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Market Reactions to Capital Structure Changes: Theory and Evidence

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Abstract

How should the stock market react when a firm issues new equity to retire debt? The traditional view is that, to reflect the loss of debt tax shields, the value of the firm should decline by an amount approximately equal to the firm's marginal corporate tax rate times the amount of debt retired. We argue that the traditional view provides an incomplete analysis of the issue. We construct a simple model of exchange offers and show that quite generally the change in firm value is unrelated to the firm's marginal tax rate. For one parameterization, the change in firm value is exactly equal to the change in dollar amount of debt. Using a sample of over 200 equity-for-debt swaps, we find that the actual market reaction is indeed unrelated to the level of the firm's marginal tax rate. Interestingly, the reaction is statistically indistinguishable from the value of debt retired, as predicted by one version of the model. Within the same framework we develop a test of a dissipative signaling equilibrium of the type described by Ross (1977). If market price reactions are guided by such an equilibrium, the change in firm value, as a percent of the change in the debt level, must be greater the steeper the *slope* of the firm's tax schedule. The market reaction is found to be inconsistent with dissipative signaling.

Key Words: Capital Structure, Exchange Offers, Debt, Taxes

JEL Classification: G32.

Introduction

How should the stock market react when a firm issues new equity to retire debt? The traditional view is that, to reflect the loss of the debt tax shields, the value of the firm should decline by an amount approximately equal to the firm's marginal tax rate times the change in the amount of debt. We argue that this view is based on an incomplete analysis of the question.

We construct a simple model of a firm's optimal capital structure and use it to examine exchange offers. A general result of the model is that, contrary to the traditional view, the change in firm value resulting from an exchange offer is unrelated to the level of the firm's marginal tax rate.

The model is based on the following reasoning. At its optimal capital structure, the capital structure that maximizes firm value, a firm's marginal benefit of debt equals its marginal cost. If a firm subsequently announces that it will swap new equity for debt, some event must have occurred to push it away from this optimum. Therefore, the market reaction to the announcement of the exchange offer includes not only a reaction to the new capital structure, but also a reaction to the information released by the "announcement" that the new capital structure is now optimal. For example, we demonstrate below that if a firm's cash flow exogenously increases by an amount, G, in perpetuity, the firm will issue new debt, d, with interest payments rd equal to G to return to an optimum. The increase in firm value associated with the security issuance therefore equals the present value of the change in cash flow (equivalently the present value of the interest payments) which equals d, and not "τd" as in the traditional analysis, where τ is the corporate tax rate.

We first present an analysis of two specific "events" under the assumption that the event that motivates the change in capital structure becomes public information when the exchange offer is announced. In our first analysis, the event that motivates the exchange offer is a once-and-for-all shift in the firm's expected cash flow. In the second analysis, the event is a once-and-for-all shift in the variance of the distibution of the firm's cash flow. In both cases, the exchange offers are considered as an optimal response to a change in the distribution of the firm's future cash flows. When the firm's capital structure was optimal prior to the "event," and is optimal again after the exchange offer, we show that the size of the market reaction to the exchange offer is unrelated to the firm's marginal tax rate.

Next, we investigate how our results change when the event does not become public information. In this case, firms may have an incentive to engage in dissipative signaling of the type described by Ross (1977). In a dissipative signaling equilibrium, firms attempt to signal higher value by issuing more debt than would be optimal with public information. Because the market understands the incentives to signal, in equilibrium, the signaling is not effective and the value of the firm increases by less than it would for an equivalent debt issue when the event becomes public information immediately. We show that, *ceteris paribus*, the change in firm value is greater, measured as a percentage of the size of the debt issue, the greater is the *slope* (not the level) of the firm's expected tax schedule. The implication for detecting dissipative signaling is robust in the sense that even if the model for changes in the firm's profitability is incorrect, the qualitative empirical predictions for testing for the presence of dissipative signaling are still valid.

The model is testable. We use the methods of Graham (1996a, 1996b, 1998) to explicitly calculate marginal tax rate functions facing two hundred firms that conduct equity-for-debt swaps (a leverage-decreasing event) in the early 1980s. Because we use firm–specific tax schedules, our methods for testing both the independence of stock price reaction and marginal tax rate and whether firms signal with capital structure are novel.

The empirical results are consistent with the predictions of the model. We find that the change in the market value of the firm is unrelated to firm-specific marginal corporate tax rates. Interestingly, we find that the ratio of the change in firm value to the market value of the retired debt equals 1.06, which is not statistically different from the "mean shift" the model prediction of 1.0. The evidence is inconsistent with the signaling explanation of capital structure changes, in that the market reaction declines with the slope of the expected marginal tax schedule.

This subject has received considerable attention. In two seminal papers, Masulis (1980, 1983) investigates the impact on security prices of capital structure changes via exchange offers. He finds that shareholder wealth increases with leverage, and concludes that the evidence is consistent with a "model of optimal capital structure where there are tax-plus-leverage-cost and information effects of debt level changes."[1]

Masulis' analysis to separate the effects of a capital structure change is not, however, consistent with the firm, prior to an informational event, starting at an optimal capital structure. The explanation provided in Masulis (1983) is that for leverage–increasing exchange offers, the value of the firm should increase by the present value of the debt tax shields plus the impact of any information release, minus the added costs of the extra debt. Thus the increase in firm value is expected to be directly related to the firm's expected marginal tax rate. Indeed, Masulis' empirical analysis focuses on measuring the "tax effect."

Masulis considers exchange offers in order to examine "pure capital structure changes." We argue that exchange offers are not pure capital structure changes, and that some change in the firm has motivated the exchange offer. The importance of this observation can be seen below.

Masulis' argument that the value of the debt tax shields should rise as more debt is added to the firm is true quite generally.[2] He also expects that for a leverage–increasing exchange offer (for example) the information effect will be positive (good news being conveyed by the firm's ability to increase its leverage) and that the costs of debt will rise with the added leverage. Such logic ignores the interactions of these effects on the firm's optimal capital structure. For example, if an increase in cash flow (the good news) has motivated an increase in leverage there is no *a priori* reason to expect that the added leverage will increase the cost of debt. Consider the example described above. Given an increase in cash flow of G per period, we show that it is optimal for the firm to increase its debt by an amount d such that $G = rd$. The resulting total increase in firm value, $G/r = d$, may be decomposed for illustration into $\tau d + (1 - \tau)d$. Note that if the marginal tax rate is high, while the increase in value from added tax shields will be high, the informational effect, $(1 - \tau)d$, will necessarily be low.[3] We will also show that, in this case, there is no change in

[1] See Masulis (1983) page 123.

