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Abstract

We relate the value of growth options in the firm's investment opportunity set to the level of debt in the firm's capital structure. Underinvestment costs of debt increase and free cash flow benefits fall with additional growth options. Thus, if debt capacity is defined as the amount of debt the firm optimally adds for an incremental project, then the debt capacity of growth options is negative. This result implies that book leverage should fall with the addition of growth options. Our tests, using a large sample of industrial firms, confirm this prediction.

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JEL Classification Numbers: G31, G32.

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1 Introduction

Over the past decade, the finance profession has made substantial progress in understanding the determinants of corporate leverage choices. Although the theory has become richer, particularly important progress has been made in testing the theory. The mounting evidence suggests that an important determinant of corporate leverage is the composition of the firm's investment opportunity set. In particular, a strong negative empirical relation between growth options and leverage measured with market values (what we call market leverage) has been documented extensively in the literature. For example, Bradley, Jarrell and Kim (1984) and Long and Malitz (1985) show that industries generally associated with high growth opportunities tend to have low market leverage. Long and Malitz (1985), Smith and Watts (1992), Barclay, Smith and Watts (1995), all document a negative relation between market leverage and the market-to-book ratio, a commonly used proxy for growth options. Rajan and Zingales (1995) extend this analysis to show that the relation between market leverage and the market-to-book ratio is negative and significant for firms across seven different countries.

The papers listed above generally focus on the relation between growth options and market leverage because extant theories provide direct implications for this economic measure of leverage. For instance, Myers (1977) suggests that growth options have a lower collateral value and are subject to underinvestment. Jensen (1986) argues that assets in place have higher collateral value and are subject to free cash flow problems. This has led the profession to conclude that "firms should use relatively more debt to finance assets in place and relatively more equity to finance growth opportunities" (Hovakimian, Opler and Titman (2001), p.2). In other words, if debt capacity is defined as the amount of debt financing the firm optimally will add for an incremental project, then the debt capacity of growth options is less than that of assets in place.

To the extent that the above empirical studies address book leverage, it generally is as a robustness check for the market leverage results.[1] Nonetheless, several previous studies document a negative and statistically significant relation between book leverage

[1] For example, Hovakimian, Opler and Titman (2001, p. 5) report that they "separately ran regressions with debt ratios measured entirely with book values, positing that some managers have book value rather than market value targets. The results in our second stage regressions, using these book value targets, were very similar to the results reported below that use market value targets."

and the market-to-book ratio as we predict in this paper. Rajan and Zingales (1995), for example, find that this negative relation holds for each of the seven countries in their study. We also document this relation below.

This paper provides two basic contributions. First, we demonstrate that the debt capacity of growth options not only is less than that of assets in place, but in fact is negative. The logic that produces this conclusion is straightforward. More growth options raise the underinvestment costs of debt while reducing the benefits of debt in terms of controlling the free cash flow problems. Thus, more growth options lowers the firm's optimal use of debt. This places tighter bounds on the firm's optimal capital structure. Specifically, it implies that debt as a fraction of the firm's assets in place should fall with more growth options. Second, we offer an economic interpretation of book leverage. We argue that book leverage should be an instrument for the ratio of debt to the firm's assets in place. Thus, the hypothesis that the debt capacity of growth options is negative implies that the ratio of debt to assets in place should fall with an increase in growth options.

In section 2, we present a simple model that captures the interaction between the corporation's investment opportunity set and its use of debt. We employ this basic model to examine how the value of growth options affects the level of debt in the firm's capital structure. We demonstrate that more growth options increases underinvestment problems while, at the same time, lowers the free cash flow benefits of debt. Thus, the debt capacity of growth options is negative. (In the appendix, we demonstrate that this fundamental intuition from our basic model is robust to a variety of extensions.) In section 3, we employ data from COMPUSTAT to test these restrictions. Consistent with our hypothesis, we find that book leverage falls as the firm's market-to-book ratio increases. We offer our conclusions in section 4.

2 Growth options and book leverage

2.1 Assumptions

This section describes how we amend and simplify the model in Stulz (1990) to examine the impact of growth options on the firm's use of debt. We construct a two-period model and thus focus on three dates. Throughout our analysis, agents are risk neutral and risk-free interest rates are zero. To finance an initial project with cost K at date $t = 0$, a firm acquires external funding from either shareholders or bondholders. This project yields cash flows at $t = 1$ given by X, where X is a random variable with uniform distribution on $[a, b]$, $a \geq 0$.

The cash flow from this initial project may be reinvested at $t = 1$. At that date, the firm has access to investment opportunities which are non-stochastic and thus independent of the cash flows from the initial project.[2] Following Stulz (1990), we assume that the marginal product of investment is decreasing and given by a step function. Specifically, the payoff (realized at $t = 2$) from investment is H ($H > 1$) per unit for the first I^* units and L ($L < 1$) per unit in excess of I^*. As a result, investment up to I^* has a positive NPV whereas investment in excess of I^* has negative NPV. This specification allows us to capture Jensen's idea that overinvestment is more severe for firms that generate large cash flows (for empirical evidence, see Harford (1999)).

Conflicts of interests between managers and shareholders potentially take a variety of different forms. Within our model, we introduce such conflicts by presuming that the manager receives private benefits from investment. These private benefits increase with the projects' NPV and are such that it is always optimal for the manager to invest. Moreover, we assume that investment policy is not contractible for two basic reasons. First, it is difficult to pre-specify the distribution of payoffs for the entire array of projects that might be available to the firm in the future. Second, any commitment by the manager to invest only in positive NPV projects would not be credible since such commitments would depend on the manager's private information.

The agency cost of managerial discretion depends on the allocation of control rights within the firm. In our model, shareholders are represented by a stockholder-elected board of directors that acts in the best interests of shareholders. The board cannot dictate investment policy because those decisions depend on the manager's private information. Thus, the board must delegate decision-making authority with respect to investments. However, the board can replace managers if anticipated overinvestment costs are too high. We presume that if the board replaces the incumbent manager, they have access to two pools of managers. First, conservative managers who can oversee current operations but are ineffective in managing new investments. Second, empire-

[2] The appendix considers the case of correlated shocks to cash flows and investment projects.

building managers who are characterized by the same overinvestment tendency as the incumbent. We also presume that the board cannot distinguish the quality of managers within pool but can distinguish across pools.[3]

2.2 Overinvestment and firm value

Before analyzing debt policy, it is useful to identify explicitly the sources of value within the firm. In this section, we determine the agency cost of free cash flow and firm value when the firm is financed exclusively with equity. We then discuss the impact of debt financing on firm value.

