Leverage dynamics, the endogeneity of corporate tax status and financial distress costs, and capital structure

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Preliminary and incomplete. Comments welcome.

Abstract

This paper empirically examines capital structure decisions in the presence of leverage dynamics and when corporate tax status and financial distress costs are allowed to be endogenous. We deal with the endogeneity of corporate tax by using a before-financing measure of the marginal corporate tax rate as a proxy for the effective corporate tax rate. We find strong evidence of a positive relation between leverage and taxes, irrespective of whether leverage dynamics are allowed for. Using the estimated probability of financial distress as a proxy for financial distress costs, we find that the role of leverage dynamics is crucial to the effect of financial distress on leverage. We find that when leverage dynamics are excluded, the estimated probability of financial distress is positively associated with leverage, that is, an increasing probability of financial distress leads to an increase in leverage. This seems counter-intuitive. When leverage dynamics are included in the model, the probability of financial distress is negatively related to leverage. Our results show that capital structure dynamics are important and suggest that firms trade-off the tax benefit that arises from increasing debt with the increase in possible financial distress that arises from increasing debt.

1 Introduction

The dynamic trade-off theory of capital structure predicts that firms adjust toward their target capital structure by offsetting the benefits of the tax shield that debt attracts with the expected costs of financial distress. This suggests that in addition to dynamics in leverage being important because it is costly to move to any target debt ratio immediately, there is a positive relationship between marginal corporate tax rates and leverage and a negative relationship between financial distress and leverage. Although extant research has made considerable efforts to empirically investigate these two latter predictions, much of it suffers from important limitations. First, it has a tendency to ignore the endogeneity of corporate tax status as identified by Graham *et al.* (1998). The problem is that since interest expense is tax deductable, a company that uses debt to finance its operations reduces taxable income, lowering its expected marginal corporate tax rate (Graham *et al.* (1998)). In this situation, both leverage and the marginal corporate tax rate are clearly endogenous. Failure to adjust any estimate of the marginal corporate tax rate for the endogeneity induced by using an after-financing estimate of the marginal corporate tax rate in turn induces a negative bias to the coefficient on this variable to the extent that the relationship between tax and leverage may appear to be negative when it is not. Graham *et al.* (1998) find that endogeneity of the marginal tax rate is not something that can be ignored. Nevertheless, several recent papers fail to account for the endogeneity of margimal corporate tax rates associated with debt ratios; see, for example, Booth *et al.* (2001), Byoun (2007) and Antoniou *et al.* (2007). A second limitation concerns financial distress costs. Several studies that empirically examine the predictions of the trade-off theory do so incorporating firm size as an inverse proxy for expected financial distress costs in their empirical specification (see, for example, Shyam-Sunder and Myers (1999), Fama and French (2002), and Flannery and Rangan (2006)). Unfortunately, even if firm size is in fact a plausible measure of financial distress costs, it is likely to capture other things as well, such as firm's financial constraints, flotation costs, information uncertainty about the firm, etc. Given that the trade-off is between the benefits of the tax shield debt attracts and financial distress costs, it seems reasonable to hypothesize that financial distress is important and a powerful measure of financial distress should be included in any empirical model examining the trade-off. There is also a concern that financial distress costs are endogenously related to debt ratios. Increasing leverage increases the probability of financial distress while an increase in the probability of financial distress should bring about decreases in the amount of debt a firm has in its capital structure. So far, the endogeneity of financial distress costs has not been considered in the existing literature. A final issue in relation to financial distress is the proxy to use. Altman's Z-score, or a modified version of it, has typically been used (see, for example, Graham (2000) and Byoun (2007)). However, studies that use Z-score typically find it to be positively related to leverage.[1] This suggests that Z-score is a poor proxy for financial distress, or models used in previous studies are misspecified because financial distress is endogenous, or the empirical relationship between financial distress and leverage is not as one would expect given the trade-off theory of capital structure.

We examine whether corporation tax and financial distress affect capital structure decisions addressing properly the endogeneity of these two factors associated with leverage. The contribution of the paper can be seen in three distinct parts. First, we modify a commonly used proxy for effective average corporate tax rates to reflect before-financing decisions rather than after-financing decisions. Our measure of effective corporate tax rates offers an alternative way to the simulated marginal corporate tax rates used Graham *et al.* (1998)without being subject to the data limitations of Graham *et al.* (1998)'s method, particularly if non-US data is used. Second, to test the association between leverage and financial distress costs we use a probability-based estimate of financial distress rather than the Z-score. Specifically, we follow Shumway (2001) and estimate the probability of financial distress using a hazard model with time-varying covariates. We use predetermined variables to estimate the probability of financial distress, so that the estimated probability of financial distress at time t is based on variables dated $t-1$. The estimated probability of financial distress is a better measure of distress costs as it conveys more information than the Z-score in three respects. First, it is based on a hazard model which accounts for how long the firm has survived before moving into financial distress and treats the estimation of the probability of financial distress as a

