

Debt and the marginal tax rate

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Abstract

Do taxes affect corporate debt policy? This paper tests whether the incremental use of debt is positively related to simulated firm-specific marginal tax rates that account for net operating losses, investment tax credits, and the alternative minimum tax. The simulated marginal tax rates exhibit substantial variation due to the dynamics of the tax code, tax regime shifts, business cycle effects, and the progressive nature of the statutory tax schedule. Using annual data from more than 10,000 firms for the years 1980–1992, I provide evidence which indicates that high-tax-rate firms issue more debt than their low-tax-rate counterparts.

Key words: Debt; Capital structure; Marginal tax rate; Taxes

JEL classification: G32; H20

1. Introduction

The marginal tax rate plays an important role in many topics in finance, including cost of capital calculations, debt policy and corporate compensation decisions, and relative pricing between taxable and nontaxable securities. Given its importance, it is surprising that the marginal tax rate (*MTR*) is almost never explicitly calculated. Instead, proxies are used to gauge a firm's tax status

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although these proxies are at best indirect and can be misleading.¹ This could explain why most financial research fails to find that tax considerations are an important factor in corporate financial decisions.²

Recent work by MacKie-Mason (1990), Shevlin (1990), and Scholes and Wolfson (1992) suggests that there are shortcomings with the manner in which tax effects have been tested in the past. The main thrust of this paper is to address these shortcomings by i) explicitly calculating company-specific marginal federal income tax rates and ii) using these rates to examine incremental financing choices, thus allowing for a direct test of whether tax status influences corporate debt policy.

Financial theory is clear that the *marginal tax rate* is relevant when analyzing incremental financing choices. However, the *MTR* is rarely, if ever, explicitly calculated because doing so requires the use of complex tax-code formulas at the federal, state, and international levels. In this paper, company-specific tax-code-consistent marginal tax rates are explicitly calculated, using an expanded version of the method first employed by Shevlin (1990), who simulates marginal tax rates over a forecasted stream of taxable income to account for the carryforward and carryback tax opportunities related to net operating losses; I extend this approach to incorporate the effect of investment tax credits and the alternative minimum tax. The simulated tax variable calculated here appears to offer a more refined measure of tax status than other tax proxies.

To appropriately capture the relation between debt and taxes, it is also important to analyze *incremental* financing decisions. To see why, imagine a company with a high marginal tax rate and virtually no debt. Suppose that this firm issues substantial debt to exploit the interest-deduction benefit offered by a high marginal tax rate. Such an action implies a positive relation between the tax rate and the choice of debt as financial instrument. However, increasing a firm's fixed debt obligation can lower its expected *MTR* by shifting the company to a lower tax bracket or by increasing the probability that the firm will pay no taxes. As a result, a time series of this company's financial data could contain high-*MTR*/low-debt and low-*MTR*/high-debt observations. A standard approach would be to regress this company's debt/equity ratio on its tax

¹Tax proxies include nondebt tax shields (Bradley, Jarrell, and Kim, 1984; Titman and Wessels, 1988; Mackie-Mason, 1990; Kale, Noe, and Ramirez, 1991), taxes paid over pre-tax income (Fisher, Heinkel, and Zechner, 1989; Givoly, Hahn, Ofer, and Sarig, 1992), or dummy variables equal to one if a firm has a net operating loss carryforward and equal to zero otherwise (Scholes, Wilson, and Wolfson, 1990; analogously, most cost of capital calculations effectively use an net operating loss dummy equal to either the top statutory rate or zero).

²See, for example, Myers (1984), Bradley, Jarrell, and Kim (1984), Titman and Wessels (1988), Smith and Watts (1992), and Gaver and Gaver (1993). Fisher, Heinkel, and Zechner (1989) have mixed results for the tax hypothesis.

status, yielding a negative coefficient – exactly the wrong inference. Therefore, examining *cumulative* measures of financial policy, such as the debt/equity ratio, to test whether tax status affects financing choice can lead to a misinterpretation of the relation between taxes and corporate policy. This paper examines changes in debt, rather than levels, to focus on incremental financing and documents a positive relation between tax rates and the use of debt as a financing instrument.

MacKie-Mason (1990) studies incremental financing decisions by converting the choice of debt over equity into a zero–one event, considering only registered security offerings and using a proxy for the marginal tax rate. I look at changes in debt levels, appropriately scaled; my approach incorporates changes in debt due to sinking-fund payments, conversion of equity into debt, etc., as well as registered offerings. We both conclude that high-tax firms are more likely to finance with debt than are low-tax firms. Givoly, Hahn, Ofer, and Sarig (1992) also use change in debt as the dependent variable. They use the lagged average of taxes paid divided by taxable income as an independent variable to measure tax status. Their tax variable is consistent with, although cruder than, using the level of the marginal tax rate as an explanatory variable; however, the variable is also consistent with their interpretation of it as a proxy for the *change* in the marginal tax rate associated with the reduction in statutory corporate tax rates resulting from the Tax Reform Act of 1986. (Note that it is possible to explicitly calculate the change in the marginal tax rate using the tax variable derived in the present paper.) Their results also indicate a positive relation between the tax variable and the change in debt.

The *MTR* calculation incorporates the effects of tax deductions and tax credits. If a company has enough nondebt tax shields (*NDTS*) to lower its expected *MTR*, the company will issue less debt than an identical firm without the shields. This is consistent with the claim by DeAngelo and Masulis (1980) that debt substitutes can lead to a firm-specific optimal leverage decision. However, my results indicate that the impact on debt policy of traditional measures of *NDTS*, such as depreciation expense and the investment tax credit, appears to be small in comparison to the influence of net operating losses.

The debt policy equation is estimated on a pooled cross-section of differenced time series data for a collection of over 10,000 Compustat firms. In testing the relation between tax status and financing choice, it is necessary to control for other factors which affect debt policy. By including control variables, it is possible to determine that the marginal tax rate is not proxying for another explanatory effect and that tax effects account for about 15% of our ability to explain debt policy. The control factors indicate that firms with high free cash flows *decrease* their debt holdings on average, firms which are growing larger or increasing research and development expenditures are likely to use debt financing, and that the usual measure of a company's growth status (book value over market value of the firm) has an ambiguous effect on incremental debt policy.

The rest of the paper proceeds as follows. Section 2 discusses how to explicitly calculate the marginal tax rate and presents its empirical distribution. Section 3 describes tax theories of capital structure. Section 4 discusses the data, while Section 5 presents the econometric techniques and results. Section 6 concludes the paper.

2. The marginal tax rate

The marginal tax rate is defined as the present value of current and expected future taxes paid on an additional dollar of income earned today. Explicit calculation of the *MTR* involves two essential features: 1) reasonably mimicking the federal tax code treatment of net operating losses (*NOLs*), investment tax credits (*ITCs*), and the alternative minimum tax (*AMT*),³ and 2) measuring managers' tax rate expectations at the time debt policy choices are made. The following discussion on losses and credits follows that in Altshuler and Auerbach (1990, pp. 63–65).

2.1. Losses, credits, and the *AMT*

Each year a firm calculates its current-year taxable income, TI_t , before credits; if the result is positive, the firm determines its pre-credit tax bill and proceeds to the credit calculations. If taxable income is negative, the firm has a net operating loss. The loss can be 'carried back' and used to offset taxable income in the preceding three years, starting with TI_{t-3} . If TI_{t-3} is completely offset, the firm next applies the losses to TI_{t-2} , and likewise to TI_{t-1} . The tax bill is recalculated for any year in which losses are carried back; the firm receives a refund if any previous-year tax bill is lowered.

If current-year losses more than offset the total taxable income from the preceding three years, the losses are then 'carried forward' and used to offset taxable income for up to 15 years into the future (changed from five years by the Economic Recovery Act of 1981). The term *carryforward* thus applies only when

³Ideally, the effect of foreign tax credits should also be considered because firms can receive a domestic tax credit for taxes paid overseas. I ignore foreign tax credits because Compustat does not provide data on company-specific repatriated foreign income. I also ignore state income taxes, even though they can be as high as 10%, because 1) gathering the data necessary to examine state taxes would be a formidable task, as the tax rules vary widely by state, and 2) assigning a state of operation to each company using Compustat data would likely be a very noisy procedure because many companies have operations in multiple states and Compustat only provides information about the state in which the company is headquartered. For more details on the federal tax code, see Courdes and Sheffrin (1983), Altshuler and Auerbach (1990), Shevlin (1990), or Scholes and Wolfson (1992).

carryback potential has been fully exhausted. If a company experiences losses in more than one year, the incremental losses are added to any unused losses from previous years; the carryback and carryforward procedures are then applied to taxable income, net of any previously taken losses, with the oldest losses applied first. Although the tax-code allows firms to bypass the carryback feature and choose to only carry losses forward, I assume that firms never bypass the carryback feature.

When available the Compustat net operating loss carryforward figure is used for net operating losses. Otherwise, I follow the lead of Altshuler and Auerbach (1990) and Shevlin (1990) and assume that the *NOL* carryforward is zero in 1972 and begin accumulating *NOLs* in 1973.

The relation between operating losses and the *MTR* is not always obvious. For example, a firm with a current-period loss could have a high marginal tax rate. Suppose that current-period losses exactly offset taxable income in the previous three periods. In this case, earning an extra dollar of income today results in the firm's tax refund decreasing by the amount τ_c , where τ_c is the applicable statutory tax rate. Thus, the firm's *MTR* is τ_c , so that the marginal tax rate can be high even when a firm has negative current-period income.

Alternatively, the effective *MTR* of a firm earning positive income today can be low if there is a positive probability that current taxes will be refunded. For example, suppose that we expect *NOLs* to occur next year as well as in all years in the foreseeable future, and that the amount of carried-back losses will more than offset current taxable income; this leads to a tax refund next year. In this case, the *MTR* today equals τ_c minus τ_c discounted one period, a relatively low rate even though current-period taxable income is positive. Thus, all else equal, a firm which is more likely to incur losses in the future will have a lower *MTR*.

