# ESTIMATING THE TAX BENEFITS OF DEBT

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In 1958, Nobel Laureates Franco Modigliani and Merton Miller published their famous irrelevance theorems.[1] One implication from these theorems is that the value of a company is not affected by the way the company finances its operations; the value of a company equals the present value of its operational cash flows, regardless of whether the firm finances its projects by issuing stocks, bonds, or some other security. To derive the irrelevance theorems, Modigliani and Miller had to make very strong "perfect capital markets" assumptions: lenders and borrowers have the same borrowing rate, there are no corporate or personal taxes, and all players in the economy have access to the same information, to name a few.

One way to think about the irrelevance theorems is that the operational cash flows of a firm determine the "size of the pie"—that is, the value of the firm. The choice of financing does not affect the size of the pie; it affects only how the pie is split between stakeholders. For example, when a firm finances 50% of its operations by issuing debt, bondholders have rights to half of the pie and stockholders have rights to the other half.

In the past four decades, much academic research has investigated the extent to which the irrelevance theorems are valid if the perfect capital markets assumptions are violated. Modigliani and Miller showed in 1963 that the irrelevance theorems do not hold when corporate income is taxed.[2] For an all-equity firm, the introduction of corporate taxes implies that the "pie" is now split between stockholders and the U.S. government. Panel A of Figure 1 shows that if the corporate tax rate is 33.3%, the government gets one-third of the pie for an all-equity firm, and stockholders get the remaining two-thirds. But if the firm chooses to finance with 50% debt and corporate income is taxed, a new wrinkle emerges (Panel B). Because the interest on debt is tax deductible, by financing with debt a firm reduces its tax liability, thereby reducing the portion of the pie given away to the government. As long as debtholders receive their portion of the pie, the stockholders get what's left over (because they are the residual owners of the firm). Therefore, stockholders get to pocket the tax savings that are achieved by financing with debt.

How much do these tax savings add to firm value? In their 1963 paper, Modigliani and Miller provided a formula to quantify the magnitude of tax savings under certain circumstances. If debt is riskless, then each year a firm will pay $r$D in interest payments, where $r$ is the interest rate and D is the face amount of debt. One dollar of interest saves the firm from paying $t$(\$1) in taxes, where $t$ is the corporate income tax rate, and \$$r$D of interest reduces the firm's tax liability by $t$(\$$r$D). Assuming that the firm issues perpetual debt (or that it always rolls the debt over as soon as it matures) and that the tax shields are no riskier than the debt that generates them, then from the well-known formula to value perpetuities (cash flow divided by the discount rate), the present value of the tax savings attributable to interest deductions is $t(rD)/r$. Noting that the $r$ in the denominator

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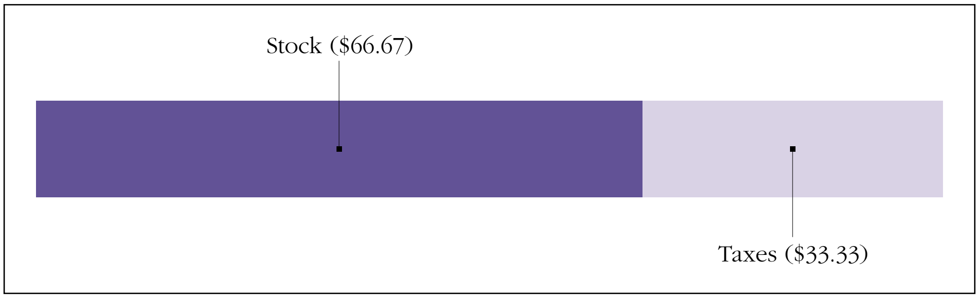
*This article is based on my paper "How Big Are the Tax Benefits of Debt?" which was published in the *Journal of Finance,* Vol. 55, 2000, pp. 1901-1941, and won the Brattle Prize as the best paper in corporate finance published in the *Journal of Finance* in 2000. The corporate marginal tax rates described in this paper can be obtained via the Internet at http://www.duke.edu/~jgraham or http://valuation.ibbotson.com.

1. Franco Modigliani and Merton Miller, "The Cost of Capital, Corporation Finance, and the Theory of Investment," *American Economic Review*, Vol. 48, 1958, pp. 261-297.

2. Franco Modigliani and Merton Miller, "Corporate Income Taxes and the Cost of Capital: A Correction," *American Economic Review*, Vol. 53, 1963, pp. 433-443.

**FIGURE 1**

PANEL A: 100% EQUITY FINANCING*




*Corporate tax rate of 33.3%. Market value of the firm: $66.67. Total value: $100 ($33.33 in taxes and $66.67 market value of common stock). Assume that the firm consists of a project that produces before-tax cash flows of $10 in perpetuity. If the discount rate is 10%, the net present total value of the project is $100 before tax. The governemnt has a claim on one-third of total value when the corporate income tax rate is 33.3% and the firm is financed entirely with common stock. The value to shareholders is $66.7 and the value of the government's claim is $33.3.

PANEL B: 50% STOCK, 50% DEBT FINANCING*


*Corporate tax rate of 33.3%. Market value of the firm: $80. Total value: $100 ($20 in taxes and $80 market value of common stock plus bonds). Continuing the example in Panel A, if $40 of debt is issued with a 10% interest rate, the firm pays $4 of interest annually and taxable income is $6 each year. The government takes $2 annually in taxes and therefore the government's slice of the pie shrinks to 20% of total value. Shareholders receive $4 annually in after-tax earnings, which are valued at $40. Moreover, given that debt is issued, shareholders also receive $40 up-front from debtholders. Therefore, relative to Panel A, shareholders are $13.33 better off. This extra $13.33 for shareholders comes from the tax savings associated with debt. Therefore, in Panel B, the portion of the present value of future cash flows owned by shareholders is depicted as $13.33 tax shield plus $26.67 stock.

cancels with the $r$ in the numerator, Modigliani and Miller derived a formula to value a firm with debt:

$$V_{\text{with debt}} = V_{\text{no debt}} + tD,$$

where V stands for firm value. Under these circumstances, tax deductions contribute $tD$ to firm value.

One important thing to keep in mind: if you think of $t$ as being the top statutory rate of, say, 35%, the valuation formula implies that interest deductions are fully valued in *every* scenario that a firm might encounter. This would be valid, for example, if the firm had at least as much taxable income as it had interest deductions in every imaginable scenario. The purpose of this paper is to determine how to value the tax benefits of debt if, in fact, tax deductions are not valuable in every scenario, perhaps because the firm is not always profitable. The paper also provides explicit estimates of how large the tax benefits of debt are relative to total firm value.

