Interest Rates, Taxes and Corporate Financial Policies

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Abstract

This paper investigates the combined effect of *nominal* interest rates and taxes on the use and maturity structure of corporate debt. The net tax gain from use of corporate debt is proportional to nominal interest rates, so that behavioral responses should be larger when interest rates are higher. For similar reasons, firms should shift towards more long-term debt as long-term rates rise relative to short-term rates. Our paper presents evidence consistent with both predictions, using corporate and personal tax return data from the *U.S. Statistics of Income*.

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1. Introduction

There has been a substantial literature examining both theoretically and empirically the effects of the tax structure on corporate use of debt vs. equity finance. According to the theoretical literature, debt finance should be encouraged to the degree that more taxes are saved on corporate interest deductions than are owed on the resulting interest income.

Most all past papers on taxes and corporate borrowing, though, ignore an important element in the theory. According to the theory, the size of the net tax savings per dollar of corporate debt is proportional to *nominal* interest rates. Everything else equal, therefore, the size of the tax incentives affecting use of corporate debt should be high in years such as the early 1980's in the U.S. when nominal interest rates were high (around 14%), and should be very low in the years immediately after 2000 when at least short-term nominal interest rates were around 1%.

If this variation in interest rates were statistically independent of the variation in tax rates, then prior estimates could still be unbiased, even if highly dependent on the sample period. However, we find below that years when corporate tax rates were high relative to personal tax rates, encouraging use of corporate debt, also tended to be years in which nominal interest rates were low, weakening the estimated effects of any tax incentives. The past neglect of variation in interest rates when estimating the sensitivity of use of corporate debt to tax incentives may be one explanation why this past literature has not found much effect of taxes on use of debt.

For similar reasons, the term structure of interest rates can affect a firm's choice of the *maturity* of its debt structure. This point is developed formally in Gordon (1982) and Brick and Ravid (1985).[1] In particular, to the degree that the long-term interest rate is higher than the short-

[1] Brick and Ravid (1991) extended the analysis to handle stochastic interest rates. Boyce and Kalotay (1979) noted a related incentive to make bonds callable when corporate tax rates are relatively high.

term rate, the tax savings from use of long-term debt increase relative to the tax savings from an equivalent amount of short-term debt. These incentives are stronger the larger the tax differential.

There are a few past papers that attempted to take into account the interaction of taxes and market interest rates on use of corporate debt. For example, Gordon (1982) tested these predictions using aggregate time-series data for the U.S. While the point estimates were consistent with the theory,[2] standard errors were high based on twenty-five observations. There have also been a few attempts to test the effects of the term structure of interest rates on the maturity structure of debt using the largely cross-sectional data from *Compustat.*[3] Here the estimated effect of tax incentives is commonly statistically insignificant or the wrong sign, given the theory. These studies using *Compustat* data suffer from the problem that the proxies for the corporate tax rate can be picking up important nontax effects on behavior.

The aim of this paper is to reexamine the combined effects of interest rates and taxes on corporate debt and debt maturity, using the *U.S. Statistics of Income Corporate Income Tax Returns,* building on the identification strategies developed in Gordon and Lee (2001).

As reported below, we find that estimated tax effects are large and significant statistically, in contrast to the results in most previous papers. In particular, reducing the tax rate on corporate income by 10 percentage points is forecast to reduce the fraction of capital financed with debt by 3 percentage points, given average interest rates.[4] The results also show important effects of the level of nominal interest rates on the overall use of debt: given average tax incentives, we estimate that an increase in market interest rates by 5 percentage points should increase the

[2] In particular, the paper finds that use of long-term debt falls when the short-term interest rate goes up, conditional on the long-term interest rate, while use of short-term debt is unaffected, raising the ratio of short-term to long-term debt. Conversely, when the long-term interest rate increases, long-term debt increases much more than short-term debt.

[3] See Barclay and Smith (1995), Stohs and Mauer (1996), Guedes and Opler (1996), Harwood and Manzon (2000) and Newberry and Novack (1999).

[4] The size of forecasted effects, though, are proportional to nominal interest rates, so vary substantially by year.

fraction of capital financed with debt by 5.4 percentage points. In addition, we report evidence that the term structure of interest rates has smaller but statistically significant effects on the maturity structure of corporate debt.

The rest of the paper is organized as follows. Section 2 briefly examines the hypotheses and develops the empirical strategy. The data are described in section 3, and regression results are reported in section 4. The paper concludes with a brief summary and discussion.

2. Theory and Specification

The theoretical forecasts for the combined effects of interest rates and taxes on a corporation's choice of an overall debt level, and of the term structure on the choice of long-term vs. short-term debt have been laid out in the past.[5] In order to motivate the particular empirical specification we use, however, it is helpful to summarize explicitly the nature of the theoretical argument.

Consider the financial decisions made by a corporation. Denote its total debt by D, its long-term debt by D_L, and its short-term debt by D_S. Denote the current short-term nominal interest rate by r_S and the current long-term nominal interest rate by r_L. Owners of long-term debt also receive an ex-post capital gain (loss if negative) of $\tilde{g}$ in a given time period.

We examine first the incentives faced by the "marginal" shareholder whose preferences determine the pricing of corporate equity.[6] Assume that this "marginal" shareholder has a personal tax rate of m, while the marginal tax rate on corporate income (including any subsequent personal taxes for this shareholder) is denoted by τ. By construction, this marginal

[5] See, e.g., Gordon (1982) and Brick and Ravid (1985).

[6] According to the model in Gordon and Bradford (1980), the tax rates faced by this "marginal" shareholder represent a weighted average of the tax rates faced by shareholders generally, weighted by their assets times the inverse of the degree of their risk aversion. These implicit tax rates characterize security pricing generally.

investor is just indifferent between investing another dollar in the firm's equity and investing it instead in either long-term or short-term bonds. In particular, the investor's marginal indifference between long-term and short-term bonds implies that

(1) $$(1-m)r_L + (1-t_g)c_g = (1-m)r_S,$$

where c_g denotes the equilibrium certainty-equivalent (pretax) income generated by the random capital gain on long-term debt, while t_g is the capital-gains tax rate on this random return.

We assume that the objective of the firm's managers when making financial decisions is to maximize the value of the firm. The specific financial choices we focus on are the fractions of the firm's capital to finance with long-term and short-term debt, denoted by d_L and d_S respectively. When choosing the optimal use of long-term and short-term debt finance, the firm trades off the resulting tax savings/dissavings with any nontax costs arising from a use of debt different from that which would be chosen ignoring tax considerations. Let these nontax costs be denoted by $C(d_L, d_S)K$, where *K* denotes the firm's capital stock. By making this function proportional to *K*, we assume that financial choices will be the same regardless of the scale of the firm, though we relax this assumption in the empirical work below. We also assume that these nontax costs are a convex function of both d_L and d_S. In particular, assume that $C_{LL} > 0$ and $C_{SS} > 0$.[7] Intuitively, firms face pressures to match the time pattern of their income and financial liabilities, to avoid having to come up with the funds to repay debt at a date when they are cash constrained and may be forced to sell nonliquid assets at a deep discount. Short-term debt would then be ideal to handle seasonal variation in expenses vs. revenue, whereas long-term debt is preferable in financing longer-lived assets. In addition, assume that the cost of adding

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[7] We are not assuming, though, that the minimum nontax costs occur when $d_L = d_S = 0$. See Jensen and Meckling (1976) for discussion of the many competing pressures that affect a firm's optimal financial structure, even ignoring taxes.

more of one maturity of debt is higher the more debt the firm has of the other maturity: $C_{LS} > 0$, with $C_{LS}C_{SL} < C_{SS}C_{LL}$. If all that matters is total debt, due for example to the risk of bankruptcy when total debt exceeds firm value, then $C_{LS} = C_{LL} = C_{SS}$.[8]

The value of the firm will adjust to leave this marginal investor indifferent at the margin between investing further in equity and short-term bonds.[9] The certainty-equivalent nominal return from equity should therefore equal the return the investor could have received instead from investing the same funds in short-term bonds:

$$\left\{(1-\tau)\left[\bar{f}(K)(1-\rho)-(d_L r_L + d_S r_S)K - C(d_L, d_S)K\right] + (1-t_g)(\pi - c_g d_L)K\right\}/V$$

$$= (1-m)r_S,$$

where the numerator of the left-hand side is the after-tax income from equity, and the denominator *V* is the initial market value of equity. Here, $\bar{f}(K)(1-\rho)$ is the certainty-equivalent pretax income to the firm for any given capital stock *K*, where $\bar{f}(K)$ is the expected return and ρ captures the equilibrium marginal cost of risk bearing. The inflationary increase in the value of the firm's capital and the certainty-equivalent loss from bearing the capital-gains risk on long-term debt are not part of the corporate income tax base, so are taxed only at the shareholder's capital-gains tax rate, t_g. Note that by definition $V = qK(1-d_L-d_S)$, where *q* equals the ratio of the market value to the book value of equity.