[2] Except for cases when the tax shield can not be used by the firm. For example, when the firm has substantial nondebt tax shields already in place. See DeAngelo and Masulis (1980).

[3] For a given increase, d, in the debt level, a low–tax firm is providing "better news" to the market than is a high–tax–rate firm.

the cost of debt.

It is the equilibrium nature of the analysis presented below that differentiates our work from that of Masulis. It is also directly responsible for the conclusion that the change in firm value is independent of the firm's marginal tax rate.

In section 1, we construct a simple model of optimal capital structure and determine the relation between capital structure changes and changes in firm value. In section 2, we derive and test the predictions of the model. In section 3, we discuss the robustness of the theory to capital structure changes other than swaps or exchange offers, and to differerent modeling assumptions. Section 4 concludes.

1 The Model

When capital markets are perfect and there is no corporate or personal taxation, classical finance theory (e.g., Modigliani and Miller (1958)) tells us that with a fixed investment policy, capital structure does not affect firm value. This ceases to be true, however, when taxes (e.g., Modigliani and Miller (1963)) are added to the mix. *Ceteris paribus*, the tax deductability of interest at the corporate level leads firms to issue debt. Indeed, without differential taxation of interest and capital gains at the personal level, (e.g., Miller (1977), DeAngelo and Masulis (1980)), or some other market imperfection, firms would be entirely comprised of debt.

Although the tax deductibility of debt at the corporate level provides substantial incentives for firms to increase their use of debt, in practice, firms' capital structures do not consist wholly of debt. Reasons often cited include bankruptcy (e.g. Warner (1977), Scott (1977)) and agency costs (e.g., Jensen and Meckling (1976)). Although direct bankruptcy costs may not be large enough to explain why firms do not issue more debt (Warner (1977), Haugen and Senbet (1978)), there are additional costs of financial distress. For example, debt is often issued with protective covenants (Smith and Warner (1979),Kalay (1982)) that may be costly to violate. In addition, increasing the amount of debt increases the incentive for equity holders to ignore profitable projects if a large portion of the gains accrue to the bondholders (e.g., Myers (1977)).

In theory, if a firm is to have an optimal capital structure that contains both equity and debt, the marginal benefits of debt must equal the marginal costs.[4] This simple insight is the basis for many of the theoretical models of capital structure choice. It matters little whether the benefits are due to tax shields and the costs due to bankruptcy (Kraus and Litzenberger (1973) or Moyen (1998)), or the costs and benefits are due to agency considerations (Jensen and Meckling (1976)), or whether the setting is static or dynamic. In our model, to facilitate the empirical tests, we directly consider only the tax deductibility of interest payments as *the* benefit of debt financing. We label this *the* benefit of debt. All other effects of debt on firm value (bankruptcy costs, agency, personal taxes, etc.) are considered together and labeled simply the (net) costs of debt finance.

Consider a firm that receives cash flow, K_t, drawn each year from a distribution $g_0(\cdot)$, where $g_0(\cdot)$ has mean μ_0 and variance σ_0^2. Suppose further that this firm currently has an amount of perpetual debt $D > 0$ on which it pays rD each period, where the annual interest rate, r, is assumed to be constant for simplicity.[5]

Taxable income each period, I_t equals $K_t - rD$. If $\tau(\cdot)$ is the firm's marginal tax rate, then income after interest and taxes, X_t, is given by

$$X_t = K_t - rD - \int_0^{K_t - rD} \tau(I_t) dI_t. \tag{1}$$

Assume that for a given distribution of cash flow, the marginal cost of debt is a function of taxable income alone. Let $MC(I_t)$ denote the marginal cost of debt, where $MC(0)$ is positive and $MC(\cdot)$ is a weakly decreasing function,

$$MC(0) > 0, \quad MC'(\cdot) \leq 0.$$

Hence, for any given cash flow, K_t, the marginal cost of debt is increasing in the debt level and decreasing in taxable income (See Figure 1). We do not specify the reason the firm's marginal cost–of–debt curve is downward–sloping. One reason might be the direct or indirect costs of bankruptcy.

[4] Empirically, we find that firms with higher marginal tax rates also have higher yield spreads relative to Treasury bonds, evidence that firms trade the benefits of debt against the increased borrowing costs.

[5] The amount of debt must be positive for the equilibrium to be characterized by first–order conditions. This assumption can be relaxed and one could investigate what happens both when firms issue debt for the first time and when firms repurchase all debt.

Another possibility is agency costs. All that is required is that in aggregate, the costs of debt are such that the marginal cost weakly increases with the debt level.

In sum, we assume that the marginal cost of debt measures the aggregate effects of debt on the firm's value except for the benefit introduced by corporate taxes. We also assume that the cost of debt is such that the marginal cost curve is a weakly decreasing function of taxable income.

Standard analysis determines that the marginal benefit of debt is equal to the firm's marginal tax rate. Consider the benefit of increasing annual interest payments rD by a dollar. This "shields" an additional dollar of income from taxation (lowers I_t by a dollar). Given that the debt is perpetual, the increase in firm value is equal to a dollar times the firm's marginal tax rate. Thus the marginal benefit of debt is $\tau(I_t)$. Consistent with Graham's (1996a) empirical findings, we assume that corporate tax schedules are positive and weakly increasing in taxable income.

$$\tau(I_t) > 0 \; \forall \; I_t > 0, \quad \tau'(\cdot) \geq 0.$$

Writing the marginal cost of debt as

$$MC\left(K_t - rD\right),$$

an equilibrium capital structure that contains both equity and debt must have the marginal cost of debt equal to its marginal benefit:

$$MC\left(K_t - rD^*\right) = \tau(K_t - rD^*), \tag{2}$$

where D^* is the unique solution for the firm's optimal capital structure. Given the restrictions on the marginal cost and benefit curves, the optimum is characterized by the first-order condition (2).[6] Let I^* denote the firm's optimal level of taxable income.