Much of what this paper has to say is about the *benefits* of debt. Researchers recognized early on that the valuation formula has an extreme implication: by maximizing D, a firm can maximize the value of the firm, and therefore a firm should be financed entirely with debt! These early researchers pointed out that there are costs to using debt, and these costs need to be balanced (or "traded off") against the tax benefits of debt. The optimal amount of debt varies by firm, and each firm should issue debt as long as the benefits outweigh the costs, but no more than that.

Later in the paper I compare the tax benefits of debt to the apparent costs and document a surprising fact: on average, firms that appear to have the lowest costs of leverage, and which therefore should best be able to service debt, have the least leverage! I also provide some explicit estimates of how much money financially conservative firms “leave on the table” in forgone tax benefits by remaining underlevered.

## NUMERICAL EXAMPLES OF VALUING INTEREST TAX SHIELDS

In this section I use a series of examples to demonstrate how to measure *t*, the marginal corporate income tax rate. Once we estimate *t* we will be ready to value each dollar of interest deductions as *t*($1). In many cases you should not think of *t* as being the statutory tax rate. Instead, you should incorporate details of the tax code when measuring *t* (tax credits and deductions, the Alternative Minimum Tax, the progressive corporate tax schedule, etc.), and consider how these various tax code features interact with the time value of money to affect the present value of the tax burden. To see how these nuances affect corporate marginal tax rates, I recommend that you read a paper Mike Lemmon and I published in Spring 1998 in this journal.[3] Rather than go into all those details again, in this paper I focus on how tax-loss carrybacks and carryforwards affect *t*, and on how interest tax deductions *reduce* a firm’s marginal tax rate.

### Calculating the Marginal Tax Rate (MTR) of a Firm with No Interest Deductions

I refer to today’s time period as period 0, next year as period 1, etc. Assume that the statutory corporate income tax rate is 35% and that in period 0 a firm has $4 in earnings before interest, tax-loss carryforwards (TLCFs), and taxes (see line 1 in Table 1, panel A). The income for period 1 through period 4 is also shown in the table. Assume that tax law allows a firm to carry losses back two years (i.e., if a firm loses money this year it can retroactively apply those losses to receive a refund for taxes paid in the previous two years) or forward up to 20 years (i.e., a firm can carry forward any losses not carried back, and use them to shield future profits from tax liability).

The firm we are considering started operating in period 0, and it knows with certainty that it will not make any additional profits after period 4. In the first period, the firm earns $4 and has no interest deductions, so its earnings before TLCFs and taxes are $4 (line 3). The firm does not have any tax losses carried forward from previous years, so its earnings before taxes are also $4 (line 5). Therefore, the firm pays $1.40 in taxes (35% of $4) in period 0 (line 6). To create an income statement, we would calculate net income at this point; however, in this paper, we are focusing on tax issues, and so we stop at tax liability.

In period 1 the firm has a $4 loss (line 1). The tax rules allow the firm to carry this $4 loss back and apply it to period 0 income. That is, in period 1 the company can refile the period 0 tax return as if it had no income in period 0 ($4 profit in period 0 minus the $4 loss in period 1). The net result is that the firm receives a tax refund of $1.40 in period 1 (line 6 in the period 1 column).

This same process continues with the firm paying tax on $2 in period 2, obtaining a $0.35 refund in period 3 because of a $1 loss, and finally paying taxes of $0.70 on $2 of profits in period 4. At this point, we perform an important calculation for future reference: at a discount rate of 10%, the period 0 present value of this firm’s tax liability, once we consider the various tax payments and refunds, is $0.93 (which is the sum of the items in line 8).

Assume now that the firm has an opportunity to undertake a project that will earn an extra $1 in period 0, and the treasurer wants to know what the tax burden will be on this incremental income. Define a company’s period 0 *marginal tax rate* (MTR) as the change in the present value of the tax liability as a result of earning an extra dollar of income in period 0. To calculate this firm’s MTR, we therefore add $1 to period 0 income, making it $5 (line 1 in the period 0 column of Table 1, panel B), and recalculate the present value of the tax liability. The calculations proceed just as before by calculating the tax payment for each year, determining tax refunds due to carryforwards and carrybacks, etc. The bottom line is that by earning an extra $1 in period 0, the present value of the tax liability

3. John Graham and Michael Lemmon, “Measuring Corporate Tax Rates and Tax Incentives: A New Approach,” *Journal of Applied Corporate Finance*, Vol. 11, 1998, pp. 54-65.

**There are two important points to remember from these numerical examples: (1) the incremental value of an extra dollar of interest deduction is equal to the marginal tax rate appropriate for that dollar, and (2) a firm can actually reduce its effective marginal tax rate by taking on debt.**

**TABLE 1**

| | | Period 0 | Period 1 | Period 2 | Period 3 | Period 4 | ... |
|---|---|---|---|---|---|---|---|
| PANEL A | | | | | | | |
| 1 | Earnings before interest, TLCFs, and taxes | 4 | –4 | 2 | –1 | 2 | 0 |
| 2 | Less: interest | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | Earnings before TLCFs and taxes | 4 | –4 | 2 | –1 | 2 | 0 |
| 4 | Less: TLCFs from previous years | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | Earnings before taxes | 4 | –4 | 2 | –1 | 2 | 0 |
| 6 | Less: taxes (@35%) | $1.40 | –$1.40 | $0.70 | –$0.35 | $0.70 | $0.00 |
| 7 | TLCFs available for future use | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | PV tax liability at 10% discount rate | $1.40 | –$1.27 | $0.58 | –$0.26 | $0.48 | $0.00 |
| 9 | [sum of PV tax liabilities=$0.93] | | | | | | |
| PANEL B | | | | | | | |
| 1 | Earnings before interest, TLCFs, and taxes | 5 | –4 | 2 | –1 | 2 | 0 |
| 2 | Less: interest | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | Earnings before TLCFs and taxes | 5 | –4 | 2 | –1 | 2 | 0 |
| 4 | Less: TLCFs from previous years | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | Earnings before taxes | 5 | –4 | 2 | –1 | 2 | 0 |
| 6 | Less: taxes (@35%) | $1.75 | –$1.40 | $0.70 | –$0.35 | $0.70 | $0.00 |
| 7 | TLCFs available for future use | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | PV tax liability at 10% discount rate | $1.75 | –$1.27 | $0.58 | –$0.26 | $0.48 | $0.00 |
| 9 | [sum of PV tax liabilities=$1.28] | | | | | | |
| PANEL C | | | | | | | |
| 1 | Earnings before interest, TLCFs, and taxes | 5 | –4 | 2 | –1 | 2 | 0 |
| 2 | Less: interest | –1 | 0 | 0 | 0 | 0 | 0 |
| 3 | Earnings before TLCFs and taxes | 4 | –4 | 2 | –1 | 2 | 0 |
| 4 | Less: TLCFs from previous years | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | Earnings before taxes | 4 | –4 | 2 | –1 | 2 | 0 |
| 6 | Less: taxes (@35%) | $1.40 | –$1.40 | $0.70 | –$0.35 | $0.70 | $0.00 |
| 7 | TLCFs available for future use | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | PV tax liability at 10% discount rate | $1.40 | –$1.27 | $0.58 | –$0.26 | $0.48 | $0.00 |
| 9 | [sum of PV tax liabilities=$0.93] | | | | | | |

