The Cost of Debt*

Jules H. van Binsbergen
Fuqua School of Business
Duke University†

John R. Graham
Fuqua School of Business
Duke University‡
and NBER

Jie Yang
Fuqua School of Business
Duke University§

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Abstract

We estimate cost functions for corporate debt using panel data from 1980 to 2006. We use exogenous shifts of Graham's (2000) debt benefit curves to identify the marginal cost curve of debt. We recover marginal cost functions that are positively sloped, as expected. By integrating the area between the benefit and cost functions we estimate that the net benefit of debt equals about 3% of asset value. Our findings are consistent over time, across industries, and when accounting for fixed adjustment costs of debt. We show that the marginal cost curve varies with firm characteristics such as size, assets in place, book-to-market ratio, cash flows, cash holdings, and whether the firm pays dividends. As such, our framework provides a new parsimonious environment within which to examine implications from competing capital structure theories. It further allows us to make recommendations about firm-specific optimal debt ratios and to approximate the cost of being under- or overlevered. Finally, we provide easy to use algorithms that allow others to implement firm-specific cost of debt curves.

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†Durham, NC 27708. Phone: (919) 660-7636. Email: jules.vanbinsbergen@duke.edu.
‡Durham, NC 27708. Phone: (919) 660-7857. Email: john.graham@duke.edu.
§Durham, NC 27708. Phone: (919) 660-2939. Email: jie.yang@duke.edu.

1 Introduction

Hundreds of papers investigate corporate financial decisions and the factors influencing capital structure. Much theoretical work characterizes the choice between debt and equity in a trade-off context: 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 of debt include committing managers to operate efficiently (Jensen, 1986) and engaging lenders to monitor the firm (Jensen and Meckling, 1976). The costs of debt include the cost of 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 include proxy variables to measure the hypothesized effects. The empirical results are somewhat mixed but a number of empirical regularities have been documented. Large firms with tangible assets and few growth options tend to use a relatively large amount of debt (Rajan and Zingales, 2003; Frank and Goyal, 2004). Firms with high corporate tax rates also tend to have higher debt ratios and use more debt incrementally (Graham, Lemmon, and Schallheim, 1998).

Tax incentives receive a lot of attention in the literature (and in the classroom) because they are relatively easy to quantify and the gross benefits seem large (e.g., for highly profitable firms, the gross benefit is 35 cents per dollar of interest deducted if the corporate income tax rate is 35 percent). Tax incentives are sufficiently quantifiable that it is possible to simulate the entire benefit function associated with interest tax deductibility and integrate under the curve to estimate the gross tax benefits of debt (Graham, 2000). Therefore, at least in the tax dimension, we are able to specify the firm-specific benefits of debt.

It has been much more elusive to quantify the costs of debt. Warner's (1977), who examines 11 bankrupt railroad companies, and Miller (1977), suggest that the traditional costs of debt (e.g., direct bankruptcy costs) appear to be low relative to the tax benefits, implying that other unobserved or hard to quantify costs are important. Weiss (1990) similarly estimates that direct bankruptcy costs are only 3.1 percent of firm value. Andrade and Kaplan (1998) estimate that for a sample of 31 highly levered firms, when distress occurs the cost of financial distress is no more than 10 to 20 percent of firm value. While these papers are instructive, our analysis contributes by determining the ex ante cost of debt for a broad cross-section of firms, not just ex post costs for a small sample of railroad or highly levered firms.

Recent papers argue that the marginal costs of debt roughly equal the marginal (tax) benefits of debt. For example, in Green and Hollifield's (2003) model, bankruptcy costs equal to three percent of firm value, combined with a personal tax disadvantage to interest income, are sufficient to derive an interior optimal debt ratio. Berk, Stanton and Zechner (2006) 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 by using the observed (equilibrium) debt choices that firms make and backing out the cost of debt that must exist to lead to these choices. The resulting cost is a function of the level of interest and is conditional on firm characteristics. These firm characteristics capture the factors that are theorized to drive the cost of debt.

To explicitly map out the cost of debt function, we need to address the standard econometric difficulties associated with identifying demand and supply curves. In our case, we start with Graham's (2000) simulated marginal tax benefit curves and the observed (equilibrium) debt choices. Observing variation in the marginal benefit curve over time and in the cross section gives us an important advantage over the standard demand and supply framework where only equilibrium points are observed. Whereas in the standard framework one has to use instrumental variables that *proxy* for shifts of the demand (supply) curve to identify the supply (demand) curve, we have the advantage of observing *actual* shifts of the marginal benefit curve. Once we purge these benefit shifts of potential correlation with cost curve shifts (econometric details are provided in Section 2), we use the variation due to pure benefit shifts to identify the cost curve.

We use marginal tax benefit variation in both the cross section and in the time series to determine marginal cost curves.[1] However, our proposed method depends on our using the right choice of control variables to purge cost effects. As such, omitted variables may induce a bias in our estimates. To ensure that our results are not driven by such econometric issues we repeat our analysis using as the identifying instrument the time-series of exogenous tax regime shifts between 1980 and 2006. We show that this natural experiment leads to estimates that are very similar to those obtained in our main specification. At the other extreme, our primary conclusions also hold when we estimate our model from 1998 to 2006. During this period there were no exogenous tax regime shifts, meaning that for this time period the identification of the cost curve is based on cross-sectional marginal benefit variation. Reassuringly, the cross-sectional approach also corroborates our main results. This indicates that our results are robust and hold whether we identify the cost curve based

[1] Using variation in the *tax* benefit function means that cost curves we identify capture all tax and non tax costs of debt, as well as any 'negative' *non-tax* benefits of debt.

on (i) cross-sectional variation of marginal benefits, (ii) time series variation of marginal benefits, or (iii) a combination of the two.

We form subsamples based on the degree of financial constraint and financial distress. We assume that unconstrained and non-distressed firms make optimal capital structure choices. We estimate different cost curves for each industry, and for investment grade ranked and junk ranked firms. Our analysis produces cost curves that are significantly positively sloped, as expected. The slopes of these curves vary in ways that make sense economically. We relate both the slope and the intercept of the cost curve to firm characteristics such as the firm's size, assets in place, book-to-market, cash flows, cash holdings and whether the firm pays dividends. We then compare our findings to implications from existing theories on the costs and benefits of debt. We also produce easy-to-implement algorithms to allow researchers and practitioners to explicitly specify the debt cost function by industry and by firm. This fills a void in the current state of affairs by providing both explicit quantification of the cost of debt and firm-specific recommendations of optimal capital structure.

Our results are robust to the presence of fixed adjustment costs. Recently 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. With fixed adjustment costs, capital structure policy can be modeled by an (s,S) rule, where an adjustment only occurs if the 'optimal' capital structure falls outside a bandwidth with lower bound s and upper bound S. We repeat our analysis by only including those firm-year observations in which a substantial rebalancing of capital structure occurs. Our results are the same for this sample, indicating that fixed adjustment costs do not drive our main results.

Armed with simulated debt benefit functions and estimated cost functions for every company in our sample, we calculate firm-specific optimal capital structure at the intersection of the curves. We also integrate the area between the curves to estimate the net benefits of debt financing as well as the cost to deviating from the optimum. We estimate that the *net* benefit of debt financing equals, on average, 2.8-3.9% of book value in perpetuity for firms at the calculated *optimum* leverage positions, compared to a gross benefit of 9.6-9.8% of book value. This implies an equilibrium cost of debt of about 5.9-6.8% of book assets. The *net* benefit of debt financing equals, on average, 0.0-1.5% of book value in perpetuity for firms at the *observed* leverage positions, compared to a gross benefit of 8.8% of book value. The difference between the equilibrium and observed numbers implies deadweight losses of about 2.4-2.8% of book value in perpetuity due to the cost of not operating at the optimal debt ratio. Firms already at their equilibrium, on average, have gross benefits of debt equaling 13.5% of book value in perpetuity, costs of debt equaling 9.6% of book value, and net benefits of 3.9% of book value. Finally, we find that the cost of being overlevered appear to be more severe than costs to being underlevered.

In addition to the research mentioned above, our analysis is related to two recent papers. Almeida and Philippon (2007) derive risk-neutral probabilities of distress that capture the fact that the marginal utility of money is high in distress states. 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 observed capital structure is consistent with optimal choices, on average. Korteweg (2007) estimates the cost of financial distress for 269 firms from 1994 to 2004. By assuming convex net costs of debt, Korteweg uses the firm value and beta levering formulas from Modigliani and Miller (1958, 1963) to identify debt costs that are approximately 5 percent of firm value in expectation. Some of the advantages of our approach are that our estimated cost of debt functions can vary by firm (even within an industry), we do not need to make specific functional form assumptions regarding beta formulas, and our end-product produces coefficient estimates that can be used to easily specify the cost of debt for any firm.

The rest of the paper proceeds as follows. In Section 2, we explain the main intuition and econometric issues underlying our instrumental variables approach. In Section 3, we describe the data and our sample selection process. In Section 4, we report and discuss our results. Section 5 presents the cost of debt functions and examines how they can be implemented in case studies. In Section 6, we calculate the benefits and costs of debt and analyze the costs of being under or overlevered. Section 7 discusses several robustness checks. Section 8 concludes.

2 Method of Estimating Marginal Cost Curves

Using the simulation techniques of Graham (2000), we create marginal tax benefit curves of debt for a large panel of approximately 125,000 firm-years between 1980 and 2006. The marginal benefit curves measure the marginal tax benefit for each dollar of incremental interest deduction.[2] The shape of these benefit curves varies by firm, but they are weakly monotonic and typically horizontal for low levels of debt and become negatively sloped for higher levels of debt (see Figure 1).

We can observe the current level of debt for each firm in each year. Henceforth, we refer to this observed level of debt as the "equilibrium amount of interest" or the "equilibrium level

[2]The marginal benefit curve simulations are described in detail in Section 3.

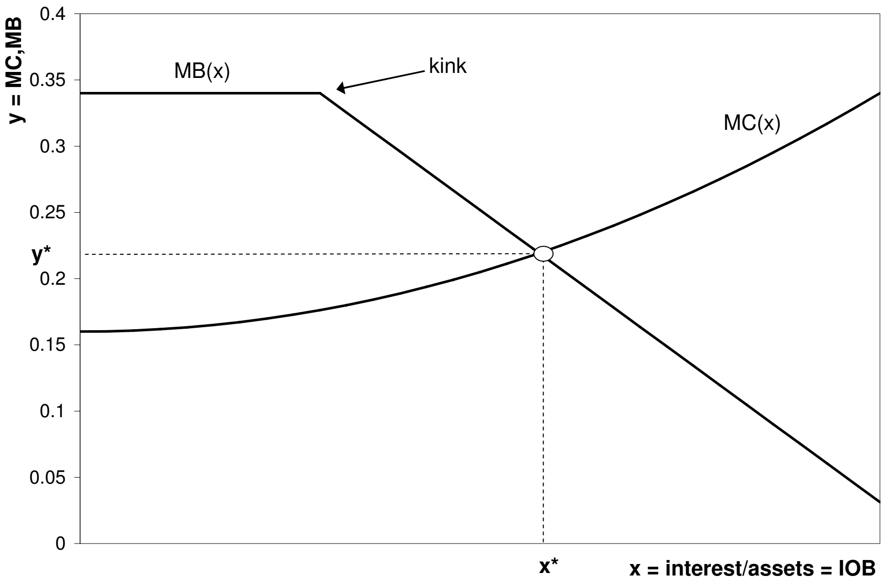

Figure 1: Capital structure equilibrium for a financially unconstrained, non-distressed firm. The figure shows the marginal benefit curve of debt, $MB(x)$, the marginal cost curve of debt, $MC(x)$, and the equilibrium amount of interest deductions, x^*, where marginal cost and marginal benefit are equated.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

of debt," denoted by $x^*_{i,t}$. That is, we implicitly assume that for financially unconstrained, non-distressed firms, the marginal cost curve of debt (MC) intersects the marginal benefit curve of debt (MB) at the equilibrium level. We refer to the corresponding marginal benefit level as the "equilibrium benefit of debt," denoted by $y^*_{i,t}$. In equilibrium at $x_{i,t} = x^*_{i,t}$ the following equality holds:

$$y^*_{i,t} \equiv MC_{i,t}\left(x^*_{i,t}\right) = MB_{i,t}\left(x^*_{i,t}\right). \tag{1}$$

The function $f_{i,t}$ describes for firm i at time t the shape of the marginal benefit curve of debt:

$$MB_{i,t} = f_{i,t}\left(x_{i,t}\right), \tag{2}$$

where $x_{i,t}$ represents the level of debt, expressed as the ratio of interest over book value of assets. Note that other measures of leverage, like the ratio of debt over the market value of assets, could alternatively be used. Figure 1 illustrates the equilibrium concept for a financially unconstrained, non-distressed firm.

Note that we cannot use standard ordinary least squares estimation techniques. Based on equilibrium $x^*_{i,t}, y^*_{i,t}$ choices, OLS is unable to determine whether variation is due to shifts in the cost or benefit curves, and hence is unable to identify either curve accurately. Only by using instrumental variables are we able to isolate benefit shifts and therefore identify

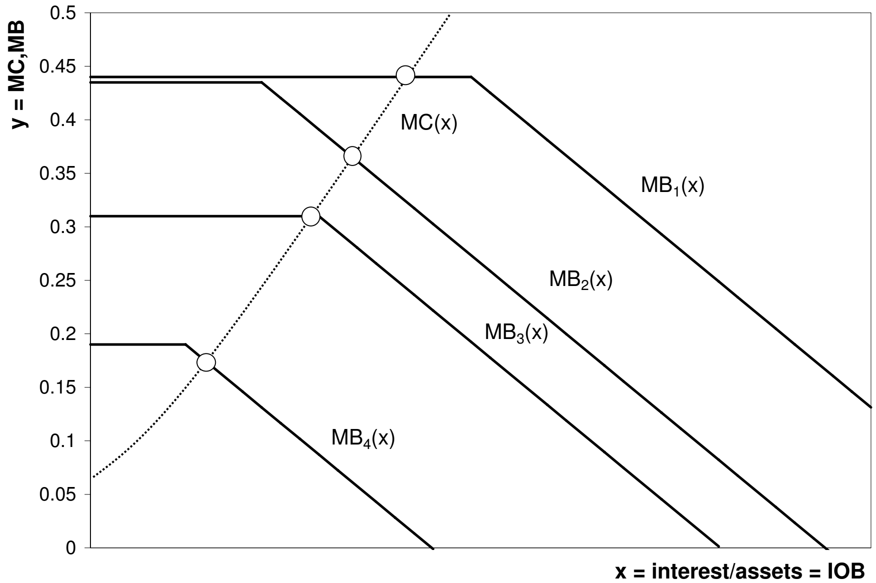

Figure 2: Identifying the cost function using shifts in the marginal benefit function. The figure shows four marginal benefit curves of debt, each intersected by the marginal cost curve of debt. The four marginal benefit curves can represent the same firm at four different points in time. The curves can alternatively represent the marginal benefit curves of 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, A, is a good proxy for the location of the curve: $MB_1(x) \supseteq MB_2(x) \supseteq MB_3(x) \supseteq MB_4(x)$ implies that $A_1 \geq A_2 \geq A_3 \geq A_4$.

the cost curve. This is described in more detail in Appendix A.

To implement the instrumental variables approach, we need to identify 'exogenous' shifts of the marginal benefit curve. In this context, the word exogenous indicates a shift of the marginal benefit curve that is uncorrelated with a shift in the marginal cost curve. In other words, we need to identify shocks to the marginal benefit curve of debt while holding the marginal cost curve constant. The exogenous benefit shifts may result from time series shifts of the marginal benefit curve of firm i, for example after a tax regime shift. Alternatively, exogenous benefit shifts may also result from cross-sectional variation in the location of the marginal benefit curve of debt at some time t. If two otherwise similar observations have different marginal benefit curves, and hence a different equilibrium level of debt, this provides information that we exploit to estimate the marginal cost curve as illustrated in Figure 2.

To identify exogenous shocks to the marginal benefit curve, which we use as the identifying instrumental variable, we can use either of two different approaches. The first approach is to find variables that proxy for, or events that cause, exogenous marginal benefit shifts. One obvious event is the tax regime changes mentioned earlier. The shifts of the marginal benefit curve induced by such natural experiments can provide an instrument that has no or very little correlation with shifts of the marginal cost curve. The disadvantage of this time-series approach, however, is that the exogenous variation of the benefit curve is limited to the information in tax regime changes. In particular, this approach does not exploit the fact that there is variation of the marginal benefit curve both in the time series and in the cross section.

An alternative approach exploits the fact that, unlike the standard framework of identifying demand and supply curves where only equilibrium points are observed, we observe the entire simulated marginal benefit curve. In other words, apart from measurement error (which we assume to be idiosyncratic), we directly observe the cross-sectional and time series variation (i.e., shifts) in the benefit curve, which we use to identify the cost function. Once we purge cost effects from this variation, we are left with an *exogenous* benefit shifter.

To implement this latter approach, we first compute for each firm in each year the total potential tax benefit of debt, $A_{i,t}$, which is equal to the area under the marginal tax benefit curve:

$$A_{i,t} = \int_{0}^{\infty} f_{i,t}\left(x_{i,t}\right) dx_{i,t}. \tag{3}$$

Since the area under the curve measures the total potential tax benefits, $A_{i,t}$ provides a natural description for the location of the marginal benefit curve and accommodates non-linearities of the marginal benefit curve (see Appendix A for a detailed discussion). 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.[3]

Next, we purge the benefit measure $A_{i,t}$ of potential cost effects. To accomplish this, we consider a set of control variables that are theorized to be correlated with the location of the debt cost curve: the log of total assets ($LTA_{i,t}$), a proxy for firms' collateralizable assets ($PPE_{i,t}$), the book-to-market ratio ($BTM_{i,t}$), whether the firm pays dividends ($DDIV_{i,t}$), cash flow ($CF_{i,t}$), and cash holdings on the balance sheet ($CASH_{i,t}$). Define C as the set of cost control variables that drive the location of the MC curve:

$$C \equiv \{LTA, PPE, BTM, DDIV, CF, CASH\}. \tag{4}$$

[3]Using alternative modeling approaches to capture shifts of the marginal benefit curve, such as accounting for the y-intercept of the marginal benefit curve or including finer partitions of the area measure, lead to similar results to those we present in Section 4. Later in this section, we also consider the location of the kink in the marginal benefit curve as an instrument for measuring the benefit function. For ease of exposition we focus initially on the area measure.

The purpose of our analysis is to estimate the marginal cost curve of debt, which we assume to be linear in both interest-over-book (IOB), denoted by $x_{i,t}$, and the cost control variables, C.[4] Under these assumptions, the marginal cost curve of debt is given by

$$MC_{i,t} = a + bx_{i,t} + \sum_{c \in C} \delta_c c_{i,t} + \xi_{i,t}. \tag{5}$$

In Section 2.1, we explain how to estimate equation 5 using generalized method of moments (GMM). We compute double-clustered standard errors following Thompson (2006) and Petersen (2007). However, since merely describing the GMM moment conditions provides relatively little intuition, we present the two-stage least squares (2SLS) equivalent of our estimation approach in Appendix B. Section 2.2 discusses alternative specifications to our primary analysis.

2.1 Generalized Method of Moments (GMM)

Define the error function $g_{i,t}$ as

$$g_{i,t} = y^*_{i,t} - a - bx^*_{i,t} - \sum_{c \in C} \delta_c c_{i,t}. \tag{6}$$

We estimate the coefficients, in an exactly identified system of equations, using generalized method of moments (GMM). The moments are obtained by interacting the error function above with the following instruments: a constant term, the variation of the marginal benefit curve $A_{i,t}$, and each of the control variables.

