order to find the unlevered value, it is necessary to specify the effective tax rate which applies to the interest tax shields. Farrar and Selwyn (1967) showed that, due to personal income and capital gains rate differential, the effective rate probably falls below the 48 percent corporate rate. [17] To see the effect of the rate, the tests will be run using variable constructed both from the V using the 48 percent correction and from a zero correction.

The AIP variable is formed from replacement cost data. The figure reported on Form 10-K gives the estimated cost of replacing the firm's production capacity (plant and equipment), net of accumulated depreciation, which would be replaced if the firm were to renew its assets as of the report date. To this number I added the book value of land. As the S.E.C. points out, these numbers are only estimates and probably contain a large amount of noise. Note also that where markets are not perfectly competitive replacement cost will not exactly reflect the "market value" of a piece of equipment.

PVGO was formed from the V, AIP, and STA variables. STA is assets not included in plant and inventories (included in AIP) or intangibles (included in PVGO), minus current liabilities and deferred taxes. PVGO is a residual formed by subtracting (AIP+STA) from V.

In using the tax shield correction in the V calculation I am implicitly

assuming the MM model without bankruptcy costs to be correct. If, in fact, expected bankruptcy costs reduce the value of the tax shield at higher degrees of leverage, the simple leverage correction will bias my estimates of the un-levered value and PVGO downward. Three problems result. Since the bias is not constant across observations, the classical errors - in - variables problem arises. This biases a_2 toward zero. The error in PVGO will be negatively correlated with the independent variable, B. This biases a_2 downward. Finally, the measurement error may bias a_1, a_3 and a_4 upward. If a_2 is negative, the first bias raises the power of this equation as a test of the MH theory. The second and third biases weaken it. The tests using PVGO resulting from the calculation of V using a zero effective tax rate will provide a check. PVGO will be biased upward. The three effects will be a) to bias a_2 toward zero, b) to bias a_2 upward, and c) to bias (a_1+a_3) downward. If a_2 is negative all strengthen it. If a_2 is positive, (a) weakens the test while (b) and (c) strengthen it.

To allow for the possibility that bankruptcy costs may be a determinant of debt usage by firms I have included an exogenous variable to proxy for the likelihood of the occurance of bankruptcy. Oldfield (1976) used a contingent-claims framework with taxes and bankruptcy costs to derive an expression giving the values of debt and equity for a levered firm. He showed that the values of the firm's securities and its optimal capital structure are functions of the variance rate of the value of the firm's assets.

We can use a method to estimate the variance of the rate of change of the market value of the firm's assets. It is similar to the technique used by Hamada (1972) to find unlevered betas. I calculate the unlevered return on the firm for each period then calculate the variance of the resulting time series.

The unlevered return on the firm for period t may be expressed as

$$u^R t = \ln\left[\frac{X_t(1-\tau) + \Delta PVGO_t}{u^S t-1} + 1\right] \tag{15}$$

Where X_t is the earnings before interest, taxes, and preferred dividends

τ is the corporate tax rate

$u^S t-1$ is the unlevered value of the firm at t-1.

We can rewrite the numerator as

$$X_t(1-\tau) + \Delta PVGO_t = [(X_t - I_t)(1-\tau) - P_t + \Delta PVGO_t] + P_t + I_t(1-\tau).$$

Using the accounting identity

$$(X_t - I_t)(1-\tau) - P_t + \Delta PVGO_t = D_t + (S_t - S_{t-1}) + \Delta PS + \Delta B(1-\tau)$$

We get

$$X_t(1-\tau) + \Delta PVGO_t = [D_t + (S_t - S_{t-1})] + P_t + I_t(1-\tau) + \Delta PS_t + \Delta B_t(1-\tau)$$

So

$$u^R t = \ln\left[\frac{D_t + S_t - S_{t-1} + P_t + I_t(1-\tau) + \Delta PS_t + \Delta B_t(1-\tau)}{u^S t-1} + 1\right] \tag{16}$$

Where[18] S_t is the value of the common stock at t

D_t is the common dividends at t

P_t is the preferred dividends at t

I_t is the interest payments at t.