These examples demonstrate that the tax treatment of losses can render some *MTR* proxies ineffective. For example, consider the *effective tax rate* equal to taxes paid (which are negative if there is a refund) divided by taxable income. The effective tax rate can be negative, or even greater than one. Typically, extreme effective tax rate estimates are truncated at arbitrary limits to make them more 'reasonable'. The approach used to model marginal tax rates in this paper explicitly models the tax-code treatment of net operating losses, calculates a *MTR* according to the statutory tax schedule, and always results in marginal tax rates between zero and the top statutory rate.

Once operating losses have been netted out against income, a company calculates its investment tax credits. Until the Tax Reform Act of 1986, firms could accumulate investment tax credits of approximately 7% of capital investment. These credits can be used to offset the first \$25,000 of taxes and 85% of taxes in excess of \$25,000 (50% before 1978) and they can be carried forward (back) up to 15 (3) years. The investment tax credit was repealed and accumulated *ITC* carryforwards were reduced by 17.5% in both 1987 and 1988 in association with the Tax Reform Act of 1986, although *ITCs* remained on the

books of some companies as recently as 1994 (and some firms may have *ITC* carryforwards on their books through the end of the century). As will be discussed in the next section, my analysis concentrates on the period 1980–1992; therefore, the *ITC* is a potentially important consideration for this paper.

Finally, the Tax Reform Act of 1986 introduced an alternative minimum tax (*AMT*) in response to some highly publicized cases in which profitable firms paid no federal taxes. The *AMT* is designed to ensure that companies with positive income pay at least some federal income taxes. The *AMT* is calculated by broadening the tax base (i.e., adding back some tax preference items such as accelerated depreciation to taxable income) and calculating an alternative tax based on a flat *AMT* rate. This rate is 20% but can be reduced to an effective 15% of the pre-tax *AMT* base by using *ITCs* or to an effective 2% by using *NOL* carryforwards (or foreign tax credits). An add-on minimum tax existed prior to 1987, but I ignore it in my analysis because, as noted by Altshuler and Auerbach, it had less bite than the *AMT*.

Taxes owed are the maximum of taxes determined from the regular formulas and those from the *AMT* formulas. If the *AMT* causes additional taxes to be paid due to adding back tax preference items to the tax base, the additional amount can be carried forward indefinitely as a tax credit. Thus, for the most part, the *AMT* affects the timing of tax payments on tax preference items and not the total nominal bill, although it can affect the total bill in certain circumstances. Companies that are highly profitable or consistently experience losses will not likely be affected by the *AMT*. Companies that cycle between losses and profits and companies with high levels of accelerated depreciation are most likely to be affected. See Manzon (1992) for an excellent discussion on the *AMT*.

The Compustat tapes do not provide much information about the tax preference items that are added back to the tax base to determine the alternative minimum tax. Therefore, I use the regular tax base but calculate the tax bill using the *AMT* tax rate. While the total tax bill may be inaccurate (because I use an incorrect tax base), the marginal impact of earning an extra dollar should reflect the true *MTR*. Finally, for ease of computer programming, I only allow an 18-year *AMT* carryforward period rather than the indefinite carryforward period stated in the tax code.

2.2. Simulating expected marginal tax rates

The ability to carry losses and credits forward and backward makes it unlikely that examining current-period financial statements will provide an accurate assessment of a company's *MTR*. Instead, it is desirable to estimate the *MTR* by supplementing historical data with a forecasted stream of future taxable income and then calculate the tax bill over the entire horizon in a manner consistent with the tax rules.

Given the 15-year carryforward feature associated with *NOLs* and *ITCs*, predictions of taxable income at least 18 years into the future should be considered when calculating the current-period *MTR*. For example, the tax consequences of earning an extra dollar of income today may not be realized for 15 years if a firm is not expected to have net taxable income for the next 14 years. Furthermore, TI_{t+15} can be affected by TI_{t+18} due to *NOL* and *ITC* carryback rules; therefore, 18 years of future income streams should be forecasted for each current-period *MTR* simulation. *AMT* carryforward rules allow an indefinite carryforward period; however, the impact beyond 18 years in the future is negligible due to discounting.

To forecast taxable income, I use Shevlin's (1990) main model which states that firm i 's taxable income follows a random walk with drift:

$$\Delta TI_{it} = \mu_i + \varepsilon_{it}, \quad (1)$$

where ΔTI_{it} is the first difference in taxable income, μ_i is the sample mean of ΔTI_{it} , and ε_{it} is distributed normally with mean zero and variance equal to that of ΔTI_{it} over the sample. Taxable income is estimated from the Compustat tapes as pre-tax book income minus deferred tax expense, with the latter term divided by the appropriate statutory corporate tax rate so that it is expressed on a pre-tax basis.

When estimating MTR_{it} for, say, $t = 1980$, forecasts of firm i 's taxable income for the years 1981–1998 are obtained by drawing 18 random normal realizations of ε_{it} and using Eq. (1). Next, the present value of the tax bill from 1977 (to account for carrybacks) through 1998 (to account for carryforwards) is calculated. Taxes paid in the years 1981–1998 are discounted using the average corporate bond yield, as gathered from Moody's Bond Record; taxes for the years 1977–1980 are not discounted or grossed-up because, for all practical purposes, tax refunds are not paid with interest.⁴ The tax bill is calculated using the entire corporate tax schedule, and not just the top statutory rate, as gathered from Commerce Clearing House publications. Next, a dollar is added to 1980's income and the present value of the tax bill is recalculated. The difference between the two tax bills represents the present value of taxes owed on an extra dollar of income earned by firm i in year $t = 1980$ (i.e., a single simulated estimate of MTR_{it}).

⁴An area for future research might be to incorporate firm-specific discount rates, including an equity component. Such an approach would reduce the size of the sample, perhaps considerably, in the process of obtaining firm-specific bond and equity information. Furthermore, this is a delicate issue because i) there is a circularity between weighted average after-tax discount rates and marginal tax rates, and ii) the appropriate firm-specific rate should reflect the tax status and investment choices of the marginal investor. Using the economy-wide bond rate sidesteps these issues (but does incorporate the economy-wide time value of money). Abstracting from uncertainty, using the bond yield is correct if the marginal investor between equity and corporate debt is a tax-free entity (e.g., a pension fund).

The simulation procedure just described is repeated 50 times to obtain 50 estimates of 1980's MTR ; each simulation is based on a new forecast of 18 years of taxable income. The 50 estimates of the marginal tax rate are averaged to determine the expected MTR_{it} for firm i in year $t = 1980$. This provides a single expected MTR_{it} for a single firm-year. The standard deviation of the MTR_{it} across the 50 simulations, $\sigma_{mtr, it}$, measures the precision with which firm i estimates its MTR in year t .

Next, the procedure is repeated 50 times for 1981 using historical data up to 1981 and predicting taxable income for 1982–1999; this produces estimates of MTR_{it} and $\sigma_{mtr, it}$ for firm i in year $t = 1981$. This technique is repeated for each company in the sample, for each year between 1980 and 1992.

Each forecast of taxable income is based upon the firm-specific sample mean and variance of changes in taxable income. Thus, a company with volatile earnings will experience NOL s, ITC deferment, etc., more frequently in its group of 50 estimates than will a company with stable positive earnings. Averaging over the 50 estimates should reflect management's *expectation* of the impact of NOL s, etc., on the firm's marginal tax rate better than would using *ex post* data.

As an example of the simulation procedure, consider the single forecast of taxable income represented by the thick solid line in Fig. 1. If the company under consideration earns an extra dollar of income today, it pays taxes of \$0.34 immediately. In the thick-solid-line scenario, the firm does not expect to experience NOL s at any time during the next 18 years, so its marginal tax rate for this simulation is 34%. In the dashed-line scenario, the firm pays taxes of \$0.34 on the extra dollar earned in period t , but anticipates getting a refund of \$0.34 in period $t + 1$, paying \$0.34 in taxes in period $t + 5$, and then remaining profitable from period $t + 6$ onward. Using a discount rate of 10%, the present value of taxes paid in this simulation is \$0.242. In the thin-solid-line scenario, the firm pays taxes at 34% in period t but expects to obtain a tax refund in period $t + 1$ because it experiences a net operating loss; the firm does not expect to pay taxes again during the next 18 years. Using a discount rate of 10%, the firm's MTR is 3.1% in this simulation ($0.031 = 0.34 - (0.34/1.10)$). The expected marginal tax rate for this firm in period t is 20.4% (which is the average of 34%, 24.2%, and 3.1%). The cross-sectional standard deviation of the rates ($\sigma_{mtr, it}$) in the three scenarios is 15.8%. The actual simulation procedure used in the paper performs 50, rather than three, simulations per MTR_{it} and considers the interplay of the ITC and AMT in addition to influence of net operating losses.