In equation 5 we assume that the control variables only cause parallel shifts of the marginal cost curve of debt and that they do not change its slope. If we also allow the slope of the cost curve to depend on the control variables, its equation is given by

$$MC_{i,t} = a + bx_{i,t} + \sum_{c \in C} \delta_c c_{i,t} + \sum_{c \in C} \theta_c c_{i,t} x_{i,t} + \xi_{i,t}, \tag{7}$$

and the error function becomes

$$g_{i,t} = y^*_{i,t} - a - bx^*_{i,t} - \sum_{c \in C} \delta_c c_{i,t} - \sum_{c \in C} \theta_c c_{i,t} x_{i,t}. \tag{8}$$

In this setting, because we have to identify the coefficient on $x_{i,t}$ as well as the coefficients on

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

$c_{i,t}x_{i,t}$ for each $c \in C$, we construct additional instruments by taking the product of $A_{i,t}$ and each of the control variables. As we argue later in the paper, simultaneously identifying and interpreting both intercept and slope effects can be challenging. We therefore also consider the case where the intercept is fixed across firms and only the slope is allowed to vary, conditional on the cost variables C. In this case the equation of the marginal cost curve is given by:

$$MC_{i,t} = a + bx_{i,t} + \sum_{c \in C} \theta_c c_{i,t} x_{i,t} + \xi_{i,t}, \tag{9}$$

and the error function is given by

$$g_{i,t} = y^*_{i,t} - a - bx^*_{i,t} - \sum_{c \in C} \theta_c c_{i,t} x_{i,t}. \tag{10}$$

2.2 Alternative Specifications

In the GMM framework above, we use the variation in the area under the marginal benefit curve, $A_{i,t}$, as our main identifying variable to instrument shifts in the benefit function. We consider five additional identification specifications, (ii) through (vi). As before, the error functions are defined according to equations 6 and 10 where $y^*_{i,t}$ is the observed marginal benefit/cost level, $x^*_{i,t}$ is the observed interest expense over book value, and C is the set of cost control variables. GMM moments are obtained by interacting the error function with the constant term, each of the control variables, and the following identifying instruments:

(i) the area under the marginal benefit curve, $A_{i,t}$ (as discussed above),

(ii) corporate tax rates from eleven tax brackets that span all tax rates and income brackets during our sample period (used in the tax regime shift analysis),

(iii) the area under the marginal benefit curve, $A_{i,t}$, along with the interest expense over book value associated with the kink in the marginal benefits curve, $x^K_{i,t}$,

(iv) (i) with firm fixed effects,

(v) (ii) with firm fixed effects,

(vi) (iii) with firm fixed effects.

We report estimates for all six specifications in Section 4 and show that our estimation results are similar and consistent across specifications. We discuss each of these specifications below.

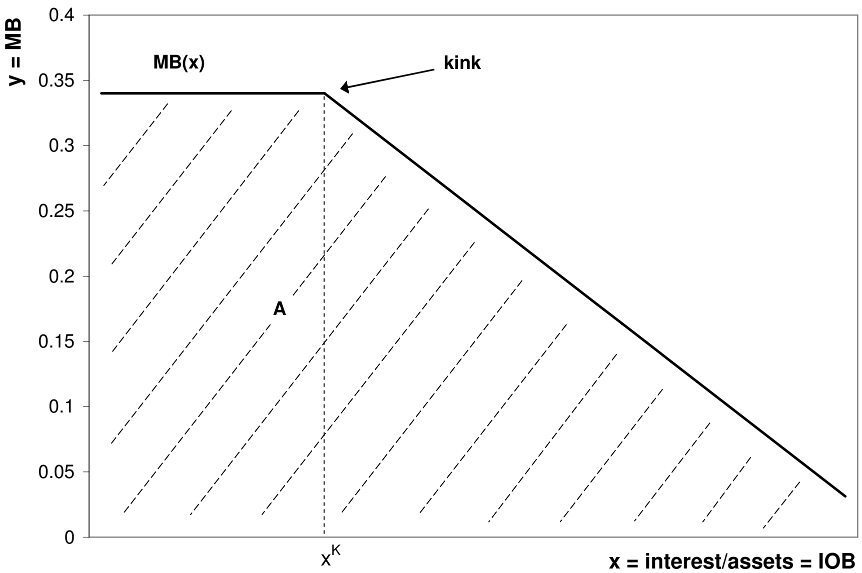

Figure 3: The kink of a marginal benefit curve is the point at which the curve begins to slope downwards. The interest expense over book assets ratio associated with the kink in the benefit curve is denoted x^K. A is the area under the entire marginal benefit curve extending out to 1000% of the observed interest expense over book assets, x^*.

2.2.1 Specification (ii): Tax regime shifts

In our main specification (i), the instrument is the area under the marginal benefit curve, $A_{i,t}$, purged of cost effects, C. Although we believe that this approach controls for the most important cost effects in the capital structure literature, there is no way to ensure that all relevant cost control variables are included. Failing to include an important cost control variable could lead to an omitted variables bias.

To rigorously address this issue, we repeat our analysis using as the identifying instrument the corporate tax regime shifts over the period 1980 to 2006. The tax regime shifts provide a natural experiment in that these shifts should directly be correlated with the benefit function and not with the cost function.

Tax regime changes can alter both statutory corporate tax rates as well as the income level applicable to each tax bracket. To incorporate both shifts, we create eleven non-overlapping brackets that span all income/tax rate combinations during our sample period.[5] For example, in 1980 the lowest tax bracket is from \$0 to \$25,000, but changes to \$0 to \$50,000 in 1988. This results in two brackets in every year: one from \$0 to \$25,000 and one

[5]To eliminate the possibility that the results from the time series analysis are driven by the rate shifts in the lower tax brackets, the entire analysis is repeated using only the top three tax brackets. The results are similar to the results using all eleven brackets.

from \$25,001 to \$50,000. The tax rates for all eleven income brackets are listed in Appendix C.

Shifts in the tax regime are further varied across firms with different fiscal year ends in the years 1987 and 1988, during which the Tax Reform Act of 1986 is implemented. The Tax Reform Act of 1986 changed the old higher statutory tax rates to new lower statutory tax rates in 1987. Firms with different fiscal year ends had different exposures between the old and new rates. Following Maydew (1997), firms with fiscal year ending prior to June 1987 remain under the old tax regime. Firms with fiscal year ending July 1987 and after gradually shift into the new regime. Firms with fiscal year ending in July 1987 are exposed to $\frac{1}{12}$ of the new statutory tax rates and $\frac{11}{12}$ of the old rates.[6] Firms with fiscal year ending in August are 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 end face half of the old tax regime and half of the new tax regime (i.e., a maximum 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 of lower tax rates.

Using time variation in the tax regime and fiscal year ends provide an arguably pristine way of estimating the marginal cost curve. The statistical advantage of this phase-in is that firms that are essentially similar in every way but fiscal year-end were affected differentially by the exogenous change in corporate tax rates, allowing identification tied just to the tax regime changes. The disadvantage is that this approach uses much less information to uncover the marginal cost curve of debt than does our primary approach, which not only relies on time series variation but on cross sectional variation as well. Recall that a strong advantage of our data set is that we 'observe' the *whole* marginal benefit curve of debt, and not just the equilibrium points where the marginal cost and marginal benefit curves intersect. When we only use the tax regime shifts, this advantage is not exploited. Moreover, for periods in which there are no tax regime shifts, such as 1998 to 2006, using only time series tax regime changes is infeasible.

2.2.2 Specification (iii): The kink in the marginal benefit curve

In the main specification (i), we use the area measure, $A_{i,t}$, to summarize the variation in the marginal benefit curve of debt. If the marginal benefit curve was linear with a constant slope and an intercept that varied, summarizing the benefit variation would be an easy task because the y-intercept, or the x-intercept, of each function would suffice. However, not only is the functional form of the benefit curve non-linear, the shape is potentially different

[6] The accounting data for a July 1987 fiscal year-end firm covers 11 months prior to and including June 1987 and one month post June 1987.

for each firm for each year. In other words, the variation of the marginal benefit curves is caused by more than just parallel shifts. As a consequence, the challenge is to summarize this changing functional form of the benefit curve, which we proxy for, in our main specification, with the area measure.

Arguably, an even better representation of the various shapes of the marginal benefit function can be achieved by also including, as an instrument, the amount of interest expense over book assets associated with the kink in the marginal benefit curve, $x_{i,t}^{K}$ (see Figure 3). We use the term 'kink' to indicate the point at which the marginal benefit curve begins to slope downward.[7] Including the kink allows us to differentiate two firms with different benefit curves that may have the same $A_{i,t}$ due to one benefit curve pivoting around the second curve. Below, we show that when we include the kink, our estimation results are very similar to the case where we only include the area measure $A_{i,t}$.

2.2.3 Specification (iv)-(vi): Firm fixed effects

Finally, we repeat specifications (i) through (iii) using firm fixed effects. Controlling for fixed effects ensures that no unmodeled firm-specific factor drives our estimation results.[8]

3 Data and Summary Statistics

3.1 Marginal Tax Benefit Curves

Our marginal benefit curves are derived as in Graham (2000). Each point on these benefit functions 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

[7] A marginal benefit curve may have several kinks. We use the first kink.

[8] Since specifications (i) and (iii) use predominantly cross-sectional instruments, the area under the marginal benefit curve ($A_{i,t}$, and the interest over book value associated with the kink in the marginal benefit curve, $x_{i,t}^{K}$), we would expect adding firm fixed effects to have more impact on these specifications than on specification (ii).

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, for a loss firm that will soon become profitable, an extra dollar of interest today effectively shields income next year, and saves the firm $0.35 one year from today. Therefore, the present value tax savings from an incremental dollar of interest today is worth the present value of $0.35 today in this situation, or about $0.33. Once carryforwards are considered, therefore, rather than stepping straight down to zero at the point of surplus interest deductions, the benefit function is sloped downward, reaching zero more 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. Therefore, we simulate tax benefit functions so that the tax benefit of interest deductions at any given point is conditional on the probability that the firm will be taxable.

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 income and 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., in 2005, tax losses can be carried forward 20 years into the future, so we forecast 20 years into the future when simulating the 2005 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. 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 $1 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 an extra dollar 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 the entire process 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. 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 the 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 2006. The benefit functions in this panel vary across firms. They can also vary through time for a given firm as the tax code or a firm's circumstances change.

3.2 Corporate Financial Statement Data

We obtain corporate financial statement data from Standard & Poor's COMPUSTAT database from 1980 to 2006. Merging the tax benefit functions with COMPUSTAT based on the eight digit firm CUSIP leaves 124,189 firm-year observations.[9] For each firm, we create empirical measures of the control variables described in the previous section, which includes

[9] To avoid issues involving changes in firm CUSIP through time, we track firms through time using COMPUSTAT's GVKEY variable, which was created for this purpose. However, merging by firm CUSIP *within* each year is not affected by this issue.

log of total book assets (LTA), plant, property and equipment over total book assets (PPE), book equity to market equity (BTM), an indicator for a dividend paying firm (DDIV), cash flow over total book assets (CF), and cash holdings over total book assets (CASH). We measure financial distress by Altman's (1968) Z-score (ZSCORE). Firms are conservatively defined to be non-distressed if they have Z-scores above the median. We measure financial constraint according to four definitions offered in the literature: (i) firms with no or limited long term leverage adjustments (LTDEIR), (ii) the Kaplan and Zingales (1997) index (KZ), (iii) the Cleary (1999) index (CL), and (iv) the Whited and Wu (2005) index (WW). We discuss the four measures in the next subsection and in Section 7. Appendix D provides a detailed description of the construction of each control variable.

We normalize equilibrium interest expense by total book assets, which hereafter we refer to as interest-over-book (IOB). Note that PPE, CF, and CASH are 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 non-positive book asset value, common equity, capital, and sales, or negative 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. Within our framework these firms can be considered to be "out of equilibrium." Further, we remove firms that were involved in substantial M&A activity, defined as acquisitions amounting to over 15 percent of total assets. Finally, 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 (A), (ii) the observed interest-over-book (IOB, x^*), (iii) the book to market ratio (BTM), (iv) the cashflow over assets ratio (CF), and (v) the cash over assets ratio (CASH).[10] This results in a sample of 110,033 firm-years, of these 91,313 have non-missing data for all relevant variables. Table 1 provides an overview of the sample construction. Table 2 provides summary statistics.

3.3 Measuring Financial Constraints

One important assumption underlying our framework is that firms are able and willing to adjust capital structure. If firms are not able to adjust their capital structures because they are financially constrained or financially distressed (i.e., out of equilibrium) they should be excluded from our estimation procedure. Moreover, recent research on dynamic capital structure highlights that firms may not continuously adjust their leverage ratios due to non-negligible adjustment costs (Leary and Roberts, 2005; Kurshev and Strebulaev, 2006; etc.).

[10] Removing the outliers of the other control variables (LTA, PPE, and DDIV) does not change the distribution of the sample much.

Therefore, when a firm does not adjust capital structure it is not clear whether the firm is acting optimally, is acting passively due to adjustment costs, or is acting suboptimally due to being constrained in financial markets. Conversely, if a company makes a (substantial) capital structure adjustment, we can deduce that transactions costs were not sufficient to prevent capital structure adjustments.

To address these issues, we also perform our analysis for those firm-year observations in which a substantial capital structure adjustment takes place, i.e., those firm-year observations in which there is substantial long term debt and/or an equity issuance or repurchase (LTDEIR). In our sample the median levels of long term debt issuance and reduction among all firm-year observations are 6.9 and 3.3 percent of book value, respectively. These numbers increase to 16.4 and 9.3 percent, respectively, when we consider debt issuances and reductions above the 75th percentile. For equity issuances and repurchases, the medians are 0.7 and 1.0 percent of book value, respectively, and 3.5 and 3.2 percent at the 75th percentile. We define a firm to be financially unconstrained if it has long term debt or equity adjustment (LTDEIR) above the median issuance or reduction. Even when we tighten the definition by including only firms above the 75th percentile, our main results do not change.

3.4 Data Description of the Subsamples

We perform our empirical analysis on two primary samples. The first sample includes all firms with non-missing $A_{i,t}$, $x^*_{i,t}$, and $C_{i,t}$. The second sample is obtained using two criteria. The first criterion is based on the firms' degree of financial distress, which we measure by ZSCORE. The second criterion is based on the firms' long term debt and equity issuance and repurchases (LTDEIR). As explained earlier, LTDEIR reflects the firm's ability to adjust its capital structure and can be interpreted as a measure of financial constraint. The two samples are then given by:

A : All firms with non-missing $A_{i,t}$, $x^*_{i,t}$, and $C_{i,t}$

B : Financially non-distressed and unconstrained firms: ZSCORE above median and LTDEIR above median

The analysis of non-distressed and unconstrained firms helps to highlight those firms that can 'freely' optimize their capital structure. Because we assume in our estimation procedure that, on average, the cost curve of debt intersects the marginal benefit curve at the actual level of debt, our estimation is most accurate for those firms that have the flexibility to actively optimize the amount of debt. If the firm is constrained, it may be (temporarily) "out of equilibrium."

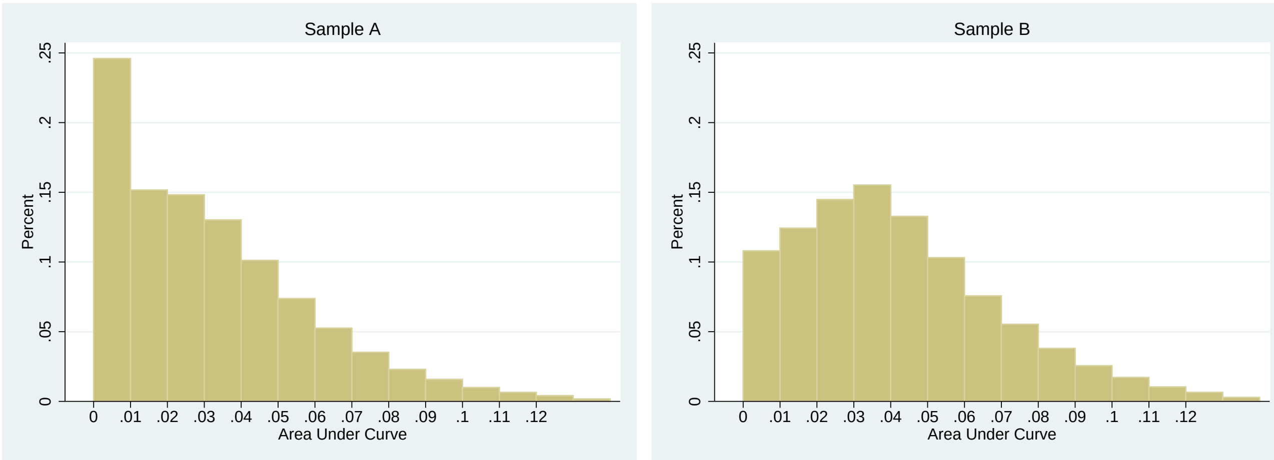

Figure 4: Histogram of the area under the curve. This figure shows the relative frequency distribution of the area under the marginal benefits curve for samples: A) all firms, B) non-distressed and unconstrained firms. Lower bins indicate firms with declining marginal benefits or constantly low marginal benefits. Higher bins indicate firms with consistently high marginal benefits.

Figure 4 plots the histograms of the area under the marginal benefits curve for each subsample. Firms with small areas have benefit functions that are either relatively flat at low benefit levels, or that are initially high but steeply downward sloping. Firms with large areas typically have marginal tax rates equal to the highest statutory tax rate. These are firms we would expect to load heavily on debt in equilibrium unless their marginal cost curve is especially steep. As we move from Sample A to Sample B, the distribution of the area under the marginal benefits curve shifts to the right. This indicates that the firms in Sample B tend to be more profitable and thus have higher total potential benefits to debt through interest deductions. Table 2 compares the summary statistics for these samples.

4 Results

As described in Section 2, we estimate the marginal cost curve for six main specifications, which differ in their identifying instrument(s): (i) using $A_{i,t}$, (ii) using tax regime shifts, (iii) using $A_{i,t}$ and $x^K_{i,t}$, and (iv)-(vi) repeat the above and include firm fixed effects. Tables 3 and 4 report the results for samples A and B, respectively, for all six specifications. Firms in utilities, finance, and public administration are excluded from the analysis.[11] All control variables 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.

[11]Firms in utilities, finance, and public administration tend to be heavily regulated. Excluding these industries is common practice in capital structure analysis.

As described in more detail below, estimated coefficients for the slope of the marginal cost curve and the intercept are similar across both samples. For sample B, the firms that are not distressed or constrained, the slope of the marginal cost curve ranges from 4.484 to 12.099 and the intercept ranges from 0.147 to 0.188 (see the second row in Table 4). Further, the signs and approximate magnitudes of the coefficients of the cost control variables are consistent across samples and specifications. This indicates that it does not seem to matter whether we identify the cost curve based on cross-sectional variation of the benefits, time series variation, or a combination of the two. We consider this to be a strong corroboration of our findings. Since the estimates for samples A and B are similar, apart from a relatively small difference in the intercept, for expositional reasons, we henceforth focus on the analysis of sample B.

4.1 Marginal Cost Curves with Fixed Intercept

In this analysis, the slope of the marginal cost curve depends on the control variables but the intercept is the same for all firms. (We allow for intercept variation in the next section.) The slope of the marginal cost curve determines the convexity of the total cost curve and measures the increase in marginal cost that results from a one-unit increase in the interest-over-book ratio. When the intercept is fixed, a larger slope on the marginal cost curve implies higher marginal cost for all values of leverage.

Within our framework, the capital structure decision follows from a tradeoff between the tax benefits of debt and the costs of debt. It is important to stress that, in our framework, the marginal benefit curve only measures 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 in our framework 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 or between different groups of investors, and any other cost that firms consider in their optimal debt choice.