ΔPS_t is the change in market value of preferred at t.

ΔB_t is the change in market value of debt at t.

If MM are correct, $_uS_{t-1} = V_{t-1} - \tau D_{t-1}$ where V_{t-1} is the value of the levered firm's securities. Substituting this expression into the denominator of (16) gives

$$_uR_t = \ln\left[\frac{D_t - S_t - S_{t-1} + P_t + I_t(1-\tau) + \Delta PS_t + \Delta B_t(1-\tau)}{V_{t-1} - \tau D_{t-1}} + 1\right] \quad (17)$$

This expression can now be used to construct a time series of unlevered returns for the firm and the variance of the series calculated.

Remember that in deriving (17) we made the assumption that $_uS_{t-1} = V_{t-1} - \tau D_{t-1}$. If the MM theory, which we wish to test, is in fact correct, my estimates of $_uR$ and $_u\sigma^2$ will be biased. Let e be the bias in the estimate $_u\hat{R}$ for some firm. Then $_u\hat{R}_t = {_uR_t} + e_t$ where $e_t = f(\frac{D_t}{V_t})$. When we calculate the variance of $_u\hat{R}_t$ we get $var(_uR) = var(_uR) + 2\,cov(_uR,e) + var(e)$.

To illustrate the problem consider a levered firm whose earnings fluctuate about a stationary expected level. The market value of the firm is 100 and is constant through time. Now imagine that due to expected bankruptcy costs MM does not hold exactly and understates the unlevered value of the firm by $1. If the earnings are $10, the actual unlevered rate of return is $\frac{\$10}{\$100} = .10$. But MM give $\frac{\$10}{\$99} = .1010$, an error of .0010. If this period's earnings were $20, the true unlevered return would be $\frac{\$20}{\$100} = .20$. MM would give $\frac{\$20}{\$99} = .2020$; the error is .0020. Finally, if this period's true unlevered return were $\frac{\$5}{\$100} = .05$, the error would be .0005. It appears that $cov(_uR,e) > 0$. The bias in the estimate of $var(_uR)$ is positive and positively related to the degree of leverage. It is easy to see in this example that firms for which MM greatly understate the unlevered value (those having high degrees of leverage) will have larger $var(e)$ and $cov(_uR,e)$ than less highly levered firms. This is a classic case of the errors-in-variables problem where the regression redisual are correlated

with one of the exogenous variables - in this case with the risk variable. The estimated risk coefficient, $\hat{a}_4$, will be biased toward zero and upward and will be a function of the true a_4 and the variances of the true, unobservable errors, σ_u^2, and the errors in the risk variable, σ_v^2.

$$\hat{a}_4 = a_4 \; \frac{\sigma_u^2}{\sigma_u^2 + \sigma_v^2} \tag{18}$$

The bias is probably not serious. Bower, Bower and Oldfield (1977) attempted to determine whether errors in estimating firm betas by multiplying unlevered betas by $\frac{uS}{S}$ (see Hamada) were induced by the use of the MM theory. In fact they found statistically significant correlation between the errors and the degree of leverage. Leverage could, however, explain only six percent of the variance of the errors.

To allow for the possibility of errors-in-variables bias I shall run the test twice. The first time I shall use the variance of the time series of estimated unlevered returns for each firm. Then the equations will be run again using an instrumental variables approach. For the instrument I shall use the variance of

$$_uR'_t = \ln\left[\frac{D_t + S_t - S_{t-1} + P_t + I_t(\tau-1)}{A_{t-1}} + 1 \right] \tag{19}$$

Where A_{t-1} is the book value of assets. This variable should be highly correlated with the variance of the true unlevered value, but we have no reason to believe it should be correlated with measurement errors. These are the requirements for a good instrument.