2.3. The empirical distribution of the MTR

Fig. 2 presents the distribution of simulated marginal tax rates for the firms in the sample for 1980, 1984, 1988, 1992, and an aggregation across all years in the sample (See Section 4 for details on sample selection). The data indicate that there is substantial variation in the marginal tax rate across firms and through

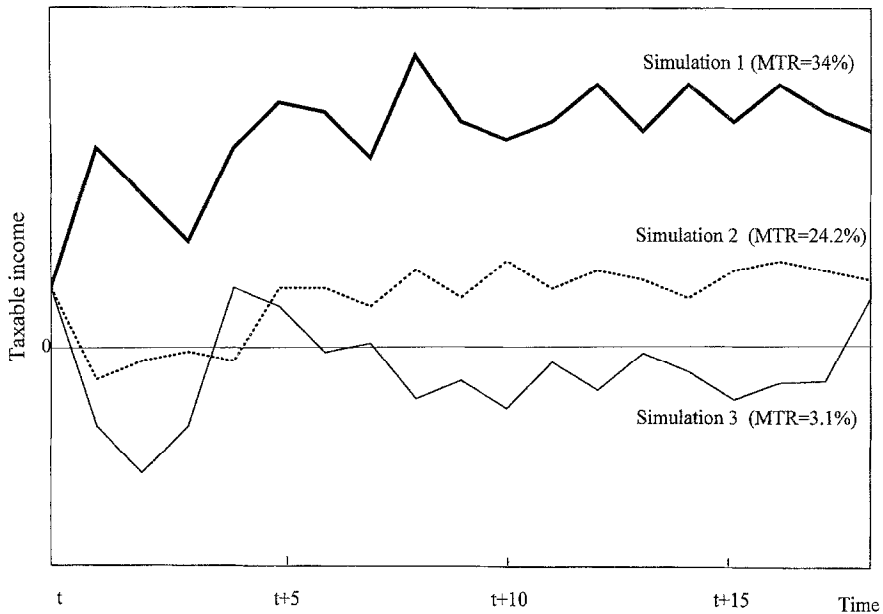


Fig. 1. An example of simulated marginal tax rates, assuming a statutory tax rate of 34%.

The three lines show a firm's forecasted taxable income streams for three different simulations, where taxable income follows a random walk with drift. In simulation 1, the firm pays \$0.34 in taxes on an extra dollar of income earned in period t , is profitable from period $t + 1$ to period $t + 18$, and therefore has a marginal tax rate of 34% in period t . In simulation 2, the firm pays \$0.34 in taxes in period t , receives a \$0.34 refund in period $t + 1$, and then pays \$0.34 in taxes in period $t + 5$. Assuming a discount rate of 10%, the present value of taxes owed on the extra dollar of income earned in period t , and hence the firm's marginal tax rate, is 24.2% in simulation 2. In simulation 3, the firm pays taxes of \$0.34 in period t , receives a refund in $t + 1$, does not pay taxes again through period $t + 18$, and has a marginal tax rate of 3.1%. In simulation 3, the firm does earn positive taxable income in periods $t + 4$, $t + 5$, $t + 7$, and $t + 18$ but does not pay taxes in any of those periods because it has a net operating loss carryforward. The firm's expected marginal tax rate in period t is 20.4% (i.e., the average of 35%, 24.2%, and 3.1%).

time. In any given year, about one-third of the firms have *MTRs* equal to the top statutory tax rate, about one-fifth have *MTRs* of zero, and the rest have *MTRs* ranging between zero and the highest rate. The cross-sectional variation in tax rates occurs because of the carryforward and carryback features of the federal tax code, as well as the progressive nature of the corporate tax rate schedule (i.e., some firms are not subject to the highest statutory tax rate). The relatively large percentage of low tax rates results because over 25% of the observations in the sample represent firms with negative taxable income.

A large percentage of *MTRs* are in the 30–35% range for 1988 and 1992; this reflects the reduction of the top statutory corporate tax rate to 34% starting in

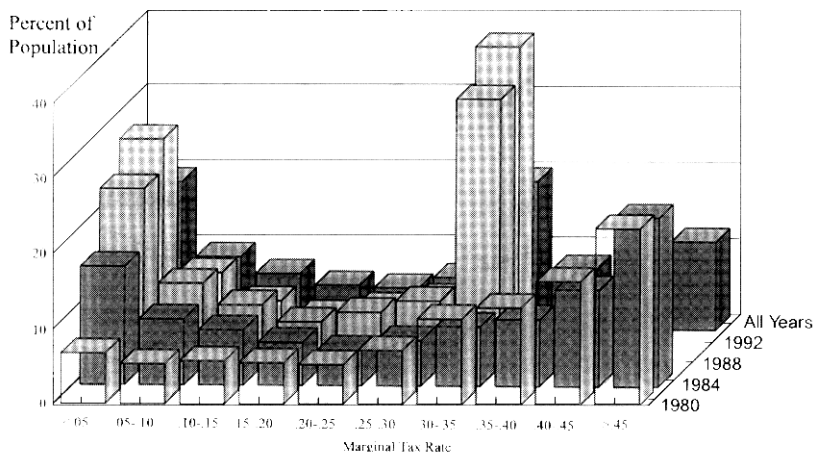


Fig. 2. The empirical distribution of the marginal tax rate.

The distribution of the marginal tax rate for all firms on the Compustat tapes with nonmissing taxable income data, a total sample of 10,240 firms. The distributions are shown for the years 1980, 1984, 1988, and 1992, and aggregated across all years from 1980–1992. The marginal tax rate is calculated for a given year as the present value of additional taxes owed from earning an extra dollar of income in that year. The tax calculation considers the effect of net operating losses, the investment tax credit, the alternative minimum tax, and other nondebt tax shields such as depreciation.

1988 (from 46% prior to the Tax Reform Act of 1986). Also, a much larger percentage of firms have *MTRs* near zero in 1988 and 1992 than in the other years. This is probably because approximately 35% percent of the firms in the sample experienced losses in the late 1980s and early 1990s, while fewer than 20% experienced losses in the early 1980s. Overall, corporate marginal tax rates vary considerably through time due to changes in the tax code and business cycle effects. The annual equally weighted average *MTRs* from 1980–1992 are 33.2%, 32.3%, 30.4%, 29.8%, 28.9%, 26.1%, 25.1%, 22.2%, 19.5%, 19.2%, 19.1%, 19.3%, and 20.0%, respectively. The value-weighted *MTRs* for the same years are 41.1%, 40.5%, 39.5%, 39.3%, 39.7%, 39.3%, 39.3%, 32.8%, 30.0%, 30.0%, 29.8%, 29.4%, and 27.8%.

One tax status proxy which has been used with some degree of success in the past is a dummy variable equal to zero if a company has a net operating loss carryforward and equal to one otherwise (Scholes, Wilson, and Wolfson, 1990). *NOL* status is potentially important because 25% of the observations in the sample are from firms with *NOL* carryforwards, and over 50% of the firms in the sample had *NOL* carryforwards at some point during the period 1980–1992. For a *NOL* dummy variable to be most effective, the distribution of *MTRs* for firms

with *NOL* carryforwards should be concentrated close to zero and the distribution for firms with no *NOL* carryforwards should be concentrated near the top statutory rate. Using the simulated tax rate data, we can directly examine whether these conditions are realized. Panels A and B in Fig. 3 indicate that the conditional distributions are skewed in the appropriate manner; however, less than half the population lies near the appropriate extreme in most years. This suggests that the *NOL* dummy variable does a good job of partitioning tax status, but that simulated tax rates offer a finer partition. (This issue will be examined further in Section 5.3.)

Finally, past empirical research indicates that many corporate policies are correlated with firm size, notwithstanding the frequent absence of theoretical justification for this result. This suggests that it may be worthwhile to examine the empirical distribution of marginal tax rates for groups of small and large firms. To accomplish this, I divided the sample into the smallest and largest size quartiles, based on the year-by-year market value of the firm. Panel C (D) in Fig. 3 indicates that small (large) firms have relatively low (high) marginal tax rates; that is, there is a positive correlation between firm size and marginal tax rates. Therefore, researchers should be careful to separate out tax effects from ‘size effects’ (see also Zimmerman, 1983; Omer, Molloy, and Ziebart, 1993). Also, the relatively small cross-sectional variation in tax rates among large companies indicates that it may be difficult to identify tax effects among, say, Fortune 500 firms. Finally, panel D indicates that large firms were somewhat insulated from the surge of near-zero marginal tax rates that occurred during the late 1980s and early 1990s.

The next section describes how the tax variables are used in the debt policy regression.

3. Explaining debt policy

The numerator for the dependent variable in the debt policy equation, $\Delta DEBT$, is the first difference in the book value of long-term debt. The change in debt level captures the effect of incremental financing; it also measures changes due to sinking fund payments or security-holder conversion of convertible securities. It is unclear if changes associated with the second group of effects represent *intentional* debt policy or are simply artifacts due to imperfect capital markets. For example, if there were no transaction costs, a firm might offset each ‘artifact’ with an intentional action; however, nontrivial transaction costs encourage companies to allow artifacts to accumulate before eventually acting to reinstate the optimal debt policy. Therefore, in an effort to isolate intentional changes in debt, an alternative debt policy variable is also examined which represents changes in debt worth at least 2% of lagged capital structure.

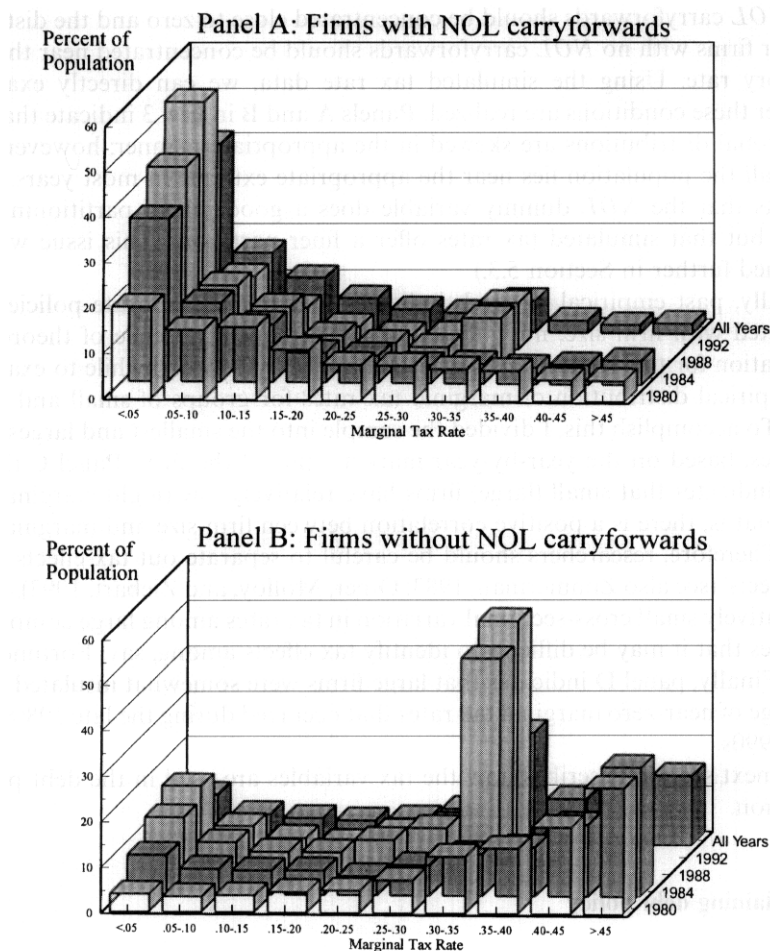


Fig. 3. The empirical distribution of the marginal tax rate given *NOL* carryforward status or firm size.

