DETERMINANTS OF CORPORATE BORROWING

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I. INTRODUCTION

There is an important gap in modern finance theory on the issue of corporate debt policy. The theory should be able to explain why the tax advantages of debt financing do not lead firms to borrow as much as possible, and it should explain the phrase "as much as possible." It should explain why some firms borrow more than others, why some borrow with short, and others with long-maturity instruments, and so on.

A variety of ideas has been advanced to fill this gap. Modigliani and Miller (MM) have suggested [(1963), pp. 111] that firms maintain "reserve borrowing capacity" -- although the need for such flexibility is not clear in the frictionless capital markets MM rely on -- and that the incremental tax advantage of borrowing declines as more debt is issued and interest tax shields become less certain. They and others have also noted that the existence of personal taxes -- specifically the difference between rates on capital gains and rates on regular income -- reduces the theoretical tax advantage of corporate borrowing.[1/] These arguments rationalize firms' reluctance to borrow "as much as possible," but they give little specific guidance beyond that.

There are other lines of argument. Firms' debt policies may reflect imperfect or incomplete capital markets.[2/] The literature on credit rationing by banks and other lenders may help explain the limits to corporate borrowing.[3/] Perhaps managers avoid high debt ratios in an

attempt to protect their jobs and stabilize their personal wealth.[4/]

Bankruptcy costs (the transaction costs of liquidation or reorganization) probably discourage borrowing, although recent research by Warner (1976) questions whether these costs are large enough to be significant. Perhaps, as Robichek and Myers (1966) argue, costs of financial distress are incurred when the firm comes under the threat of bankruptcy, even if bankruptcy is ultimately avoided.[5/]

There is doubtless some truth in each of these ideas, but they do not add up to a rigorous, complete and sensible explanation of corporate debt policy.[6/] This paper presents a new approach which does not rely on any of the ideas mentioned above. It leads to a theory under which it is rational for firms to limit borrowing, even when interest is tax-deductible and capital markets are strictly perfect and complete. The theory shows that a form of capital rationing by lenders can exist in such conditions. It specifies an asset characteristic that encourages relatively heavy borrowing; this characteristic is not "low risk" in any of the usual senses of that phrase. Finally, the theory explains a number of previously puzzling phenomena. For example, it clarifies why practical people set target debt ratios in terms of book rather than market values, and why firms tend to "match maturities" of assets and debt obligations.

The theory rests on a relatively simple argument. It starts with the observation that most firms are valued as going concerns, and that this value reflects an expectation of continued future investment by the firm. However, the investment is discretionary. The amount

invested depends on the net present values of opportunities as they arise in the future. In some future states of nature the firm will stop investing altogether.

Thus part of the value of a firm is accounted for by the present value of options to make further investments on possibly favorable terms. This value depends on the rule for deciding whether the options are to be exercised. The paper shows that a firm with risky debt outstanding, and which acts in its stockholders' interest, will follow a different decision rule than one which can issue risk-free debt or which issues no debt at all. The firm financed with risky debt will, in some states of nature, pass up valuable investment opportunities -- opportunities which could make a positive net contribution to the market value of the firm.

Issuing risky debt reduces the present market value of the firm by inducing a future investment strategy that is suboptimal in the sense just described. The loss in market value is absorbed by the firm's current stockholders. Thus, in the absence of corporate income taxes, the optimal strategy is to issue no risky debt. If there is a corporate tax, and interest is tax-deductable, the optimal strategy involves a tradeoff between the tax advantages of debt and the costs of the suboptimal future investment strategy.

The argument is similar to Jensen and Meckling's (1976) analysis of agency costs and optimal capital structure. The suboptimal investment policy is an agency cost induced by risky debt. However, this particular cost was not recognized by Jensen and Meckling. Their theory of optimal

capital structure is based on different phenomena.

Galai and Masulis (1976) have also recognized that the firm's investment policy depends on capital structure. However, this is a relatively minor part of their paper. They do not extend their insight to a full theory of corporate investment and borrowing policy.

The paper's formal argument is presented for a simple case in Section II. Several issues raised by the formal argument are discussed in Section III. The most important of these is the possibility that debt contracts could be rewritten to insure that the firm follows an optimal investment policy. I conclude that this possibility is remote. The costs of writing and enforcing such a contract would, in general, be extremely large.

Section IV gives a general statement of the theory and considers how optimal debt policy changes as firms merge, or as different assets are combined in a single firm. Section V summarizes empirical implications. A brief concluding section indicates areas for further research.

II. THE BASIC IDEA

Statement of the Problem

At first glance, some of the oddest practical rules of thumb for judging debt policy are those which depend on ratios of debt to the book value of equity or to total book capitalization. Anyone familiar with modern finance theory considers ratios based on market values much more pertinent. Yet there is an element of sense in the practical procedures. It is not that book values are more accurate than stock market values, but simply that they refer to assets already in place. A significant part of many firms' market values is accounted for by assets not yet in place, i.e., by the present value of future growth opportunities. In this section I will show that the amount of debt "supported by" growth opportunities will be substantially less, other things equal, than is supported by assets already in place. I start with this case because it provides the clearest and most dramatic illustration of the basic idea advanced in this paper.

I will assume that there are no corporate taxes and no bankruptcy costs. The firm's managers act in the shareholders' interest. Capital markets are perfect and complete, so that investors can construct portfolios with any conceivable pattern of returns across future states of nature.[7/] Let:

V = the current equilibrium market value of the firm, and

V_D, V_E = the current equilibrium market values of debt and equity respectively.

As was previously noted, V can be broken down into the present value of assets already in place and the present value of future growth

opportunities. More precisely,

$$V = V(A) + V(G) \qquad (1)$$

where V(A) = the market value of assets already in place,[8] and

V(G) = the present value of future investment opportunities.

The usual interpretation is that a positive value of V(G) reflects future investments which are expected to yield a rate of return in excess of the opportunity cost of capital. However, since the firm may choose not to puruse future investment opportunities, V_G is best regarded as the present value of the firm's options to make future investments. The basic distinction being drawn here is between assets whose ultimate value depends on further, discretionary investment by the firm, and assets whose ultimate value does not depend on such investment.

For simplicity, consider a firm with no assets in place or contracted for (V(A) = 0) and only one future investment opportunity. The firm is initially all-equity financed. It must decide whether to invest I one period hence, at t = 1. It is invests, the firm obtains an asset worth V(s) at t = 1, where s is the state of nature then obtaining.

Obviously, the investment will be made only if $V(s) \geq I$. The decision is shown in Fig. 1.[9] For states displayed to the right of s_a ($s \geq s_a$), the investment is made. This is noted by setting the decision variable $x(s) = 1$. For states $s < s_a$, $x(s) = 0$. Thus s_a is the "breakeven" state.