At the financial policies that maximize firm value, $\partial q/\partial d_L = \partial q/\partial d_S = 0$.[10] Using equation (1) to simplify, the resulting first-order conditions are:

(2a) $$(\tau - m)r_L/(1-\tau) = C_L(d_S, d_L) \text{ and}$$

[8] When nontax costs of debt depend *just* on aggregate debt, however, we would forecast corner solutions for long-term vs. short-term debt, contrary to the data.
[9] Of course, both returns also equal that on long-term bonds, as follows from equation (1).
[10] In addition, at the optimal capital stock for the firm, *q* = 1.

(2b) $$(\tau - m)r_S /(1-\tau) = C_S(d_S, d_L)\ .$$

We then solve these two equations for the optimal values of d_S and d_L, finding in general that

(3a) $$d_L^* = d_L\big((\tau - m)r_L /(1-\tau), (\tau - m)r_S /(1-\tau)\big),\ \text{and}$$

(3b) $$d_S^* = d_S\big((\tau - m)r_S /(1-\tau), (\tau - m)r_L /(1-\tau)\big).$$

Given our assumptions, use of any given maturity of debt will be an increasing function of the first argument in equations (3ab), and a decreasing function of the second argument to the extent that $C_{LS} > 0$.

In the empirical work, for simplicity we will focus on the case where the two specifications in equations (3ab) are linear:[11]

(4a) $$\frac{D_S}{K} = \delta_S + \alpha_S \frac{(\tau - m)r_S}{1-\tau} - \beta_S \frac{(\tau - m)(r_L - r_S)}{1-\tau}, \quad \text{and}$$

(4b) $$\frac{D_L}{K} = \delta_L + \alpha_L \frac{(\tau - m)r_L}{1-\tau} + \beta_L \frac{(\tau - m)(r_L - r_S)}{1-\tau}.$$

Together, these equations imply that the firm's overall debt/capital ratio should satisfy

(4c) $$\frac{D}{K} = \delta + a_S \frac{(\tau - m)r_S}{1-\tau} + a_L \frac{(\tau - m)r_L}{1-\tau}.$$

The expected signs of all coefficients are positive, given the way each equation is specified. In the special case where $C_{LS} = 0$, only the own interest rates matter, in which case $\beta_S = \beta_L = 0$ and $\alpha_i = a_i$ for $i = S, L$.

Note that virtually all past empirical tests for tax effects on use of corporate debt looked just for effects of $(\tau - m)/(1-\tau)$. By ignoring the interaction with interest rates, results can be misleading, suggesting constant effects over time of taxes on debt rather than effects that vary in size depending on nominal interest rates.

In general the desired level of the debt/capital ratio and the desired maturity structure ignoring tax incentives, δ_S and δ_L, can vary by firm and over time. In particular, assume that $\delta_S = X\theta_S + \varepsilon_S$, while $\delta_L = X\theta_L + \varepsilon_L$. We will include in the vector *X* a flexible function of the amount of assets of the firm, a measure of the business cycle, this business-cycle measure interacted with the log(assets) of the firm in order to allow for a differing impact of the business cycle on small vs. large firms, and information on the asset composition of the firm's capital stock.[12]

In addition, we include throughout a dummy variable equal to 1 in all years following the 1986 Tax Reform Act. Under the 1986 Tax Reform Act, individuals could no longer deduct nonmortgage interest payments and passive business losses (which commonly arose due to large interest deductions). For individuals for whom these restrictions became binding in 1986, increasing their net holdings of bonds (borrowing less) no longer resulted in any tax liabilities. To the extent such individuals play an important role in the market, corporate debt should then be more attractive than our figures suggest. We saw no way to capture these effects of the 1986 Tax Reform that go beyond changes in tax rates, other than through such a dummy variable.[13]

3. Description of Data Set

Data come from three sources: SOI Corporate Returns, SOI Individual Returns, and the Individual Model File (IMF).[14] All information about firms comes from the SOI Corporate Returns, which are available for 51 years from 1950 to 2000. These data report summary

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[11] We also reparameterize the equation so that it depends on the interest rate for that maturity and the term structure, to aid in the later interpretation of the results.

[12] The expectation is that firms use more long-term debt to finance longer-lived assets.

[13] This dummy variable also provides some control for other elements of the 1986 Act, such as changes in the Alternative Minimum Tax, that are not otherwise controlled for.

[14] The IMF is a stratified sample of individual tax returns in the United States, made available for research purposes by the IRS, and is available from 1964 until 1993, except for 1965.

information taken from the corporate income tax returns each year, and cover all corporations in the US that file tax returns. While no information is available by firm, for confidentiality reasons, aggregate information for key variables is reported separately each year for between ten and fourteen different asset intervals.[15] Units of observation in our empirical analysis are these asset categories. As a result, our dependent variables will be the average debt per firm of a given maturity over average capital per firm among all firms in a given size category, so is a weighted average of the dependent variables in equation (4a-c) for firms within a given size category, weighting by the assets of each firm.

Since the break points between asset-size categories are not fixed in nominal (let alone real) terms, and since on occasion the number of asset size categories changes, this data set is not strictly a panel data set. We therefore include detailed controls for the effects of asset size on firm behavior, to control flexibly for any effects of firm size per se on financial policy.

In order to estimate equations (4a-c), the first variables we need to measure are the dependent variables, requiring data on short-term debt, long-term debt, and total firm assets. The amount of debt held by firms in each asset category is reported separately for short-term and long-term debt. Short-term debt equals the accounting book value of "mortgages, notes, and bonds payable in less than one year," while long term debt matures in a year or more. Total debt is simply the sum of the two. The (accounting) book value of assets in each size category again is reported directly in the SOI Tables.

Note, however, that the theory assumes that all long-term debt pays a given long-term interest rate, and similarly for short-term debt. Long-term bonds payable within one year are listed as short-term debt, yet pay the long-term rate. Since the firm can adjust other short-term

[15] The asset categories change slightly over time, but a typical breakdown is: (0, 0.025m), (0.025m, 0.05m), (0.05m, 0.1m), (0.1m, 0.25m), (0.25m, 0.5m), (0.5m, 1m), (1m, 2.5m), (2.5m, 5m), (5m, 10m), (10m, 25m), (25m, 50m), (50m, 100m), (100m, 250m), and ($>$250m), where ``m" indicates millions of (nominal) dollars.

debt at the margin to compensate for any residual long-term debt, our existing specification should handle this without problem. In addition, some long-term debt contracts have a floating interest rate. These bonds have the nontax characteristics of long-term debt but generate tax incentives tied to the short-term interest rate. To that extent, higher short-term interest rates can lead to more rather than fewer long-term bonds.[16]

The next variable we need to measure is the marginal corporate tax rate for each size category of firm. It is not always easy to find exogenous variation in tax incentives to use in identifying the causal effects of taxes on corporate use of debt. One potential source of exogenous variation is changes in the tax law. The time-series variation in at least the top statutory corporate tax rate largely comes from the 1986 Tax Reform Act. Yet this tax reform was sufficiently comprehensive that it is difficult to isolate the effects of corporate vs. personal tax rates per se on corporate financial decisions.[17] The corporate tax schedule is progressive, however, and the lower bracket rates did change frequently during the sample period, variation we make use of below.