increases to $1.28. To determine this firm's period 0 marginal tax rate, we subtract the present value of the tax liability found in line 9 of panel A ($0.93) from that in line 9 of panel B ($1.28). This firm pays an extra $0.35 in tax on the extra $1 of period 0 earnings, and therefore has a MTR of $t = 35\%$ on an additional $1 of income in period 0.

## Tax Benefit of $1 of Interest Deductions

Now suppose the treasurer wants to determine the benefit of financing this project with enough debt so that the extra $1 of earnings is shielded by $1 of interest deductions in period 0 (see line 2, Table 1, panel C). By using debt that generates $1 of interest, this firm reduces the present value of its tax liability from $1.28 to $0.93, a savings of $0.35. Relative to the scenario depicted in panel B, by using $1 of interest, the firm saves $0.35 in taxes and increases the portion of the pie available to stockholders by $0.35. Therefore, Table 1 proves by example that $1 in interest deductions increases firm value by $t$($1).

## Tax Benefit of a Second Dollar of Interest Deductions

The treasurer is intrigued by the possibility of increasing firm value simply by using debt to gener-

**TABLE 2**

| | | Period 0 | Period 1 | Period 2 | Period 3 | Period 4 | ... |
|---|---|---|---|---|---|---|---|
| PANEL A | | | | | | | |
| 1 | Earnings before interest, TLCFs, and taxes | 5 | –4 | 2 | –1 | 2 | 0 |
| 2 | Less: interest | –2 | 0 | 0 | 0 | 0 | 0 |
| 3 | Earnings before TLCFs and taxes | 3 | –4 | 2 | –1 | 2 | 0 |
| 4 | Less: TLCFs from previous years | 0 | 0 | 1 | 0 | 0 | 0 |
| 5 | Earnings before taxes | 3 | –3 | 1 | –1 | 2 | 0 |
| 6 | Less: taxes (@35%) | $1.05 | –$1.05 | $0.35 | –$0.35 | $0.70 | $0.0 |
| 7 | TLCFs available for future use | 0 | 1 | 0 | 0 | 0 | 0 |
| 8 | PV tax liability at 10% discount rate | $1.05 | –$0.95 | $0.29 | –$0.26 | $0.48 | $0.0 |
| 9 | [sum of PV tax liabilities=$0.61] | | | | | | |
| PANEL B | | | | | | | |
| 1 | Earnings before interest, TLCFs, and taxes | 5 | –4 | 2 | –1 | 2 | 0 |
| 2 | Less: interest | –3 | 0 | 0 | 0 | 0 | 0 |
| 3 | Earnings before TLCFs and taxes | 2 | –4 | 2 | –1 | 2 | 0 |
| 4 | Less: TLCFs from previous years | 0 | 0 | 2 | 0 | 1 | 0 |
| 5 | Earnings before taxes | 2 | –2 | 0 | 0 | 1 | 0 |
| 6 | Less: taxes (@35%) | $0.70 | –$0.70 | $0.0 | $0.0 | $0.35 | $0.0 |
| 7 | TLCFs available for future use | 0 | 2 | 0 | 1 | 0 | 0 |
| 8 | PV tax liability at 10% discount rate | $0.70 | –$0.64 | $0.0 | $0.0 | $0.24 | $0.0 |
| 9 | [sum of PV tax liabilities=$0.30] | | | | | | |
| PANEL C | | | | | | | |
| 1 | Earnings before interest, TLCFs, and taxes | 5 | –4 | 2 | –1 | 2 | 0 |
| 2 | Less: interest | –4 | 0 | 0 | 0 | 0 | 0 |
| 3 | Earnings before TLCFs and taxes | 1 | –4 | 2 | –1 | 2 | 0 |
| 4 | Less: TLCFs from previous years | 0 | 0 | 2 | 0 | 2 | 0 |
| 5 | Earnings before taxes | 1 | –1 | 0 | 0 | 0 | 0 |
| 6 | Less: taxes (@35%) | $0.35 | –$0.35 | $0.0 | $0.0 | $0.0 | $0.0 |
| 7 | TLCFs available for future use | 0 | 3 | 1 | 2 | 0 | 0 |
| 8 | PV tax liability at 10% discount rate | $0.35 | –$0.32 | $0.0 | $0.0 | $0.0 | $0.0 |
| 9 | [sum of PV tax liabilities=$0.03] | | | | | | |

ate interest deductions. She sits down to analyze how much incremental value could be added if the firm increased period 0 interest deductions from $1 to $2. In this scenario, the firm has only $3 of earnings before taxes in period 0 (line 5 of Table 2, panel A); therefore, the firm can only use $3 of its period 1 loss to receive a tax refund, which amounts to a refund of $1.05 in period 1 (line 6). The firm banks the unused dollar of loss (line 7 in period 1) and carries it forward to offset future income. In period 2 the firm earns $2 but subtracts the $1 tax loss carried forward (line 4) to reduce earnings before tax to $1 (line 5). The action in period 3 and period 4 proceeds as before. The net effect is that the present value of the tax liability is reduced from $0.93 when the firm has only $1 in interest deductions (Table 1, panel C) to $0.61 when it has $2 of interest (line 9 of Table 2, panel A). Therefore, the marginal benefit of using *the second dollar* of interest is $0.32.

