NBER WORKING PAPER SERIES

THE COST OF DEBT

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Working Paper 16023
http://www.nber.org/papers/w16023

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
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May 2010

We thank Rick Green (the Acting Editor), and an anonymous referee, Heitor Almeida, Ravi Bansal, Jonathan Berk, Michael Brandt, Alon Brav, Hui Chen, Dave Denis, Simon Gervais, Cam Harvey, Han Hong, Ralph Koijen, Mike Lemmon, Rich Mathews, Bertrand Melenberg, Mitch Petersen, Francisco Perez Gonzalez, Anamara Pieschacon, Adriano Rampini, Michael Roberts, David Robinson, Ilya Strebulaev, George Tauchen, Larry Weiss, Toni Whited, participants at the WFA meetings, the NBER Summer Institute, the EFA meetings, UNC Tax Symposium, the McKinsey Corporate Finance Conference, and seminar participants at Duke University, Georgetown University, Indiana University, New York University, Purdue University, Rice University, University of Chicago, University of Pittsburgh, and The Wharton School for helpful comments. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

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NBER Working Paper No. 16023
May 2010
JEL No. G3,G30,G32,G33

ABSTRACT

We estimate firm-specific marginal cost of debt functions for a large panel of companies between 1980 and 2007. The marginal cost curves are identified by exogenous variation in the marginal tax benefits of debt. The location of a given company's cost of debt function varies with characteristics such as asset collateral, size, book-to-market, asset tangibility, cash flows, and whether the firm pays dividends. By integrating the area between benefit and cost functions we estimate that the equilibrium net benefit of debt is 3.5% of asset value, resulting from an estimated gross benefit of debt of 10.4% of asset value and an estimated cost of debt of 6.9%. We find that the cost of being overlevered is asymmetrically higher than the cost of being underlevered and that expected default costs constitute approximately half of the total ex ante cost of debt.

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Hundreds of papers investigate corporate financial decisions and the factors that influence capital structure. Much theoretical work characterizes the choice between debt and equity in a trade-off context in which firms choose their optimal debt ratio by balancing the benefits and costs. Traditionally, tax savings that occur because interest is deductible have been modeled as a primary benefit of debt (Kraus and Litzenberger, 1973). Other benefits include committing managers to operate efficiently (Jensen, 1986) and engaging lenders to monitor the firm (Jensen and Meckling, 1976). The costs of debt include financial distress (Scott, 1976), personal taxes (Miller, 1977), debt overhang (Myers, 1977), and agency conflicts between managers and investors or among different groups of investors. For the most part, these theoretical predictions have been tested using reduced form regressions that attempt to explain variation in capital structure policies based on estimated slope coefficients for factors such as firm size, tax status, asset tangibility, profitability, and growth options (Rajan and Zingales, 1995; Frank and Goyal, 2009; Graham, Lemmon, and Schallheim, 1998).

In this paper, we empirically estimate the marginal cost curve for corporate debt using an approach analogous to textbook supply/demand identification (Working, 1927; Hayashi, 2000). In our main analysis, we first simulate tax benefit functions using the approach of Graham (2000). We observe a firm's actual debt choice in a given year, which is represented by a single point on its tax benefit function, and assume for our estimation sample that this point represents the equilibrium intersection of the marginal cost and benefit of debt functions. As the benefit functions shift, the variation in the intersection points allows us to empirically map out the location of the cost of debt function. That is, we estimate what the (perceived) marginal cost of debt must be to rationalize the typical firm's capital structure choices.

These estimated marginal cost curves should capture ex ante costs that managers trade off against tax benefits as they choose their optimal capital structure. These factors include costs of financial distress and agency costs, among others.[1] Note that we do not distinguish

[1]As described in more detail below, because we start with marginal tax benefit functions, the estimated

actual costs from costs as they are perceived or responded to by managers. These perceived costs could potentially differ from actual costs due to biases in the managerial decision-making process. For example, a firm with ample potential tax benefits that uses very little debt may actually face very high costs of debt, or the company may use little debt due to managerial bias. Either way, the low debt choice would be captured as a high cost of debt in our estimation procedure.

To interpret the actual debt choice as representing the intersection of marginal cost and benefit curves, we focus on firms that appear able to make unconstrained (optimal) choices. In our main analysis we therefore set aside financially distressed companies (based on a measure of Altman's Z-score). We also set aside firms that may be financially constrained (e.g., zero debt firms) by only retaining firm-year observations in which a material rebalancing of capital structure occurs. We assume that the remaining firms make (close to) optimal debt choices, and we use these choices to back out what the (actual or perceived) costs of debt must be to justify observed debt ratios. We note that our results are robust to including these apparently distressed or constrained firms in the sample, and also to different definitions of financial constraint. Related to this issue, our analysis is robust to the presence of fixed adjustment costs. It has been argued (e.g., Fischer, Heinkel and Zechner, 1989; Leary and Roberts, 2005; and Strebulaev, 2007) that fixed adjustment costs prevent firms from responding instantaneously to changing conditions, leading to infrequent capital structure adjustments. By estimating our model on only those firm-year observations in which a substantial rebalancing of capital structure occurs, we mitigate the effect of fixed adjustment costs.

We use two different identification strategies which lead to qualitatively and quantitatively similar marginal cost of debt functions. Both of these strategies rely on variation in marginal tax benefits. In the first approach, we simulate a marginal tax benefit

cost of debt functions also capture the non-tax benefits of debt. These non-tax benefits are effectively negative costs.

function for each firm-year observation. This allows us to use a panel of time series and cross-sectional benefit variation to identify the cost curve. For this approach to work, the cost curve must remain fixed as the benefit function varies. To hold the cost function fixed, we include in the specification control variables that have been used in the prior literature to capture costs. To the extent that these control variables hold the cost environment constant, we can use the remaining variation in marginal benefits to estimate the cost curve. One advantage of this method is that it can be used in any sample period, including periods when there are no tax regime changes. In particular, we show that our estimates are robust across different time subsamples and when including time dummies. Another advantage is that the inclusion of the control variables allows the cost curve to shift location conditional on firm characteristics. However, this identification method relies importantly on the assumption that the control variables are comprehensive and hold the cost environment constant. The second identification strategy deemphasizes cross-sectional variation, and the need to control for the cost environment, by relying only on time series variation in the benefit curves due to the 1986 Tax Reform Act (TRA).

Based on these identification approaches, the ex ante marginal cost of debt curves that we estimate are positively sloped (i.e., cost increases with interest expense), as expected. The positive slope is indicative of debt costs that increase directly with the amount of debt used, such as expected costs of financial distress. The location of the cost functions vary (i.e., shift) with firm characteristics such as asset collateral, size, book-to-market, asset tangibility, cash flows, and dividend-paying status. That is, the location of the cost function varies with firm-specific features of the cost of debt. For example, the cost function shifts downward as a firm's collateral increases. In general, our approach produces an ex ante estimate of the net cost of debt function for a wide variety of firms. This expands upon previous research, much of which provides point estimates for the ex post cost of debt for small subsets of firms. We also produce easy-to-implement algorithms that allow researchers and practitioners to explicitly specify firm-specific debt cost functions.

As described above, we estimate the cost functions on a subsample of firms that appear not to be financially constrained or distressed. We subsequently use the estimated coefficients to compute a cost of debt curve for any firm, including those that are distressed or constrained. Armed with firm-specific simulated marginal tax benefit functions and estimated marginal cost of debt functions for thousands of companies, we can infer optimal capital structure for any given firm at the intersection of the benefit and cost curves, as illustrated in Figure 1. We also integrate the area between the curves to estimate the net benefits of debt financing, and similarly estimate the cost of deviating from the optimum. For the full sample of firms, the equilibrium gross benefits of debt are 10.4% of book value, the costs are 6.9%, and the net benefits are 3.5%.[2] In this full sample, among firms that we label as financially constrained or distressed, our numbers imply that deadweight losses from using less debt than the implied optimum (i.e., actual debt usage is less than the debt ratio occurring at the intersection of marginal cost and benefit) average 1.4% of book value. In contrast, deadweight losses from superoptimal debt choices average 3.8%. Thus, in our sample, the cost of being overlevered appears to be more severe than being underlevered.

[INSERT FIGURE 1]

Traditional debt cost studies examine small samples and focus on a subset of the ex post costs of debt. Warner (1977), for example, studies 11 bankrupt railroad companies, and estimates that ex post direct bankruptcy costs are about 5.3% of firm value. Weiss (1990) similarly estimates that direct bankruptcy costs are only 3.1% of firm value in a sample of 37 companies. Bris, Welch and Zhu (2006) estimate ex post legal costs for 212 firms filing for bankruptcy in New York and Arizona. In their sample, direct Chapter 11 expenses average about 9.5% of asset value. Andrade and Kaplan (1998) estimate that for a sample of 31

[2]Note that we measure gross *tax* benefits with the benefit function. Therefore, the cost function measures the costs of debt *net of any non-tax benefits* (which would show up as negative costs in the cost function). That is, what we refer to as the costs of debt are actually the all-in costs of debt minus any non-tax benefits of debt. This consideration does not affect the estimation or interpretation of the net benefits of debt. See footnote 25.

highly levered firms, when distress occurs the cost of financial distress is no more than 10% to 20% of firm value. Miller (1977) and others note that once one considers the relatively low probability that financial distress will occur, the ex ante costs of debt appear to be small. One conclusion from these traditional papers is that there must be other reasonably large costs of debt to justify the debt choices that firms make. While these traditional papers are instructive, our analysis contributes by directly estimating ex ante all-in costs of debt, and by examining a broad cross-section of firms rather than a small ex post sample.

Recent research argues that thorough consideration leads to costs of debt that roughly equal the marginal (tax) benefits of debt in equilibrium.[3] For example, in Green and Hollifield's (2003) model, bankruptcy costs equal to 3% of firm value, combined with a personal tax disadvantage to interest income, are sufficient to justify an interior optimal debt ratio. Berk, Stanton and Zechner (2010) conclude that higher wages due to increased labor risk associated with greater corporate leverage should be modeled as a cost of debt. Carlson and Lazrak (2006) argue that increased firm risk due to asset substitution produces costs sufficient to offset the tax benefits of debt. Our approach captures these and other costs of debt that drive observed (equilibrium) corporate debt choices. The resulting cost curve is a positive function of the level of debt and its location is conditional on firm characteristics related to the theorized factors just discussed, among others.

Our approach is related to three other recent papers. Almeida and Philippon (2007) derive risk-neutral probabilities of default that capture the fact that the marginal utility of money is high in distress states. (Chen (2008) and Bhamra, Kuhn and Strebulaev (2008) make a similar point.) Using these probabilities, they estimate that the expected cost of distress is approximately equal to the tax benefits of debt estimated in Graham (2000), suggesting that on average observed capital structure is consistent with optimal choices. More specifically, the authors provide a point estimate of the cost of default that is about 4% of firm value for investment grade firms and about 9% for speculative debt. We estimate

[3] In addition, see Parrino and Weisbach (1999).

that the all-in cost of debt is about 6% (17%) of firm value for investment (speculative) grade firms. Therefore, our estimates are in the same ballpark but larger than Almeida and Philippon's, which is logical because their estimates reflect default costs while ours include default as well as other costs of debt (such as agency costs). Overall, our analysis shows that default costs, as estimated by Almeida and Philippon (2007), amount to approximately half of the total costs of debt, leaving about half of the costs to be explained by other factors and theories.[4]

Korteweg (2009) estimates the net benefits to leverage from a data set of about 30,000 firm-months between 1994 and 2004. By generalizing the Modigliani-Miller beta levering and firm valuation formulas, he estimates how the net benefits of debt must vary with leverage and other covariates to explain the observed variation in stock and bond betas and valuations. For identification he assumes within-industry homogeneity with respect to asset betas, but he allows the net benefit function to vary on a firm-by-firm basis, based on individual firm characteristics. Even with this different approach, he estimates median net benefits to leverage of about 4% relative to total firm value, close to our results.

Finally, Morellec, Nikolov and Schürhoff (2008) argue that, from a manager's point of view, debt is constraining to the extent that it can justify observed capital structure levels. As mentioned before, our framework captures costs as they are perceived or responded to by managers to the extent they are reflected in debt choice.

The rest of the paper proceeds as follows. In Section I, we explain the main intuition and econometric issues underlying our instrumental variables approach and provide details for our identification strategies. In Section II, we describe the data and our sample selection process. In Section III, we present and discuss our results, and in Section IV we compute firm-specific marginal cost of debt functions and discuss several case studies. In Section V, we calculate the benefits and costs of debt and analyze the costs of being underlevered or

[4]We also benchmark the reasonableness of our numbers by showing that our estimated cost of debt for firms in the 90th to 99th percentile range are very similar to the costs estimated by Andrade and Kaplan (1998) for highly levered firms.

overlevered. Section VI discusses several robustness checks. Finally, Section VII concludes.

I Estimating Marginal Cost Curves

The main objective of this paper is to estimate the marginal cost curve of debt, given in equation (1). In particular, we estimate a linear parametrization in which the marginal cost of debt for firm $i \in 1, ..., N$ at time $t \in 1, ..., T$ is linear in the amount of leverage, $x_{i,t}$, and a set of control variables, $C_{i,t}$:

$$MC_{i,t} = a + bx_{i,t} + \sum_{c \in C} \theta_c c_{i,t} + \xi_{i,t}. \tag{1}$$

In this parametrization, a denotes the intercept of the marginal cost curve of debt and b denotes the slope.[5] Each θ_c is a coefficient for the firm specific control variables in C. The variable $\xi_{i,t}$ is an orthogonal shock.[6]

In Section I.A, we present the general methodology and equations we use to estimate the marginal cost of debt. Section I.B details two separate identification strategies. Section I.C compares and contrasts the two strategies.

I.A General Method

We use exogenous variation of the marginal benefit curve of debt to identify the marginal cost curve of debt. To obtain a firm-year panel of benefit curves, we simulate the tax savings benefit for each dollar of incremental interest deduction using the method of Graham (2000). More generally, let $MB_{i,t}$ denote the marginal benefit curve of debt of firm i at time t as a

[5]Note that linearity of the marginal cost of debt implies that the total cost of debt is a quadratic function of interest ($x_{i,t}$). Further, a positive slope on $x_{i,t}$ in the marginal cost function implies that the total cost curve is convex.

[6]We explore a generalization of equation (1) in which we include interaction terms between leverage and each of the control variables. In this generalization both the slope and the intercept of the marginal cost curve depend on the control variables. We find that this generalization adds little to the fit of the model, nor does it change any of our main conclusions. The results are available upon request.

function of the amount of leverage and an orthogonal shock $\eta_{i,t}$:

$$MB_{i,t} = f_{i,t}(x_{i,t}) + \eta_{i,t}. \tag{2}$$

The shock $\eta_{i,t}$ represents a shift of the marginal benefit curve.

We assume that financially unconstrained, non-distressed firms choose their equilibrium debt level optimally. Therefore, the observed level of debt of firm i in year t is the value of leverage, $x^*_{i,t}$, where the marginal benefit curve and the marginal cost curve intersect. Henceforth, for unconstrained, non-distressed firms, we refer to this observed level of debt as the "equilibrium amount of interest" or the "equilibrium level of debt," denoted by $x^*_{i,t}$. We refer to the corresponding "equilibrium marginal benefit/cost of debt" as $y^*_{i,t}$. In equilibrium, at $x_{i,t} = x^*_{i,t}$, it holds that:

$$y^*_{i,t} = MC_{i,t}\left(x^*_{i,t}\right) = MB_{i,t}\left(x^*_{i,t}\right). \tag{3}$$

To estimate the marginal cost curve of debt, one can not simply perform an OLS regression of $y^*_{i,t}$ on $x^*_{i,t}$ and the controls, as in equation (1). Since leverage and marginal costs/benefits are determined jointly, there is an endogeneity problem. If we use OLS, this endogeneity problem can lead to biased estimates.[7] Based on equilibrium $(x^*_{i,t}, y^*_{i,t})$ choices, OLS is unable to distinguish whether variation in these choices is due to shifts in the marginal cost or benefit curves, and hence is unable to identify either curve unambiguously. Furthermore, shifts of the marginal benefit curve $(\eta_{i,t})$ are potentially correlated with shifts of the marginal cost curve $(\xi_{i,t})$. By using instrumental variables that proxy for benefit shifts and that are uncorrelated with cost shifts, we can identify the cost curve.[8]

Suppose that we have an instrument z. As described above, this instrument needs to

[7]The classic illustration of biases created by endogenous regressors is Working (1927), who explores this problem in the context of supply and demand curves. See also Hayashi (2000).

