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REAL DETERMINANTS OF CORPORATE LEVERAGE

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Abstract

The U.S. corporate tax distorts the behavior of both real and financial decisions. With respect to the former, the variation in depreciation allowances and investment tax credit provisions across types of investments leads to widely varying effective tax rates, especially since 1981. Financial policy is distorted by the differential treatment of debt and equity. The purpose of this paper is to examine, using firm-level panel data, the relationship between real and financial decisions by corporations, in part to determine the extent to which these biases offset or reinforce each other.

Our results are tentative and suggest that patterns of real and financial behavior are only partially consistent with predictions of various capital structure models (e.g. bankruptcy/agency cost, limited tax shield) and that there is no obvious offset on the financial side to the tax bias against investment in structures.

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I. Introduction

This study presents empirical estimates of the importance of different characteristics of corporations in influencing the propensity of such corporations to finance their investments by borrowing. It also considers the determinants of the type of borrowing firms do, by estimating jointly the determinants of short-term and long-term borrowing. Such analysis is important because there are several competing hypotheses about the determinants of corporate borrowing that are difficult to choose among on the basis of economic theory alone.

Our task is facilitated by a rich data panel based on information on nearly 200 corporations gathered from several sources, including information on the composition of the capital stocks of individual firms. The large number of variables representing firm characteristics facilitates the evaluation of different models of leverage, while the availability of at least 9 years of data on each firm allows us to distinguish between short run and long run determinants of borrowing.

The tax law plays a central role in most models of corporate leverage, and it is recent changes in the tax law that motivate some of the current interest in the question of what determines corporate borrowing. One important issue to which much recent attention has been devoted is the apparently large bias built into the Accelerated Cost Recovery System (ACRS) for depreciable assets introduced by the Economic Recovery Tax Act of 1981. According to most calculations, the combination of the investment tax credit and either three-year or five-year write-off gave investments in business equipment deductions and credits that exceeded in present value the benefits conveyed by immediate expensing. As is well-known, a corporate tax with expensing (and without interest deductibility) is "neutral" in the sense that it does not distort corporate investment decisions. Put another way, the effective corporate marginal tax rate on investment is zero. The presence of tax benefits in excess of expensing therefore implies the existence of a marginal subsidy, i.e. a negative tax rate. Indeed, the ACRS benefits are so generous that the aggregate effective tax rate on equipment investment is now essentially zero, after the introduction in the 1982 tax act of a 50 percent basis adjustment for investment credits received.[1]

Under the current law, structures do not receive this effective tax exemption offered to equipment. Though the tax lifetime for most business structures (15 years) is now much shorter than before, structures typically receive no investment tax credits. As a result, estimates suggest that the effective tax rates on structures now lie below the statutory rate of 46 percent (i.e., depreciation allowances are more generous than economic depreciation) but much closer to this rate than zero.[2] Further, nondepreciable assets, such as land, do not qualify for any investment incentives comparable to accelerated depreciation or the investment tax credit.

This suggests that there exists a potentially serious distortion facing the choice of investment mix by corporations.[3] However, such a conclusion is necessarily valid only if a separation prevails between real and financial corporate decisions. Under some models of debt-equity choice, there may be a tax advantage to the use of debt finance which is dissipated by other costs to the firm as leverage increases. If these costs relate systematically to the firm's investment mix, one would expect debt-equity ratios to differ for this reason. For example, one could imagine a case in which leverage costs are lower for structures, with the additional leverage this would make possible acting to offset the tax disadvantage structures face on the "real" side.

This is an example of the type of issue we seek to resolve in the analysis that follows. We begin, in Section II, with a brief review of the literature on optimal financial structure in the presence of taxation, with particular emphasis on the choice of debt-equity ratio. Section III develops the different variants of the model of corporate borrowing that will be estimated. The model shares with its predecessors the weakness of being an *ad hoc* model, rather than one derived rigorously from a firm's dynamic optimization problem. However, this seems unavoidable in the current context, and the model contains enough flexibility to be compatible with different underlying behavioral hypotheses. Section IV presents a description of the construction of the data set and the definitions of the variables used in the regressions, and Section V presents the regression results.

II. Theories of Corporate Leverage

Most theories of corporate leverage begin with the twin observations that corporate taxation appears to bias the choice of financial policy completely toward debt, and that corporations typically finance perhaps only one quarter of their accumulations of capital by actually issuing debt.[4] The challenge is to explain why the simple Modigliani-Miller (1963) "all debt" result does not hold.

One suggested answer was provided by Miller (1977), who argued that the presence of a progressive personal income tax with favorable treatment of equity income (because of the partial exclusion and deferral advantage associated with capital gains taxation) would lead to an equilibrium with firms facing the same cost of capital for debt and equity. In this equilibrium, the tax advantage to debt would just be offset by a lower before-tax return to equity holders. This model implies that in equilibrium, taxation does not alter the original finding of Modigliani and Miller (1958) that financial policy is irrelevant. Moreover, it offers no reason why financial policy would relate to real investment decisions or other characteristics of firms.

Certain fundamental problems with the Miller result have been pointed out by a number of authors. For example, the implicit tax rate on municipal debt does not appear to be anywhere near the corporate rate suggested by the model.[5] Moreover, the portfolios of individual investors contain both equity and taxable debt, rather than exhibiting the segmentation that Miller's hypothesis would predict. Thus, it seems that certain additions must be made to Miller's model to explain observed behavior.