1.1 Symmetric Information

Consider an exogenous change in the firm's cash flow distribution $g_0(\cdot)$. We examine two cases: first, a once-and-for-all change in the mean of the distribution and second, a once-and-for-all change in

[6]We assume that the optimization problem is from the point of view of the owners of the firm, who recognize any agency problems that exist between themselves and the manager of the firm.

its variance. We consider these cases because Cornett and Travlos (1989) and Shah (1994) find that firm performance changes after an exchange offer. Their results indicate that firms that conduct leverage–decreasing exchange offers usually have lower realized future cash flow, while firms that conduct leverage–increasing exchange offers have realized future cash flow that features reduced volatility rather than an increased level. For simplicity, until section 1.2, we assume that the true change in the firm's profitability becomes public information at the time the capital structure change is announced. This implies that firms have no incentive to use capital structure to signal the magnitude of profitability changes. We also restrict attention, until Section 3, to the case of exchange offers.

Mean shifts

From an initial optimum, we assume that the firm's mean cash flow exogenously increases by G dollars per year and that its distribution is otherwise unchanged. For the firm to return to an optimum, it must alter its capital structure so that the marginal benefit of debt again equals the marginal cost. Because we assume that the firm's marginal cost and marginal benefit of debt depend only on its taxable income,[7] it must be that I^* remains the level of taxable income at which the marginal benefit of debt equals marginal cost.[8]

This situation is illustrated in Figure 1. From the firm's initial optimum, the increase in expected cash flow from I^* to I' implies that the marginal benefits of debt are larger than the marginal costs. In response, the firm increases its debt level until the added interest payments reduce taxable income enough so that the marginal costs and benefits of debt are again equated. This occurs at I^*, so that the firm's optimal policy is to issue enough new debt, d, to shield all of the additional cash flow: $G = rd$. An immediate consequence of this argument is that the change in the value of the firm is independent of the prevailing marginal tax rate. [9]

[7]Note that we have assumed away the possibility that good past realizations affect current bankruptcy probabilities. This is equivalent to assuming that the firm pays out its entire net income as a dividend each period.

[8]Our results are not sensitive to the initial distribution of a firm's future cash flow. What is important for our analysis here is that the component of cash flow that is a surprise involves a mean shift only. Any predictable component should already be factored into the stock price, as should any program of expected capital structure changes resulting from the predictable component.

[9]It is important to differentiate this from a more traditional presentation, which states that, in the absence of bankruptcy and agency costs, when the distribution of the firm's future cash flow is known, the value of a levered

The result that the change in firm value is independent of the marginal tax rate is easiest to see when tax rates are constant (i.e., a horizontal marginal benefit function in figure 1). In that case, the marginal benefit of debt is τ. Shifting mean operating cash flow leaves the marginal benefit of debt unchanged. In the new equilibrium, marginal costs must also be unchanged. Therefore, optimal taxable income must also be unchanged, because the level of taxable income is the sole determinant of the cost of debt. The firm optimally issues or retires enough debt so that the change in interest payments exactly offsets the change in operating cash flow, and taxable income returns to its previous level. It is therefore the change in the firm's profitability that dictates the size of the change in firm value, and the level of the firm's marginal tax rate does not affect the market reaction. Note that this argument holds for any tax rate, τ.

For ease of presentation, we assume that the change in profitability and the change in capital structure occur simultaneously (we require only that the market learns of the change at the announcement of the change in capital structure). We can now examine the market reaction to the change in the firm's profitability and relate it to the change in leverage.

Before the exchange offer, per period, taxable income is $I_t = K_t - rD$. When the exchange offer is announced and the market learns of the firm's change in profitability, the value of the firm changes to reflect the new information. The question here is: How does the change in firm value relate to the change in the value of the debt? For a change in the market value of the firm's debt, d, the optimality condition implies that $rd = G$, so that the distribution of the firm's taxable income is unchanged. The assumption that G represents a perpetual increase in the firm's mean cash flow and this optimality condition, abstracting away from issues of seniority of the new debt relative to the old, imply that the change in the value of the firm should equal the change in the value of the firm's debt.

The fact that the change in firm value equals the change in the market value of the debt relies on two assumptions: 1) the mean of the distribution of the firm's annual cash flow changes, and 2)

firm exceeds the value of an unlevered firm by the present value of the debt tax shields. In our model, a change in the distribution of the firm's future cash flow initiates the capital structure change. The change in firm value is thus the sum of the present value of the additional tax shields *and* the change in after-tax firm profitability. This last component is missing from the traditional version.

that it does so in perpetuity. Put another way, the value of the firm increases by the present value of the change in the interest payments. When the change in the cash flow distribution is a mean shift in perpetuity, this equals the change in the value of the debt ($rd/r = G/r$). If the mean of the cash flow distribution increases for a finite time, the change in the value of the firm should equal the present value of the interest payments, not the entire value of the debt.

Empirically, even if these assumptions hold it may be difficult to find that the change in firm value equals the change in the firm's debt. We have assumed that all of the information concerning the firm's cash flow is released at the announcement of the exchange offer. If there is any information leakage before the announcement date, then the measured change in value will be less than predicted. For example, if the market learns of the cash flow change before the capital structure adjustment is announced, the change in firm value measured at the announcement of the exchange offer will reflect only the resolution of the remaining uncertainty.

Our results do not imply that the amount of debt in a firm's capital structure is independent of the marginal tax rate. The firm's optimal capital structure is such that the marginal benefit of debt equals its marginal cost, and the marginal benefit of debt is determined by the firm's marginal tax rate. *Ceteris paribus*, the higher a firm's marginal tax rate, the greater the amount of debt the firm will have in equilibrium. In our analysis, the fact that both the firm's tax schedule and the firm's cost curve are functions of taxable income delivers the result that the *change* in value due to a capital structure adjustment is independent of the level of the tax rate. In contrast, the change in firm value due to an exchange offer motivated by an exogenous change in the firm's tax schedule would not be independent of the firm's tax rate.

Finally, consider exchange offers where the firm issues debt for the first time and exchange offers where the firm repurchases all of its existing debt. In the first case, the firm's optimal capital structure was not initially interior, thus it must have been that the marginal cost of debt exceeded its marginal benefit. For these firms, issuing debt conveys much better news than would have been the case had the firm's initial optimum been interior. One would expect the firm's value to increase by more than the value of the debt issued. Conversely, firms that repurchase all of their debt have equilibrium capital structures for which the marginal costs of debt now exceed the marginal benefits. Hence, repurchases of this sort are extremely bad news.[10]

A Change in the Variance of Future Cash Flow

In this section, we suppose that the change in firm profitability is a reduction in cash flow variability, and investigate whether it is possible to predict stock price reactions to exchange offers. We also consider whether it is possible to determine if the change in profitability was due to a mean shift or a risk shift.