You might wonder why the marginal benefit is only $0.32 when the firm saved $0.35 in period 0 taxes by using the second dollar of interest. The reason is that by using an extra dollar of interest in period 0, the firm reduces the *present value* benefit of the tax-loss deduction associated with the $4 loss in period 1. Without the second dollar of interest, the effect of a $4 loss in period 1 is a $1.40 refund in period 1 (Table 1, panel C). With the second dollar

**The marginal benefit of incremental dollars of interest *declines* as more interest is added. Another important point to notice is that, because of the dynamic nature of the tax code (e.g., carrybacks and carryforwards), it is necessary to consider past and future taxable taxable income when estimating today's effective marginal tax rate.**

of interest, the tax benefit of the period 1 loss is realized as a refund of $1.05 in period 1 and a $0.35 tax reduction in period 2 (Table 2, panel A). Pushing $0.35 of the benefit from period 1 to period 2 reduces the net benefit of the second dollar of interest by $0.03 ($-\$0.03 = -0.35/(1.1) + 0.35/(1.1)^2$).

I have ignored one important detail. Earlier I said that we could value the benefit of using interest by using the simple formula $t(\$rD)$. And yet, I just showed that the incremental value of the second dollar of interest deduction is $0.32. For this to be correct, I have to demonstrate that, *when the firm already has $1 of interest deductions*, its marginal tax rate $t$ is 32%. Remember that I defined the MTR as the change in the present value of the tax liability from earning an extra dollar of income in period 0. In this case, when the firm already has $1 of interest deductions, its marginal tax rate is 32%; therefore, the marginal tax rate $t$ measures the benefit of a second dollar of interest deduction, given that the firm already has a single dollar of interest deduction.

### Tax Benefit of a Third, Fourth, Fifth, and Sixth Dollar of Interest Deductions

The treasurer realizes that she is onto something. She can create value simply by financing with debt. She next determines that if she uses a third dollar of interest deduction in period 0, she reduces taxable income to $2 in period 0 and also can carry forward enough of the period 1 loss to completely shield income (and avoid paying taxes) in period 2; furthermore, this will allow her to carry the period 3 loss forward to period 4 and reduce tax liabilities in that period, too (see Table 2, panel B). The net effect of a third dollar of interest deduction is to reduce the present value of the tax liability from $0.61 (with $2 of interest deductions) to $0.30 (with $3 of deductions). She notices that the present value benefit of each *incremental* dollar of interest deduction is declining because some of the tax benefits of having an extra dollar of interest in period 0 are not realized until period 2 or period 4; however, she believes that the $0.31 marginal benefit of adding a third dollar of interest is larger than the marginal cost, so she plans on recommending that the firm add enough debt to produce at least $3 of interest deductions.

If the firm were to add a fourth dollar of interest deduction, the treasurer determines that the company would reduce its period 0 tax liability to $0.35, which would be promptly refunded in period 1, and never pay taxes again after period 0! (See Table 2, panel C.) This reduces the present value of the firm's tax obligation to $0.03 (= $0.35 – $0.35/1.1). The net tax benefit of adding this fourth dollar of interest would thus be $0.27 (resulting from a reduction in the present value of the tax liability from $0.30 to $0.03).

If the firm were to add a fifth dollar of interest deduction in period 0, it would reduce its period 0 tax liability to zero. This would allow the period 1 tax loss to be carried forward in its entirety to shield future income. In fact, this tax loss would be sufficient to completely shield all future income. By adding a fifth dollar of period 0 interest, the firm would reduce the present value of its tax liability to zero, and so the fifth dollar of interest would produce tax benefits of only $0.03.

Finally, if the firm were to somehow issue enough debt to produce $6 of interest deductions in period 0, then this last dollar of interest deduction would be worthless. The marginal tax benefit of the sixth dollar of interest deduction is zero.

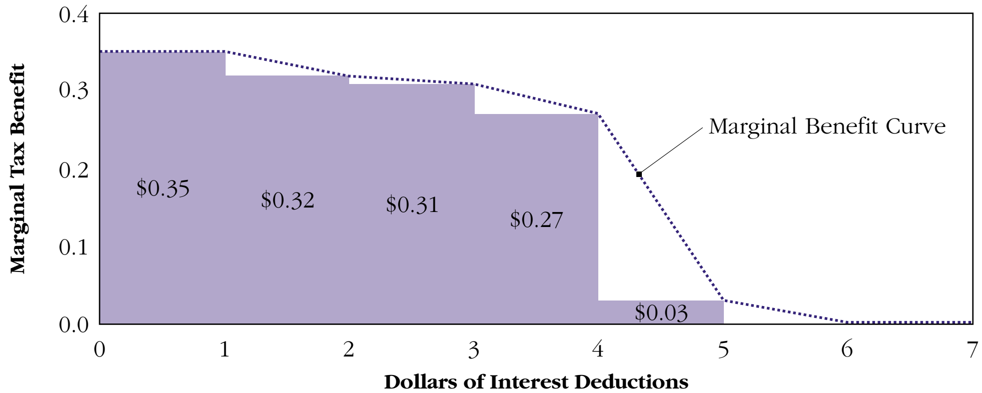
### Summarizing the Examples

There are two important points to remember from these numerical examples: (1) the incremental value of an extra dollar of interest deduction is equal to the marginal tax rate appropriate for that dollar, and (2) a firm can actually reduce its effective marginal tax rate by taking on debt. Another way to say this is that $t$ is a declining function of interest deductions, and therefore the marginal benefit of incremental dollars of interest *declines* as more interest is added. Another important point to notice is that, because of the dynamic nature of the tax code (e.g., carrybacks and carryforwards), it is necessary to consider past and future taxable income when estimating today's effective marginal tax rate.

## CALCULATING MARGINAL BENEFIT FUNCTIONS FOR INTEREST TAX SHIELDS

In this section I create benefit functions for interest tax deductions and use these functions to value the tax benefit of debt. For instance, Figure 2 shows the tax benefit function for the numerical examples in the previous section. The largest rectangular block represents the benefit of the first $1 of interest deductions, the second largest block represents the benefit of the second dollar of interest, etc.