Several of the models we consider have in common the property of there being certain costs faced by firms that increase with leverage, making interior debt-equity ratios optimal in spite of the presence of a partial <u>tax</u> advantage to debt finance. We consider these models next, discussing their empirically testable implications.

A. Bankruptcy/Agency Cost Models

The most basic explanation for interior debt-equity ratios is costly bankruptcy.[6] It is important to emphasize that the bankruptcy event must not simply be costly to some security holders in the sense of causing a redistribution of resources among different classes. The possibility of such redistributions could be allowed for adequately by an adjustment of the normal coupon rate on debt. For potential bankruptcy to discourage the issuance of debt, there must be costs to the firm as a whole, such as legal fees, court costs, or the loss on disposition of fixed assets (under liquidation). Moreover, these costs must be sufficiently large to be important relative to debt's tax advantage when bankruptcy is a likely outcome. Empirical evidence tends to refute this,[7] if we take the observed frequency of bankruptcy as a rough probability measure.

In models of imperfect information, or dynamic models in which financial and investment decisions occur at different times, additional costs associated with bankruptcy can arise because of the inability of bondholders to constrain the behavior of corporate managers. In a static model, it may be difficult for creditors to monitor the behavior of firms (Ross, 1977). In dynamic models, managers may have the incentive to choose socially inefficient investment plans, because they do not internalize the effects of such plans on the value of outstanding long term debt (Jensen and Meckling, 1976). For example, firms with high levels of outstanding long-term debt can choose to undertake very risky projects that increase the probability of bankruptcy. Under limited corporate liability, this transfers resources from debt-holders to equity holders, and may do so to a sufficient extent that risky projects with low total payoffs will dominate (from the equity-holders' viewpoint) safer projects with higher total present value. The ineffficency induced by this moral hazard is a social cost that, presumably, must be borne by the firm and its owners ex ante in the form of higher coupon payments to holders of long-term debt. It would clearly be in the stockholders' interest to constrain the firm's behavior in order to avoid such costs. While mechanisms to achieve this do exist (e.g., bond covenants restricting future borrowing), it would be costly if not impossible to use them to replicate the desired outcome.

If such costs to leverage remain, it may be possible to identify differences across firms in the level of such costs. For example, Myers (1977) suggests that the moral hazard problem is more acute for firms whose value derives from the anticipated rents from future investment opportunities rather than from existing assets or assets which the firm is committed to purchase. Presumably, there would also be less of a problem for firms with a narrow range of investment opportunities from which to choose. A second determinant of the level of agency costs should be the firm's bankruptcy risk, holding debt level constant. One can model this using an option-pricing framework by assuming that bankruptcy will occur if the value of the firm as a whole drops below the level of claims against the firm. The cost of such a "bankruptcy option" depends, following the standard option-pricing results (Black and Scholes, 1973; Merton, 1973) on the firm's value as well as the variance of its value over time.

Myers also suggests that the agency problem may give rise to maturity-matching of financial claims and real assets, although he also points out that the problem could be alleviated if firms engaged only in short-term borrowing, since debt would always be fully redeemed before the making of decisions about future projects. One could imagine the occurrence of either of these practices, but it is more difficult to derive a model that produces them. One purpose of our empirical analysis is to determine whether such behavior can actually be detected in practice.

B. Limited Tax Shield Models

The U.S. corporate income tax treats gains and losses asymmetrically. Losses may be carried back up to three years to obtain a refund of past taxes, but the excess of any remaining losses must be carried forward, without interest, and subject to expiration after fifteen years (seven years during this paper's sample period). Firms without taxable income need not be in financial distress or on the verge of bankruptcy. However, the prospect of not being able to use the future tax deductions provided by interest payments makes debt less attractive, and may cause firms to limit their leverage. This is the essence of the explanation offered by De Angelo and Masulis (1980). It is attractive as an explanation of debt policy because, unlike bankruptcy or agency costs, tax costs are easily measured.

The hypothesis also has a number of testable implications. First, firms with substantial loss carryforwards should, *ceteris paribus*, choose to issue less debt. Second, firms investing in assets with a greater fraction of their total after-tax returns generated by investment tax credits and depreciation deductions should also use less debt finance. This is seen most simply if we imagine a project which costs one dollar and lasts for one period, yielding a gross return f subject to taxation at rate τ, after a depreciation deduction equal to a fraction d of gross rents. If r is the required after-tax rate of return required by the firm (in addition to the return of the initial one dollar investment), then the after-tax return satisfies:

$$(1) \qquad (1-\tau)f + \tau df = (1+r)$$

This implies that the firm's taxable income is:

$$(2) \qquad f(1-d) = \frac{(1+r)(1-d)}{(1-\tau) + \tau d}$$

which decreases with d. This result carries over directly to a multiperiod model if capital decays geometrically and depreciation deductions exceed actual depreciation by a given fraction of income, say α. In this case, taxable income as a fraction of capital is a function only of α and not the asset's depreciation characteristics.[8] More realistically, effective tax rates on assets differ not through variations in α but through differences in the timing of depreciation deductions and qualification for investment tax credits. Thus, the magnitude of a firm's taxable income will depend not only on the effective tax rate on the assets it owns but also on their age structure. For example, a unit of equipment under the original 1981 version of ACRS would receive tax benefits in the first year of service sufficient to shelter income equal to 37 percent of the asset's purchase price.[9] On the other hand, this same asset would receive no deductions at all after five years. Because acceleration of this sort (though not as extreme) has been present for many years, the fraction of a firm's income sheltered by deductions and credits will generally increase with the rate at which the firm accumulates capital, given the firm's capital stock composition.