The current value of the firm is the sum of the values of its assets in place and investment opportunities. Because the manager has decision rights over investment policy and investment policy is not contractible, the (time zero) value of the firm's investment opportunity set depends on the investment policy expected to be selected by the manager. In our basic model, the manager always wants to invest. As a result, the value of the firm's investment opportunities depends on the level of the resources expected to be available for investment. Within our framework, raising funds to invest more than I^* would harm existing shareholders because new investors buy securities at their fair market price but investment in excess of I^* has a negative NPV. Hence, the board would not allow the manager to raise outside funds that would permit an investment of more than I^* at $t = 1$. (We discuss below the allocation of control rights with respect to financing policy.) However, the manager may use the cash flows from assets in place to invest in negative NPV projects. Therefore, the expected agency cost

[3] In other words, we presume that the board of directors cannot assess the quality of managers within a pool; in particular the board cannot identify within the second pool managers with a low versus high empire-building tendency. Within our model the private benefits of the manager increase with the project's NPV. This assumption implicitely reflects the fact that managers derive private benefits of control. In this model, investing more today means that more resources will be squandered and, hence, that the manager will have a reduced ability to overinvest next period. As a result, the expected level of overinvestment depends on the manager's intertemporal elasticity of substitution for the consumption of perquisites. In such a framework, assuming that the board cannot assess the quality of managers is similar to assuming that the board cannot assess the managers' intertemporal elasticity of substitution for the consumption of perquisites. Section A.1 of the Appendix extends the basic model to consider the case in which the the board can assess the quality of potential replacement managers.

of free cash flow is

$$(1-L)\int_{I^*}^{b}\frac{X-I^*}{b-a}dX=\frac{(1-L)}{2\,(b-a)}(b-I^*)^2, \tag{1}$$

and the value of the unlevered firm satisfies

$$v=\frac{a+b}{2}+(H-1)\,I^*-\frac{(1-L)}{2\,(b-a)}(b-I^*)^2. \tag{2}$$

If managers automatically selected the investment policy that maximized shareholder value, firm value would equal the expected present value of the cash flows from assets in place ($\frac{a+b}{2}$) plus the NPV of profitable investment projects ($(H-1)\,I^*$). (Or if investment policy were contractible, the board could force managers to invest only in profitable projects.) But within our model, managers have incentives to overinvest and investment decisions are not contractible. As a result, the value of the firm depends on the agency cost of managerial discretion. Equations (1) and (2) thus describe the extent to which overinvestment by the manager reduces firm value.

2.3 Leverage and underinvestment

As Jensen (1986) argues, debt can control the free cash flow problem by limiting the resources under the manager's control, and hence, the amount the manager can invest. Moreover, financing policy is observable and contractible: The board must approve financing decisions. Thus, the board can use its control of financing policy to set leverage. Although within our basic model the only role of debt is to control the manager's ability to overinvest, the debt policy that maximizes firm value does not eliminate overinvestment. Indeed, when the firm issues debt, it induces underinvestment if firm value is low. As a result, the debt level that maximizes the value of equity is the one that best balances the costs of overinvestment versus underinvestment.[4]

[4] The corporate finance literature has modeled at least three types of leverage-related circumstances that lead to a failure to undertake positive NPV projects: Stockholder-bondholder conflicts (Myers (1977)), default (Stulz (1990)), and financing constraints (Fazzari, Hubbard, and Petersen (1988)). Although these mechanisms are not mutually exclusive, we focus in this paper on the second source of underinvestment costs. Adding financing constraints would strenghten the basic result of the paper that the debt capacity of growth options is negative. Also, it is important to recognize that Myers' underinvestment cost relies on the same basic structure as the one modeled in this paper (i.e. debt

We assume that debt issued at date $t = 0$ matures at date $t = 1$. Proceeds from the debt issue may be paid as a dividend at date $t = 0$ or used to finance assets in place. Within our model, debt financing affects firm value in two ways. First, by reducing the resources available for investment at $t = 1$, debt constrains managers from investing in negative NPV projects, thereby controlling the free cash flow problem. Second, by changing the default policy of the firm, debt reduces the likelihood that the firm invests in positive NPV projects, thereby inducing underinvestment.

We denote the values of equity and debt when the firm has issued debt with face value D by $e(D)$ and $d(D)$. We consider a stock-based definition of insolvency wherein the firm defaults on its debt obligations if the expected (present) value of its cash flows is less than the firm's outstanding liabilities. When the firm can raise outside equity to finance positive NPV investments, the present value of the cash flows from the firm's assets and investment projects is $X + I^* (H - 1)$ for $X \leq I^*$. As a result, the firm defaults on its debt obligations whenever $X < D - I^* (H - 1)$.[5] Thus, if absolute priority is enforced upon default and the firm loses its investment opportunities should it become insolvent, the values of equity and debt respectively satisfy

$$e(D) = \int_{D - I^*(H-1)}^{b} \frac{X - D + I^* (H - 1)}{b - a} dX + (L - 1) \int_{D + I^*}^{b} \frac{X - D - I^*}{b - a} dX, \quad (3)$$

and

$$d(D) = \int_{D - I^*(H-1)}^{b} \frac{D}{b - a} dX + \int_{a}^{D - I^*(H-1)} \frac{X}{b - a} dX, \quad (4)$$

where we assume that $a < D - (H - 1) I^*$.

Equation (3) shows that the value of the shareholders' claim equals the cash flow from assets in place in the non-default states plus the NPV of the investment opportunities. This NPV depends on the firm's investment policy. Three cases are possible: (i) underinvestment (for $X \in [a, D - I^* (H - 1))$), (ii) optimal investment (for

induced incentives to default on growth options) and hence we expect the basic result of the paper to hold in that setting as well. Incoporating the cost of underinvestment highlighted by Myers would require a more detailed modeling of the incentives of the manager, an important component of which is established by compensation policy.

[5] When the firm does not have access to financial markets at date $t = 1$, the amount invested in new projects is capped by the cash flows from assets in place and the default condition is defined by a liquidity constraint. Therefore, the underinvestment problem associated with debt financing is more severe and the value of equity is lower.

$X \in [D - I^* (H-1), D + I^*]$), and (iii) overinvestment (for $X \in (D + I^*, b]$). As we show below, the debt level that maximizes firm value optimally trades off the underinvestment cost associated with low values of the firm's operating cash flows against the overinvestment cost associated with high values of the firm's operating cash flows.

2.4 Optimal leverage

The board of directors has control rights over financing policy. Thus, the board can enforce financial policies that maximize shareholder value. When analyzing leverage decisions that maximize equity value (what we call optimal leverage), it is important to draw a clear distinction between the value of equity ex ante (before the debt issuance) and ex post (after debt has been issued). The value of equity ex post is given by the present value of the payoffs accruing to shareholders after the debt has been sold (see equation (3) above). The value of equity ex ante is the sum of the value of equity ex post and the market value of debt at the time it is issued. As a result, although the default policy of the firm typically is selected ex post so as to maximize equity value, optimal leverage is determined ex ante so as to maximize firm value. Therefore, optimal capital structure is defined by

$$D \in \arg\max_{[0,b]} v(D), \tag{5}$$

where firm value, $v(D) = e(D) + d(D)$, is given by

$$v(D) = \frac{a+b}{2} + I^* (H-1) \frac{b + I^* (H-1) - D}{b-a} - (1-L) \frac{(b - I^* - D)^2}{2(b-a)}. \tag{6}$$

Consistent with the above argument, equation (6) demonstrates that although debt controls the free cash flow problem (third term on the right hand side of equation (6)), it also reduces the value of its growth options (second term on the right hand side of equation (6)). These effects of debt financing on the value of the firm's investment opportunity set are represented on Figure 1 which describes the trade-off made by the firm when determining the value-maximizing amount of debt.