Panel A (B) shows the distribution of the marginal tax rate for all Compustat firms with nonmissing taxable income data which have (do not have) net operating loss carryforwards; firms with (without) *NOL* carryforwards comprise approximately 25% (75%) of the sample. Panel C (D) shows the distribution of the marginal tax rate for all Compustat firms with nonmissing taxable income data in the smallest (largest) quartile of firms, where size is defined by market value of the firm. The data are presented for the years 1980 (1981 for size conditioning), 1984, 1988, and 1992, and aggregated across all years from 1980–1992. The total sample contains tax rates for 10,240 firms. The marginal tax rate is calculated for a given year as the present value of additional taxes owed from earning an extra dollar of income in that year. The tax calculation considers the effect of net operating losses, the investment tax credit, the alternative minimum tax, and other nondebt tax shields such as depreciation.

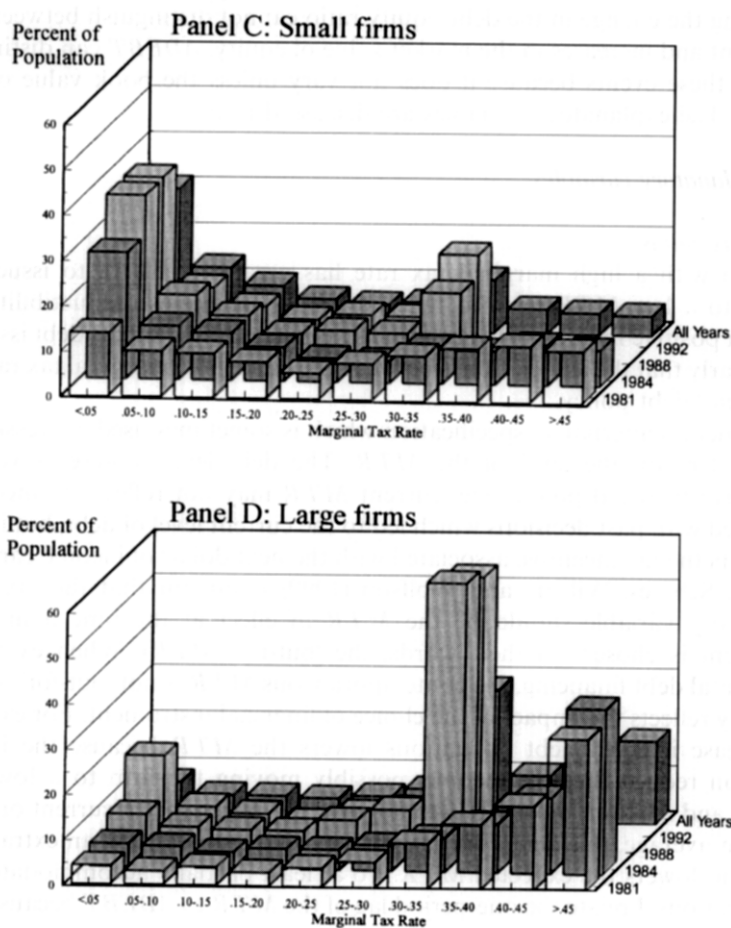


Fig. 3 (continued)

The value of $\Delta DEBT$ is deflated by the lagged market value of the firm, defined as the book value of debt plus the market value of equity. This is a common adjustment which standardizes the unit of measurement across firms. Note that the dependent variable is not the change in the debt/value ratio; it is defined as the first difference in $DEBT$ (performed first) divided by lagged firm value (performed second). This definition helps attenuate possible mismeasurement of debt policy due to large variation in the market value of equity. For example, suppose that a firm does not raise capital in a given year but that the value of its existing equity increases due to a booming stock market. This may cause the firm's debt/equity ratio to shrink considerably. Thus, a variable

measuring the change in the debt/equity ratio cannot distinguish between debt retirement and increases in the market value of equity. $\Delta DEBT$ can distinguish between these events because it does not vary unless the book value of debt changes. The explanatory variables are discussed next.

3.1. Explanatory variables

3.1.1. Tax status

A firm with a high marginal tax rate has greater incentive to issue debt, relative to a low- MTR firm, to take advantage of interest deductibility; this implies a positive relation between firm i 's tax rate, MTR_i , and its debt issuance. Note clearly that the association is between the *level* of the marginal tax rate and *incremental* debt policy.

Consider an alternative specification which is sometimes used: regressing the level of debt on the level of the MTR . The debt level represents years of cumulative financial policy. The current MTR may not reflect the incentives associated with past decisions which led to the current level of debt, but instead represents the tax incentive associated with the next dollar of income earned or shielded. Scholes, Wilson, and Wolfson (1990) point out that the tax status explanatory variable should be the MTR in effect at the time a financing instrument is chosen (in their words, the 'but-for' MTR). When examining incremental debt financing, the contemporaneous MTR is not 'but-for' because it already reflects the impact of the choice of financial instrument. For example, an increase in fixed debt obligations lowers the MTR because the interest deduction reduces taxable income, possibly moving the firm to a lower tax bracket, and makes it more likely that a firm will experience a current or future NOL ; on average, this defers the tax obligation due to earning an extra dollar today and lowers the expected MTR . To at least partially accommodate these considerations, I relate the one-period lag of the MTR to $\Delta DEBT$ because these variables are both consistent with decisions made at the margin.⁵

Although MTR_{it-1} is probably a very reasonable proxy for management's perception of the 'true' MTR as they make decisions in period t , it may suffer two limitations as a but-for tax measure. The true tax rate to gauge the tax advantage of interest deductibility should probably i) be an average of future expected MTR s (matching the life of the debt instrument) and ii) reflect the impact of deducting the total amount of interest and not just one dollar's worth. However, correcting for these issues is beyond the scope of this paper because doing so would require issue-specific information on principal and coupon rates (not available from Compustat) and a much more complicated MTR simulation algorithm.

⁵Rather than using a lagged tax variable, Graham, Lemmon, and Schallheim (1995) measure but-for tax status with a simulated variable based on contemporaneous earnings *before* interest and taxes.

It is sometimes argued that firms with volatile income streams issue less debt than firms with stable streams. However, this argument is not very persuasive when comparing a firm with profits which vary between, say, three and nine million dollars each year versus a firm which makes six million dollars each year. The impact of volatility on debt issuance is much more important if the volatility jeopardizes the firm's ability to take interest tax deductions. Recall that volatility reduces the expected MTR for firms which cannot take interest deductions in every state of nature (because of carryforwards, etc.); in fact, it may seem that for a risk-neutral firm volatility is only relevant to the degree that it lowers the expected MTR . However, if the MTR is an increasing function of taxable income (i.e., if the function mapping taxable income into tax liability is convex), then a firm with a large value of σ_{mtr} will have a larger expected tax bill than a firm with an identical MTR but a lower σ_{mtr} , and therefore issue debt more aggressively. If this hypothesis is true, the coefficient on σ_{mtr} should be positive. (Recall that $\sigma_{mtr,it}$ is the standard deviation of the estimated MTR_{it} for firm i across 50 tax simulations associated with year t .)

Finally, the simulated tax rate provides a mechanism for estimating a firm's 'true' MTR ; however, in a large cross-section of firms, is it reasonable to expect that *all* managers make leverage decisions based on the simulated rate? If some managers make decisions based on their firm's current statutory tax status, then estimated regression coefficients should indicate that, on average, firms with statutory rates above (below) the expected MTR will issue more (less) debt than firms for which the statutory rate equals the expected rate. That is, $\tau_{stat,it-1} - MTR_{it-1}$ should be positively related to debt usage, where $\tau_{stat,it-1}$ is firm i 's statutory tax rate in period $t-1$. According to this hypothesis, the coefficient on this variable will be zero if firms make tax-based leverage decisions based solely on simulated rates.

3.1.2. The relative cost of debt and equity

In the spirit of Miller (1977), DeAngelo and Masulis (1980), and Scholes and Wolfson (1992), it can be argued that the relation between the personal tax rate on interest payments, the personal tax rate on equity, and the corporate tax rate can influence the choice between debt and equity financing. In particular, suppose that there is a marginal investor who is indifferent between the after-tax returns from debt and equity. For a given level of risk, this determines the equilibrium relation between debt and equity prices which in turn defines MTR^* for which some marginal corporation is indifferent between the after-corporate-tax proceeds from issuing debt or equity. Corporations with a marginal tax rate above (below) MTR^* have an incentive (disincentive) to issue debt relative to issuing equity. If so, the relative tax advantage associated with debt, $ADVDEBT$ (defined as $(1 - \tau_{debt})/[(1 - \tau_{equity})(1 - MTR_{it-1})]$), should be positively related to debt issuance. This variable primarily captures the effect of the Tax Reform Act of 1986 on the relative tax advantage of debt. The average

annual values of *ADVDEBT* for the years 1981–1992 are 0.97, 0.99, 1.03, 0.99, 0.99, 1.01, 1.08, 1.33, 1.28, 1.27, 1.28, and 1.29, respectively. Given that MTR_{it-1} is already included in the regression, an alternative specification which excludes $(1 - MTR_{it-1})$ from the denominator of *ADVDEBT*, and thereby examines only the effect of relative personal tax rates on debt and equity, will also be examined.