In complete markets, the value of the firm is

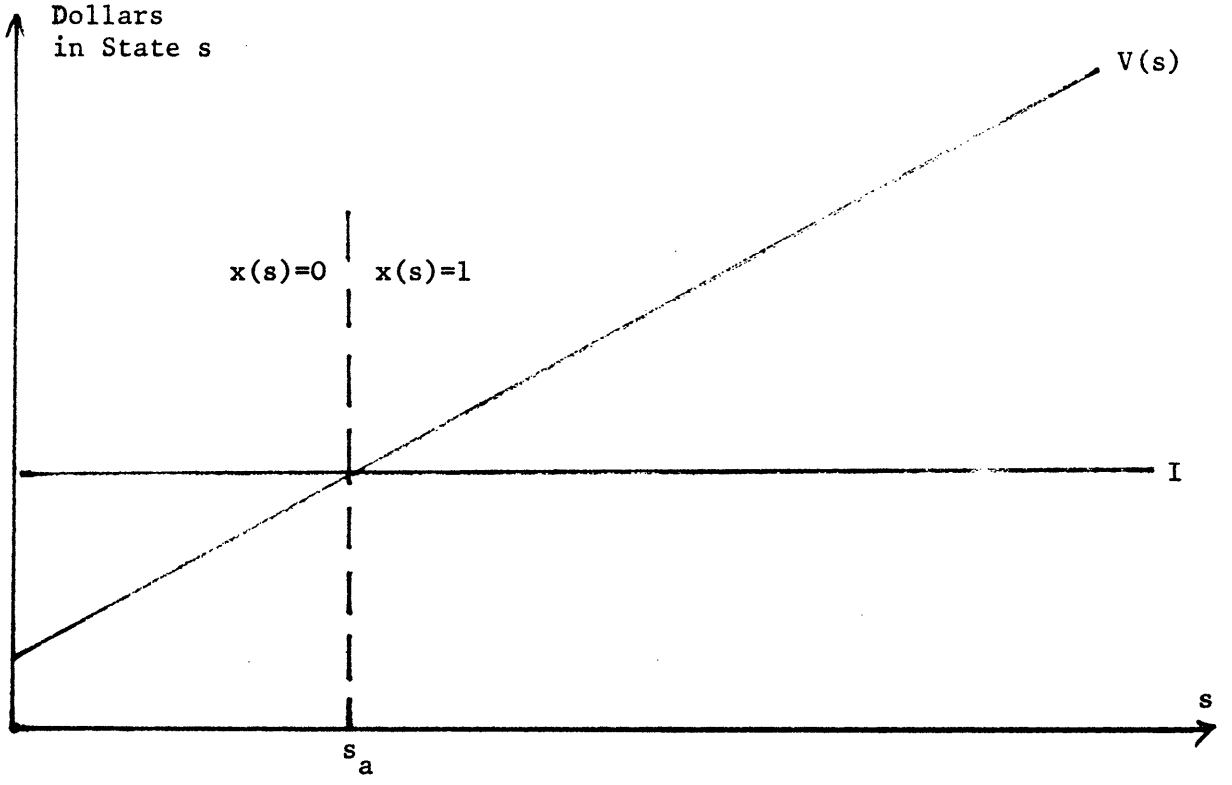


FIGURE 1

The Firm's Investment Decision under All-Equity Financing

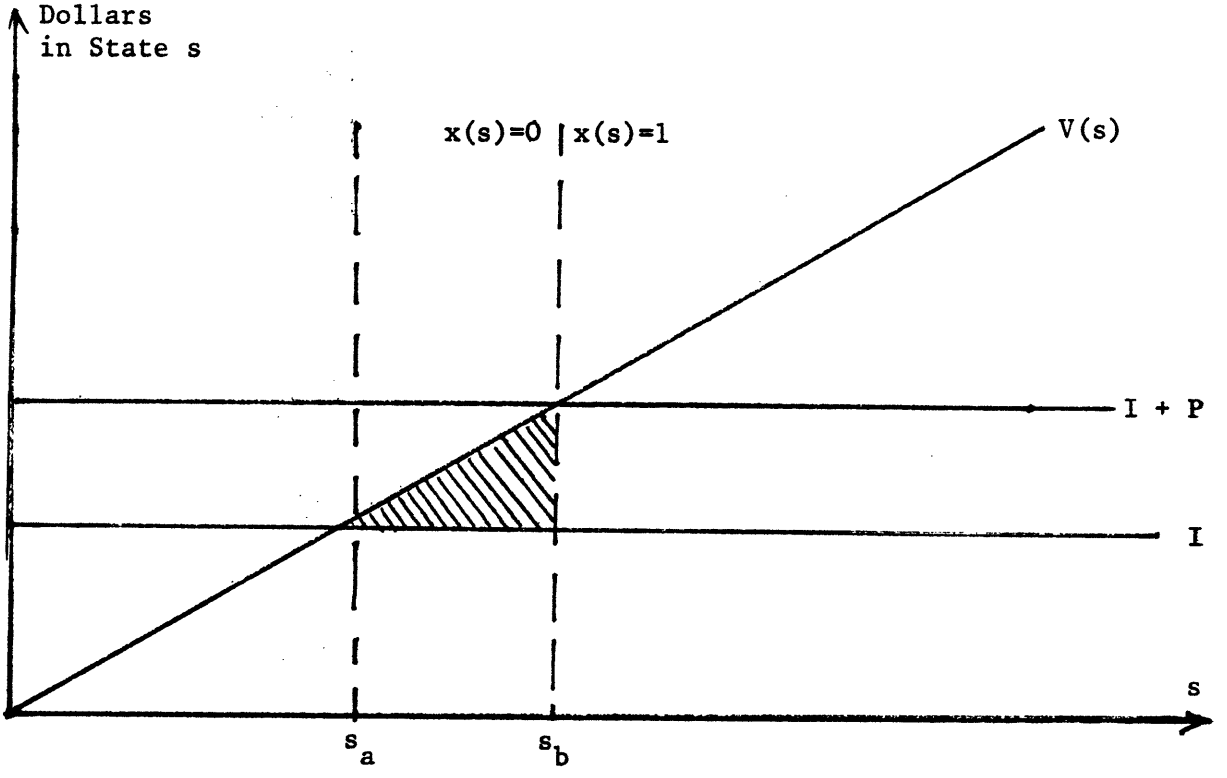


FIGURE 2

The Firm's Investment Decision with Prior Debt Financing

$$V = \int_0^\infty q(s)x(s)[V(s) - I]ds, \qquad (2)$$

where q(s) is the current equilibrium price of a dollar delivered at period t = 1 if and only if state s occurs. Under all-equity financing, x(s) = 0 for $s < s_a$, and s(s) = 1 for $s \geq s_a$, so

$$V = \int_{s_a}^\infty q(s)[V(s) - I]ds. \qquad (3)$$

The Link Between Borrowing and the Market Value of the Firm

Since the firm will be worth nothing in states $s < s_a$, it can issue no safe debt. However, it can issue risky debt with the promised payment P. Assume first that the debt matures before the investment decision is made, but after the true state of nature is revealed. Then if $V(s) - I \geq P$, it will clearly be in the stockholders' interest to pay the debtors off. If $V(s) - I < P$, however, the bondholders will take over, and will exercise the firm's option to invest if $V(s) \geq I$. Thus the equilibrium market value of the debt at t = 0 is

$$V_D = \int_{s_a}^\infty q(s)[\min(V(s) - I, P)]ds. \qquad (4)$$

In this case shareholders can borrow the entire value of the firm if they wish. If P is made large enough to exceed V(s) - I in all states, then $V_D = V$ as given by Eq. (3). The amount borrowed is a matter of indifference to stockholders -- Modigliani and Millers' Proposition I is well-known to hold under present assumptions.[10/]

The interesting case occurs when the debt matures after the firm's investment option expires. Then outstanding debt will change the firm's investment decision in some states. From the shareholders' viewpoint, the option is worth exercising only if V(s) exceeds the sum of I, the required outlay, and P, the promised payment to the firm's creditors. If $V(s) < I + P$ and the investment is made, shareholders' outlay I will exceed $V(s) - P$, the market value of their shares. The new situation is shown if Fig. 2. Here $x(s) = 0$ for $s \geq s_b$ and $x(s) = 1$ for $s < s_b$; s_b is the "breakeven" state in which $V(s) = I + P$.

The firm's value at $t = 0$ is now given by

$$V = \int_{s_b}^{\infty} q(s)[V(s) - I]ds, \qquad (5)$$

where s_b depends on P, the promised payment to creditors. So long as $s_b > s_a$, there is a loss of value in some states of nature. The loss is shown by the shaded triangle in Figure 2. A higher P implies a larger triangle and a lower V. In fact, if P is set high enough, V(s) will be less than I + P in all states, x(s) will be zero in all states, and the firm will be worthless.

The creditors will receive nothing at all if $s < s_b$. Thus:

$$V_D = \int_{s_b}^{\infty} Pq(s)ds. \qquad (6)$$

Clearly $V_D < V$, except in the limit where $P \to \infty$, $s_b \to \infty$ and $V \to 0$. Also, V must be less than its all-equity value (given by Eq. (3)) whenever P is positive. Consequently, the relationship of V_D to P must be as shown in Fig. 3. There is a definite limit, $V_D(\max)$, to how much the firm can