Another potential source of identification is variation in marginal tax rates across firms at any date. Since statutory tax schedules are shared by firms, cross-sectional variation in marginal corporate tax rates depends on variation in the particular economic circumstances of each firm. In notation, the marginal corporate rate τ is a function of some economic circumstances, X: $\tau(X)$. Yet any tax rate that by construction is simply a function of X could be serving as a proxy for X in the empirical work, leading to a biased coefficient.

[16] An additional question is then under what conditions a firm borrows at a fixed rate or a floating rate. Since we have no data on this choice, we do not examine this question.

[17] For example, nonmortage interest deductions were phased out under the legislation, as were deductions for passive losses on investments in noncorporate firms (which commonly arose due to large interest deductions). By severely restricting interest deductions under the personal tax, the Act should induce firms to do more borrowing. In addition, the corporate and personal alternative minimum tax became much more important, effects that are hard to capture in the empirical work.

Many past papers, for example, use dummy variables for the presence of tax loss carryforwards and the size of nondebt tax shields as indicators for cross-sectional variation in tax incentives. Yet firms with losses (as proxied by having tax loss carryforwards) may be pressed to borrow for nontax reasons, since they likely face immediate liquidity pressures. As a result, firms with tax loss carryforwards will likely be observed to borrow more, in spite of the fact that their tax incentives are to avoid use of debt, because this measure of tax incentives is serving as a proxy for immediate liquidity pressures. Similarly, firms with large nondebt tax shields (mainly depreciation) presumably have more tangible assets, which provide good collateral for debt, generating a potentially positive association between nondebt tax shields and use of debt, in spite of the tax implications. Other aspects of firm circumstances that researchers have used in constructing a measure of corporate tax rates include current profits and the volatility of past profits.[18] Again, these economic circumstances per se can easily affect a corporation's desired use of debt for nontax reasons, making it hard to interpret the coefficient of such a measure of the corporate tax rate.[19]

In Gordon and Lee (2001), we focused on these identification problems, using *U.S. Statistics of Income Corporate Tax Returns* that report information on the average values of key entries in the balance sheet and income statements for firms in various asset size categories in each year over an extended time period, based on tax return data.[20] Since the corporate tax schedule is progressive, and changes shape frequently over time, we focused on using this variation in the shape of the corporate tax schedule to identify tax effects on corporate use of debt. The calculated tax rate still depends on the amount of assets for a firm, but we included a

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[18] For example, Graham (1996) uses data on current profits and the volatility of past profits to simulate the effective marginal corporate tax rate for a firm, taking into account many complications in the corporate tax provisions.

[19] For example, firms with high current profits face as a result fewer liquidity pressures, so likely borrow less. Firms with more volatile profits ceteris paribus are worse credit risks, so would have a harder time borrowing.

[20] Shih (1996) also used SOI corporate returns to conduct aggregate time-series analysis of the determinants of interest expense / total revenue. He found an association with corporate tax rates, personal tax rates, interest rates, and inflation. No attempt was

flexible function of firm assets, e.g. $f(X)$, in the estimation. As a result, $\tau(X)$ differs from $f(X)$ due to its time variation arising from changes in the tax law, providing an exogenous source of variation.

In this paper, following Gordon and Lee (2001), we set the marginal corporate tax rate for firms in size category *i* in year *t* to $\tau_t(\bar{\theta}_{it}\bar{K}_{it})$, where $\tau_t(.)$ represents the statutory corporate tax schedule in year *t*, $\bar{\theta}_{it}$ is the average taxable income per dollar of assets in this size category in that year, as reported in the data, and $\bar{K}_{it}$ is the average assets per firm.[21] The tax rate still depends heavily on $\bar{K}_{it}$, and corporate use of debt can easily vary depending on firm size. To control for independent effects of $\bar{K}_{it}$ on firm debt, we added as controls a very flexible function of $\bar{K}_{it}$.[22]

Various issues arise with this measure of the corporate tax rate. One concern is that average income/assets for firms in a given size category may have direct effects on corporate debt decisions. In Gordon and Lee (2001), we used as an instrument to correct for any potential bias a tax rate that depended instead on $\bar{K}_{it}$ times a fixed number representing an average profit rate for all firms. Results were unaffected, so we do not worry about such endogeneity here.

Note that our data include firms with both profits and losses. We intentionally do not make use of data on whether firms have profits or losses in estimating the corporate tax rate, since this information can have independent effects on corporate use of debt. Our data also

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made, though, to test whether the size of these tax effects varied with interest rates, or whether interest rates affect use of debt, and not just interest expense.

[21] If the marginal corporate tax rate differs when we use the minimum vs. maximum capital stock per firm within a size category, then we use a weighted average marginal tax rate, assuming a uniform distribution of firms within the asset interval for that size category.

[22] The functional form we chose was $\sum_{j=1}^{n} \beta_j (\ln K_{it})^j$. We report results with n=9, given that powers of $\ln K_{it}$ up to this order were statistically significant in some of the specifications.

unavoidably include both C and S corporations.[23] Both types of firms, however, face the same tax incentive to use debt if the firms face the same marginal tax rate,[24] so problems arise only to the extent that S corporations face a different tax rate. That firms are observed to shift quickly between C and S corporate status as relative tax rates change suggests that the tax rates faced by C and S corporations are very close.[25] The data also include all industries, so we are not in a position to test for differential responses by industry.

Personal income tax rates are calculated using the Individual Model File, when available, and otherwise with data from the SOI Individual Returns. The representative tax rate for income reported under the personal income tax is defined to equal the weighted average marginal tax rate, weighting by taxable income. One complication in capturing the effects of personal taxes on interest income is the role of pension funds and other institutional saving, which to a first approximation face a zero marginal tax rate on interest income. Assuming that pensions are as likely to rebalance their portfolios in response to a change in corporate financial policy as households are on the financial portfolios they control directly, we set m_t equal to the weighted average tax rate calculated from personal tax returns multiplied by the fraction of household assets held outside of pensions and life insurance companies.

We also need to measure the effective personal tax rate on income from corporate equity. There is much debate in the tax literature on the appropriate measure of the effective tax rate on both dividends and capital gains.[26] We follow conventional practice here and set the personal

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[23] The data also unavoidably include financial institutions as well as some pass-through entities (REIT's and RIT's). The *SOI* tables unfortunately do not include breakdowns simultaneously by industry as well as by asset size. To the extent our tax measure is irrelevant for these other sectors (as we expect), then the coefficients do in fact measure the effects of tax incentives on the behavior of nonfinancial corporations.

[24] Ayers et al (2001) notes, though, that this argument applies only to outside debt: Unlike C corporations, S corporations have no tax incentive to borrow from their shareholders. Ayers et al then find similar effects of taxes on use of outside debt for C and S corporations.

[25] For evidence on shifting between C and S corporate status, see e.g. Gordon and MacKie-Mason (1990).

[26] See, e.g. Auerbach (1979), Bernheim (1991) and Constantinides (1983) for arguments that these effective tax rates can be zero or even negative.

tax rate on net-of-corporate-tax equity income equal to $d_t m_t + (1 - d_t) a_t t_{gt}$, where d_t denotes the aggregate dividend payout rate,[27] t_{gt} denotes the top capital gains tax rates, while a_t measures the gains from deferral of capital gains until realization and the tax exemption of capital gains at death. Following Feldstein et al. (1983), we set a_t equal to 0.25.