The personal tax rate on interest for the marginal investor, τ_{debt} , is inferred from the lagged difference between the one-year yield on municipal and taxable bonds, as published in Salomon Brother's Bond Market Roundup. The personal tax rate on equity income, τ_{equity} , is equal to the lagged tax rate on long-term capital gains.

3.1.3. Probability of bankruptcy

If bankruptcy is costly, many theories argue that debt usage should be a decreasing function of the probability of bankruptcy (e.g., Bradley, Jarrell, and Kim, 1984; MacKie-Mason, 1990). Like MacKie-Mason, I use a variant of Altman's (1968) *ZPROB* to measure the probability of bankruptcy. *ZPROB* equals total assets divided by the sum of 3.3 times earnings before interest and taxes plus sales plus 1.4 times retained earnings plus 1.2 times working capital. My measure is the inverse of MacKie-Mason's. The theory implies a negative coefficient on *ZPROB*. Recall that MTR_{it} already measures the expected effect of entering non-tax-paying status (such as bankruptcy) on the interest deductibility incentive to issue debt. Therefore, *ZPROB* may empirically capture other direct and indirect costs of bankruptcy, such as legal fees, soured relations with suppliers and creditors, the drain on management time, agency costs associated with debt, etc.

An alternative approach to measuring non-interest-deduction incentives to avoid financial distress is also available. For the most part, companies which have *NOL* carryforwards are currently, or have recently been, experiencing some level of financial distress. It is likely that creditors and suppliers for these firms will be 'on alert' and will threaten to withhold future supplies, or only provide them at a very high cost, if there is any indication that the firm cannot meet its fixed obligations. This can create a disincentive to issue debt for a firm currently experiencing a net operating loss, relative to a firm not currently experiencing a loss, even if both firms have the same *expected* marginal tax rate (because the expected *MTR* reflects the tax implications of bankruptcy, but not the costs associated with suppliers, legal fees, etc.). If so, firms currently in *NOL* carryforward status might issue debt less aggressively than firms without carryforwards because of the offsetting effect of expected bankruptcy costs. This hypothesis can be tested by interacting MTR_{it-1} with dummy variables indicating whether a firm has an *NOL* carryforward: $MTR_{NOL, it-1}$ ($MTR_{nonNOL, it-1}$) is equal to MTR_{it-1} if firm *i* had (did not have) an *NOL* carryforward in period $t - 1$, and equals zero otherwise. If the expected bankruptcy cost hypothesis is

true, firms with *NOLs* will issue debt less aggressively than firms without *NOLs* (i.e., the estimated coefficient on $MTR_{NOL,it-1}$ should be less than the coefficient on $MTR_{nonNOL,it-1}$). Note that this hypothesis must be tested in a separate regression from a specification which includes MTR_{it-1} as a stand-alone variable.⁶ Another possibility would be to include, say, MTR_{it-1} and $MTR_{NOL,it-1}$ in the same regression. I use $MTR_{NOL,it-1}$ and $MTR_{nonNOL,it-1}$ to facilitate comparison between simulated tax rates and the *NOL* dummy variable. For example, the coefficient on $MTR_{NOL,it-1}$ ($MTR_{nonNOL,it-1}$) is associated with the sample of data shown in panel A (B) of Fig. 3.

3.1.4. Nondebt tax shields

DeAngelo and Masulis (1980) argue that nondebt tax shields are a substitute for the interest deduction associated with debt; therefore, the optimal amount of debt in a firm's capital structure is a decreasing function of *NDTS*. It follows that an increase in *NDTS* should, all else equal, be accompanied by a reduction in debt. *NDTS* are measured as the sum of book depreciation and *ITC*. The variable included in the regression is first differenced and then deflated by the lagged market value of the firm to be consistent with the dependent variable. The change in research and development (ΔRD) and advertising expenses (ΔAD) can also be viewed as *NDTS* and should be negatively related to debt usage if they serve as tax substitutes (Bradley, Jarrell, and Kim, 1984).

MacKie-Mason argues that an extra dollar of *NDTS* does not crowd out interest deductibility for profitable firms; e.g., a company with large *NDTS* may be profitable, have a high *MTR*, and issue a lot of debt. On the other hand, a company experiencing 'tax exhaustion' (e.g., a firm which has exhausted all contemporaneous tax write-off opportunities because it has *NDTS* that more than offset operating income) is likely to avoid debt financing because the associated interest deduction is crowded out by *NDTS*. Therefore, *NDTS* should have a negative influence on debt usage for firms with a high value for *ZPROB* (because these companies are close to tax exhaustion and most likely cannot fully exploit the deductibility of interest). That is, a high value of *ZPROB* is consistent with a low *MTR*, according to this argument, and implies that debt can be crowded out by *NDTS*. MacKie-Mason conjectures a negative

⁶There could, of course, be *NOL* (non*NOL*) firms which issue debt aggressively (cautiously) because they anticipate that their *NOL* status will change in the near future; this would offset the effect cited in the text. It is an empirical question as to which effect dominates. It is also difficult to empirically distinguish the test of whether managers simulate tax rates from the test of whether expected bankruptcy costs matter. For example, the coefficient for $MTR_{NOL,it-1}$ will be lower than the coefficient for $MTR_{nonNOL,it-1}$ if not all managers simulate tax rates because *NOL* (non*NOL*) firms have low (high) statutory tax rates, on average. This is the same relation as hypothesized in the expected bankruptcy cost argument; that is, the two arguments are empirically similar. Analogously, $\tau_{stat,it-1} - MTR_{it-1}$ may be positively related to debt usage if firms with high (low) expected bankruptcy costs have a lower (higher) statutory rate than their expected rate.

coefficient on his ‘debt substitution’ variable (*NDTS* times *ZPROB*). In summary, MacKie-Mason separates the ‘profitability’ and ‘debt substitution’ aspects of nondebt tax shields by using *NDTS* and *NDTS* interacted with *ZPROB* as two separate variables; his results are consistent with the profitability (debt substitution) component being positively (negatively) related to debt usage.

MacKie-Mason’s approach has strong intuitive appeal. However, the ability of a firm to carry losses and *NDTS* backward or forward is only modeled indirectly, through the interaction with *ZPROB*, and is not reflective of the tax code. In contrast, my simulated *MTR* calculation directly measures the effect of *NDTS* on the marginal tax rate in a manner which is consistent with the federal tax code. As noted by MacKie-Mason (p. 1474), ‘tax shields should matter only to the extent that they affect the marginal tax rate on interest deductions’. Thus, the predominant tax effect of *NDTS* should be captured by the simulated *MTR*.

Finally, the general point of the DeAngelo and Masulis article is that company-specific optimal debt policies may arise because companies have varying abilities to deduct interest expense. This is consistent with the tax hypothesis stated above, given the explicit modeling of the tax code in the simulated *MTR* calculation.

3.1.5. Control variables

While the primary focus of this paper is to investigate whether leverage decisions are affected by tax status, it is important to control for competing explanations of debt policy. Otherwise, it is possible that the tax variables do not really test tax hypotheses but instead proxy for other explanations of debt policy, such as firm quality. Including control factors also allows us to determine the relative contribution of tax variables to the debt policy specification. Briefly, the regression equations estimated below include control variables to proxy for each firm’s free cash flow, investment opportunity set, size, R&D and advertising expense, and asset tangibility. When appropriate, the control variables are expressed in difference form to be consistent with the specification of the dependent variable, although *ZPROB* and *ZPROB* interacted with *NDTS* are not differenced because using these variables in level form allows for a more direct comparison of the results derived here with those in MacKie-Mason’s article (first-differenced forms of these variables do not change the conclusions drawn about the other explanatory variables). A detailed explanation of the capital structure theories related to each control variable is available from the author upon request. (An abbreviated description of the variables appears in the footnotes to Table 2.)

4. The data sample

The data are gathered from the annual Compustat Full-Coverage (NASDAQ, OTC, some NYSE, and regional-exchange firms which file 10-K forms with the SEC), Primary, Secondary, and Tertiary (large NYSE companies) and merged

industrial research (firms which have dropped off the other tapes because of mergers, LBOs, liquidation, etc.) tapes. These tapes contain information from 1973 through 1992. The *MTR* simulations require a start-up period to accumulate *NOLs*. Data from 1973–1979 are used as the start-up period and from 1980–1992 to simulate marginal tax rates. There are 88,282 observations, representing 12,197 companies, available over the 1980–1992 period. This total is misleading, however, because a firm which exists for one year is assigned 20 observations, one with data and 19 with missing values, by Compustat. After deleting observations with missing values for the control variables, the sample contains 64,445 observations covering 10,865 companies.

Financial firms (with two-digit SIC codes between 60 and 64) are deleted from the sample because they follow a different set of tax rules. This eliminates 2,610 observations and 468 firms. Observations are also eliminated if the absolute value of the change in debt, or the absolute change in other variables deflated by market value, is greater than the lagged market value of the firm. This helps eliminate outliers such as firms in severe financial distress or perhaps data coding errors on the Compustat files and deletes an additional 658 observations and 44 firms.

The analysis of debt policy is limited to 1981–1992 because the *MTR* lagged one period is used as an explanatory variable. This requirement results in the deletion of an additional 6,990 observations and 113 companies. The final sample has 10,240 firms and 54,181 firm-year observations.