We interpret the cost coefficients embedded in the cost of debt functions, and compare the implications from these coefficients to the capital structure regularities documented in the literature. For example, it has been documented that large firms with tangible assets and few growth options tend to use relatively large amounts of debt (Frank and Goyal, 2004). Table A summarizes the effect of the control variables on the cost of debt function, and summarizes the standard capital structure result (as presented in Frank and Goyal

Control Variable	Cost of Debt	Leverage
LTA	+	+/-
PPE	−	+
BTM	−	+
DDIV	+	−
CF	+	−
CASH	+	−

Table A: The influence of each of the control variables on (i) the cost of debt as estimated in Tables 3 and 4, and (ii) the leverage of the firm, as documented in the capital structure literature.

(2004) among others). As we highlight below when we discuss the effect of each control variable, the effects of individual cost variables on the cost of debt function are consistent with debt usage implications in the existing capital structure literature, which corroborates the implications from our analysis. There are a great many unanswered questions in the capital structure literature in terms of interpreting individual coefficients, and by no means do we believe that our procedure solves all these puzzles and unanswered questions. Rather, our procedure quantifies just how large the influence of individual variables must be on the cost of debt to explain observed capital structure choices.

The average firm has a cost curve of debt with an estimated slope of 5.124. That is, when we set all the control variables to their mean values (of zero since they are standardized), the estimated slope of the marginal cost curve of debt equals 5.124. Suppose that the IOB changes from 0.02 to 0.03, then the marginal cost of taking on an additional dollar of debt would increase by 5.124 cents per dollar. The firm will find it optimal to increase interest-over-book until the marginal cost of an additional dollar of debt equals the marginal benefit of debt, which, if interest is fully deductible is around 35 cents per dollar.

The 0.511 coefficient on LTA indicates that large firms face a higher cost of debt. All else equal, a firm that has LTA one standard deviation higher than the average faces a slope of 5.635 as opposed to 5.124. This might initially seem somewhat surprising because it implies that large firms face higher costs of debt, but our result is consistent with recent research that indicates that large firms use less debt (Faulkender and Petersen, 2006; Kurshev and Strebulaev, 2006).[12] Other research (as summarized in Frank and Goyal, 2004) documents a positive relation between size and debt usage. The differing firm size implications on debt ratios documented in various capital structure papers implies that the influences of size on

[12]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.

the costs versus benefits of debt dominate in different settings and samples. In our sample, size increases the marginal cost of debt.

For PPE, the coefficient equals -0.496 (note that PPE is normalized by the book value of assets), so high PPE firms have a lower cost of debt. (And, all else equal, a lower cost of debt should lead to higher debt usage, which is consistent with the capital strucuture literature summarized in Table A.) All else equal, a firm that has PPE one standard deviation larger than the average faces a marginal cost slope of 4.628 as opposed to 5.124. Figure 5 illustrates how a one standard deviation increase in PPE (high PPE) and a one standard deviation decrease in PPE (low PPE) pivot the marginal cost curve.

Firms with growth opportunities (i.e., a low book-to-market (BTM)) on average face a higher cost of debt (coefficient of -0.289). 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.

Dividend paying firms (DDIV) face a higher cost of debt (or at least act as if they face a higher cost of debt), as indicated by the 0.894 coefficient on Table 4. All else equal, committing to pay dividends reduces the availability of cash flows to service debt, given the extreme stickiness of dividend payments (e.g., Brav et al., 2005), thereby increasing debt costs. This result and interpretation are consistent with the negative relation between dividend-paying status and debt ratios documented in Frank and Goyal (2004) and elsewhere (see Table A).

Debt choices by firms with large cash holdings (CASH) and cash flows (CF) imply that these firms face a higher cost of debt, with coefficient estimates of 1.616 and 1.867, respectively. Firms with large cash holdings may know they have high costs of debt and so in equilibrium hold large amounts of cash to avoid external financing. Similarly, profitable (high CF) firms may have no need for debt as they are able to fund their projects internally. Both results are consistent with the pecking order theory of using internal financing before external financing.

Finally, it is important to note that we measure the cost of debt as perceived by the firm as reflected in its chosen debt policy. This cost of debt could, but does not have to, coincide with the cost of debt perceived by debt markets.

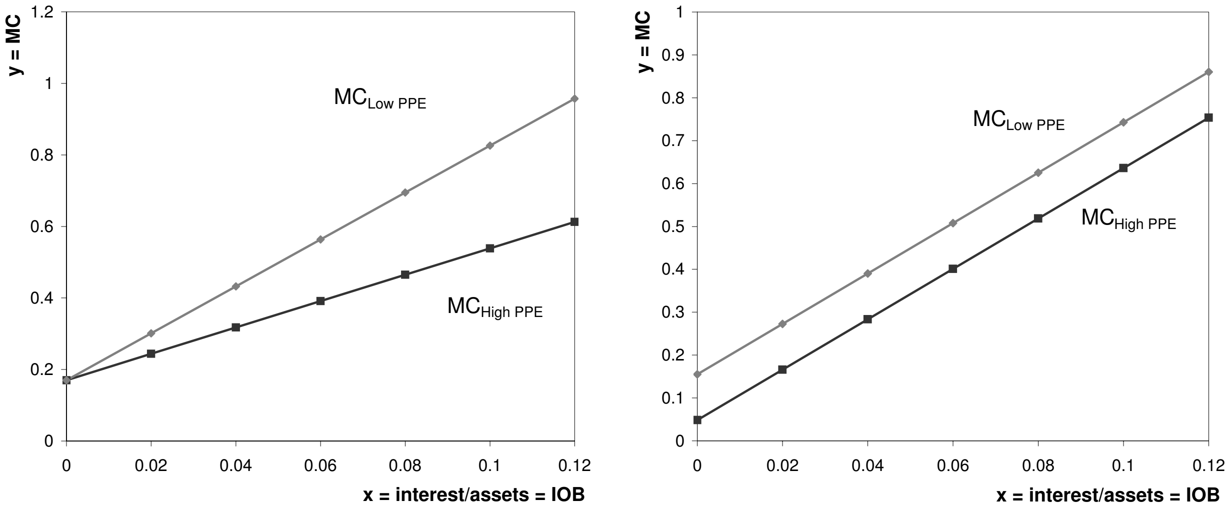

Figure 5: Comparing marginal cost curves for firms with high and low assets in place (PPE). The left panel shows the effect of a one standard deviation increase (decrease) in PPE on a marginal cost curve with a fixed intercept and varying slope. The right panel shows the effect of a one standard deviation increase (decrease) in PPE on a marginal cost curve with a fixed slope and varying intercept.

4.2 Marginal Costs with Fixed Slope

In the previous section, we allowed the slope of the marginal cost curve to depend on the control variables but did not allow these variables to influence the intercept. Alternatively, we can assume that the slope of the marginal cost curve is fixed across firms but that the intercept is conditional on the control variables. The results for the six specifications are presented in the last six columns of Table 3 and Table 4, with qualitative results identical to the ones described in the previous section. That is, small, non-dividend paying firms with high collateralizable assets, few growth options, and low cash and cashflow make debt choices consistent with them facing a lower cost of debt. Note that in this case the interpretation of the coefficients of the control variables is somewhat different than before. Whereas previously a one standard deviation increase of a control variable pivoted the cost curve around its y-intercept, now a one standard deviation leads to a parallel shift of the whole curve. Figure 5 illustrates how a one standard deviation increase (decrease) of PPE leads to a parallel upward (downward) shift of the marginal cost curve.

4.3 Marginal Costs with Varying Slopes and Intercepts

In the previous two sections, we assumed that either the intercept or the slope of the cost curve is the same for all firms. In this section, we explore the possibility that both the slope and the intercept vary with the control variables. In equation 7 we include the control variables and the interaction terms between interest-over-book (IOB) and the control variables. Econometrically this is challenging because the information contained in our instruments may not be sufficient to separately identify slope and intercept effects. Indeed our estimation results indicate that when we include the interaction terms, the statistical significance of the estimated costs decreases, specifically when we move from Sample A to Sample B and the sample size drops by almost two-thirds.

In addition, slope and intercept effects may offset each other, clouding the interpretation. Only when the coefficient signs of a given control variable are the same for both the slope (interaction term) and the intercept is the resulting effect of that control variable on the marginal cost curve unambiguous. When the slope and intercept coefficients have opposite signs, the effect is ambiguous, leading to a higher cost curve in one region and a potentially lower cost curve in another (e.g., higher intercept but flatter slope). This is not surprising and can be understood in the following way. When we fix the intercept, as in section 4.1, variation in the control variables implies pivoting the marginal cost curve around the intercept point. When we fix the slope across all firms and only allow the intercept to vary with the control variables, as in section 4.2, changes in the control variables lead to parallel shifts of the cost curve. However if we let both the intercept and the slope vary, the procedure can pivot around some center point of the curve, making interpretation and comparisons of the cost of debt more challenging.

4.4 Marginal Costs By Subgroup

In previous sections, we estimated marginal cost curves for all firms except those in utilities, finance, and public administration. We assumed that firms that have the ability to adjust their leverage will adjust optimally. In particular, we focused on the results from the group of firms that are financially unconstrained and non-distressed. Our estimation technique can easily be used to find marginal cost curves for different subgroups. Again, the key assumption is that firms within that subgroup have the ability to lever optimally conditional on being classified within their subgroups.

4.4.1 By Industry

The estimated coefficients from equation 9 by industry are given in Table 5. These estimates allow the slope of the marginal cost curve to vary with the control variables while keeping the intercept fixed within an industry. The estimated coefficients are based on industries categorized by two-digit Standard Industry Classification (SIC) codes. The industry classification is documented in Appendix E. We find positive, and highly significant slopes for the full sample as well as in each industry. The slope is particularly steep for utilities and flat for finance, insurance and real estate firms. At the same time, the intercept is particularly low for utilities and high for finance, insurance, and real estate.

4.4.2 By Credit Rating

We also estimate coefficients from equation 9 by whether the firm is investment grade or junk (see Table 6). The slope for junk bonds (14.949 for Sample A and 7.956 for Sample B) is much steeper than the slope for investment grade bonds (8.161 and 4.649). On the other hand, the intercept for junk bonds (-0.409 for Sample A and -0.048 for Sample B) is much lower than that for investment grade bonds (0.127 and 0.236). However, firms with junk bond ratings on average have much higher debt holdings than firms with investment grade ratings suggesting that the slope differences dominate the intercept differences (i.e., firms with junk bond ratings have higher marginal debt costs than firms with investment grade status). The average interest expense for junk bond firms is 4.6% of book value and 3.3% for investment grade firms. The average debt for junk bond firms is 41.2% of book assets and for investment grade firms is 24.9%.

4.5 Interpreting Recent Capital Structure Theories

In this section, we address recent research that explores the effect of specific factors on the cost of debt function. In each of these cases, it turns out that these theories suggest the inclusion of a control variable that either (i) has low data quality, (ii) has many missing values and hence would lead to a small sample size, or (iii) is redundant with other control variables in the cross section or time series. For these reasons, we have not included them in the main analysis discussed above. However, these examples illustrate that our framework can be used to analyze implications from various capital structure theories. After the tax benefits of debt have been accurately modeled, the estimated coefficients on the control variables in the cost curve can be used to assess the importance of various factors that affect capital structure decisions.

4.5.1 Macroeconomic Influences

Chen (2006) and Almeida and Philippon (2007) propose that bankruptcies are concentrated in bad times, i.e., periods when consumers' 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 significant role in the time variation of the cost of debt from the viewpoint of financial markets.

Table 7 presents the results for the analysis when we include the Moody's Baa-Aaa spread (CS) as a control variable. When the spread is high, indicative of bad times with high volatility, 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 true and the coefficient is significant (with a coefficient of 0.664).[13]

4.5.2 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 is reflected in the cost of debt, deterring firms from using debt, all else equal. Graham (1999) shows that when empirically modeling debt ratios, a specification that adjusts for 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 one of the cost control variables.

Table 7 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 high personal tax penalty do indeed face higher marginal costs of debt (with a coefficient of 0.924). This is consistent with Graham's (1999) findings. However, the PTP measure is sensitive to outliers, so we exclude it from the main specification.

4.5.3 Asymmetric information

Myers' (1984) pecking order theory of capital structure suggests that it is costlier for firms with higher information asymmetry to issue equity over debt. Thus firms with higher information asymmetry should face a lower marginal cost of debt when deciding between debt and equity. On the other hand, these firms face higher costs of debt when deciding between internal financing and external debt despite tax benefits of debt, suggesting firms with high information asymmetry face a higher cost of debt. Including a control variable that proxies for information asymmetry allows us to estimate in our framework the effects of information asymmetry on the cost of debt. One crude proxy for information asymmetry is whether the

[13] Note that this analysis is infeasible when including year dummies.

firm has a S&P credit rating (DCR).[14] Firms that have credit ratings have presumably less information asymmetry than firms that do not. Table 7 reports the coefficients for DCR. We see that firms with low information asymmetry have lower marginal costs of debt (with a coefficient of -0.568).

5 Using the Marginal Cost and Marginal Benefit Functions to Infer Optimal Capital Structure

Using the fixed intercept, varying slope results from Table 4, the marginal cost of debt as a function of the interest-over-book value (x) for any particular firm i at time t can be determined by:

$$\begin{aligned} &MC(IOB) = \alpha + \beta * IOB \\ &\alpha = 0.170 \\ &\beta = 5.124 + 0.511\text{LTA} - 0.496\text{PPE} - 0.289\text{BTM} + 0.894\text{DDIV} + 1.616\text{CF} + 1.867\text{CASH} \end{aligned} \tag{11}$$

and, when using the fixed slope, varying intercept results the curve is given by:

$$\begin{aligned} &MC(IOB) = \alpha + \beta * IOB \\ &\alpha = 0.102 + 0.019\text{LTA} - 0.019\text{PPE} - 0.020\text{BTM} + 0.038\text{DDIV} + 0.092\text{CF} + 0.059\text{CASH} \\ &\beta = 5.873 \end{aligned} \tag{12}$$

where each of the control variables are standardized based on Sample A to have a mean of zero and a standard deviation of one. The mean and standard deviation for each of the control variables for Sample A are reported below:

	LTA	PPE	BTM	DDIV	CF	CASH
Mean	4.899	0.326	0.757	0.372	0.087	0.142
Std. Dev.	2.292	0.237	0.640	0.483	0.158	0.184

Note that these statistics differ slightly from Table 2 since we exclude firms in utilities, finance, and public administration in the estimated coefficients shown in equations 11 and 12.

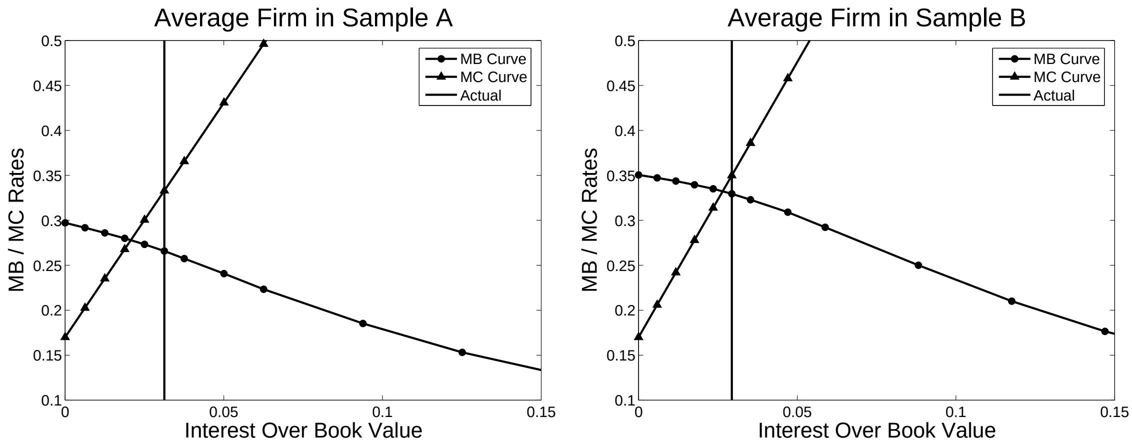

Figure 6: The average (representative) firm in Samples A and B. The marginal cost curves are obtained using equation 11. These marginal benefit curves are based on the average marginal tax rate and interest over book values at 0%, 20%, 40%, ..., 1000% of observed IOB, for each representative sample.

5.1 The Representative Firm

In Table 8 and Figure 6 we show the marginal benefit and cost curves for the average (representative) firm in samples A and B. The marginal cost curves are derived using equation 11 above, which is based on coefficients estimated in Table 4. For Sample A, we set the control variables equal to their average value of 0 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 and apply to equation 11. To obtain the average marginal benefit curve, we compute the average marginal tax rate and interest over book value at 0%, 20%, 40%, ..., 1000% of the observed IOB.

Figure 6 indicates that, on average, firms in Sample B are in equilibrium, as is assumed in the sample construction. Sample A, in contrast, includes the firms in Sample B plus 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 overlevered. These statistics can be used by researchers to calibrate models of aggregate capital structure behavior.

[14]Ideally, we should use actual S&P ratings to test not only for information asymmetry, but also quality of firm, but we are limited in sample size from either lack of data on COMPUSTAT or low number of firms with S&P ratings.

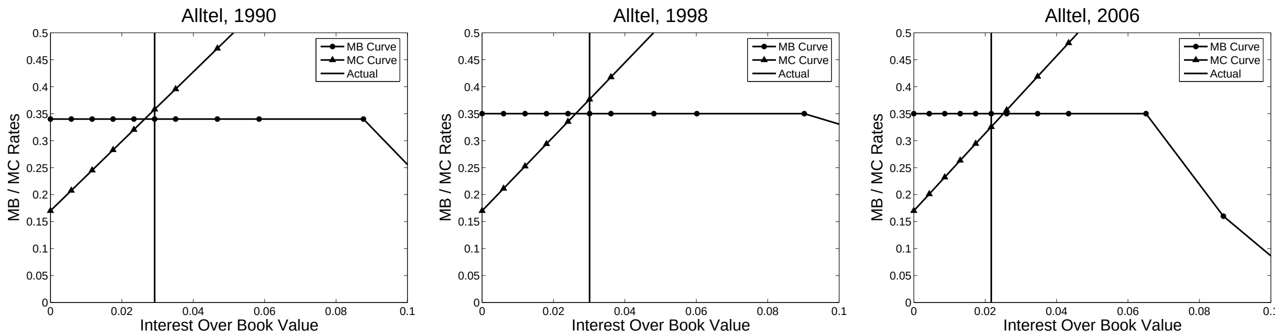

Figure 7: Marginal benefit and marginal cost curves for Alltel in i) 1990, ii) 1998, and iii) 2006. The vertical line reflects the actual observed interest over book value.

5.2 Case Studies of Optimal Debt Usage

Once the cost and benefit functions have been estimated, they can be used to draw inference on firm-specific optimal capital structure. We illustrate with four cases. The following companies are chosen for expositional purposes: i) Alltel, in the communications industry, ii) Black & Decker, in the manufacturing industry, iii) Cigna, in the insurance industry, and iv) U.S. Playing Cards, in the manufacturing industry. Note that although we did not include Cigna in the estimation of the cost curve because it is an insurance firm, we can compute a cost curve for it. The marginal cost curve is derived using equation 11.[15]

5.2.1 Alltel

The first panel of Table 9 displays the rankings of a number of financial ratios for Alltel across three years: i) 1990, ii) 1998, and iii) 2006. Alltel is a large firm that consistently pays dividends and has relatively high sales. However, from 1990 to 2006, both Alltel's capital to assets ratio and growth opportunities decrease. The drop in collaterizability increases marginal cost while fewer growth opportunities decrease the marginal cost of debt. The optimal capital structure as suggested by our model drops from 0.03 to 0.02 over time. The actual debt to equity ratio for Alltel drop as well.

Figure 7 displays the marginal benefit and marginal cost curves for Alltel in i) 1990, ii) 1998, and iii) 2006. We see that in each year, Alltel stays close to its 'equilibrium', i.e., the marginal cost curve and the marginal benefit curves intersect close to the actual amount of debt the firm employs.