The next key variables we need to measure are the short-term and long-term interest rates. Here, we used the 3-year Treasury bond rate as a proxy for long-term interest rates and the 3-month Treasury bill rate for the short-term interest rate.[28] This choice merits some discussion, since the coupon rate that firms in fact face will both be higher and vary by firm, due to the surcharge creditors require to compensate for default risk. The key point to note is that competition among lenders should ensure that the actual pattern of repayments has the same value to the lender as receiving the risk-free rate instead. The mirror image of this statement is that the cost of the actual pattern of repayments to the borrowers should have the same cost as paying the risk-free rate instead. We used the government interest rates as proxies for the short-term and long-term risk-free interest rates.[29]

In addition, we need some control for business cycle effects on use of debt. As one control, we used the ratio of the Dow Jones Index to GDP, on the grounds that behavior can change as soon as new information arrives about changing economic trends, and not just when these changes materialize.[30] We allowed the response to business cycles to vary by size of firm

[27] Here, we used the actual dividend payout ratio for Standard and Poor's 500 firms. Results were not sensitive to this choice.

[28] As an alternative to the 3-year rate, we also tried the 5-year rate and the 10-year rate. Results were little affected. We focused on the 3-year bond rate on the presumption that bonds tend to be issued initially for ten years, leading to an average remaining maturity of 5 years, but bonds are often repaid early.

[29] We also tried using the AAA corporate bond rate and the short-term prime rate, on the grounds that these bonds approximated default free securities, yet may have rates that differ from those on government bonds for other reasons. (The administrative oversight for corporate loans could be higher, interest receipts are subject to state income taxes unlike government bond interest, etc.) Results again were virtually unchanged. We preferred using government bond rates, since even AAA bonds face some default risk that can vary in size over time.

[30] To calculate the yearly value for the Dow Jones Index, we took the average of the opening and closing price in each month, then averaged these monthly figures for each year. We also tried using the percent change in real GDP as a cyclical control. Other coefficients were unchanged, but the coefficient of this control was insignificant and the fit was a bit worse.

by interacting this variable with $\ln \overline{K}_{it}$. As additional business-cycle controls, we included the inflation rate and the unemployment rate, since these two variables appear to be the key inputs to monetary policy according to Taylor's rule.[31] We also included controls for the asset composition of the firm's capital stock.[32]

Since SOI Individual Returns are not available before 1954 and SOI Corporate Returns do not report short-term debt and the composition of assets in 1962 and 1966-1969, our sample consists of 42 years from 1954 through 2000, excluding 1962 and 1966-1969. With about twelve asset categories on average per year, we end up with 489 observations.

Summary statistics are reported in Table 1. On average, long-term debt has been 64% of the total debt of US corporations, though this share varied greatly across size of firm and across years. The share of long-term debt in total debt tends to increase with firm size, as shown in Figure 1, as would be expected based on the above theory, since large firms face higher corporate tax rates than do smaller firms and since long rates generally exceed short rates. Nominal 3-year and 3-month TB interest rates varied greatly during the sample period, from a mere 1% to 14%. Figure 2 describes the variation over time in statutory corporate tax rates, comparing nominal taxable corporate income in each year with the resulting marginal corporate tax rate. As seen from the Figure, there is substantial variation both within each year and across years in marginal tax rates. Using the real rather than nominal taxable income in this graph, e.g. correcting for inflation, would lead to further variation in corporate tax rates across years.

4. Regression results

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[31] For the inflation rate, we used the yearly percent change in the CPI.

[32] The information available includes the fraction of the capital represented by depreciable assets, land, cash, and other assets.

Since past papers have ignored the effects of interest rates, we start in column (1) in Table 2 with a specification that also ignores interest rates: $\frac{D_{it}}{K_{it}} = a(\tau_{it} - m_t)/(1-\tau) + X_{it}B + \varepsilon_{it}$. There are a number of differences between this specification and that reported in Gordon and Lee (2001).[33] The key difference is that we excluded year dummies in order to identify more clearly the role of interest rates. While the previous paper found a highly significant coefficient of around 4.2, the coefficient now is -1.11 and statistically insignificant.

The sensitivity of the estimated coefficient to the inclusion of year dummies we take as strongly suggestive of the importance of interest rate effects. If the correctly specified variable is $(\tau_{it} - m_t)r_{St}/(1-\tau_{it}) \equiv T_{it}r_{St}$ but the variable T_{it} is included instead, how should its estimated coefficients compare with that of $T_{it}r_{St}$? Note that

(5) $$T_{it}r_{St} = T_{it}(\bar{r} + \Delta r_{St}) = \bar{r}T_{it} + T_{it}\Delta r_{St}$$

-Including T_{it} rather than $T_{it}r_{St}$ is equivalent to including the first term on the right-hand side of equation (5) but omitting the second term from the specification. If Δr_{St} and T_{it} are statistically independent, then there is no bias: the expectation of the estimated coefficient of T_{it} should simply equal $\bar{r}$ times the true coefficient.[34] However, if Δr_{St} and T_{it} are negatively correlated, then the coefficient of T_{it} is biased downwards due to this omitted variable. In fact, the data show that the correlation in the sample between Δr_{St} and T_{it} is -0.37.

The other coefficients in column (1) are as expected, though. Consistent with past results, more debt is used to the extent that the firms' assets are longer term. Firms also use more debt

[33] This specification differs from those in Gordon and Lee (2001) because five more years of data are included, year dummies are not included, other yearly variables are included instead, two more powers of $\ln K_{it}$ are included as controls, personal taxes on equity income are included, and the tax variable has $1-\tau_{it}$ in the denominator.

during recessions.[35] As expected, firms use more debt after the 1986 Tax Reform, even after controlling for changes in tax rates.

Column 2 provides a nonparametric test to see if the data suggest an interaction of the tax variable with market interest rates. To do so, we interact the tax variable with dummy variables indicating whether the short-term interest rate in that year is in the bottom, second, third, or top quartiles of its values during the full sample period. The prediction is that all of these coefficients should be positive, and an increasing function of the size of nominal interest rates. We find that the coefficients do increase monotonically with the size of interest rates. For all but the lowest quartile they are positive, and those for the highest two quartiles (but also the lowest quartile) are statistically significant.[36] At least for years with interest rates in the highest two quartiles, the coefficient on the tax variable is broadly similar to the value in Gordon-Lee (2001). Why might the estimated effect of taxes on use of debt have the wrong sign, though, in years with the lowest interest rates? Note that for years when interest rates are in the bottom quartile, variation in the expression suggested by the theory, $T_{it} r_{St}$, will be heavily dominated by movements in r_{St}, e.g. the variable doubles if interest rates are 2% rather than 1%. To capture the effects of this omitted variation in the interest rate, the estimated coefficient of T_{it} needs to be negative, given the negative correlation between T_{it} and r_{St}. In the other quartiles, there could still be a downward bias, but variation in $T_{it} r_{St}$ is more likely to be dominated by differences in effective tax rates across size categories and over time.

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[34] There should be no bias as well if year dummies are included, as in Gordon-Lee (2001). Netting out year effects, the two variables on the right-hand side of equation (5) become $\bar{r}(T_{it} - \bar{T}_t)$ and $(T_{it} - \bar{T}_t)\Delta r_{St}$. These two variables are uncorrelated, implying no bias from omitting the latter variable from the specification.

[35] While overall debt levels are not affected by the inflation rate or the unemployment rate, for any given the value of the Dow, firms shift away from short-term debt when the inflation rate and the unemployment rates are high, perhaps due to more uncertainty about short-term fluctuations in monetary policy.

[36] Note that we also report in brackets White-corrected robust standard errors to address the possibility that error terms within asset category over time can be correlated. Error terms within a year across asset categories can also be correlated. Robust standard errors addressing as well this possible problem are yet larger, but coefficient estimates remain significant.