[Insert Figure 1 Here]

The higher the selected debt level, the higher the probability that the firm will underinvest $((D - I^* (H-1) - a)/(b-a))$, and the lower the value of the firm's growth options.

On the other hand, the higher the debt level, the lower the probability of overinvestment $([b-(D+I^*)]/(b-a))$ and the lower the cost associated with overinvestment $((L-1)[b-(D+I^*)]/2)$. This trade-off is also reflected in the first-order condition

$$-\frac{I^*(H-1)}{b-a}+(1-L)\frac{(b-I^*-D)}{b-a}=0,$$

from which we get the following proposition.

Proposition 1 *The debt level that maximizes firm value satisfies*

$$D^*=\max\left\{b-I^*\frac{H-L}{1-L},0\right\}. \tag{7}$$

Proposition 1 determines the debt level that maximizes firm value. This debt level is selected within our model for two reasons. First, the board of directors has discretion over financing policy. As a result, the manager would be replaced for failure to select the debt level described by equation (7). Second, this debt level ensures that the value of the firm's investment opportunities is always positive. As a result, shareholders and, hence, the board of directors are better off not replacing the incumbent manager whatever the realized cash flows from assets in place. Indeed, assume that at $t=1$ we have $X=b$ (which yields the highest possible level of overinvestment). In this case, using equation (7), the value of the investment opportunities is given by

$$I^*(H-1)+(L-1)(b-I^*-D^*)=0$$

When $X<b$, there is less overinvestment by the manager and the value of the firm's investment opportunities is positive. Therefore, when this financing policy is implemented, the value of investment opportunities under the incumbent manager is at least as great as its value with a replacement manager and thus, within our model, adopting the optimal financing policy drives the probability of replacement to zero.[6]

Proposition 1 relates the debt level that maximizes shareholder value to the characteristics of the firm's assets in place and investment opportunities. Equation (6) shows

[6] This presumes that the board of directors cannot hire a manager that would produce more value from the firm's investment opportunity set. This presumption relies on the fact that investment policy is not contractible and that the board's ability to assess the quality of outside managers is limited. Also, we assume that the market for corporate control operates costlessly. Section A.1 of the Appendix relaxes these assumptions.

that more growth options in the investment opportunity set (i.e. an increase in I^*) increases underinvestment costs of debt and, at the same time, decreases the expected cost of overinvestment.[7] The underinvestment costs of debt rise, the free cash flow benefits of debt fall; the optimal amount of debt in the firm's capital structure thus falls. In particular, the derivative of the debt level that maximizes firm value with respect to the number of positive NPV projects (i.e. I^*) is

$$\frac{\partial D^*}{\partial I^*} = -\frac{H - L}{1 - L} < 0. \tag{8}$$

The value of the firm's investment opportunities depends not only on the number of positive NPV projects I^* but also on the return to both profitable projects, H, and unprofitable projects, L. Thus we examine next the impact of the return on investment on the use of debt. First, as the return on the good investment projects increases, the underinvestment cost of debt increases. This effect is captured by the derivative of the debt level that maximizes firm value with respect to the profitability of positive NPV projects (H). We have

$$\frac{\partial D^*}{\partial H} = -\frac{I^*}{1 - L} < 0, \tag{9}$$

It thus is optimal for the firm to issue less debt as H increases. Second, as the opportunity cost of investment in excess of I^* decreases (as L increases), the overinvestment cost decreases. This effect is captured by the derivative of the debt level that maximizes firm value with respect to the profitability of investment in excess of I^* (L):

$$\frac{\partial D^*}{\partial L} = -I^* \frac{H - 1}{(1 - L)^2} < 0. \tag{10}$$

It thus is optimal for the firm to issue less debt as L increases.

We then have the following result.

Proposition 2 *The optimal debt level is decreasing in the value of the firm's investment opportunities.*

[7] In fact, the expected cost of underinvestment depends on both the probability of underinvestment and the magnitude of this cost conditional on underinvestment. The latter component of this expected cost increases with additional growth options. The former component decreases with additional growth options. Thus the expected cost of underinvestment exhibits a kink: It first increases and then decreases with additional growth options. Nonetheless, the cost of overinvestment always decreases with additional growth options and the magnitude this effect always dominates the change in underinvestment costs at optimal leverage.

Proposition 2 states that, as firm value rises with the addition of growth option, the amount of debt that maximizes firm value decreases. In other words, the debt capacity of growth options is negative. To facilitate the testing of this proposition, we now examine its implications for book leverage. The logic behind using the market-to-book ratio as a measure of a firm's growth options implies that the book value of assets serves as a proxy for the value of assets in place. Therefore, book leverage is defined by

$$BL = \frac{D^*}{K}. \tag{11}$$

where K is the historical cost of the firm's assets and hence is equal to the book value of the firm's assets.

The market-to-book ratio of the firm at date 0 is

$$M/B = \frac{v\left(D^*\right)}{K}, \tag{12}$$

with (using equations (6) and (7) and after simplifications)

$$v\left(D^*\right) = \frac{a+b}{2} + \left(I^*\right)^2 \frac{2H\left(1-L\right)+H-1}{2\left(b-a\right)\left(1-L\right)}. \tag{13}$$

Using equations (11), (12) and (13), it is possible to analyze the impact of a change in the market-to-book ratio due to a change in the firm's investment opportunities (represented by I^*, H, and L) on the firm's book leverage. This impact is measured by the following derivative

$$\frac{\partial BL}{\partial M/B} = \frac{\partial D^*}{\partial I^*}\frac{\partial I^*}{\partial v\left(D^*\right)} + \frac{\partial D^*}{\partial H}\frac{\partial H}{\partial v\left(D^*\right)} + \frac{\partial D^*}{\partial L}\frac{\partial L}{\partial v\left(D^*\right)}. \tag{14}$$

Because $\frac{\partial v(D^*)}{\partial I^*} > 0$, $\frac{\partial v(D^*)}{\partial H} > 0$ and $\frac{\partial v(D^*)}{\partial L} > 0$, we have with equations (8), (9) and (10):

$$\frac{\partial BL}{\partial M/B} < 0. \tag{15}$$

We then have the following result.