C.   An Alternative Formulation

A check on the results obtained from tests of equation (13) can be obtained by estimating

$$B = a_1 V + a_2 STA + a_3 PVGO + a_4 R.V + e \qquad (20)$$

In some ways the results are easier to interpret than those of the other equation. MMB suggests that when comparing two firms having equal unlevered market values V, we should find equal levels of debt, holding risk constant. This must be so since PVGO and AIP support equal amounts of debt. Hence, $a_3=0$, $a_1>0$, $a_2=0$ and $a_4<0$. MH, on the other hand, predicts that of the two firms the one with the greater PVGO (and, necessarily smaller AIP) will have less debt. Thus $a_3<0$, and $a_1>0$ since raising V while holding PVGO constant amounts to raising AIP. $a_4<0$.

As with equation (13) the power of this equation in testing the MH theory depends on the construction of V. Using V corrected for tax shields is likely to result in biases which have an ambiguous effect on the test. The use of V uncorrected should bias $(\hat{a}_1 + \hat{a}_2)$ down and $\hat{a}_2$ upward and toward zero. All known biases reduce the likelihood of acceptance of MH.

IV.   Summary of Results and Conclusions

A.   Results of the Tests

Ordinary least squares was used to estimate the coefficients of equation (13). Although all coefficients conformed to those predicted by the moral hazard theory, examination of the residuals strongly supported the exptected existence of heteroskedasticity. The bias in the estimated standard errors frustrates hypothesis testing.

In order to reduce the problem, generalized (weighted) least squared was

applied to the equation. Under the hypothesis that the variance of the residual for firm i is given by $\sigma^2 AIP^2$, I normalized each of the variables in equation (13) by dividing by AIP. The results are shown below.

		COEFFICIENT	STD. ERROR	T VALUE	PARTIAL COR.	E
MULTIPLE R		0.52303				
STD ERROR OF Y.X		0.11523				
R SQUARE		0.27350				

MULTIPLE REGRESSION EQUATION
VARIABLE BMVAIP =

	VARIABLE	COEFFICIENT	STD. ERROR	T VALUE	PARTIAL COR.	E
RISK	X- 5	-.2579111	.7935597D-01	-3.250	-.2405	
	X-16	-.1308060D-01	.6053914D-01	-.2161	-.1647E-01	
	X-17	-.1865001	.6633115D-01	-2.812	-.2096	
	X-18	-.6274177D-01	.5720857D-01	-1.097	-.8333E-01	
	X-19	-.5596870D-01	.6576841D-01	-.8510	-.6475E-01	
	X-20	-.1019256	.4216405D-01	-2.417	-.1813	
	X-21	-.2856450D-01	.3812644D-01	-.7497	-.5707E-01	
	X-22	-.9627272D-01	.5694219D-01	-1.691	-.1279	
	X-23	-.8462263D-01	.6021549D-01	-1.405	-.1065	
	X-24	-.1454035	.4133824D-01	-3.517	-.2590	
	X-25	-.1621675	.4050036D-01	-4.004	-.2920	
	X-26	-.6252627D-01	.3889948D-01	-1.607	-.1217	
	X-27	-.1076783	.4786203D-01	-2.250	-.1691	
	X-28	-.8607513D-01	.4814179D-01	-1.788	-.1351	
STA	X-43	.2247060	.5577654D-01	4.029	.2930	
PVGO	X-44	-.5414020D-01	.1297153D-01	-4.174	-.3033	
AIP	X-70	.3034725	.3195909D-01	9.496		

R BAR SQUARE   0.2060

The results support the moral hazard theory. The estimated coefficient of AIP (.30) indicates that an increase in physical assets is 30 percent debt financed. The estimated coefficient of PVGO (-.05) is substantially below that of AIP (t=10.017) as the theory predicts. The estimated value of -.26 for a_4 supports the hypothesis of an inverse relationship between debt financing and the risk of the firm's assets.