[15]The qualitative results are similar if we instead fix the slope and let the intercept vary with the control variables.

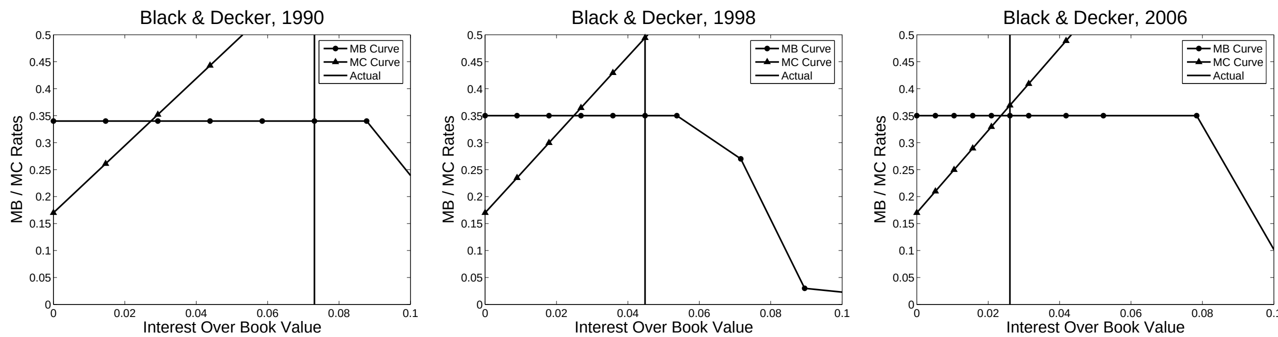

Figure 8: Marginal benefit and marginal cost curves for Black & Decker in i) 1990, ii) 1998, and iii) 2006. The vertical line reflects the actual observed interest over book value.

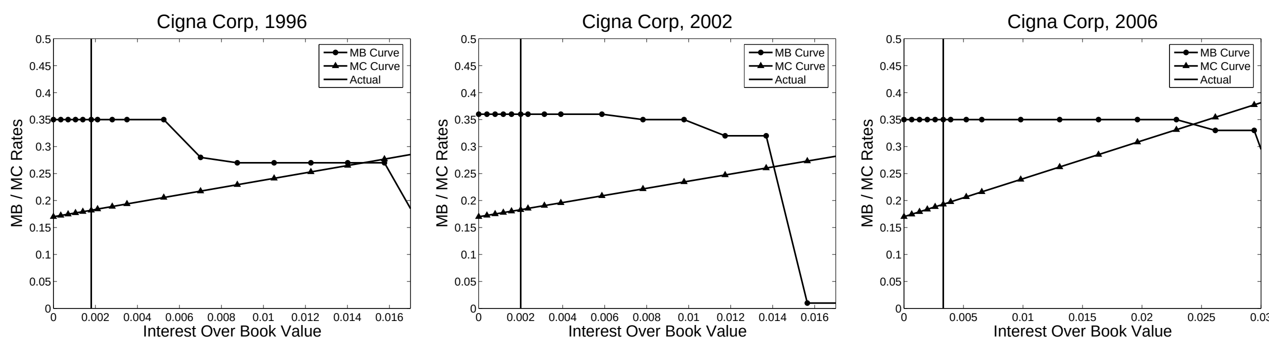

Figure 9: Marginal benefit and marginal cost curves for Cigna in i) 1996, ii) 2002, and iii) 2006. The vertical line reflects the actual observed interest over book value.

5.2.2 Black & Decker

The second panel of Table 9 displays the rankings of fundamentals for Black & Decker across i) 1990, ii) 1998, and iii) 2006. Like Alltel, Black & Decker is also a large firm that pays dividends and has consistent sales. The firm's low collaterizability suggests high marginal costs based on our estimation results (Table 4), less debt than Black and Decker uses in 1990. Relative to the model implied debt ratio, Black and Decker is overlevered in 1990. This seems to be caused by Black and Decker's substantial debt usage when it acquired Emhart Corporation in 1989. In the mid 1990s, Black and Decker issued equity for the purpose of paying down its debt. Thus by 1998, Black and Decker's actual leverage had decreased and the firm has moved closer to its optimal debt ratio.

5.2.3 Cigna

The third panel of Table 9 examines the rankings of fundamentals for Cigna for the years i) 1996, ii) 2002, and iii) 2006. Cigna is a large firm with little collaterizability, low cash holdings, and low sales. This all points to a high marginal cost of debt for Cigna and a low 'optimal' IOB. However, Cigna is also one of the most entrenched firms (above the 95th percentile) based on the Gompers, Ishii, Metrick (2003) index (GINDEX). Berger, Ofek, and Yermack (1997) argue that entrenched managers have a tendency to avoid debt. We see from Figure 9 that while the optimal IOB is low as suggested by our model, the observed IOB for Cigna is even lower, and the company is severely underlevered. This underlevering costs the firm approximately 1.4% of book value in perpetuity. Although this is not a large percentage, given Cigna's asset size, it still amounts to approximately $1.1 million lost due to underlevering. Though this is just one handpicked example to illustrate the use of our marginal cost curves and optimal capital structure, this case appears to agree with the Berger, Ofek, Yermack findings.

5.2.4 U.S. Playing Card Company

The last panel of Table 9 lists the financial rankings for U.S. Playing Card Company over the years i) 1980, ii) 1983, and iii) 1986. We present this firm because it underwent a leveraged buyout (LBO) in 1981 but still had COMPUSTAT data until 1986. An optimal LBO target should have the potential for large gains from increasing their debt obligations. This would suggest that before the LBO, targets are underlevered. We see from Figure 10 that in 1980, that is indeed the case for U.S. Playing Card Company.

In 1980, the gains from levering up would amount to approximately 5.4% of the firm's asset value. The leveraged buyout for U.S. Playing Card was announced and effective in 1981. By 1983, we see a huge increase in the firm's debt to equity ratio (from 0.0284 to 0.5790). This put the firm in a highly overlevered state. However, by 1986 we see a larger marginal benefits curve indicating the improved financial health of the firm (since the firm is more likely to operate in profitable states). Furthermore, we start to see the firm slowly decreasing its debt obligations towards its 'optimum.' Unfortunately, the firm disappears from COMPUSTAT in 1986 and we cannot observe whether eventually the firm reaches its optimum. However, this case would agree with the belief that although LBOs initially put the firm in an overlevered state, at least in some cases, there are long term benefits.

These cases illustrate that our analysis can be used not only to interpret capital structure theories, but also to provide a benchmark against which companies can compare their capital structure decisions. Our analysis identifies the intersection of each firm's marginal benefit and marginal cost curves, where the costs are inferred from the debt choices made by firms with similar characteristics, as reflected in the estimated marginal cost curve.

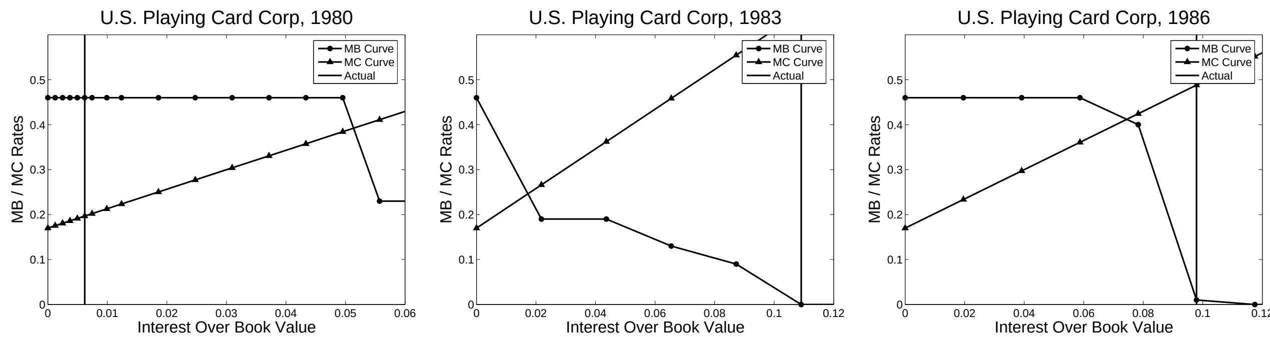

Figure 10: Marginal benefit and marginal cost curves for U.S. Playing Card in i) 1980, ii) 1983, and iii) 1986. The vertical line reflects the actual observed interest over book value.

6 Quantifying the Costs and Benefits of Debt

As seen in Section 5, using both the marginal benefit and marginal cost functions, we can compute the 'optimal' or 'equilibrium' IOB for a firm as the value for the interest over book value where the two curves intersect.[16] This allows us to infer how the firm's chosen debt usage compares to the model recommended debt usage. We quantify over and underleverage as follows.

First, for each firm, we normalize the current interest-over-book value (IOB) to one. (In other words, each firm operates at 100% of its observed IOB.) The 'equilibrium' level of IOB, described above, is then normalized by the observed level, i.e., 'equilibrium' capital structure is expressed as a proportion of the observed. For example, a firm that has an equilibrium factor of 0.8 should, according to our model, optimally have 80% of its actual IOB. That is the firm should reduce leverage until the equilibrium to observed proportion equals to 1.0. Suppose the normalized equilibrium level of debt equals e, then the percentages of underleverage and overleverage are given by:

$$\text{Underleverage} = 1 - 1/e \text{ when } e > 1, and \tag{13}$$

$$\text{Overleverage} = 1/e - 1 \text{ when } e < 1. \tag{14}$$

Proceeding with our example of a firm with an equilibrium factor of 0.8, this approach implies this firm is overlevered by 25%. We can also say this firm is 25% "out of equilibrium." Equipped with these definitions, we can use our benefit and cost functions to quantify the gross and net benefits of debt and the costs of being "out of equilibrium." Note that we use the statement in a relative sense: we refer to the firms as overlevered (underlevered) if the

[16] Strictly speaking, this 'optimum' should be interpreted as the representative debt ratio for firms with similar characteristics to the firm under consideration, based on coefficients estimated on Sample B.

observed debt usage is too high (low) relative to the optimum implied by the coefficients of our empirical model, as esimated on Sample B firms.

6.1 Gross and Net Benefits of Debt

The observed (equilibrium) gross tax 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 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).

Table 10 reports the unconditional summary statistics for the gross benefit, cost, and net benefit of debt for all firms in our sample for which we estimate marginal benefit and cost curves. Note that this analysis includes constrained and distressed firms that we excluded in our estimation of equations 11 and 12. Values are reported for firms both at the observed level of interest-over-book values (IOB) as well as at the equilibrium implied by equations 11 and 12. All values are reported as percentages of book value in perpetuity.[17] We see that the average gross benefit of debt is higher at the equilibrium levels of debt than at the observed levels of debt. In contrast, the average cost of debt is lower at the equilibrium levels than at the observed levels. This results in a higher net benefit of debt for firms at the equilibrium implied by our analysis, relative to their observed levels. On average, the net benefit of debt at the implied equilibrium is 2.85% of book value in perpetuity, and 0.0% of book value in perpetuity at observed debt levels. Although 2.85% of book value in perpetuity is modest, for a portion of the sample, the net benefits of debt are high. Figure 11a shows a histogram of firms sorted according to their gross benefit of debt and paired with the corresponding cost of debt. Firms above the 95th percentile have net benefits of debt on average of 9.3% of book value. Figure 11b shows the time series of the observed and equilibrium gross and net benefits of debt. The drop in tax benefits around 1987 is the result of the reduction in corporate marginal tax rate following the Tax Reform Act of 1987.

Table 11 reports the summary statistics for gross benefit, cost, and net benefit of debt conditional on how far the firm is out of equilibrium based on equations 13 and 14. Panel A shows the results for all firms, panel B for financially distressed firms only, panel C for financially constrained firms only, and panel D for firms with an area under the marginal benefit curve above the median (i.e., firms with high potential tax benefits from debt). Again

[17] For example, a gross benefit of 5% means 5% of book value in perpetuity.

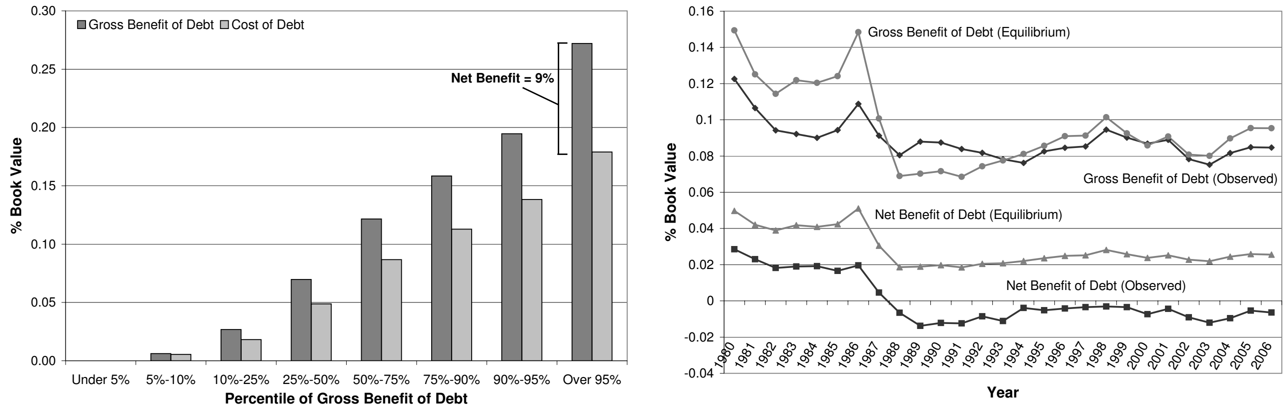

Figure 11: a) Histogram based on observed gross benefit of debt percentiles with paired cost of debt observations, b) observed and equilibrium gross benefit of debt and net benefit of debt over sample period 1980 to 2006.

we see that the net benefits of debt under equilibrium levels are higher than at observed levels. This result is consistent for both over and underlevered firms. The difference between the equilibrium and observed net benefits, i.e., the deadweight cost of being out of equilibrium, increases as firms move further out of equilibrium and is on average 5.81% of firm value for firms that are 80% or more from the equilibrium under panel A, 6.20% for financially constrained firms in panel B, 4.71% for financially constrained firms in panel C, and as high as 7.30% of book value in perpetuity for firms with high potential tax benefits of debt in panel D.

6.2 Cost of Being Underlevered or Overlevered

Our analysis allows us to answer the question: how costly is it for firms to be out of equilibrium? The cost of being 'overlevered' can provide insights on the potential cost of financial distress, while the cost of being 'underlevered' can shed light on the cost of financial constraints or managerial conservation.

Figure 12 illustrates how we estimate the cost of being overlevered. The cost of being overlevered, DW_o, is the loss due to additional costs from having interest over book value (IOB) above the equilibrium. This is because overlevered firms pay higher costs relative to the benefits received. At the other extreme, the cost of being underlevered, DW_u, is the deadweight loss from lower benefits due to having IOB below the equilibrium; the deadweight loss comes from leaving money on the table in the form of unused benefits relative to cost of debt.[18] The cost of being out of equilibrium, DW_t, sums DW_o and DW_u.

[18]Recall that even though the benefit functions are based on *tax* benefits, *non-tax* benefits are also captured

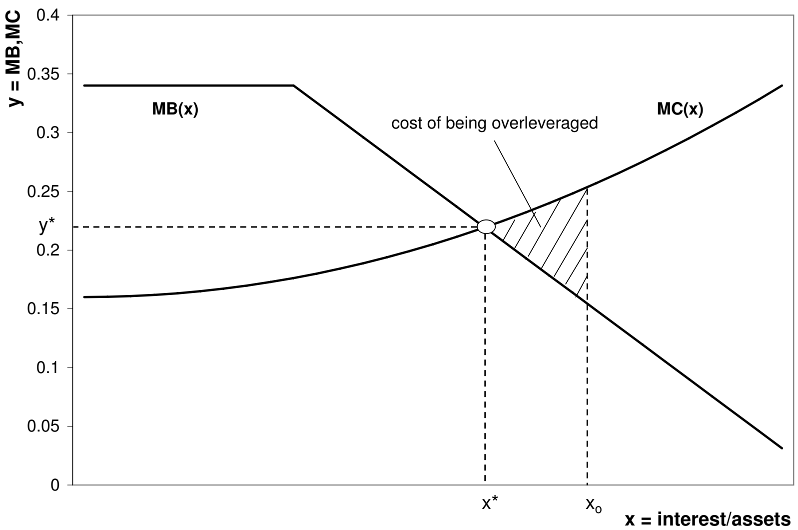

Figure 12: The costs of being overlevered. The figure shows the marginal benefit curve of debt, $MB(x)$, the marginal cost curve of debt, $MC(x)$, and the equilibrium level of debt, x^*, where marginal cost and marginal benefit are equated. The marginal benefit level at x^* (which equals the cost level at x^*) is denoted by y^*. The actual level of debt, denoted by x_o, exceeds the equilibrium level of debt x^*. The shaded area indicates the deadweight loss of being overlevered.

Tables 10 and 11 also report the costs of being "out of equilibrium," the values of the deadweight losses mentioned above. Table 10 shows that on average the cost of being out of equilibrium is 2.85% of book value in perpetuity. However, we see that the costs for overlevered firms (on average, 4.34% of book value in perpetuity) are much higher than those for underlevered firms (on average, 1.17% of book value in perpetuity). This asymmetry suggests that it is more costly for firms to be overlevered than underlevered. At the extreme cases (99th percentile), the cost of being overlevered can be as high as 32.0% of book value in perpetuity, while the cost of being underlevered reaches only to 6.88%.

Table 11 shows that, not surprisingly, the cost of deviating from the optimum increases as the firm is more out of equilibrium. From this table we can see that the cost to being overlevered is about the same as the cost to being underlevered for firms less than 80% out of equilibrium. For firms that are more than 80% out of equilibrium, the costs of being overlevered (6.4% of book value) dominate the cost of being underlevered (2.4% of book value). This pattern is consistent with the financially distressed and financially constrained firms in panels B and C. Finally, for firms with high potential tax benefits of debt in panel D, the asymmetry between overleverage and underleverage seems to disappear.

in our analysis (as negative costs) in the cost function. Therefore, the net costs or benefits of debt measure reflects both tax and non-tax costs and benefits.

Finally, in Table 12 we address the hypothetical question what the costs of being under or overlevered are, if a firm that is currently in equilibrium had X% of what it should, for several values of X. Panel A shows the results for all firms, and panel B for firms with high potential tax benefits of debt. The numbers reveal that the cost of debt is disproportionately higher if a firm were to overlever versus to underlever. A firm with $\frac{1}{5}$ of the equilibrium IOB will only face, on average, a cost of being underlevered of 2.6% of book assets in perpetuity. However, a firm with 5 times the equilibrium IOB will face, on average, a cost of being overlevered equal to 80.5% of book assets. Obviously this asymmetry is partially driven by scale issues and the way we define under and overleverage. However, even at twice the optimal IOB, the cost of being overlevered is 5.8% of book assets.

Panel C and panel D give the results for firms with investment grade status and junk status based on S&P rating, respectively. Investment grade firms face lower costs of being under or overlevered. Not surprisingly, junk firms face higher costs of being overlevered too. Although this result is not surprising, it is reassuring that our marginal cost curve and measures of firm welfare analysis agree with these S&P ratings.

7 Robustness checks

7.1 Alternative financial constraint measures

As discussed previously, our estimation procedure depends on the assumption that unconstrained and non-distressed firms optimize their capital structures. In this section we explore how excluding firms based on a variety of financial constraint or financial distress measures affects our results. Previously, we used long-term debt issuance or reduction as a measure of financial constraint. As additional robustness checks, we also identify unconstrained firms based on (i) the financial constraints measure of Kaplan and Zingales (1997) as estimated by Lamont, Polk, and Saá-Requejo (2001), hereafter referred to as KZ, (ii) the Cleary (1999) index, hereafter called CL, and (iii) the Whited and Wu (2005) index, hereafter called WW. We also tighten our definition of being financially unconstrained to include only firms that have made long term debt or equity adjustments in the top quartile (as opposed to above the median).