Proposition 3 *Book leverage decreases with the firm's market-to-book ratio.*

Prior studies of the impact of investment opportunities on the firm's use of debt have focused on market leverage – the face value of debt divided by the market value of the firm. Yet, tests employing market leverage have low power with respect to the proposition that the debt capacity of growth options is negative. Indeed, it is difficult to confirm Proposition 2 using this measure of leverage because an increase in growth options increases the market value of the firm (increasing the denominator of market leverage) at the same time that the numerator might be decreasing. However, looking at the face value of debt to assets in place, this identification problem is resolved. Proposition 3 shows that the result that the debt capacity of growth option is negative generates the empirical prediction that the relation between growth options and book leverage is negative. Thus, the restriction implied by Proposition 3 is more limiting than a simple statement that firms with more growth options have lower market leverage. In the appendix, we show that this result is robust by extending our basic model to include: (1) costs associated with control transactions, (2) taxes and direct costs of financial distress, and (3) correlated shocks to cash flows and investment opportunities.

3 Empirical analysis

A number of papers have documented a negative relation between investment opportunities and leverage - measured as the ratio of debt to the market value of the firm's assets.[8] In their survey article, Harris and Raviv (1991) conclude that the existing empirical studies generally agree that leverage increases with fixed assets, nondebt tax shields, and firm size, and decrease with volatility, advertising expenditures, research and development expenditures, bankruptcy probability, profitability and uniqueness of the product. Below, we test the hypothesis that book leverage decreases with growth options. We use several proxies for growth options, including the market-to-book ratio, advertising and R&D expenditures, and the earnings price ratio. When estimating the relation between book leverage and growth options, we also control for the other primary determinants of leverage as summarized by Harris and Raviv.

3.1 Data

To estimate the empirical relation between growth options and leverage, we construct a large sample of firms from the COMPUSTAT database. We restrict our sample to

[8] See Smith and Watts (1992), Rajan and Zingales (1995), Jung, Kim and Stulz (1996), and Hovakimian, Opler and Titman (2001).

U.S. companies with SIC codes between 2000 and 5999 to focus on the U.S. industrial corporate sector. Our data span the years 1950 to 1999 and include slightly more than 109,000 firm-year observations for 9,037 unique firms. Calculating financial ratios across this large number of observations produces extreme outliers. For example, if one measures book leverage as the ratio of total debt to the book value of assets, as expected, more than 99 percent of the observations fall between zero and one. However, the maximum book leverage in the full sample is 1,423. To avoid giving these extreme observations undue influence on the regression results, we truncate our sample by setting the largest and smallest 0.5 percent of the observations to missing for each variable that is a financial ratio. This reduces our basic sample to 104,746 firm-year observations. We discuss the effects of this truncation as we perform robustness checks below. Table 1 provides descriptive statistics for the variables used on our analysis.

[Insert Table 1 Here]

Variable Definitions

Book leverage (BL). We measure book leverage as the ratio of the book value of total debt divided by the book value of assets. Total debt is defined as long-term debt (COMPUSTAT data item 9) plus debt in current liabilities (COMPUSTAT data item 34).[9] The book value of assets is defined as total assets/liabilities and stockholders equity (COMPUSTAT data item 6). In our sample, the average book leverage is 25%.

Growth options (GO). We measure growth options using the firm's market-to-book ratio which we define as the market value of the firm divided by the book value of assets. The market value of the firm is defined as the market value of equity (fiscal-year-end price per share (data item 199) times number of shares outstanding (data item 54)) plus liabilities (data item 181) plus preferred stock (data item 10) minus balance sheet deferred taxes and investment tax credits (data item 35). The book value of assets is defined above (data item 6). The mean market-to-book ratio is 1.59.

When estimating the relation between book leverage and growth opportunities, it is important to control for other factors that have been shown to affect leverage. Thus, we include the following control variables in our regressions.

[9]If the notes to the financial statements indicate that the figure for long-term debt includes the current portion of long-term debt, then we subtract the current portion on long-term debt from debt in current liabilities to avoid double counting.

Regulation. To control for the effects of regulation, we construct a dummy variable that is set equal to one for firms in regulated industries and zero other wise. Regulated industries in our sample include railroads (SIC code 4011) through 1980, trucking (4210 and 4213) through 1980, airlines (4512) through 1978, telecommunications (4812 and 4813) through 1982 and gas and electric utilities (4900 to 4939). Only 7 percent of our observations reflect regulated firms.

Firm size. We measure firm size as the natural log of sales (data item 12) in constant 1996 dollars. Mean log sales is 18.91, which corresponds to sales of $163.12 million.

Profitability. Profitability is measured as operating income before depreciation (data item 13) divided by total assets (data item 6). Average profitability is 11%.

Fixed-asset ratio. The fixed-asset ratio is defined as net property plant and equipment (data item 8) divided by total assets (data item 6). In our sample, the average fixed-asset ratio is 34 percent.

Taxes. We use several variables to proxy for the firm's effective marginal tax rate and non-debt tax shields. First, we construct a dummy variable that is equal to one if the firm has a net operating loss carryforward (data item 52), and zero otherwise. Firms with net operating loss carryforwards are expected to be in a low or zero marginal tax bracket. Second, we construct a dummy variable that is set equal to one for firms with investment tax credits (data item 208), and zero otherwise. Only 8% of our observations report ITCs. Both of these tax variables have been problematic in estimating the effect of taxes on corporate leverage. For example, firms with net operating loss carryforwards tend to be high-leverage firms in financial distress. Thus the coefficient on this variable in leverage regressions tends to have the opposite sign from what is predicted by the tax hypothesis.[10] To determine the sensitivity of our results to these tax proxies, we also

[10] Our regressions attempt to identify the impact of the factors included on the right-hand side (RHS) of the regression on the firm's target leverage. If it is expensive to adjust the firm's capital structure, some deviation from target leverage will be optimal. With respect to most of the RHS variables, the deviations appear symmetric and the regression coefficient identifies variations in target leverage across the population as the RHS variable varies. But in the case of tax loss carryforwards, there appears to be a material selection-bias problem. Firms with tax loss carryforwards frequently are firms financially distressed. Such firms tend to have leverage that is greater than their target leverage. Thus, this raises the possibility that the tax loss carryforwards variable reflects deviations from target leverage rather than variations in target leverage.

estimate our regressions using the simulated marginal tax rates developed in Graham (1996). However, since the simulated tax rates are not available prior to 1980, and the inclusion of these tax rates have little impact on the coefficients of interest in the regressions, we postpone the discussion of these results to the section on sensitivity checks below.

3.2 Regression Results

Our basic regression has the form

$$BL_{i,t} = \alpha_i + \beta_i GO_{i,t} + \gamma_i CV_{i,t} + \varepsilon_{i,t}, \tag{16}$$

in which $CV_{i,t}$ is the vector of control variables. Table 2 reports the regressions of book leverage on the market-to-book ratio and the control variables described above. Because our data has a panel structure (including both time series and cross-sectional observations), we need to account for the correlation structure of the regression errors.

As in Fama and MacBeth (1973) and Fama and French (2000), we first estimate annual cross-sectional regressions. Then we average the slope coefficients of the cross-sectional regressions. The t-statistics are calculated using the time-series standard error of the average slope coefficients. This procedure has the advantage that the time-series standard errors are robust to contemporaneous correlation in the regression residuals across firms. However, the standard errors from this estimation method still are affected by time-series correlation in the regression errors. In addition, although this method fully exploits any cross-sectional variation in the sample, information from the time series is largely ignored.