**FIGURE 2**
MARGINAL BENEFIT CURVES MEASURING THE TAX BENEFIT OF INTEREST DEDUCTIONS*




*The figure summarizes the tax benefit of debt derived in the numerical examples in the text. Each rectangular box represents the present value tax benefit of adding another dollar of interest deduction. For example, by adding up the area inside all of the rectangular boxes, we "integrate under the benefit function" and determine the tax benefit of five dollars' interest deductions. The line that connects the upper-right corners of the boxes represents a "smoothed" estimate of the tax benefits of debt. I refer to that line as the marginal benefit function of interest deductions. Notice how the marginal benefit of debt is a declining function of the level of interest deductions.

To determine the tax benefit of adding $4 of interest, for example, the treasurer simply adds up the area inside the largest four rectangles. To summarize the tax benefits of interest deductions even more succinctly, the treasurer connects the top right corners of all of the rectangles to create a marginal benefit function. This function is downward sloping, which indicates that the incremental benefit of adding an extra $1 of interest declines as additional interest is added; in other words, $t$ is a declining function of interest deductions.[4] Eventually (at $5 of interest), there is no value to adding additional dollars of interest.

## Marginal Benefit Functions for Some Real Firms

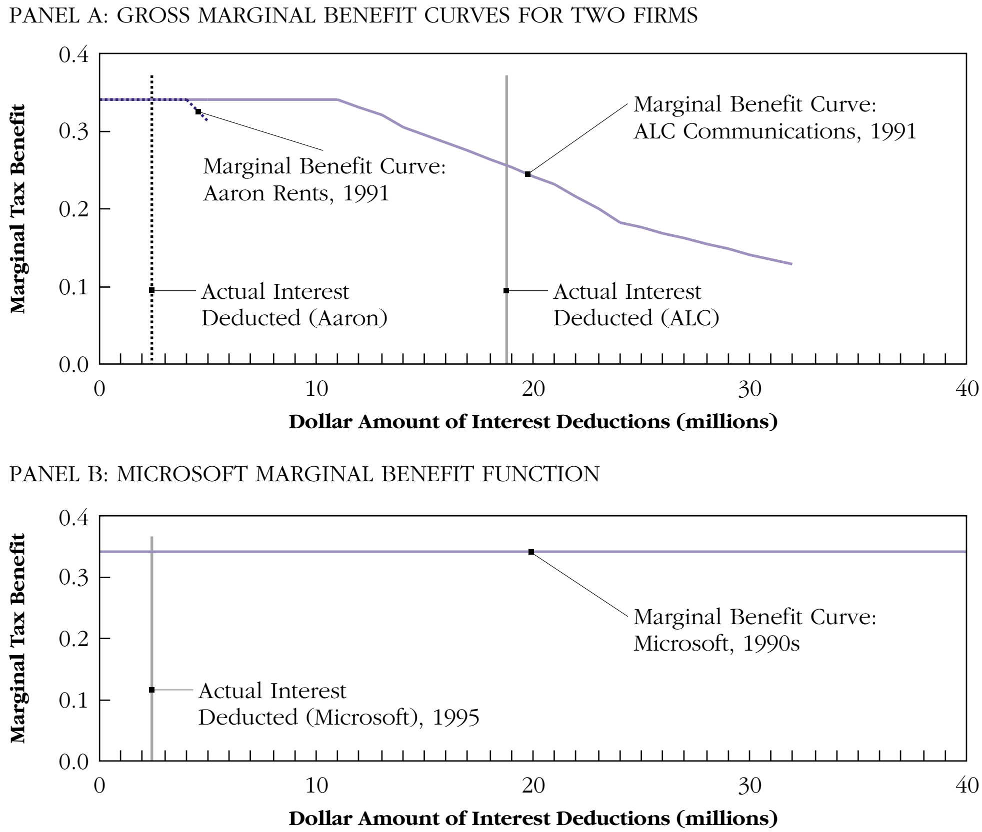
Using Standard & Poor's COMPUSTAT database, I have calculated marginal benefit functions for thousands of firms from 1980-1999. For details, you should read my "How Big Are the Tax Benefits of Debt?" paper, published in the *Journal of Finance* in October 2000. In a rough sense, I follow the procedure outlined in the numerical examples above. That is, I consider the past and future income of a given firm when determining the period 0 tax benefit of debt, and determine the marginal benefit for ever-increasing amounts of interest deductions. However, in the full-blown procedure I consider more features of the tax code, and I make many forecasts of possible scenarios for future income, averaging across these scenarios to determine the *expected* tax benefit of period 0 tax deductions. For example, if you assume that the information depicted in Table 1 is for the "good scenario" and there is an equally likely "bad scenario" in which the firm is unprofitable in every year, the *expected* tax benefit of adding the first dollar of interest is $0.175 (= .5(0.35) + .5(0.0) ). I actually forecast 50 different scenarios of future income for each firm in each year, calculate the tax benefit of various levels of interest deductions for each of these scenarios, and then average across the 50 scenarios to determine the expected benefit for each of the various levels of interest deductions.

Panel A of Figure 3 shows marginal benefit functions for two firms, ALC Communications and Aaron Rents, in 1991. (Note that the top statutory corporate tax rate was 34% in 1991.) The rightmost dotted line shows that ALC had approximately $18 million of interest deductions in 1991. The first $11 million of interest was worth $3,740,000 to ALC, which is $0.34 per dollar of interest. Once ALC got beyond $11 million of interest, however, the incremental benefit of additional interest began to decline. This occurred because as more interest was added, there were

4. Mike Lemmon, Jim Schallheim, and I make this point in our paper "Debt, Leases, Taxes, and the Endogeneity of Corporate Tax Status," *Journal of Finance*, Vol. 53, 1998, pp. 131-161.

**There are two types of firms for which the tax benefits of debt are large. The first are regulated utilities. The other are those that undergo leveraged buyouts.**

**FIGURE 3**
MARGINAL BENEFIT FUNCTIONS FOR THREE FIRMS




some scenarios in which ALC was unable to use the tax benefit of incremental interest at all, and others in which the benefit was not realized in period 0 but instead was realized in period 1, period 2, or later. Averaging across the present value benefit in these various scenarios, I estimated the expected marginal benefit, which as shown in the figure declines as more interest is added.