A final implication of this model of leverage determination is that the firm's riskiness, this time as measured by the fluctuations of earnings before interest but after taxes[10] should also discourage borrowing because the asymmetric tax treatment of gains and losses will lower the expected tax savings from any given level of debt.

C. Tax Clientele Models

If the Miller equilibrium holds, each firm will be completely indifferent in its choice of debt-equity ratio. The foregoing models suggest that asymmetries in the legal treatment of gains and losses, either through limited corporate liability under bankruptcy or the lack of a loss offset in the tax law, may cause the Miller result to break down. An additional reason why this may happen concerns the issue of whether investors can obtain the same patterns of returns holding either only debt or only equity. If they cannot, then a firm's financial policy will generally matter, and will affect the welfare of different individuals differently (Auerbach and King, 1983). In this case, the choice of financial policy by a firm acting "in the interests of its shareholders" depends on who these shareholders are. Tax clienteles may develop for different firms, with investors in higher personal tax brackets having a greater relative preference for the firms they own to finance through retentions rather than borrowing (Auerbach, 1984). Put another way, such investors would prefer to borrow on their own account, rather than have firms do it for them, if their personal tax rate is sufficiently high. Since most equity finance comes through retained earnings, this suggests that a corporation facing increasing costs to leverage will use less debt finance, the higher is the tax rate of its clientele.

D. Summary

There are several empirical implications of the foregoing models about overall debt-equity ratios. Risky firms should borrow less, whether risk is measured by fluctuations in valuation or in earnings. Fast growing firms should borrow less, because of their higher ratio of growth opportunities to existing capital, and because of their greater tax shield from depreciation deductions and investment tax credits. Firms investing in assets receiving generous tax treatment, such as equipment, generally, relative to structures and land, should use less debt for the same reason. Firms with high-tax clienteles should use less debt than others.

We have more limited predictions about the maturity structure of debt that firms will choose. If firms engage in maturity matching, we would expect to see a smaller fraction of long-term debt used to finance equipment, which typically depreciates more rapidly. We might also expect that firms eschewing long-term debt for agency reasons would shift to short-term debt rather than equity finance. Particularly with respect to the question of maturity structure, it is important that the model we estimate has the capacity of separating long-term determinants of leverage from those that may dominate borrowing decisions in the short run.

III. A Model of Corporate Borrowing

Our approach differs from that taken in much of the literature on financial decisions in two major respects. We model the borrowing by individual firms as a continuous process. That is, our model attempts to explain changes in levels of debt rather than discrete new issues. This seems appropriate for firms as large as those in our sample. We also express all variables in real terms, corrected for inflation. The process by which such variables were obtained from book value data is described in the next section. Our model is similar in some respects to that estimated by Taggart (1977) using quarterly aggregate time series data. However, there are several important differences and allowances for the ability to distinguish effects across firms as well as over time. We estimate both a single equation model for all debt and a two-equation model to explain short-term and long-term debt.

The basic model is intended to capture three characterizations of firm borrowing behavior.

(1) a long run target debt-equity ratio based on the factors outlined in Section II;

(2) a lag in adjustment to changes in this desired ratio; and

(3) the short-run importance of cash flow constraints.

To illustrate the interaction of these points, consider a firm with a major tax loss carryforward that wishes to undertake an investment project. This firm may wish to use only retained earnings, but sufficient earnings may not be available, particularly as the loss carryforward probably indicates low cash flow as well as low taxable income. Hence, we might observe this firm borrowing more in the short run than would be predicted by the underlying attractiveness of debt finance. It is important that our model allow such borrowing to be distinguished from borrowing based on longer-term considerations. A simple cross-section regression would not be capable of separating such factors.

We outline first the model of aggregate firm borrowing. The long-run desired debt-assets ratio b^* is taken to be a linear function of several variables. These variables vary over time, over firms, or over both time and firms. We assume that firms borrow to close part of the gap between the current ratio of debt to assets and the desired one,[11] but also are influenced by current cash flow needs. We define this cash flow deficit as the change in the firm's debt-assets ratio that would be required for the firm to finance its new investment out of internal funds and borrowing, while at the same time maintaining dividends at their trend level and avoiding the issuance of new shares. The motivation for this variable is that both new share issues and dividend cuts are activities generally taken to be costly to the firm: the former because of tax considerations, the latter because of the undesirable signal it may convey.[12]

The cashflow deficit variable is constructed by subtracting from the sum of gross investment and trend dividends[13] (uses) the sum of after-tax cash flow (after-tax earnings plus depreciation) and the product of the current debt-assets ratio and gross investment (sources), and dividing the difference by assets. This variable equals zero when investment and trend dividends can be exactly covered by internal funds plus borrowing at the current debt-assets ratio. If it is positive, an increase in the debt-assets ratio will be needed if dividend cuts and new share issues are to be avoided.