As an alternative method for dealing with the correlation structure of the residuals, table 2 also reports a fixed-effects regression. In this regression, we subtract the firm-specific time-series mean for each variable from each observation The slope coefficients are then estimated using ordinary least squares and the standard errors are adjusted for the appropriate degrees of freedom. (This technique is equivalent to adding a dummy variable for each firm in the sample.) The fixed-effects regression removes correlation in the residuals that is caused by firm-specific effects. In contrast to the cross-sectional regression, the fixed-effects regression preserves information from the time-series variation in the sample. However, the fixed-effects regression ignores most of the information differences across firms.

[Insert Table 2 Here]

The coefficient on the market-to-book ratio is negative and statistically significant in both the cross-sectional and fixed-effects regressions. In the cross-sectional regression, the coefficient is -0.01 and the t-statistic is -4.99. Thus, even after adjusting the standard error for any time-series correlation in the residuals, this coefficient will remain significant. In the fixed-effects regression, the coefficient is also -0.01, and the t-statistic is -18.05.

Although the magnitude of the coefficient on the market-to-book ratio is relatively small (in comparison, Barclay, Smith and Watts (1995) estimate a coefficient of -0.06 when market leverage is regressed on the market-to-book ratio), it is important to remember the interpretation of this coefficient. Other things equal, when firms add valuable investment opportunities that increase the market value of the firm (but do not increase the value of assets in place), the optimal debt level actually declines. This is consistent with our hypothesis that the debt capacity of growth options is negative.

3.3 Robustness Checks

To test the robustness of our results, we estimate the regressions with the following specifications:

Truncation. As reported above, we truncate the extreme 0.5 percent of the distribution for the financial ratios in our sample. Truncation has a material effect on the coefficients in the regression. In particular, the market-to-book ratio is not statistically significant in regressions with no truncation of extreme outliers. The results generally are not sensitive, however, to the amount of truncation. We estimate our regressions truncating from 0.1 percent to 10 percent of the extreme observations from each tail of the distribution. The qualitative results are not affected by the amount of truncation within this range.[11]

[11] The only paper of which we are aware that reports a positive and significant coefficient when book leverage is regressed on the market-to-book ratio is Fama and French (2000). Fama and French use a different approach than we do to deal with extreme outliers. Because all of the financial ratios in their (and our) regressions are scaled by book assets, Fama and French exclude all firms with book assets less than $2.5 million. Using their sample period (1965 to 1999), their truncation procedure would

Alternative definitions of debt. The COMPUSTAT data implies a broad definition of corporate debt. For example, in addition to bonds and mortgages, long-term debt also includes capitalized lease obligations and other similar long-term fixed claims. To determine whether our results are sensitive to the measure of debt, we reestimate our base regressions using five alternative definitions of debt to calculate the book leverage ratio. These definitions are:

- long-term debt plus debt in current liabilities plus preferred stock minus cash and short-term investments,
- long-term debt plus debt in current liabilities plus preferred stock,
- long-term debt plus debt in current liabilities minus capitalized leases,
- long-term debt plus debt in current liabilities minus capitalized leases minus convertible debt
- long-term debt plus debt in current liabilities minus capitalized leases minus convertible debt minus short-term debt (debt in current liabilities).

To make the regression comparable, we use data from 1969 to 1999 because data are not available for all of the required fields before 1969. Using the same control variables as in Table 2, the coefficients for the market-to-book ratio for these five regression range from -0.014 to -0.04 and the t-statistics range from -9.26 to -21.90.

Growth-option proxies. The market-to-book ratio is the most common proxy used to estimate the value of a firm's growth options. However, other proxies also have been employed. We estimate our regressions using R&D to sales, R&D plus advertising to sales, and the earnings price ratio as alternate growth-option proxies. The R&D to sales

reduce our sample size by slightly less than 3 percent (from 101,120 firm-year observations to 98,425 observations) which is more than the 1 percent of the observations that we drop. Their procedure, however, does not eliminate the problem with outliers. For example, if we use their sample period and truncation procedure, the maximum market-to-book ratio in our sample would be 303, which is well over one hundred standard deviations from the mean. When we replicate the Fama-French regressions, we find that the sign of the coefficient on the market-to-book ratio flips from positive to negative when we truncate these extreme outliers.

and R&D plus advertising to sales generate the same qualitative results as the market-to-book ratio. The earnings price ratio also produces consistent results if we restrict the sample to firms with positive earnings-price ratios.

Tax proxies. The tax proxies in our base case regression, are crude at best. Graham (1996) provides a more sophisticated proxy for the firms expected marginal tax rate. If we replace the investment-tax-credit dummy variable with Graham's expected marginal tax rate, the coefficient and t-statistic for the market-to-book ratio are largely unaffected.

Time periods. COMPUSTAT greatly expanded their coverage in 1965. Thus, the years 1950 to 1964 have relatively few observations per year. When we estimate our regression using only data from 1965 to 1999, both the coefficient and the t-statistics for the market-to-book ratio increase. In fact, if we restrict the sample to a more recent time period, such as 1980 to 1999, the coefficient and t-statistic for the market-to-book ratio are even larger.

4 Conclusions

This paper makes two fundamental contributions to our understanding of optimal capital structure. First, we point out that the debt capacity of growth options is negative – where by the debt capacity of an asset we mean the optimal (or value maximizing) increment to the level of debt associated with the ownership of that asset. Previously, others have argued that the debt capacity of growth options is lower than the debt capacity of assets in place. This argument generated the empirical prediction (generally confirmed by the data) that market-value leverage ratios should be lower for firms with more growth options than for firms with more assets in place. It generally has been presumed, however, that although the debt capacity of growth options may be small, it is positive. We show that this is not the case. If the market value of a firm increases through the addition of growth options, we show that the value maximizing level of debt declines, other things being equal.

Second, we offer a clear economic interpretation of book leverage and make clear economic predictions about the relation between growth options and leveraged measured with book values. The logic behind using the market-to-book ratio as a measure of a firm's growth options implies that the book value of assets serves as a proxy for the value of assets in place. Thus, while the market-value leverage ratio measures the ratio of debt to the total market value of the firm, the book-value leverage ratio measures the ratio of debt to the value of assets in place.

A weaker prediction that the debt capacity of growth options is lower than the debt capacity of assets in place is sufficient to generate a negative relation between growth options and leverage measured with market values. If the debt capacity of growth options is small but positive, however, then one should expect a positive relation between growth options and leverage measured with book values. Since growth options increase the market value of the firm, but not its book value, a positive debt capacity of growth options would increase book leverage ratios. Our prediction that the debt capacity of growth options is negative, however, generates the stronger empirical prediction that the relation between growth options and book leverage ratios should be negative.

A Appendix

This appendix investigates the robustness of the results derived in section 2. Because it is clear from the analysis in section 2 that increasing the profitability of investment opportunities decreases optimal leverage, we focus in this section on the impact of the number of growth options on the firm's use of debt.