These coefficients, even with any downward bias, indicate nontrivial effects of taxes on use of debt during periods when nominal interest rates are above average in value. During years with high interest rates for example, lowering the tax rate on corporate income from .46 to .36 would reduce the forecasted fraction of capital financed with debt by about 1.1%, relative to a sample mean of 26%. Similarly, holding tax rates at their mean, increasing interest rates from values in the lowest to values in the highest quartile increases the fraction of capital financed with debt by over 7%.

Column 3 then reports the results from estimating equation (4c), interacting the tax variable with both the short-term interest rate and the difference between long-term and short-term interest rates. Here, we find that the short-term interest rate is strongly statistically significant, while the term structure has a moderately large coefficient but is not statistically significant. In years where the short-term interest rate and the difference between long rates and short rates both equal the sample mean, the implied coefficient on the tax variable itself is 4.7 (=5.62*.741+1.03*.472), so implies larger effects of taxes than those reported in column (2).[37] Cutting the tax rate on corporate income by ten percentage points lowers forecasted debt levels by 1.0% of capital, whereas the same tax changes in a year with the highest observed short interest rate (holding the term structure fixed) would raise debt levels by 2.3% of capital, and by only 0.2% of capital in years with the lowest short-term interest rate. In years with the mean tax rates, raising the short-term interest rate by 10 percentage points would raise forecasted debt levels by 3.0% of capital.[38]

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[37] Note that this estimate is just slightly larger than the estimate of 4.2 found in Gordon and Lee (2001), where year dummies implicitly controlled for interest rate effects.

[38] That the results here show less sensitivity to interest rates than those in column 2 again suggests more of a downward bias in years where interest rates were in the bottom quartile than in years when interest rates were in higher quartiles.

Column 4 reports estimates for equation (4a), explaining D_L / K. Here, we find highly statistically significant effects of the long-term interest rates, but no effects of the short-term rate, perhaps because of the use of floating interest rates on some of the long-term debt.

Column 5 reports comparable estimates for equation (4b), explaining D_S / K. Here, we find highly statistically significant effects of the short-term interest rates. Again, the coefficient on the term structure is small and statistically insignificant. By construction, the sum of the coefficients for a given independent variable in columns 4 and 5 equal that in column 3.

The small and statistically insignificant coefficients on the term structure in columns (4) and (5) of Table 2 suggest that $C_{LS} \approx 0$, in which case the nontax costs of additional short-term (long-term) debt do not depend on the amount of long-term (short-term) debt that the firm has. This suggests that possible liquidity constraints when debt comes due, perhaps as a result of asymmetric information, may be a more important consideration than the threat that the firm faces bankruptcy risk when overall debt levels become too high.[39]

Table 3 shows that our including a flexible control for firm size does have important effects on the estimated coefficients of the tax variables. Without controls for firm size (column 1) or even including linear or quadratic functions of $\ln(\overline{K}_{it})$, all of the estimated tax coefficients are larger, suggesting that the tax variables can easily serve as proxies for firm size without due care. By including a 9th order polynomial in $\ln(\overline{K}_{it})$ for firm size, we are asking a lot of the data, but feel more confident that the estimated coefficients indeed capture effects of the tax law. In particular, without such extensive controls the results suggest that that tax effects are roughly twice as large, and that only the long-term interest rate matters.

[39] See Myers and Majluf (1984) for a model of corporate finance focusing on such liquidity constraints arising from asymmetric information.

Table 4 reports the regression results separately for large and small-firms. We use 10 million 1995 US dollar as the divider, which generates two sub-samples with almost identical size. The results generally confirm strong responsiveness of debt to taxes.[40] For example, the implied coefficient of the tax variable, evaluated at average short term and long-term interest rates, is 3.5 in column (1) and 3.87 in column (4), in contrast to 4.7 in column 3 of Table 2.[41] One intriguing new result, though, is that a high long-term rate discourages small firms from taking on short-term debt, the first strong evidence for $C_{LS} > 0$. It is unsurprising that small firms need to worry more about their overall debt levels, given their much higher failure rates.

Our results above make use of both cross-sectional and time-series variation in the data. In theory, the expected coefficient estimates should be the same, regardless of the source of variation. If the two sources of variation generate quite different estimates, however, this could be a symptom of potential biases due to either inadequate controls for nontax differences across firms of different sizes or due to inadequate controls across time, e.g. for business cycle effects.

As a specification check, we reestimated the above results using aggregate time-series data. Specifically, we constructed aggregate figures for each year by taking a weighted average of the data for each size category, weighting by assets held by firms within each size category. Rather than trying to estimate again the effects of firm size, asset composition, and the interaction of firm assets and business cycle effects, we subtract $X\hat{\theta}$ from the dependent variable, using the estimates from the corresponding column in Table 2.[42] We did not subtract off the estimated effects of taxes, however, in order to facilitate the interpretation of the tax coefficients based on purely time-series variation. We also leave in the business cycle control

[40] Even though the coefficient on the short-term interest is not significant in the equation for smaller firms, the large and statistically significant coefficient on the term structure still implies strong positive effects of the short-term rate and negative effects of the long-term rate.

[41] That both estimated effects are slightly smaller than those from Table 2 is not surprising. With less variation in tax incentives within each of these subsamples, any downward bias due to measurement error should be larger.

[42] In these cases, the cross-sectional variation is essential to identify the size of these effects.

variables, and the dummy variable for years after the 1986 Tax Reform. These variables vary only with time, so remain well identified even when we restrict the sample to aggregate time-series data.

Results are reported in Table 5, with columns 1-3 in Table 5 corresponding to columns 3-5 in Table 2. Coefficient estimates for D/K in the two Tables are very close. Short-term debt is estimated to be slightly more responsive to short-term interest rates, and long-term debt slightly less responsive to long-term interest rates in the time-series estimates, though neither difference is large relative to the estimated standard errors. Taken together, these results provide no clear evidence of any specification biases.

As a further test of the above specification, we examined the sensitivity of the above results to the method used for defining the appropriate corporate tax rate for each size category. In the above results, the assigned corporate tax rate, $\tau_t(\overline{\theta}_{it}\overline{K}_{it})$, equals the statutory tax rate calculated using the average taxable profits per dollar of assets for firms in each size category. Yet effective tax rates can vary among firms in a size category due to variation in the current profit rates.[43] Ignoring this variation should result in a downward bias in the coefficient.[44]

In principle, we would like to measure $E(\tau_t(\theta_{it}\overline{K}_{it}) \mid \overline{K}_{it})$. To test the sensitivity of our results to variation in taxable profits across firms within a size category, we calculate $E\tau_t((\overline{\theta}_{it}(1+\sigma\tilde{\varepsilon})\overline{K}_{it})$, where $\tilde{\varepsilon}$ is a standard normal variable while σ is a parameter we experiment with.[45] Prior results implicitly set $\sigma = 0$.[46] Column 1 of Table 6 reports results for

[43] The average profit rate could be approximately right if there were unlimited averaging across many years. But with the limited averaging provided by existing carryback and carryforward provisions, taxable profit rates will vary across firms.

[44] Our calculated tax rate jumps discretely when average profits in a size category cross into a higher tax bracket, whereas the average marginal tax rate should increase smoothly as expected profits increase. To compensate for the larger variation in our calculated tax rate, the estimated coefficient should be smaller.

[45] This procedure is analogous to that used by Graham (1986). Graham started with a firm's profits in a year and simulated the degree to which profits are smoothed due to carryback and carryforward provisions. We start with average profits for firms in a given size category, and simulate how much taxable profits vary across firms due to random variation in profit rates not averaged out due to existing carryback and carryforward provisions.

D/K when τ is calculated using $\sigma = 1$, while column 2 reports results for $\sigma = 2$.[47] As expected, the coefficients on both the short-term and the long-term interest rates are higher than those reported in column 3 of Table 2, roughly doubling in size. Equivalent results are reported in columns 3 and 4 of Table 6 for D_L / K, and in columns 5 and 6 for D_S / K. In each case the coefficient of the tax term times the interest rate of the same maturity roughly doubles in size, while the coefficient of the term structure term remains small and statistically insignificant.