[8]In unreported analysis, we use OLS (without instruments) to directly estimate equation (1). The estimated slopes are negative, small, and insignificant, implying that the OLS estimates result in a line that lies somewhere between the marginal benefit and marginal cost curves.

satisfy two criteria. It needs to be correlated with shifts of the marginal benefit curve, and it needs to be uncorrelated with shifts of the marginal cost curve:

$$corr\,(z, \eta) \neq 0 \tag{4}$$

$$corr\,(z, \xi) = 0. \tag{5}$$

Identification thus requires *exogenous* variation in the marginal benefit curve; that is, the marginal benefit curve of debt must shift while the marginal cost curve remains constant. The exogenous benefit variation may result from time series shifts of the marginal benefit curve of firm i, e.g., tax regime shifts, or, alternatively, from cross-sectional variation in the location of the marginal benefit curve of debt at some time t. See Figure 2 for an illustration.

[INSERT FIGURE 2]

With an instrument, z, that satisfies the two conditions above, one can use two stage least squares (2SLS) to estimate the marginal cost curve depicted in equation (1). The first stage regression consists of regressing x^* on z and control variables, C, and obtaining fitted values, $\hat{x}$. In the second stage regression, y^* is regressed on the fitted value of the first stage, $\hat{x}$, and control variables, C. The standard errors from the second stage of a 2SLS regression do not reflect the uncertainty of the first stage estimation and should therefore not be used to compute the t-statistics of estimated coefficients. Instead, we report GMM standard errors. These standard errors are double clustered by both firm and year as in Thompson (2009) and Petersen (2009). The moments corresponding to the estimation procedure are given by:

$$g_a(a, b, \{\theta_c\}) = \frac{1}{NT} \sum_i \sum_t \left(y_{i,t} - a - bx_{i,t} - \sum_{c \in C} \theta_c c_{i,t} \right), \tag{6}$$

$$g_z(a, b, \{\theta_c\}) = \frac{1}{NT} \sum_i \sum_t \left(y_{i,t} - a - bx_{i,t} - \sum_{c \in C} \theta_c c_{i,t} \right) z_{i,t}, \tag{7}$$

$$g_c(a, b, \{\theta_c\}) = \frac{1}{NT} \sum_i \sum_t \left(y_{i,t} - a - bx_{i,t} - \sum_{c \in C} \theta_c c_{i,t} \right) c_{i,t}, \quad \text{for } c \in C. \tag{8}$$

Apart from these standard errors, we present our results in terms of 2SLS to facilitate exposition. See Appendix A for a detailed discussion of the 2SLS procedure as well as the first stage regression results. One novel result from the first stage is that we document firm-specific time series tax effects.[9]

I.B Identification Strategies

In this section, we detail two separate identification approaches that we use to identify the marginal cost curve of debt. These approaches can broadly be characterized as follows: (i) Panel Approach, (ii) 1986 Tax Reform Act. Both identification strategies use variation in marginal tax benefits of debt to identify the cost curve. The set of control variables C is the same for each strategy. The identifying instrument, z, that we use in each identification strategy is given by:

(i) the area under the marginal benefit curve: $AREA$. (See Section I.B.1.)

(ii) the implementation of the 1986 Tax Reform Act: *TRA86*. (See Section I.B.2.)

I.B.1 Identification Strategy (i): Panel Approach

Our panel of simulated marginal benefit curves exhibits substantial variation both in the time series and in the cross-section. The time series variation is mainly due to tax regime changes, such as the Tax Reform Act (TRA) of 1986. The cross-sectional variation in benefit curves is related to (but not limited to) the occurrence of taxable losses and the ability to carry those losses backwards or forward. We use this variation of the marginal benefit curves to identify the marginal cost curve of debt.

As noted above, we have the advantage of observing a simulated version of the *whole* marginal benefit curve of debt. This allows us to observe the variation in (or shifts of) these benefit curves. To measure these shifts, we first compute for each firm in each year the total

[9] To our knowledge, this is the most direct time-series tax evidence in the literature. See Graham (2003).

potential tax benefit of debt, $AREA_{i,t}$, which is equal to the area under the marginal tax benefit curve:

$$AREA_{i,t} = \int_{0}^{\infty} f_{i,t}\left(x_{i,t}\right) dx_{i,t}. \tag{9}$$

Since the area under the curve measures the total potential tax benefits, $AREA$ provides a natural description of the location of the marginal benefit curve and accommodates non-linearities in benefits. If the marginal benefit curve shifts upward (downward), then the area under the curve increases (decreases) in tandem. Henceforth, we interpret variation in this area measure as variation (shifts) of the marginal benefit curve.[10] That is, for this specification, $z \equiv \{AREA\}$.

As conveyed in equations (4) and (5), to obtain unbiased cost estimates we should only use variation of the marginal benefit curve that is uncorrelated with variation in the marginal cost curve. To accomplish this, we include in the specification a set of control variables C that are theorized to be correlated with the location of the debt cost curve: a measure of collateralizable assets (COL), the log of total assets (LTA), the book-to-market ratio (BTM), a measure of intangible assets ($INTANG$), cash flow (CF), and whether the firm pays dividends ($DDIV$). These variables represent the standard measures of debt costs extensively used in the literature (Frank and Goyal, 2009).[11] In summary, C denotes the set of cost control variables that drive the location of the MC curve:

$$C \equiv \{COL, LTA, BTM, INTANG, CF, DDIV\}. \tag{10}$$

Assuming that these control variables adequately hold the cost environment constant, the remaining variation of the marginal benefit curves can be used to identify the cost curve.

[10] We explore alternative definitions that capture shifts of the marginal benefit curve, such as partitions of the area measure, or including as a second instrument the location of the kink in the marginal benefit curve. We repeat the analysis and all results hold. For ease of exposition, we focus on the area measure.

[11] These variables are defined in Section II and in Appendix B.

We estimate this specification both with and without year dummies in both stages of the regression. Including year dummies ensures that the identification of the slope of the cost curve is driven by the *cross-sectional* variation of the marginal benefit curves and not by time series variation. Reassuringly, we estimate similar cost curves in both cases.

I.B.2 Identification Strategy (ii): 1986 Tax Reform Act

Identification strategy (ii) uses the Tax Reform Act (TRA) of 1986 to identify the marginal cost of debt curve. Under the 1986 TRA, corporate tax rates were reduced by 12 percentage points for most firms. Furthermore, the 1986 TRA was phased-in in a manner that differentially moves firms with different fiscal year-ends into the new, lower tax regime. For example, firms with fiscal year-ends in June 1987 had all 12 months of income subject to tax rates at the old 46% tax rate that year (see Maydew (1997)). Income for upper bracket July 1987 fiscal year-end firms was subject to a blended tax rate that was $\frac{1}{12}$ of the new 34% statutory tax rate and $\frac{11}{12}$ of the old 46% tax rate. Firms with a fiscal year end in August were exposed to $\frac{2}{12}$ of the new tax rate and $\frac{10}{12}$ of the previous tax rate for each income bracket, and so on. Firms with December fiscal year ends faced half of the old tax regime and half of the new tax regime (i.e., an upper bracket maximum tax rate of $\frac{1}{2}(0.46)+\frac{1}{2}(0.34)=0.40$). By June 1988, all firms had switched over to the new regime that had a maximum 34% tax rate. This phase-in offers the identification advantage of the tax rate change affecting otherwise similar firms at slightly different points in time.

Let $FYR_{i,t}$ denote the month of firm i's fiscal year end in year t and let $TRA86_{i,t}$ denote the variable that captures the phase-in of the new tax regime. $TRA86_{i,t}$ takes the value 0 in and before 1986 and takes the value 1 in and after 1989. For 1987 and 1988, the phase-in variable is defined as:

$$
TRA86_{i,t} = \begin{cases} 0, & \text{if } FYR_{i,t} \leq 6 \text{ and } t = 1987, \text{ or } t < 1987 \\ (FYR_{i,t} - 6)/12 & \text{if } FYR_{i,t} > 6 \text{ and } t = 1987 \\ (FYR_{i,t} + 6)/12 & \text{if } FYR_{i,t} \leq 6 \text{ and } t = 1988 \\ 1, & \text{if } FYR_{i,t} > 6 \text{ and } t = 1988, \text{ or } t > 1988. \end{cases} \tag{11}
$$

In our second identification strategy, we use $TRA86_{i,t}$ as our identifying instrument. This instrument allows identification from the Tax Reform Act of 1986 to come from two sources: 1) a general before and after time-series effect captured by the 0 before 1987 and 1 after 1988, and 2) an additional effect captured by the 1/12, 2/12, etc. phasing-in in 1987 and 1988 that affects different firms differently depending on their fiscal year-ends. In unreported analysis, we document that identification is possible based on either 1) or 2) above; however, we combine the two in the $TRA86_{i,t}$ variable used in specification (ii).

I.C Comparing the Two Identification Strategies

Each of the identification strategies has advantages and disadvantages. Identification strategy (i) uses all of the variation in the marginal benefit curves available in the data panel. This includes both time series and cross sectional variation. Recall that a unique advantage of our data set is that we "observe" the *whole* simulated marginal benefit curve of debt, and not just the equilibrium points where the marginal cost and marginal benefit curves intersect.[12] In other words we observe a simulated proxy for shocks to the marginal benefit curve $\eta_{i,t}$, which we argue allows us to create an instrument, $AREA_{i,t}$, that is highly correlated with these marginal benefit shifts, as required by equation (4). In identification method (ii), this advantage of knowing the whole benefit function is not exploited. Moreover, identification strategy (i) can be used in periods in which there are no corporate tax regime

[12]In many cases, including the Working (1927) example, one only observes equilibrium points. In Working (1927) these equilibrium points are equilibrium prices and quantities. We have the advantage of "observing" one of the two curves. In the Working (1927) analogy this would imply observing the whole demand curve.

shifts.

The downside of identification strategy (i) is that, in order for it to produce valid estimates, the potential correlation between marginal benefit shifts and marginal cost shifts needs to be captured fully by the cost control variables so as to fulfill the criteria in equation (5). As such, omitted variables might lead to biased cost curve estimates. Specification (ii) arguably relies less on this assumption, although we include cost control variables in both identification strategies. However, the associated cost of specification (ii) is that the information used for identification is more limited than the information used in specification (i). In addition to the variation of specification (ii), specification (i) also includes variation due to other tax regime changes as well as cross-sectional variation. Due to this trade-off between information and the need to control for the cost environment, we present the estimation results of both strategies. Reassuringly, we find similar results for both strategies.

II Data and Summary Statistics

II.A Marginal Tax Benefit Curves

Our marginal benefit curves are derived as in Graham (2000). Each point on a benefit function measures the present value tax benefit of a dollar of interest deduction. To illustrate, ignore for this paragraph dynamic features of the tax code such as tax loss carryforwards and carrybacks and other complexities. The first point on the tax benefit function measures the tax savings associated with deducting the first dollar of interest. Additional points on the function measure the tax savings from deducting a second dollar of interest, a third dollar, and so on. Based on the current statutory federal tax schedule, each of these initial interest deductions would be worth $0.35 for a profitable firm, where 0.35 is the corporate marginal income tax rate. At some point, as incremental interest deductions are added, all taxable income would be shielded by interest deductions, and incremental deductions would be worthless. Therefore, ignoring the complexities of the tax code, a static tax benefit function would be a step function that has an initial value of 0.35 and eventually drops to 0.0.

The dynamic and complex features of the tax code have a tendency to stretch out and smooth the benefit function. First, consider dynamic features such as tax loss carryforwards. At the point at which all current taxable income is shielded by current interest deductions, an extra dollar of interest leads to a loss today, which is carried forward to shield profits in future years. For example, if that extra dollar of interest today effectively shields income next year, it will save the firm \$0.35 one year from today. In this situation, the present value tax savings from an incremental dollar of interest today is worth the present value of \$0.35 today, or about \$0.33. Once carryforwards are considered, therefore, rather than stepping straight down to zero at the point of surplus current-period interest deductions, the benefit function slopes downward, reaching zero gradually. Other features of the tax code that we consider, such as tax loss carrybacks, the alternative minimum tax, and investment tax credits also smooth the tax benefit function (see Graham and Smith (1999) for details).

Second, consider an uncertain world in which the probability of profitability is between zero and one. Say, for example, that there is a 50-50 chance that a firm will be profitable. In this case, even with a simple, static tax code, the expected tax benefit is \$0.175 for one dollar of interest deduction if profits are taxed at 35%. Therefore, we simulate tax benefit functions so that our measure of the tax benefit of interest deductions at any given point is conditional on the probability that the firm will be taxable today and in the future.

More specifically, we calculate one point on a tax benefit function for one firm in one year as follows. (Recall that each point on the function represents the expected corporate marginal tax rate (MTR) for that level of taxable income net of interest deduction.) The first step for a given firm-year involves calculating the historic mean and variance of the change in taxable income for each firm. Using this historical information, the second step forecasts future income many years into the future to allow for full effects of the tax carryforward feature of the tax code (e.g., 2006 tax law specified that tax losses could be carried forward 20 years into the future and back two years, so we forecast 22 years into the future when simulating the 2006 benefit curves). These forecasts are generated with random draws from a normal distribution, with mean and variance equal to that gathered in the first step; therefore, many different forecasts of the future can be generated for each firm.[13] In particular, we produce 50 forecasts of the future for each firm in each year.

The third step calculates the present value tax liability along each of the 50 income paths generated in the second step, accounting for the tax-loss carryback, carryforward, and other dynamic features of the tax code. The fourth step adds $10,000 (the smallest increment observable in Compustat data) to current year income and recalculates the present value tax liability along each path. The incremental tax liability calculated in the fourth step, minus that calculated in the third step, is the present value tax liability from earning extra income today; in other words, the economic MTR. A separate marginal tax rate is calculated along each of the forecasted income paths to capture the different tax situations a firm might experience in different future scenarios. The idea is to mimic the different planning scenarios that a manager might consider. The final step averages across the MTRs from the 50 different scenarios to calculate the expected economic marginal tax rate for a given firm-year.

These five steps produce the expected marginal tax rate for a single firm-year, for a given level of interest deduction. To calculate the entire benefit function (for a given firm in a given year), we replicate steps two through five for 17 different levels of interest deductions. Expressed as a proportion of the actual interest that a firm deducted in a given firm-year, these 17 levels are 0%, 20%, 40%, 60%, 80%, 100%, 120%, 160%, 200%, 300%, 400%, ..., 1000%. To clarify, 100% represents the actual level of deductions taken, so this point on the benefit function represents that firm's actual marginal tax rate in a given year, considering the present value effects of the dynamic tax code. The marginal tax benefit function is completed by "connecting the dots" created by the 17 discrete levels of interest deduction.

[13] As an alternative to using this random walk with drift model to forecast future taxable income, we construct benefit functions based on the bin forecasting model of Blouin, Core and Guay (2009). Using this alternative approach does not change our qualitative conclusions.

Note that the area under the benefit function up to the 100% point represents the gross tax benefit of debt for a given firm in a given year for its chosen capital structure, ignoring all costs.

These steps are replicated for each firm for each year, to produce a panel of firm-year tax benefit functions for each year from 1980 to 2007. The benefit functions in this panel vary across firms. They can also vary through time for a given firm as the tax code or the firm's circumstances change.

II.B Corporate Financial Statement Data

We obtain corporate financial statement data from Standard & Poor's Compustat database from 1980 to 2007 and calculate tax benefit functions for 126,611 firm-year observations. We normalize interest expense by total book assets, which hereafter we refer to as interest-over-book (IOB). Control variables collateral (COL), intangible assets ($INTANG$), and cash flow (CF) are also normalized by total book assets. For the construction of LTA, we chain total book assets to 2000 dollars to adjust for inflation before taking logarithms. We further remove any firms with negative book asset value, common equity, capital, sales, or dividends. Such firms have either unreliable Compustat data or are likely to be distressed or severely unprofitable and therefore constrained with respect to accessing financial markets. Next, we delete observations that are involved in substantial M&A activity, defined as acquisitions amounting to over 15% of total assets. Third, we remove outliers defined as firm-year observations that are in the first and 99th percentile tails for (i) area under the marginal benefits curve ($AREA$), (ii) the observed interest-over-book (IOB), (iii) the book to market ratio (BTM), and (iv) the cashflow over assets ratio (CF).[14] Finally we remove all firms in the financial and insurance, utilities, and public administration industries because they tend to be heavily regulated. This results in a sample of 91,687 firm-years, of which 79,942

[14]Removing the outliers of the other control variables (COL, LTA, $INTANG$, and $DDIV$) does not change the distribution of the sample much.

have non-missing data for IOB and all control variables. Table I provides an overview of the sample construction.