In order to investigate the importance of the assumption of an interest tax-shield equal to .48 times the level of debt, the equation was run using unadjusted values for V and PVGO. The results do not differ greatly.

```
MULTIPLE R                    0.47170
STD ERROR OF Y.X              0.11921
R SQUARE                      0.22250
   MULTIPLE REGRESSION EQUATION
VARIABLE          COEFFICIENT           STD. ERROR      T VALUE    PARTIAL COR.    EL
BMVALP    =
.N
       RISK  X-11     -.2490090          .79702420-01     -3.124        -.2317
             X-16     -.1622203D-01      .62047290-01      -.2589       -.1974E-01
             X-17     -.1818050          .66829400-01     -2.041        -.1974
             X-18     -.5533726D-01      .39220680-01      -.9344       -.7107E-01
             X-19     -.5094418D-01      .68064330-01      -.7485       -.5698E-01
             X-20     -.1003070          .43741550-01     -2.293        -.1722
             X-21     -.3695213D-01      .39425650-01      -.9373       -.7128E-01
             X-22     -.9167584D-01      .58988620-01     -1.554        -.1177
             X-23     -.8375637D-01      .62343790-01     -1.344        -.1019
             X-24     -.1431092          .42940630-01     -3.333        -.2463
             X-25     -.1586922          .42150000-01     -3.765        -.2759
             X-26     -.6266619D-01      .40260040D-01    -1.557        -.1179
             X-27     -.1088718          .49542400-01     -2.198        -.1653
             X-28     -.8213564D-01      .49869890-01     -1.647        -.1246
       STA   X-43      .2209175          .58075290-01      3.804         .2786
       PVGO  X-44     -.4483633D-01      .13562710-01     -3.306        -.2444
       AIP   X-70      .3115679          .33104000-01      9.412
```

R BAR SQUARE   0.1502

As expected from the previous discussion, $\hat{a}_2$ rises. The change is due, at least in part, to the positive covariance of the error in PVGO and B in the second regression. Some of the effect may be due to a reduction in the variance of the error. In any case, the estimates seem robust with respect to the tax assumption.

In both equations, variables X-16 through X-28 are dummy variables used to allow different slope coefficients on AIP for different two-digit industries. It can be seen the dummies pick up significant differences in financing behavior between industries. Three-digit dummies were tested but found not to yield significantly better expanatory power.

Each of the risk variables described in the previous section was tested. No significant differences was found in the coefficients estimated from the different variables. The fit was slightly better with the original form.

I turn now to estimating equation (20). As with equation (13), OLS

estimates of the coefficients conformed well to the moral hazard theory, but
the variance of the estimated residuals appeared highly correlated with firm
size. Accordingly, all observations were weighted by the reciprocal of the
market value of the firm, V, and the equation re-estimated. The results are
shown below.

MULTIPLE R	0.69065
STD ERROR OF Y.X	0.13992
R SQUARE	0.47700

MULTIPLE REGRESSION EQUATION

VARIABLE		COEFFICIENT	STD. ERROR	T VALUE	PARTIAL COR.	EL
BMVV	=					
STA	X- 7	-.1896251D-01	.7477339D-01	-.2536	-.1933E-01	
PVGO	X-11	-.1670062	.1872064D-01	-8.921	-.5624	
RISK	X-14	-.1798814	.1972774	-.9118	-.6935E-01	
	X-16	-.3682849D-01	.9994836D-01	-.3685	-.2808E-01	
	X-17	-.1449988	.1177364	-1.232	-.9349E-01	
	X-18	.5325289D-01	.9467513D-01	.5613	.4276E-01	
	X-19	-.2118614D-01	.1081854	-.1958	-.1493E-01	
	X-20	-.5589224D-01	.7087648D-01	-.7886	-.6002E-01	
	X-21	-.8811025D-01	.6042206D-01	-1.459	-.1105	
	X-22	-.5313438D-01	.9440524D-01	-.5628	-.4288E-01	
	X-23	.2662346D-01	.1008481	.2640	.2013E-01	
	X-24	-.1307762	.7046824D-01	-1.856	-.1401	
	X-25	-.1471307	.7507496D-01	-1.960	-.1478	
	X-26	-.7636165D-01	.6400522D-01	-1.193	-.9060E-01	
	X-27	-.8122904D-01	.7938026D-01	-1.023	-.7779E-01	
	X-28	-.1707429D-01	.8007704D-01	-.2132	-.1626E-01	
V	X-70	.3249984	.5448972D-01	5.964		