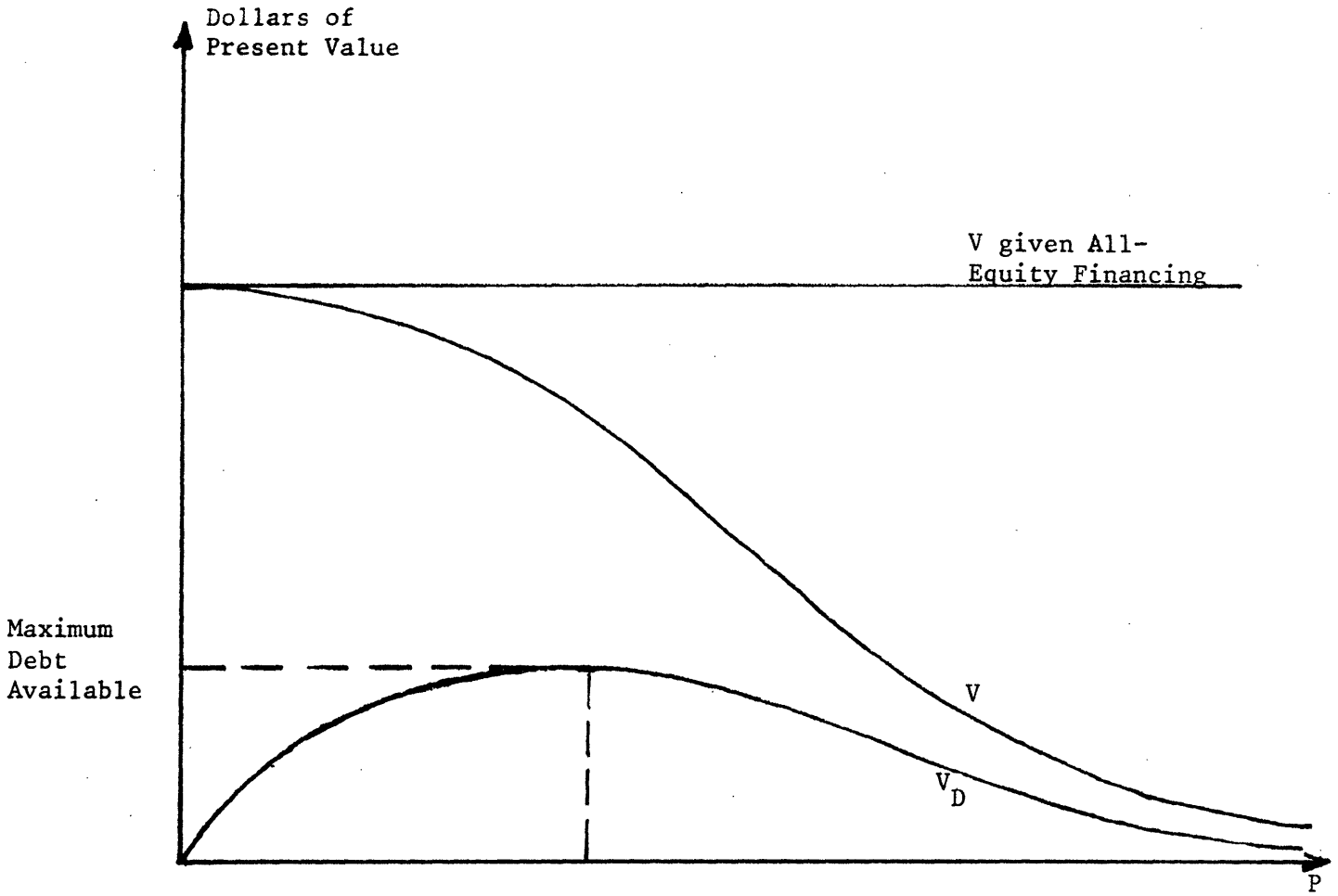


FIGURE 3

Firm and Debt Values as a Function
of Payment Promised to Creditors

borrow (assuming it wants to). This limit is less than V and falls even further short of what V would be under all-equity financing. This is an interesting result because it shows that credit rationing can occur even in perfect capital markets. After a point the firm cannot borrow more by offering to pay a higher interest rate. In fact, it may find that an offer to pay more reduces the amount of credit available to it. As far as I know this is the first rationale for credit rationing that does not depend on market imperfections.[11/]

Since the shareholders' objective is to maximize V, the market value of the firm, the optimal policy in the case described by Fig. 3 is to issue no debt at all. Any promised payment will lead the firm to abandon a project with positive net present value in some future states. Thus V is a monotonically decreasing function of P, and it is maximized when P and V_D equal zero.

Taxes

We must seek some other factor to explain why firms issue risky debt. One obvious candidate is the corporate income tax. Almost all countries subsidize debt, as opposed to equity, financing by allowing interest on corporate debt as a tax-deductible expense.[12/] This fact justifies a brief digression to consider how taxes affect optimal borrowing in the case discussed above. (But remember that this paper's main point has nothing to do with taxes.)

The analysis is much as before except that the present value of the tax shields generated by debt at first outweighs the decline in V

due to loss of valuable future investment opportunities. But a point is reached at which the two effects just balance and further borrowing decreases the value of the firm. This is the point of optimal capital structure.

Exactly where this point is reached depends on whether the interest tax shields retain their value if the firm goes bankrupt and on whether there is a limit to the amount of interest allowed as a tax-deductible expense. Suppose the firm can deduct the full amount $P - V_D$ in all states, and the tax rate is T. Then the value of the firm is:

$$V = \int_{s_b}^{\infty} [V(s) - I]q(s)ds + T(P - V_D) \int_0^{\infty} q(s)ds, \qquad (7)$$

where s_b is defined by $V(s_b) = I + P - T(P - V_D)$, and the debt value V_D is given by:

$$V_D = \int_0^{s_b} T(P - V_D)q(s)ds + \int_{s_b}^{\infty} Pq(s)ds. \qquad (8)$$

But an examination of Eq. (7) reveals a quite unreasonable feature: V can be made arbitrarily large by choosing a large enough value for P. It is more reasonable to suppose that the tax authorities allow deductions based on some maximum interest rate R. Then the firm's value is:

$$V = \int_{s_b}^{\infty} [V(s) - I]q(s)ds + \min(RTV_D, T(P - V_D)) \int_0^{\infty} q(s)ds. \qquad (9)$$

As $P \to \infty$, $V \to RTV_D \int q(s)ds$. But as this happens $V_D \to V$. At the limit, therefore, $V_D = RTV_D \int q(s)ds$, which is satisfied only if $V_D = 0$.[13/] Thus we have the sensible result that V and V_D each approach zero if P is set high enough. Moreover, there is a definite maximum amount of debt that firms can raise if they attempt to do so. This amount is less than the market value of the firm.

The behavior of V and V_D as a function of P is shown in Fig. 4. The figure is drawn so that the maximum value of V occurs before that of V_D. That is, the firm does not attempt to borrow as much as it can. This is always true providing that Eq. (9) holds, and that P is high enough that the tax shield is RTV_D rather than $T(P - V_D)$. To show this, we calculate $\delta V/\delta P$:

$$\frac{\delta V}{\delta P} = -\left(\frac{\delta s_b}{\delta P}\right) V(s_b)q(s_b) + RT\left(\frac{\delta V_D}{\delta P}\right) \int_0^\infty q(s)ds.$$

Evaluating the derivative at $\delta V_D/\delta P = 0$, we find that $\delta V/\delta P$ must be negative. Thus the firm must go beyond the point of maximum firm value in order to borrow the maximum amount. This is not in the shareholders' interest, so the firm will stop at the point where V is maximized.

A second case occurs when the tax shield is lost as the firm goes bankrupt. Then:

$$V = \int_{s_b}^\infty [V(s) - I + T(P - V_D)]q(s)ds, \qquad (10)$$

and V_D is given by Eq. (6).