[1]Early studies of capital structure (e.g., Kim and Sorensen (1986) and Titman and Wessels (1988)) use a firm's operating risk, measured as either the coefficient of variation or the standard deviation of earnings before interest and taxes (EBIT), to proxy for financial distress costs. These studies find no evidence of a negative relationship between financial distress costs and leverage.

dynamic multi-period problem that uses all available firm-year observations to estimate the probability. Unlike hazard models, static bankruptcy prediction models (e.g. see, Altman (1968) and Ohlson (1980)) do not use the time series of annual observations for each firm as they are estimated only with each firm's last observation. As a result, static models produce inconsistent and biased estimates first documented by Shumway (2001). Second, it uses both accounting and market information to predict corporate default whereas the Z-score only uses accounting-based variables. Third, there is evidence to suggest that most of the accounting information contained in the Z-score is unrelated to the prediction of corporate bankruptcy. In particular, using a discrete hazard model Shumway (2001) shows that sales, retained earnings, and working capital are not associated with the probability of bankruptcy. The final contribution of the paper is that it sheds light on the extent to which Z-score captures financial distress costs.

Along with the issues above, we also examine the role of leverage dynamics in capital structure decisions through a partial adjustment-type model. We formulate our empirical model as a dynamic panel data model estimated using Generalized Method of Moments (hereafter, GMM), which allows us to deal with endogeneity of the probability of financial distress. We find that regardless of whether dynamics are included in the model, there is a positive relationship between tax and leverage once we consider the endogeneity of corporate tax status, consistent with the results of Graham *et al.* (1998). This finding highlights the need to use proxies for marginal corporate tax rates that are not related endogenously to debt ratios in examining the tax effect on leverage. When leverage dynamics are excluded from the model, there is a positive relationship between the probability of financial distress and leverage. However, once we allow for leverage dynamics, the relationship between leverage and the probability of financial distress becomes negative and statistically significant, in line with the prediction of the tradeoff theory. We also substitute the probability of financial distress with the modified version of Altman's Z-score to explore whether Z-score can capture financial distress costs. Surprisingly, while leverage dynamics enter in the model, the sign of the Z-score does not change. We show that this occurs as Z-score does not measure accurately financial distress costs. Instead, it captures the same information as profitability for the low-performing firms. The rest of the paper is organized as follows. Section 2 motivates our empirical approach and discusses the data. Section 3 presents and interprets the results and Section 4 concludes.

2 Model Specification

As the basis of our empirical model, we use a partial adjustment formulation (see Flannery and Rangan (2006) and Byoun (2007) for other examples of partial adjustment models):

$$Lev_{i,t} = (1-\lambda)Lev_{i,t-1} + \lambda Lev^*_{i,t} + \epsilon_{i,t} \tag{1}$$

where $Lev_{i,t}$ is actual leverage for firm i in year t, $Lev_{i,t-1}$ is actual leverage for firm i in year $t-1$, $Lev^*_{i,t}$ is target leverage for firm i in year t, λ is the speed of adjustment towards target leverage, and $\epsilon_{i,t}$ is an error term. Target leverage is a very important component of the partial adjustment model. The target is assumed to depend upon a vector of variables, $\boldsymbol{\beta}'\mathbf{x}_{i,t}$. Substituting for $Lev^*_{i,t}$ in (1) gives the basis of our empirical model:

$$Lev_{i,t} = (1-\lambda)Lev_{i,t-1} + \lambda(\boldsymbol{\beta}'\mathbf{x}_{i,t}) + \epsilon_{i,t} \tag{2}$$

For (2) to be operational, we need to specify the variables $\mathbf{x}$. Guided by our earlier discussion and established practice in the literature, we specify target leverage as a function of seven factors.

1. Average Tax Rate Before Financing (ATRBF)

   We use this variable as a measure of the firm's marginal effective tax rate. It is calculated as income tax expense plus (interest expense $\times$ the top statutory tax rate), divided by earnings before interest and tax.[2] Since we add back a proxy of the interest tax shield, i.e., interest expense $\times$ the top statutory tax rate to the income tax expense in the numerator and we use a before-financing taxable income in the denominator ATRBF is exogenous to

[2]Following Sharpe and Nguyen (1995) and Graham *et al.* (1998) , ATRBF is set to zero if the numerator is negative, and is set to one if the numerator is positive and the denominator is negative.

debt ratios. From the predictions of the trade-off theory of capital structure, we expect there to be a positive relationship between ATRBF and leverage.