Kaplan and Zingales (1997) categorize the 49 low dividend paying firms of Fazzari, Hubbard, and Petersen (1988) into five degrees of financial constraint and estimate an ordered logit model to obtain the probability of a firm falling into any one of the five financial constraint categories, with financial slack being the lowest state and financial constraint the highest state. Lamont, Polk, and Saá-Requejo (2001) report the coefficients for the KZ index that uses only variables available on COMPUSTAT. We use these coefficients to construct our KZ index. Following the approach of Kaplan and Zingales (1997), Cleary (1999) calculates a more 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 obtain a measure for financial constraint. We reproduce this procedure over Cleary's (1999) sample period of 1987 to 1994 to obtain the coefficients for our CL index. Finally, in a recent paper, Whited and Wu (2005) argue that the KZ measure is inconsistent with the intuitive behavior of financially constrained firms. They 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 highly constrained firm is a slow growing firm in a fast growing industry. A fully unconstrained firm is a fast growing firm in a slow growing industry.

The formula for the KZ index is given by

$$KZ_{i,t} = -1.002CF_{i,t} + 3.139LTD_{i,t} - 39.367TDIV_{i,t} - 1.314CASH_{i,t} + 0.282Q_{i,t}, \quad (15)$$

the CL index is given by

$$\begin{aligned} CL_{i,t} = \; & 0.176CUR_{i,t-1} - 0.0003FC_{i,t-1} + 0.008SL_{i,t-1} - 2.802NI_{i,t-1} \\ & +0.018SG_{i,t-1} + 4.372DEBT_{i,t-1}, \end{aligned} \quad (16)$$

and the WW index is given by

$$\begin{aligned} WW_{i,t} = \; & -0.091CF_{i,t} - 0.062DDIV_{i,t} + 0.021LTD_{i,t} - 0.044LTA_{i,t} \\ & +0.102ISG_{i,t} - 0.035SG_{i,t}, \end{aligned} \quad (17)$$

where CF is cash flows, LTD is long-term debt, TDIV is total dividends over assets, Q is Tobin's Q, DDIV is an indicator for a dividend paying firm, ISG is industry sales growth, SG is the firm's sales growth, CUR is the firm's current ratio, FC is the fixed charge coverage, NI is the firm's net income margin, DEBT is the firm's debt ratio, and SL is the ratio of slack over net fixed assets.

Thus, in addition to our Sample A and Sample B, defined in Section 3, we also perform our analysis using the following samples:

C : KZ below median and ZSCORE above median,

D : CL below median and ZSCORE above median,

E : WW below median and ZSCORE above median, and

F : LTDEIR above 3rd quartile and ZSCORE above median.

The estimation results are presented in Table 13. The slopes range from 3.212 to 4.955 and the intercepts range from 0.172 to 0.247 for the varying slope and fixed intercept analysis. These are very similar to the results we obtain in Table 4. Furthermore the qualitative and quantitative results on LTA, DDIV, CF, and CASH match fairly well. However Sample C, which uses the KZ index, estimates a positive effect of PPE and BTM on the marginal cost of debt opposite from our main results. Samples C and D, which use the CL and WW indices respectively, find negative effects of PPE on the cost of debt, as we find in our main analysis, and no effect of BTM on the marginal cost. Overall, especially based on the CL and WW indices, these robustness checks produce results that are largely consistent with those produced by the definition of financial constraint that we use in our main analysis (LTDEIR).

8 Conclusion

We use panel data from 1980 to 2006 to estimate cost curves for corporate debt. We simulate debt tax benefit curves and assume that for financially unconstrained and non-distressed firms, the benefit curve intersects the cost curve at the actual level of debt, on average. Using this equilibrium condition, exogenous shifts to the benefit curves enable us to identify the marginal cost function. We recover marginal cost curves that are steeply positively sloped. Both the slope and the intercept of these curves depend on firm characteristics such as size, collateral, book-to-market, cash flows, cash holdings, and whether the firm pays dividends. Our findings are robust to several different identification strategies, Our results are also robust when accounting for fixed adjustment costs of debt. As such, our framework provides a new parsimonious environment to estimate and evaluate competing capital structure theories. We also provide firm-specific recommendations of optimal debt policy against which firms' actual debt choices can be benchmarked and quantify the welfare costs to the firm from being away from the model-recommended optimal capital structure. Finally, our estimates indicate that the perpetual net benefits of debt are about 4% of asset value.

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Appendix A: Identification

In this appendix we discuss our estimation procedure in a stylized example where both the marginal cost and the marginal benefit curves are linear. We address specifically where and how our approach differs from the standard instrumental variables approach. We then explain why the area under the marginal benefit curve is a reasonable instrument for the location of the curve.

A stylized model

Suppose that the marginal cost and the marginal benefit curves are both linear functions of the interest-over-book (IOB) value x_t:

$$\begin{aligned} MC_t(x_t) &= bx_t + \xi_t \\ MB_t(x_t) &= dx_t + \eta_t, \end{aligned}$$

where $b > 0$ and $d < 0$. We omit intercepts for ease of exposition. In this specification, ξ_t represents parallel shifts of the marginal cost curve and η_t represents parallel shifts of the marginal benefit curve. Further, we allow for a correlation between ξ_t and η_t so, potentially:

$$cov(\xi_t, \eta_t) \neq 0$$

In equilibrium (the optimum) it holds that:

$$y_t^* = MC_t(x_t^*) = MB_t(x_t^*).$$

Substituting we find:

$$\begin{aligned} bx_t + \xi_t &= dx_t + \eta_t \\ x_t^* &= \frac{\eta_t - \xi_t}{b-d} \\ y_t^* &= b\left(\frac{\eta_t - \xi_t}{b-d}\right) + \xi_t = d\left(\frac{\eta_t - \xi_t}{b-d}\right) + \eta_t, \end{aligned}$$

which indicates that if $\xi_t > 0$ (i.e., a parallel upward shift of the marginal cost curve), optimal leverage decreases, and if $\eta_t > 0$, (i.e., a parallel upward shift of the marginal benefit curve), leverage increases. Now suppose that we perform a simple OLS regression of y_t^* on x_t^*. The resulting coefficient is given by:

$$\beta = \frac{cov(y_t^*, x_t^*)}{var(x_t^*)} = b + \frac{(b-d)\left[cov(\xi_t, \eta_t) - var(\xi_t)\right]}{var(\eta_t - \xi_t)}$$

Note that when $var(\eta_t) = 0$, meaning that the marginal benefit curve does not shift, this expression simplifies to:

$$\beta = d$$

In other words, estimating this equation with the marginal benefit function is fixed, so all variation comes from the marginal cost curve, produces results that map out the marginal benefit curve. On the other hand, to identify the cost curve, when $var(\xi_t) = 0$, the marginal cost curve does not shift and the expression simplifies to:

$$\beta = b$$

When both variances are greater than zero, the OLS approach does not estimate either of the curves properly and we end up with an estimate somewhere in between b and d. To properly estimate the marginal cost curve we therefore need an instrument. Let us call this instrument z_t. This instrument needs to 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:

$$\begin{aligned} cov(z_t, \eta_t) &\neq 0 \\ cov(z_t, \xi_t) &= 0 \end{aligned}$$

Now suppose that we have the luxury of observing the whole marginal benefit curve. This corresponds to observing the coefficient b and, more importantly, η_t. Graphically, we can measure η_t by employing the vertical distance between the marginal benefit curves at any point x_t along the x-axis. Recall that all marginal benefit curves are parallel in this appendix, so it does not matter at which x_t we measure the distance. In this case, meeting the first requirement is straightforward. We simply pick:

$$z_t = \eta_t$$

This will ensure that in fact:

$$corr(z_t, \eta_t) = corr(\eta_t, \eta_t) = 1$$

However, this instrument does not necessarily satisfy the second requirement, because shifts in the marginal benefit curve and the marginal cost curve may be correlated:

$$cov(\xi_t, \eta_t) \neq 0.$$

We resolve this by projecting η_t on a set of control variables C:

$$\eta_t = \sum_{c=1}^{C} \beta_c c_t + \varepsilon_t. \tag{18}$$

In this case, ε_t will have zero (or very little) correlation with ξ_t as long as the control variables accurately capture the shifts of the marginal cost curve. All that remains in ε_t are pure shifts in benefits that are uncorrelated with cost effects. We can then use ε_t as the identifying instrument to recover the marginal cost curve of debt.

Now suppose that we observe the marginal benefit curves over a domain $\left[0, \bar{X}\right]$, then another way to measure the shifts of the curve is simply to compute the area under each of the curves. This area measure can be written as:

$$A_t = \bar{A} + \bar{X}\eta_t$$

for some constant $\bar{A}$. Note that the area is a linear function of η_t and therefore using the area measure on the left-hand side of equation 18 is equivalent to using η_t.

If the two measures η_t and A_t are equivalent, then why do we bother using the area measure A_t? When the marginal benefit curve is not linear and the shifts of the curve are not parallel, then we can no longer measure the shifts of the curves by simply looking at the shifts of the intercepts, because the shifts of the curve may be different at each value of x_t along the x-axis. For example, let us go back to Figure 2. The shapes of the marginal benefit curves are not only non-linear but not analytically tractable. If we just rely on the intercepts to describe the marginal benefit curves, then $MB_1(x)$ and $MB_2(x)$ would be summarized as the same curve, which they obviously are not. The intercept shift at the first initial values of x are not equal to the intercept shift at later values of x. The area measure provides an attractive alternative because it equally weighs the shift of the marginal benefit curve at each value of x_t. Using the area measure, we get $A_1 \geq A_2$, correctly recognizing that $MB_1(x) \supseteq MB_2(x)$.

Table B presents the OLS results from directly estimating equations 9 and 5. As the results indicate, the estimated slopes are neither positive nor significant, implying the OLS is effectively estimating a line that lies somewhere between the marginal benefit and marginal cost curves.

Table B: OLS coefficient estimates of equations 9 and 5 without using any identifying instruments.

	Varying Slope, Fixed Intercept		Fixed Slope, Varying Intercept	
	Sample A	Sample B	Sample A	Sample B
Constant	0.273 ***	0.332 ***	0.277 ***	0.291 ***
	(0.009)	(0.008)	(0.008)	(0.008)
IOB	-0.056	-0.929 ***	-0.425 ***	-0.073
	(0.070)	(0.093)	(0.094)	(0.112)
LTA*IOB	0.296 ***	0.299 ***		
	(0.059)	(0.065)		
PPE*IOB	-0.279 ***	-0.187 ***		
	(0.024)	(0.051)		
BTM*IOB	-0.100 **	0.053		
	(0.042)	(0.064)		
DDIV*IOB	0.991 ***	0.588 ***		
	(0.060)	(0.067)		
CF*IOB	1.404 ***	1.940 ***		
	(0.084)	(0.131)		
CASH*IOB	0.008	0.219 ***		
	(0.059)	(0.073)		
LTA			0.012 ***	0.009 ***
			(0.003)	(0.003)
PPE			-0.014 ***	-0.006 ***
			(0.001)	(0.002)
BTM			-0.001	0.001
			(0.002)	(0.004)
DDIV			0.035 ***	0.022 ***
			(0.003)	(0.003)
CF			0.076 ***	0.074 ***
			(0.004)	(0.006)
CASH			0.002	0.006 ***
			(0.002)	(0.002)
No. Obs.	79570	28737	79570	28737
R^2	0.2630	0.1900	0.4034	0.1901

Appendix B: 2SLS Estimation

To provide intuition, we discuss the 2SLS equivalent of our GMM estimation procedure as applied in equations 5 and 6. As explained earlier, first we purge $A_{i,t}$ of possible cost effects, by performing the following regression:

$$A_{i,t} = \beta_0 + \sum_{c \in C} \beta_c c_{i,t} + \varepsilon_{i,t}. \tag{19}$$

By construction, the error term $\varepsilon_{i,t}$ of this regression is orthogonal to the regressors (i.e., the control variables). To the extent that the regressors span the information set that describes the location of the marginal *cost* curve of debt, the error term $\varepsilon_{i,t}$ can be interpreted as the exogenous variation of the marginal *benefit* curve of debt that is not correlated with shifts of the MC curve. We use this variation as the instrumental variable to identify the marginal cost curve of debt. It is important to note that this variation of the marginal benefit curve includes the tax regime shifts described in the text, and also includes other marginal benefit shifters both in the time series and in the cross-section. That is, the exogenous variation (both time series and cross-sectional) in the benefit curve is large and not limited to tax regime shifts. The disadvantage is that when purging the cost effects, we may not have controlled for all possible cost variables. As in all model specifications, this could possibly lead to an omitted variable bias. To ensure that our results are not driven by such econometric issues, in the main text we also perform our analysis using the tax regime shifts as the instrument. We show that this leads to highly similar results.

This error term, $\varepsilon_{i,t}$, which captures pure benefit shifts, is then the main identifying instrument used by the 2SLS approach. The first stage of the 2SLS analysis involves projecting firms' equilibrium debt levels $x^*_{i,t}$ onto a constant, $\varepsilon_{i,t}$, and the control variables in C:

$$x^*_{i,t} = \beta_0 + \beta_\varepsilon \varepsilon_{i,t} + \sum_{c \in C} \beta_c c_{i,t} + \eta_{i,t}, \tag{20}$$

where $\eta_{i,t}$ is the error term of the first-stage regression.[19] The fitted values of this regression, denoted by $\hat{x}^*_{i,t}$, represents the variation in the equilibrium debt level due to exogenous shifts of the marginal benefit curve, while holding the marginal cost curve fixed. In the second stage, the 2SLS approach would regress $y^*_{i,t}$ on a constant, $\hat{x}^*_{i,t}$, and the control variables in C to obtain the slope and the intercept of the marginal cost curve.

$$y^*_{i,t} = a + b\hat{x}^*_{i,t} + \sum_{c \in C} \delta_c c_{i,t} + \xi_{i,t}, \tag{21}$$

where $\xi_{i,t}$ is the error term of the second-stage regression, which is uncorrelated with $\hat{x}_{i,t}$ by construction. Including the control variables in both stages of the analysis serves two purposes. First, as mentioned in the previous paragraph, it allows us to control for shifts in the location of the marginal cost curve. Second, it allows us to separately examine

[19]Given the presence of the control variables in the first stage, $\varepsilon_{i,t}$ can be replaced in equation 20 by $A_{i,t}$. We have presented equation 19 merely to convey the intuition that $\varepsilon_{i,t}$ captures the exogenous variation of the marginal benefit curve, as this residual is by construction orthogonal to the cost control variables.

the contribution of each control variable to the estimated functional form of the marginal cost curve. Note, however, that the standard errors taken straight from the second stage regression would not be correct since they would represent the standard errors of $\hat{x}_{i,t}$ instead of $x_{i,t}$. Therefore, rather than use 2SLS, we estimate our model using GMM to obtain correct, double-clustered standard errors (Thompson (2006) and Petersen (2007)).

Appendix C

Corporate tax rates over the period 1980 to 2006. Both the corporate tax rates as well as their corresponding income tax brackets change during this period. To resolve this issue, eleven non-overlapping income tax brackets are created for all years.[20]

Year	Income Tax Bracket in Thousands $$										
	0 to 25	25 to 50	50 to 75	75 to 100	100 to 335	335 to 1000	1000 to 1405	1405 to 10000	10000 to 15000	15000 to 18333	18333+
1980	0.170	0.200	0.300	0.400	0.460	0.460	0.510	0.460	0.460	0.460	0.460
1981	0.170	0.200	0.300	0.400	0.460	0.460	0.510	0.460	0.460	0.460	0.460
1982	0.160	0.190	0.300	0.400	0.460	0.460	0.510	0.460	0.460	0.460	0.460
1983	0.150	0.180	0.300	0.400	0.460	0.460	0.510	0.460	0.460	0.460	0.460
1984	0.150	0.180	0.300	0.400	0.460	0.460	0.510	0.460	0.460	0.460	0.460
1985	0.150	0.180	0.300	0.400	0.460	0.460	0.510	0.460	0.460	0.460	0.460
1986	0.150	0.180	0.300	0.400	0.460	0.460	0.510	0.460	0.460	0.460	0.460
1987	0.150	0.165	0.275	0.370	0.425	0.400	0.425	0.400	0.400	0.400	0.400
1988	0.150	0.150	0.250	0.340	0.390	0.340	0.340	0.340	0.340	0.340	0.340
1989	0.150	0.150	0.250	0.340	0.390	0.340	0.340	0.340	0.340	0.340	0.340
1990	0.150	0.150	0.250	0.340	0.390	0.340	0.340	0.340	0.340	0.340	0.340
1991	0.150	0.150	0.250	0.340	0.390	0.340	0.340	0.340	0.340	0.340	0.340
1992	0.150	0.150	0.250	0.340	0.390	0.340	0.340	0.340	0.340	0.340	0.340
1993	0.150	0.150	0.250	0.340	0.390	0.340	0.340	0.340	0.350	0.380	0.350
1994	0.150	0.150	0.250	0.340	0.390	0.340	0.340	0.340	0.350	0.380	0.350
1995	0.150	0.150	0.250	0.340	0.390	0.340	0.340	0.340	0.350	0.380	0.350
1996	0.150	0.150	0.250	0.340	0.390	0.340	0.340	0.340	0.350	0.380	0.350
1997	0.150	0.150	0.250	0.340	0.390	0.340	0.340	0.340	0.350	0.380	0.350
1998	0.150	0.150	0.250	0.340	0.390	0.340	0.340	0.340	0.350	0.380	0.350
1999	0.150	0.150	0.250	0.340	0.390	0.340	0.340	0.340	0.350	0.380	0.350
2000	0.150	0.150	0.250	0.340	0.390	0.340	0.340	0.340	0.350	0.380	0.350
2001	0.150	0.150	0.250	0.340	0.390	0.340	0.340	0.340	0.350	0.380	0.350
2002	0.150	0.150	0.250	0.340	0.390	0.340	0.340	0.340	0.350	0.380	0.350
2003	0.150	0.150	0.250	0.340	0.390	0.340	0.340	0.340	0.350	0.380	0.350
2004	0.150	0.150	0.250	0.340	0.390	0.340	0.340	0.340	0.350	0.380	0.350
2005	0.150	0.150	0.250	0.340	0.390	0.340	0.340	0.340	0.350	0.380	0.350
2006	0.150	0.150	0.250	0.340	0.390	0.340	0.340	0.340	0.350	0.380	0.350

[20] This table lists the general tax rates for each year. This does not account for the 1987-1988 phasing-in effect of the TRA 1986 for firms with differing fiscal year-ends. We use the actual fiscal year-end adjusted rates for firms in 1987 and 1988.

Appendix D

Detailed description on the construction of the control variables used in the analysis and variables included in the summary statistics reported in Table 2. Numbers in parentheses indicate the corresponding COMPUSTAT annual industrial data items.

$$\text{LTA} = \log(\text{Total Assets (6)})$$

$$\text{PPE} = \frac{\text{Net Plants, Property, and Equipment (8)}}{\text{Total Book Assets (6)}}$$

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

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

$$\text{CF} = \frac{\text{EBIT (18) + Depreciation (14)}}{\text{Total Book Assets (6)}}$$

$$\text{CASH} = \frac{\text{Cash and Short Term Investments (1)}}{\text{Total Book Assets (6)}}$$

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

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

$$\text{TLC} = \frac{\text{Net Carryloss Forward (52)}}{\text{Net Sales (12)}}$$

$$\text{DDIV} = \begin{cases} 1 & \text{if S\&P Historical Long-Term Debt Ratings (180) is not missing} \\ 0 & \text{if S\&P Historical Long-Term Debt Ratings (180) is missing (21)} = 0 \end{cases}$$

$$\text{PTP} = \tau_p - (1 - \tau_c)\tau_e \quad \text{for } \tau_c = \text{observed marginal tax rate} \quad \text{and } \tau_e = [d + (1 - d)g\alpha]\tau_p$$

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.