We begin by modeling an increase in cash flow variability as an increase in the marginal cost curve. Thus, for every level of expected taxable income the marginal cost of debt is lower. For example, the reduction in costs for all cash flow levels might stem from a decrease in cash flow volatility that reduces the expected costs (direct or indirect) of bankruptcy.

Because the marginal cost curve moves upward, the optimal point, where marginal benefit equals marginal cost, features less debt. If the marginal benefit curve does not move, then in addition, the firm's marginal tax ate should rise.

But a secondary effect documented by Graham (1996) is that given a particular expected cash flow, an increase in cash flow variability reduces the firm's marginal tax rate. This lowers the marginal benefit curve. This does not affect the result that the change in firm value is independent of the tax rate, but theoretically, it means that the firm's marginal tax rate need not rise when there is a variance increase. Theoretically, a variance increae can either increase or decrease the firm's marginal tax rate.

Nevertheless, the general result holds – the change in firm value accompanying a capital structure change is independent of the firm's marginal tax rate. This is because, while the level of the change in value resulting from a change in the variance of cash flow and the subsequent capital structure adjustment depends upon the shapes of the marginal cost and benefit curves it will not depend upon the initial level of the curves or upon the level of the initial optimum. See Figure 2.

[10] Such repurchases ought to be very rare, since these firms are likely to be too liquidity–constrained to conduct exchange offers in the first place.

Were both the marginal cost and marginal benefit curves shifted upward by a constant amount, so that the firm's optimal marginal tax rate rose, a variance increase lead to exactly the same reduction in firm value, which on figure 2 is the area between the MC and MC' marginal cost curves.

Within our model, it is possible to distinguish variance changes from a mean shift in expected cash flow by comparing the firms' marginal tax rate before and after the exchange offer. Our model predicts that (given the extant empirical evidence) the marginal tax rate should generally change if the variance of future cash flows changes. unfortunately, the direction of the change is indeterminate.

1.2 Asymmetric Information

If information is asymmetric, the firm might not issue the amount of debt detailed above. To illustrate the results, we consider the case where a change in the mean cash flow, G, is unobservable to market participants at the time of the exchange offer, and d is the optimal amount of debt to issue absent signaling or agency considerations. In the leverage-increasing scenario, the firm may have an incentive to issue new debt $d' > d$ to convince the market that the news is better than it actually is. In this section, we investigate the implications when this incentive leads to a dissipative signaling equilibrium of the type described by Ross (1977).[11] In such an equilibrium, because the firm's type (here, the firm's expected cash flow) is fully revealed, the signaling cost is dissipated. A consequence is that in such an equilibrium, firm values rise by less than the market value of the debt issue because all firms (except the very worst) issue too much debt.

The signaling equilibrium produces other testable implications. For example, firms in higher marginal tax brackets obtain greater tax benefits than firms in low marginal tax brackets. One might expect that this means that high tax firms have a greater incentive to signal because they receive greater tax shields. This reasoning leads to the conclusion that all else equal, one would see a relatively smaller stock price reaction to an exchange offer for high tax firms than for low

[11] This informational structure need not lead to a signaling equibrium. For a signaling equilibrium to exist, it must be incentive compatable.

tax firms because "overissuing" is cheaper for high tax firms. We now show that this reasoning is incorrect. The important determinant of the signaling component of the stock price reaction is not the level of the marginal tax rate, but instead, the slope of the marginal tax rate schedule, $\tau'(I_t)$.

To see why, recall that at its optimum, a firm with a high marginal tax rate does *not* initially issue more debt is because there are high marginal costs to doing so. Such a firm's high marginal cost stems from two sources. First, we assume that the cost curve increases in the amount of debt the firm has outstanding. Second, the benefit curve due to tax shields is decreasing in the amount of debt. The firms that find it most costly to signal, and hence need to over–issue by less communicate a given signal, are the firms that have either steep marginal benefit curves, steep marginal cost curves, or both. Figure 3 shows that as the benefit curve becomes more steeply sloped, the costs of over-issuing debt increase[12]. However, it is again true that the *level* of the marginal tax rate, where the marginal cost and benefit curves cross, is unimportant when the slopes of the curves are known.

Unfortunately, we have not found a satisfactory way of measuring the firm's marginal cost curve. This leaves the benefit curve, which we can estimate using Graham's (1996a, 1996b, 1998) techniques. Focusing only on the benefit curve lessens the power of our results, because of the omitted variable. Still, the model's implications will not be overturned unless the absolute values of the slopes of the cost and benefit curves are negatively correlated.[13]

If firms with high marginal tax rates have more steeply increasing marginal benefit curves, issuing more debt is relatively *more* costly for them, rather than relatively cheaper. Therefore, they get more "bang for the buck" of debt issued; consequently, they will (over)issue less debt, and will hence experience greater stock price reactions per dollar of debt issued. This holds generally for firms with steeper marginal benefit curves. The steeper is the marginal tax schedule, the larger the increase in firm value relative to the size of the debt issue. If marginal tax rate levels are

[12]The logic for a steeper cost curve is analogous.

[13]There is no *a priori* reason to expect that the marginal benefit curve will be flat when the marginal cost curve is steep, or vice versa. One could argue that because firms with flat marginal tax schedules (at high rates) are highly profitable, these firms might have less steeply sloped marginal cost curves so that the (absolute values of) the slopes of the marginal cost curve and the marginal tax schedule could be positively correlated. Our qualitative result holds when the slopes are positively correlated or uncorrelated.

correlated with the steepness of the marginal tax rate curve, marginal tax rates will appear to be related to market reactions due to exchange offers in a world where there is dissipative signaling by firms, contrary to our predictions. However, the relation should disappear if the slope of the marginal benefit curve is controlled for.

2 Empirical Tests

2.1 Summary of Testable Implications

The most robust implication from our model is

H1: in an exchange offer, for a given change in debt, the resulting change in firm value is unrelated to the firm's marginal tax rate.

This result holds whether the change in cash flows is a mean shift, a variance shift, or some combination of the two. It holds whether the information about the firm's profitability is public or private.

For a particular type of cash flow change, the theory places additional restrictions on the stock price reaction in an exchange offer.

H2a: If the cash flow change is an increase (decrease) in the mean of the distribution of cash flow, the firm's optimal policy is to issue (repurchase) enough debt to shield all the additional cash flow. In this case, the change in firm value equals the present value of the interest payments from the additional debt issued (repurchased), which, in the case of a permanent change equals the market value of the debt.