To determine the tax benefit of debt to ALC in 1991, I integrated under the benefit function up to the point where it intersects the dotted line. To integrate, I break the area under the curve up into a bunch of rectangles and sum the area inside the rectangles. The tax benefit of $18 million of interest was worth approximately $4,800,000 to ALC in 1991. But this was just for 1991. Assume now that ALC wanted to determine the value of having $18 million of interest in every year, starting in 1991. One approach would be for ALC to calculate a time series of tax benefit functions for 1991, 1992, etc., that is, to integrate under each of the benefit functions to determine the tax benefits of debt for each respective year, and then calculate the present value of the time series of tax benefits. Performing calculations like this for ALC indicates that a policy of taking $18 million of interest *perpetually* would add approximately $50 million of value to ALC in 1991. (This $50 million is analogous to the $t$D term on the right-hand side of the Miller and Modigliani valuation formula shown at the beginning of this article.) Given that ALC was worth $306 million in 1991, the tax benefits of debt were worth approximately 16% of firm value!

Panel A of Figure 3 also shows the marginal benefit function for Aaron Rents in 1991. We can perform all the same calculations for Aaron Rents. The tax benefit of the $2 million of interest that Aaron Rents had in 1991 was easy to calculate because Aaron's benefit function is horizontal up to the dotted line, and so the tax benefit of $2 million in interest was simply $680,000 (= 0.34 x $2 million) in 1991. Notice that Aaron's benefit function does not become downward sloping until it reaches $3.2 million of interest. In other words, Aaron could have taken 1.6 times the amount of interest deduction it actually took, and still enjoyed the full tax benefit of $0.34 per dollar for the entire amount. I refer to the

**TABLE 3***

| Company | | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Coca–Cola | tax benefit/value (%) | 7.4 | 4.9 | 4.4 | 2.9 | 1.5 | 1.4 | 1.6 | 1.4 | 1.4 | 0.2 | 0.1 | 0.9 |
| | kink | 6.0 | 7.0 | 7.0 | 7.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 |
| Intel | tax benefit/value (%) | 0.0 | 5.7 | 5.7 | 4.9 | 3.4 | 1.5 | 1.0 | 1.4 | 0.8 | 0.0 | 0.0 | 0.1 |
| | kink | 1.0 | 5.0 | 5.0 | 6.0 | 7.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 |
| Entergy | tax benefit/value (%) | 27.5 | 20.1 | 18.6 | 18.5 | 18.2 | 16.9 | 16.4 | 16.1 | 15.3 | 16.8 | 16.7 | 20.6 |
| | kink | 3.0 | 3.0 | 3.0 | 2.0 | 2.0 | 2.0 | 2.0 | 1.6 | 1.6 | 2.0 | 1.6 | 1.6 |
| Safeway | tax benefit/value (%) | 58.8 | 38.2 | 36.6 | 35.7 | 32.0 | 27.4 | 28.2 | 22.4 | 20.4 | 17.2 | 15.5 | 12.1 |
| | kink | 0.8 | 0.6 | 1.0 | 1.0 | 1.0 | 1.0 | 1.4 | 1.4 | 1.6 | 1.6 | 1.6 | 2.0 |

*Firm value is measured as the book value of debt plus the market value of equity, except in the case of Safeway, where it is measured as book assets. Kink is the amount by which interest deductions can be multiplied before the incremental value of debt financing begins to decline.

point where the benefit function becomes downward sloping as the "kink" in the benefit function, and express the kink as a proportion of the actual interest deduction. For Aaron, the kink is 1.6 in 1991. This occurs because for all the scenarios I forecast for Aaron in 1991, taxable income was at least $3.2 million, so they could have realized the full tax benefit on all amounts of interest up to $3.2 million.

In contrast to Aaron's kink of 1.6, ALC had a kink of 0.6 in 1991; that is, ALC's benefit function became downward sloping at interest deductions equal to 60% of the actual interest deductions taken. Having a lower kink means that ALC had a more aggressive debt policy than Aaron in 1991 because ALC deducted enough interest that it did not fully realize the tax benefits in every scenario. (To confirm that ALC uses debt more aggressively than does Aaron, note that ALC's debt-to-capital ratio was 43% in 1991, in comparison to Aaron's 29%.) In the next section, I use kink as a measure of the aggressiveness of debt policy and compare it to the costs of debt. The trade-off theory of capital structure choice tells us that Aaron must face higher costs of debt, which causes Aaron to choose a more conservative debt policy than does ALC.

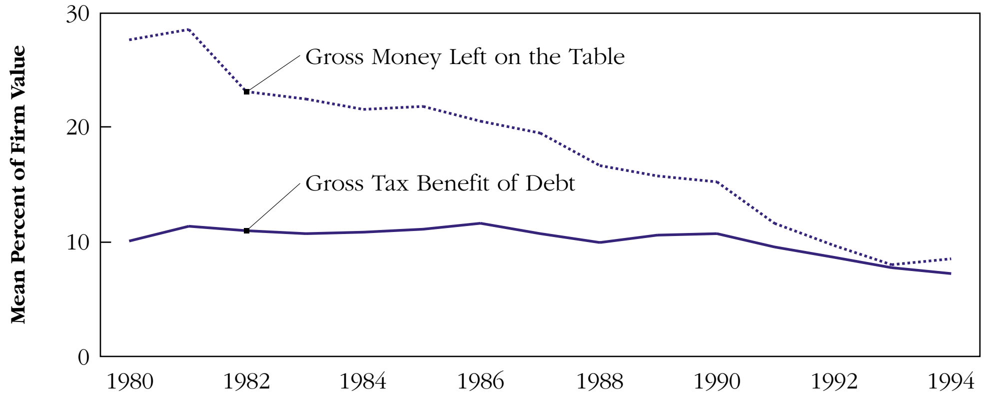
Panel B of Figure 3 shows the benefit function of interest deductions for Microsoft in 1995. Despite its enormous size and profitability, Microsoft took only $2 million of interest deductions, the same amount that Aaron Rents had in 1991! Microsoft had a kink of 8.0 in 1995. (For computational reasons, I only allow kink to have a maximum of 8.0.) This large value of kink indicates that Microsoft has a much more conservative debt policy than Aaron Rents or ALC. One other thing to note is that Microsoft eliminated even this $2 million of interest by 1997.

The pattern of profitable firms using little debt, and therefore receiving relatively few tax benefits from interest deductions, is pervasive. For example, Table 3 summarizes the capitalized tax benefits for a few well-known companies. In 1987, the tax benefits of debt were worth 7.4% of firm value for Coca-Cola. In the 1990s, however, Coca-Cola was profitable enough that it reduced its leverage, and the tax benefits of debt fell to about 1% of firm value. Coca-Cola's kink increased from 6.0 to 8.0 over this same period, indicating that its debt policy became more conservative. Intel had a brief unprofitable period in the mid-1980s and its tax benefits were close to 6% of value in 1988. As profitability improved, however, Intel used debt more conservatively (kink increased from 1.0 to 8.0) and the tax benefits of debt declined to nearly zero.