The general behavior of V and V_D is again as shown by Fig. 4,

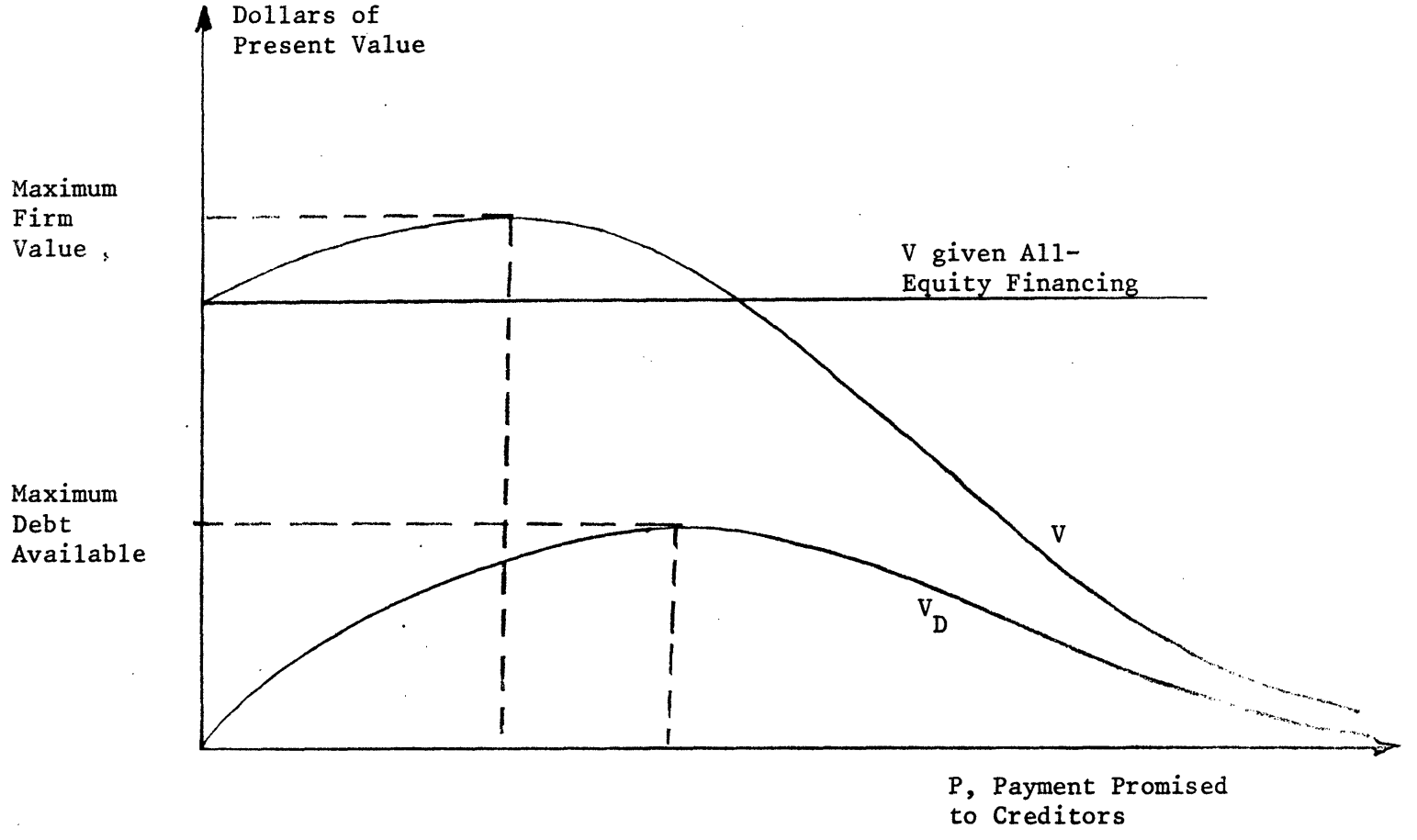


FIGURE 4

Firm and Debt Values when Debt Interest is Tax-Deductible

although in this case it cannot be guaranteed that the maximum value of V is reached before the maximum value of V_D. This result holds generally only if the tax shield is restricted to TRV_D (or to any amount that is independent of P). But this is not crucial. The essential point is that the firm will choose P to maximize V, not V_D. Only be rare coincidence will these two functions reach their maximum levels at the same point. The firm should not attempt to borrow as much as possible.

III. DISCUSSION

Assets as Call Options

What are the essential characteristics of the "growth opportunity" discussed in the previous section? They flow from the fact that it can be regarded as a call option on a real asset. The option's exercise price is the future investment needed to acquire the asset. Whether the option has any value when it expires depends on the asset's future value, and also on whether the firm chooses to exercise. The decision to exercise is not trivial and automatic, as it is for options written on securities, since it depends on the magnitude of promised payments to bondholders.

Thus the most fundamental distinction is not between "growth opportunities" and "assets in place," but between (1) assets that can be regarded as call options, in the sense that their ultimate values depend, at least in part, on further discretionary investment by the firm and (2) assets whose ultimate value does not depend on further discretionary investment.

In reality, the difference between "assets in place" and "growth opportunities" is more one of degree than kind. The market value of almost all real assets can be partly attributed to associated call options. That is, the ultimate payoff of almost all assets depends on future discretionary investment by the firm. The discretionary investment may be maintenance of plant and equipment. It may be advertising or other marketing expenses, or expenditures on raw materials, labor, research and development, etc. All variable costs are discretionary investments.

For most lenders the relevant asset is the firm itself. Their loan's value depends on the value of the firm as a going concern, not on the

value of any specific physical asset. (It is true that lenders often protect themselves by requiring security in the form of specific assets for which secondary markets exist. But that is an attempt to avoid the problems analyzed in this paper.) The value of a going concern can be maintained only be continual positive action; in a well-functioning, competitive industry the firm should have to work hard simply to keep up. This is not simply a matter of maintaining plant and equipment. There is continual effort devoted to advertising, sales, improving efficiency, incorporating new technology, and recruiting and training employees. All of these activities require discretionary outlays. They are options the firm may or may not exercise; and the decision to exercise or not depends on the size of payments that have been promised to the firm's creditors.

Thus the issues introduced in the discussion of growth opportunities are really very general ones. The heart of the matter is that the existence of debt changes the firm's actions in some circumstances. It creates situations ex post in which management can serve shareholders' interests only by making sub-optimal decisions. Ex ante, this reduces the value of the firm (other things equal) and reduces shareholders' wealth.

The Form of the Debt Contract

Why not eliminate this problem by adding a clause to the debt contract? That is, the contract would be rewritten to require the firm to take on each investment project in all states where its net present value is positive.

There are several reasons why this is practically impossible. I will discuss these reasons in the context of the simple case presented

in Section II, although they also apply to the general case as discussed in Section IV.

First, such a contract is not enforceable when it counts, since limited liability protects shareholders from mandatory future assessments. To make the contract work, firm's owners would all have to sign contracts as individuals, with each shareholder bearing a pro rata share of the possible assessment. The difficulties of obtaining such an agreement go beyond the costs of paperwork, distributing information, and monitoring.[14/] Consider an individual who accepts, in principle, the argument for forfeiting part of his right to limited liability. (Presumably the possible assessment would be limited to some maximum amount.) It is not in his interest, acting individually, to guarantee his share of the potential assessment. The resulting increase in firm value accrues to all shareholders, not to him alone. In other words, the commitment to advance funds is, from the individual shareholder's viewpoint, a public good.

Second, even if such a contract is laboriously constructed, there will rarely be any objective basis for judging whether it is breached. In the example discussed in Section II, bondholders could press for specific performance only by showing that $V(s) > I$. But for most corporate investments $V(s)$ is not objectively observable. Instead it is estimated by management, who will no doubt be appropriately pessimistic if their unbiased estimate of $V(s)$ is greater than I but less than $I + P$. Even if $V(s)$ is observable, its magnitude is typically under management control. If it turns out that $V(s)$ is potentially between I and $I + P$, a management that acts in the shareholders' interests will surely be able to find some suboptimal policy that dissipates

the opportunity, forcing its actual value below I. No sane lawyer will attempt to write a contract requiring management to "abstain from suboptimal decisions."

The only enforceable contract is a promise by the firm, backed up by the present value of I in escrow, to take the investment opportunity whatever happens. Then the value of the firm, including the escrow, is:

$$V = \int_0^\infty V(s)q(s)ds. \tag{10}$$

Since the investment in this case is not discretionary, the existence of debt does not affect it, and the firm can go to 100 percent debt if it wishes.

Why do we not observe firms committing themselves to future investments? Evidently this action has offsetting costs. The firm's net debt under such a contract is V_D less the value of the escrow fund. If the escrow fund exceeds V_D, the firm ends up as a net lender rather than a net borrower. In that case, what is the point? Even if the firm is a net borrower, the tax payments on the escrow fund's interest partly or wholly offset the tax shields provided by interest on V_D.

More important, the debt contract forces the firm to accept projects with negative net present values in unfavorable states of nature. Thus the value of the firm declines by:

$$\Delta V = \int_0^{s_a} [V(s) - I]q(s)ds < 0.$$

Note that $V(s) < I$ in states $0 < s < s_a$.

Thus there is a tradeoff between the loss ΔV and the extra debt capacity created by the commitment to invest. Of course, if it is unlikely that V(s) will be less than I, then the cost ΔV is small and the commitment to invest in all states may be worthwhile. Nevertheless this exception proves the rule. The lower the probability that V(s) will be less than I, the less this asset has of the essential characteristics of a growth opportunity, and the more it is like an asset already in place.

Renegotiating the debt contract. -- Thus it seems extremely difficult to write and enforce a debt contract which insures optimal (i.e., firm value maximizing) capital budgeting decisions. But if the problem cannot be solved ex ante, perhaps it can be solved ex post. If creditors and shareholders find themselves in a position where the net present value of an investment project is positive, but less than the payment promised to creditors, then it is in both sides' interest to renegotiate the debt contract.[15/]

This is not impossible, merely costly. There are the direct costs of renegotiating, perhaps magnified by the mutual suspicion which tends to arise in situations of financial distress. Second, the creditors cannot renegotiate intelligently without an estimate of the net present value of the project in question. They cannot depend on management's estimate, since the shareholders' interest is served by downplaying the opportunity's value.[16/] Yet it is doubtful that creditors could obtain an adequate estimate of this value without continual monitoring of the firm's actions and prospects -- a costly duplication of one important aspect of the management function.