H2b: If the cash flow change is a change in the variance of the distribution of cash flow, then the marginal tax rate can change. The direction of the change is, however, indeterminate.

When the cash flow change is private information to firms, it may be that exchange offers must be understood as part of a dissipative signaling equilibrium. Because we are able to measure the slope of the marginal benefit curve directly, we can investigate whether firms with more steeply sloped marginal benefit curves experience greater stock price reactions as a function of the amount of debt issued, as they should if firms are indeed in a dissipative signaling equilibrium. We test this implication with the following specification:

$$\frac{\Delta V}{d} = \beta_0 + \beta_1 \tau'(I_t). \tag{3}$$

In the signaling equilibrium, all firms engage in dissipative signaling except the firm(s) that finds dissipative signaling most costly. Therefore, the change in firm value as a percentage of the market value of the debt should be less than or equal to one, and firms with the more steeply sloped marginal benefit curves should have, on average, greater stock price reactions. Hence, the signaling equilibrium implies that β_0 is less than one, and β_1 is positive.

This places strong restrictions on the signaling equilibrium. Were the coefficient on β_1 zero, this would be evidence against the hypothesis that firms signal with capital structure. Even if the hypothesis that β_0 equals one (i.e., the prediction H2a) is rejected, if β_1 is not positive, the hypothesis that firms signal with capital structure can be rejected. Our modeling of the signaling equilibrium leads to two hypotheses.

H3a: If the change in cash flow is a pure mean shift, in an exchange offer, the value of the firm should increase by less than the market value of the debt issued ($\beta_0 = 1$)

H3b: The more steeply sloped is the firm's tax schedule, the greater the percentage increase in the value of the firm as a proportion of the amount of debt issued. ($\beta_1 > 0$)

2.2 Data and Preliminary Tests

We focus our empirical investigation on capital structure changes that occur when firms issue equity to retire debt. Our data consist of 245 equity-for-debt swaps that occur between mid-1981 and mid-1984. This sample of leverage-decreasing security exchanges is also examined by Hand (1987,1989) and Israel, Ofer, and Siegel (1989). See Hand (1989) for an excellent description of the sample and institutional details; some of our data description is paraphrased from Hand's article.

Market interest rates were relatively high in the early 1980s, so the repurchased bonds we examine were typically retired at a substantial discount (market value equal to about two-thirds of face value). During our sample period, corporations were obligated to pay capital gains taxes on the discount associated with bond retirement, unless they were able qualify for the "stock–for–debt exception". To qualify for this tax–free recognition of the capital gain, a firm had to satisfy several conditions. First, the bonds had to be purchased on the open market by investment bankers (or some other third party). Second, the banker had to act as a principal and incur the risk of actually owning the bonds. Finally, the stock aspect of the transaction could not be satisfied completely with cash, or with token shares.[14] [15]

Once the investment bank owned the bonds, the corporation would trade treasury or newly issued common stock (and perhaps some cash) for the bonds. The firm would also publically announce the swap. Hand (1989) cites evidence that the public release of information (over the Dow Jones broad tape) almost always coincided with the day the stock was registered with the SEC, suggesting that information leakage should be small for our sample. As in Hand (1989), we treat the event period as the two-day period starting with the SEC registration date ($t = 0$ and $t = 1$) to accommodate announcements that occurred after the close of the market.

Once the investment bank owned the common stock, it typically sold the shares (within two days) on the open market in a registered secondary offering. The entire transaction took less than one or two weeks from the initial contact between the investment banker and the firm to the secondary offering of the stock by the bank. For its troubles, the investment bank received fees averaging 3.8 percent of the market value of the equity plus 0.3 percent of the face value of the debt.

Table 1 contains summary statistics for variables of interest. The mean amount of debt retired has a face value of \$33.1 million. Market prices for the bonds are gathered from Interactive Data Corporation and are available for 155 of the 245 sample firms. As of the end of the day preceding the event date, the average market value of the retired debt is \$21.8 million, indicating that the

[14] All the firms in our sample qualify for the stock–for–debt exception.

[15] The absence of capital gains implications for the firms in our sample makes it relatively "clean" from the persepctive of measuring the price imact of a capital structure change. Although it might be possible to gather a larger sample to construct more powerful tests, this larger sample would not share this attractive feature. For the larger sample, it would be necessary to correct for capital gains effects when they exist.

average bond was selling at about 66 cents on the dollar.

The mean change in firm value is $22.2 million, which excludes 1) the reduction in market value due to investment banker's fees (equal to about 4% of the new equity), 2) the normal movement in the price of the common stock attributable to market movements (as estimated by the market model), and 3) changes due to any cash payments in the swap deal. The average abnormal return to the announcement of the equity issuance is -1.3% as estimated by the market model; 173 out of 245 of the excess returns are negative. Thus, the price reaction to equity issuance is consistent with that reported in the extant literature.

The mean ratio of the change in firm value divided by the market value of retired debt is 1.06, with a standard error of 0.30 (see Table 2). Thus, as predicted in hypothesis H2a, the mean ratio is not statistically distinguishable from 1.0. Also, note that the ratio is approximately two standard deviations from the upper bound on possible tax benefits of debt. (The maximum statutory corporate tax rate was 0.46 in the early 1980s, a figure that ignores all offsetting costs.) Although not tabulated, the median $\frac{\Delta V}{d}$ ratio for our sample is 0.73. Finally, although our theory makes predictions about the change in firm value relative to the market value of the retired debt, we also report the ratio of the change in the value of equity relative to the change in book value of debt. We report this figure to see if our inability to identify market prices for 90 of the bond issues affects our results. The mean ratio of the change in the equity value of the firm divided by the book value of retired debt is 0.86, which again is within one standard deviation of 1.0. This estimate is roughly two-thirds the estimate based on market debt, which is consistent with a one-third discount and suggests that our sample of market prices is representative.

Table 1 also contains information on the reported earnings gain attributable to the swap (SwapGain). Hand (1989) shows that equity-for-debt swaps can lead to paper earnings gains, which may help firms smooth earnings. We do not investigate this issue in detail but include SwapGain as a control variable in our regressions. The average swap leads to a paper earnings gain of $7.8 million.

Finally, Table 1 reports summary statistics for the corporate marginal tax rate (MTR) and the slope of the interest deduction benefit function. We follow the approach used by Graham (1996a, 1996b, 1998) to estimate the tax variables. See the appendix for a description of how these variables are estimated. Seventy-seven percent (66%) of the firms in the sample have a benefit function that is flat (i.e., a slope of zero) as measured by slope1% (slope3%) (see Table 1). The average slope is approximately 0.02.