A.1 Costly control transactions

Proposition 1 characterizes the debt level that maximizes firm value. This capital structure would be selected by the manager if there were a perfectly functioning market for corporate control – one that operated costlessly. But if control challenges are costly, the manager has some discretion over policy choices and, thus, the firm's capital structure reflects both the manager's preferences as well as the costs imposed by control transactions. We now analyze leverage decisions when control transactions are costly. Throughout the section, we presume that the incumbent manager has specific human capital in administering the firm's assets. We also assume that this specific human capital is associated only with the initial manager. Thus, if the incumbent is dismissed, the optimal successor is chosen to manage the firm thereafter (i.e. we assume for simplicity that overinvestment costs are zero for this alternative manager).

Given an investment opportunity, the incumbent manager always wants to invest since he derives perquisites from investment. If completely entrenched, the manager would minimize the likelihood of a constraint by choosing $D = 0$. However, policies that imply a greater likelihood of a reduction in firm value expose the manager to a higher probability of a takeover. Thus, potential control challenges give the manager an incentive to incorporate the impact of the firm's financing policy on firm value and prompt the manager to use debt as a credible promise that resources will not be squandered (see also Zwiebel (1996) and Morellec (2000)).

In order to examine the impact of the market for corporate control on the policy choices of the manager, we have to determine the value implications of a successful control transaction. In our framework the gains associated with a successful control challenge are determined by the improvement in the target's investment policy due to the replacement of the incumbent manager. The potential costs of a control transaction are determined by (i) the ability of the next best management team to generate profits from the firm's assets in place and (ii) out-of-pocket costs, which we label C.

If the manager is able to commit credibly to policy choices that promise owners more value than their next best alternative, control challenges effectively are precluded. After a successful control transaction, the value of the firm can be expressed as

$$v_{(\delta)}\left(0\right)=\delta\frac{b+a}{2}+I^{*}\left(H-1\right), \tag{A.1}$$

where $1-\delta\geq 0$ represents the value added by the incumbent manager to assets in place. (In equation (A.1) the firm is financed exclusively with equity in case of a successful control challenge because within our basic model, issuing debt would induce underinvestment in some states of the world but, given our assumptions, would provide no offsetting benefits.) Therefore, control challenges can be precluded if

$$v\left(D^{*}\right)+C\geq v_{(\delta)}\left(0\right). \tag{A.2}$$

or

$$\left(1-\delta\right)\frac{a+b}{2}+C\geq I^{*}\left(H-1\right)\frac{D^{*}-a-I^{*}\left(H-1\right)}{b-a}+\left(1-L\right)\frac{\left(b-I^{*}-D^{*}\right)^{2}}{2\left(b-a\right)}. \tag{A.3}$$

From this expression, we see that when (A.2) is satisfied strictly, the difference between the debt level selected by the manager, D, and the debt level that would be chosen if the stockholders chose leverage, D^{*}, is increasing in the number of growth options. Thus, book leverage decreases as firm value increases with the addition of growth options when the manager has decision rights over financing policy and control challenges are costly.

A.2 Stochastic investment opportunities, taxes and costs of financial distress

In this section, we incorporate in the previous setting both a tax advantage of debt and costs of financial distress. Moreover, we consider that both cash flows from assets in place as well as the number of growth options, I^{*}, are random. Specifically, we assume that (i) the firm's operating cash flows are taxed at a constant rate, τ,[12] (ii) proportional

[12] We consider for simplicity that the tax shield of debt applies to the total payments made to bondholders. This assumption captures in a one-period model the features of the debt tax shield for an infinite-horizon company.

costs of financial distress α_X (for assets in place) and α_I (for growth options) are incurred upon default, and (iii) the number of positive NPV projects at $t = 1$ is given by

$$I^* = \rho X + \overline{I}, \tag{A.4}$$

where $\overline{I} \geq -\rho a$ and $\rho \in [-1, 1]$. This specification implies that the value of assets in place and the number of growth options available to the firm are correlated (presumably positively). Moreover, it ensures that the number of growth options in the firm's investment opportunity set is positive (i.e. $I^* \geq 0$).[13]

Within this setting, firm value satisfies

$$\begin{aligned} v(D) &= (1-\tau)\left[\int_a^b \frac{X + I^*(H-1)}{b-a}dX - \int_a^{\frac{D-\overline{I}(H-1)}{(1+\rho(H-1))}} \frac{\alpha_X X + \alpha_I I^*(H-1)}{b-a}dX\right] \quad \text{(A.5)} \\ &+\tau\left(D\int_D^b \frac{1}{b-a}dX + \int_0^D \frac{X}{b-a}dX\right) + (1-\tau)(L-1)\int_{\frac{D+\overline{I}}{1-\rho}}^b \frac{X-D-I^*}{b-a}dX \end{aligned}$$

Solving this equation and taking its derivative with respect to debt gives

$$\begin{aligned} \frac{\partial v(D)}{\partial D} &= \tau\frac{b-D}{b-a} + (1-\tau)(1-L)\frac{b(1-\rho)-\overline{I}-D}{(b-a)(1-\rho)} \quad \text{(A.6)} \\ &-\alpha_X(1-\tau)\frac{D-\overline{I}(H-1)}{(b-a)(1+\rho(H-1))^2} - \alpha_I(1-\tau)\frac{(\overline{I}-\rho D)(H-1)}{(b-a)(1+\rho(H-1))^2} \end{aligned}$$

From this equation, we can see that an increase in the firm's debt level has several effects on firm value. First, the tax shield provided by debt is more important (first term of the RHS). Second, overinvestment is less severe (second term). Third, direct costs of financial distress and underinvestment costs of debt increase (third and fourth terms).

The optimal debt level D^* solves

$$\left.\frac{\partial v(D)}{\partial D}\right|_{D=D^*} = 0. \tag{A.7}$$

[13] To analyze the impact of the correlation coefficient ρ on debt policy for firms having the same unconditional number of growth options $E(I^*)$, we could also presume that

$$\overline{I} = E(I^*) - \rho E(X).$$

However, this assumption would not affect the sign of the relation between book leverage and the number of growth options in the firm's investment opportunity set.

Therefore, the optimal debt level can be expressed as

$$D^* = \frac{1-\rho}{\Omega}\left[b\left(1-L+\frac{\tau}{1-\tau}\right)-\overline{I}\left(\frac{1-L}{1-\rho}+(\alpha_I-\alpha_X)\frac{(H-1)}{(1+\rho(H-1))^2}\right)\right], \quad \text{(A.8)}$$

where

$$\Omega = 1-L+\frac{\tau(1-\rho)}{1-\tau}+(1-\rho)\frac{\alpha_X+\alpha_I\rho(H-1)}{(1+\rho(H-1))^2}. \quad \text{(A.9)}$$

The number of growth options available to the firm is represented by $\overline{I}$. The derivative of the optimal debt level with respect to the number of growth options satisfies

$$\frac{\partial D^*}{\partial \overline{I}} = -\frac{1}{\Omega}\left[1-L+(\alpha_I-\alpha_X)\frac{(1-\rho)(H-1)}{(1+\rho(H-1))^2}\right]. \quad \text{(A.10)}$$

This yields the following result.