This variable differs from the standard "external deficit" variable in its inclusion of trend rather than actual dividends. Moreover, it includes borrowing at the current debt-asset ratio on the sources side because the partial adjustment model is expressed in debt-asset ratios rather than in levels of debt. Formulating the model in this way allows us to distinguish between increases in the level of debt as the firm grows and fluctuations around this trend that result in changes in the incentives to use debt finance.[14]

The basic model, then, is of the form:

$$(3) \qquad \Delta b_{it} = \lambda_0 (b^*_{it} - b_{it-1}) + \gamma_0 f_{it}$$

Where f_{it} is the firm's deficit as just defined, b_{it} is the firm's ratio of debt to assets, (the latter equal to its fixed capital stock plus working capital) and

$$(4) \qquad b^*_{it} = \underset{\sim}{\alpha}_0 \cdot \underset{\sim}{x}_{it}$$

is the firm's long run target debt-assets ratio based on the determinants $\underset{\sim}{x}_{it}$.

The model that distinguishes between the ratio of long-term debt to assets (ℓ) and that of short-term debt to assets (s) has two equations of a form similar to (3):

$$\Delta \ell_{it} = \lambda_1(\ell^*_{it} - \ell_{it-1}) + \phi_1(s^*_{it} - s_{it-1}) + \gamma_1 f_{it} \tag{5a}$$

$$\Delta s_{it} = \lambda_2(\ell^*_{it} - \ell_{it-1}) + \phi_2(s^*_{it} - s_{it-1}) + \gamma_2 f_{it} \tag{5b}$$

where each equation includes not only its own gap between desired and actual levels but that from the other equation. Similarly, we define ℓ^* and s^* by:

$$\ell^*_{it} = \underset{\sim}{\alpha}_1 \cdot \underset{\sim}{x}_{it} \tag{6a}$$

$$s^*_{it} = \underset{\sim}{\alpha}_2 \cdot \underset{\sim}{x}_{it} \tag{6b}$$

Because we make no prior distinction between the variables determining ℓ^* and those determining s^*, the vectors $\underset{\sim}{\alpha}_1$ and α_2 can not be identified using equations (5a) or (5b) alone (unless the cross effects ϕ_1 and λ_2 are zero). However, they are exactly identified by the equations together. Further, since the two equations have the same set of explanatory variables, maximum likelihood estimation of the system is accomplished by performing ordinary least squares on the equations separately.

The vector $\underset{\sim}{x}_{it}$ includes dummy variables for each firm and for each year (save the last). The former are included to account for interfirm differences in the desired ratio of debt to assets, while the latter are intended to pick up year to year differences in the incentive to borrow that are common across firms, as might be caused by macroeconomic fluctuations (e.g., changes in the inflation rate or the term structure). Indeed, an interesting side result of the estimation procedure is the pattern of these dummy variables over time.

Also available are many other measures of firm attributes, but most of these are either constant or change slowly over the sample period, making it impossible to include them in regressions along with the individual firm effects. Only the firm's tax loss carryforward has sufficient year-to-year variance to be included in the initial estimation procedure. The remainder, however, may be used in a second estimation stage to explain the variation in the individual firm constants, in a cross-section regression. The need for this two stage procedure would be obviated if the firm dummies were omitted from the first estimation stage, and the various firm characteristics included in the vector $\underline{x}$ directly. However, such a procedure would introduce a large, firm specific error (equal to the unexplained part of the firm's own fixed effect) that would likely be correlated with other explanatory variables, leading to inconsistent estimation.[15]

IV. Data

The data used in this paper come from three sources. The basic data on firms come from a copy of the Compustat tape covering the years 1958 to 1977. From this tape, we selected those firms for which all observations of a subset of key variables were available. Long-term debt corresponds to the Compustat category of all debt maturing in more than one year. Short-term debt also includes long-term debt maturing within one year. Total assets equals fixed capital, plus inventories, plus other current assets net of non-debt current liabilities. (An alternative approach to the measurement of total assets is to use the total market value of equity plus debt. This is discussed below in Section V.) Balance sheet and income statement data on long-term debt, capital, inventories and earnings were corrected from book value through a series of steps described in detail in Auerbach (1984). We review these steps briefly below.

Long-term debt was converted to market value using assumptions about the initial age structure of such debt in 1958, the maturity of new issues, and the coupon rate on such issues. From this corrected data series, we calculated the change in the market value of outstanding long term debt due to interest fluctuations, adding this plus the inflation gain on net financial liabilities (long-term debt plus short-term debt less financial assets) to book earnings.

Inventories were corrected according to information on the primary method of inventory accounting used by each firm. The inventory valuation adjustment so obtained was subtracted from book earnings to correct for their inclusion of excess inventory profits.

Depreciation was estimated by assuming that book depreciation is correct except for the fact that it is based on initial asset prices. The method used calculates that rate of declining balance (exponential) depreciation, δ, that, when applied to a perpetual inventory calculation for updating capital stocks beginning with the 1958 book value for net fixed capital, yields the stated 1977 book value. (If all assets actually were written off, and did depreciate, at a single rate, this calculation would yield the correct rate.) Using this estimate of δ, we generated a corrected series for capital stocks and depreciation using the perpetual inventory method, starting in 1958. As with debt and inventories, the difference between corrected and book depreciation was subtracted from book earnings. The measure of corrected cash flow entering into the computation of the cash flow deficit f is simply the sum of corrected after-tax profits plus corrected depreciation.

After such corrections, all variables were deflated to be expressed in constant dollars rather than current dollars. Each firm's earnings growth rate was estimated by fitting a quadratic trend over the period 1963-1977 for the firm's corrected earnings, before interest but after taxes, and taking the growth rate along this trend at the sample midpoint, 1970. The variance of firm earnings was approximated by the sample variance around this trend, normalized by the squared trend value in 1970.