Using these estimates, we find that increasing interest rates by 5 percentage points, assuming that $\tau - m = .27$ and $(1-\tau) = .48$, should increase the fraction of capital financed with debt by 5.4 percentage points (e.g., going from 25.7% on average to 31.1%), based on the estimates in column 2 of Table 6. A rise in r_L by 200 basis points, for any given value of r_S, would increase $(D_L - D_S)/K$ by 1.1 percentage points using the results in columns 4 and 6 in Table 6.

The estimated sensitivity to tax rates is comparable. When $r_L = 6.6\%$, $r_S = 5.6\%$, and $m_t = 24\%$, reducing τ_{it} by ten percentage points, i.e. from 46% to 36%, would reduce the fraction of capital financed with debt by 3 percentage points, using the coefficient estimates in column 2 of Table 6.[48] The same tax change would lower D_L / K by 1.9 percentage points and D_S / K by 1.1 percentage points, using the estimates in columns 4 and 6 in Table 6.

5. **Summary and Discussions**

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[46] Given the observed profit rate, however, we did allow dollar profits to vary within a size category in proportion to the assets of each firm, assuming that firm assets have a uniform distribution within the size category

[47] Note that in each case, the resulting tax rate is a weighted average of all the different tax brackets, weighting by the probability that the resulting taxable income is in the appropriate range for that bracket. We focus on results for $\sigma = 2$, since this degree of variation is broadly consistent with the fraction of assets reporting taxable losses within any given size category.

[48] Note that this figure will differ across years, depending on the prevailing nominal interest rates.

Consistent with theoretical forecasts, we provide empirical evidence that both the overall corporate use of debt and the maturity structure of this debt are affected by the level and the term structure of nominal interest rates. Inflationary increases in interest rates do have real effects due to this interaction with the tax law.

In particular, our estimates suggest that the variation in nominal interest rates seen during our sample period is estimated to have lead to a 14.1 percentage point variation in the fraction of capital financed with debt, while a 200 basis point increase in the long-term interest rate for any given value of the short-rate is predicted to lead to 1.1 percentage point variation in the fraction of capital being financed with long-term rather than short-term debt.

In addition, once the interaction of taxes with interest rates is taken into account, estimated effects of taxes on use of debt are found to be substantial. In particular, raising the effective tax rate on corporate income from the minimum to the maximum value in our sample is forecast to raise the fraction of capital financed with debt by 11.3 percentage points during years with average interest rates, but by much more during years with high interest rates and much less during years with low interest rates. Controlling for interest rates leads to larger estimated effects of taxes on average, since in the data interest rates were negatively correlated with tax incentives.

These tax effects, of course, would be substantially reduced if only real interest payments rather than nominal interest payments were deductible (and taxable). The results therefore provide additional empirical evidence on the value of indexing the tax law appropriately for inflation.

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Table 1. Summary Statistics

Variable	Notation	Sources	Obs	Mean	st. dev.	Min	Max
Corporate debt							
total debt / assets		*SOI: Corporate Returns*	489	25.68	8.05	9.86	43.13
long-term debt / assets		*SOI: Corporate Returns*	489	16.12	4.55	7.30	30.32
short-term debt / assets		*SOI: Corporate Returns*	489	9.56	3.98	0.79	17.34
long-term debt / total debt		*SOI: Corporate Returns*	489	64.01	7.24	49.00	93.51
Tax rates							
Corporate income tax rate including any subsequent personal taxes on equity income	τ_{it}	Authors' calculation using *SOI: Corporate Returns, Economic Report of the President (ERP)*	489	45.97	11.76	23.39	60.66
Personal tax rate × the fraction of household assets outside of pensions and life insurance	m_t	Authors' calculation using *SOI: Individual Returns, FFA*	42	24.15	2.47	20.39	29.24
(Corporate – personal tax rates) divided by (1– corporate tax rates)	$\frac{(\tau_{it} - m_t)}{(1-\tau_{it})}$	Authors' calculation using *SOI: Corporate Returns, SOI: Individual Returns, ERP, FFA*	489	0.46	0.29	0.01	0.92
Interest rates and other yearly variables							
3-year Treasury Bond rate	$r_{L,t}$	*ERP*	42	6.65	2.85	1.63	14.44
3-month Treasury Bill rate	$r_{S,t}$	*ERP*	42	5.62	2.80	0.95	14.03
3-year – 3-month Treasury rate	$r_{L,t} - r_{S,t}$	*ERP*	42	1.02	0.67	-0.33	2.31
Consumer price index	*CPI*	*ERP*	42	0.60	0.36	0.19	1.23
weighted average of τ_{it}	$\bar{\tau}_t$	see source for τ_{it}	42	51.62	6.45	41.11	59.32
weighted average of $\tau_{it} - m_t$	$\bar{\tau}_t - m_t$	see source for τ_{it} and m_t	42	27.47	4.93	18.59	35.28
Dow Jones index / GDP	*DowGDP*	GDP from *ERP*	42	0.71	0.33	0.27	1.27
Inflation rate		*ERP*	42	4.18	3.14	-0.37	13.50
Unemployment rate		*ERP*	42	6.06	1.37	4.02	9.69
Corporate assets							
Real assets per return	A^r_{it}	*SOI: Corporate Returns*	489	375	1,041	0.02	4,803
Net depreciable assets / assets		*SOI: Corporate Returns*	489	20.84	6.44	5.82	35.66
Land / assets		*SOI: Corporate Returns*	489	3.63	2.41	0.11	8.31
Cash / assets		*SOI: Corporate Returns*	489	9.77	4.45	2.80	28.69
Account receivable / assets		*SOI: Corporate Returns*	489	22.43	4.75	7.55	34.39
Intangible assets / assets		*SOI: Corporate Returns*	489	1.45	1.43	0.08	6.23

Note: 1. Units of the variables are percents except for real assets per return and average Dow Jones index / GDP, for which units are million US $ and a fraction, respectively.
2. Dow Jones indices are downloaded from www.forecasts.org and *The Flow of Funds Accounts in the United States* are downloaded from the Federal Reserve Board's wet site.
3. $\bar{\tau}_t$ is the weighted average of τ_{it} within a year, weighting by assets. Since firms with larger assets face higher tax rates, the mean of $\bar{\tau}_t$ is larger than the mean of τ_{it}.