There are two types of firms for which the tax benefits of debt are large. The first is regulated utilities. Table 3 shows that the tax benefits of debt equaled approximately 15-20% of firm value in most years for Entergy. Moreover, Entergy's kink was often approximately 2.0, which indicates that Entergy used debt aggressively compared to Coca-Cola and Intel. (Recall that a kink of 2.0 means that Entergy could have doubled its interest deductions before encountering the downward sloping, or declining marginal benefit, portion of its benefit function.) The

**For most of the 1980s, tax benefits averaged approximately 10% of firm value, although they declined to around 8% in the 1990s.**

**FIGURE 4**
THE TAX BENEFITS OF DEBT*




*The solid line shows the gross tax benefits of debt (expressed as a percentage of firm value). The dotted line shows the *additional* tax benefit that could be obtained if firms with kink greater than one levered up to the kink in their interest benefit functions. The term "gross" means that the lines represent benefits only. No costs have been subtracted from the lines, including the personal tax penalty associated with interest income.

other type of firm with large tax benefits of debt are those that undergo leveraged buyouts, represented by Safeway in Table 3. After completing its famous LBO in 1986, the tax benefits of debt jumped to more than 50% of asset value for Safeway in 1988! At the same time, kink dropped to about 1.0 (indicating that Safeway's debt policy became more aggressive).

Figure 4 summarizes the tax benefits of debt, expressed as a percentage of market value, averaged across approximately 10,000 firms per year for each year from 1980 to 1994. For most of the 1980s, tax benefits averaged approximately 10% of firm value, although they declined to around 8% in the 1990s. Some reasons for the decline in benefits are that 1) corporate profitability increased in the 1990s, so some firms decreased their reliance on debt, and 2) firms did not increase their usage of debt to keep pace with the increases in market value that occurred as the stock market soared in the 1990s.

## Money Left on the Table by Conservative Use of Debt

Figure 4 shows the "money left on the table" by a conservative debt policy. To determine the money left on the table, I assume that firms lever up to the kink in their benefit function (e.g., a firm with a kink of 3.0 triples its interest deductions). That is, I assume that firms add debt until the marginal benefit begins to decline. I do this because firms with kinks greater than one are on the horizontal portions of their benefit functions, and so effectively they expect to have positive taxable earnings in all scenarios over this range of interest deductions. If, over this same range of positive earnings, the cost of debt function does not increase rapidly, the trade-off theory implies that a firm should take on additional debt until it is at or just to the right of the kink in its benefit function (because the cost function will not cross the benefit function anywhere to the left of the kink). Under these conditions, it is reasonable to integrate under the benefit function up to the kink to determine forgone benefit.

The incremental gross tax benefit produced by levering up to the kink varied between 28% (in the early 1980s) and 8% (in 1993) of the market value of the average firm (see Figure 4). The mean was 15.7% over the entire sample period. These numbers suggest that the consequences of being underlevered are significant but have been declining.

## DO FIRMS USE DEBT CONSERVATIVELY BECAUSE THEY FACE HIGH COSTS OF DEBT?

From Figure 3, we know that some firms use debt more conservatively than others. For example, Microsoft (kink equals 8.0) has a less aggressive financing policy than either Aaron Rents (kink equals 1.6) or ALC Communications (kink equals 0.6). The trade-off theory of capital structure choice tells us that firms use debt conservatively when the costs of debt are high. I tested this hypothesis by regressing kink, which is my measure of debt conservatism, against various measures of the cost of debt. The details of this regression analysis are in the *Journal of Finance* version of this paper; in what follows, I provide an overview and highlight the results.

One of the costs of debt is the cost of financial distress. I used several variables to measure this cost, including the product of the likelihood of financial distress (measured by the variability in the ratio of operating earnings to assets) and the proportion of firm value likely to be lost in liquidation (asset intangibility, measured by the sum of R&D and advertising expenses divided by sales). Higher levels of this measure should be associated with higher debt costs and thus less reliance on debt financing. I also examined whether owners' equity was negative and whether the firm had net operating loss carryforwards as indicators of financial distress and thus lower use of debt.

Another cost of debt is the cost of forgone investment opportunities. Stewart Myers has argued that firms sometimes forgo positive NPV investments if the projected benefits accrue largely to the firms' existing debtholders instead of to the shareholders.[5] The severity of this problem increases with the proportion of firm value that is attributable to growth options, implying that growth firms will tend to use less debt. Because the market value of the firm will tend to reflect its growth opportunities, I used the market-to-book value of assets to measure this cost of debt; higher values will tend to be associated with higher costs of debt and thus lower use of debt.

Cash flows and liquidity can also affect the level of borrowing. Firms with higher cash flows (measured by cash flow from operations divided by assets) tend to take on less debt,[6] although Michael Jensen has argued that firms with large free cash flows (and limited investment opportunities) should issue debt, thereby committing to distribute free cash flows as interest payments, in order to discipline management to work more efficiently.[7] Firms with greater liquidity (measured by the quick and current ratios) should have lower borrowing costs and hence be able to take on more debt.

Firms with more entrenched managements may be less inclined to commit to pay out cash flows as interest payments and thus will tend not to take on debt because doing so will limit their ability to empire-build or pursue other interests of their own.[8] I used various measures of entrenchment, including the percentage of common shares held by the CEO, the tenure of the CEO, and the composition of the board of directors (insiders versus outsiders). Finally, several other variables are associated with the use of debt, including industry concentration, product uniqueness, industry cyclicality, firm size, information asymmetry (non-dividend-paying firms are subject to larger information asymmetries), and asset collateral. I incorporated measures of each of these variables into the regression analysis.

In general, I found that firms with *lower apparent costs* of debt tend to be *more conservative* in their use of debt, which seems backwards. For example, firms that pay dividends should face low information asymmetry costs and thus use debt more aggressively, but I found the opposite. Firms with positive owners' equity, no net operating loss carryforwards, and low expected costs of financial distress should use more debt, but I found that they use less. And large, liquid firms in non-cyclical industries tend to use debt conservatively, which again seems backwards.

Though most do not, some of the regression results indicate that high debt costs cause firms to use debt conservatively, consistent with the trade-off theory of capital structure choice. Small firms, firms with strong growth opportunities, firms in highly concentrated markets, firms with highly unique products, and firms with less valuable asset collateral all tend to use less debt. Firms with entrenched managements are only slightly more inclined to use debt conservatively.