A second source of data is the actual 10K reports filed by the individual firms. These reports contain more detailed information than is provided by Compustat. In particular, many firms list separate capital stocks, depreciation and investment for several classes of capital. The most detailed common breakdown is transportation equipment, other equipment, structures and land, with some firms aggregating the first two and last two of these categories. Firms that did not provide uninterrupted data between 1969 and 1977, or that did not follow this general asset classification, were omitted from the sample. For the remainder, disaggregated, corrected capital stocks were created following the perpetual inventory method described above, using 1968 and 1977 net capital stocks and investment and depreciation reported for the intervening years. Such capital stocks were not used directly, but were divided by their annual sum to generate capital stock fractions. These fractions were averaged over time for each firm and used in the second estimation stage as explanatory variables.

Of the 189 firms for which capital stocks by asset category were computed, 149 have separate categories for land and structures, while 40 combine the two into a single category. Forty firms report separate statistics for transportation equipment, while the remaining firms lump all equipment together. The average capital stock depreciation rates derived for each category appear realistic, though there is substantial variance in these rates across firms. The summary statistics for these depreciation rates are reported in Table 1. (It should be remembered that the equipment category includes all equipment for 149 firms, and that the structures category includes land as well for 40 firms.) The category means are quite consistent with estimates of economic depreciation found in the literature.[16]

Table 1
Depreciation Rates

Category	Number Observed	Mean	Variance
Structures	189	.072	.006
Land	149	.025	.010
Equipment	189	.138	.010
Transportation Equipment	40	.225	.010

In the regressions reported in this paper, we omit the firms for which no structures/land breakdown is available, and add together the equipment categories for those firms reporting transportation equipment separately. This leaves us with 143 firms in the final sample.[17]

The final source of data is the CRSP tape, which provided daily return and dividend data. In an earlier paper (Auerbach, 1983), we performed a series of regressions on daily data for each of the firms in our sample, using observations for every tenth trading day between 1963 and 1977 plus all days on which the firm's common stock went ex dividend. The regressions were of the form:

(7) $$g_t = \theta_0 + \theta_1 d_t + \theta_2 m_t + \theta_3 r_t$$

where g_t and d_t are the stock's capital gains per dollar of stock and dividend per dollar, respectively, and m_t and r_t are the rate of change in the Standard and Poor's Index and the Treasury bill rate. This equation derives from a version of the Capital Asset Pricing Model with progressive personal taxes, with θ_2 a measure of the firm's "beta". The term θ_1 ought to be -1 in the absence of taxes. Over the sample of firms for which (7) was estimated, θ_1 has an average of -.787. Under certain assumptions, this divergence may be attributed to the differential taxation of dividends and capital gains, and the variation in θ_1 across firms may be traced to differences in tax clienteles.[18] The estimated values (θ_1+1) are used in the present paper as estimates of the clientele tax rate and beta of each firm. To estimate the variance in value for each firm, we take the variance over this same sample (excluding ex dividend days) of each firm's proportional capital gains, g_t, which yields a normalized measure of the variance of the firm's equity value, and multiply it by the sample ratio of equity to debt plus equity for the firm, yielding an overall volatility measure analogous to the "unlevered" beta.

V. Estimation Results

For convenience, we rewrite the one-equation and two-equation models here:

One equation

$$\Delta b_{it} = \lambda_0 (b^*_{it} - b_{it-1}) + \gamma_0 f_{it}$$

$$b^*_{it} = \underset{\sim}{\alpha}_0 \cdot \underset{\sim}{x}_{it}$$

Two equations

$$\Delta \ell_{it} = \lambda_1 (\ell^*_{it} - \ell_{it-1}) + \phi_1 (s^*_{it} - s_{it-1}) + \gamma_1 f_{it}$$

$$\Delta s_{it} = \lambda_2 (\ell^*_{it} - \ell_{it-1}) + \phi_2 (s^*_{it} - s_{it-1}) + \gamma_2 f_{it}$$

$$\ell^*_{it} = \underset{\sim}{\alpha}_1 \cdot \underset{\sim}{x}_{it} \; ; \; s^*_{it} = \underset{\sim}{\alpha}_2 \cdot \underset{\sim}{x}_{it}$$

The measure of total assets by which we divide measures of debt to form ratios includes corrected book values of both fixed capital and working capital, as described in Section IV. However, one could argue that an alternative, market value-based measure is preferable, one that simply adds up the value of all claims against the firm, including common and preferred stock, long-term debt and short-term debt. The benefit of using the second method is that it may more accurately reflect the value of a firm's than any measure based on book values, even "corrected" ones. For example, a firm with energy-intensive plant and equipment would suffer a loss in value if energy prices rose unexpectedly, because the discounted value of the quasi-rents anticipated to flow from its assets would fall. If measured properly, this would appear as capital stock depreciation, but such a measure is difficult to obtain except indirectly through market valuation. Similarly, a firm with large amounts of income from intangibles (goodwill, patents, monopoly rents, etc.) may have a comprehensive stock of income-generating assets much larger than the measured capital stock. Arguing against the use of the value-based method is the uncertainty about the equilibrium ratio of market value to the correctly measured value of assets. This amounts to a question about the long-run value of Tobin's q. For example, under a Miller-type equilibrium with retained earnings serving as the marginal source of finance, firms would be indifferent in their choice of debt-equity ratio but the value of debt plus equity would increase with leverage (Auerbach, 1979).[19] In addition, it is unclear how much firms react to volatile year-to-year fluctuations in value in determining desired levels of debt.