The mean marginal tax rate for the sample firms is 38.7% (see Table 1). Although not tabulated, the volatility of *ex post* income distribution averages $670 million. If the *ex ante* income distribution is used to parameterize the drift and volatility of taxable income, the volatility is $169 million. The typical firm in our sample also experiences a reduction in earnings, suggesting that perhaps the motivation for the exchanges in this sample was a reduction in the level of cash flows as well as an increase in their volatility. Because the volatility of taxable income changes (it increases) after the equity-for-debt swap (i.e., going from the *ex ante* to the *ex post* income distribution), hypothesis H2b predicts that the mean tax rate based on the *ex ante* distribution should be different from the *ex post* tax rate of 38.7%. The mean *ex ante* tax rate is 43.4%. The *ex post* tax rate is statistically significantly lower than the *ex ante* tax rate at a 1% level according to both an analysis of variance (which tests the equality of the mean tax rates) and a Wilcoxon rank-sum test (which tests the equality of the *ex ante* and *ex post* distributions of tax rates). This seems to indicate that when the variance of cash flows increases, not only does the marginal cost curve move up, but the marginal benefit curve also moves down. In such a situation, the equilibrium expected tax rate could be lower *ex post* than *ex ante*.

2.3 Regression tests

Our primary empirical specification is

$$\frac{\Delta V}{d} = \beta_0 + \beta_1 slopex\% + \beta_2 SwapGain. \tag{4}$$

We estimate the model using iterated generalized method of moments, which produces standard errors that are heteroscedastic-consistent. Our first regression uses the entire sample and measures the slope of the benefit function (slope1%) over the range of 99% to 101% of the actual level of interest. The estimated intercept of 1.5 with a standard error of 0.46, indicates that the intercept is not statistically different from 1.0 at a 5% level of significance (see column 3a in Table 3). This evidence supports the prediction summarized in hypothesis H2a. In contrast, the signaling hypothesis calls for an intercept less than 1.0, which is not consistent with the estimated β_0. In addition, the estimated coefficient, β_1, on slope1% is negative, although not statistically different from zero at a 5% level. This is the opposite sign from that predicted by the signaling model (hypothesis H3a). Finally, the negative coefficient on SwapGain indicates that a large reported earnings gain attenuates the negative price reaction that occurs when firms issue equity to replace outstanding debt; however, the coefficient is not significant.

The estimated β_1 coefficient indicates that firms with steeply sloped benefit functions experience smaller price reactions when they retire debt. If the level of the marginal tax rate and its slope are correlated we may find that the marginal tax rate is (spuriously) related to the market reaction if the slope of the tax schedule is not controlled for. To test this line of reasoning in more depth, we include MTR as a separate explanatory variable.[16] Consistent with our main hypothesis, H1, the estimated coefficient on the MTR variable, when it is included in the basic specification, is insignificantly different from zero. In fact, including the MTR term inflates the standard errors on all the variables, so none of the coefficients are significantly different from zero. The result that the level of the marginal tax rate is unrelated to the change in the value of the firm holds for all variations of our empirical specification. The inflation of standard errors is consistent with multicollinearity between the slope1%, MTR, and the intercept, given that many firms have flat benefit functions (and firms with flat functions usually have MTRs of 46%). Consequently, the primary results we present do not include the MTR variable in the regression specification.

The analysis is repeated using slope3% (which measures the slope of the benefit function from 97% to 103% of the actual level of interest), rather than slope1%, as an explanatory variable (see column 3b). Again, the intercept is within two standard errors of 1.0, which supports our prediction that the market reaction to debt retirement is proportional to d. The coefficient on the slope variable is now significantly negative. Consequently, the data provide evidence inconsistent with the notion that firms use debt policy to signal their type to the market. As before, we experiment with

[16] This is done for each of the regressions, although these results are not shown in Table 3.

adding MTR as a separate explanatory variable. Consistent with hypothesis H1, MTR is again insignificantly different from zero, while the coefficient on the slope term remains significantly negative. Given that the standard error falls by nearly half when slope3% is used, relative to using slope1%, we use slope3% in the remainder of the empirical analysis. (The qualitative findings do not change if we use slope1%.)

We are concerned that a microstructure effect could introduce noise into our experiment. Recall that the debt retirements in our sample are fairly small relative to the value of the typical firm, and that the market value of retired debt is in the denominator of our dependent variable. Also, note that ΔV can be relatively big (relative to d) for a large firm for even normal price movements (for example, movements from the bid to the ask price, or vice versa). This implies that for a given d, $\frac{\Delta V}{d}$ may be big for large capitalization firms for reasons unrelated to our hypotheses and could induce a form of heteroscedasticity into the data.

Because we use GMM, our estimates may not be severely affected by this problem; nonetheless, we perform an experiment to check if our conclusions are disproportionally affected by observations for which d is particularly small. Column 3c shows estimation results when 46 observations are deleted for which $\frac{d}{V_{t-1}}$ is less than 0.5%. The intercept is now closer to 1.0 with a much tighter distribution, and the standard errors on the slope3% and SwapGain variables are also much smaller. These findings indicate that the microstructure effect may lead to noisy parameter estimates but that our qualitative results are not adversely affected. Once again, MTR has an insignificant coefficient when it is included as a separate variable (not shown).

Thirty-one of the observations in the sample represent equity-for-debt swaps that are performed by firms that are bank holding companies (or that are owned by bank holding companies). To ensure that our conclusions are not affected by potentially different tax or non-tax incentives for banks, we delete these 31 observations. As shown in column 3d, excluding the bank holding company observations does not substantially affect the estimated coefficients.

Finally, we investigate the consequences of using the larger sample that is available if we do not use the market value of debt. Columns 3e and 3f use the change in equity value in place of the change in firm value. In 3e, for comparison, the denominator is the change in the market value of debt. In 3f the denominator is the change in the book value of debt. Using the book value of debt, column 3f, the intercept is 1.3, which is within one standard error of unity, and the slope3% coefficient is significantly negative. These results corroborate our market value of debt findings.