[INSERT TABLE I]

For each firm, we create empirical measures of the following control variables: asset collateralizability (plant, property, equipment and inventory) over total book assets (COL), log of total book assets (LTA), book equity to market equity (BTM), intangible assets over total book assets ($INTANG$), cash flow over total book assets (CF), and an indicator for a dividend paying firm ($DDIV$). We measure financial distress by a modified version of Altman's (1968) Z-score ($ZSCORE$). Firms are conservatively defined to be non-distressed if they have $ZSCORE$s in the top tercile. We measure financial constraint as having limited long-term leverage adjustments, collectively referred to as $LTDEIR$.[15] This approach allows us to address issues related to fixed adjustment costs, as discussed below. Appendix B provides a detailed description of the construction of the control variables.

II.C Data Samples, Financial Constraint, and Financial Distress

We perform our empirical analysis on two primary samples:

Sample A : All firm-year observations with non-missing marginal benefit curves, interest over book values, and all control variables.

Sample B : Financially non-distressed and unconstrained firms: $ZSCORE$ in top tercile and equity or long term debt issuances and/or repurchases ($LTDEIR$) in top tercile.

Long-term debt and equity issuances and reductions, hereafter collectively referred to as $LTDEIR$, are obtained from the statement of cash flows and normalized by total book

[15] We also look at two other definitions for financial constraint offered in the literature: (i) the Cleary (1999) index (CL), and (ii) the Whited and Wu (2006) index (WW). These are discussed in Section VI.

assets. Firms are defined to be financially unconstrained in Sample B, captured by the dummy variable, $UNFC$, if they have any long-term debt issuance ($DISS$), long-term debt reduction ($DRED$), equity issuance ($EISS$), or equity reduction ($ERED$), i.e., any capital structure adjustments, that are in the top tercile.[16] A conservative cutoff of one-third makes it more likely that the firms in our estimation sample are able to make unconstrained (optimal) choices. However, the actual cutoff of the top tercile is arbitrary and is not crucial to our estimation results. Our main results do not change if we loosen or tighten the definition and include firms above the median or 75th percentile (see Section VI). Summary statistics for $UNFC$ and the four separate measures are presented in Table II.

There are two reasons that we focus our attention on Sample B. First, our empirical approach assumes that observed debt ratios represent equilibrium choices. Compared to constrained or distressed firms, the observations in Sample B are relatively likely to represent unconstrained, long-term capital structure equilibria. Of course, one could argue that the constrained and distressed firms included in Sample A also make optimal choices, possibly in response to steeper cost functions. In this way of thinking, comparing the results across the samples will highlight the differing costs facing distressed and constrained firms.

The second reason that we focus on Sample B is to attenuate the effect of observations that might be severely affected by fixed adjustment costs. Recent research highlights that firms might not continuously fine-tune their leverage ratios due to non-negligible adjustment costs (Fisher, Heinkel and Zechner, 1989; Leary and Roberts, 2005; Kurshev and Strebulaev, 2006; etc.), which can lead to data that reflect passive, or no change, observations. Sample B avoids this issue by only including firm-year observations for which there is substantial long-term debt and/or equity issuance, or repurchase observations for which fixed transactions did not constrain the firm into inaction. Overall, relative to Sample A, Sample B should be relatively free of the effects of financial constraints, financial distress, and fixed adjustment costs and thus we can interpret observations as representing "equilibrium choices." Table II

[16] All four variables are scaled by book value.

presents the summary statistics for both samples.

[INSERT TABLE II]

III Estimation Results

As described in Section I.B, we estimate the marginal cost curve for two main specifications: (i) Panel Approach, (ii) 1986 Tax Reform Act. We repeat specification (i) with firm fixed effects and year fixed effects, which we denote as specifications (iii) and (iv), respectively.

Tables III and IV report the estimation results of these specifications for Samples B and A, respectively. All control variables, except $DDIV$, are standardized (i.e., have mean zero and standard deviation of one within Sample A) so that the coefficients have a one standard deviation interpretation. $DDIV$ is a binary variable with values of $\{0,1\}$.

[INSERT TABLE III]

[INSERT TABLE IV]

We analyze the estimation results in detail below, but first discuss some overarching issues. The signs on the coefficients of the cost control variables are consistent across samples and specifications. It is worth noting that, compared to panel specification (i), the slope is somewhat larger in TRA86 specification (ii), but the intercepts are smaller. So relatively speaking, the MC curve pivots upward in specification (ii). Thus, it is hard to say unambiguously that one estimated MC curve dominates the other (because slope and intercept effects offset). Furthermore, compared to specification (i), the standard errors in specification (ii) are larger. This is expected given that much capital structure variation is cross-sectional (Lemmon, Roberts, Zender, 2008) and not captured in specification (ii). Nonetheless, the qualitative similarity across these two approaches is reassuring.

Within our framework, the capital structure decision follows from a tradeoff between the costs and benefits of debt. It is important to highlight that our marginal benefit curves only measure the tax benefits of debt. As a consequence, the other benefits of debt, such as committing managers to operate efficiently (Jensen, 1986) and engaging lenders to monitor the firm (Jensen and Meckling, 1976), are included as negative costs, and therefore are reflected in our estimated marginal cost curves. Our cost curves also include the traditional costs of debt, such as the cost of financial distress (Scott, 1976), debt overhang (Myers, 1977), agency conflicts between managers and investors, and any other cost or nontax benefits that are reflected in the optimal debt choices. As noted in the introduction, there is ambiguity regarding which agent optimizes debt policy (e.g., managers versus shareholders), and we do not attempt to determine the identity of the optimizing agent.

Below we interpret the cost coefficients embedded in the cost of debt functions, and compare the implications from these coefficients to capital structure regularities documented in the literature. For expositional reasons we henceforth focus on the analysis of Sample B for specification (i), the panel identification approach. Table V summarizes the effect of the control variables on the cost of debt function, and compares these coefficients to standard capital structure results (as presented in Frank and Goyal (2009) and elsewhere). As we highlight below when we discuss the individual control variables, the effects of the control variables on the cost of debt function are consistent with debt usage implications in the existing capital structure literature. This is reassuring, in spite of the fact that we take a different approach and have a different dependent variable ($y^*_{i,t}$) than the existing literature.[17] As for the sign of any given coefficient, there are still open questions in the capital structure literature in terms of interpreting individual coefficients, and by no means does our procedure resolve all the open questions. Rather, our procedure quantifies just how large the influence of individual variables on the cost of debt must be to explain observed capital structure

[17] Our approach has a measure of debt on the right hand side, while in the traditional approach debt is on the left hand side as dependent variable. The coefficients we estimate should have the opposite sign to be consistent with estimates from the traditional approach.

choices.

[INSERT TABLE V]

III.A Marginal Cost Curves

In this section, we discuss the estimated cost curves. Based on panel identification strategy (i), the typical firm has a cost curve of debt with an estimated slope of 4.810 and estimated intercept of 0.112. That is, when control variables are set to their mean values (of zero since they are standardized) and $DDIV$ is set to 0, the estimated slope of the interest-over-book variable equals 4.810 and the estimated intercept is 0.112. Therefore, if IOB changes from 0.02 to 0.03, the marginal cost of taking on this additional debt would be 16.0 cents (= 4.810*0.01 + 0.112) per dollar of interest.[18]

The -0.040 coefficient on COL implies that high collateral firms have a lower cost of debt. All else being equal, a lower cost of debt should lead to higher debt usage, which is consistent with the positive relation between COL and debt ratios found in the standard capital structure literature, as shown in Table V. Further, all else equal, a firm that has COL one standard deviation larger than the average faces a marginal cost intercept of 0.072 as opposed to 0.112 (as shown in Figure 3).

The 0.016 coefficient on LTA indicates that large firms face a higher cost of debt. Holding all else constant, a firm that has LTA one standard deviation higher than the average faces an intercept of 0.128 as opposed to 0.112. This might initially seem surprising because it implies that large firms face higher costs of debt or at least make choices as if they do. However, note that our result is consistent with recent research that indicates that, all else equal, large firms use less debt (Faulkender and Petersen, 2006; Kurshev and Strebulaev, 2006).[19]

[18]Recall that the intercept of the marginal cost curve equals the slope of the total cost curve, and the slope of the marginal cost curve equals the convexity of the total cost curve.

[19]Kurshev and Strebulaev (2006) argue that fixed costs of external financing lead to infrequent restructuring and create a wedge between small and large firms. Small firms choose proportionally more leverage at the moment of refinancing to compensate for less frequent rebalancing.

In contrast, other research (as summarized in Frank and Goyal, 2009) documents a positive relation between size and debt usage. The differing firm size implications documented in various capital structure papers implies that the influence of size on the costs versus benefits of debt varies in different settings and samples. In our sample, larger firms use less debt (ceteris paribus) which is consistent with a higher cost of debt.

Firms with growth opportunities (i.e., low book-to-market (BTM)) on average face a higher cost of debt (coefficient of -0.018). This is consistent with the common finding that for growth firms the opportunity cost of debt is high because debt can restrict a firm's ability to exercise future growth opportunities due to debt overhang (Myers, 1977). The inflexibility arising from debt covenants could also restrict a firm's ability to optimally invest and exercise growth options, effectively increasing the cost of debt.

The coefficients on the other variables also have implications that are similar to extant capital structure research (see Table A). The -0.025 coefficient on $INTANG$ suggest that firms with more intangible assets face lower costs of debt, consistent with intangibles supporting debt claims in ways similar to collaterizable assets. The 0.085 coefficient on CF implies that firms with high cash flow behave as though they face higher costs by using less debt, consistent with implications from the pecking order theory. Finally, the 0.064 coefficient on $DDIV$ indicates that dividend paying firms face higher costs of debt, perhaps because dividends are rarely omitted (Brav et al., 2005), and therefore, all else being equal, leave fewer funds to cover interest obligations.

[INSERT FIGURE 3]

IV Firm-Specific Costs and Optimal Capital Structure

Using the estimated coefficients from the panel specification, in column (i) of Table III, the marginal cost of debt for any particular firm i at time t can be computed by:

$$MC(IOB) = \alpha + \beta * IOB \tag{12}$$

with

$$\alpha = 0.112 - 0.040\ \mathit{COL} + 0.016\ \mathit{LTA} - 0.018\ \mathit{BTM} - 0.025\ \mathit{INTANG} + 0.085\ \mathit{CF} + 0.064\ \mathit{DDIV}$$

$$\beta = 4.810$$

Each of the control variables, except $DDIV$, is standardized (demeaned and divided by the standard deviation) to have a mean of zero and a standard deviation of one. $DDIV$ is a binary variable with values of {0,1}. The mean and standard deviation for each of the non-standardized control variables are reported below:

	COL	LTA	BTM	INTANG	CF
Mean	0.497	5.048	0.762	0.058	0.093
Std. Dev.	0.230	2.167	0.628	0.106	0.154

Equation (12) provides a linear approximation for ex-ante firm-specific MC curves of debt. To be precise, the computation of the firm-specific marginal cost of debt functions also requires values for orthogonal cost shocks, $\xi_{i,t}$ in equation (1). Equation (12) assumes that $\xi_{i,t}$ is zero.[20]

Equation (12) can be used to estimate the marginal cost of debt for a firm at any given level of debt (IOB). Thus, equation (12) allows us to compare marginal costs across firms or subsets of firms, and, when combined with the marginal benefit curves of debt, draw inference

[20] This does not preclude making individual adjustments to specific firms if information outside of the empirical model is available.

about optimal capital structure. Moreover, the estimated marginal cost curve includes not only expected bankruptcy costs, but all costs that are relevant to a firm's capital structure decision. Therefore equation (12) can be used in future capital structure research to estimate debt costs.

IV.A The Representative Firm

[INSERT TABLE VI]

In Table VI and Figure 4 we show the marginal benefit and cost curves for the average (representative) firm in Samples A and B using data from 1980 to 2007. The marginal cost curves are derived using equation (12). For Sample A, we set the control variables equal to their average values (0 for all controls except $DDIV$, which has an average of 0.389) to arrive at the cost curve of debt for the average firm. For Sample B, we calculate the average standardized values for each control variable, using the means and standard deviations from the table above. We then apply these values to equation (12). To obtain the average marginal benefit curve, we compute the sample average marginal tax rate and interest over book value at 0%, 20%, 40%, ..., 1000% of the observed IOB.

[INSERT FIGURE 4]

Figure 4 indicates that, on average, firms in Sample B are in equilibrium, as we assumed in the sample estimation. Sample A also includes financially constrained and distressed firms. Relative to Sample B, the average marginal benefit curve in Sample A is shifted downward, and the representative firm is slightly overlevered. The MB and MC data presented in Table VI can be used by researchers to calibrate models of aggregate capital structure behavior.

IV.B Case Studies

Once the cost and benefit functions have been estimated, they can be used to analyze firm-specific capital structure. We illustrate two case studies, chosen for expositional purposes:

i) Hasbro, Inc., and ii) Black & Decker. The marginal cost curves are derived using equation (12), where, as mentioned above, the idiosyncratic shock, $\xi_{i,t}$ is set to zero.

IV.B.1 Hasbro, Inc.

[INSERT FIGURE 5]

The first panel of Table VII displays the decile rankings of financial ratios for Hasbro, Inc. in 1990, 1999, and 2007. Hasbro is a large, family leisure product manufacturing company that consistently pays dividends and has relatively high intangible assets. From 1990 to 1999, Hasbro's intangibles doubled and book-to-market ratio almost halved. The increase in intangibles decreased the marginal cost of debt, while the increase in growth opportunities raised the marginal cost, with the net effect of a lower marginal cost curve. From 1999 to 2007, Hasbro's intangibles decreased, cash flows increased, and the company's book-to-market ratio decreased. All three effectively increased the marginal cost of debt, resulting in a higher marginal cost of debt curve (the firm-specific intercept of the marginal cost curve decreased from 0.247 in 1990 to 0.222 in 1999 and increased to 0.280 in 2007).

Consistent with these changes in marginal cost, Hasbro's model-implied optimal interest-over-book increased from 0.019 in 1990 to 0.027 in 1999 and decreased to 0.016 by 2007 (see Figure 5). In 1990 Hasbro chose an actual IOB that is approximately at the model-implied "equilibrium," i.e., the point where the estimated marginal cost and marginal benefit curves intersect. In 1999, Hasbro increased actual debt usage, consistent with a reduction in costs, though the firm did not use the full amount of debt that the model implies it should. By 2007, the firm changed debt in the direction recommended by the model and operated at the model-implied equilibrium level of debt.

IV.B.2 Black & Decker

[INSERT FIGURE 6]

The second panel of Table VII displays fundamentals for Black & Decker in 1990, 1999, and 2007. Black & Decker is a large firm that pays dividends and has stable sales. The firm's low collateral and intangible assets suggest high marginal costs based on our estimation results (Table III), and the model recommends less debt than Black and Decker uses in 1990. That is, relative to the model implied debt ratio, Black and Decker was overlevered in 1990. This excessive debt stems from Black and Decker's highly levered acquisition of Emhart Corporation in 1989. In the mid 1990s, Black and Decker issued equity in order to pay down its debt.[21] Thus by 1999, Black and Decker's actual leverage had decreased and the firm had moved closer to its model-implied optimal debt ratio. In 2007, the firm was in equilibrium given that its actual IOB coincides with the model-implied interest-over-book-assets ratio.