Table 2. Baseline regressions, OLS

Dependent variable	(1) D/K	(2) D/K	(3) D/K	(4) D_L/K	(5) D_S/K
$(\tau_{it}-m_t)/(1-\tau_{it})$	-1.105 (1.041) [1.416]				
$(\tau_{it}-m_t)/(1-\tau_{it})$ $\times$(dummy for bottom quartile of $r_{S,t}$)		-2.928 (0.929)** [1.400]+			
$(\tau_{it}-m_t)/(1-\tau_{it})$ $\times$(dummy for second quartile of $r_{S,t}$)		0.800 (1.020) [1.470]			
$(\tau_{it}-m_t)/(1-\tau_{it})$ $\times$(dummy for third quartile of $r_{S,t}$)		2.850 (0.973)** [1.453]+			
$(\tau_{it}-m_t)/(1-\tau_{it})$ $\times$(dummy for top quartile of $r_{S,t}$)		4.583 (1.050)** [1.714]*			
$(\tau_{it}-m_t)/(1-\tau_{it})\times r_{S,t}$			0.741 (0.089)** [0.138]**		0.278 (0.063)** [0.119]**
$(\tau_{it}-m_t)/(1-\tau_{it})\times r_{L,t}$				0.463 (0.055)** [0.067]**	
$(\tau_{it}-m_t)/(1-\tau_{it})\times(r_{L,t}-r_{S,t})$			0.472 (0.310) [0.290]	0.057 (0.199) [0.214]	-0.047 (0.219) [0.269]
DowGDP	-3.342 (0.571)**	-0.888 (0.537)+	-2.856 (0.528)**	-0.850 (0.325)**	-2.006 (0.373)**
DowGDP$\times\log(A^r_{it})$	-0.247 (0.117)*	-0.002 (0.107)	-0.060 (0.112)	0.037 (0.069)	-0.097 (0.079)
Dummy for post 1986	1.732 (0.424)**	2.267 (0.383)**	2.298 (0.402)**	1.731 (0.247)**	0.567 (0.284)*
Inflation rate	0.068 (0.043)	-0.012 (0.038)	0.013 (0.047)	0.065 (0.029)*	-0.052 (0.033)
Unemployment rate	0.073 (0.089)	0.212 (0.078)**	0.001 (0.092)	0.177 (0.057)**	-0.176 (0.065)**
Net dep. assets / total assets	0.136 (0.049)**	0.221 (0.043)**	0.148 (0.046)**	0.192 (0.028)**	-0.044 (0.032)
Land / total assets	0.836 (0.237)**	0.477 (0.212)*	0.992 (0.222)**	0.781 (0.136)**	0.211 (0.157)
Cash / total assets	-0.293 (0.091)**	-0.225 (0.079)**	-0.270 (0.084)**	0.237 (0.052)**	-0.507 (0.060)**
Accounts receivable / total assets	-0.047 (0.054)	-0.126 (0.047)**	-0.136 (0.051)**	-0.022 (0.031)	-0.114 (0.036)**
Intangible assets / total assets	1.066 (0.175)**	0.762 (0.155)**	1.190 (0.143)**	1.028 (0.088)**	0.162 (0.101)
Number of observations	489	489	489	489	489
Adjusted R^2	0.951	0.963	0.957	0.949	0.912

Standard errors in parentheses. White-corrected robust standard errors assuming that the observations are independent across asset category but not necessarily independent within asset category in brackets. Constant term and up to the 9th polynomial in log of assets are included, but not reported. + significant at 10% level; * significant at 5% level; ** significant at 1% level.

Table 3. Robustness to changes in firm-size controls, OLS

Dependent variables are the ratio of total, long-term, or short-term debt to total assets in percent.

	(1) without firm-size controls	(2) with log(assets)	(3) 2^{nd} order polynomial	(4) 9^{th} order polynomial
total debt / assets				
$(\tau_{it} - m_t)/(1-\tau_{it}) \times r_{S,t}$	1.283	1.308	1.296	0.741
	(0.131)**	(0.126)**	(0.129)**	(0.089)**
	[0.323]**	[0.321]**	[0.276]**	[0.138]**
$(\tau_{it} - m_t)/(1-\tau_{it}) \times (r_{L,t} - r_{S,t})$	1.655	1.673	1.625	0.472
	(0.472)**	(0.455)**	(0.470)**	(0.310)
	[0.509]**	[0.513]**	[0.482]**	[0.290]
Adjusted R^2	0.884	0.893	0.892	0.957
long-term debt / assets				
$(\tau_{it} - m_t)/(1-\tau_{it}) \times r_{L,t}$	0.664	0.661	0.635	0.463
	(0.059)**	(0.058)**	(0.060)**	(0.055)**
	[0.125]**	[0.120]**	[0.103]**	[0.067]**
$(\tau_{it} - m_t)/(1-\tau_{it}) \times (r_{L,t} - r_{S,t})$	0.133	0.134	0.051	0.057
	(0.230)	(0.229)	(0.232)	(0.199)
	[0.229]	[0.235]	[0.277]	[0.214]
Adjusted R^2	0.927	0.927	0.928	0.949
short-term debt / assets				
$(\tau_{it} - m_t)/(1-\tau_{it}) \times r_{S,t}$	0.619	0.646	0.661	0.278
	(0.098)**	(0.090)**	(0.092)**	(0.063)**
	[0.250]*	[0.220]*	[0.196]**	[0.119]*
$(\tau_{it} - m_t)/(1-\tau_{it}) \times (r_{L,t} - r_{S,t})$	0.858	0.878	0.940	-0.047
	(0.355)*	(0.324)**	(0.335)*	(0.219)
	[0.450]+	[0.478]+	[0.384]*	[0.269]
Adjusted R^2	0.733	0.777	0.777	0.912

Standard errors in parentheses. White-corrected robust standard errors assuming that the observations are independent across asset category but not necessarily independent within asset category in brackets.

+ significant at 10% level; * significant at 5% level; ** significant at 1% level.

Each column reports the results of three regressions for total debt / assets, long-term debt / assets, and short-term debt / assets. In each regression, the same set of independent variables as in columns (3)-(5) of Table 2 is included in the regressions, but not reported. Regression results with up to the 3^{rd} polynomial in log of assets through with up to the 8^{th} polynomial in log assets lie between the results in columns (3) and (4), and are not reported. Results in column (4) of Table 3, the same as columns (3)-(5) of Table 2, are repeated for comparison.

Table 4. Large- vs. small-firms, OLS

Dependent variables are the ratio of total, long-term, or short-term debt to total assets in percent.

	(1)	(2)	(3)	(4)	(5)	(6)
Sample	asset categories with real assets > 10m			asset categories with real assets < 10m		
Dependent variable	D/K	D_L/K	D_S/K	D/K	D_L/K	D_S/K
$(\tau_{it}-m_t)/(1-\tau_{it})\times r_{S,t}$	0.521 (0.099)** [0.113]**		0.252 (0.065)** [0.040]**	0.734 (0.190)** [0.319]+		-0.010 (0.124) [0.162]
$(\tau_{it}-m_t)/(1-\tau_{it})\times r_{L,t}$		0.269 (0.054)** [0.095]*			0.744 (0.122)** [0.203]*	
$(\tau_{it}-m_t)/(1-\tau_{it})\times(r_{L,t}-r_{S,t})$	0.593 (0.201)+ [0.259]+	0.246 (0.176) [0.231]	0.078 (0.213) [0.179]	-0.244 (0.602) [0.488]	-0.249 (0.400) [0.320]	-0.738 (0.391)+ [0.476]
Number of observations	243	243	243	246	246	246
Adjusted R^2	0.956	0.948	0.940	0.757	0.816	0.762

Standard errors in parentheses. White-corrected robust standard errors assuming that the observations are independent across asset category but not necessarily independent within asset category in brackets.

+ significant at 10% level; * significant at 5% level; ** significant at 1% level.

In each regression, the same set of independent variables as in columns (3)-(5) of Table 2 is included in the regressions, but not reported.

Table 5. Time series regressions, OLS, using weighted averages

Dependent variables are yearly variation in the ratio of total, long-term, or short-term debt to total assets unexplained by non-tax variables or non-yearly variables.

	(1)	(2)	(3)
Estimation method	OLS	OLS	OLS
Dependent variable	D/K	D_L/K	D_S/K
$(\tau_{it} - m_t)/(1-\tau_{it}) \times r_{S,t}$	0.733		0.440
	(0.210)**		(0.117)**
$(\tau_{it} - m_t)/(1-\tau_{it}) \times r_{L,t}$		0.292	
		(0.117)*	
$(\tau_{it} - m_t)/(1-\tau_{it}) \times (r_{L,t} - r_{S,t})$	2.110	1.151	0.666
	(0.729)**	(0.401)**	(0.406)
DowGDP	-2.652	-1.384	-1.268
	(1.137)*	(0.633)*	(0.632)+
Dummy for post 1986	2.762	1.703	1.059
	(0.606)**	(0.338)**	(0.337)**
Inflation rate	0.203	0.156	0.047
	(0.112)+	(0.062)*	(0.062)
Unemployment rate	-0.528	-0.131	-0.397
	(0.219)*	(0.122)	(0.122)**
Constant	1.140	1.866	-0.726
	(2.186)	(1.217)	(1.216)
Number of observations	42	42	42
Adjusted R^2	0.781	0.810	0.668

Standard errors in parentheses. + significant at 10% level; * significant at 5% level; ** significant at 1% level.
Sample years are 42 years from 1954 to 2000 except for 1962 and 1966-9. Dependent variables are the average values of the ratio of debt to assets each year, corrected for the effects of the non-tax variables or non-yearly variables using coefficients from column (3), (4), and (5) of Table 2.