## Personal Tax Costs

At this point, we have seen that the tax benefits of debt are moderately important for the typical firm (they equal about 10% of firm value). We have also seen that many firms could double or triple the tax benefit of debt by levering up. Finally, the evidence just presented largely indicates that firms with *low apparent costs* of debt are the most conservative in their use of debt, suggesting that it is not the costs of debt that deter firms from taking on more leverage.

5. Stewart Myers, "Determinants of Corporate Borrowing," *Journal of Financial Economics*, Vol. 3, 1977, pp. 799-819.
6. Stewart Myers, "Still Searching for the Optimal Capital Structure," *Journal of Applied Corporate Finance*, Vol. 6, 1993, pp. 4-14.
7. Michael Jensen, "Agency Costs of Free Cash Flow, Corporate Financing, and Takeovers," *American Economic Review*, Vol. 76, 1986, pp. 323-329.
8. René Stulz, "Managerial Discretion and Optimal Financing Policies," *Journal of Financial Economics*, Vol. 26, 1990, pp. 3-27.

**Once you consider the dynamic effects of the tax code, there is considerable variation in effective corporate tax rates and, as expected, the firms with the highest effective corporate tax rates respond to tax incentives and use the most debt.**

In some sense, then, we are right where Merton Miller was in 1977 when, in his presidential address to the American Finance Association, he observed that the tax benefits of debt seem much larger than the apparent costs.[9] To try to explain this phenomenon, Miller proposed that in equilibrium, the personal tax disadvantage of debt might be large enough to offset the corporate tax advantage of interest deductions. That is, he acknowledged that interest deductibility might make debt attractive to a firm, relative to equity; however, he pointed out that interest is taxed as ordinary income for the investor, while equity is often taxed at lower capital gains tax rates, and moreover, capital gains taxation can be deferred indefinitely. Therefore, holding risk constant, investors demand a higher pre-tax return on debt relative to equity (so that, adjusted for risk, the *after-personal-tax* return on debt and equity are similar). In other words, the relatively high personal tax rates on debt impose a cost on the firm by increasing the coupon rate on the debt. Miller conjectured that the personal tax cost of debt was equal to the corporate tax advantage in equilibrium, and therefore there is no tax advantage to debt once you net out personal tax costs. This implies that no firm should have a tax incentive to issue debt.

The Miller equilibrium is difficult to prove or disprove because we cannot observe the personal tax rates that are actually implicit in the relative pricing of debt and equity. My research indicates that Miller's hypothesis is not a complete explanation of the tax incentives to use debt. First, there was a period in the 1980s when the statutory tax rates on interest and capital gains were identical, which, according to Miller's model, should have implied that firms would greatly increase their use of debt—but there is little evidence that this happened. Moreover, Miller's theory is based on the notion that there is a single economy-wide corporate marginal tax rate $t$. On the contrary, my work shows that once you consider the dynamic effects of the tax code, there is great heterogeneity in effective corporate tax rates and, importantly, the firms with the highest effective corporate tax rates respond to tax incentives and use the most debt, which should not happen if Miller's equilibrium explains the world.[10]

Nonetheless, I have adjusted my estimates of the tax benefits of debt by subtracting the potential personal tax costs of debt (consult the *Journal of Finance* version of this paper for details). According to my estimates, personal taxes reduce the tax benefit of debt to approximately 7% of firm value, rather than 10%. Importantly, even after adjusting for personal taxes, the cross-sectional implication remains that the firms that seem best able to service debt (i.e., firms with the lowest apparent costs) use the *least* amount of debt, on average.

## CONCLUSION

The first half of this paper derived a method of valuing interest tax shields. The standard approach (using $t$D) assumes that full tax benefits are realized on every dollar of interest deduction in every scenario. In contrast, my approach considers the probability that interest tax shields will not be useful in some scenarios. Their value can be eroded by the time value of money when tax benefits are deferred to future periods, and by other complicating features of the tax code. My estimates imply that the tax benefits of debt equal about 10% of firm value, or approximately 7% when personal taxes are considered.

The second half of this paper showed that firms that use debt conservatively appear to face *low costs of debt*, according to most variables that measure cost. This is puzzling. It is possible that the variables I use are imperfect measures of cost or that I have not considered some cost of debt in my analysis. If this is the case, however, the costs that I mismeasure or leave out would have to be quite large to explain the degree of conservatism in corporate debt policy. It is also possible that some of the results in this paper occur because I use financial statement data rather than actual tax returns.

I think that it is important for treasurers and CFOs to critically reevaluate their companies' debt policies. Each firm should explicitly calculate the benefits that could be obtained by increasing leverage, even if taking on more debt causes credit ratings to slip a notch. Would the costs of using more leverage be larger than the benefits? If not, the firm should consider issuing debt and using the proceeds

9. Merton Miller, "Debt and Taxes," *Journal of Finance*, Vol. 32, 1977, pp. 261-275.

10. John Graham, "Debt and the Marginal Tax Rate," *Journal of Financial Economics*, Vol. 41, 1996, pp. 41-73; idem, "Do Personal Taxes Affect Corporate Financing Decisions?," *Journal of Public Economics*, Vol. 73, 1999, pp. 147-185; and John Graham, Michael Lemmon, and James Schallheim, "Debt, Leases, Taxes, and the Endogeneity of Corporate Tax Status," *Journal of Finance*, Vol. 53, 1998, pp. 131-161.

to retire common stock. 3M Corp. recently reached the conclusion that it should increase leverage, even though this caused 3M's debt to be downgraded by Moody's Investors Service from AAA to Aa1. Moody's reports that the downgrade resulted from

*continued growth in leverage at 3M resulting from management's decision to lever the company's capital structure through increased share repurchases and debt issuances. 3M management's tolerance for financial leverage has been increasing since the early 1990s … weakening the company's historically extremely strong debtholder protection … 3M didn't dispute Moody's rating move, but emphasized the company's increased leverage is part of a 'strategy, a conscious effort to increase shareholder value' by more effectively exploiting its financial strength.* (*Wall Street Journal*, "Rating for 3M Debt Is Cut by Moody's, Citing More Leverage," February 6, 1998, p. A3)

I suspect that many debt-conservative firms, if they objectively consider the issue, will reach the conclusion that they should use more debt.

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