Appendix E

Firms are classified by their two-digit SIC codes into industries. The following table describes the industries and the corresponding two-digit SIC codes we use in our analysis.

Agriculture, Forestry, and Fishing	01-09
Mining	10-14
Construction	15-17
Manufacturing	20-39
Transportation	40-47
Communication	48
Utilities	49
Wholesale Trade	50-51
Retail Trade	52-59
Finance, Insurance, and Real Estate	60-67
Services	70-89
Public Administration	91-99

Table 1: Sample construction. y^* is the 'equilibrium' marginal benefit level, x^* is the observed or 'equilibrium' interest payments over book value (IOB), A is the area under the marginal benefit curve, and C is the set of control (cost) variables. $C \equiv \{LTA, PPE, BTM, DDIV, CF, CASH\}$. ZSCORE is a measure of financial distress. LTDEIR is the long term debt and/or equity issuance or repurchase used to measure for financial constraint. KZ, CL, and WW are financial constraint measures as defined by Kaplan and Zingales (1997), Cleary (1999), and Whited and Wu (2005) indices respectively.

Sample		No. Obs
All firm-year obs. with marginal benefit (MB) curves and COMPUSTAT data in 1980-2006		124,189
Non-M&A firm-years with positive book value, common equity, capital, and sales		110,033
Sample with non-missing $(y^*_{i,t}, x^*_{i,t}, A_{i,t}, C_{i,t})$ variables:	Sample A	91,313
Sample of financially unconstrained and non-distressed firm-years: LTDEIR above median and ZSCORE above median	Sample B	29,268
For robustness checks:		
Sample of financially unconstrained and non-distressed firm-years: KZ below median and ZSCORE above median	Sample C	23,436
Sample of financially unconstrained and non-distressed firms-years: CL below median and ZSCORE above median	Sample D	20,783
Sample of financially unconstrained and non-distressed firms-years: WW below median and ZSCORE above median	Sample E	21,116
Sample of financially unconstrained and non-distressed firms-years: LTDEIR above third quartile and ZSCORE above median	Sample F	15,123

Table 2: Summary statistics for the samples used in the analysis. LTA is log of total assets expressed in 2000 dollars, PPE is property, plant, and equipment over total book values, BTM is book equity to market equity, DDIV is an indicator for dividend paying firms, CF is net cashflow over total book values, and CASH is cash holdings over total book values. HCR is the historical credit rankings based on the S&P long term domestic issuer credit ratings. ZSCORE is a measure of financial distress. KZ, CL, and WW are financial constraint measures as defined by the Kaplan and Zingales (1997), Cleary (1999), and Whited and Wu (2005) indices, respectively. TLC is total tax loss carryforwards normalized by total sales. PTP is the personal tax penalty on interest as measured in Graham (1999).

Sample A: All Firms					
	No. Obs	Mean	Std. Dev	Min	Max
Area Under Curve	91313	0.032	0.027	0.000	0.137
Interest Over Book Value	91313	0.031	0.024	0.000	0.132
LTA	91313	5.130	2.256	-5.745	13.771
PPE	91313	0.321	0.247	0.000	1.000
BTM	91313	0.778	0.638	0.035	4.644
DDIV	91313	0.413	0.492	0	1
CF	91313	0.086	0.150	-0.814	0.398
CASH	91313	0.140	0.183	-0.200	1.000
HCR	17036	4.075	1.291	1	10
ZSCORE	82635	1.537	2.042	-13.506	5.586
KZ	59288	0.309	1.326	-1.503	15.192
CL	73166	-3.714	10.544	-114.273	5.233
WW	70521	-0.226	0.122	-0.517	0.121
TLC	66080	2.922	104.133	0.000	15571.430
PTP	77591	0.243	0.092	-0.192	0.452
Sample B: Financially Unconstrained and Non-distressed Firms LTDEIR above median and ZSCORE above median					
	No. Obs	Mean	Std. Dev	Min	Max
Area Under Curve	29268	0.042	0.027	0.000	0.137
Interest Over Book Value	29268	0.029	0.022	0.000	0.132
LTA	29268	5.318	1.889	0.096	12.211
PPE	29268	0.282	0.175	0.000	0.953
BTM	29268	0.692	0.550	0.035	4.598
DDIV	29268	0.475	0.499	0	1
CF	29268	0.160	0.081	-0.568	0.398
CASH	29268	0.128	0.153	-0.002	0.993
HCR	5031	3.823	1.240	1	10
ZSCORE	29268	2.790	0.753	1.790	5.586
KZ	21988	-0.071	0.701	-1.502	11.924
CL	24809	-3.595	8.453	-113.833	4.082
WW	25559	-0.243	0.107	-0.517	0.121
TLC	23830	0.024	0.355	0.000	50.598
PTP	25641	0.251	0.089	-0.186	0.452

Table 3: Marginal cost of debt using all firms in Sample A except those in utilities, finance, and public administration. We present GMM estimates of the coefficients in equations 9 and 5. The error functions are defined according to equations 10 and 6 where $y^*_{i,t}$ is the observed marginal benefit/cost level, $x^*_{i,t}$ is the observed interest expenses over book value (IOB) and C is the set of cost control variables. GMM moments are obtained by interacting the error function with the following instruments: the constant term, each of the control variables, and an additional identifying instrument. We consider five different specifications for this additional instrument, denoted by (i)-(vi): (i) the area under the marginal benefit curve $A_{i,t}$, (ii) the corporate tax rates from eleven tax brackets across time, (iii) the IOB associated with the 'kink' of the marginal benefit curve, $x^K_{i,t}$ in addition to $A_{i,t}$, (iv)-(vi) (i)-(iii) with firm fixed effects. The set of control variables is $C \equiv \{LTA, PPE, BTM, DDIV, CF, CASH\}$, where LTA is log of total assets expressed in 2000 dollars, PPE is plant, property, and equipment over total book values, BTM is book equity to market equity, DDIV is an indicator for dividend paying firms, CF is net cashflow over total book values, and CASH is cash holdings over total book values. The control variables are standardized to have mean zero and standard deviation one based on Sample A (and are not re-standardized across samples). Robust, clustered standard errors are reported in the parentheses. Standard errors are clustered by both firm and year as in Thompson (2006) and Petersen (2007). Significance at the 10% level is indicated by *, 5% level by **, and 1% level by ***.

	(9) $MC_{i,t} = a + bx_{i,t} + \sum_{c \in C} \theta_c c_{i,t} x_{i,t} + \xi_{i,t}$ (slope varies)						(5) $MC_{i,t} = a + bx_{i,t} + \sum_{c \in C} \delta_c c_{i,t} + \xi_{i,t}$ (intercept varies)					
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Constant	0.013	0.087 ***	0.049 ***	-0.217 ***	0.093 **	-0.188 ***	-0.002	0.045 **	0.009	-0.296 ***	0.012	-0.283 ***
	(0.011)	(0.020)	(0.009)	(0.043)	(0.039)	(0.039)	(0.014)	(0.019)	(0.013)	(0.050)	(0.048)	(0.047)
IOB	9.036 ***	6.556 ***	7.782 ***	16.405 ***	6.180 ***	15.528 ***	8.423 ***	6.798 ***	8.116 ***	17.684 ***	7.813 ***	17.360 ***
	(0.396)	(0.895)	(0.322)	(1.442)	(1.462)	(1.298)	(0.460)	(0.703)	(0.411)	(1.587)	(1.605)	(1.508)
LTA*IOB	0.705 ***	0.421 ***	0.663 ***	0.816 *	1.106 ***	0.540						
	(0.100)	(0.096)	(0.094)	(0.489)	(0.301)	(0.458)						
PPE*IOB	-0.808 ***	-0.756 ***	-0.737 ***	-0.474 **	-0.165	-0.421 *						
	(0.069)	(0.072)	(0.062)	(0.234)	(0.136)	(0.222)						
BTM*IOB	-0.355 ***	-0.291 ***	-0.293 ***	-0.452 ***	-0.381 ***	-0.407 ***						
	(0.056)	(0.043)	(0.046)	(0.114)	(0.060)	(0.107)						
DDIV*IOB	1.599 ***	1.946 ***	1.492 ***	1.287 ***	1.453 ***	1.255 ***						
	(0.097)	(0.127)	(0.083)	(0.183)	(0.133)	(0.172)						
CF*IOB	2.315 ***	3.024 ***	2.328 ***	2.399 ***	2.370 ***	2.343 ***						
	(0.139)	(0.141)	(0.128)	(0.166)	(0.197)	(0.159)						
CASH*IOB	2.738 ***	2.652 ***	2.252 ***	2.996 ***	2.165 ***	2.847 ***						
	(0.240)	(0.459)	(0.194)	(0.302)	(0.441)	(0.270)						
LTA							0.017 ***	0.019 ***	0.016 ***	0.081 ***	0.043 ***	0.076 ***
							(0.003)	(0.003)	(0.003)	(0.013)	(0.008)	(0.013)
PPE							-0.024 ***	-0.022 ***	-0.024 ***	-0.050 ***	-0.019 ***	-0.049 ***
							(0.003)	(0.003)	(0.003)	(0.008)	(0.007)	(0.008)
BTM							-0.012 ***	-0.008 ***	-0.012 ***	-0.023 ***	-0.013 ***	-0.023 ***
							(0.002)	(0.002)	(0.002)	(0.004)	(0.002)	(0.004)
DDIV							0.069 ***	0.064 ***	0.068 ***	0.075 ***	0.050 ***	0.074 ***
							(0.004)	(0.005)	(0.004)	(0.007)	(0.006)	(0.007)
CF							0.096 ***	0.093 ***	0.095 ***	0.106 ***	0.085 ***	0.104 ***
							(0.005)	(0.005)	(0.005)	(0.009)	(0.008)	(0.009)
CASH							0.083 ***	0.069 ***	0.080 ***	0.117 ***	0.060 ***	0.115 ***
							(0.008)	(0.008)	(0.007)	(0.013)	(0.010)	(0.012)
No. Obs.	78949	71678	78516	78949	71678	78516	78949	71678	78516	78949	71678	78516
Fixed Effects?	N	N	N	Y	Y	Y	N	N	N	Y	Y	Y

Table 4: Marginal cost of debt using all firms in Sample B except those in utilities, finance, and public administration. We present GMM estimates of the coefficients in equations 9 and 5. The error functions are defined according to equations 10 and 6 where $y^*_{i,t}$ is the observed marginal benefit/cost level, $x^*_{i,t}$ is the observed interest expenses over book value (IOB) and C is the set of cost control variables. GMM moments are obtained by interacting the error function with the following instruments: the constant term, each of the control variables, and an additional identifying instrument. We consider five different specifications for this additional instrument, denoted by (i)-(vi): (i) the area under the marginal benefit curve $A_{i,t}$, (ii) the corporate tax rates from eleven tax brackets across time, (iii) the IOB associated with the 'kink' of the marginal benefit curve, $x^K_{i,t}$ in addition to $A_{i,t}$, (iv)-(vi) (i)-(iii) with firm fixed effects. The set of control variables is $C \equiv \{LTA, PPE, BTM, DDIV, CF, CASH\}$, where LTA is log of total assets expressed in 2000 dollars, PPE is plant, property, and equipment over total book values, BTM is book equity to market equity, DDIV is an indicator for dividend paying firms, CF is net cashflow over total book values, and CASH is cash holdings over total book values. The control variables are standardized to have mean zero and standard deviation one based on Sample A (and are not re-standardized across samples). Robust, clustered standard errors are reported in the parentheses. Standard errors are clustered by both firm and year as in Thompson (2006) and Petersen (2007). Significance at the 10% level is indicated by *, 5% level by **, and 1% level by ***.

	(9) $MC_{i,t} = a + bx_{i,t} + \sum_{c \in C} \theta_c c_{i,t} x_{i,t} + \xi_{i,t}$ (slope varies)						(5) $MC_{i,t} = a + bx_{i,t} + \sum_{c \in C} \delta_c c_{i,t} + \xi_{i,t}$ (intercept varies)					
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Constant	0.170 ***	0.147 ***	0.188 ***	-0.026	0.160 ***	-0.010	0.102 ***	0.057 ***	0.107 ***	-0.137 ***	0.032	-0.124 ***
	(0.012)	(0.016)	(0.010)	(0.034)	(0.029)	(0.032)	(0.015)	(0.020)	(0.014)	(0.039)	(0.035)	(0.037)
IOB	5.124 ***	5.571 ***	4.484 ***	12.099 ***	4.576 ***	11.608 ***	5.873 ***	7.208 ***	5.712 ***	13.042 ***	7.714 ***	12.700 ***
	(0.494)	(0.718)	(0.436)	(1.204)	(1.086)	(1.147)	(0.535)	(0.714)	(0.490)	(1.209)	(1.115)	(1.152)
LTA*IOB	0.511 ***	0.797 ***	0.443 ***	0.218	1.951 ***	0.025						
	(0.091)	(0.110)	(0.080)	(0.469)	(0.364)	(0.458)						
PPE*IOB	-0.496 ***	-0.799 ***	-0.424 ***	-0.514	-0.183	-0.506						
	(0.091)	(0.120)	(0.083)	(0.316)	(0.196)	(0.313)						
BTM*IOB	-0.289 ***	-0.315 ***	-0.273 ***	-0.492 ***	-0.296 ***	-0.493 ***						
	(0.075)	(0.077)	(0.072)	(0.145)	(0.082)	(0.140)						
DDIV*IOB	0.894 ***	1.165 ***	0.862 ***	1.031 ***	1.100 ***	1.011 ***						
	(0.080)	(0.100)	(0.071)	(0.177)	(0.104)	(0.172)						
CF*IOB	1.616 ***	3.217 ***	1.556 ***	1.394 ***	3.321 ***	1.244 ***						
	(0.193)	(0.195)	(0.165)	(0.245)	(0.183)	(0.222)						
CASH*IOB	1.867 ***	3.617 ***	1.579 ***	2.487 ***	2.291 ***	2.230 ***						
	(0.224)	(0.367)	(0.193)	(0.295)	(0.385)	(0.277)						
LTA							0.019 ***	0.024 ***	0.019 ***	0.109 ***	0.066 ***	0.104 ***
							(0.002)	(0.003)	(0.002)	(0.014)	(0.014)	(0.013)
PPE							-0.019 ***	-0.023 ***	-0.019 ***	-0.017 *	-0.007	-0.016 *
							(0.003)	(0.004)	(0.003)	(0.010)	(0.007)	(0.009)
BTM							-0.020 ***	-0.024 ***	-0.019 ***	-0.037 ***	-0.022 ***	-0.036 ***
							(0.003)	(0.004)	(0.003)	(0.005)	(0.004)	(0.005)
DDIV							0.038 ***	0.043 ***	0.037 ***	0.047 ***	0.038 ***	0.046 ***
							(0.004)	(0.004)	(0.003)	(0.005)	(0.004)	(0.005)
CF							0.092 ***	0.092 ***	0.092 ***	0.113 ***	0.101 ***	0.112 ***
							(0.007)	(0.007)	(0.007)	(0.009)	(0.007)	(0.009)
CASH							0.059 ***	0.071 ***	0.057 ***	0.084 ***	0.058 ***	0.081 ***
							(0.007)	(0.008)	(0.007)	(0.010)	(0.008)	(0.010)
No. Obs.	28438	26492	28326	28438	26492	28326	28438	26492	28326	28438	26492	28326
Fixed Effects?	N	N	N	Y	Y	Y	N	N	N	Y	Y	Y

Table 5: Marginal cost of debt by industry. GMM estimation of the coefficients in equation 9 (see below) by industry. Industries are defined according to Appendix D. The error function is defined in equation 10 where $y^*_{i,t}$ is the 'equilibrium' marginal benefit/cost level, $x^*_{i,t}$ is the observed or 'equilibrium' interest expenses over book value (IOB) and C is the set of cost control variables. GMM moments are obtained by interacting the error function with the following instruments: the constant term, the variation of the marginal benefit curve $A_{i,t}$, and each of the control variables. The set of control variables is $C \equiv \{LTA, PPE, BTM, DDIV, CF, CASH\}$, where LTA is log of total assets expressed in 2000 dollars, PPE is plant, property, and equipment over total book values, BTM is book equity to market equity, DDIV is an indicator for dividend paying firm, and CF is net cashflow over total book values, CASH is cash holdings over total book values. The control variables are standardized to have mean zero and standard deviation one for each industry. Robust, clustered standard errors are reported in the parentheses. Standard errors are clustered by both firm and year as in Thompson (2006) and Petersen (2007). Significance at the 10% level is indicated by *, 5% level by **, and 1% level by ***.

$$(9)\ MC_{i,t} = a + bx_{i,t} + \sum_{c \in C} \theta_c c_{i,t} x_{i,t} + \xi_{i,t} \text{ (slope varies)}$$

	Constant	IOB	LTA *IOB	PPE *IOB	BTM *IOB	DDIV *IOB	CF *IOB	CASH *IOB	No. Obs
Sample A: All Firms									
All Industries	0.030 ***	8.567 ***	0.693 ***	-0.599 ***	-0.360 ***	1.590 ***	2.123 ***	2.467 ***	91313
	(0.010)	(0.374)	(0.097)	(0.073)	(0.048)	(0.091)	(0.128)	(0.230)	
All Industries Except Utilities, Finance, & Public Admin.	0.013	9.036 ***	0.705 ***	-0.808 ***	-0.355 ***	1.599 ***	2.315 ***	2.738 ***	78949
	(0.011)	(0.396)	(0.100)	(0.069)	(0.056)	(0.097)	(0.139)	(0.240)	
Mining & Construction	-0.010	8.213 ***	0.609	0.098	-0.497 ***	1.320 ***	2.235 ***	1.829 ***	7164
	(0.018)	(0.586)	(0.430)	(0.221)	(0.167)	(0.291)	(0.271)	(0.547)	
Utilities	-0.142 ***	14.719 ***	-0.180	-0.073	-0.363	2.125 ***	1.371 ***	1.936 ***	4382
	(0.046)	(1.388)	(0.220)	(0.275)	(0.234)	(0.309)	(0.257)	(0.403)	
Manufacturing	0.018	11.085 ***	0.469 ***	-0.042	-0.382 ***	1.854 ***	3.332 ***	4.597 ***	44343
	(0.015)	(0.600)	(0.151)	(0.118)	(0.077)	(0.157)	(0.152)	(0.356)	
Wholesale & Retail Trade	-0.074 **	8.660 ***	0.810 ***	-0.873 ***	-0.469 ***	1.185 ***	1.220 ***	0.457	10770
	(0.032)	(0.714)	(0.192)	(0.156)	(0.108)	(0.159)	(0.219)	(0.283)	
Transportation, Warehousing, & Communication	-0.048	8.987 ***	0.496 *	-0.598 **	-0.167	1.849 ***	2.257 ***	0.935 *	4288
	(0.035)	(0.875)	(0.299)	(0.262)	(0.178)	(0.305)	(0.333)	(0.548)	
Finance, Insurance, & Real Estate	0.179 ***	4.080 ***	0.457 **	-0.404 ***	-0.254 ***	0.828 ***	1.023 ***	0.816 ***	7235
	(0.010)	(0.292)	(0.222)	(0.099)	(0.094)	(0.114)	(0.114)	(0.202)	
Services & Leisure	-0.063 ***	10.283 ***	1.197 ***	-1.363 ***	-0.307 ***	0.817 ***	2.033 ***	3.891 ***	11981
	(0.019)	(0.600)	(0.242)	(0.161)	(0.100)	(0.177)	(0.163)	(0.365)	
Sample B: Financially Unconstrained and Non-distressed: LTDEIR above median and ZSCORE above median									
All Industries	0.170 ***	5.159 ***	0.572 ***	-0.504 ***	-0.281 ***	0.913 ***	1.519 ***	1.851 ***	29268
	(0.012)	(0.489)	(0.094)	(0.098)	(0.075)	(0.082)	(0.186)	(0.215)	
All Industries Except Utilities, Finance, & Public Admin.	0.170 ***	5.124 ***	0.511 ***	-0.496 ***	-0.289 ***	0.894 ***	1.616 ***	1.867 ***	28438
	(0.012)	(0.494)	(0.091)	(0.091)	(0.075)	(0.080)	(0.193)	(0.224)	
Mining & Construction	0.145 ***	6.547 ***	0.500	1.018 *	-0.766 **	0.733	1.491 ***	1.528 ***	705
	(0.027)	(0.998)	(0.762)	(0.591)	(0.338)	(0.469)	(0.487)	(0.453)	
Utilities	0.049	11.254 ***	0.208	0.613	-0.432	0.927	0.525	1.819 ***	189
	(0.093)	(2.854)	(0.773)	(0.593)	(0.636)	(0.606)	(0.343)	(0.664)	
Manufacturing	0.174 ***	6.835 ***	0.358 ***	0.193	-0.368 ***	0.908 ***	1.895 ***	3.587 ***	17853
	(0.013)	(0.585)	(0.111)	(0.128)	(0.084)	(0.093)	(0.201)	(0.299)	
Wholesale & Retail Trade	0.004	7.200 ***	0.775 ***	-0.643 ***	-0.681 ***	0.806 ***	0.411	0.305	5477
	(0.037)	(0.855)	(0.193)	(0.172)	(0.151)	(0.151)	(0.281)	(0.236)	
Transportation, Warehousing, & Communication	0.166 ***	3.723 ***	0.948 **	-0.929 **	-0.202	0.469	1.731 ***	0.275	814
	(0.026)	(0.669)	(0.455)	(0.364)	(0.176)	(0.353)	(0.377)	(0.423)	
Finance, Insurance, & Real Estate	0.246 ***	3.392 ***	0.981 **	-0.634 *	0.265	0.738 **	0.613 *	1.039 ***	535
	(0.018)	(0.906)	(0.476)	(0.365)	(0.242)	(0.306)	(0.332)	(0.248)	
Services & Leisure	0.150 ***	5.281 ***	0.948 ***	-0.426 **	-0.161	0.257 *	1.522 ***	2.425 ***	3500
	(0.021)	(0.816)	(0.202)	(0.192)	(0.125)	(0.147)	(0.341)	(0.357)	