[INSERT TABLE VII]

V Quantifying the Costs and Benefits of Debt

As seen in Section IV, the intersection of the estimated marginal benefit and marginal cost functions can be used to determine "optimal" or "equilibrium" interest over book for a given firm. This allows us to infer how a given firm's chosen debt level compares to model recommended debt usage. We refer to a company as being overlevered (underlevered) if its observed debt usage is too high (low) relative to the optimum implied by the coefficients of our empirical model. Strictly speaking, this "optimum" should be interpreted as the representative debt ratio for firms with characteristics similar to the firm under consideration, based on coefficients estimated on Sample B. Recall that our cost of debt curve is an ex-ante measure that effectively assumes expected cost shocks are zero after controlling for the cost environment using firm specific characteristics. In other words, we have effectively assumed throughout that firms in Sample B operate in equilibrium, on average.[22]

[21] Source: http://query.nytimes.com/gst/fullpage.html?res=9E0CE3DB1E3CF930A25750C0A964958260

[22] Deviations from the model-implied equilibrium for Sample B firms can be interpreted either as noise or as idiosyncratic firm-year biases (which average to zero).

In this section, we analyze all the firms in Sample A. For expositional ease, we refer to the financially distressed or constrained firms that have chosen debt ratios that deviate from the model-implied optimum as being overlevered and underlevered. An alternative interpretation is that the constrained and distressed firms are correctly levered, given the options available to them. In this interpretation, the results in this section should be interpreted as indicating the cost that financial constraint or distress imposes on a company, in terms of preventing the firm from operating at the long-run, unconstrained, undistressed equilibrium (that is reflected in the choices and coefficient estimates of Sample B firms).

Equipped with our marginal benefit and marginal cost curves, and with these interpretation issues in mind, we now quantify the gross benefits and costs of debt, net benefits of debt, and the costs of being "out of equilibrium."

V.A Gross and Net Benefits of Debt

[INSERT FIGURE 7]

The observed (equilibrium) gross benefits of debt, GBD_o (GBD_e), is the area under the marginal benefit curve up to the observed (equilibrium) level of interest over book value (IOB). The observed (equilibrium) cost of debt, CD_o (CD_e), is the area under the marginal cost curve up to the observed (equilibrium) level of IOB. The observed (equilibrium) net benefit of debt, NBD_o (NBD_e), is the difference between the gross benefit of debt and the cost of debt (i.e., the area between the curves, up to the observed (equilibrium) level of IOB). Cost measures are based on equation (12), which uses coefficient estimates of the marginal cost curve from Sample B, as presented in column (i) of Table III. Figure 7 illustrates how we measure the equilibrium gross benefit of debt, cost of debt, and net benefit of debt.[23]

[INSERT TABLE VIII]

[23] Recall from footnote 2 that the benefit function measures the gross *tax* benefit of debt, and the cost function captures the cost of debt net of any non-tax benefits. Also, our net benefit measure is equivalent to the difference between a function that captures *all* benefits of debt and a cost function that captures *all* costs of debt; that is, we measure the net *all-in* benefit of debt.

Panel A of Table VIII reports the unconditional summary statistics for the gross benefit, cost, and net benefit of debt for all firm-year observations in Sample A. Recall that this analysis includes constrained and distressed firms that were excluded in the estimation of equation (12). All values are reported as percentages of book value in perpetuity; for example, a gross benefit of 5% would occur if the annual benefit was 0.5% and the discount rate was 0.10.[24] We see that the average gross benefit of debt is higher at the equilibrium levels of debt (10.4%) than at the observed levels (9.0%). In contrast, the average cost of debt is lower at the equilibrium levels (6.9%) than at the observed levels (7.9%). These numbers imply that the net benefit of debt would be larger if firms were to operate at the equilibria implied by our analysis, relative to their observed levels: on average, the net benefit of debt at the implied equilibrium is 3.5% of book value in perpetuity versus 1.1% at observed debt levels.[25] Although 3.5% of book value seems modest, for a portion of the sample, the net benefits of debt are large. Figure 8a presents a histogram of firms sorted according to their equilibrium gross benefit of debt and paired with their corresponding equilibrium cost of debt. Firms above the 95th percentile have net benefits of debt that average 10.8% of book value at equilibrium levels. Figure 8b shows the time series of the equilibrium gross and net benefits of debt for all firms and for firms with high (above median) equilibrium net benefits of debt. The decrease in benefits around 1987 is the result of the reduction in corporate marginal tax rates following the Tax Reform Act of 1986.

The mean observed (equilibrium) cost of debt is 7.9% (6.9%) of book asset value (see Table VIII). It is worth noting that the observed cost of debt is as high as 17.8% (41.0%) of asset value for firms in the 90th (99th) percentile of the cost distribution, much higher than the ex ante equilibrium cost of debt of 13.7% (17.7%) of asset value for firms in the 90th

[24]We use the Moody's average corporate bond yield as the discount rate for all firms in a given year.

[25]As mentioned in Footnote 1, the cost of debt functions include non-tax benefits of debt, and therefore can be thought of as lower bound cost estimates. That is, if all benefits of debt were captured in the benefit function and no benefits were captured as negative costs, both the cost and benefit functions would shift upward relative to our curves. However, the area between the curves would not be affected. Thus, while non-tax benefits can affect the location and interpretation of the cost function, this does not alter the interpretation of the area between the benefit and cost functions as representing the net benefit of debt. In our estimates, therefore, the area between the curves measures the all-in net benefit of debt.

(99th) percentile.

[INSERT FIGURE 8]

V.B Cost of Being Underlevered or Overlevered

Our analysis allows us to address the question: how costly is it for firms to operate out of capital structure equilibrium? The cost of being "overlevered" can provide insights into the potential cost of financial distress, while the cost of being "underlevered" can shed light on the cost of financial constraints or managerial conservatism. The cost of being overlevered, DW_o, is the deadweight loss measured as the area between the cost and benefit curves when a firm has more debt than recommended by our model (see Figure 7d). The cost of being underlevered, DW_u, is the deadweight loss from leaving money on the table due to using less debt than implied by the model. Recall that one interpretation of DW_u is that it represents the value lost from suboptimal debt usage (relative to unconstrained debt usage) imposed by financial constraints limiting the amount of debt a firm can use.

Panel B of Table VIII reports DW_o and DW_u for firms that are financially distressed and/or constrained (firms in Sample A, but not in Sample B). The table shows that on average the cost of overlevering is 3.8% of book value in perpetuity, while the average cost of underlevering is 1.4%. This asymmetry of higher costs to being overlevered than underlevered is consistent with the rebalancing behavior documented in Leary and Roberts (2005).

In extreme cases (99th percentile), the capitalized cost of overlevering can be as high as 30.1% of book value, while the cost of being underlevered reaches only 8.1%. Note that the cost of overleverage is 10.6% at the 90th percentile. These numbers are in the same ballpark as the 10% to 23% of firm value estimates of the ex post cost of distress for the 31 highly leveraged transactions studied by Andrade and Kaplan (1998).

[INSERT FIGURE 9]

One way to conceptualize the cost of being under- or overlevered is to study companies that operate at or near their model-implied equilibrium and examine what the implied cost of debt would be if they were to hypothetically lever up or down. Table IX summarizes the cost of being underlevered or overlevered if firms that are currently within 5% of their equilibrium were to hypothetically change their IOB to X% of their equilibrium IOB. Panel A analyzes Sample A firms that operate near their model-implied equilibrium. As expected, the gross benefit of debt and cost of debt increase with IOB. As seen before, the numbers reveal that the cost of debt is disproportionately higher if a firm were to overlever versus underlever. If firms were to hypothetically move away from their equilibria by doubling their leverage, they would on average face a deadweight cost of 6.2% of book value. On the other hand, if firms were to hypothetically move away from their equilibria by eliminating their debt, they would face a deadweight cost of 4.5%. These results are shown in Figure 9. The asymmetrically larger costs of overleverage may help explain at least partially why some firms might use debt conservatively.

[INSERT TABLE IX]

The 1999 and 2007 Black and Decker graphs in Figure 6 help convey the intuition of why the cost of overleverage is asymmetrically higher than the cost of underleverage. Starting at the equilibrium point, the benefit function is flat as one moves to the left and approaches the y-axis, which limits the cost of underleverage. In contrast, the benefit function decreases as one moves to the right into overleverage territory (until it reaches 0); therefore there is more area between the curves as you move from the equilibrium point to the right versus to the left. Note that this is not an artifact of the way we do our analysis. Rather, the structure of the US tax code (with less than full tax loss offsets) contributes importantly to the asymmetrically larger cost of overleverage.

Panel B and panel C of Table IX present the hypothetical results for investment grade and speculative grade firms that are within 5% of being in equilibrium. For both sets of firms, the cost of being overlevered is again larger than being underlevered (see Figure 9). The asymmetry between the cost of being overlevered versus being underlevered is minimal for investment grade firms and is more severe for junk rated firms. These results are reassuring in that this analysis implies that speculative rated firms face higher marginal costs than do investment grade firms.

[INSERT FIGURE 10]

Finally, Figure 10 presents the "value gained from capital structure" graph that appears in Myers (1984) and in most corporate finance textbooks (e.g., Graham, Smart, and Megginson, 2010). The value function is humped-shaped because capital structure adds value up to the optimal point (the intersection of the marginal cost and marginal benefit curves), then declines after that point. We use our empirical estimates to calibrate this well-known graph, based on firms that operate within ±5% of model-implied optimal debt usage, and separately for firms that have high net benefits of debt. One previously unanswered question about the value graph is whether it is flat, and over what region; that is, how much value is lost if a firm does not make an capital structure choice? Our results indicate that for the typical near-equilibrium firm, optimal capital structure increases firm value by 4.5% of book assets on average, and by 5.9% of book assets for high net benefit firms. As mentioned earlier, the value reaches more than 11% for one in twenty firms (see Figure 8a). The value function is fairly flat if a typical firm were to operate within ±20% of the optimum.

V.C Benchmarks and Reality Checks

[INSERT FIGURE 11]

In Section V.A, we showed that the 90th and 99th percentile ex ante cost of debt numbers that we estimate are comparable to the ex post estimates in Andrade and Kaplan (1998). In Section V.B, we showed that the cost of hypothetical overleverage is higher for junk rated firms relative to costs for investment grade firms. We now provide another benchmark by comparing our results to the recent literature on default costs of debt. This exercise allows us to quantify the importance of default costs among all costs of debt, and to back out the implied magnitude of costs other than those for default. It also serves as a benchmark to ensure that our numbers are sensible.

Almeida and Phillippon (2007) argue that firms are more likely to face financial distress in bad times when marginal utility is high, and thus the cost of distress should reflect this. They measure the net present value of distress costs using risk adjusted default probabilities calculated for corporate bond spreads (see Table IV of their paper). Figure 11a compares their risk-adjusted distress costs as a percentage of firm value to our measure of the ex ante cost of debt as a percentage of firm value for AAA, AA, A, BBB, BB, B rated firms over their sample period from 1985 to 2004. It is comforting that our cost of debt numbers are in the same general ballpark as the Almeida and Phillippon calculations. Our cost of debt estimate is larger than the Almeida and Phillippon calculations because our numbers include more than just default costs. Based on this comparison, expected default costs of debt amount to approximately half of the total costs of debt. Agency and other costs constitute the other half of the cost of debt.

As an additional exercise, we also perform this analysis for three time periods. Figure 11b compares the Almeida and Phillippon cost of distress against our cost of debt for the following periods: 1980 to 1986, 1989 to 1996, and 1998 to 2007. Periods 1980 to 1986 and 1989 to 1996 are similar to each other. In the period 1998 to 2007, agency and other non-default costs of debt appear to have fallen for investment grade firms (i.e., our estimate is near Almeida and Phillippon's). Thus, either the true costs of debt fell after 1998 and/or corporate debt choices were made less conservatively for credit ratings BBB and higher.

Though we present aggregated numbers in Figure 11 to allow comparison to Almeida and Phillippon (2007), we emphasize that one advantage of our approach is that we can also estimate firm-specific costs of debt.

VI Robustness Checks

VI.A Assessing Other Capital Structure Theories

In this section we address research that explores the effect of specific factors on the cost of debt. Each of the theories involves the inclusion of an additional control variable. It turns out that these extra variables either (i) are redundant with other control variables in the cross section or time series, or (ii) have low data quality. For these reasons, we have not included them in the main analysis presented above. However, these examples illustrate that our framework can potentially be used to analyze implications from various capital structure theories.

VI.A.1 Macroeconomic Influences

Chen (2008) and Almeida and Philippon (2007) propose that bankruptcies are concentrated in bad times, i.e., periods when marginal utilities are high. This leads investors to demand higher credit risk premia during bad times due to higher default rates and higher default losses. This naturally suggests that credit spreads should play a role in the time variation of the cost of debt.

Table X presents analysis when Moody's Baa-Aaa credit spread (CS) is included as a control variable. When the spread is high, we expect the cost of debt to be high. Thus, we expect a positive sign on the credit spread variable. We see that this is indeed the case; the estimated 0.026 coefficient is statistically significant. Note that this analysis is infeasible when including year dummies or when using an identification strategy that relies on time series information (such as specification (iv) in Table III).

VI.A.2 Personal Tax Penalty

Miller (1977), Green and Hollifield (2003), and others argue that despite the corporate tax deduction from using debt, investors pay higher taxes on interest income, leading to a personal tax penalty for corporate tax usage. If investors face higher interest income tax relative to capital gains tax, they will demand a premium for holding debt, which would be reflected in the cost of debt and deter firms from using debt, all else being equal. Graham (1999) shows that when empirically modeling debt ratios, a specification that adjusts for the personal tax penalty statistically dominates specifications that do not. Following Graham's (1999) method of measuring the personal tax penalty (PTP), we include this measure in our analysis as an additional cost control variable.

Table X presents the coefficients for the marginal cost curve when including the personal tax penalty (PTP) as a control variable. We see that firms that face a high personal tax penalty do indeed face higher marginal costs of debt (the coefficient indicates a MC function with an intercept 0.037 larger). This is consistent with Graham's (1999) findings. However, the PTP variable is sensitive to outliers, and does not affect other implications, so we exclude it from the main specification.

[INSERT TABLE X]

VI.B Time Period Subsamples

In Section I.B, we introduce two identification strategies to estimate the marginal cost of debt curve. The panel approach, specification (i), uses the area under the marginal tax benefit curve, $AREA$, as the identifying instrument. As previously mentioned, a main advantage of using specification (i) is that it uses both time-series and cross-sectional information. Therefore, this specification can be applied to any time period, even eras without tax regime changes, to identify the marginal cost of debt. Table XI provides the results for the estimation of the marginal cost curve as specified in equation (1) for the periods 1980-1986 (pre-TRA 1986), 1989-1997 (post-TRA 1986), 1998-2007 (recent period), and 1980-2007 with year dummies.[26] In all four cases, we are able to identify and obtain reasonable estimates using

[26]By including year dummies in Table XI, we remove time series influences and use only cross-sectional information to identify the cost curves.

only cross-sectional information.

[INSERT TABLE XI]

VI.C Alternative Financial Constraint and Distress Measures

As discussed previously, our estimation procedure relies on the assumption that unconstrained and non-distressed firms optimize their capital structures. Previously, we used the lack of a change in long-term debt or equity as an indication of financial constraint. As additional robustness checks, we also identify unconstrained firms based on the Cleary (1999) index, hereafter CL, and the Whited and Wu (2006) index, hereafter WW. Separately, we also loosen (tighten) our definition of being financially unconstrained to include only firms that have made long-term debt or equity adjustments ($LTDEIR$) in the top half (quartile), as opposed to the top tercile. Finally, we loosen (tighten) the definition of being financially non-distressed to include firms with $ZSCORE$s in the top half (quartile).

Cleary (1999) calculates a general financial constraint measure by grouping firms into categories based on whether they increase or decrease dividend payments. Using this classification procedure, Cleary (1999) performs discriminant analysis to measure financial constraint. We reproduce this procedure over our sample period of 1980 to 2007 to obtain the coefficients for a CL index. In a recent paper, Whited and Wu (2006) derive an alternative measure of financial constraint by formulating the dynamic optimization problem of a firm that faces the constraint that the distributions of the firm (e.g., dividends) need to exceed a certain lower bound. They parameterize the Lagrange multiplier on this constraint and estimate its coefficients with GMM. Effectively, the WW index indicates that a firm is financially constrained if its sales growth is considerably lower than its industry's sales growth. In other words, a constrained firm is a slow-growing firm in a fast-growing industry. Note that the higher the indices, the more constrained the firm.