In summary, in none of the specifications does the level of the firms' marginal tax rate influence the size of the market reaction to equity-for-debt swaps when the slope of the marginal tax schedule is controlled for. For a variety of specifications we estimate that the intercept in a regression with $\frac{\Delta V}{d}$ as dependent variable is within two standard deviations of 1.0. This finding is consistent with the prediction from our model that the market reaction to debt retirement reflects the loss of cash flow with present value equal to the market value of debt; this reaction is larger than it would be if the only consequence of reduced debt is loss of tax benefits. In each specification we also find that firms with steeper benefit functions have smaller market reactions to debt retirement. Given that the signaling model predicts that firms with steeply sloped benefit functions should receive a more favorable market reaction, this finding is inconsistent with the idea that firms use capital structure to send dissipative signals.

3 Robustness and Extensions of the model

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In this section, we investigate the robustness of our empirical predictions to various modeling misspecifications. In the main, the results are robust as long as the capital structure change stems from a change in firm profitability. If instead, the capital structure change is a result of an exogenous change in the tax code, the change in firm value *is* a function of the change in the firm's marginal tax rate.

Difficulties in identifying when information becomes public

Unless the change in the firm's cash flow becomes public information at the same time that the firm changes its capital structure, the full informational effect of the capital structure change will not be realized on the day that the exchange offer is announced. For example, when the cash flow change is a pure mean shift, information leakage before the announcement date implies that on the announcement date, some information will already be incorporated in prices so that change in firm value will be smaller (in absolute value) than the market value of the new debt. In theory, the stock price change should occur when the information becomes public. In practice, it is impossible to know when the information becomes public so that identifying the event date for empirical work may be problematic. Masulis (1978) finds evidence that there is information leakage for about 10% of the offers in his sample.

Anticipated future debt issues

As a result of better (worse) firm performance, a firm may, for example, conduct a series of debt issues (retirements) as cash flow increases over time. If the series of debt changes is anticipated, then the market reaction to the initial debt offering/retirement would be much larger than the size of that offering, because the market would be reacting in part to anticipated future capital structure changes. Market reactions to future capital structure changes at the time of the subsequent capital structure changes would therefore be much smaller. Treating the capital structure changes for a single firm as independent events would leave the expected change in firm value as a function of the size of the debt issue unaffected (if the anticipated future changes are all included in the sample), but the variance of the estimate would increase, reducing the power of the analysis. This may provide an explanation for why we estimate intercepts that are greater than one (even if not statistically so).

Transaction Costs

Transaction costs for capital structure changes can, however, present difficulties for empirical work (Fisher, Henkel, Zechner (1989)) by preventing immediate adjustment of capital structure to changes in profitability. This follows because in an efficient market, investors react to new information about profitability when they learn about it. With respect to event studies, if the capital structure change is delayed due to transaction costs, there is no guarantee that the timing of the stock price reaction and the capital structure change will coincide. This effect will in general reduce the size of the stock price reaction found by employing the procedure for identifying the event date used in this paper.

Liquidity Constraints

It might be sensible to consider debt for equity and equity for debt exchange offers separately because of liquidity constraints. Firms are not likely to be able to repurchace all the desired debt in the event of bad news. This might cause firm value to decrease by more than the value of the debt - it might make decreases in leverage look like really bad news relative to the amount of debt repurchased, as indeed, they would be.

Debt issues for firms that are not taxed

Firms issued debt prior to corporate taxation. Jensen and Meckling (1976) argue that this may be optimal because there are agency costs associated with both equity and debt. To the extent that there was an interior optimum before corporate taxation, it might have been determined by some combination of bankruptcy costs and agency costs and benefits. This is completely consistent with our analysis. All that changes with the introduction of tax benefits is that, at the optimum, the marginal net costs from agency and bankruptcy considerations will be positive and firms will use more leverage.

Exogenous Changes to Corporate Tax Rates

It is important to distinguish changes in firm value that derive from changes in firm profitability from changes that stem from exogenous changes in the tax or legal environment. An exogenous change in the tax code has an impact on the firm's tax schedule, and hence, on its optimal capital structure. Thus, it may be possible to distinguish the effects of capital structure changes resulting from changes in a firm's profitability from capital structure changes stemming from changes in corporate tax rates. For example, when corporate tax rates fall, our model predicts that so will the amount of debt in the optimal capital structure. Yet firm profitability rises. In a simple model where information about reduced tax rates and changes in capital structure occur simultaneously, firm value would rise on the announcement of an equity-for-debt exchange offer. There are, however, practical difficulties involved in identifying the event date. Indeed, there may be no stock price reaction on the date of the capital structure change, if it is distinct from the date of the tax law change, because the entire reaction may already have occurred when the change in the tax law is announced.[17]

4 Conclusion

We construct a simple model of capital structure changes and show that when a firm conducts an exchange offer the change in firm value is unrelated to the firm's marginal tax rate. This result holds even under asymmetric information when there is a dissipative signaling equilibrium of the type described by Ross (1977). In a signaling equilibrium, however, the steeper the slope of the firm's tax schedule, the greater the change in firm value as a percentage of the amount of debt issued. Hence, it is possible within our framework to determine whether firms signal with capital structure changes. The predictions of the model are robust to various theoretical misspecifications.

We test the model. Using a sample of equity-for-debt swaps that occurred in the early 1980s, we find that firm value changes are unrelated to the firm's marginal tax rate and that the data are inconsistent with dissipative capital structure signaling. We also find that the average change in the market value of the firm is indistinguishable from the amount of debt retired. This is notable because traditional analysis of the issue (Masulis (1983)) suggests that the change in value should be on the order of the corporate tax rate times the amount of debt retired. We conclude that our empirical results are consistent with firms optimizing by making capital structure decisions in response to shocks that push them out of equilibrium.

[17] Or, the reaction might occur at the time when it became apparent that a change in the tax law was likely.

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Table 1 Summary Statistics

Summary statistics are shown for variables of interest. Book debt is the face amount of the debt involved in the equity-for-debt swap, while market debt is the market price of the retired bonds on the day closest to but preceding the event date. The debt numbers are negative because they represent a reduction in debt. ΔV is the change in the market value of the firm (change in the market value of equity plus the change in the market value of the debt) excluding any change due to transactions costs or normal market movements (the latter estimated by the market model). The debt and equity numbers are in millions of dollars. Debt-to-equity is the ratio of the market value of the exchanged bonds to the value of equity immediately preceding the event. Abnormal return is the residual from the market model. SwapGain is the reported tax-free earnings gain from the swap (expressed in millions of dollars). MTR is the corporate marginal tax rate. Slope1% (slope3%) is the slope of the interest deduction marginal benefit function, calculated over the range 99%-to-101% (97%–to–103%) of the level of pre-event interest deductions. N means number of observations. n.a. means not applicable.