2. Probability of Financial Distress (PROBFD)

   This is the fitted value from the multi-period logistic regression

$$P_{i,t} = \frac{1}{1 + e^{(-\alpha + \ '\mathbf{x}_{i,t-1})}} \tag{3}$$

   where $P_{i,t}$ is the probability that firm i will enter either bankruptcy or liquidation at time t and $\boldsymbol{\beta}'\mathbf{x}_{i,t-1} = \beta_1 PROF_{i,t-1} + \beta_2 BLEV_{i,t-1} + \beta_3 REL\_SIZE_{i,t-1} + \beta_4 EXPR_{i,t-1} + \beta_5 \sigma_{i,t-1}$.[3] In contrast to Shumway (2001), we place greater emphasis on the prediction of corporate financial distress, that is, when a firm enters bankruptcy or liquidation, rather than on bankruptcy alone.The dependent variable is a dummy equalling zero if the firm has not filed for bankruptcy or entered liquidation. If the firm has entered liquidation or bankruptcy, then the dependent variable equals one only for its last firm-year observation; zero otherwise. $PROF$ is profitability, which we define as earnings before interest, taxes depreciation and amortization (EBITDA) divided by total assets. $BLEV$ is book leverage, defined as the book value of debt divided by the book value of debt plus stockholders' equity, REL_SIZE is a firm's market capitalization expressed relative to the total market capitalization of NYSE and AMEX firms, $EXPR$ is a firm's past return in excess of the market and σ_i is firm i's stock return volatility. We expect there to be a negative relationship between the probability of financial distress and leverage.

3. Firm Size (SIZE)

   We define this as the natural logarithm of sales. Larger firms tend to be more diversified and tend to have less volatile cash flows. Larger firms can therefore issue more debt than smaller firms. We therefore expect to see a positive relationship between firm size and leverage.

[3]Shumway (2001) shows in detail that a hazard model is econometrically equivalent to a multi-period logit model.

4. Tangibility (TANG)

   This is defined as fixed assets divided by total assets. If a firm has a large amount of fixed (tangible) assets then these assets can serve as collateral to debtholders. If debt is collateralized then the risk of the lender suffering agency costs of debt diminishes and the firm's debt capacity increases. We therefore expect to see a positive relationship between tangibility and leverage.

5. Profitability (PROF)

   This is defined as earnings before interest, tax, depreciation and amortization (EBITDA) divided by total assets. More profitable firms are therefore more likely to have accumulated retained earnings and thus have less incentive to issue debt.

6. Market to book (MTB)

   This is defined as the market value of assets divided by book value of assets. Market to book proxies for growth opportunities. Due to the agency costs of debt firms issue less leverage to protect their investment opportunities; see Myers (1977)

7. Industry Leverage (IND_LEV)

   This is defined as the industry median book leverage, based on four-digit SIC codes. This factor accounts for industry effects on leverage. McKay and Phillips (2005) and Frank and Goyal (2004) find strong industry effects in the cross section of firms' leverage.

With regard to the definition of *Lev*, we use a book measure of leverage and a market-based measure to assess the robustness of our results. Book leverage is defined as book value of debt divided by book value of debt plus stockholders' equity. Market leverage is measured as book value of debt divided by book value of debt plus market value of equity. More information about how we construct our variables is provided in the Appendix.

2.1 Data

Our sample initially comprises 13,820 active and inactive non-financial (SIC codes 6000–6999 are excluded) and non-utility (SIC codes 4900–4949 are excluded) firms traded on NYSE, AMEX and NASDAQ over the period 1950–2002. The accounting and market data are obtained from the CRSP/Compustat Merged Database. We obtain data on the top statutory tax rates from the Office of Tax Policy Research at the University of Michigan. We exclude firm-years in which the firm has missing data. As a result, the final sample contains 11,501 firms and 107,068 firm-year observations from 1950–2002. All inactive listed firms that entered any type of bankruptcy or liquidation are considered financially distressed. Our sample includes 911 financially distressed firms, of which 688 went bankrupt and 223 entered liquidation between 1950 and 2002.

All the variables are winsorized at the upper and lower 0.5 tails except market leverage, size and probability of financial distress.[4] Table 1 presents some descriptive statistics for the winsorized variables. Profitability and the probability of financial distress (PROF and PROBFD respectively) are the most volatile variables. The mean average tax rate before financing (ATRBF) is very similar to the average before-financing corporate tax rate used in Graham *et al* (1998), suggesting that our measure is a reasonable alternative to that used by Graham *et al.* (1998).