Since each of these methods of defining assets has arguments in its favor, we estimated regressions for both the book-based (Method I) and market-based (Method II) asset measures. The results for the first estimation stage were relatively similar, so only those for Method I are discussed in the text. These are shown in Table 2. (An analogue to Table 2 for Method II is presented and discussed in the Appendix.)

The attribute vector, $\underset{\sim}{x}$, includes firm dummies, time dummies, and the previous year's tax loss carryforward.[20] The estimates are for the period 1969-1977, for which data on all variables described above were available.

Table 2
Models of Borrowing

Dependent Variable	(2.1) All Borrowing (Δb)	(2.2) Long-Term Borrowing (Δℓ)	(2.3) Short-Term Borrowing (Δs)
Independent Variable			
Lagged Debt (b)	-.274 (.021)	--	--
Lagged Long-Term Debt (ℓ)	--	-.304 (.021)	.040 (.005)
Lagged Short-Term Debt (s)	--	.201 (.108)	-.738 (.026)
Cash Flow Deficit (f)	-.015 (.029)	.005 (.028)	-.012 (.067)
Tax Loss Carryforward ($x10^3$)	-.356 (.139)	-.296 (.136)	-.031 (.032)
Firm Dummies (mean)	.070	.070	.002
Year Dummies			
1969	-.010 (.005)	-.017 (.003)	.004 (.001)
1970	-.027 (.005)	-.031 (.005)	.004 (.001)
1971	-.015 (.005)	-.017 (.005)	.004 (.001)
1972	-.008 (.005)	-.007 (.005)	.001 (.001)
1973	-.009 (.005)	-.009 (.005)	.001 (.001)
1974	-.018 (.005)	-.018 (.005)	-.001 (.001)
1975	-.048 (.005)	-.049 (.005)	.001 (.001)
1976	-.020 (.005)	-.020 (.005)	.001 (.001)
SSR	2.53	2.37	.136
$\bar{R}^2$	.208	.239	.467

Standard errors in parentheses.

The first column of Table 2 shows the estimates for the single equation model, while the second and third present the reduced form estimates for the two equation model. An interesting feature of all three regressions is the relatively large size of the coefficient on the own lagged variable -- the annual adjustment speed. These speeds, 27.4 percent per year for all debt, 30.4 percent for long-term debt, and 73.8 percent for short-term debt are particularly large given that they relate not to levels of debt but ratios of debt to assets. A second point is that the cross effects between long-term and short-term debt are both positive and significant, indicating a substitutability of the two forms of finance. The cash flow deficit is insignificant in all three equations, a somewhat surprising result. It suggests, for example, that a drop in cash flow, holding investment constant, will not affect borrowing independently of other factors. This is rather implausible, and suggests that a more elaborate specification would be useful. The tax loss carryforward is negative in all three regressions, as predicted, and significant in the first two.

From the estimates in Table 2, we can solve for the annual desired debt-asset ratios for any firm. As a representative example, we consider a firm with no cash flow deficit and no tax loss carryforward, and with a firm effect equal to the mean of such effects over firms (shown in Table 2).

The estimated targets b^*, ℓ^* and s^* for debt in each sample year are shown in Table 3.[21] The numbers are reasonable in magnitude, compared to observed aggregate debt-asset ratios. None of the three series shows

Table 3
Estimated Desired Debt-Assets Ratios*

Year	(3.1) All Borrowing (b*)	(3.2) Long-Term Borrowing (ℓ*)	(3.3) Short-Term Borrowing (s*)	(3.4) (ℓ*+s*)
1969	.281	.185	.017	.202
1970	.157	.136	.016	.152
1971	.202	.184	.017	.201
1972	.227	.214	.014	.228
1973	.225	.208	.015	.223
1974	.189	.178	.011	.189
1975	.080	.073	.007	.080
1976	.184	.171	.013	.184
1977	.256	.239	.015	.254

*Calculated for a firm with mean fixed effect and no cash flow deficit or tax loss carryforward.

any noticeable trend over the period, and the estimates tend to move together. An indication that the aggregate equation fits reasonably well relative to the two equation system comes from the fact that the sum of the estimated values of s^* and ℓ^* is generally very close to b^*. The year to year movements reflect those actually observed in the aggregate (see, for example, the statistics in Robert Taggert's paper in this volume), such as the decline in leverage from 1973 to 1975 and increase thereafter to 1977. However, the movements from year to year in Table 3 are larger in magnitude, since they reflect changes in long-run targets rather than actually attained values.