In summary, in addition to using Sample A and Sample B throughout the paper, we also perform our analysis using the following samples:

C : CL in bottom tercile and $ZSCORE$ in top tercile,

D : WW in bottom tercile and $ZSCORE$ in top tercile,

E : $LTDEIR$ above median and $ZSCORE$ above median, and

F : $LTDEIR$ in top quartile and $ZSCORE$ in top quartile.

The estimation results are presented in Table XII. The slopes range from 3.491 to 5.578 and the intercepts range from 0.086 to 0.192 for the estimation of equation (1). These are similar to the results we obtain in Table III. Furthermore, the qualitative and quantitative results on all control variables except BTM match fairly well. For Sample D where the BTM coefficient is positive, the estimate is insignificant. Overall, the robustness analyses produce results that are largely consistent with those in the main analysis.

[INSERT TABLE XII]

VII Conclusion

We use panel data from 1980 to 2007 to estimate the marginal cost function for corporate debt. We simulate debt tax benefit curves and assume that for financially unconstrained and non-distressed firms, the marginal benefit curve intersects the marginal cost curve at the observed level of debt, on average. Using this equilibrium condition, exogenous shifts by the benefit curves enable us to identify the marginal cost function. We employ two identification strategies: (i) a full panel approach using all time-series and cross-sectional information from 1980 to 2007, (ii) a time series approach focused on the 1986 Tax Reform Act.

The estimated marginal cost curves are positively sloped. The intercept depends on firm characteristics such as collateral, size, book-to-market, intangibles, cash flows, and whether the firm pays dividends. As such, our framework provides a new parsimonious environment to evaluate competing capital structure theories. Our findings are robust to firm fixed effects, year fixed effects, across time periods, and when accounting for fixed adjustment costs of debt. We provide an easy-to-use formula that allows for the implementation of firm-specific marginal cost functions. We also provide firm-specific recommendations of optimal debt policy against which firms' actual debt choices can be benchmarked, and we quantify the welfare costs to the firm from deviating from the model-recommended optimum.

Our estimates indicate that the optimal capitalized net benefits of debt are about 3.5% of asset value. We also find that the cost of overlevering is greater than the cost of underlevering. Finally, our estimates are benchmarked to several papers, including Almeida and Phillippon (2007). We find that default cost of debt amounts to approximately half of total cost of debt, implying that agency costs and other non-default costs contribute about half of the total ex ante costs of debt.

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Appendix A

In this appendix, we present the first and second stage 2SLS equations in the estimation of the marginal cost of debt curve as presented in equation (1), and discuss the first stage regression results.

In the first stage, equilibrium leverage, x^*, is regressed on the identifying instrument, z, and the set of control variables, C:

$$x^*_{i,t} = \beta_0 + \beta_z z_{i,t} + \sum_{c \in C} \beta_c c_{i,t} + \nu_{i,t}. \tag{A.1}$$

We obtain fitted values from the first stage regression, $\hat{x}$. In the second stage, we regress equilibrium marginal cost, y^*, on the fitted values from the first stage, $\hat{x}$, and control variables, C:

$$y^*_{i,t} = a + b\hat{x}_{i,t} + \sum_{c \in C} \theta_c c_{i,t} + \omega_{i,t}. \tag{A.2}$$

To provide further insight into these identification strategies, we present the first stage regression results in Table A.I.

In the panel approach, we use the area under the marginal benefit curve, $AREA$, as the identifying instrument. Holding the marginal cost curve constant, we expect an outward shift of the marginal benefit curve (which is downward sloping) to result in an increase in leverage. Indeed, the coefficient on $AREA$ is positive and significant. In the second specification we use the *TRA86* variable, as defined in the main text, over the period 1980-2007 as the identifying instrument. As the new tax regime was implemented, tax rates decreased making leverage less attractive. We therefore expect a negative sign on *TRA86*, which is what we find.[27] Note that the estimated coefficients for the control variables have the same signs as those estimated in the extant capital structure literature (see Table V).

[27] We note that this provides some of the first purely time-series evidence that taxes affect corporate capital structure decisions (as called for by Graham (2003)).

Table A.I: First stage regression estimated on unconstrained and non-distressed firms (Sample B). In the first stage regressions, $x^*_{i,t}$ is regressed on z and C, where $x^*_{i,t}$ is the observed interest expenses over book value (IOB), z is the identifying instrument, and C is the set of cost control variables. We consider two main specifications: (i) panel approach, $z \equiv \{AREA\}$ and (ii) 1986 Tax Reform Act, $z \equiv \{TRA86\}$. The set of control variables is $C \equiv \{COL, LTA, BTM, INTANG, CF, DDIV\}$. COL is collateralizable assets over total book values, LTA is log of total assets expressed in 2000 dollars, BTM is book equity to market equity, $INTANG$ is intangible assets over total book values, CF is net cashflow over total book values, and $DDIV$ is an indicator for dividend paying firms. All control variables, except $DDIV$, are standardized to have mean zero and standard deviation one based on all firms (Sample A). $DDIV$ is a binary variable with values {0,1}. Robust, clustered standard errors are reported in the parentheses. Standard errors are clustered by both firm and year, as in Thompson (2009) and Petersen (2009). Significance at the 10% level is indicated by *, 5% level by **, and 1% level by ***.

$x^*_{i,t} = \beta_0 + \beta_z z_{i,t} + \sum_{c \in C} \beta_c c_{i,t} + \nu_{i,t}$			
	(i) $z \equiv \{AREA\}$		(ii) $z \equiv \{TRA86\}$
Constant	0.0233 ***	Constant	0.0430 ***
	(0.0010)		(0.0014)
COL	0.0062 ***	COL	0.0083 ***
	(0.0004)		(0.0005)
LTA	-0.0016 ***	LTA	-0.0015 **
	(0.0004)		(0.0005)
BTM	0.0035 ***	BTM	0.0027 ***
	(0.0005)		(0.0006)
INTANG	0.0026 ***	INTANG	0.0039 ***
	(0.0005)		(0.0005)
CF	-0.0110 ***	CF	-0.0048 ***
	(0.0007)		(0.0007)
DDIV	-0.0066 ***	DDIV	-0.0067 ***
	(0.0006)		(0.0008)
AREA	0.3611 ***	TRA86	-0.0091 ***
	(0.0179)		(0.0016)
No. Obs.	12704	No. Obs.	12883

Appendix B

A detailed description follows of the construction of the control variables used in the analysis and variables included in the summary statistics reported in Table II. Numbers in parentheses indicate the corresponding Compustat annual industrial data items.

Collateralizable assets, $COL = \frac{\text{Total Inventories (3) + Net Plant, Property, and Equipment (8)}}{\text{Total Book Assets (6)}}$

Log of total assets, $LTA = \log(\text{Total Assets (6)} * \text{Adjustment to 2000 Dollars})$

Book equity to market equity, $BTM = \frac{\text{Total Common Equity (60)}}{\text{Fiscal Year Close Price (199) * Common Shares Outstanding (54)}}$

Intangible assets, $INTANG = \frac{\text{Intangibles (33)}}{\text{Total Book Assets (6)}}$

Cash flow, $CF = \frac{\text{Operating Income Before Depreciation (13)}}{\text{Total Book Assets (6)}}$

Dividend paying firms, $DDIV = \begin{cases} 1 & \text{if Common Dividends (21)} > 0 \\ 0 & \text{if Common Dividends (21)} = 0 \end{cases}$

S&P credit rating, $CR =$ S&P Historical Long-Term Debt Ratings (280) organized into 10 rating groups: 1=AAA, 2=AA, 3=A, 4=BBB, 5=BB, 6=B, 7=CCC, 8=CC, 9=C, 10=D

Firm Value = Fiscal Year Close Price (199)*Common Shares Outstanding (54)
+ Debt in Current Liabilities (34) + Long-term Debt (9)
+ Liquidating Value of Preferred Stock (1) - Deferred Tax and Investment Tax Credit (35)

$ZSCORE = \frac{\text{3.3*Pretax Income (170) + 1.0*Net Sales (12) + 1.4*Retained Earnings (36) + 1.2*Working Capital (179)}}{\text{Total Book Assets (6)}}$

$$\text{Financially unconstrained firms, } UNFC = \begin{cases} 1 & \text{if } \frac{\text{Long-term Debt Issuance (111)}}{\text{Total Assets (6)}} \geq \text{66th percentile} \\ & \text{or } \frac{\text{Long-term Debt Reductions (114)}}{\text{Total Assets (6)}} \geq \text{66th percentile} \\ & \text{or } \frac{\text{Equity Issuances (108)}}{\text{Total Assets (6)}} \geq \text{66th percentile} \\ & \text{or } \frac{\text{Equity Reduction (115)}}{\text{Total Assets (6)}} \geq \text{66th percentile} \\ 0 & \text{otherwise} \end{cases}$$

Long-term debt issuance, $DISS = \frac{\text{Long-term Debt Issuance (111)}}{\text{Total Assets (6)}}$

Long-term debt reduction, $DRED = \frac{\text{Long-term Debt Reductions (114)}}{\text{Total Assets (6)}}$

Equity issuance, $EISS = \frac{\text{Equity Issuances (108)}}{\text{Total Assets (6)}}$

Equity reduction, $ERED = \frac{\text{Equity Reduction (115)}}{\text{Total Assets (6)}}$

Credit spread, $CS = \text{Moody's Baa Rate} - \text{Moody's Aaa Rate} \quad (Source : Economagic)$

Personal tax penalty, $PTP = \begin{array}{l} \tau_p - (1-\tau_c)\tau_e \\ \text{for } \tau_c = \text{observed marginal tax rate} \quad \text{and } \tau_e = [d + (1-d)g\alpha]\tau_p \end{array}$

where d is the dividend payout ratio, g is 0.4 before 1987 and 1.0 after (although $g\tau_p$ is never greater than 0.28), α is 0.25, and τ_p is 47.4% for 1980-1981, 40.7% for 1982-1986, 33.1% for 1987, 28.7% for 1988-1992, and 29.6% for 1993 and onwards.

Table I: Sample construction. y^* is the "equilibrium" marginal benefit/cost level, x^* is the observed or "equilibrium" interest payments over book value (IOB), and C is the set of (cost) control variables. $C \equiv \{COL, LTA, BTM, INTANG, CF, DDIV\}$. $ZSCORE$ is a measure of financial distress. $LTDEIR$ stands for long-term debt or equity issuances or repurchases as described in the text. CL and WW are financial constraint measures as defined by Cleary (1999) and Whited and Wu (2006) indices, respectively.

Sample		No. Obs
All firm-year obs. with marginal benefit (MB) curves and Compustat data in 1980-2007		126,611
Non-M&A firm-years with positive book value, common equity, capital, and sales		112,239
Sample excluding finance and insurance, utilities, and public administration industries		91,687
Sample with non-missing $(y^*_{i,t}, x^*_{i,t}, C_{i,t})$ variables:	Sample A	79,942
Sample of financially unconstrained and non-distressed firm-years: LTDEIR above second tercile and ZSCORE above second tercile	Sample B	12,883
For robustness checks:		
Sample of financially unconstrained and non-distressed firm-years: CL in bottom tercile and ZSCORE in top tercile	Sample C	8.554
Sample of financially unconstrained and non-distressed firm-years: WW in bottom tercile and ZSCORE in top tercile	Sample D	10,316
Sample of financially unconstrained and non-distressed firm-years: LTDEIR above median and ZSCORE above median	Sample E	28,479
Sample of financially unconstrained and non-distressed firm-years: LTDEIR in top quartile and ZSCORE in top quartile	Sample F	6,623

Table II: Summary statistics for all firms (Sample A) and unconstrained, non-distressed firms (Sample B). IOB is the observed interest over book value (x^*), COL is collateralizable assets over total book values, LTA is log of total assets expressed in 2000 dollars, BTM is book equity to market equity, $INTANG$ is intangible assets over total book values, CF is net cashflow over total book values, and $DDIV$ is an indicator for dividend paying firms. $AREA$ is the area under the marginal benefit curve, used as the identifying instrument in panel specification (i). CR is the credit rankings based on the S&P long-term domestic issuer credit ratings, where 1=AAA, 2=AA, 3=A, 4=BBB, 5=BB, 6=B, 7=CCC, 8=CC, 9=C, 10=D. $ZSCORE$ is a measure of financial distress. $UNFC$ is an indicator for financially unconstrained firms, defined as having long-term debt and equity issuance and/or reduction in the top tercile. $DISS$, $DRED$, $EISS$, and $ERED$ are long-term debt issuance, long-term debt reduction, equity issuance, and equity reduction, respectively, that are used to calculate $UNFC$. CL and WW are financial constraint measures as defined by the Cleary (1999) and Whited and Wu (2006) indices, respectively.

Sample A: All Firms						
	No. Obs.	Mean	Std. Dev.	Min	Med	Max
IOB	79942	0.032	0.024	0.000	0.026	0.136
COL	79942	0.497	0.230	0.000	0.516	1.000
LTA	79942	5.048	2.167	-3.518	4.904	12.989
BTM	79942	0.762	0.628	0.030	0.588	4.539
INTANG	79942	0.058	0.106	0.000	0.000	0.593
CF	79942	0.093	0.154	-0.985	0.119	0.395
DDIV	79942	0.389	0.488	0.000	0.000	1.000
AREA	79125	0.033	0.027	0.000	0.028	0.139
CR	14100	4.183	1.304	1.000	4.000	10.000
ZSCORE	76302	1.644	2.102	-15.693	2.000	5.591
UNFC	79431	0.525	0.499	0.000	1.000	1.000
DISS	79353	0.082	0.220	0.000	0.007	8.568
DRED	79448	0.079	0.221	0.000	0.020	8.396
EISS	79652	0.039	0.123	0.000	0.002	2.804
ERED	79698	0.011	0.045	0.000	0.000	5.690
CL	52104	0.182	1.269	-6.925	0.167	8.602
WW	72940	-0.243	0.120	-0.541	-0.239	0.078
Sample B: Financially Unconstrained and Non-distressed Firms (LTDEIR in top tercile and ZSCORE in top tercile)						
	No. Obs.	Mean	Std. Dev.	Min	Med	Max
IOB	12883	0.029	0.023	0.000	0.024	0.135
COL	12883	0.493	0.203	0.000	0.512	0.976
LTA	12883	5.283	1.819	0.211	5.156	12.211
BTM	12883	0.633	0.509	0.030	0.493	4.443
INTANG	12883	0.053	0.088	0.000	0.007	0.591
CF	12883	0.179	0.082	-0.441	0.177	0.395
DDIV	12883	0.494	0.500	0.000	0.000	1.000
AREA	12704	0.045	0.028	0.000	0.041	0.139
CR	2124	3.718	1.252	1.000	4.000	10.000
ZSCORE	12883	3.169	0.659	2.372	2.997	5.586
UNFC	12883	1.000	0.000	1.000	1.000	1.000
DISS	12833	0.131	0.358	0.000	0.017	8.568
DRED	12846	0.134	0.363	0.000	0.040	8.396
EISS	12871	0.035	0.079	0.000	0.006	0.994
ERED	12877	0.034	0.069	0.000	0.001	1.730
CL	9200	-0.114	1.067	-6.872	-0.057	7.218
WW	12061	-0.266	0.101	-0.541	-0.264	0.075

Table III: Marginal cost of debt estimates using unconstrained, non-distressed firms (Sample B). We estimate the coefficients in equation (1), where $y^*_{i,t}$ is the observed marginal benefit/cost level (recall that that in equilibrium it holds that $y^*_{i,t} = MC_{i,t}(x^*_{i,t}) = MB_{i,t}(x^*_{i,t})$), $x^*_{i,t}$ is the observed interest expenses over book value (IOB), z is the identifying instrument, and C is the set of cost control variables. We consider two main specifications: (i) panel approach, $z \equiv \{AREA\}$, (ii) 1986 Tax Reform Act, $z \equiv \{TRA86\}$. Specifications (iii) repeats (i) with firm fixed effects. Specification (iv) repeats specification (i) with year dummies. The set of control variables is $C \equiv \{COL, LTA, BTM, INTANG, CF, DDIV\}$. COL is collateralizable assets over total book values, LTA is log of total assets expressed in 2000 dollars, BTM is book equity to market equity, $INTANG$ is intangible assets over total book values, CF is net cashflow over total book values, and $DDIV$ is an indicator for dividend paying firms. All control variables, except $DDIV$, are standardized to have mean zero and standard deviation one based on all firms (Sample A). $DDIV$ is a binary variable with values {0,1}. Robust, clustered standard errors are reported in parentheses. Standard errors are clustered by both firm and year as in Thompson (2009) and Petersen (2009). Significance at the 10% level is indicated by *, 5% level by **, and 1% level by ***.