$\Delta DEBT$ has a mean of 0.008 and a standard deviation of 0.139 indicating that the average firm had a 0.8% annual increase in debt usage over the sample period. Sample statistics for the tax variables are included in Table 1. The *MTR* ranges between zero and 0.46, with a mean of 0.241 and a standard deviation of 0.154. The other variables also exhibit a reasonable amount of variation across the sample. Note that the effective tax rate has a mean of 0.196, but that it ranges from -620.9 to 623.3 . Also, both *NDTS* interacted with *ZPROB* and the effective tax rate are essentially uncorrelated with the other tax variables.

There is a modest degree of collinearity across the proposed tax variables. To investigate possible effects of multicollinearity, I drop the variables with cross-correlations greater than 0.10 from the regression, one at a time. The results for the remaining variables are essentially unchanged, with the exception that the sign of *ADVDEBT* (representing the relative tax advantage of debt) changes when *MTR* was dropped from the regression specification. (This exception will be discussed below.)

5. Empirical results

5.1. Econometric technique and primary findings

Coefficients for the proposed independent variables are estimated in a linear regression. The standard errors are obtained using White's (1980) technique and

Table 1
Descriptive statistics of the tax variables

	Mean	Std. dev.	Minimum	Maximum
MTR_{t-1}^a	0.241	0.154	0.000	0.460
$\sigma_{mix,t-1}^b$	0.071	0.058	0.000	0.203
$\tau_{stat,t-1} - MTR_{t-1}^c$	0.026	0.188	- 0.460	0.460
$MTR_{NOL,t-1}^d$	0.039	0.095	0.000	0.460
$MTR_{nonNOL,t-1}^e$	0.202	0.174	0.000	0.460
$ADVDEBT_{t-1}^f$	1.130	0.257	0.638	1.726
$NDTS_t * ZPROB_t^g$	0.043	2.215	- 141.6	312.6
Effective tax rate ^h	0.196	7.769	- 620.9	623.3
NOL dummy variable ⁱ	0.264	0.441	0.000	1.000

Cross-correlations								
	σ_{mir}	$\tau_{stat} - MTR$	MTR_{NOL}	MTR_{nonNOL}	$ADVDEBT$	$NDTS^* ZPROB$	Effective tax rate	NOL dummy
MTR	-0.098	-0.301	0.078	0.841	0.563	0.005	0.012	-0.370
σ_{mir}	1.000	0.130	0.058	-0.117	-0.344	-0.006	0.005	0.008
$\tau_{stat} - MTR$		1.000	-0.110	-0.211	-0.094	-0.007	0.051	-0.013
MTR_{NOL}			1.000	-0.474	-0.026	0.011	-0.002	0.696
MTR_{nonNOL}				1.000	0.512	-0.001	0.012	-0.681
$ADVDEBT$					1.000	-0.005	0.006	-0.286
$NDTS^* ZPROB$						1.000	-0.001	0.003
Effective tax rate							1.000	-0.009

^a One-period lag of the simulated marginal tax rate.

^b One-period lag of the standard deviation of the simulated marginal tax rate.

^c One-period lag of the difference between a firm's statutory and simulated marginal tax rates.

^d One-period lag of the simulated MTR for firms with net operating loss carryforwards; zero for firms without NOL carryforwards.

^e One-period lag of the simulated MTR for firms without net operating loss carryforwards; zero for firms with NOL carryforwards.

^f One-period lag of the ratio (one minus the marginal investor's personal tax rate on interest income) over the quantity (one minus the personal tax rate on long-term capital gains) times (one minus MTR_t). The personal tax rate on interest income is inferred from the yield differential on taxable and tax-free one-year bonds.

^g Nondebt tax shields divided by lagged market value of the firm, the quantity multiplied by the probability of bankruptcy.

^h Taxes paid divided by taxable income.

ⁱ Equal to one if a firm has a NOL carryforward, equal to zero if the firm does not have a NOL carryforward.

are thus heteroscedastic-consistent. The results for the regression using all 54,181 observations are shown in the leftmost columns of Table 2. In Table 2, Δ indicates a first difference and each variable is denoted with a time subscript, t . The firm subscript, i , is suppressed in the table, and throughout the remainder of the text, for notational simplicity. First consider the results for the specification which appear in the leftmost column of the table, which I will refer to as the ‘main regression’ of the paper. The adjusted R^2 is 0.050, and the F -value of 205.1 (p -value < 0.01) confirms the significance of the overall regression equation. With the exception of $ZPROB$, the t -statistics for all of the proposed tax variables are statistically significant at a 5% confidence level. The estimated coefficient of 0.069 on the marginal tax rate confirms a positive relation between tax rates and debt usage. This finding holds for subsamples of firms with high growth and low growth (results not reported), confirming that the MTR does not just proxy for future growth. The coefficient of 0.044 on $\tau_{stat,t-1} - MTR_{t-1}$ indicates that, on average, statutory tax status affects debt decisions; this can occur because either i) not all firms simulate tax rates or ii) expected bankruptcy costs matter (see footnote 6). The positive coefficient on σ_{mtr} is consistent with the notion that firms with larger expected tax bills issue more debt than firms with smaller tax bills, but the same expected MTR .

The coefficient for $ADVDEBT$ has a sign opposite from that hypothesized, possibly because the relative advantage of issuing debt may already be captured in the coefficient on MTR_{t-1} . To investigate this issue further, I run an alternative regression in which MTR_{t-1} is dropped from the specification (results not shown in Table 2); in this case, $ADVDEBT$ is positive, although the overall adjusted R^2 dropped to 0.0466. Finally, to more directly examine the contribution of personal-tax considerations on corporate debt policy, the main regression is rerun after dropping $(1 - MTR_{t-1})$ from the denominator of $ADVDEBT$ [i.e., $ADVDEBT = (1 - \tau_{debt})/(1 - \tau_{equity})$]. The estimated coefficient is negative and significant (results not reported in Table 2). The overall implication of these results is that the relative taxation of debt and equity at the personal level does not seem to affect corporate debt policy in the manner anticipated.

The sign on $ZPROB$ is negative, as hypothesized, but insignificant. Finally, the coefficient on the change in $NDTS$ times $ZPROB$ is negative, as hypothesized, and weakly significant. This is consistent with the notion that not all firms simulate marginal tax rates, or perhaps that the simulation procedure does not model the effect of $NDTS$ perfectly. (The relative explanatory power of the change in $NDTS$ times $ZPROB$ will be compared to that of the simulated tax rate in Section 5.4.)

The third column of Table 2 repeats the regression for observations in which the absolute change in debt is at least 2% of market value. This should eliminate debt changes which are unintentional artifacts due, perhaps, to transactions costs and should also cut down on the noise in the data. This change eliminates

almost one-half of the observations and increases the adjusted R^2 to 0.113. Paring down the data does not change the qualitative results regarding the individual variables. The estimated coefficient on MTR_{t-1} almost doubles to 0.127. These results should be interpreted cautiously, however. Because the intentional debt policy regressions eliminate observations based on the magnitude of the dependent variable, it is possible that the observed increase in coefficients and adjusted R^2 has been spuriously induced. I am unable to distinguish between the ‘eliminate unintentional debt policy’ and ‘spuriously induced’ explanations. I thank Jim Brickley for pointing this out.

Table 2 also contains results for regressions in which MTR_{t-1} is replaced by $MTR_{NOL,t-1}$ and $MTR_{nonNOL,t-1}$ to analyze the possibility that firms which are currently experiencing *NOL* carryforwards will act differently than non*NOL* firms with the same expected marginal tax rate. Given the 0.032 (0.071) coefficient for *NOL* (non*NOL*) firms, it appears that *NOL* firms pursue interest deductibility less aggressively than non*NOL* firms. The differing coefficients for *NOL* and non*NOL* firms could be interpreted as implying either that not all firms expend the resources necessary to simulate marginal tax rates or that *NOL* firms have higher expected bankruptcy costs.

5.2. Cross-sectional analysis

The results so far are based on a pooled cross-section of time series data. To determine if the results hold for nonpooled data, a cross-sectional regression is run for each year in the sample and for an aggregation of the data over three-year and 12-year horizons (see Table 3).

The positive influence of MTR , $\tau_{stat,t-1} - MTR_{t-1}$, and $\sigma_{mr,t-1}$ on debt policy is relatively robust to purely cross-sectional analysis, although there is a noticeable deterioration in the relation between debt policy and MTR in 1986 and 1987, possibly due to the Tax Reform Act of 1986. The effects of MTR and $\tau_{stat,t-1} - MTR_{t-1}$ are generally more significant when the data are aggregated over three or 12 years. This may indicate that equilibrating movements in debt policy take more than one year to occur.

5.3. Sensitivity analysis

I repeat the analysis in Table 2 modifying the definition of the dependent variable so that it measures 1) long-term plus short-term debt and 2) total debt (long-term plus short-term plus convertible debt). The overall results do not change for these alternative specifications. The results are also robust to dropping the data from the merged industrial research tape; this confirms that the observed relations hold for a sample of firms which have not gone out of business or otherwise disappeared from the public record.

Table 2

The results of pooled time-series, cross-sectional regressions estimating the empirical factors which cause debt policy

The full data sample consists of all firms with nonmissing Compustat observations for the dependent and independent variables. The regressions use annual data from 1981–1992. Statistical significance is determined with White (1980) standard errors to correct for heteroskedasticity. The dependent variable in the regressions is the change in debt: $\Delta DEBT_t$.