These monitoring and renegotiation costs are worthwhile to the extent that the incidence of suboptimal investment decisions is reduced, but

the prospect of these costs nevertheless reduces the present market value of the firm.[17/]

Shortening debt maturity. -- One apparently easy way out is to shorten the maturity of outstanding debt. Debt that matures before an investment option is to be exercised does not induce suboptimal investment decisions. Thus it seems that permanent debt capital is best obtained by a policy of rolling over short maturity debt claims.

The roll-over cannot be automatic however. If it is, we are back to the problem described in Section II. Borrowing short does not in itself reduce monitoring costs. What it does offer is the setting for continuous and gradual renegotiation, in which the firm can, in principle, shift at anytime back to all-equity financing, or to another source of debt capital. This seems to be the ideal solution, except for the costs of maintaining such a continuous, intimate and flexible relationship.[18/]

Monitoring and protective covenants. -- It is important to remember that monitoring costs are borne by stockholders. In well-functioning capital markets lenders forsee the costs, which are therefore reflected in the equilibrium promised interest rates for various debt contracts. When debt is issued, the costs' present value is reflected in the market value of the firm and absorbed by stockholders, who have the residual claim on firm value.

It is up to shareholders to decide whether to accept these costs. They could borrow on terms which exclude renegotiation and monitoring. They may not be able to borrow as much,[19/] and they may have to pay an extremely high promised interest rate, but they can do it.

The reason why firms accept loan terms which compensate lenders for monitoring and renegotiation is that the costs thus incurred are offset by the increase in firm value due to a lower incidence of suboptimal investment decisions.

It is the same with loan covenants. Managers complain about "restrictive covenants" but they are rational from the debtors' point of view as well as the creditors'. It is true that lenders may demand such covenants before lending money at a given interest rate, but the choice of covenants is fundamentally the shareholders'. Where covenants exist, we must conclude that managers and shareholders have found that it pays to accept them. They freely choose to accept constraints today which rule out behavior which seems rational tomorrow. The resulting arrangement is an exact financial analogue to a situation described by Homer (c. -900, pp.227-28):

> I carved
> a massive cake of beeswax into bits
> and rolled them in my hands until they softened --
> no long task, for a burning heat came down
> from Hêlios, lord of high noon. Going forward
> I carried wax along the line, and laid it
> thick on their ears. They tied me up, then, plumb
> amidships, back to the mast, lashed to the mast,
> and took themselves again to rowing. Soon,
> as we came smartly within hailing distance,
> the two Seirênês, noting our fast ship
> off their point, made ready, and they sang . . .
> The lovely voices in ardor appealing over the water
> made me crave to listen, and I tried to say
> 'Untie me!' to the crew, jerking my brows;
> but they bent steady to the oars.

Restrictions on dividends. -- Jeffrey Halis, in his comments on an earlier version of this paper, has described how restricting dividend payments can protect against the suboptimal investment decisions induced by risky debt.[20/]

In the simple case discussed in Section II, I assumed that the investment I was fresh equity capital, raised by issuing stock. I could just as well represent a dividend foregone. But if dividends are restricted, the firm must invest in something. If funds can be placed in cash or a real asset offering V(s) > I, the real asset will be chosen and the value of the firm will be maximized.

I regard this as a strong rationale for restrictive covenants on dividends, and a partial solution to the warped investment incentives created by risky debt. The reasons it is only a partial solution include the following:

1. There are still monitoring costs, since there are so many possible channels for transferring capital to the firm's owners. This is particularly difficult when owners are also managers. As Jensen and Meckling (1976) point out, transfers can take a variety of non-pecuniary forms.
2. The investment incentives are still not exactly right. That is, the best investment policy from the shareholders' viewpoint is not the one which maximizes the market value of the firm. Shareholders will prefer risky assets to safe ones, other things equal. Thus they may reject valuable safe assets in favor of riskier assets with lower, or even negative net present value.[21/] This has been discussed by Jensen and Meckling (1976) and Galai and Masulis (1976).

3. The dividend restriction, if binding, may force the firm to invest in assets with negative net present values in unfavorable states of nature.[22/]

4. A dividend constraint is helpful only when cash is actually available for payout. Consider the following scenario. Firm X issues what seems a moderate amount of long term bonds. It accepts a covenant restricting dividend payments if retained earnings fall below a certain threshold.[23/] Additional debt is also restricted in these circumstances. But the firm falls on bad times, and losses accumulate to the point where the dividend constraint is binding. In this situation there is little cash for dividends or plowback. The shortage of cash does not matter if there are no good investment opportunities. But it may make economic sense to spend money to save the firm. If so, the funds will have to be raised by stock issue, unless the debt contract is renegotiated. But here the analysis of section II applies directly. Moreover, the firm's financial distress has made its bonds riskier than they were when issued. As is shown below, the riskier the debt, the weaker is shareholders' incentive to commit additional capital to the firm.

Secondary Markets for Real Assets

Consider a firm which is holding a real asset for which there is a secondary market. In each period the firm will compare the present value

of using the asset (for at least one more period) with the cash it could obtain by selling it. If it decides to use the asset, it is in effect investing the secondary market value.

Figure 1 depicts this case exactly, if we interpret V(s) as the value of use, given state s, and I as the secondary market value. (I could also depend on the state occuring.) The rational decision is to sell ($x(s) = 0$) if $V(s) < I$.

However, if the firm has debt outstanding, having promised to pay the amount P, the rational move from the shareholders' point of view is to sell if $V(s) < I + P$. When this condition holds, selling generates the amount I, whereas not selling generates only $V(s) - P$, which is less than I. The shareholders should attempt to liquidate and run, leaving the creditors holding the empty bag.

If this option is open, then all of the analysis presented in Section II applies exactly. The fact that we were there concerned with possible future investment, and here with possible disinvestment, is immaterial. The two cases are exactly symmetrical. Holding I, the set of contingent values V(s), and other parameters equal, we can say that the "debt capacity" of an asset in place is exactly the same as that of a growth opportunity.

This pleasant symmetry does not carry over into real life however. For one thing, it is illegal (specifically, fraudulent) to liquidate assets and distribute the proceeds to shareholders if bankruptcy is imminent. More improtant, it is relatively easy to write a clause in the debt contract prohibiting this maneuver. So long as the creditors have veto power over dividends or any form of return of capital under conditions of financial distress, they are protected.[21/]

The existence of a secondary market for an asset will in general increase the present market value of the firm, providing that the appropriate restrictive covenants can be written. This is directly evident from Figure 1. The existence of a secondary market allows a higher payoff ($I > V(s)$) for states $s < s_a$, while the payoff for states $s > s_a$ is the same. However, if the appropriate restrictive covenants for some reason cannot be written or enforced, then we have the paradoxical result that the existence of a secondary market actually reduces the value of the firm, and reduces the amount of debt that can be issued against any promised payment P.

IV. GENERALIZATION

Restatement of the Problem: Imperfections in Real Asset Markets

The value of the firm as a going concern depends on its future investment strategy. Thus it is useful for expositional purposes to think of the firm as composed of two distinct asset types: (1) real assets, which have market values independent of the firm's investment strategy, and (2) real options, which are opportunities to purchase real assets on possibly favorable terms.

The existence of valuable real options presumes some adjustment costs, market power, or other imperfections in the real sector. There are no investment opportunities offering positive present value if product and factor markets are perfectly competitive and in continuous, long-run equilibrium. The value of real options reflects the possibility of rents or quasi-rents.

Moreover, the theory presented here rests on certain specific imperfections in the market for real options. It is necessary that the value of such an option vanishes or declines if not exercised by the firm. This assumption may be justified in several ways.

1. The real options may be firm-specific, having no value to any other firm. This could occur if real options are embodied in real assets, so that the options cannot be purchased separately. Real options may also be firm-specific if generated by experience curves, learning-by-doing, or other similar phenomena.

2. If real options are not firm-specific they may nevertheless be traded in thin and imperfect secondary markets. If so, the real

option's "liquidation value" is less than its value as part of a going concern. This limits the extent to which a real option can be used as specific security for a debt claim. Even if a clear and enforceable contract could be written, permitting creditors to claim a specific real option if not exercised by the firm at the optimal time, creditors would face a costly and lengthy task. By the time they sue, recover the option, and resell it or exercise it themselves, the value of the opportunity may vanish.

One can think of real options that are separable, objectively identifiable, relatively long-lived, and for which reasonable secondary markets exist. Examples are patents, certain trademarks, franchises and operating licenses. Such options should "support" debt to the same extent as otherwise similar real assets.