Table 6: Marginal cost of debt by whether a firm has an investment grade or junk rating based on the S&P historical long term bond rating. GMM estimation of the coefficients in equation 9 (see below) by industry. The error function is defined in equation 10 where $y^*_{i,t}$ is the 'equilibrium' marginal benefit/cost level, $x^*_{i,t}$ is the observed or 'equilibrium' interest expenses over book value (IOB) and C is the set of cost control variables. GMM moments are obtained by interacting the error function with the following instruments: the constant term, the variation of the marginal benefit curve $A_{i,t}$, and each of the control variables. The set of control variables is $C \equiv \{LTA, PPE, BTM, DDIV, CF, CASH\}$, where LTA is log of total assets expressed in 2000 dollars, PPE is plant, property, and equipment over total book values, BTM is book equity to market equity, DDIV is an indicator for dividend paying firm, and CF is net cashflow over total book values, CASH is cash holdings over total book values. The control variables are standardized to have mean zero and standard deviation one for each rating group. Robust, clustered standard errors are reported in the parentheses. Standard errors are clustered by both firm and year as in Thompson (2006) and Petersen (2007). Significance at the 10% level is indicated by *, 5% level by **, and 1% level by ***.

$$(9)\ MC_{i,t} = a + bx_{i,t} + \sum_{c \in C} \theta_c c_{i,t} x_{i,t} + \xi_{i,t} \text{ (slope varies)}$$

	Constant	IOB	LTA *IOB	PPE *IOB	BTM *IOB	DDIV *IOB	CF *IOB	CASH *IOB	No. Obs
Sample A: All Firms									
Investment Grade	0.158 ***	6.923 ***	0.137	-0.370 ***	-0.249 **	0.206 *	0.252	0.612 ***	10766
	(0.024)	(1.002)	(0.147)	(0.128)	(0.125)	(0.120)	(0.181)	(0.183)	
Junk	-0.373 ***	14.383 ***	1.396 ***	-1.246 ***	-0.459 ***	1.019 ***	0.936 ***	1.771 ***	6270
	(0.063)	(1.352)	(0.343)	(0.230)	(0.161)	(0.216)	(0.242)	(0.403)	
Sample A: All Firms Except Those in Utilities, Finance, and Public Administration									
Investment Grade	0.127 ***	8.161 ***	0.502 ***	-0.413 ***	-0.203	0.207	0.407	0.847 ***	8032
	(0.030)	(1.211)	(0.173)	(0.151)	(0.143)	(0.140)	(0.236)	(0.197)	
Junk	-0.409 ***	14.949 ***	1.405 ***	-1.268 ***	-0.418 ***	0.929 ***	1.002 ***	1.965 ***	5718
	(0.070)	(1.491)	(0.372)	(0.225)	(0.159)	(0.221)	(0.276)	(0.484)	
Sample B: All Firms									
Investment Grade	0.228 ***	4.328 ***	0.010 ***	-0.009 *	-0.002	0.009 **	0.015 ***	0.012 **	3523
	(0.026)	(1.151)	(0.003)	(0.005)	(0.004)	(0.004)	(0.004)	(0.005)	
Junk	-0.043	7.903 ***	0.546	-0.936 ***	-0.566 ***	0.532 ***	0.575 *	1.353 ***	1508
	(0.054)	(1.285)	(0.355)	(0.315)	(0.190)	(0.216)	(0.298)	(0.370)	
Sample B: All Firms Except Those in Utilities, Finance, and Public Administration									
Investment Grade	0.236 ***	4.649 ***	0.404 ***	-0.017	0.095	0.251 *	0.174	0.554 ***	3450
	(0.024)	(1.111)	(0.147)	(0.163)	(0.149)	(0.143)	(0.177)	(0.190)	
Junk	-0.048	7.956 ***	0.512	-0.876 ***	-0.565 ***	0.510 **	0.548 *	1.341 ***	1467
	(0.055)	(1.310)	(0.333)	(0.314)	(0.184)	(0.207)	(0.309)	(0.407)	

Table 7: Alternative control specifications. GMM estimation of the coefficients in equations 9 and 5 for all firms in Sample B except those in utilities, finance, and public administration. The error functions are defined according to equations 10 and 6 where $y^*_{i,t}$ is the 'equilibrium' marginal benefit/cost level, $x^*_{i,t}$ is the observed or 'equilibrium' interest expenses over book value (IOB) and C is the set of cost control variables. GMM moments are obtained by interacting the error function with the following instruments: the constant term, the variation of the marginal benefit curve $A_{i,t}$, and each of the control variables. The set of control variables is $C \equiv \{LTA, PPE, BTM, DDIV, CF, CASH\}$, and one of each alternative control specification: $\{CS, PTP, DCR\}$. LTA is log of total assets expressed in 2000 dollars, PPE is plant, property, and equipment over total book values, BTM is book equity to market equity, DDIV is an indicator for dividend paying firms, CF is net cashflow over total book values, and CASH is cash holdings over total book values. CS is the spread between Moody's Baa rate and Aaa rate, PTP is the personal tax penalty as measured in Graham (1999), and DCR is a dummy for whether the firm has an S&P credit rating. The control variables are standardized to have mean zero and standard deviation one based on Sample A (and are not re-standardized across samples). Robust, firm-clustered GMM standard errors are reported in the parentheses. Significance at the 10% level is indicated by *, 5% level by **, and 1% level by ***.

(9) $MC_{i,t} = a + bx_{i,t} + \sum_{c \in C} \theta_c c_{i,t} x_{i,t} + \xi_{i,t}$ (slope varies)			
	CS	PTP	DCR
Constant	0.194 ***	0.206 ***	0.173 ***
	(0.010)	(0.009)	(0.012)
IOB	4.209 ***	3.705 ***	5.003 ***
	(0.352)	(0.281)	(0.476)
LTA*IOB	0.626 ***	0.768 ***	0.894 ***
	(0.078)	(0.076)	(0.097)
PPE*IOB	-0.479 ***	-0.446 ***	-0.496 ***
	(0.076)	(0.077)	(0.089)
BTM*IOB	-0.435 ***	-0.390 ***	-0.337 ***
	(0.065)	(0.058)	(0.074)
DDIV*IOB	0.650 ***	0.836 ***	0.841 ***
	(0.080)	(0.079)	(0.080)
CF*IOB	1.526 ***	1.430 ***	1.556 ***
	(0.174)	(0.178)	(0.189)
CASH*IOB	1.646 ***	1.499 ***	1.838 ***
	(0.196)	(0.172)	(0.222)
CS*IOB	0.664 ***		
	(0.134)		
PTP*IOB		0.924 ***	
		(0.123)	
DCR*IOB			-0.568 ***
			(0.082)
No. Obs.	28438	24935	28438

(5) $MC_{i,t} = a + bx_{i,t} + \sum_{c \in C} \delta_c c_{i,t} + \xi_{i,t}$ (intercept varies)			
	CS	PTP	DCR
Constant	0.131 ***	0.155 ***	0.102 ***
	(0.015)	(0.011)	(0.014)
IOB	4.943 ***	4.214 ***	5.810 ***
	(0.431)	(0.320)	(0.499)
LTA	0.021 ***	0.025 ***	0.037 ***
	(0.002)	(0.002)	(0.003)
PPE	-0.018 ***	-0.016 ***	-0.019 ***
	(0.003)	(0.003)	(0.003)
BTM	-0.021 ***	-0.021 ***	-0.021 ***
	(0.003)	(0.003)	(0.003)
DDIV	0.032 ***	0.038 ***	0.037 ***
	(0.003)	(0.003)	(0.003)
CF	0.089 ***	0.079 ***	0.090 ***
	(0.006)	(0.006)	(0.007)
CASH	0.051 ***	0.045 ***	0.057 ***
	(0.006)	(0.005)	(0.007)
CS	0.020 ***		
	(0.004)		
PTP		0.035 ***	
		(0.004)	
DCR			-0.024 ***
			(0.002)
No. Obs.	28438	24935	28438

Table 8: Marginal benefit and marginal cost functions of debt for the average (representative) firm in Sample A and Sample B. The marginal cost curve is calculated using equation 11. The marginal benefit curve is calculated by taking the average of the marginal tax rates and interest expenses over book assets at 0%, 20%, 40%, ..., 1000% of observed IOB.

	Sample A			Sample B		
	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	0.2972	0.1699	0.0000	0.3505	0.1699
20% of Obs.	0.0063	0.2917	0.2025	0.0059	0.3472	0.2059
40% of Obs.	0.0125	0.2860	0.2352	0.0118	0.3437	0.2419
60% of Obs.	0.0188	0.2799	0.2678	0.0176	0.3395	0.2779
80% of Obs.	0.0250	0.2733	0.3004	0.0235	0.3350	0.3139
100% of Obs.	0.0313	0.2658	0.3330	0.0294	0.3295	0.3499
120% of Obs.	0.0375	0.2574	0.3656	0.0353	0.3229	0.3859
160% of Obs.	0.0500	0.2408	0.4309	0.0470	0.3090	0.4578
200% of Obs.	0.0626	0.2233	0.4961	0.0588	0.2922	0.5298
300% of Obs.	0.0938	0.1852	0.6592	0.0882	0.2500	0.7097
400% of Obs.	0.1251	0.1531	0.8223	0.1176	0.2101	0.8897
500% of Obs.	0.1564	0.1284	0.9853	0.1470	0.1764	1.0696
600% of Obs.	0.1877	0.1099	1.1484	0.1764	0.1513	1.2496
700% of Obs.	0.2190	0.0959	1.3115	0.2058	0.1314	1.4295
800% of Obs.	0.2502	0.0853	1.4746	0.2351	0.1159	1.6094
900% of Obs.	0.2815	0.0767	1.6377	0.2645	0.1034	1.7894
1000% of Obs.	0.3128	0.0699	1.8007	0.2939	0.0936	1.9693

Table 9: Key financial characteristics of the four firms studied in our case analysis. TA is the total assets expressed in thousands of 2000 dollars, MCAP represents the market capitalization expressed in thousands of 2000 dollars, BTM is the book equity to market equity ratio, PPE stands for plants, property, and equipment over total book assets, DIVIDENDS is the total dividend payout in thousands of dollars over total book assets, SALES is firm sales over total book assets, CASH is cash holdings over total book assets, CF is income over total book value and D/E is the debt to equity ratio.

	Alltel					
	1990		1998		2006	
	Decile	Value	Decile	Value	Decile	Value
TA	10	3458.1	10	9902.8	10	15669.2
MCAP	10	3639.6	10	17332.0	10	19771.1
PPE	9	0.6688	8	0.5150	7	0.2852
BTM	3	0.3640	2	0.1988	7	0.5470
DIVIDENDS	10	0.0389	9	0.0287	9	0.0224
CASH	3	0.5998	4	0.5541	3	0.4298
CF	3	0.0162	2	0.0059	5	0.0509
SALES	9	0.2075	9	0.1985	7	0.1422
D/E	9	0.3450	9	0.3725	6	0.1470
	Black & Decker					
	1990		1998		2006	
	Decile	Value	Decile	Value	Decile	Value
TA	10	7762.1	9	4069.7	8	4482.6
MCAP	9	754.9	10	5436.7	9	4925.2
PPE	3	0.1405	5	0.1889	4	0.1186
BTM	9	1.6073	1	0.1115	2	0.2018
DIVIDENDS	7	0.0041	8	0.0114	8	0.0208
CASH	4	0.8205	7	1.1836	8	1.2286
CF	3	0.0142	4	0.0228	4	0.0445
SALES	6	0.1183	8	0.1674	8	0.1703
D/E	10	0.4679	8	0.2982	7	0.2230
	Cigna					
	1996		2002		2006	
	Decile	Value	Decile	Value	Decile	Value
TA	10	108613.9	10	85154.6	10	36217.3
MCAP	10	11436.9	10	5531.5	10	12409.7
PPE	1	0.0081	1	0.0121	1	0.0149
BTM	7	0.6919	5	0.6693	3	0.2980
DIVIDENDS	7	0.0024	7	0.0021	6	0.0003
CASH	2	0.1914	2	0.2175	3	0.3903
CF	5	0.0429	4	0.0323	4	0.0463
SALES	2	0.0194	2	0.0170	3	0.0500
D/E	3	0.0103	3	0.0169	3	0.0305
	U.S. Playing Card					
	1980		1983		1986	
	Decile	Value	Decile	Value	Decile	Value
TA	3	28.3	5	96.1	6	133.3
MCAP	3	17.1	6	107.7	5	55.7
PPE	7	0.3986	7	0.4287	7	0.3941
BTM	6	0.9710	1	0.2115	3	0.4193
DIVIDENDS	1	0.0000	1	0.0000	1	0.0000
CASH	7	1.6628	5	0.9334	4	0.8091
CF	9	0.1535	6	0.0852	3	0.0204
SALES	5	0.1223	7	0.1440	5	0.0902
D/E	2	0.0284	10	0.5790	9	0.3687

Table 10: Summary statistics for benefits and costs of debt. Measures are based on the marginal cost curves estimated from equations 9 and 5 for sample B for all industries except utilities, finance, and public administration. The observed gross benefits of debt, GBD_o, is the area under the marginal benefits curve up to the observed level of interest over book value (IOB). The observed cost of debt, CD_o is the area under the marginal cost curve up to the observed level of IOB. The observed net benefits of debt, NBD_o, is the area under the marginal benefits curve minus the area under the marginal cost curve up to the observed IOB. Equilibrium is defined as the intersection of the marginal benefit and cost curves. The equilibrium gross benefits of debt, GBD_e, is the area under the marginal benefits curve up to the equilibrium level of IOB. The equilibrium cost of debt, CD_e is the area under the marginal cost curve up to the equilibrium level of IOB. The equilibrium net benefits of debt, NBD_e, is the area under the marginal benefits curve minus the area under the marginal cost curve up to the equilibrium IOB. 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. The cost of being out of equilibrium, DW_t, combines DW_o and DW_u into one measure.

Analysis Based on (9) $MC_{i,t} = a + bx_{i,t} + \sum_{c \in C} \theta_c c_{i,t} x_{i,t} + \xi_{i,t}$ (slope varies)										
	N	Mean	Std. Dev.	1%	10%	25%	Median	75%	90%	99%
Observed gross benefits of debt (GBD_o)	91992	0.0884	0.0791	0.0000	0.0033	0.0246	0.0724	0.1301	0.1945	0.3410
Observed costs of debt (CD_o)	91992	0.0882	0.0895	0.0000	0.0104	0.0294	0.0651	0.1158	0.1917	0.4261
Observed net benefits of debt (NBD_o)	91992	0.0002	0.0624	-0.2450	-0.0634	-0.0099	0.0156	0.0320	0.0465	0.0820
Equilibrium gross benefits of debt (GBD_e)	91992	0.0957	0.0819	0.0000	0.0000	0.0146	0.0984	0.1432	0.1886	0.3085
Equilibrium costs of debt (CD_e)	91992	0.0672	0.0546	0.0000	0.0000	0.0108	0.0705	0.1018	0.1325	0.2070
Equilibrium net benefits of debt (NBD_e)	91992	0.0285	0.0343	0.0000	0.0000	0.0024	0.0270	0.0413	0.0568	0.1065
Cost of being out of equilibrium (DW_t)	91992	0.0283	0.0564	0.0000	0.0003	0.0024	0.0100	0.0277	0.0748	0.2676
Cost of overleveraging (DW_o)	48216	0.0434	0.0694	0.0000	0.0004	0.0036	0.0181	0.0546	0.1151	0.3203
Cost of underleveraging (DW_u)	43776	0.0117	0.0293	0.0000	0.0002	0.0017	0.0065	0.0148	0.0247	0.0688
Analysis Based on (5) $MC_{i,t} = a + bx_{i,t} + \sum_{c \in C} \delta_c c_{i,t} + \xi_{i,t}$ (intercept varies)										
	N	Mean	Std. Dev.	1%	10%	25%	Median	75%	90%	99%
Observed gross benefits of debt (GBD_o)	91992	0.0884	0.0791	0.0000	0.0033	0.0246	0.0724	0.1301	0.1945	0.3410
Observed costs of debt (CD_o)	91992	0.0731	0.0879	-0.0374	0.0022	0.0177	0.0503	0.0978	0.1718	0.4157
Observed net benefits of debt (NBD_o)	91992	0.0153	0.0600	-0.2213	-0.0323	0.0004	0.0192	0.0441	0.0692	0.1260
Equilibrium gross benefits of debt (GBD_e)	91992	0.0978	0.0736	0.0000	0.0000	0.0259	0.0993	0.1537	0.1944	0.2653
Equilibrium costs of debt (CD_e)	91339	0.0592	0.0496	-0.0463	0.0000	0.0103	0.0664	0.1007	0.1191	0.1528
Equilibrium net benefits of debt (NBD_e)	91339	0.0393	0.0362	0.0000	0.0000	0.0101	0.0322	0.0590	0.0861	0.1514
Cost of being out of equilibrium (DW_t)	91339	0.0238	0.0477	0.0000	0.0002	0.0018	0.0083	0.0247	0.0584	0.2388
Cost of overleveraging (DW_o)	43605	0.0359	0.0645	0.0000	0.0003	0.0020	0.0110	0.0401	0.1011	0.3123
Cost of underleveraging (DW_u)	47734	0.0129	0.0175	0.0000	0.0002	0.0016	0.0068	0.0176	0.0329	0.0784

Table 11: Conditional summary statistics for benefit and cost measures based on the marginal cost curves described in equation 11. Observations are grouped based on how far a firm-year observation actually observed is from the equilibrium for i) all observations, ii) overlevered firm-years, and iii) underlevered firm-years. Panel A includes all firms in Sample A. Panel B includes only financially distressed firms. Panel C includes only financially constrained firms. Panel D includes firm with high potential tax benefits of debt (areas under the marginal benefit curve above the median). The observed gross benefits of debt, GBD_o, is the area under the marginal benefits curve up to the observed level of interest over book value (IOB). The observed cost of debt, CD_o is the area under the marginal cost curve up to the observed level of IOB. The observed net benefits of debt, NBD_o, is the area under the marginal benefits curve minus the area under the marginal cost curve up to the observed IOB. Equilibrium is defined as the intersection of the marginal benefit and cost curves. The equilibrium gross benefits of debt, GBD_e, is the area under the marginal benefits curve up to the equilibrium level of IOB. The equilibrium cost of debt, CD_e is the area under the marginal cost curve up to the equilibrium level of IOB. The equilibrium net benefits of debt, NBD_e, is the area under the marginal benefits curve minus the area under the marginal cost curve up to the equilibrium IOB. 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. The cost of being out of equilibrium, DW_t, combines DW_o and DW_u into one measure.