R BAR SQUARE 0.4283

The coefficients are easier to interpret than those from equation (13).
The coefficient of V (.32) gives the proportional rise in long-term debt as a
firm's market value rises due to an increase in physical assets. This estimate
agrees with those for AIP in the previous equation. The coefficient of PVGO
(-.17) gives the proportional reduction in long-term debt as a firm's capita-
lized growth opportunities rise while physical assets fall by a like amount.
In other words, it gives the trade-off between PVGO and AIP. Note that the
trade-off between net short-term assets and physical assets is insignificantly
different from zero (-.02). This test, too, supports MH.

Finally, equation (20) was tested using data not adjusted for interest
tax-shields. Since two independent variables, V and PVGO, may contain errors,
it is not possible to estimate the effect on the estimates of using unadjusted
data. This equation, also, seems robust with respect to the tax-shield ad-
justment. The estimates derived from unadjusted data are shown below.

```
MULTIPLE R              .  0.62850
STD ERROR OF Y.X           0.13941
R SQUARE                   0.39501
  MULTIPLE REGRESSION EQUATION
VARIABLE          COEFFICIENT          STD. ERROR      T VALUE   PARTIAL COR.
BMVV    =
```

VARIABLE	COEFFICIENT	STD. ERROR	T VALUE	PARTIAL COR.
PVG X- 7	-.1139032	.1818248D-01	-6.264	-.4310
STA X-13	-.4485569D-02	.67339CCD-01	-.6061E-01	-.5079E-02
RISK X-14	-.1130773	.1457337	-.8102	-.6106E-01
X-16	-.7050939D-02	.7337395D-01	-.9610E-01	-.7327E-02
X-17	-.1513073D-01	.6595523D-01	-.1761	-.1342E-01
X-18	.7087995D-01	.6958451D-01	1.019	.7743E-01
X-19	.1745527D-01	.7942943D-01	.2198	.1676E-01
X-20	-.6085055D-02	.5206343D-01	-.1165	-.8853E-02
X-21	-.6273277D-01	.4452673D-01	-1.409	-.1068
X-22	.1803230D-02	.6945717D-01	.2596E-01	.1980E-02
X-23	.6497636D-01	.7371635D-01	.8814	.6706E-01
X-24	-.4574618D-01	.5194607D-01	-.8806	-.6699E-01
X-25	-.2372253D-01	.5499257D-01	-.4317	-.3290E-01
X-26	-.4513160D-01	.4707539D-01	-.9581	-.7286E-01
X-27	-.4516283D-01	.5830104D-01	-.7746	-.5896E-01
X-28	.2983117D-01	.5866548D-01	.5093	.3881E-01
V X-70	.2715723	.3992374D-01	6.802	

R BAR SQUARE   0.3387

The estimated coefficients are again within the ranges predicted by the model.

The final problem to be considered stems from the use of 1976 data for
the tests. In 1976 Tobin's q[19] was less than one. Thus the sample of firms
used is likely to show bias toward low values of PVGO. In fact, this is so.
The mean of PVGO for the sample was negative. This might bias the estimates
of a_1 up and a_2 down. To check this effect, similar tests were run for 1974
and 1966 when q was 1.04 and 1.38 respectively. (See Holland and Myers.) To
avoid estimating market values for debt and preferred, book values were used
for those items. Otherwise, the tests are identical to those reported previously.[20]

The results are shown on the following pages. For comparability, the 1976

test was rerun using the new method. It can be seen that, in general, the estimates are not markedly different from those reported above for 1976. In most cases a_1 is lower in years of high q, while a_2 is higher in those years.