	(1) $y^*_{i,t} = MC_{i,t} = a + bx^*_{i,t} + \sum_{c \in C} \theta_c c_{i,t} + \xi_{i,t}$			
	$z \equiv \{AREA\}$ (i)	$z \equiv \{TRA86\}$ (ii)	$z \equiv \{AREA\}$ (iii)	$z \equiv \{AREA\}$ (iv)
Constant	0.112 ***	-0.188 **	-0.128 ***	0.227 ***
	(0.018)	(0.089)	(0.042)	(0.014)
IOB	4.810 ***	13.188 ***	12.002 ***	3.139 ***
	(0.534)	(2.407)	(1.199)	(0.193)
COL	-0.040 ***	-0.112 ***	-0.076 ***	-0.028 ***
	(0.005)	(0.022)	(0.015)	(0.003)
LTA	0.016 ***	0.036 ***	0.110 ***	0.019 **
	(0.003)	(0.008)	(0.016)	(0.002)
BTM	-0.018 ***	-0.046 ***	-0.040 ***	-0.018 ***
	(0.004)	(0.010)	(0.007)	(0.002)
INTANG	-0.025 ***	-0.052 ***	-0.032 ***	-0.013 ***
	(0.005)	(0.012)	(0.007)	(0.002)
CF	0.085 ***	0.120 ***	0.088 ***	0.075 ***
	(0.007)	(0.017)	(0.010)	(0.004)
DDIV	0.064 ***	0.106 ***	0.090 ***	0.042 ***
	(0.008)	(0.020)	(0.013)	(0.004)
No. Obs.	12704	12833	12704	12704
Firm Fixed Effects?	N	N	Y	N
Year Fixed Effects?	N	N	N	Y

Table IV: Marginal cost of debt estimates using all firms (Sample A). We estimate the coefficients in equation (1), where $y_{i,t}$ is the observed marginal benefit/cost level (recall that that in equilibrium it holds that $y^*_{i,t} = MC_{i,t}(x^*_{i,t}) = MB_{i,t}(x^*_{i,t})$), $x^*_{i,t}$ is the observed interest expenses over book value (IOB), z is the identifying instrument, and C is the set of cost control variables. We consider two main specifications: (i) panel approach, $z \equiv \{AREA\}$, (ii) 1986 Tax Reform Act, $z \equiv \{TRA86\}$. Specifications (iii) repeats (i) with firm fixed effects. Specification (iv) repeats specification (i) with year dummies. The set of control variables is $C \equiv \{COL, LTA, BTM, INTANG, CF, DDIV\}$. COL is collateralizable assets over total book values, LTA is log of total assets expressed in 2000 dollars, BTM is book equity to market equity, $INTANG$ is intangible assets over total book values, CF is net cashflow over total book values, and $DDIV$ is an indicator for dividend paying firms. All control variables, except $DDIV$, are standardized to have mean zero and standard deviation one based on all firms (Sample A). $DDIV$ is a binary variable with values {0,1}. Robust, clustered standard errors are reported in parentheses. Standard errors are clustered by both firm and year as in Thompson (2009) and Petersen (2009). Significance at the 10% level is indicated by *, 5% level by **, and 1% level by ***.

	(1) $y^*_{i,t} = MC_{i,t} = a + bx^*_{i,t} + \sum_{c \in C} \theta_c c_{i,t} + \xi_{i,t}$			
	$z \equiv \{AREA\}$ (i)	$z \equiv \{TRA86\}$ (ii)	$z \equiv \{AREA\}$ (iii)	$z \equiv \{AREA\}$ (iv)
Constant	-0.029 *	-0.133 **	-0.355 ***	-0.025 ***
	(0.016)	(0.056)	(0.054)	(0.008)
IOB	7.915 ***	10.856 ***	17.984 ***	7.829 ***
	(0.423)	(1.492)	(1.614)	(0.229)
COL	-0.070 ***	-0.092 ***	-0.126 ***	-0.068 ***
	(0.005)	(0.011)	(0.014)	(0.003)
LTA	0.015 ***	0.017 ***	0.069 ***	0.013 ***
	(0.003)	(0.004)	(0.013)	(0.002)
BTM	-0.018 ***	-0.022 ***	-0.025 ***	-0.015 ***
	(0.002)	(0.003)	(0.004)	(0.002)
INTANG	-0.037 ***	-0.046 ***	-0.040 ***	-0.039 ***
	(0.004)	(0.007)	(0.006)	(0.002)
CF	0.080 ***	0.083 ***	0.103 ***	0.081 ***
	(0.005)	(0.005)	(0.009)	(0.002)
DDIV	0.133 ***	0.156 ***	0.160 ***	0.134 ***
	(0.009)	(0.015)	(0.014)	(0.005)
No. Obs.	79125	79942	79125	79125
Fixed Effects?	N	N	Y	N
Year Fixed Effects?	N	N	N	Y

Table V: The influence of each of the control variables on the cost of debt (as estimated in Tables III and IV) is shown in the left column, in comparison to the influence of the variable on the corporate debt ratios in the right column (as documented in the capital structure literature). COL is asset collateralizability, LTA is firm size in terms of book assets, BTM is the book to market ratio, $INTANG$ is asset intangibility, CF is cashflow, and $DDIV$ is an indicator for dividend paying firms. Generally speaking, our estimated coefficients are consistent with those in the capital structure literature, given that the coefficient signs are opposite between the two approaches.

	Dependent Variable	
Control Variable	Cost of Debt	Leverage
COL	−	+
LTA	+	+/-
BTM	−	+
INTANG	−	+
CF	+	−
DDIV	+	−

Table VI: Marginal benefit and marginal cost functions of debt for the average (representative) firm in all firms (Sample A) and unconstrained, non-distressed firms (Sample B). The marginal benefit curve is calculated by taking the average of the marginal tax rates (MB) and interest expenses over book assets (IOB) at 0%, 20%, 40%, ..., 1000% of observed IOB. That is, 100% of observed is the actual level of IOB in a given firm-year. The marginal cost curve is calculated using equation (12), which estimates equation (1) on Sample B (column (i) in Table III), and the sample means of the standardized values of the cost control variables.

	Sample A All Firms			Sample B Unconstrained, Non-distressed Firms		
	Interest Over Book Value (IOB)	Marginal Benefit (MB)	Marginal Cost (MC)	Interest Over Book Value (IOB)	Marginal Benefit (MB)	Marginal Cost (MC)
0% of Observed	0.0000	0.3033	0.1123	0.0000	0.3547	0.1738
20% of Obs.	0.0063	0.2978	0.1427	0.0060	0.3519	0.2025
40% of Obs.	0.0127	0.2920	0.1732	0.0119	0.3491	0.2312
60% of Obs.	0.0190	0.2858	0.2036	0.0179	0.3459	0.2599
80% of Obs.	0.0253	0.2791	0.2341	0.0239	0.3421	0.2886
Observed IOB	0.0317	0.2715	0.2646	0.0299	0.3377	0.3174
120% of Obs.	0.0380	0.2629	0.2950	0.0358	0.3318	0.3461
160% of Obs.	0.0507	0.2459	0.3559	0.0478	0.3200	0.4035
200% of Obs.	0.0633	0.2282	0.4168	0.0597	0.3049	0.4609
300% of Obs.	0.0950	0.1893	0.5691	0.0896	0.2649	0.6045
400% of Obs.	0.1266	0.1564	0.7213	0.1194	0.2269	0.7481
500% of Obs.	0.1583	0.1308	0.8736	0.1493	0.1945	0.8916
600% of Obs.	0.1900	0.1117	1.0259	0.1791	0.1687	1.0352
700% of Obs.	0.2216	0.0970	1.1781	0.2090	0.1480	1.1788
800% of Obs.	0.2533	0.0858	1.3304	0.2388	0.1307	1.3224
900% of Obs.	0.2849	0.0768	1.4827	0.2687	0.1167	1.4659
1000% of Obs.	0.3166	0.0697	1.6349	0.2985	0.1056	1.6095

Table VII: Key financial characteristics for Hasbro, Inc. and Black & Decker. TA is total assets expressed in thousands of 2000 dollars, D/E is the debt to equity ratio, COL is collateralizable assets over total book assets, BTM is the book equity to market equity ratio, $INTANG$ is intangible assets over total book assets, CF is net cashflow over total book value, and $DIVS$ is total dividend payout over total book assets. For each variable, both decile rankings within the sample and actual values for each firm and year are provided.

	Hasbro, Inc.					
	1990		1999		2007	
	Decile	Value	Decile	Value	Decile	Value
TA	9	1693.5	10	4614.0	9	2688.5
D/E	3	0.0443	5	0.0942	8	0.2192
COL	2	0.2386	2	0.1630	2	0.1381
BTM	7	0.9563	5	0.5090	4	0.3470
INTANG	10	0.1835	10	0.3934	9	0.2958
CF	8	0.1736	7	0.1586	9	0.2120
DIVS	8	0.0089	9	0.0105	10	0.0303
	Black & Decker					
	1990		1999		2007	
	Decile	Value	Decile	Value	Decile	Value
TA	10	7763.1	9	4148.2	9	4493.9
D/E	10	0.4679	7	0.2111	7	0.2179
COL	2	0.2838	4	0.3715	5	0.3219
BTM	9	1.6073	2	0.1762	4	0.3257
INTANG	3	0.0000	5	0.0000	9	0.2751
CF	6	0.1183	8	0.1735	7	0.1471
DIVS	7	0.0041	9	0.0104	9	0.0201

Table VIII: Summary statistics for benefits and costs of debt. Cost measures are based on equation (12), which itself is based on Sample B coefficient estimates from column (i) in Table III. The observed (equilibrium) gross benefits of debt, GBD_o (GBD_e), is the area under the marginal benefit curve up to the observed (equilibrium) level of interest over book value (IOB). The observed (equilibrium) cost of debt, CD_o (CD_e), is the area under the marginal cost curve up to the observed (equilibrium) level of IOB. The observed (equilibrium) net benefits of debt, NBD_o (NBD_e), is the area under the marginal benefit curve minus the area under the marginal cost curve up to the observed (equilibrium) IOB. Observed is defined as the actual IOB that the firm employs. Equilibrium is defined as the intersection of the marginal benefit and cost curves. The cost of being overlevered, DW_o, is the deadweight loss from additional costs due to observed IOB being greater than the equilibrium. The cost of being underlevered, DW_u, is the deadweight loss from lower benefits due to observed IOB being below the equilibrium.

Panel A: All Firms (Sample A)										
	No. Obs.	Mean	Std. Dev.	1%	10%	25%	Median	75%	90%	99%
Observed gross benefits of debt (GBD_o)	78398	0.0900	0.0796	0.0000	0.0056	0.0274	0.0729	0.1308	0.1964	0.3485
Observed costs of debt (CD_o)	78398	0.0791	0.0860	-0.0207	0.0052	0.0226	0.0567	0.1066	0.1776	0.4098
Observed net benefits of debt (NBD_o)	78398	0.0109	0.0577	-0.2180	-0.0387	0.0000	0.0158	0.0375	0.0622	0.1154
Equilibrium gross benefits of debt (GBD_e)	78398	0.1039	0.0781	0.0000	0.0000	0.0309	0.1034	0.1616	0.2076	0.2902
Equilibrium costs of debt (CD_e)	78398	0.0688	0.0536	-0.0305	0.0000	0.0163	0.0733	0.1124	0.1371	0.1774
Equilibrium net benefits of debt (NBD_e)	78398	0.0352	0.0333	0.0000	0.0000	0.0083	0.0278	0.0530	0.0798	0.1392
Panel B: Financially Distressed and/or Constrained Firms (in Sample A and not in Sample B)										
	No. Obs.	Mean	Std. Dev.	1%	10%	25%	Median	75%	90%	99%
Cost of overlevering (DW_o)	31881	0.0379	0.0635	0.0000	0.0003	0.0024	0.0130	0.0452	0.1057	0.3008
Cost of underlevering (DW_u)	34045	0.0140	0.0181	0.0000	0.0002	0.0018	0.0076	0.0194	0.0359	0.0812

Table IX: Among firms that operate within 5% of equilibrium, the hypothetical benefits and costs of debt if they were to operate out of equilibrium. Cost measures are based on equation (12), which estimates equation (1) on Sample B (column (i) in Table III). The gross tax benefits of debt, GBD, is the area under the marginal benefits curve up to the indicated level of interest over book value (IOB). The cost of debt, CD is the area under the marginal cost curve up to the indicated level of IOB. The net benefits of debt, NBD, is the area under the marginal benefits curve minus the area under the marginal cost curve up to the indicated IOB. Equilibrium is defined as the intersection of the marginal benefit and cost curves. The cost of being overlevered, DW_o, is the deadweight loss from additional costs due to having IOB above the equilibrium. The cost of being underlevered, DW_u, is the deadweight loss from lower benefits due to having IOB below the equilibrium.

	Panel A: All Firms (Sample A)					
	N	GBD	CD	NBD	DW_o	DW_u
0% of equilibrium IOB	3497	0.0000	0.0000	0.0000		0.0447
20% of equilibrium IOB	3497	0.0272	0.0116	0.0156		0.0291
40% of equilibrium IOB	3497	0.0543	0.0264	0.0279		0.0168
60% of equilibrium IOB	3497	0.0812	0.0443	0.0369		0.0078
80% of equilibrium IOB	3497	0.1079	0.0654	0.0425		0.0021
at equilibrium IOB	3497	0.1342	0.0896	0.0446		
120% of equilibrium IOB	3497	0.1588	0.1169	0.0419	0.0028	
160% of equilibrium IOB	3497	0.2026	0.1811	0.0215	0.0232	
200% of equilibrium IOB	3497	0.2405	0.2579	-0.0174	0.0621	
300% of equilibrium IOB	3497	0.3117	0.5050	-0.1933	0.2379	
400% of equilibrium IOB	3497	0.3575	0.8309	-0.4734	0.5181	
500% of equilibrium IOB	3497	0.3878	1.2355	-0.8477	0.8924	
	Panel B: Investment Grade Firms					
	N	GBD	CD	NBD	DW_o	DW_u
0% of equilibrium IOB	547	0.0000	0.0000	0.0000		0.0258
20% of equilibrium IOB	547	0.0237	0.0146	0.0091		0.0167
40% of equilibrium IOB	547	0.0473	0.0311	0.0162		0.0096
60% of equilibrium IOB	547	0.0709	0.0496	0.0213		0.0044
80% of equilibrium IOB	547	0.0945	0.0700	0.0245		0.0012
at equilibrium IOB	547	0.1180	0.0923	0.0257		
120% of equilibrium IOB	547	0.1407	0.1166	0.0241	0.0016	
160% of equilibrium IOB	547	0.1830	0.1709	0.0121	0.0136	
200% of equilibrium IOB	547	0.2222	0.2331	-0.0109	0.0366	
300% of equilibrium IOB	547	0.3037	0.4222	-0.1186	0.1443	
400% of equilibrium IOB	547	0.3630	0.6599	-0.2969	0.3226	
500% of equilibrium IOB	547	0.4045	0.9459	-0.5414	0.5671	
	Panel C: Speculative Firms					
	N	GBD	CD	NBD	DW_o	DW_u
0% of equilibrium IOB	323	0.0000	0.0000	0.0000		0.0592
20% of equilibrium IOB	323	0.0356	0.0148	0.0208		0.0384
40% of equilibrium IOB	323	0.0710	0.0339	0.0371		0.0221
60% of equilibrium IOB	323	0.1062	0.0572	0.0489		0.0102
80% of equilibrium IOB	323	0.1411	0.0848	0.0563		0.0029
at equilibrium IOB	323	0.1757	0.1167	0.0591		
120% of equilibrium IOB	323	0.2079	0.1528	0.0552	0.0040	
160% of equilibrium IOB	323	0.2633	0.2377	0.0256	0.0336	
200% of equilibrium IOB	323	0.3079	0.3397	-0.0318	0.0910	
300% of equilibrium IOB	323	0.3794	0.6692	-0.2898	0.3490	
400% of equilibrium IOB	323	0.4173	1.1052	-0.6878	0.7470	
500% of equilibrium IOB	323	0.4398	1.6475	-1.2077	1.2669	

Table X: Alternative control variables. We estimate the coefficients in equation (1), where $y_{i,t}$ is the observed marginal benefit/cost level (recall that that in equilibrium it holds that $y^*_{i,t} = MC_{i,t}(x^*_{i,t}) = MB_{i,t}(x^*_{i,t})$), $x^*_{i,t}$ is the observed interest expenses over book value (IOB), z is the identifying instrument, and C is the set of cost control variables. We consider the panel approach for which $z \equiv \{AREA\}$. The set of control variables is $C \equiv \{COL, LTA, BTM, INTANG, CF, DDIV\}$, and one of each alternative control specification: $\{CS, PTP\}$. COL is collateralizable assets over total book values, LTA is log of total assets expressed in 2000 dollars, BTM is book equity to market equity, $INTANG$ is intangible assets over total book values, CF is net cashflow over total book values, and $DDIV$ is an indicator for dividend paying firms. CS is the spread between Moody's Baa rate and Aaa rate, and PTP is the personal tax penalty as measured in Graham (1999). All control variables, except $DDIV$, are standardized to have mean zero and standard deviation one based on all firms (Sample A). $DDIV$ is a binary variable with values {0,1}. Robust, clustered standard errors are reported in parentheses. Standard errors are clustered by both firm and year as in Thompson (2009) and Petersen (2009). Significance at the 10% level is indicated by *, 5% level by **, and 1% level by ***.