This paper takes the existence of real options as exogenous. It does not ask whether they are acquired via purchase of real assets, via learning-by-doing, or via direct expenditure in research, advertising, training or some other activity. The development of a theory of the firm which treats real options as endogenous is a challenging subject for future research.

The immediate problem is to extend the arguments given in Section II to cases in which investment occurs in more than one period, and in which firms hold more than one type of asset.

Long Term Borrowing

A detailed, dynamic model of the firm's investment and borrowing behavior is beyond the scope of this paper. But it is not hard to predict the qualitative effects of debt financing on the firm's investment policy and market value.

We consider a firm holding options on real assets, one of which can be partially or wholly exercised at time t. Exercising the option requires a fresh commitment of equity capital by shareholders.[25/] The firm may have assets in place at t. It also has bonds outstanding which mature at some point beyond t.[26/]

Since $V_t = V_{E,t} + V_{D,t}$, the effect of an incremental discretionary investment on the market value of equity is $dV_E/dI = dV/dI - dV_D/dI$. The investment policy which maximizes the value of the firm is to continue investing as long as $dV/dI > 1$. This means exercising all options which (1) have positive net present value and (2) for which period t is the expiration date or the optimal time for exercise. But options having positive net present value are not necessarily attractive to the firm's owners. Whether they are depends on the sign and magnitude of dV_D/dI.

At any point in time the value of outstanding bonds is related to the value of the firm and on the undertainty about the firm's future value.[27/]

$$V_{D,t} = f_t(V_t, \sigma^2(V_{t+1}/V_t))$$

where $\sigma^2(V_{t+1}/V_t)$, henceforth σ_t^2, is the variance rate of overall market value. Therefore

$$\frac{dV_{E,t}}{dI_t} = \left(\frac{dV_t}{dI_t}\right)\left(1 - \frac{\delta f_t}{\delta V_t}\right) - \frac{\delta f_t}{\delta \sigma_t^2} \cdot \frac{\delta \sigma_t^2}{\delta I_t} \quad . \tag{11}$$

In other words, there is a transfer of value from stockholders, who make the investment, to bondholders, who contribute nothing. Call this transfer Z:

$$Z_t \equiv \frac{dV_t}{dI_t} - \frac{dV_{E,t}}{dI_t} = \frac{dV_t}{dI_t} \cdot \frac{\delta f_t}{\delta V_t} + \frac{\delta f_t}{\delta \sigma_t^2} \cdot \frac{\delta \sigma_t^2}{\delta I_t} \quad . \tag{12}$$

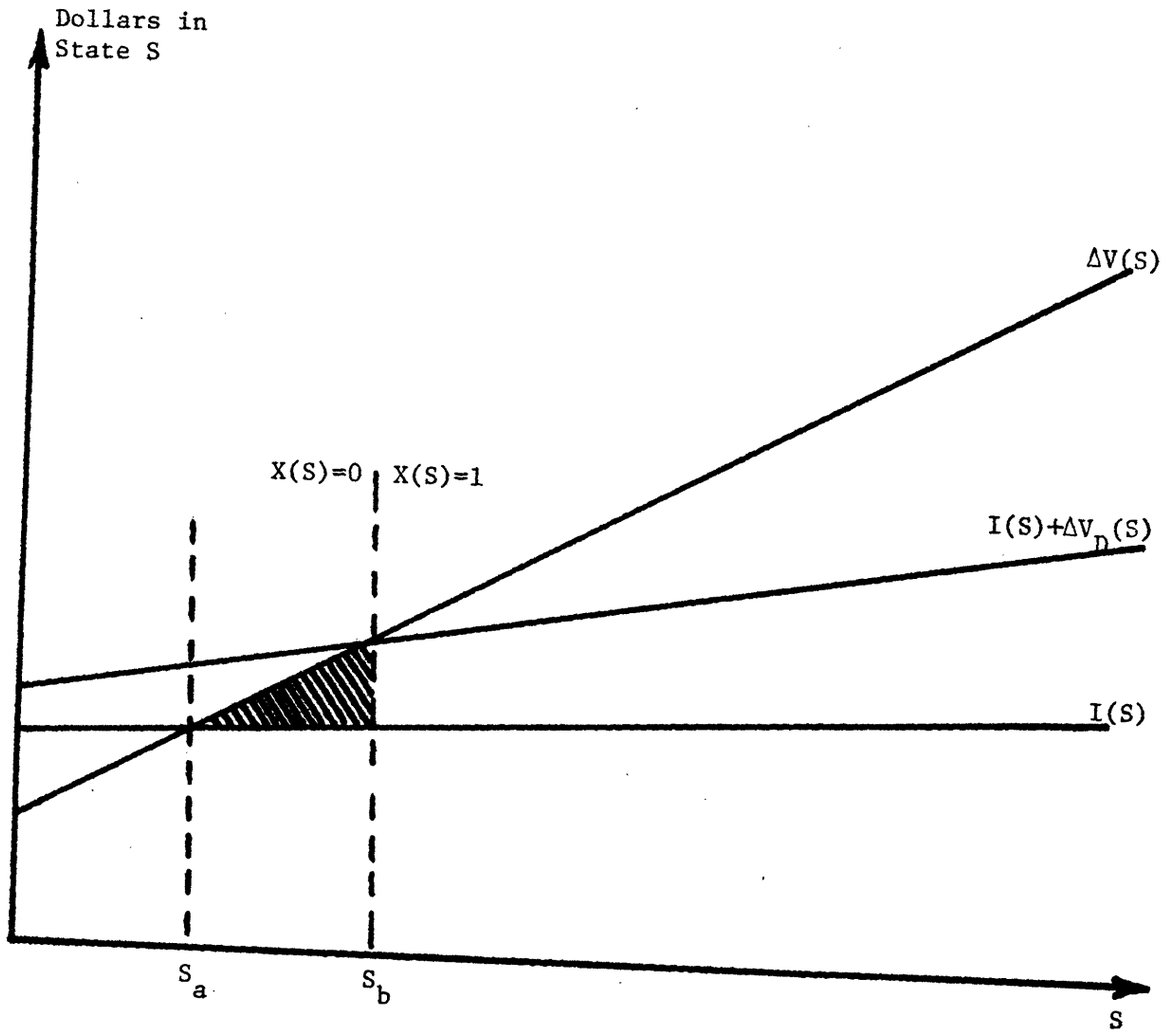
Appropriate investment incentives exist only when $Z_t = 0$.

First take the case where $\delta\sigma_t^2/\delta t = 0$, so that the firm's "risk class" is unaffected by the decision to exercise. Now $\delta f_t/\delta V_t$ will always be positive except in the limiting case where the debt is default risk free. Thus $Z > 0$. The existence of risky debt in period t weakens the incentive to invest, induces a suboptimal investment strategy, and reduces the market value of the firm in all periods prior to t.

This result rests on no assumptions about the firms' other assets or opportunities. The only assumption made about the debt is that there is some risk of default in t or afterwards. The only assumption made about capital markets is that changes in the market value of risky debt are positively correlated with changes in the market value of all the firm's assets.

Equations (11) and (12) assume a continuous investment schedule (with decreasing returns to scale) rather than discrete projects which have to be accepted or rejected. In this situation the firm may pass up a valuable option, or it may invest less than the optimal amount. The discrete case is shown in Figure 5. In the figure $\Delta V(s) - I(s)$ is the present value of the investment option if exercised. It is positive for all states $s > s_a$. ΔV_D is the capital gain to bondholders if the option is exercised -- which will not happen unless $\Delta V(s) \geq \Delta V_D(s) + I(s)$. Thus a valuable option is foregone for states $s_a < s < s_b$.

The implications of Figure 5 are just as shown in Figs. 3 and 4. The shaded area indicates the loss of net present value for these states.



$I(S)$ = discretionary outlay

$\Delta V(S)$ = increase in firm value if outlay is made ($X(S)=1$).

$\Delta V_D(S)$ = increase in debt value if outlay is made, including debt service in $t=1$.

FIGURE 5

The Firm's Investment Decision with Prior Debt Financing -- Multiperiod Case

Spillover effects. -- The fact that too little will be invested in some or all states of nature at time t reduces the value of the firm prior to t. Consider how this affects investment strategy in t-1. The suboptimal strategy at t reduces V_{t-1}. This, in turn, reduces the market value of outstanding debt at t-1, assuming the debt matures after t's investment decision. It also makes the debt riskier: $\delta f_{t-1}/\delta V_{t-1}$ increases.[28/] Therefore, Z_{t-1} increases, and investment incentives are weakened in period t-1 as well as t.

A similar effect may occur after period t, if the existence of risky debt in t leads the firm to pass up valuable investment opportunities. If this happens, the value of the firm is less in t+1, debt in t+1 is less valuable and riskier, and investment incentives are weakened.