B. Conclusions

The tests performed on data in a sample of 189 large firms were not able to reject the hypothesis that growth opportunities support less long-term debt than physical assets. Since only the moral hazard theory makes this distinction between the effects of these types of assets on financial structure, these are tests of this theory.

A number of questions remain. Most of these have to do with the construction of the variables. Since PVGO cannot be measured directly, is it possible to derive better estimates using different methods to estimate AIP? One possibility is to capitalize current earnings to get a measure of the value of assets in place. Another problem spot is the risk variable. It is encouraging to note that as constructed here, the risk variable is not strongly correlated with PVGO and is probably not picking up the risk of the growth opportunities. The use of only ten observations to estimate a variance, though, probably results in a high standard error of that estimate.

In spite of these points, the results shown here seem robust and strongly support the theory.

TABLE 1

REGRESSIONS ON MIXED DATA
NO TAX CORRECTION

	1976 Market/ data previously reported	1976	1974	1966
Mean q		1.36	1.20	2.05
R-squared	0.22	0.27	0.28	0.21
Risk	-.2209 (3.124)	-.1400 (1.908)	-.2402 (2.176)	.0743 (1.468)
STA	.2209 (3.804)	.1548 (2.270)	.1500 (1.763)	-.2228 (3.126)
PVGO	-.0448 (3.306)	-.0618 (5.016)	-.0477 (4.144)	-.0232 (2.869)
AIP	.3116 (9.412)	.3139 (9.576)	.3032 (8.407)	.1876 (4.597)
R Bar Squared		0.20	0.22	0.13
Mean q		1.36	1.20	2.05
R-squared	0.40	0.54	0.43	0.39
Risk	-.1180 (0.810)	-.1290 (1.081)	-.2149 (1.230)	.0250 (0.198)
STA	-.0045 (0.067)	-.1076 (1.530)	-.0928 (0.991)	-.2117 (2.114)
PVGO	-.1140 (6.264)	-.2731 (9.163)	-.1765 (6.232)	-.1710 (6.004)
V	.2720 (6.802)	.2628 (7.393)	.2565 (5.088)	.1280 (3.399)
R Bar Squared		0.50	0.38	0.33

Numbers in parentheses are t statistics for the estimated coefficient above.

TABLE 2
TAX RATE 0.48

	1976 Market data previously reported	1976	1974	1966
Mean q		1.36	1.20	2.05
R-squared	0.27	0.56	0.32	0.23
Risk	-.2579 (3.250)	-.1022 (1.462)	-.1801 (1.663)	.0967 (1.944)
STA	.2247 (4.029)	.1686 (2.563)	.1550 (1.870)	-.2172 (3.083)
PVGO	-.0541 (4.174)	-.0711 (6.158)	-.0566 (5.167)	-.0280 (3.553)
AIP	.3035 (9.469)	.3042 (9.583)	.2898 (8.171)	.0967 (4.570)
R Bar Squared		0.31	0.26	0.16
Mean q		1.36	1.20	2.05
R-squared	0.69	0.65	0.53	0.49
Risk	-.1799 (0.912)	-.1446 (1.390)	-.2746 (1.734)	-.0051 (0.044)
STA	-.0190 (0.254)	-.0670 (1.089)	-.0726 (0.850)	-.1768 (1.937)
PVGO	-.1679 (8.921)	-.2897 (12.77)	-.2121 (9.044)	-.2083 (8.794)
V	.3250 (5.964)	.2404 (7.878)	.2302 (5.008)	.1305 (3.833)
R Bar Squared		0.62	0.49	0.44

Numbers in parentheses are t statistics for the estimated coefficients above.

FOOTNOTES

1. Costs of financial distress include reduction of corporate cash flow which may result from default or near default on debt and reorganization as well as bankruptcy.