Proposition 4 *The optimal debt level is decreasing in the number of positive NPV projects available to the firm whenever*

$$\frac{1}{\Omega}\left[1-L+(\alpha_I-\alpha_X)\frac{(1-\rho)(H-1)}{(1+\rho(H-1))^2}\right] \geq 0, \quad \text{(A.11)}$$

where Ω is defined in equation (A.9). When the correlation coefficient between the cash flows from assets in place and the firm's investment opportunity set is positive ($\rho \geq 0$), debt reduces with additional growth options if

$$(1-\rho)\alpha_X \leq \frac{(1-L)(1+\rho(H-1))^2}{H-1}+(1-\rho)\alpha_I. \quad \text{(A.12)}$$

The higher the correlation between investment projects and cash flows from assets in place, the greater the likelihood that this inequality is satisfied.

Several factors are important in determining the impact of growth options on the debt level that maximizes firm value. First, as the number of growth options increases, overinvestment costs fall but underinvestment costs of debt rise. Second, if the firm has more growth options, it defaults less often, reducing expected bankruptcy costs and increasing the tax advantage of debt. It is important to recognize that, because of the intangible nature of growth options, the costs of financial distress associated with investment opportunities (α_I) typically are larger than those associated with assets in place (α_X). Moreover, the correlation coefficient between the cash flows from assets in place and the firm's investment opportunity set (ρ) typically is positive. In this case, our model predicts that the firm's use of debt decreases with the number growth options.

When the correlation coefficient between the cash flows from assets in place and the number of growth options is negative, the term Ω in the denominator of equation (A.11) potentially is negative. In this case, the debt level that maximizes firm value would increase with the number of growth options. Figure 2 represents the factor Ω as a function of ρ and H. Input parameter values are set as follows: $\tau = 0.2$, $\alpha_X = 0.2$, $\alpha_I = 0.5$, $L = 0.9$, $\rho \in [-1, 0]$ and $H \in [1, 2]$.

[Insert Figure 2 Here]

Figure 2 shows that for Ω to be negative (and, hence, for the optimal debt level to be increasing with the number of growth options), the correlation coefficient ρ has to be extremely negative while, at the same time, the average profitability of growth options $H - 1$ has to be quite high. For example when $\rho = -0.6$, the average profitability of the firm's growth options ($H - 1$) must be larger than 90% for debt to be decreasing in the number of growth options available to the firm. Furthermore, this result is sensitive to the magnitude of the loss incurred on growth options upon default (α_I). The lower this loss, the more extreme these parameter values must be. For example, when $\alpha_I = 0.3$ and $\rho = -0.6$, the average profitability of the firm's growth options must be larger than 123% for debt to decrease with the number of growth options. These simulation results suggest that, even in cases where the correlation coefficient between the cash flows from assets in place and the number of growth options is negative, the optimal debt level still falls with additional growth options across a wide range of input parameter values.

References

[1] Barclay, M., C. Smith, and R. Watts, 1995, "The Determinants of Corporate Leverage and Dividend Policies", *Journal of Applied Corporate Finance* 7, 4-19.

[2] Bradley, M., G. Jarell, and E. H. Kim, 1984, "On the Existence of an Optimal Capital Structure: Theory and Evidence", *Journal of Finance* 39, 857-878.

[3] Fama, E., and K. French, 2000, "Testing Tradeoff and Pecking Order Predictions About Dividends and Debt", Working Paper, University of Chicago.

[4] Fama, E., and J. MacBeth, 1973, "Risk, Return and Equilibrium: Empirical Tests", *Journal of Political Economy* 71, 607-636.

[5] Fazzari, S., R. Hubbard, and B. Petersen, 1988, "Financing Constraints and Corporate Investment", *Brooking Papers on Economic Activity* 88, 141-195.

[6] Graham, J., 1996, "Debt and the Marginal Tax Rate", *Journal of Financial Economics* 41, 41-73.

[7] Harford, J., 1999, "Corporate Cash Reserves and Acquisitions", *Journal of Finance* 54, 1969-1997.

[8] Harris, M. and A. Raviv, 1991, "The Theory of Capital Structure", *Journal of Finance* 46, 297-355.

[9] Hovakimian, A., T. Opler, and S. Titman, 2001, "The Debt-Equity Choice", *Journal of Financial and Quantitative Analysis* 36, 1-24

[10] Jensen, M., 1986, "Agency Costs of Free Cash Flow, Corporate Finance and Takeovers", *American Economic Review* 76, 323-329.

[11] Jung, K., Y. Kim, and R. Stulz, 1996, "Timing, Investment Opportunities, Managerial Discretion, and the Security Issue Decision", *Journal of Financial Economics* 42, 159-185.

[12] Long, M., and I. Malitz, 1985, "The Investment-Financing Nexus: Some Empirical Evidence", *Midland Finance Journal*, 53-59.

[13] Morellec, E., 2000, "Managerial Discretion, Leverage and Firm Value", Working Paper, University of Rochester.

[14] Myers, S., 1977, "Determinants of Corporate Borrowing", *Journal of Financial Economics* 5, 147-175.

[15] Rajan, R., and L. Zingales, 1995, "What Do We Know About Capital Structure? Some Evidence from International Data", *Journal of Finance* 50, 1421-1467.

[16] Smith, C., and R. Watts, 1992, "The Investment Opportunity Set, and Corporate Financing, Dividend, and Compensation Policies", *Journal of Financial Economics* 32, 262-292.

[17] Stulz, R., 1990, "Managerial Discretion and Optimal Financial Policies", *Journal of Financial Economics* 26, 3-27.

[18] Zwiebel, J., 1996, "Dynamic Capital Structure under Managerial Entrenchment", *American Economic Review* 86, 1197-1215.

Figure 1
Agency costs and debt financing

The value of the shareholders' claim equals the cash flow from assets in place in the non-default states plus the NPV of the investment opportunities. This NPV depends on the firm's investment policy. Three cases are possible: (i) underinvestment (for $X \in [a, D - I^* (H-1)))$, (ii) optimal investment (for $X \in [D - I^* (H-1), D + I^*])$, and (iii) overinvestment (for $X \in (D + I^*, b])$.