	Panel A: All firms in Sample A								Panel B: Financially distressed firms							
	N	GBD_o	CD_o	NBD_o	GBD_e	CD_e	NBD_e	DW_t	N	GBD_o	CD_o	NBD_o	GBD_e	CD_e	NBD_e	DW_t
	All Observations															
< 5% of equilibrium	4079	0.1351	0.0965	0.0386	0.1366	0.0970	0.0396	0.0010	1914	0.1407	0.1005	0.0401	0.1434	0.1011	0.0423	0.0022
5%-10% from eq.	3909	0.1295	0.0917	0.0378	0.1329	0.0930	0.0399	0.0021	1829	0.1353	0.0955	0.0398	0.1408	0.0970	0.0438	0.0040
10%-20% from eq.	8008	0.1301	0.0923	0.0378	0.1367	0.0967	0.0400	0.0022	3743	0.1372	0.0974	0.0398	0.1449	0.1017	0.0432	0.0034
20%-40% from eq.	14954	0.1190	0.0837	0.0353	0.1385	0.0978	0.0407	0.0053	6732	0.1273	0.0903	0.0371	0.1467	0.1027	0.0440	0.0069
40%-60% from eq.	13729	0.0980	0.0694	0.0286	0.1383	0.0966	0.0417	0.0131	5562	0.1115	0.0815	0.0299	0.1479	0.1011	0.0468	0.0169
60%-80% from eq.	11486	0.0678	0.0516	0.0162	0.1204	0.0840	0.0364	0.0202	4352	0.0830	0.0672	0.0158	0.1271	0.0860	0.0411	0.0253
> 80% from eq.	35827	0.0595	0.1069	-0.0473	0.0357	0.0250	0.0107	0.0581	24782	0.0516	0.1053	-0.0537	0.0268	0.0185	0.0083	0.0620
	Overleveraged Observations															
	N	GBD_o	CD_o	NBD_o	GBD_e	CD_e	NBD_e	DW_o	N	GBD_o	CD_o	NBD_o	GBD_e	CD_e	NBD_e	DW_o
< 5% of equilibrium	1804	0.1340	0.0974	0.0366	0.1320	0.0942	0.0378	0.0012	819	0.1398	0.1019	0.0379	0.1392	0.0987	0.0405	0.0026
5%-10% from eq.	1713	0.1352	0.0992	0.0360	0.1273	0.0900	0.0373	0.0014	783	0.1399	0.1025	0.0374	0.1330	0.0931	0.0399	0.0025
10%-20% from eq.	3265	0.1447	0.1091	0.0356	0.1278	0.0903	0.0375	0.0019	1603	0.1482	0.1116	0.0366	0.1316	0.0925	0.0391	0.0025
20%-40% from eq.	4752	0.1589	0.1278	0.0310	0.1269	0.0901	0.0368	0.0057	2403	0.1620	0.1304	0.0316	0.1314	0.0923	0.0391	0.0075
40%-60% from eq.	3638	0.1675	0.1456	0.0219	0.1190	0.0838	0.0351	0.0132	1917	0.1701	0.1483	0.0218	0.1233	0.0858	0.0375	0.0157
60%-80% from eq.	2485	0.1790	0.1675	0.0115	0.1128	0.0809	0.0318	0.0203	1346	0.1806	0.1700	0.0106	0.1165	0.0828	0.0338	0.0232
> 80% from eq.	30559	0.0673	0.1240	-0.0568	0.0249	0.0177	0.0072	0.0639	22786	0.0547	0.1138	-0.0591	0.0198	0.0138	0.0059	0.0650
	Underleveraged Observations															
	N	GBD_o	CD_o	NBD_o	GBD_e	CD_e	NBD_e	DW_u	N	GBD_o	CD_o	NBD_o	GBD_e	CD_e	NBD_e	DW_u
< 5% of equilibrium	2275	0.1360	0.0959	0.0401	0.1402	0.0992	0.0410	0.0009	1095	0.1413	0.0995	0.0418	0.1465	0.1030	0.0436	0.0018
5%-10% from eq.	2196	0.1251	0.0859	0.0393	0.1372	0.0953	0.0419	0.0026	1046	0.1318	0.0902	0.0416	0.1466	0.0999	0.0467	0.0051
10%-20% from eq.	4743	0.1200	0.0808	0.0393	0.1428	0.1011	0.0417	0.0024	2140	0.1289	0.0868	0.0421	0.1549	0.1086	0.0463	0.0041
20%-40% from eq.	10202	0.1005	0.0631	0.0374	0.1439	0.1014	0.0425	0.0051	4329	0.1081	0.0680	0.0401	0.1552	0.1085	0.0467	0.0066
40%-60% from eq.	10091	0.0729	0.0419	0.0310	0.1452	0.1012	0.0440	0.0130	3645	0.0806	0.0464	0.0342	0.1609	0.1092	0.0518	0.0176
60%-80% from eq.	9001	0.0371	0.0196	0.0175	0.1225	0.0849	0.0376	0.0202	3006	0.0393	0.0212	0.0181	0.1319	0.0875	0.0444	0.0262
> 80% from eq.	5268	0.0147	0.0073	0.0074	0.0987	0.0673	0.0314	0.0240	1996	0.0160	0.0082	0.0077	0.1063	0.0712	0.0351	0.0273

	Panel C: Financially constrained firms								Panel D: High potential tax benefits of debt firms (A_{it} above the median)							
	N	GBD_o	CD_o	NBD_o	GBD_e	CD_e	NBD_e	DW_t	N	GBD_o	CD_o	NBD_o	GBD_e	CD_e	NBD_e	DW_t
	All Observations															
< 5% of equilibrium	1068	0.1281	0.0909	0.0372	0.1306	0.0914	0.0392	0.0020	3061	0.1406	0.1013	0.0392	0.1416	0.1016	0.0400	0.0007
5%-10% from eq.	978	0.1203	0.0844	0.0359	0.1238	0.0860	0.0377	0.0018	2878	0.1366	0.0984	0.0382	0.1401	0.0997	0.0404	0.0022
10%-20% from eq.	2103	0.1205	0.0846	0.0359	0.1282	0.0895	0.0387	0.0027	5966	0.1357	0.0972	0.0385	0.1429	0.1024	0.0405	0.0020
20%-40% from eq.	3961	0.1111	0.0764	0.0347	0.1328	0.0932	0.0395	0.0049	11253	0.1244	0.0881	0.0363	0.1447	0.1032	0.0414	0.0051
40%-60% from eq.	3965	0.0886	0.0601	0.0286	0.1344	0.0929	0.0415	0.0130	9782	0.1044	0.0737	0.0307	0.1480	0.1046	0.0434	0.0127
60%-80% from eq.	4169	0.0529	0.0375	0.0154	0.1110	0.0751	0.0359	0.0205	5770	0.0975	0.0758	0.0216	0.1555	0.1098	0.0456	0.0240
> 80% from eq.	11012	0.0503	0.0854	-0.0352	0.0379	0.0260	0.0120	0.0471	6941	0.1812	0.2309	-0.0497	0.0838	0.0604	0.0233	0.0730
	Overleveraged Observations															
	N	GBD_o	CD_o	NBD_o	GBD_e	CD_e	NBD_e	DW_o	N	GBD_o	CD_o	NBD_o	GBD_e	CD_e	NBD_e	DW_o
< 5% of equilibrium	456	0.1278	0.0922	0.0356	0.1282	0.0892	0.0389	0.0033	1415	0.1405	0.1026	0.0379	0.1376	0.0992	0.0384	0.0005
5%-10% from eq.	405	0.1242	0.0907	0.0334	0.1174	0.0822	0.0352	0.0017	1272	0.1426	0.1062	0.0364	0.1340	0.0963	0.0377	0.0013
10%-20% from eq.	830	0.1326	0.0989	0.0337	0.1178	0.0820	0.0358	0.0021	2269	0.1555	0.1189	0.0366	0.1362	0.0982	0.0380	0.0014
20%-40% from eq.	1091	0.1510	0.1206	0.0304	0.1206	0.0850	0.0355	0.0051	3472	0.1702	0.1375	0.0326	0.1344	0.0964	0.0380	0.0053
40%-60% from eq.	849	0.1550	0.1343	0.0207	0.1108	0.0771	0.0337	0.0130	2380	0.1897	0.1643	0.0254	0.1308	0.0939	0.0369	0.0115
60%-80% from eq.	614	0.1684	0.1564	0.0120	0.1076	0.0756	0.0320	0.0200	1693	0.2050	0.1906	0.0144	0.1253	0.0910	0.0343	0.0198
> 80% from eq.	8519	0.0610	0.1085	-0.0475	0.0223	0.0156	0.0067	0.0542	6627	0.1875	0.2406	-0.0531	0.0736	0.0536	0.0200	0.0732
	Underleveraged Observations															
	N	GBD_o	CD_o	NBD_o	GBD_e	CD_e	NBD_e	DW_u	N	GBD_o	CD_o	NBD_o	GBD_e	CD_e	NBD_e	DW_u
< 5% of equilibrium	612	0.1283	0.0899	0.0384	0.1324	0.0930	0.0394	0.0010	1646	0.1406	0.1002	0.0404	0.1450	0.1037	0.0413	0.0009
5%-10% from eq.	573	0.1176	0.0799	0.0377	0.1283	0.0887	0.0396	0.0019	1606	0.1319	0.0922	0.0397	0.1450	0.1025	0.0425	0.0028
10%-20% from eq.	1273	0.1127	0.0753	0.0374	0.1350	0.0944	0.0405	0.0031	3697	0.1236	0.0840	0.0396	0.1470	0.1050	0.0420	0.0024
20%-40% from eq.	2870	0.0959	0.0595	0.0363	0.1374	0.0963	0.0411	0.0048	7781	0.1039	0.0660	0.0379	0.1492	0.1063	0.0429	0.0050
40%-60% from eq.	3116	0.0705	0.0399	0.0307	0.1408	0.0972	0.0437	0.0130	7402	0.0770	0.0446	0.0324	0.1535	0.1080	0.0455	0.0131
60%-80% from eq.	3555	0.0330	0.0170	0.0160	0.1116	0.0750	0.0366	0.0206	4077	0.0528	0.0281	0.0246	0.1680	0.1176	0.0503	0.0257
> 80% from eq.	2493	0.0135	0.0066	0.0069	0.0913	0.0615	0.0298	0.0228	314	0.0484	0.0255	0.0229	0.2971	0.2042	0.0929	0.0700

Table 12: Conditional summary statistics of benefit and cost of debt for firms in equilibrium. Measures are based on the marginal cost curves described in equation 11. The gross 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. The cost of being out of equilibrium, DW_t, combines DW_o and DW_u into one measure.

	Panel A: All firms in Sample A							Panel B: High potential tax benefits of debt firms (A_{it} above the median)						
	N	GBD	CD	NBD	DW_t	DW_o	DW_u	N	GBD	CD	NBD	DW_t	DW_o	DW_u
20% of equilibrium	4079	0.0272	0.0138	0.0134	0.0262		0.0262	3061	0.0282	0.0143	0.0139	0.0261		0.0261
40% of equilibrium	4079	0.0544	0.0304	0.0240	0.0156		0.0156	3061	0.0564	0.0316	0.0248	0.0152		0.0152
60% of equilibrium	4079	0.0814	0.0497	0.0317	0.0079		0.0079	3061	0.0846	0.0519	0.0327	0.0073		0.0073
80% of equilibrium	4079	0.1084	0.0717	0.0366	0.0029		0.0029	3061	0.1126	0.0751	0.0375	0.0025		0.0025
at equilibrium	4079	0.1351	0.0965	0.0386	0.0010	0.0012	0.0009	3061	0.1406	0.1013	0.0392	0.0007	0.0005	0.0009
120% of equilibrium	4079	0.1601	0.1241	0.0360	0.0036	0.0036		3061	0.1677	0.1305	0.0372	0.0028	0.0028	
160% of equilibrium	4079	0.2046	0.1874	0.0172	0.0224	0.0224		3061	0.2188	0.1977	0.0211	0.0189	0.0189	
200% of equilibrium	4079	0.2438	0.2616	-0.0179	0.0575	0.0575		3061	0.2656	0.2768	-0.0112	0.0512	0.0512	
300% of equilibrium	4079	0.3198	0.4953	-0.1755	0.2151	0.2151		3061	0.3590	0.5265	-0.1674	0.2074	0.2074	
400% of equilibrium	4079	0.3699	0.7976	-0.4277	0.4673	0.4673		3061	0.4216	0.8503	-0.4287	0.4687	0.4687	
500% of equilibrium	4079	0.4027	1.1684	-0.7658	0.8053	0.8053		3061	0.4622	1.2483	-0.7861	0.8261	0.8261	

	Panel C: Investment grade rated firms							Panel D: Junk rated firms						
	N	GBD	CD	NBD	DW_t	DW_o	DW_u	N	GBD	CD	NBD	DW_t	DW_o	DW_u
20% of equilibrium	860	0.0240	0.0127	0.0113	0.0206		0.0206	304	0.0316	0.0164	0.0152	0.0286		0.0286
40% of equilibrium	860	0.0479	0.0278	0.0201	0.0118		0.0118	304	0.0632	0.0360	0.0272	0.0166		0.0166
60% of equilibrium	860	0.0719	0.0454	0.0265	0.0054		0.0054	304	0.0946	0.0586	0.0360	0.0078		0.0078
80% of equilibrium	860	0.0958	0.0653	0.0304	0.0015		0.0015	304	0.1259	0.0844	0.0415	0.0022		0.0022
at equilibrium	860	0.1196	0.0878	0.0319	0.0000	0.0000	0.0000	304	0.1569	0.1132	0.0437	0.0001	0.0000	0.0001
120% of equilibrium	860	0.1427	0.1126	0.0301	0.0018	0.0018		304	0.1851	0.1451	0.0399	0.0039	0.0039	
160% of equilibrium	860	0.1864	0.1697	0.0167	0.0152	0.0152		304	0.2316	0.2183	0.0132	0.0305	0.0305	
200% of equilibrium	860	0.2271	0.2364	-0.0094	0.0413	0.0413		304	0.2690	0.3039	-0.0350	0.0787	0.0787	
300% of equilibrium	860	0.3101	0.4460	-0.1359	0.1678	0.1678		304	0.3347	0.5722	-0.2375	0.2813	0.2813	
400% of equilibrium	860	0.3668	0.7165	-0.3497	0.3816	0.3816		304	0.3749	0.9181	-0.5431	0.5869	0.5869	
500% of equilibrium	860	0.4038	1.0478	-0.6441	0.6760	0.6760		304	0.4007	1.3414	-0.9407	0.9845	0.9845	

Table 13: Analysis on alternative definitions of being financially unconstrained (C) KZ index below median, (D) CL index below median, (E) WW index below median, and (F) LTDEIR in the top quartile. GMM estimation of the coefficients in equations 5 and 9 for all industries except utilities, finance, and public administration. The error functions are defined according to equations 6 and 10 where $y^*_{i,t}$ is the 'equilibrium' marginal benefit/cost level, $x^*_{i,t}$ is the observed or 'equilibrium' interest expenses over book value (IOB) and C is the set of cost control variables. GMM moments are obtained by interacting the error function with the following instruments: the constant term, the variation of the marginal benefit curve $A_{i,t}$, and each of the control variables. The set of control variables is $C \equiv \{LTA, PPE, BTM, DDIV, CF, CASH\}$, where LTA is log of total assets expressed in 2000 dollars, PPE is plant, property, and equipment over total book values, BTM is book equity to market equity, DDIV is an indicator for dividend paying firms, CF is net cashflow over total book values, and CASH is cash holdings over total book values. The control variables are standardized to have mean zero and standard deviation one based on Sample A (and are not re-standardized across samples). Robust, clustered standard errors are reported in the parentheses. Standard errors are clustered by both firm and year as in Thompson (2006) and Petersen (2007). Significance at the 10% level is indicated by *, 5% level by **, and 1% level by ***.

	(9) $MC_{i,t} = a + bx_{i,t} + \sum_{c \in C} \theta_c c_{i,t} x_{i,t} + \xi_{i,t}$				(5) $MC_{i,t} = a + bx_{i,t} + \sum_{c \in C} \delta_c c_{i,t} + \xi_{i,t}$			
	Sample C	Sample D	Sample E	Sample F	Sample C	Sample D	Sample E	Sample F
Constant	0.247 ***	0.209 ***	0.231 ***	0.172 ***	0.197 ***	0.167 ***	0.154 ***	0.096 ***
	(0.006)	(0.007)	(0.008)	(0.014)	(0.007)	(0.009)	(0.014)	(0.018)
IOB	3.832 ***	4.687 ***	3.212 ***	4.955 ***	4.714 ***	4.995 ***	4.949 ***	5.767 ***
	(0.313)	(0.425)	(0.322)	(0.521)	(0.357)	(0.502)	(0.458)	(0.576)
LTA*IOB	0.177 *	0.327 ***	0.320 **	0.493 ***				
	(0.102)	(0.126)	(0.147)	(0.110)				
PPE*IOB	0.325 **	-0.400 ***	-0.213 *	-0.501 ***				
	(0.158)	(0.129)	(0.110)	(0.107)				
BTM*IOB	0.294 **	0.047	0.099	-0.358 ***				
	(0.119)	(0.113)	(0.131)	(0.080)				
DDIV*IOB	0.716 ***	1.103 ***	0.960 ***	0.760 ***				
	(0.092)	(0.117)	(0.125)	(0.089)				
CF*IOB	1.408 ***	1.434 ***	1.764 ***	1.380 ***				
	(0.197)	(0.254)	(0.306)	(0.191)				
CASH*IOB	1.053 ***	1.092 ***	1.044 ***	1.937 ***				
	(0.172)	(0.272)	(0.235)	(0.232)				
LTA					0.008 ***	0.011 ***	0.005	0.019 ***
					(0.003)	(0.003)	(0.004)	(0.003)
PPE					0.010 ***	-0.013 ***	-0.009 ***	-0.022 ***
					(0.004)	(0.003)	(0.003)	(0.004)
BTM					0.003	-0.005	-0.009 **	-0.024 ***
					(0.004)	(0.004)	(0.005)	(0.004)
DDIV					0.025 ***	0.035 ***	0.034 ***	0.034 ***
					(0.002)	(0.004)	(0.004)	(0.004)
CF					0.066 ***	0.077 ***	0.082 ***	0.088 ***
					(0.005)	(0.007)	(0.009)	(0.007)
CASH					0.036 ***	0.033 ***	0.039 ***	0.059 ***
					(0.004)	(0.005)	(0.006)	(0.008)
No. Obs.	22689	20187	20616	14700	22689	20187	20616	14700