2. Call option values are directly related to the total risk of the underlying asset See Black and Scholes (1973).

3. The term "moral hazard" has been applied primarily in the theoretical literature on insurance. Arrow has written (1971, p.220), "If the amount of the insurance payment is in any way dependent on a decision of the insured as well as on a state of nature, then the effect is very much the same as that of any excise tax and optimality will not be achieved either by the competitive system or be[sic] an attempt by the government to simulate a perfectly competitive system." It will be shown that a moral hazard may be created when a firm has debt outstanding. Investment decisions may no longer depend only on the state of nature, but also on the level of debt.

4. For all s, $\dfrac{d[A(I_0, s) + G(I_1, s)]}{ds} \geq 0$.

5. The second term in the derivative involves the derivative of the lower limit.
$$-\frac{\partial s^*}{\partial I_1} \frac{A(I_0, s^*) + G(I_1, s^*) - (1+r_b)^2 B_0 (1-T) - B_0 T}{1+P},$$

but by the definition of s^*, the numerator is zero.

6. This result can, of course, be generalized to state that the level of investment at $t=1$ is a decreasing function of B_0.

7. Although this hypothesis has yet to be tested, the literature suggests that this is not an unrealistic approximation See Holzman (1955), Krantz (1961), Testa (1963), and Tobolowsky (1960).

8. The last term in (8) is the result of differentiating the limits of the last integral.

9. Of course, institutional constraints limit debt to a much lower level.

10. As before, it is assumed that investment in growth opportunities is entirely equity financed.

11. What we have is essentially a dynamic programming problem to be solved by a Bellman backward technique. We started in at $t=1$ (equation (4)) and found I_1^* as a function of B_0 and the state q. Now we move back to $t=0$ and solve for B_0^* given our conditional solution for I_1^*.

12. Ingersoll (1976) found that firms seldom follow the optimal call policy given by his model for convertible bonds.

13. The MH model does not address the difference between productive assets and financial ones. Thus, without further elaboration, each is assumed a similar amount of debt. This hypothesis will be tested.

14. Yield curves were constructed for each rating (Aaa, Aa, etc.) by finding the arithmetic average of the yields on all bonds of each maturity in the Moody's bond indices.