Thus, if the existence of risky debt in t causes an inappropriate investment strategy in t, it will also cause an inappropriate strategy both before and after t. This strengthens the negative link between the existence of risky debt and the present market value of the firm.

Shifts in Asset Risk. -- Up to this point I have assumed that discretionary investment does not affect σ_t^2, the variance rate of market value. But the effects of a shift in risk are easily seen from Eqs. (11) or (12). If investment decreases σ^2 then the transfer to bondholders is greater than was assumed above, and the incidence and extent of suboptimal investment choices increases.[29/] An increase in σ_t^2, on the other hand, is favorable. In fact, the shift in σ_t^2 could be so great that Z is negative, leading the firm to exercise investment options with negative net present values. Only by chance, however, will Z be zero, insuring that the owner's self-interest drives them to maximize firm value.

We have an interesting, perhaps surprising, conclusion. The impact of risky debt on the market value of the firm is less for firms holding investment options on assets that are risky relative to the firms' present assets.[30/] In this sense we may observe risky firms borrowing more than safe ones.

Borrowing Against a Portfolio of Assets

One alleged advantage of corporate diversification is that diversified firms can borrow more. The combination of assets with less than perfectly correlated returns gives a variance rate for the combination's value that is less than the average rate of the assets considered separately. The usual conclusion is that this increases the amount the firm can or should borrow.[31/]

The conclusion does not follow from the theory presented here. The following preliminary analysis indicates that there should be no consistent relationship between "diversification" and "debt capacity."

We return to the simple world analyzed in section II, except that the firm holds two real options. We simplify notation by redefining $V_i(s)$ as option i's net value contingent on s. Previously net value was $V_i(s) - I_i$. The present value of project i is

$$V_i = \int_{S_i} q(s)V_i(s)ds, \tag{13}$$

where S_i is the set of all states for which $V_i(s) > P_i$, where P_i is the amount promised to creditors. P_i is a positive constant, but the debt is risky: $V_i(s) < P_i$ in some states.

The present value of option i in portfolio with the other option j is

$$V_i(j) = \int_{S_i(j)} q(s)V_i(s)ds, \qquad (14)$$

where $S_i(j)$ is the set of states in which option i is exercised. $S_i(j)$ includes states s for which $V_i(s) \geq P_i + P_j - \max[V_j(s),0]$, and for which $V_i(s) \geq 0$.

The conditions defining $S_i(j)$ need a word of further explanation. First, there is never an incentive to exercise an option with negative net present value. Thus, $V_i(s)$ must be positive. Suppose both options have positive net present value. Then the firm will accept both or neither, depending on whether $V_i(s) + V_j(s)$ exceeds $P_i + P_j$. However, suppose $V_j(s)$ is negative. In this case i is exercised only if it can carry the burden of j's debt, that is, if $V_i(s) > P_i + P_j$.

The problem can be precisely stated as follows. What is the relationship of $V_i(j) + V_j(i)$ to $V_i + V_j$? Alternatively, is $DV_i + DV_j > 0$, where $DV_i \equiv V_i(j) - V_i$ and $DV_j \equiv V_j(i) - V_j$? DV_i can be loosely interpreted as "diversification value" -- more precisely, as the change in the present value of option i due to the co-existence of j and its associated debt burden. DV_i changes when the existence of j changes the firm's investment strategy with respect to i.[32/]

Under general assumptions we cannot say whether $DV_i + DV_j$ is positive. In some instances the existence of j will cause the firm to exercise option i when $V_i(s)$ is positive but less than P_i. (See Box 2 on Table 1.) In other cases the existence of j will prevent exercise of i when $V_i(s) > P_i$. (See boxes 4 and 7.) In many states the decision about i is unaffected by the existence of j.

Table 1

BORROWING AGAINST A PORTFOLIO OF REAL OPTIONS

	$V_i(s) \geq P_i$	$P_i > V_i(s) \geq 0$	$V_i(s) < 0$
$V_j(s) \geq P_j$	① Take both $DV_i = 0$ $DV_j = 0$	② Take both if $V_i(s) + V_j(s) - P_i - P_j \geq 0$, otherwise reject both. X_i may = 1 (0 before). $DV_i \geq 0$. X_j may = 0 (1 before). $DV_j \leq 0$.	③ Reject i, take j if $V_j(s) - P_i - P_j \geq 0$. $DV_i = 0$. X_j may = 0 (1 before). $DV_j \leq 0$.
$V_j(s) < P_j$ $V_j(s) \geq 0$	④ Take both if $V_i(s) + V_j(s) - P_i - P_j \geq 0$. Otherwise reject both. X_i may = 0 (1 before). $DV_i \leq 0$. X_j may = 1 (0 before). $DV_j \geq 0$.	⑤ Reject both. $DV_i = 0$. $DV_j = 0$.	⑥ Reject both. $DV_i = 0$. $DV_j = 0$.
$V_j(s) < 0$	⑦ Reject j, take i if $V_i(s) - P_i - P_j \geq 0$. X_i may = 0 (1 before). $DV_i \leq 0$. $DV_j = 0$	⑧ Reject both. $DV_i = 0$. $DV_j = 0$.	⑨ Reject both. $DV_i = 0$. $DV_j = 0$.

Similar statements can be made about project j in portfolio with i.

It may be possible to reach more specific conclusions by making stronger assumptions about the joint distributions of $V_i(s)$ and $V_j(s)$.[33/]

V. CONCLUSIONS

The analysis presented in this paper adds up to a theory of the corporate borrowing decision. The theory does not rely on imperfect or incomplete financial markets. Although I have dealt only with certain simple cases, it still leads to testable propositions.

According to the theory, the amount of debt issued by the firm should set equal to V_D^*, that amount which maximizes the market value of the firm. It has no direct relationship to the probability of default or the amount lenders are willing to advance.

The theory predicts that V_D^* will be inversely related to the ratio of discretionary expenditures to total asset value. Discretionary expenditures include all future investment, maintenance and other variable operating costs which, if undertaken, increase the end-of-period value of the firm. "Discretionary expenditure" corresponds roughly to investment plus all variable costs. Although a general measure of this concept will be somewhat difficult to derive from accounting data, the following specific propositions should hold, other things equal, if the theory is right.

1. Assets-in-place should be financed with more debt than growth opportunities. The investment in assets-in-place is a sunk cost and, by definition, not discretionary. (I assume that secondary markets for assets in place do not exist or that sale in secondary markets can be regulated by the debt contract.)

2. For assets in place, the following factors should be associated with heavy debt financing: (a) capital-intensity and high operating leverage, (b) profitability, ideally measured in terms of expected future value of the firm's assets.

The theory also provides a rationalization for certain aspects of the operations of bond markets. I have already explained why firms are not observed borrowing against the present value of future growth. Sinking funds can be interpreted as creditors' attempts to reduce their exposure in parallel with the expected decline in the value of assets in place when the loan is made. It is also some protection against the debtors running off with the cash flow that these assets produce.

This same argument explains why firms attempt to match the maturities of their assets and liabilities. As far as I can see, standard finance theory gives no reason why firms should not finance long-lived assets with short-term debt, or conversely, short-lived assets with long-term debt.

Of course, these predictions are not a complete statement of the theory's implications. Others were noted in the main text of the paper. No doubt there are still others that I haven't grasped yet.

Areas for Further Research of Real Asset Valuation

All of this paper's interesting results stem from the idea of regarding real assets as options whose ultimate value depends on future discretionary investment by the firm. It may be that this idea's most important application will turn out to be the valuation of real assets. Let me conclude by stating one important theorem.

Following MM (Miller and Modigliani,(1961)), we can regard the market value of the firm as representing two components, the present value of (earnings generated by) assets in place, and the present value of growth opportunities. In MM's model growth opportunities have value if investors expect the rate of return earned on future investments to exceed

the firm's cost of capital. No distinction is drawn between the cost of capital for assets in place vs. future investment.[34/]

This model can be given an interesting reinterpretation in terms of option theory. At any point in time the firm is a collection of tangible and intangible assets. Assume the tangible assets are accumulated units of productive capactiy -- i.e. real assets -- all drawn from the same risk class. The intangible assets are options to purchase additional units in future periods. The sum of these option values is clearly what MM mean by the present value of growth. A similar interpretation can be put on going concern value.

We immediately have the question of whether growth options arrive randomly or systematically, whether they are "free" or must be purchased by the firm, and whether they have value if split off from the assets the firm already holds. It may be that real options are acquired only through the purchase of real assets in place -- i.e., exercising options today may create more options for possible exercise tomorrow. This paper has barely begun to consider how corporate investment decisions might be modelled.