We turn next to the second stage of our estimation, that of explaining differences in the desired debt-assets ratios of different firms using firm characteristics. We perform cross section regressions for long-term debt, short-term debt, and all debt, with the dependent variables in the regression being the estimated structural coefficient of the firm's dummy variable in the expressions for ℓ^*, s^* and b^*, respectively. Because the two methods of defining total assets (corrected book versus value) provide somewhat different results, we present both sets, in Tables 4 and 5, respectively. The explanatory variables in each table, all described above, are "unlevered" variances of firm value and earnings, the firm's "clientele tax rate" estimated from <u>ex</u> dividend day regressions, the estimated rate of depreciation of the firm's capital stock, and variables reflecting the composition of the firm's assets. For the first definition of assets (corrected book value) we include the fraction of fixed capital accounted for by structures, equipment, and land (which sum to one), multiplied by the ratio of fixed capital to total assets. This yields the fraction that each component of fixed capital accounts for of the firm's total assets, fixed and current. The coefficients of these fractions may be interpreted as the optimal debt-assets ratio for the particular type of asset, relative to that for current assets. When the market value-based measure of assets is used, we must adopt some convention for allocating the difference between market value and the value of assets carried over from the first measure. We choose to allocate the entire difference to intangible assets previously unaccounted for, and include in the regression the fraction of the new capital stock measure represented by goodwill (the remaining three fractions, for structures, land and equipment, are scaled up or down accordingly). This fraction has a highly significant and negative coefficient in all three regressions reported in Table 5. The absolute value of the coefficient on goodwill is nearly as large as that of the constant in the aggregate regression, indicating that very little debt is used to finance goodwill, as we have measured it. This may be interpreted in at least two ways. One may take it as an indication that firms finance intangible assets with less debt, in accordance with the theory of agency (at least to the extent that the intangibles indicate more discretion on the part of the firm's managers). On the other hand, this finding may also reflect the possibility that managers base their borrowing decisions on book asset measures (perhaps corrected for inflation) but not on stock market values.

Except for the asset composition variables, the explanatory variables have very similar coefficients in the two tables, although they are not necessarily consistent with the predictions of the various theories discussed in Section II. The clientele tax rate variable is always insignificant, perhaps reflecting on its quality as a tax rate proxy. The growth rate and variance of earnings always have positive coefficients, usually significant. Neither of these results has an obvious explanation. The rate of capital depreciation always exerts a positive effect, which also was not predicted. However, this effect is only significant for short-term borrowing, consistent with the notion of maturity-matching. The variance of value does perform as predicted, but never significantly so. All in all, these results provide rather negative evidence with respect to all of the theories of leverage presented above.

The coefficients of the capital stock fractions differ considerably between Tables 4 and 5, presumably because of the inclusion in the latter table of the goodwill fraction. When the first, corrected-book measure of assets is used, only equipment has a significant coefficient, which is positive. When goodwill is added both to the measure of assets and to the regression as a fraction of the new asset measure, the coefficient of structures becomes significantly negative, and that of land significantly positive. While there is no indication that structures are financed with greater leverage than equipment, the instability of these results is quite disturbing. Given that the allocation of the entire difference between market and corrected book values to goodwill is arbitrary and not necessarily appropriate, it is quite difficult to draw conclusions here.

Table 4
Firm Characteristics and Borrowing

Dependent Variable (Firm Effect)	(4.1) All Borrowing (b*)	(4.2) Long-Term Borrowing (ℓ*)	(4.3) Short-Term Borrowing (s*)
Constant (xA)	.177 (.053)	.186 (.048)	-.007 (.007)
Variance of Value ($x10^{-3}$)	-.117 (.096)	-.119 (.087)	.009 (.012)
Clientele Tax Rate	-.017 (.024)	-.020 (.022)	.022 (.003)
Variance of Earnings	.290 (.131)	.239 (.119)	.044 (.017)
Growth Rate of Earnings	.409 (.175)	.416 (.159)	.012 (.022)
Rate of Capital Depreciation	.243 (.229)	.164 (.207)	.057 (.029)
Fraction Structures	.271 (.303)	.278 (.274)	.012 (.039)
Fraction Land	-.205 (.325)	-.260 (.295)	.027 (.041)
Fraction Equipment	.166 (.061)	.136 (.055)	.024 (.007)
SSR	1.34	1.10	.022
$\bar{R}^2$	.147	.145	.157

Standard errors in parentheses.

Table 5
Firm Characteristics and Borrowing
(Alternative Assets Definition)

Dependent Variable (Firm Effect)	(5.1) All Borrowing (b*)	(5.2) Long-Term Borrowing (ℓ*)	(5.3) Short-Term Borrowing (s*)
Independent Variable			
Constant (xA)	.187 (.040)	.191 (.038)	.002 (.006)
Variance of Value ($x10^{-3}$)	-.080 (.075)	-.086 (.070)	.006 (.011)
Clientele Tax Rate	-.007 (.019)	-.010 (.017)	.003 (.003)
Variance of Earnings	.189 (.116)	.148 (.110)	.037 (.017)
Growth Rate	.640 (.166)	.591 (.156)	.044 (.024)
Rate of Capital Depreciation	.224 (.180)	.175 (.170)	.042 (.026)
Fraction Structures	-.548 (.227)	-.480 (.214)	-.056 (.033)
Fraction Land	.652 (.206)	.563 (.195)	.079 (.030)
Fraction Equipment	.012 (.042)	-.006 (.040)	-.004 (.006)
Fraction Goodwill	-.159 (.033)	-.142 (.032)	-.015 (.005)
SSR	.786	.697	.017
$\bar{R}^2$	.511	.484	.371

Standard errors in parentheses.

VI. Conclusion

Our partial adjustment models of borrowing suggest rapid speeds of adjustment, particularly for short-term debt, and desired ratios of debt, and its long-term and short-term components, to assets during the period 1969-1977 that, while not constant, exhibit no obvious trend. Some firm characteristics are insignificant in explaining cross-sectional differences in leverage, while others appear to contradict the prediction of various theories in their impacts. The effects of firm growth rates on the level of borrowing is inconsistent with the predictions of "agency" models of leverage. The positive effects of earnings variance on borrowing appears to contradict the "tax shield" borrowing model, but the tax loss carryforward has the negative effect that this model would predict.