3 Results

3.1 A Static Model

As a benchmark, we begin by estimating a static version of the model by setting $\lambda = 1$ in (2). The static model we estimate is

$$\begin{aligned} Lev_{i,t} = \beta_0 + \beta_1 ATRBF_{i,t} + \beta_2 PROBFD_{i,t} + \beta_3 SIZE_{i,t} \\ + \beta_4 TANG_{i,t} + \beta_5 PROF_{i,t} + \beta_6 MTB_{i,t} \\ + \beta_7 IND\_LEV_{i,t} + \epsilon_{i,t} \end{aligned} \tag{4}$$

[4]We did not winsorize market leverage and size because descriptive statistics indicate that they are normally distributed, although the results remain unaltered if we also winsorize these two variables.

We estimate the static model using Tobit and Fixed effects regression models.[5] In particular we use a double-censored Tobit estimator as the dependent variable is restricted to the range zero to one. We also use a Fixed effects estimator to control for unobserved sources of firm heterogeneity that are relatively constant over time.[6] Table 2 shows the regression results for book leverage. Size, tangibility, profitability, growth opportunities and median industry leverage are all significant and have the expected signs. The results are also robust to the method of estimation, so we will discuss the results as a whole. Consider Model 1, which uses the estimated probability of financial distress as the proxy for financial distress. The results indicate a positive and significant association between average tax rate before-financing (ATRBF) and book leverage, consistent with the trade-off theory. However, the coefficient on PROBFD is significantly *positive*, suggesting that as the probability of financial distress increases, so does leverage. To examine whether this seemingly counter-intuitive result is due to the choice of proxy for financial distress, model 2 uses the modified Altman's Z-score in place of PROBFD. The lower is the Z-score, the more likely the firm is to be in financial distress. We would therefore expect to find a positive relationship between Z-score and leverage. The relationship is a statistically significant *negative* one, consistent with the results using PROBFD. To examine whether the results reported in table 2 are a result of using book leverage, table 3 reports regression results for (4) with market leverage replacing book leverage as the dependent variable. As for book leverage, there is a positive association between ATRBF and market leverage, as we would expect. We also find a significantly positive relationship between PROBFD and market leverage and a statistically negative relationship between Z-score and market leverage. These results are consistent with the findings in Graham *et al* (1998). The effect of size, tangibility, profitability, growth opportunities and median industry leverage is the same as with the book leverage regressions.

[5] For the fixed effects regressions, $\epsilon_{i,t} = \eta_i + \upsilon_{i,t}$ in (4) where η_i are the fixed effects.

[6] We also estimated random-effects regressions. However, a Hausman specification test suggests that the fixed effects specification is most appropriate in estimating the static model.

3.2 Enter Leverage Dynamics

Several studies have documented that leverage dynamics are important in explaining capital structure empirically (see, for example, Leary and Roberts, 2005, Flannery and Rangan, 2006, and Byoun, 2007). To examine the effects of leverage dynamics on the results of the previous section, we relax the restriction that $\lambda = 1$ in (2). The model we estimate is

$$\begin{aligned} Lev_{i,t} = \beta_0 + \beta_1 Lev_{i,t-1} + \beta_2 ATRBF_{i,t} + \beta_3 PROBFD_{i,t} + \beta_4 SIZE_{i,t} \\ +\beta_5 TANG_{i,t} + \beta_6 PROF_{i,t} + \beta_7 MTB_{i,t} \\ +\beta_8 IND\_LEV_{i,t} + \eta_i + \eta_t + \epsilon_{i,t} \end{aligned} \tag{5}$$

The term η_i in Equation (5) represents the time-invariant unobservable firm-specific effects whereas η_t represents time-specific effects, which are common to all firms but vary over time. Allowing for a lagged dependent variable to appear on the right hand side in (5) creates a dynamic panel data model. An OLS estimated coefficient on $Lev_{i,t-1}$ would be upward biased as η_i is correlated with $\epsilon_{i,t}$. Including fixed effects in (5) to control for unobserved heterogeneity will also induce a bias on the coefficient of $Lev_{i,t-1}$. This is because fixed effects are correlated with the lagged dependent variable; see for example Nickell (1981) and Baltagi (2001). A within transformation removes the time-invariant fixed effect by expressing all variables as deviations from their firm-specific time-series means. However, this simultaneously creates a correlation between the transformed lagged dependent variable and the transformed error term, introducing a bias in our dynamic panel data model.