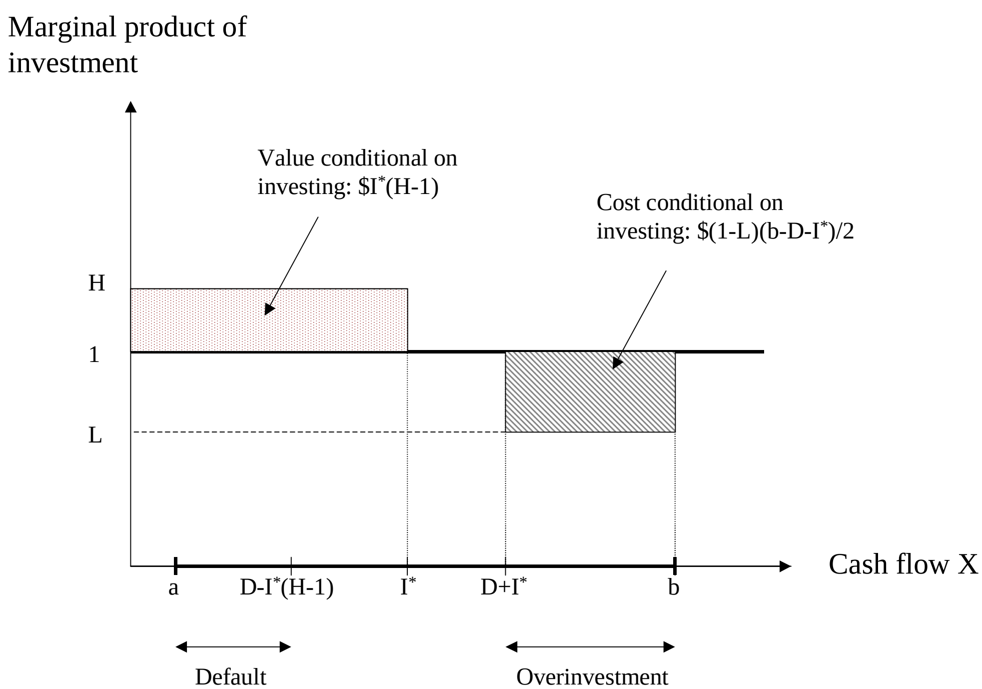

Figure 2

When the correlation coefficient between the cash flows from assets in place and the number of growth options is negative, the term Ω in the denominator of equation (A.11) potentially is negative. In this case, the debt level that maximizes firm value would increase with the number of growth options. Figure 1 represents the factor Ω as a function of ρ and H. Input parameter values are set as follows: $\tau = 0.2$, $\alpha_X = 0.2$, $\alpha_I = 0.5$, $L = 0.9$, $\rho \in [-1, 0]$ and $H \in [1, 2]$.

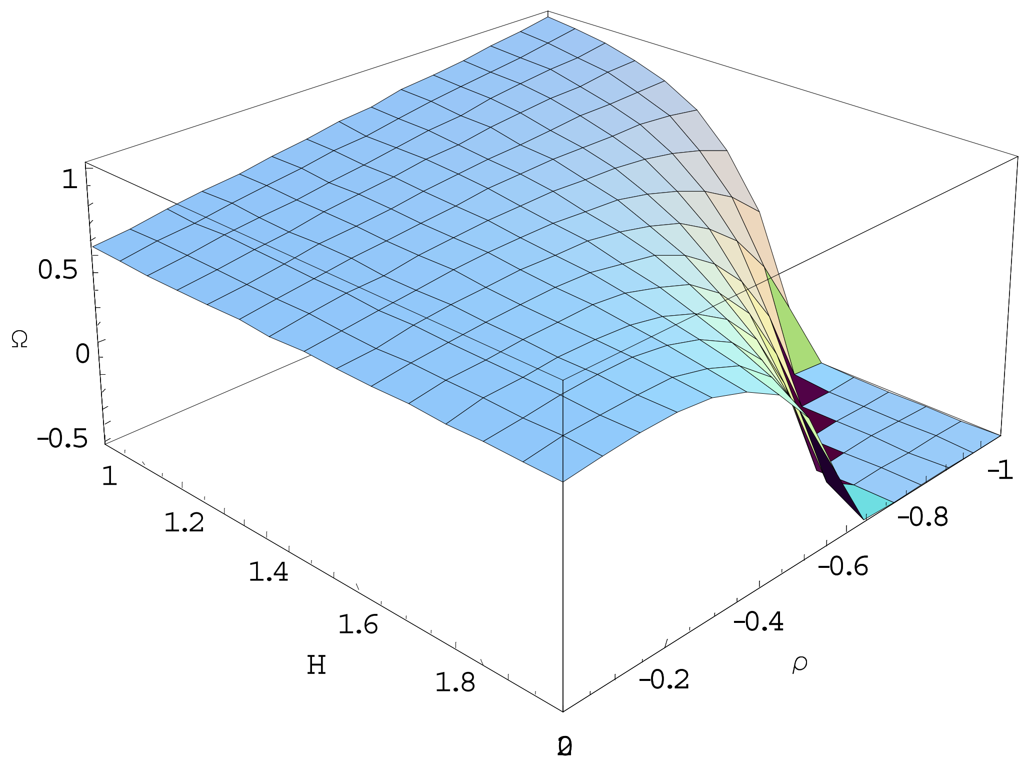

Table 1
Summary statistics

Summary statistics for book leverage and variables commonly used to explain leverage. Sample: All firms on COMPUSTAT between 1950 and 1999 with SIC codes from 2000 to 5999 (104,746 firm-year observations)

Variable	Mean	Standard Deviation	25th Percentile	Median	75th Percentile
Book leverage	0.25	0.19	0.10	0.23	0.37
Market-to-book ratio	1.59	1.24	0.94	1.20	1.74
Regulation dummy	0.07	0.25	0.00	0.00	0.00
Log of real sales	18.91	2.09	17.62	18.94	20.26
ITC dummy	0.08	0.26	0.00	0.00	0.00
Fixed asset ratio	0.34	0.22	0.17	0.29	0.46
Profitability	0.11	0.17	0.08	0.13	0.19
Net-operating-loss dummy	0.20	0.40	0.00	0.00	0.00

Table 2
Regressions estimating the determinants of book leverage

Book leverage (total debt divided by the book value of assets) is regressed on the firm's market-to-book ratio, a dummy variable for regulated firms, the log of real sales, a dummy variable for firms with investment tax credits, the firm's fixed-asset ratio, the firm's profitability (return on assets), and a dummy variable for firms with net-operating-loss carryforwards. The table reports estimates from cross-sectional regressions with Fama-MacBeth standard errors and from fixed-effects regressions. t-statistics are in parentheses. Sample: All firms on COMPUSTAT between 1950 and 1999 with SIC codes between 2000 and 5999 (104,746 firm-year observations).

Dependent Variable	(1) Cross-Sectional Regression	(2) Fixed-Effects Regression
Intercept	0.17 (8.71)	NA
Market-to-book ratio	-0.01 (-4.99)	-0.01 (-18.05)
Regulation dummy	0.10 (9.83)	0.08 (14.57)
Log of real sales	0.00 (4.34)	0.02 (47.06)
ITC dummy	-0.02 (-6.06)	0.00 (-3.34)
Fixed asset ratio	0.17 (15.41)	0.25 (57.14)
Profitability	-0.46 (-11.84)	-0.24 (-67.65)
Net-operating-loss dummy	0.07 (12.46)	0.05 (44.71)