15. See Myers (1977) for a discussion of this point.

16. In selecting the appropriate index, the Moody's rating on the firm's preferred stock or bonds was used.

17. Ongoing work by Fama and Miller suggest that arbitrage opportunities may reduce the effective rate to zero.

18. In calculating (16) for each firm I assume $\Delta PS_t = \Delta B_t = 0$ for all t.

19. The ratio of total market value to net plant, equipment, and inventories.

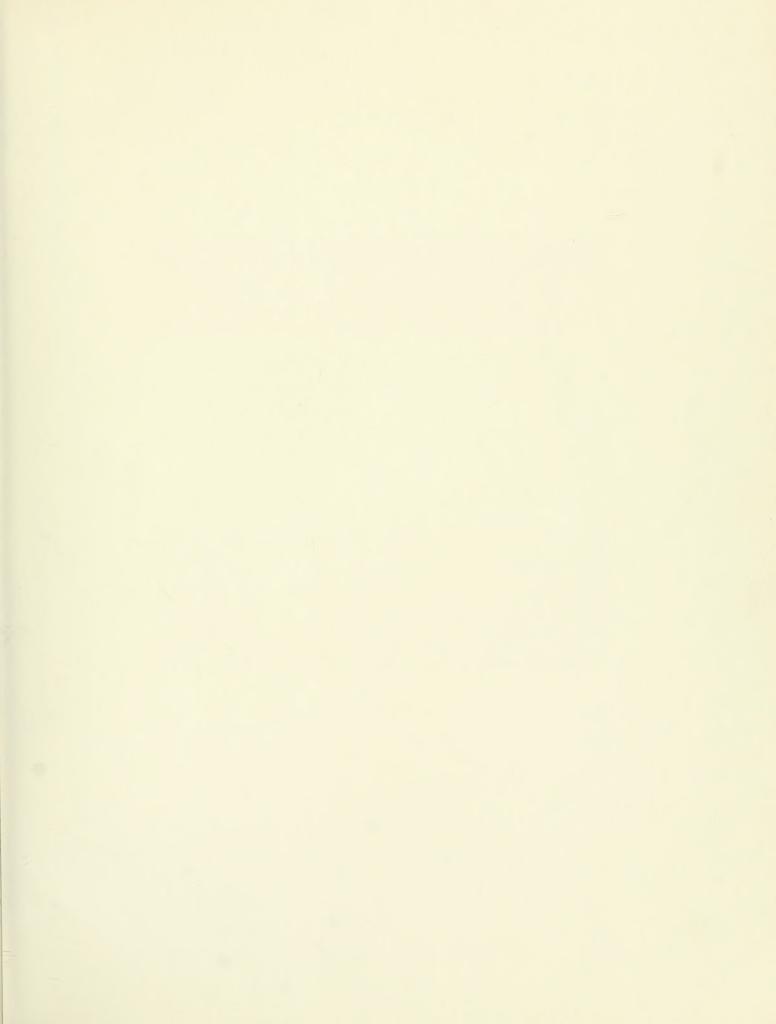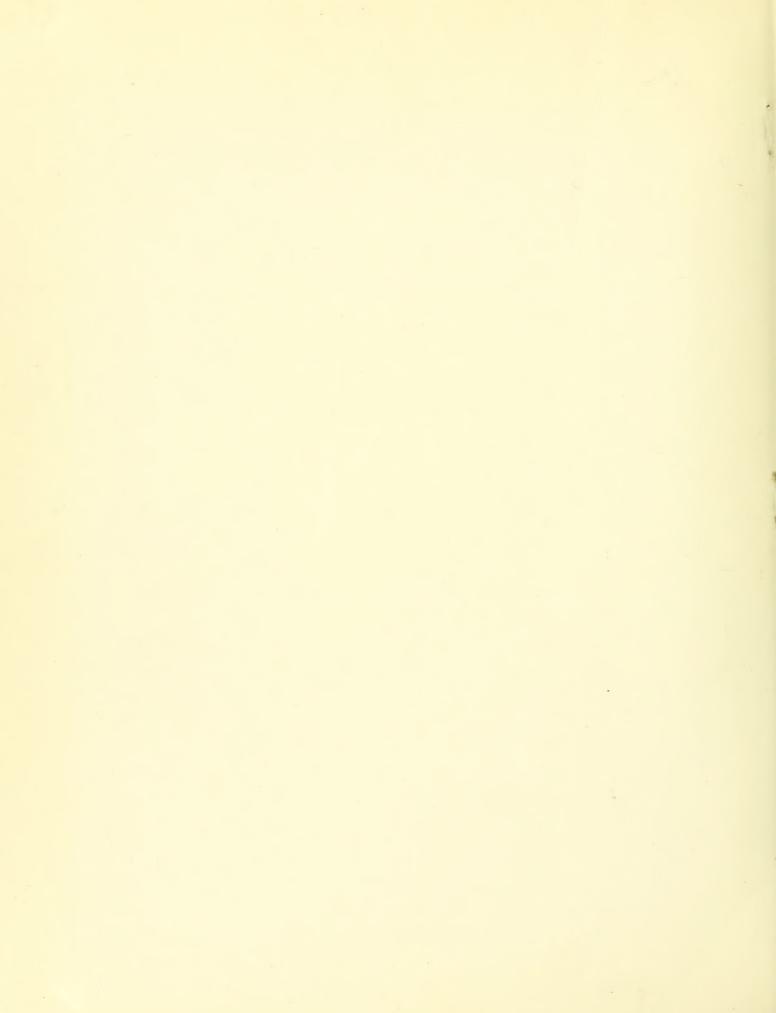20. The sample consists of a subset of 185 of the 189 original firms.

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