But back to MM. Note that stock options are almost always riskier than the stocks they are written on. Suppose that is true for real options also.[35/] Consequently the observed risk of a common stock (e.g. its beta) will be a positive function of the proportion of the stock's value accounted for by growth in MM's sense. Two implications are immediately obvious.

1. Neo classical valuation models, like MM's, which use the same "cost of capital" to evaluate earnings from present vs. future investment, are mis-specified. (Whether this is empirically serious is, of course, unclear.)

2. One cannot measure the equilibrium capitalization rate for a firm's stock (e.g., by measuring its beta and calculating E[R] from the capital asset pricing model) and then use it as a hurdle rate for capital budgeting. This will be an overestimate of the correct rate for any firm having valuable growth opportunities.

FOOTNOTES

*Sloan School of Management, M.I.T. An earlier version of this paper (Myers (1975)) was presented at seminars at the London Graduate School of Business Studies, the Graduate School of Business, Duke University and the Faculte Universitaire Catholique du Mons, Belgium. I wish to thank the London Graduate School of Business Studies for research support and Richard Brealey, Fischer Black, Frederick Grauer, and Robert Merton for helpful comments.

1. See Farrar and Selwyn (1967) and Stiglitz (1972).

2. Durand's early critique of the MM propositions (1959) rests on market imperfections. The effects of incomplete markets on the firm's capital structure choice were emphasized later by Robichek and Myers (1966) and Stiglitz (1974), among others.

3. See, for example, Jaffee (1971).

4. Donaldson (1963).

5. But Robichek and Myers did not understand why a high probability of bankruptcy should in itself make it difficult to raise additional financing, or why it should lead to suboptimal investment decisions. I say this on the best authority.

6. Fama and Miller state that "there is little in the way of convincing research, either theoretical or empirical, that explains the amount of debt firms have in their capital structure." (1972, p. 173). I think this statement commands wide agreement -- although Fama and Miller might not apply it to recent work by Jensen and Meckling (1976) or Galai and Masulis (1976).

7. I adopt this framework to show that the theory developed below does not depend on some subtle imperfection or gap in financial markets. But neither does it depend on full perfection and completeness -- these are sufficient, but not necessary conditions. See Section IV below.

8. What about future opportunities the firm is contractually obligated to accept? If the obligation really is ironclad, then they should be included in V(A). However, usually the firm can default on such obligations. Given limited liability, the contract can be ironclad only if there is an escrow account or some other security to back up the investment outlay.

9. For convenience, the states are plotted in order of increasing V(s). This entails no loss in generality.

10. Hirshleifer (1966, pp. 264-68).

11. For example, Jaffee and Modigliani conclude "that credit rationing [by banks] will be profitable, even in long-run equilibrium, as long as there is uncertainty of loan repayment and banks cannot discriminate perfectly among customers." (1969, p. 861). (Emphasis added.)

12. Not everyone would agree, however, that the corporate income tax is the only tax relevant to the firm's choice of capital structure. See Farrar and Selwyn (1966) and Stiglitz (1972), for example.

13. Note that $\int RTq(s)ds$ is on the order of .05 -- that is, substantially less than 1.0.

14. There are many things creditors would have to guard against. For example, shareholders can protect themselves against possible assessment by setting up a thinly capitalized, intermediate corporation to hold the firm's shares.

15. Renegotiation may lead to an arrangement in which creditors accept less than the face amount of their securities in exchange for the owner's commitment to put up funds for further investment. The arrangement may call for either party to buy out the other, or for a third party to buy out the first two.

16. The firm may even "demand" renegotiation when $V(s) > I + P$. After all, they can always claim that $V(s) < I + P$. Without monitoring creditors cannot know which is the truth.

    This may be one reason why conditions of financial distress often are resolved by a third party buying out all security holders -- via a merger, for example. Of course this simplifies capital structure and removes many of the conflicts of interest that would otherwise lead to good opportunities being passed up. But the possibility of a third party offer also assists debtor-creditor negotiations, since debtors are less tempted to downplay the firm's investment prospects.

17. Remember that the market value of the firm is reduced by the present value of these costs. Moreover, the reduction is an increasing function of the amount of debt the firm carries. Thus, even if this strategy could completely eliminate suboptimal investment decisions -- which I doubt -- the behavior of the value of the firm as a function of financial leverage would be as shown in Figures 2 and 3.

18. There is still another possibility. Creditors could reserve the right to bring in an independent fact-finder and mediator ex post when there are symptoms of financial distress and suspicion that a suboptimal investment policy if being followed. Both creditors and debtors may be better off placing their fate in the hands of an impartial third party than by attempting to negotiate bilaterally.

The major disadvantage of this approach is the difficulty of defining when the mediator is to be called in. The firm would not give its creditors an open option to renegotiate the firm's capital structure at any time they choose, yet there seems no fully objective way of defining the degree of "financial distress" or "suboptimal investment policy" that justifies calling the mediator. The potential advantage of the approach is that creditors may be willing to cut back on routine monitoring if the option of mediation is available. This saves money and makes the firm more valuable than it would be otherwise.

In many cases the bankruptcy process is really a mediation and fact finding service provided by society at large. Sometimes debt contracts are tightly construed, but often creditors' absolute priority over bondholders is sacrificed in the search for a reorganization plan that can be accepted by all parties. This makes sense: Ex post fact-finding and mediation are needed to reduce routine monitoring costs and reduce the conflicts of interest and incentives for deception that inevitably arise in conditions of financial distress. Bankruptcy law provides for these services. But the services have little value if reserved exclusively for terminal cases. Thus the law holds out some hope for debtors as well as creditors.

19. As Figure 3 shows, there is a maximum amount the firm can borrow. The maximum depends on the rate at which firm value declines as financial leverage increases. The decline may be less rapid if monitoring and renegotiation are allowed.

20. See Halis (1976), esp.

21. However, Halis (1976) and Ingersoll (1976) argue that the bias in favor of investing in riskier assets can be offset if the firm has appropriate amounts of warrants or convertible issues outstanding.

22. See above, pp. 16-17.

23. It would not make sense for the firm to forfeit the right to pay dividends in any circumstances -- see paragraph 3 just above. Nor would the firm allow creditors to say when dividends could be paid, since creditors are better off anytime earnings are retained, regardless of whether the firm has valuable investment opportunities.

24. They do not care if the asset is liquidated and the proceeds put in cash or securities. Normally the new assets will provide better security than the original ones.

25. The commitment can be a dividend foregone. See p. above.

26. There may or may not be a cash payment P_t due to bondholders. I assume, however, that any such payment is made after the firm decides whether to exercise its investment option. Any payment made before this decision is a sunk cost.

27. Discussions with Jeffrey Halis were helpful in simplifying the following exposition.

28. I assume that $\delta^2 f/\delta V^2 < 0$. See Merton (1974).

29. The risk of the real asset acquired is taken into account in its net present value. Thus dV_t/dI_t already reflects the effects of a shift in σ_t^2 on firm value.

30. A special case of this result can be derived from Figure 2. Greater uncertainty about the value V(s) corresponds to a steeper slope of V(s) plotted against s. The steeper the slope, the smaller the area of the shaded triangle representing lost present value.

31. Lewellen (197). See also Higgins and Schall (197).

32. Note I am asking whether the present value of the <u>firm</u> increases at $t = 0$ when i and j are combined. $DV_i + DV_j$ will be fully captured by equity if debt with a promised payment $P_i + P_j$ is issued <u>after</u> assets i and j are combined. However, if two separate debt issues are made, promising P_i and P_j and secured by V_i and V_j, respectively, and if i and j are then combined (a surprise to the two creditor groups), then creditors will receive a capital gain or loss.

33. However, examination of Table 1 prompts the suspicion that $DV_i + DV_j$ will be more often negative than positive, particularly if $V_i(s)$ and $V_j(s)$ lack strong positive correlation. Observe that in box 2 $DV_i \geq 0$ is offset by $DV_j \leq 0$. Similarly in box 4 $DV \geq 0$ and $DV_i \leq 0$. But in boxes 3 and 7 the only possibilities are $DV_j \leq 0$ and $DV_i < 0$, respectively. If $V_i(s)$ and $V_j)s)$ are negatively correlated, so that boxes 3 and 7 are likely cases, the present value of $DV_i + DV_j$ will probably be negative. But this is the case in which intuition tugs us to say that "diversification value" ought to be largest.

34. See, in particular, Miller and Modigliani (1966).

35. It is not necessarily true, as Michael Brennan has pointed out. See the discussion in Myers and Turnbull (1976).

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