	Estimated coefficients			
	All observations		Intentional debt policy ($ \Delta DEBT > 0.02$) ^a	
<i>Tax variables</i>				
MTR_{t-1} ^b	0.069*		0.127*	
$\sigma_{mtr,t-1}$ ^c	0.050*	0.054*	0.046**	0.050*
$\tau_{stat,t-1} - MTR_{t-1}$ ^d	0.044*	0.042*	0.070*	0.067*
$MTR_{NOL,t-1}$ ^e		0.032*		0.068*
$MTR_{nonNOL,t-1}$ ^f		0.071*		0.133*
$\Delta VDEBT_{t-1}$ ^g	− 0.008**	− 0.009*	− 0.015*	− 0.017*
$ZPROB_t^h (\times 1000)$	− 0.002	− 0.002	− 0.009	− 0.009
$NDTS_t^i \times ZPROB_t^i$	− 0.001**	− 0.001**	− 0.001*	− 0.001*
<i>Control variables</i>				
$\Delta MATURITY_t^j (\times 1000)$	0.001**	0.001*	− 4.441	− 4.495
$FREE_t^k (\times 1000)$	− 0.003**	− 0.003**	− 0.046*	− 0.046*
$\Delta SIZE_t^l$	0.038*	0.038*	0.061*	0.061*
$\Delta RD_t^m (\times 100)$	0.008**	0.008*	0.009*	0.009*
$\Delta AD_t^n (\times 10)$	0.004	0.004*	0.138*	0.139*
$\Delta NDTS_t^o$	0.227*	0.229*	0.482*	0.482*
$\Delta PLANT_t^p (\times 1000)$	0.003*	0.003*	0.004*	0.004*
$\Delta INTAN_t^q$	0.359*	0.358*	0.445*	0.444*
Intercept	− 0.006	− 0.004	− 0.005	− 0.024
Adjusted R^2	0.050	0.051	0.113	0.114
F-value	205.1*	194.2*	273.4*	258.0*
Durbin–Watson d	2.068	2.068	2.137	2.138
Number of obs.	54181	54181	29835	29835
Mean ($\Delta DEBT$)	0.008	0.008	0.017	0.017

^a $\Delta DEBT$ is the change in long-term book value of debt divided by the lagged level of the market value of the firm.

^bOne-period lag of the simulated marginal tax rate.

^cOne-period lag of the standard deviation of the simulated marginal tax rate.

^dOne-period lag of the difference between a firm's statutory and simulated marginal tax rates.

^eOne-period lag of the simulated MTR for firms with net operating loss carryforwards; zero for firms without NOL carryforwards.

^fOne-period lag of the simulated MTR for firms without net operating loss carryforwards; zero for firms with NOL carryforwards.

As mentioned earlier, the effect of foreign tax credits should be incorporated into the domestic marginal income tax rate calculation; however, Compustat does not provide information on repatriated foreign income. To verify if excluding foreign credits could be biasing the results, the regressions were run on a sample of domestic-only firms, i.e., companies which had no foreign income (as determined by annual Compustat variable 273). The results are essentially unchanged on the domestic-only subsample.

The estimates are also robust with respect to estimation on other subsets of the data. For example, no substantial change occurs if the data is restricted to 1981–1986 or 1987–1992. The results are also essentially unchanged when the simulated 1987 *MTRs* are replaced with rates which accurately anticipate the change in the statutory schedule associated with the Tax Reform Act of 1986. Likewise, the results hold on a subset of firms making products that require specialized servicing and also on a subset of firms that do not require such servicing (see Titman, 1984). Finally, eliminating data for companies that have been involved with a merger or acquisition, as indicated by Compustat footnotes, does not alter the findings.

It was previously noted that *NDTS* times *ZPROB* is a weakly significant measure of tax status. This is also true if the variables associated with the simulated tax rate are dropped from the specification. To further gauge the relative value of simulating tax rates, two other commonly used proxies for the

Table 2 (continued)

^aOne-period lag of the ratio (one minus the marginal investor's personal tax rate on interest income) over the quantity (one minus the personal tax rate on long-term capital gains) times (one minus *MTR_t*). The personal tax rate on interest income is inferred from the yield differential on taxable versus tax-free one-year bonds.

^bProbability of bankruptcy, defined as total assets divided by the sum of 3.3 times earnings before interest and taxes plus sales plus 1.4 times retained earnings plus 1.2 times working capital.

^cNondebt tax shields divided by lagged market value of the firm, the quantity multiplied by the probability of bankruptcy.

^dChange in investment opportunity set: change in book value of assets divided by market value of the firm.

^eFree cash flows: pre-tax, pre-interest-expense cash flow, net of investments and funds from debt and equity issuance or retirement.

^fChange in the log of real sales.

^gChange in research and development expenses as a percentage of sales.

^hChange in advertising expenses as a percentage of sales.

ⁱChange in nondebt tax shields divided by market value of the firm.

^jChange in fixed plant and equipment divided by total assets.

^kChange in intangible assets divided by total assets.

Superscript asterisks indicate significance at $p < 0.01$ (*) and $p < 0.05$ (**).

Table 3
Cross-sectional regressions

The first twelve rows contain the coefficients on the tax variables estimated over a cross-section of firms for one year. The control variables are also included in the regressions but their estimated coefficients are not reported. All firms on the Compustat tapes which do not have missing values for the explanatory variables are included in the regressions. The next four rows show the results for cross-sectional regressions over three-year aggregates of the variables. The last row contains the results from a single cross-sectional regression in which the data are aggregated over the 12-year period 1981–1992. The dependent variable in each regression is $\Delta DEBT$, the change in long-term book value of debt divided by the lagged level of the market value of the firm.

	MTR^a	σ_{mar}^b	$\tau_{stat} - MTR^c$	$\Delta DVDEBT^d$	$ZPROB^e$	$\Delta NDTS^*$ $ZPROB^f$	Adjusted R^2
<i>Annual regressions</i>							
1981	0.034*	0.023	0.042*	n.a.	0.0001**	–0.001*	0.057
1982	0.021	0.040**	0.013**	n.a.	0.0001	–0.010**	0.635
1983	0.072	0.054	0.020**	n.a.	–0.0001*	–0.003*	0.108
1984	0.046	0.108*	0.027*	n.a.	–0.0001	0.002	0.100
1985	0.119*	0.060***	0.036*	n.a.	0.0001	–0.0004	0.083
1986	0.013	0.035	0.023**	n.a.	–0.0045	0.003	0.102
1987	–0.025	0.091*	0.033*	n.a.	–0.0001	–0.0002*	0.099
1988	0.106*	0.051	0.076*	n.a.	0.0001**	–0.007*	0.095
1989	0.012	0.084***	0.061*	n.a.	0.0002**	–0.004	0.085
1990	0.108***	–0.085**	0.098*	n.a.	–0.0001	–0.003	0.049
1991	0.080	–0.050	0.021	n.a.	0.0005**	–0.009*	0.025
1992	0.138*	–0.055	0.033**	n.a.	–0.0007	–0.001	0.030

<i>Three-year aggregates</i>					
1981-1983	0.093*	0.351*	0.033**	-0.001	-0.001*
1984-1986	0.094*	0.262*	0.063*	0.032	-0.002*
1987-1989	0.055***	0.316*	0.106*	0.052*	-0.001
1990-1992	0.234*	-0.148**	0.152*	-0.076*	-0.0004
<i>Twelve-year aggregates</i>					
1981-1992	0.263*	0.657*	0.145*	-0.016*	0.0002
					-0.002
					0.099

^aOne-period lag of the simulated marginal tax rate.

^bOne-period lag of the standard deviation of the simulated marginal tax rate.

^cOne-period lag of the difference between a firm's statutory and simulated marginal tax rates.

^dOne-period lag of the ratio (one minus the marginal investor's personal tax rate on interest income) over the quantity (one minus the personal tax rate on equity income) times (one minus the corporate income tax rate). The personal tax rate on interest income is inferred from the yield differential on taxable versus tax-free one-year bonds. The personal tax rate on equity income is the capital gains tax rate.

^eProbability of bankruptcy.

^fNondebt tax shields divided by lagged market value of the firm, the quantity multiplied by the probability of bankruptcy.

Superscript asterisks indicate significance at $p < 0.05$ (*), $p < 0.10$ (**), and $p < 0.15$ (***).

n.a. stands for not applicable.

marginal tax rate are examined. In particular, MTR_{t-1} , $\tau_{stat,t-1} - MTR_{t-1}$, $\sigma_{mtr,t-1}$, and $ADVDEBT_{t-1}$ are replaced in the main regression by the one-period lag of 1) a dummy variable equal to one when a company has a *NOL* carryforward and, separately, 2) the effective tax rate, i.e., taxes paid divided by taxable income. Both these measures have the correct sign in their respective regressions (results not reported), although only the *NOL* dummy variable is statistically significant. The fact that all of the tax measures have the correct sign in their respective regressions attests to the importance of examining incremental financing policy. The relative explanatory power of the various tax measures is explored more fully below.

Additional unreported regressions are run to determine if MTR_{t-1} measures tax status for two subsets of data: i) firms that do not have a net operating loss carryforward and ii) firms that do. The estimated coefficients are positive and significant in both subsamples, implying that MTR_{t-1} provides a finer partition of corporate tax status than does the *NOL* carryforward categorization (recall panels A and B from Fig. 3).

The estimated coefficient on *NDTS* interacted with *ZPROB* implies that firms near tax exhaustion may decrease their use of debt to avoid losing the tax shield provided by *NDTS*, although the relation is fairly weak statistically. However, recall that the effect of *NDTS* is also directly measured in the simulated marginal tax rate. This suggests that an alternative way to gauge the importance of *NDTS* is to compare the simulated *MTR* to an alternative simulated *MTR* which is identical except that it ignores *NDTS*. To accomplish this, I simulate tax rates based on pre-tax book income *plus depreciation*, and exclude the effect of the *ITC*;⁷ this procedure produces a tax rate which is not affected by *NDTS*. If *NDTS* significantly influences marginal tax rates, then we can expect the tax rates which exclude the effect of *NDTS* to i) vary considerably from the simulated tax rates previously derived in the paper and ii) be less significant in explaining debt policy than the *MTR* that includes the effects of *NDTS*. However, the simulated *MTR* and the non*NDTS* simulated *MTR* have a correlation coefficient of 0.85. Furthermore, the estimated coefficient for the tax variable that excludes the effect of *NDTS* is of the same level of significance as the simulated *MTR* used in the main regression (both variables are significant at p -value < 0.001). Taken together, these results confirm that traditional measures of *NDTS* play a fairly minor role in determining the corporate marginal tax rate.