The results do not indicate that firms borrow more to invest in structures than in equipment but the results here vary substantially according to the measure of assets used. Richer models of firm behavior appear to be required before more definitive conclusions can be reached.

Appendix

This appendix presents in Table 2.A the first-stage estimation results for the alternative definition of firm assets, based on market value rather than corrected book value. The only important difference is in the significant coefficients in all three equations of the cash flow deficit, which had insignificant coefficients in all three equations in Table 2. One suspects that this result is attributable to large short-run fluctuations in value being ignored by firms. For example, a large decline in the value of the firm would increase the cash flow gap, since "normal" debt increases (the current debt to assets ratio multiplied by the change in assets) would be negative. At the same time, the observed change in the debt-assets ratio would be positive, even if there were no change in the level of debt, because of the decline in the value of assets. It is difficult in this model to distinguish between the hypothesis that firms simply ignore changes in value, and the hypothesis that the reduction in desired debt is just offset by the increase in the cash flow deficit. To sort out this problem, one would need a model that disaggregates different sources of the cash flow deficit.

Table 2A

Models of Borrowing: Alternative Assets Definition

Dependent Variable	(2.A1) All Borrowing (Δb)	(2.A2) Long-Term Borrowing (Δℓ)	(2.3A) Short-Term Borrowing (Δs)
Independent Variable			
Lagged Debt (b)	-.441 (.021)	--	--
Lagged Long-Term Debt (ℓ)	--	-.437 (.022)	.032 (.005)
Lagged Short-Term Debt (s)	--	-.171 (.112)	-.794 (.026)
Cash Flow Deficit (f)	.346 (.019)	.318 (.019)	.025 (.004)
Tax Loss Carryforward ($x10^3$)	.051 (.157)	.063 (.153)	.042 (.036)
Firm Dummies (Mean)	.101	.099	.003
Year Dummies:			
1969	-.032 (.006)	-.039 (.006)	.003 (.001)
1970	-.038 (.006)	-.043 (.006)	.005 (.001)
1971	-.043 (.006)	-.044 (.006)	.003 (.001)
1972	-.035 (.006)	-.034 (.006)	.0004 (.001)
1973	.009 (.006)	.005 (.006)	.004 (.001)
1974	.025 (.006)	.022 (.006)	.003 (.001)
1975	-.046 (.006)	-.050 (.006)	.002 (.001)
1976	-.024 (.006)	-.025 (.006)	.002 (.001)
SSR	3.17	2.97	.161
$\overline{R}^2$	.542	.532	.470

Standard errors in parentheses.

Footnotes

1. See Hulten and Robertson (1982).

2. For example, see the <u>Economic Report of the President</u> (1982), or Hulten and Robertson (1982).

3. A justification for the use of effective tax rates in welfare analysis is given by Auerbach (1982).

4. Such a fraction is typical of the time series debt-capital ratios calculated by Gordon and Malkiel (1981).

5. Gordon and Malkiel (1981) present results suggesting a value between .2 and .3, versus a corporate tax rate (historically) of at least .46.

6. See, for example, Scott (1976).

7. See, for example, Miller (1977).

8. This follows from the fact that the user cost of capital to which the marginal product of capital will be set equals $c = q(r+\delta)(1-\frac{\tau(\delta+\alpha r)}{r+\delta})/(1-\tau)$, where q is the relative capital goods price. Therefore, taxable income as a fraction of assets, $(\frac{cK-\delta qK}{qK})$, equals $(\frac{\tau}{1-\tau})r(1-\alpha)$.

9. This results from a 15 percent deduction and a 10 percent investment tax credit, which shields income of 22 percent.

10. One would subtract not taxes actually paid but those that would be paid by the firm were it entirely financed by equity.

11. This partial adjustment specification imposes a common, geometric lag structure on the different determinants of the desired ratio of debt to assets. Further research on this topic might consider more

general lag specifications to determine whether these restrictions are justified.

12. These points are quite common in literature. See, for example, Auerbach (1984).

13. Trend dividends are calculated by regressing the firm's annual dividends on a constant, time and time squared over the period 1963-1977.

14. An alternative approach, used in an earlier version of this paper, would be to detrend levels of debt.

15. Additional problems of inconsistency could arise if the remaining errors for each firm were correlated over time, even after being purged of fixed effects. An attempt to control for this using two stage least squares, with the lagged debt-assets ratios and cash flow deficit variables regressed in the first stage on several lagged values of the firm's sales proved unsuccessful, in that the sales variables proved to be very poor instruments. No other obvious candidates came to mind. Given the rapid adjustment speeds found in the basic model (Table 2 below) and the usual tendency of positive autocorrelation to bias such speeds downward, one may hope that the potential problem is not a serious one here.

16. See Hulten and Wykoff (1981) for example.

17. There are 149 firms with complete capital stock data (see Table 1) but six had missing values for one of the other explanatory variables, the tax loss carryforward.

18. These interpretations are not universally accepted. See the criticisms of Miller and Scholes (1982), for example.

19. This occurs because a firm's equity is valued at $q_D(A-B)$, where A is the value of a firm's assets, B the value of its debt, and q_D is a constant less than one, based on the relative tax rates on dividends and capital gains.

20. In a few cases in which this value was missing, we used the one from two years before.

21. Note that to obtain ℓ^* and s^*, one must solve for the structural parameters in α_1 and α_2 in (6) from the reduced form estimates of the two equation system for ℓ and s.

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