	(1) $y^*_{i,t} = MC_{i,t} = a + bx^*_{i,t} + \sum_{c \in C} \theta_c c_{i,t} + \xi_{i,t}$	
	Credit Spread (CS)	Personal Tax Penalty (PTP)
Constant	0.153 ***	0.167 ***
	(0.017)	(0.012)
IOB	3.770 ***	3.197 ***
	(0.405)	(0.295)
COL	-0.033 ***	-0.028 ***
	(0.004)	(0.003)
LTA	0.018 ***	0.022 ***
	(0.002)	(0.002)
BTM	-0.020 ***	-0.019 ***
	(0.004)	(0.003)
INTANG	-0.019 ***	-0.012 ***
	(0.003)	(0.003)
CF	0.078 ***	0.066 ***
	(0.006)	(0.005)
DDIV	0.050 ***	0.066 ***
	(0.006)	(0.005)
CS	0.026 ***	
	(0.004)	
PTP		0.037 ***
		(0.005)
No. Obs.	12704	11907

Table XI: Marginal cost of debt estimated on unconstrained, non-distressed firms (Sample B) using panel specification (i) for 1980-1986, 1989-1997, 1998-2007, and 1980-2007 with year dummies. We estimate the coefficients in equation (1), where $y_{i,t}$ is the observed marginal benefit/cost level (recall that that in equilibrium it holds that $y^*_{i,t} = MC_{i,t}(x^*_{i,t}) = MB_{i,t}(x^*_{i,t})$), $x^*_{i,t}$ is the observed interest expenses over book value (IOB), z is the identifying instrument, and C is the set of cost control variables. We consider specification (i) where $z \equiv \{AREA\}$. The set of control variables is $C \equiv \{COL, LTA, BTM, INTANG, CF, DDIV\}$. COL is collateralizable assets over total book values, LTA is log of total assets expressed in 2000 dollars, BTM is book equity to market equity, $INTANG$ is intangible assets over total book values, CF is net cashflow over total book values, and $DDIV$ is an indicator for dividend paying firms. All control variables, except $DDIV$, are standardized to have mean zero and standard deviation one based on all firms (Sample A). $DDIV$ is a binary variable with values {0,1}. Robust, clustered standard errors are reported in parentheses. Standard errors are clustered by both firm and year as in Thompson (2009) and Petersen (2009). Significance at the 10% level is indicated by *, 5% level by **, and 1% level by ***.

	(1) $y^*_{i,t} = MC_{i,t} = a + bx^*_{i,t} + \sum_{c \in C} \theta_c c_{i,t} + \xi_{i,t}$			
	1980-1986	1989-1997	1998-2007	1980-2007
Constant	0.177 ***	0.187 ***	0.178 ***	0.227 ***
	(0.029)	(0.011)	(0.015)	(0.014)
IOB	4.275 ***	2.336 ***	2.605 ***	3.139 ***
	(0.509)	(0.210)	(0.308)	(0.193)
COL	-0.042 ***	-0.022 ***	-0.023 ***	-0.028 ***
	(0.006)	(0.003)	(0.004)	(0.003)
LTA	0.025 ***	0.020 ***	0.019 ***	0.019 ***
	(0.005)	(0.002)	(0.003)	(0.002)
BTM	-0.026 ***	-0.017 ***	-0.009	-0.018 ***
	(0.005)	(0.005)	(0.007)	(0.002)
INTANG	-0.029 ***	-0.009 ***	-0.007 ***	-0.013 ***
	(0.006)	(0.002)	(0.003)	(0.002)
CF	0.117 ***	0.062 ***	0.061 ***	0.075 ***
	(0.013)	(0.004)	(0.006)	(0.004)
DDIV	0.050 ***	0.034 ***	0.044 ***	0.042 ***
	(0.006)	(0.005)	(0.007)	(0.004)
No. Obs.	3058	8694	4075	12704
Year fixed effects?	N	N	N	Y

Table XII: Analysis of alternative definitions of being financially unconstrained (C) Cleary (1999) index in bottom tercile, (D) Whited and Wu (2006) index in bottom tercile, (E) long term debt and equity issuance and/or reduction (LTDEIR) above median and a measure of Altman's ZSCORE above median, (F) LTDEIR in top quartile and ZSCORE in top quartile. We estimate the coefficients in equation (1), where $y_{i,t}$ is the observed marginal benefit/cost level (recall that that in equilibrium it holds that $y^*_{i,t} = MC_{i,t}(x^*_{i,t}) = MB_{i,t}(x^*_{i,t})$), $x^*_{i,t}$ is the observed interest expenses over book value (IOB), z is the identifying instrument, and C is the set of cost control variables. We consider the panel approach for which $z \equiv \{AREA\}$. The set of control variables is $C \equiv \{COL, LTA, BTM, INTANG, CF, DDIV\}$. COL is collateralizable assets over total book values, LTA is log of total assets expressed in 2000 dollars, BTM is book equity to market equity, $INTANG$ is intangible assets over total book values, CF is net cashflow over total book values, and $DDIV$ is an indicator for dividend paying firms. All control variables, except $DDIV$, are standardized to have mean zero and standard deviation one based on all firms (Sample A). $DDIV$ is a binary variable with values {0,1}. Robust, clustered standard errors are reported in parentheses. Standard errors are clustered by both firm and year as in Thompson (2009) and Petersen (2009). Significance at the 10% level is indicated by *, 5% level by **, and 1% level by ***.

	(1) $y^*_{i,t} = MC_{i,t} = a + bx^*_{i,t} + \sum_{c \in C} \theta_c c_{i,t} + \xi_{i,t}$			
	Sample C	Sample D	Sample E	Sample F
Constant	0.192 ***	0.175 ***	0.086 ***	0.117 ***
	(0.012)	(0.019)	(0.017)	(0.021)
IOB	3.491 ***	4.175 ***	5.578 ***	4.493 ***
	(0.488)	(0.466)	(0.504)	(0.586)
COL	-0.021 ***	-0.032 ***	-0.048 ***	-0.037 ***
	(0.004)	(0.005)	(0.005)	(0.005)
LTA	0.014 ***	0.007 *	0.018 ***	0.015 ***
	(0.003)	(0.004)	(0.002)	(0.004)
BTM	-0.002	0.004	-0.021 ***	-0.014 ***
	(0.005)	(0.005)	(0.003)	(0.005)
INTANG	-0.016 ***	-0.021 ***	-0.026 ***	-0.022 ***
	(0.004)	(0.004)	(0.004)	(0.005)
CF	0.068 ***	0.066 ***	0.092 ***	0.085 ***
	(0.007)	(0.009)	(0.007)	(0.009)
DDIV	0.050 ***	0.054 ***	0.070 ***	0.061 ***
	(0.008)	(0.010)	(0.007)	(0.008)
No. Obs.	8495	10241	28169	6518

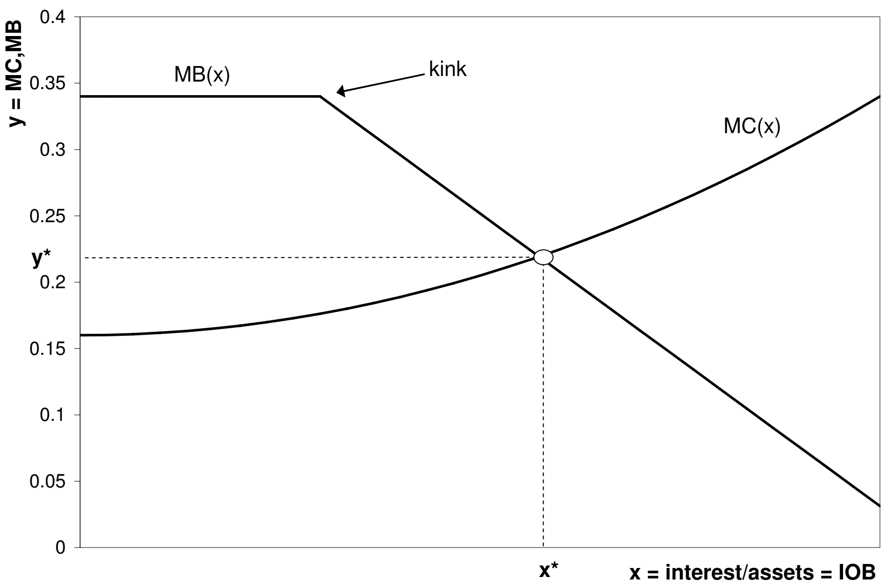

Figure 1: Capital structure equilibrium for a financially unconstrained, non-distressed firm. The figure shows the marginal benefit curve of debt, $MB(x)$, the marginal cost curve of debt, $MC(x)$, and the equilibrium amount of interest deductions over book value, x^*, where marginal cost and marginal benefit are equated. The equilibrium marginal benefit (which equals the equilibrium marginal cost) is denoted by y^*. Also, note that the benefit function becomes downward sloping at the point we refer to as the "kink."

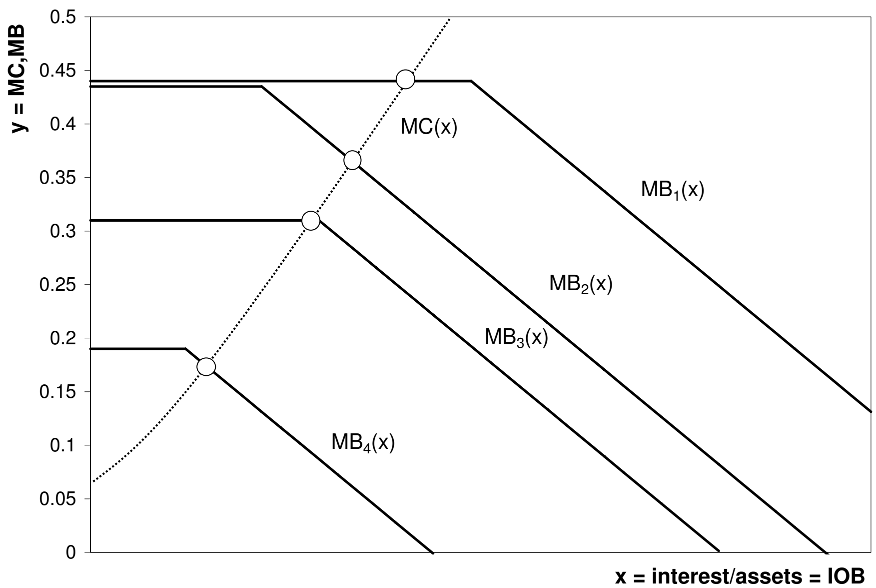

Figure 2: Identifying the cost function using shifts in the marginal benefit function. The figure shows four marginal benefit curves of debt, each intersected by the marginal cost curve of debt. The four marginal benefit curves can represent the same firm at four different points in time. The marginal benefit curves can alternatively represent four different firms at the same point in time. Empirically, we use both cross-sectional and time-series variation in marginal benefit curves to identify the marginal cost function of debt. Notice that the area under the marginal benefit curve, $AREA$, is a good proxy for the location of the curve: $MB_1(x) \geq MB_2(x) \geq MB_3(x) \geq MB_4(x)$ implies that $AREA_1 \geq AREA_2 \geq AREA_3 \geq AREA_4$.

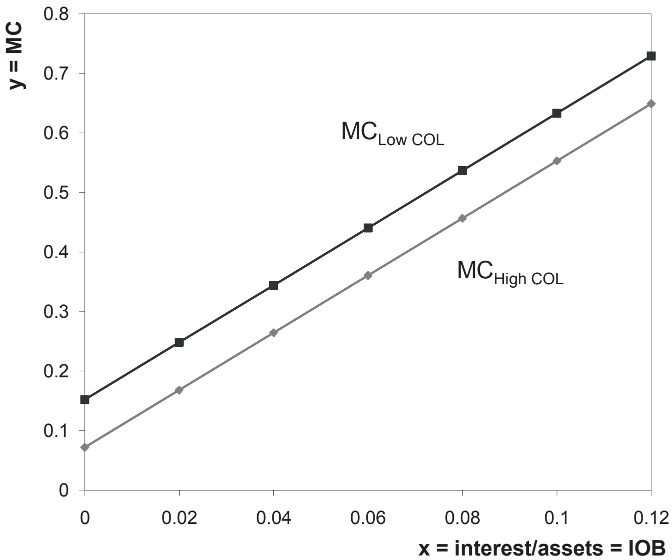

Figure 3: Comparing marginal cost curves for firms with high and low asset collateral (COL). The figure shows the effect of a one standard deviation increase (decrease) in COL when all other firm characteristics remain at the average. Firms with high collateral face a lower cost of debt.

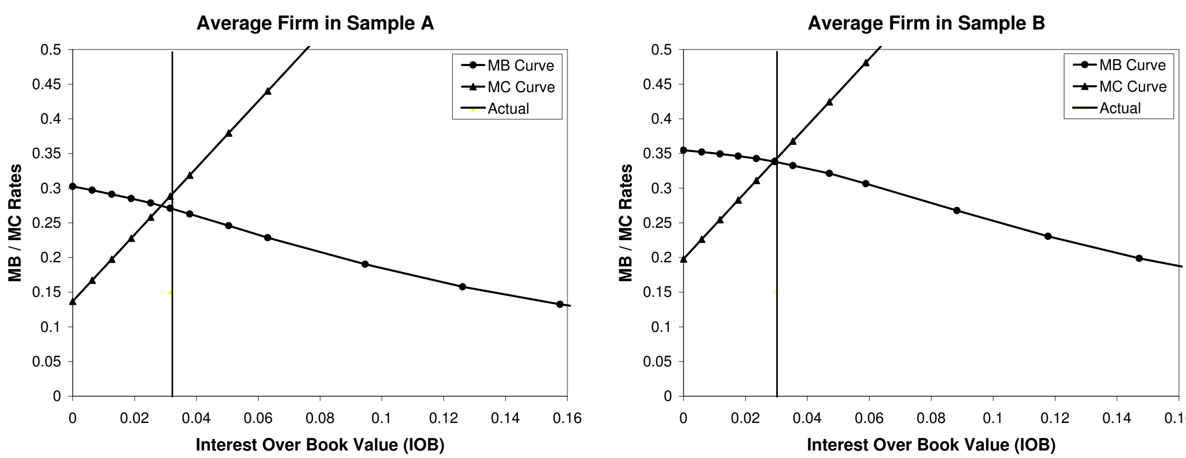

Figure 4: The average (representative) firms in Samples A and B. The marginal benefit curves are based on the average marginal tax benefit and interest over book values for each sample. The marginal cost curves are obtained using equation (12) and sample means of the standardized cost control variables.