⁷Technically, *NOL* carryforwards are nondebt tax shields. However, the definition of *NDTS* used throughout the paper applies only to depreciation and *ITC* to remain consistent with the previous literature. To save on computer resources, the analysis in this paragraph only examines firms on the Compustat Primary, Secondary, and Tertiary tape.

5.4. Significance of the estimated coefficients

A statistically significant relation between leverage decisions and tax status has been documented in the previous sections. But how important is tax status as a determinant of debt policy, relative to the explanatory power of other factors causing debt policy (i.e., relative to the control variables)? And how much extra explanatory power do the variables associated with the simulated *MTR* add beyond that in other proxies for the marginal tax rate?

To answer these questions, first note that the adjusted R^2 from a regression using only the control variables and *ZPROB* on the full sample is 4.36%. Although not particularly impressive, an R^2 of 4.36% is in line with results from many cross-sectional studies and/or first-difference specifications. Still, the number is lower than might be expected given the strong tax and other incentives associated with debt financing, probably due to a relatively noisy dependent variable. The question as to why we cannot explain more than 5% of the variation in debt policy is a future challenge for financial researchers. For the time being, any improvements in the adjusted R^2 from including various tax variables in the specification are relative to a fairly low starting point.

With this caveat in mind, and to answer the first question above, consider the ratio of the adjusted R^2 from the full regression (5.00%) to the adjusted R^2 from the control regression (see panel A of Table 4). This ratio implies that the tax variables add about 14.7% to the explanatory power of the debt policy equation ($0.147 = (0.0500/0.0436) - 1$). The percentage of increased explanatory power is 16.3% when *MTR* is replaced by *MTR_{NOL}* and *MTR_{nonNOL}*. Considering a regression including just *MTR* and $\tau_{stat} - MTR$, the simulated tax variables add 13.3% to the explanatory power of the debt policy equation. To the extent that the tax variables are correlated with other explanations of debt policy such as firm size (see Fig. 3), these estimates may represent lower bounds.

To answer the second question about the explanatory power of various proxies for tax status, consider the adjusted R^2 after replacing the simulated tax variables with the other tax proxies used in the finance literature: the *NOL* dummy variable, the effective tax rate, and the interaction of the change in *NDTS* with the probability of bankruptcy.⁸ (The *NOL* dummy variable is equal to one if the firm has a *NOL* carryforward and equal to zero otherwise.) The enhanced explanatory power of these specifications are 7.6%, 0.0%, and 0.02%, respectively (see Table 4). (Using an alternative *NOL* specification, perhaps better referred to as a non*NOL* variable, equal to the highest statutory tax rate (0.46 prior to 1987, 0.395 in 1987, 0.34 after 1987) if the firm did not have *NOL* carryforwards and zero otherwise, improves the adjusted R^2 to 0.0479, an

⁸Graham (1995) provides a detailed analysis of the relative merit of various proxies for the marginal tax rate.

Table 4

Significance of tax variables in explaining debt policy

Panel A shows the significance of tax variables relative to the explanatory power from using just the control variables (from Table 2) and the probability of bankruptcy as independent variables. Relative significance is measured by comparing the adjusted R^2 of the control regression to R^2 s from regressions which include tax variables. For example, the adjusted R^2 of the control regression, using only the control variables and the probability of bankruptcy, is 0.0436. The adjusted R^2 of a regression which includes the tax variables which are related to the simulated MTR , in addition to the control variables and the probability of bankruptcy, is 0.0500. Thus, the tax variables related to the simulated MTR offer an improvement of approximately 14.7% in the explanatory power of the of debt policy specification ($0.147 = (0.0500/0.0436) - 1$). Also shown are the relative importance of alternative tax specifications.

Panel B shows the percentage increase in the dependent variable from the 'main regression' (i.e., the regression reported in the leftmost column of Table 2), and the analogous regression for 'intentional debt policy', for a hypothetical firm which moves from the average marginal tax rate (0.24) to the top marginal tax rate in the sample (0.46), all else equal.

Panel A

Included tax variables	Adjusted R^2	Added explanatory power
None ^a	0.0436	N.A.
$MTR, \sigma_{mtr}, \tau_{stat} - MTR, ADVDEBT$ ^b	0.0500	14.7%
$MTR_{NOL}, MTR_{nonNOL}, \sigma_{mtr}, \tau_{stat} - MTR, ADVDEBT$ ^c	0.0507	16.3%
$MTR, \tau_{stat} - MTR$ ^d	0.0494	13.3%
NOL dummy variable ^e	0.0469	7.6%
Effective tax rate ^f	0.0436	0.0%
$NDTS * ZPROB$ ^g	0.0437	0.02%

Panel B

Shocked tax variable	Percentage change in the dependent variable: $\Delta DEBT$	
	All observations	Intentional debt policy ($ \Delta DEBT > 0.02$)
MTR	1.52%	2.79%

^aThis specification regresses the dependent variable, $\Delta DEBT$, on the control variables from Table 2 as well as $ZPROB$, where $ZPROB$ is the probability of bankruptcy, defined as total assets divided by the sum of 3.3 times earnings before interest and taxes plus sales plus 1.4 times retained earnings plus 1.2 times working capital.

^bThis specification regresses the dependent variable, $\Delta DEBT$, on the control variables from Table 2 as well as $ZPROB$, the lagged simulated marginal tax rate, the lagged difference between the statutory and simulated marginal tax rates, and the relative tax advantage of debt.

^cThis specification regresses the dependent variable, $\Delta DEBT$, on the control variables from Table 2 as well as $ZPROB$, a variable equal to the lagged simulated marginal tax rate for NOL firms or zero for other firms, a variable equal to the lagged simulated marginal tax rate for non NOL firms or zero for other firms, the lagged difference between the statutory and simulated marginal tax rates, and the relative tax advantage of debt.

^dThis specification regresses the dependent variable on the control variables as well as the probability of bankruptcy, the lagged simulated marginal tax rate, and the lagged difference between the statutory and simulated marginal tax rates.

improvement in predictive power of 9.9%.) Thus, in a relative sense, the *NOL* dummy variable explains roughly one-half of the variance in debt policy explained by the simulated tax variables, while the other tax measures explain virtually nothing. In conclusion, simulating tax rates appears to offer the most refined measure of corporate tax status, although the *NOL* dummy variable also provides a reasonable proxy. It is surprising, however, that taxes do not explain a larger portion of debt policy.

To gauge the economic significance of the estimated coefficient of 0.069 on MTR_{t-1} reported in Table 2, consider the impact on leverage policy resulting from a movement from the average *MTR* of 0.24 (see Table 1) to the maximum for this sample period (0.46). All else equal, a hypothetical firm with a tax rate of 46% would annually issue 1.52% more debt, measured as a percent of capital structure, than an identical firm with a tax rate of 24% ($0.0152 = 0.069(0.46 - 0.24)$; see panel B of Table 4). If the coefficient from the intentional debt policy equation is used (0.127), a 46% *MTR* firm would annually issue 2.79% more debt than a 24% *MTR* firm.

6. Conclusion

It is hard to imagine that the ability to deduct interest payments from taxable income does not contribute to the decision to issue corporate debt. This implies that tax status affects corporate debt policy, although much previous academic research fails to validate this hypothesis. This paper simulates marginal tax rates that are consistent with the federal tax code. These explicitly calculated marginal tax rates are used to empirically document a positive relation between tax status and incremental debt policy. This result is consistent with a growing body of research (MacKie-Mason, 1990; Scholes, Wilson, and Wolfson, 1990; Givoly, Hahn, Ofer, and Sarig, 1992) that finds that tax status affects corporate decision-making. Two common themes running through this research are the use of incremental financing and/or an appropriately specified measure of tax status.

The tax-code-consistent marginal tax rates calculated in this paper indicate that there is substantial variation in marginal tax rates across time and across

Table 4 (continued)

^eThis specification regresses the dependent variable $\Delta DEBT$ on the control variables as well as the probability of bankruptcy and a dummy variable equal to one if the firm has *NOL* carryforwards and zero otherwise.

^fThis specification regresses the dependent variable on the control variables plus the probability of bankruptcy and the lagged effective tax rate (taxes paid divided by taxable income).

^gThis specification regresses the dependent variable on the control variables plus the probability of bankruptcy and the lag of *NDTS* times the probability of bankruptcy.

firms. There is also variation for subsets of the data which include just large (small) firms, as well as for firms with (without) *NOL* carryforwards. With respect to *NOL* status, firms do not appear to be as responsive to the tax incentives associated with debt when they have *NOL* carryforwards, relative to when they do not. This suggests that expected bankruptcy costs are relatively high when a firm is in the *NOL* state, dampening the intensity of debt usage.

The results suggest that a net operating loss dummy variable is a reasonable tax status proxy. However, the *NOL* dummy variable only accounts for approximately one-half of the explanatory power of the simulated tax variables. Simulating marginal tax rates provides a finer partition of tax status than simply conditioning on whether a company has a net operating loss carryforward.

Finally, the following two questions pose future challenges to financial researchers: 1) given the large number of theories available to explain the use of debt, why is our ability to empirically explain debt policy not much better than it is, and 2) given the strong tax incentives associated with debt issuance, why do taxes not explain a larger portion of debt policy than that documented here?

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