	N	Mean	Minimum	Maximum	N > 0
Book debt	245	-33.1	-197.5	-1.07	n.a.
Market debt	155	-21.8	-110.15	-0.82	n.a.
ΔV	155	-22.2	-548.9	442.1	n.a.
Debt-to-equity	155	-1.9%	-12%	0.04%	n.a.
Abnormal return	245	-1.3%	-11.5%	7.8%	72
SwapGain	245	7.8	-4.6	73.6	n.a.
MTR	203	38.7%	5.6%	46%	n.a.
Slope1%	203	0.023	0	2.6	46
Slope3%	203	0.021	0	1.8	69

Table 2

The top row shows the mean change in the market value of the firm divided by amount (market value) of debt retired is shown for non-missing observations. As a robustness check, the entire sample is used by considering the change in the market value of equity divided by the change in the book value of debt (second row). The standard errors are heteroscedastic consistent.

	N	Mean	Standard Error
ΔV /Market Debt	155	1.06	0.30
ΔE /Book Debt	245	0.86	0.24

Table 3 Regression Analysis

Regression results are shown based on iterated generalized method of moments, so the listed standard errors are heteroscedastic consistent. The regression is of the form

$$\frac{\Delta V}{d} = \beta_0 + \beta_1 slopeX\% + \beta_2 SwapGain. \tag{5}$$

ΔV is the change in the market value of the firm excluding changes due to transactions costs or normal market movements (the latter estimated by the market model). d is the market value of the debt retired (except in the book debt column, where it is the face amount of the debt involved in the equity-for-debt swap). Slope1% (slope3%) is the slope of the interest deduction marginal benefit function, calculated over the range 99%–to–101% (97%–to- 103%) of the level of pre-event interest deductions. SwapGain is the reported tax-free earnings gain from the swap (expressed in millions of dollars). Columns 3a and 3b show the results when the sample includes all firms for which market prices are available for bonds. Column 3c repeats the analysis using only those observations for which $\frac{d}{V_{t-1}}$ is greater than 0.5% in absolute value. Column 3d shows results based on excluding observations for which the firm doing the swap is a bank holding company. As a robustness check, columns 3e and 3f use the change in the value of equity in the numerator of the dependent variabe. In 3e the denominator is the change in the market value of debt and in 3f it is the change in the book value of debt.

The model predicts that the intercept β_0 should equal 1.0 if the change in cash flow results from a mean shift only (no change in variance), there is no informational leakage prior to the event date, and firms do not use capital structure to signal. If there is dissapative signaling, β_0 should be less than one and β_1 should be greater than zero.

	(3a) Market sample (N=131)	(3b) Market sample (N=131)	(3c) big changes in debt (N=109)	(3d) excluding bank holding companies (N=124)	(3e) market value of debt (N=155)	(3f) book value of debt (N=203)
dependent variable	$\frac{\Delta V}{\Delta(mkt\ debt)}$	$\frac{\Delta V}{\Delta(mkt\ debt)}$	$\frac{\Delta V}{\Delta(mkt\ debt)}$	$\frac{\Delta V}{\Delta(mkt\ debt)}$	$\frac{\Delta E}{\Delta(mkt\ debt)}$	$\frac{\Delta E}{\Delta(book\ debt)}$
intercept β_0	1.50 (0.456)	1.54 (0.455)	1.12 (0.284)	1.52 (0.514)	1.80 (0.473)	1.29 (0.403)
slope1% β_1	-1.065 (0.710)					
slope3% β_1		-1.991 (0.356)	-1.624 (0.241)	-2.052 (0.396)	-2.393 (0.373)	-1.832 (0.314)
SwapGain β_2	-0.028 (0.026)	-0.029 (0.026)	-0.027 (0.020)	-0.028 (0.027)	-0.042 (0.024)	-0.036 (0.018)
R^2	0.8%	1.4%	4.2%	1.3%	2.3%	1.9%

Appendix: Calculating the Slope of the Marginal Tax Rate Schedule

To estimate a tax rate we append a forecast of taxable income (EBT) from year $t+1$ through $t+18$ to historic income data from $t-3$ to t. The forecast assumes that income follows a random walk with drift and is included so that we can incorporate the effects of the tax-loss and tax-credit carrybacks and carryforwards into our tax rate estimates. To make a forecast of taxable income, we take year t income as given and draw random innovations from a normal distribution with mean and volatility equal to that in the data after the event date. We use data after the event (rather than before the event) to measure drift and volatility because our model assumes that the capital structure swap is precipitated by a change in the income distribution. Note, we do *not* use the taxable income realizations as our forecasted income stream – we use the *ex post* distribution to parameterize the drift and volatility of forecasted income.

Once we have a stream of taxable income from $t-3$ to $t+18$, we calculate the present value of the tax bill over the entire time horizon (using Moody's average corporate bond yield as discount rate). The tax bill is based on an algorithm that allows firms to carry losses and investment tax credits back three years and forward fifteen years (as dictated by the tax code). Next, we add \$10,000 to year t income and recalculate the present value tax bill. The difference between the two tax bills (divided by \$10,000) equals the present value tax obligation owed from earning an extra dollar of income in year t; that is, it equals the marginal tax rate. We replicate the experiment 300 times for each firm, starting with a fresh forecast of taxable income each time. We average over the 300 simulations to obtain the expected marginal tax rate in year t separately for each firm, with year t representing the fiscal year-end immediately preceding the event date. We use Compustat data to estimate the tax rates, which leaves 203 observations with sufficient data availability to calculate a tax rate.

The interest deduction marginal benefit functions are determined by simulating a collection of MTRs for each firm. For example, a hypothetical tax rate is calculated as if a firm takes 99% of the actual of interest expense in year t. This tax rate is referred to as $MTR^{99\%}$ and reflects what a firm's tax rate would be if it retired approximately one percent of its debt outstanding. Analogously, $MTR^{101\%}$ is the firm's hypothetical tax if a firm were to use 101% of the actual amount of interest recorded in the period preceding the event date. The slope of the tax function for one percent changes in interest expense (slope1%) is estimated as the absolute difference between $MTR^{99\%}$ and $MTR^{101\%}$ divided by 0.02. Analogously, slope3% is based on the absolute difference between and $MTR^{97\%}$ and $MTR^{103\%}$. We determine the slope of benefit functions over these fairly small ranges of interest expense because the size of the debt retirements in our sample are small (the mean $\frac{d}{V_{t-1}}$ is about 2%; see Table 1).