Table 6. Sensitivity to alternative calculation of corporate tax rates

Dependent variables are the ratio of total, long-term, or short-term debt to total assets in percent.

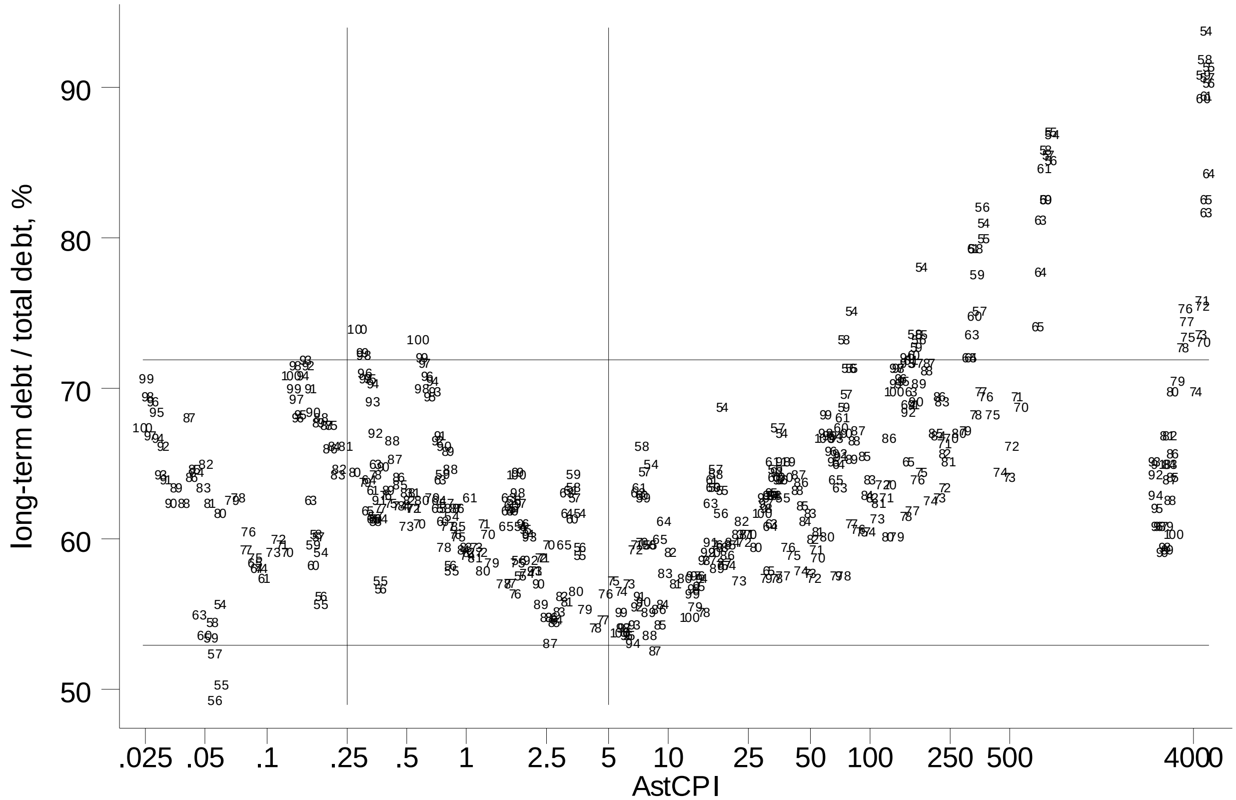
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	D/K		D_L/K		D_S/K	
Assumption on σ	$\sigma=1$	$\sigma=2$	$\sigma=1$	$\sigma=2$	$\sigma=1$	$\sigma=2$
$(\tau_{it}-m_t)/(1-\tau_{it})\times r_{S,t}$	1.259 (0.145)** [0.193]**	1.932 (0.212)** [0.295]**			0.472 (0.103)** [0.153]**	0.806 (0.150)** [0.244]**
$(\tau_{it}-m_t)/(1-\tau_{it})\times r_{L,t}$			0.788 (0.089)** [0.119]**	1.125 (0.132)** [0.160]**		
$(\tau_{it}-m_t)/(1-\tau_{it})\times(r_{L,t}-r_{S,t})$	0.820 (0.474)+ [0.424]+	0.970 (0.681) [0.671]	0.072 (0.301) [0.330]	-0.137 (0.442) [0.524]	-0.039 (0.336) [0.305]	-0.018 (0.483) [0.420]
Number of observations	489	489	489	489	489	489
Adjusted R^2	0.957	0.958	0.949	0.949	0.912	0.914

Standard errors in parentheses. White-corrected robust standard errors assuming that the observations are independent across asset category but not necessarily independent within asset category in brackets.

+ significant at 10% level; * significant at 5% level; ** significant at 1% level.

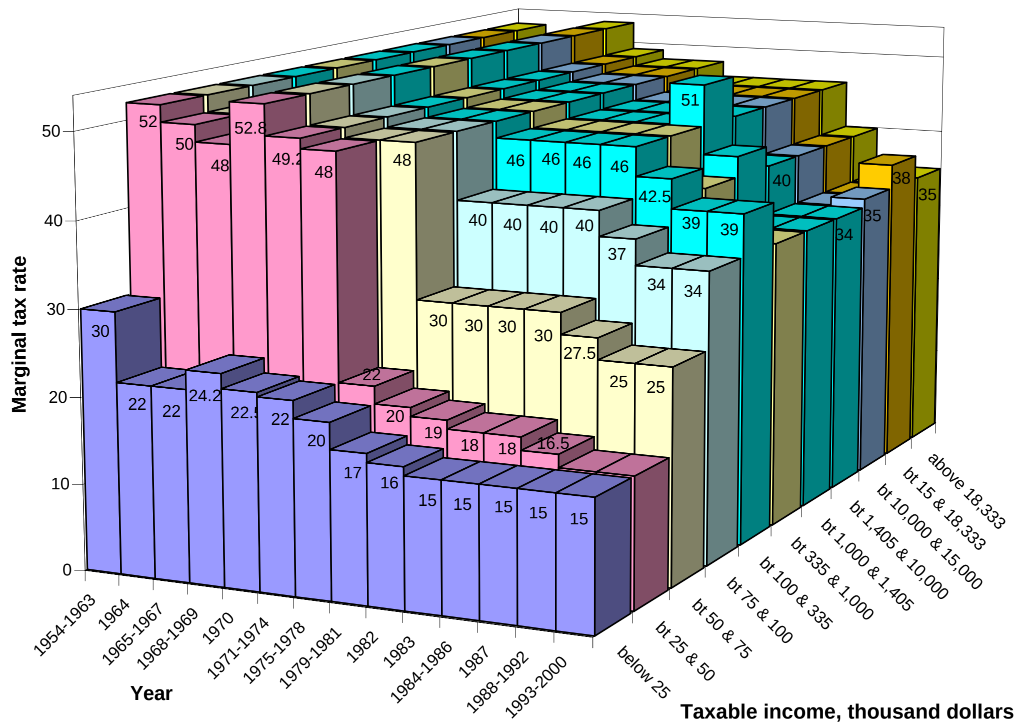
In each regression, the same set of independent variables as in columns (3)-(5) of Table 2 is included in the regressions, but not reported.

Figure 1. Ratio of long-term to total debt, by firm assets, 1954-2000



Note: Real assets per firm are on the x-axis, where log scale is used. The label is the year of the observation.
Source: Authors' calculation using *SOI Corporate Returns.*

Figure 2. US Corporate tax rate structure, 1954-2000



Note: All figures represent nominal income.
Source: Gordon and Lee (2001), updated to year 2000.