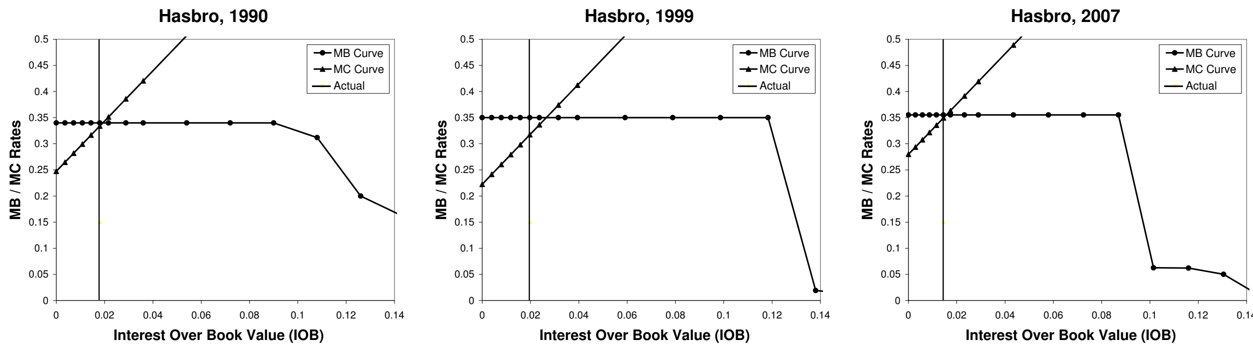

Figure 5: Marginal benefit and marginal cost curves for Hasbro, Inc. The vertical line reflects actual debt usage.

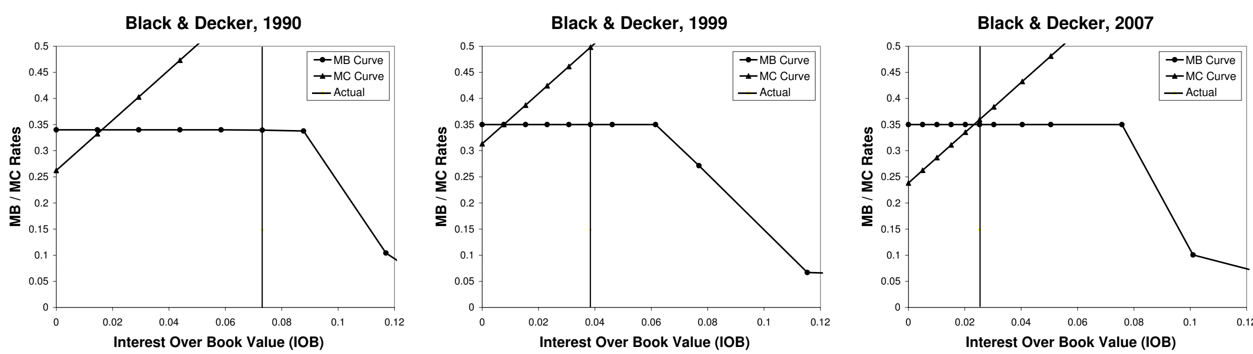

Figure 6: Marginal benefit and marginal cost curves for Black & Decker. The vertical line reflects actual debt usage.

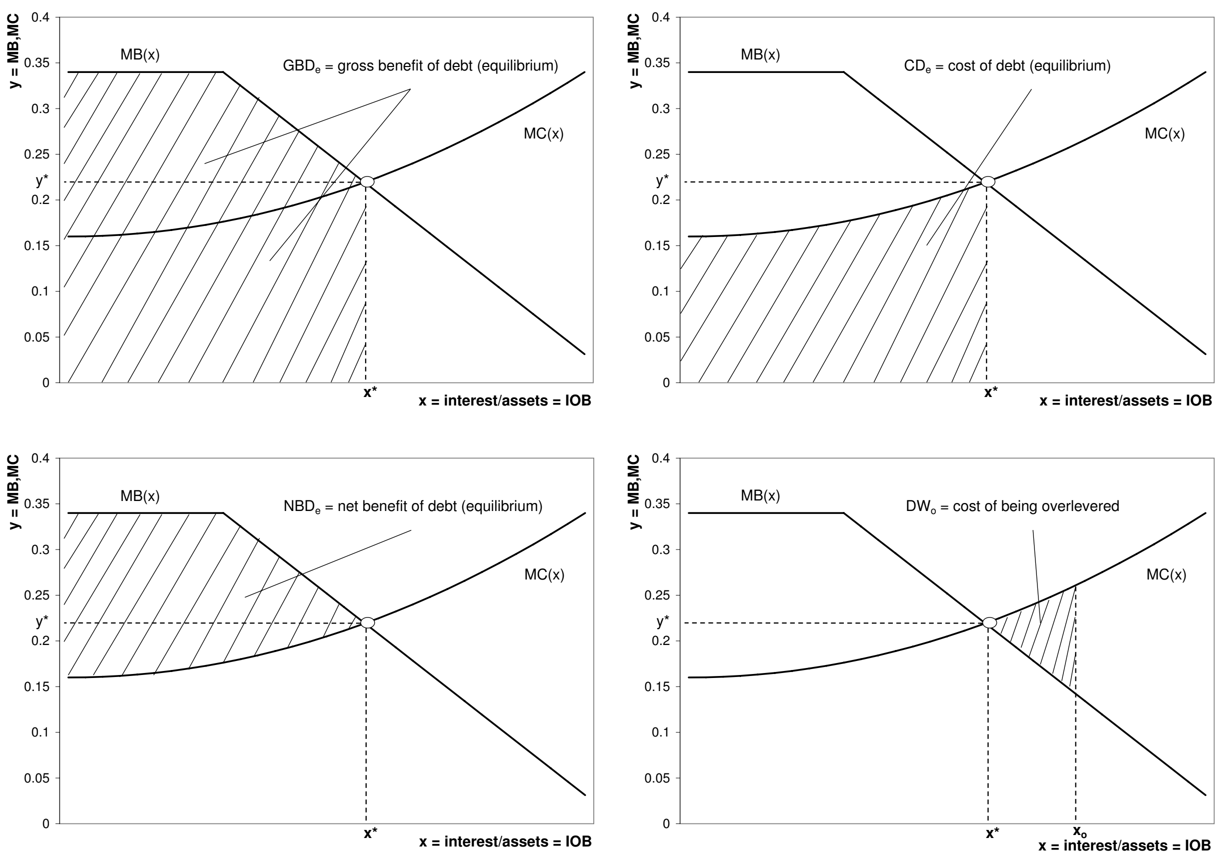

Figure 7: The figures show the marginal benefit curve of debt, $MB(x)$, the marginal cost curve of debt, $MC(x)$, and the equilibrium level of debt, x^*, that occurs where marginal cost and marginal benefit are equated. The marginal benefit level at x^* (which equals the marginal cost level at x^*) is denoted by y^*. Panel A depicts the equilibrium gross benefit of debt, the shaded area under the MB curve up to x^*. Panel B depicts the equilibrium cost of debt, the shaded area under the MC curve up to x^*. Panel C depicts the equilibrium net benefit of debt, the shaded area between the MB and MC curves up to x^*. Panel D depicts the cost of being overlevered, the shaded area between the MC and MB curves from the equilibrium, x^*, to the observed debt, x_o, in the case where the actual level of debt, x_o, exceeds the equilibrium level of debt x^*.

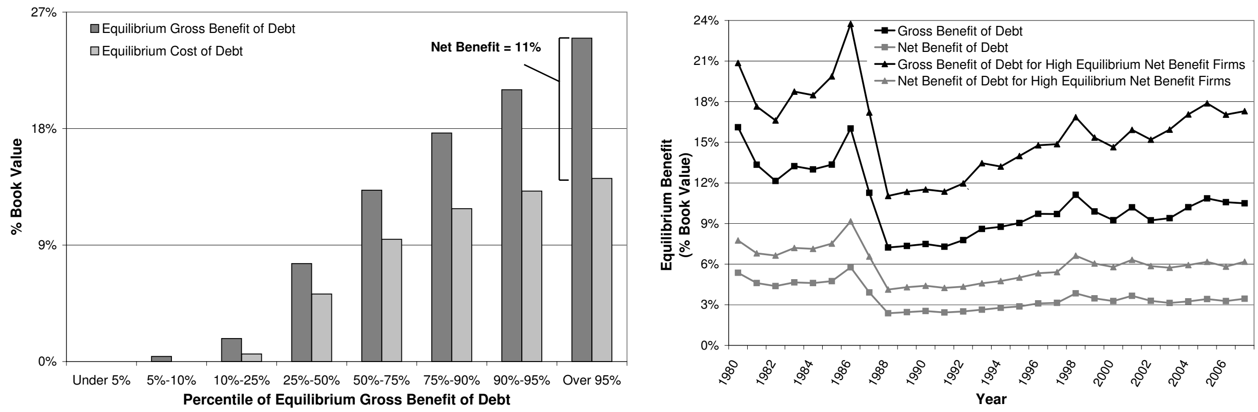

Figure 8: a) Histogram based on equilibrium gross benefit of debt percentiles with paired equilibrium cost of debt observations, b) equilibrium gross and net benefit of debt from 1980 to 2007 for all firms and high equilibrium net benefit firms (firms with equilibrium net benefit of debt above the 50th percentile).

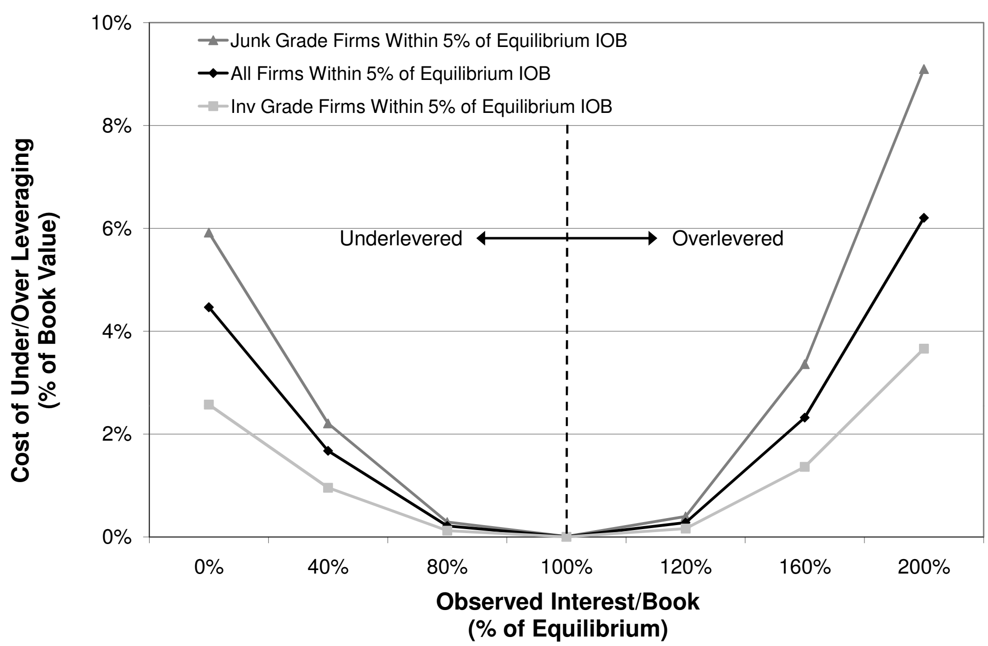

Figure 9: Hypothetical deadweight costs of being underlevered or overlevered for companies within 5% of their equilibrium IOB among Sample A firms, investment grade firms, and junk rated firms.

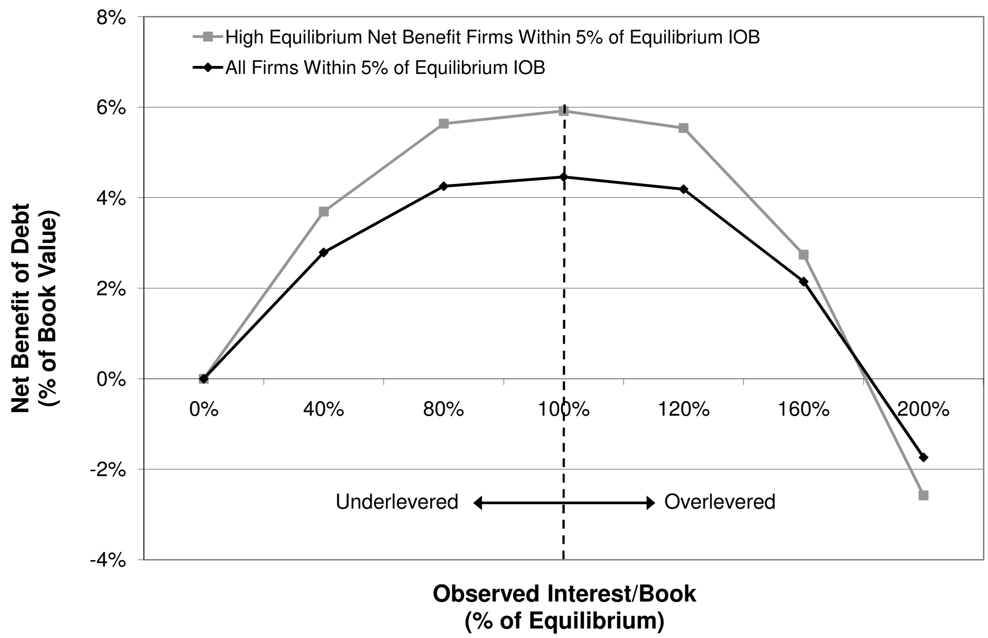

Figure 10: Hypothetical net benefit of debt (gross benefit of debt minus cost of debt) for firms within 5% of their equilibrium *IOB* for Sample A firms and for firms with high equilibrium net benefit of debt (firms with equilibrium net benefit above the 50th percentile). The curve shows that for the typical near-equilibrium firm, optimal capital structure increases book value by an amount equal to 4.5% of book assets. For a firm with high benefits of debt, optimal capital structure increases firm value by about 5.9% of book assets. The capital structure value function is fairly flat for movements within ±20% of optimal, but falls off steeply for larger deviations.

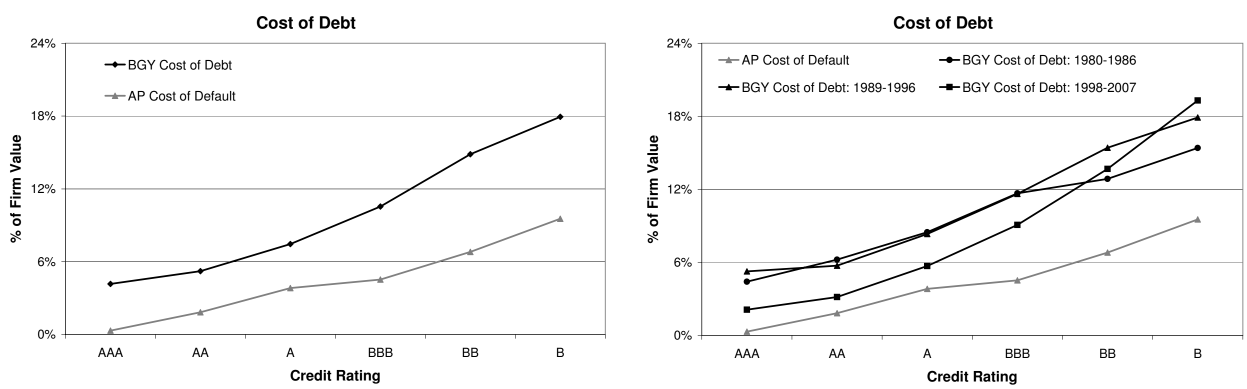

Figure 11: Comparing Almeida and Phillippon (2007) risk-adjusted net present value distress costs as a percentage of firm value against our ex ante measure of the cost of debt for AAA, AA, A, BBB, BB, and B rated firms. The Almeida and Phillippon (2007) distress costs, based on a default rate of 16.5%, are obtained from Table IV of their paper. Our cost measures are calculated using equation (12). a) Cost of debt numbers for the Almeida and Phillippon sample period of 1985 to 2004. The numbers imply that the cost of default is about half of the total cost of debt, suggesting that the other half is due to non-default costs. b) Cost of debt numbers for three periods in our sample period: 1980 to 1986, 1989 to 1996, and 1998 to 2007.