To address the bias in the partial adjustment model, Flannery and Rangan (2006) use the fixed effects instrumental variables (IV) approach. They use the lagged book debt ratio as an instrument for the lagged market debt ratio to estimate their dynamic regression model for market leverage.[7] However, their IV approach is subject to two potential shortcomings. First, the results rely on the validity of the instrument. Generally, it is very difficult to find a reliable instrument, which is highly correlated with the endogenous variable and at the same time not

[7] Following Flannery and Rangan (2006) we instrument lagged book (market) leverage with lagged market (book) leverage for the dynamic book and market leverage regressions, respectively. The results remain qualitatively the same as with the core results presented in the paper.

correlated with the error term. Second, Flannery and Rangan (2006) assume that the set of the independent variables are strictly exogenous.Flannery and Rangan's IV approach is not applicable to our partial adjustment model as apart from the lagged dependent variable the probability of financial distress is an endogenous variable.[8]

To obtain unbiased coefficients for the dynamic panel data model described in Equation (5) we employ the Arellano and Bond's (1991) GMM technique. In particular, to estimate the partial adjustment model we first difference (5) and hence it is converted to the following equation:

$$\begin{aligned}\Delta Lev_{i,t} = \beta_1 \Delta Lev_{i,t-1} + \beta_2 \Delta ATRBF_{i,t} + \beta_3 \Delta PROBFD_{i,t} + \beta_4 \Delta SIZE_{i,t} \\ + \beta_5 \Delta TANG_{i,t} + \beta_6 \Delta PROF_{i,t} + \beta_7 \Delta MTB_{i,t} \\ + \beta_8 \Delta IND\_LEV_{i,t} + \delta_{i,t}\end{aligned} \tag{6}$$

The Arrellano-Bond's first-differenced estimator allows us to deal with the endogeneity in two ways. First, it removes the firm-specific fixed effects. Second, it does not require the set of the factors that determine the target debt ratio to be strictly exogenous. They can either be pre-determined or endogenous. The first-differenced GMM estimator is appropriate for our partial adjustment model as it enables the probability of financial distress along with the remaining factors that specify target leverage to be treated as endogenous variables. We use the Arellano and Bond (1991) two-step first-differenced GMM estimator. We also use the approach of Windmeijer (2005) approach to correct for the finite sample bias associated with the two-step first-differenced GMM estimator.

Tables 4 and 5 report the results for the dynamic panel data model for book and market leverage respectively. Due to econometric issues associated with the Arellano-Bond dynamic panel GMM estimator, we are forced to restrict the sample period to 1963–2002 for our dynamic

[8]We perform an endogeneity test (not reported) to confirm that the probability of financial distress cost is an endogenous variable using the endog option of the ivreg2 command in STATA. We reject the null hypothesis that the probability of financial distress can be treated as an exogenous variable.

empirical specification.[9] The lagged leverage terms are statistically significant and show that leverage is quite persistent. The most striking result, however, is the change in sign on the probability of financial distress, PROBFD. The presence of lagged leverage in the model now generates a significant *negative* relationship between financial distress and leverage. In the dynamic model, irrespective of whether we use book leverage or market leverage, an increase in the probability of financial distress leads to a decrease in leverage, which is as we would expect. This change in relationship does not occur, however, when Z-score is used in place of the probability of financial distress.

Taken together, the results in Tables 4 and 5 have significant implications with respect to the role of leverage dynamics in corporate financing decisions. We report a strong positive association between current and lagged leverage, which indicates that leverage is heavily path-dependent, in line with Hennessy and Whited (2005) and Strebulaev (2007). By allowing for leverage dynamics and for the probability of financial distress to be endogenous, we also demonstrate that leverage dynamics are of crucial significance in interpreting the role of financial distress in relation to leverage.

3.3 What About Z-score?

The results in Tables 4 and 5 also show that the association between Z-score and leverage does not change, even after allowing for leverage dynamics and allowing Z-score to be treated as an endogenous variable. One possible explanation of this finding is that put forward by Graham *et al* (1998), that Z-score is an *ex post* measure of financial distress. However, it is also possible that Z-score is not a good proxy for financial distress. To explore whether Z-score encapsulates financial distress we incorporate *both* the estimated probability of financial distress (PROBFD) and Z-score in (5). If Z-score captures the same information as PROBFD, either the association between PROBFD and leverage or the association between Z-score and leverage should be considerably weakened. Table 6 reports the results. The sign of PROBFD remains positive and significant whereas the sign of Z-score remains negative and significant

[9]When we estimate the Arellano-Bond GMM regression over the 1950–2002 sample period, the number of instruments is very large relative to the number of cross-sectional units and the length of the time series for each cross sectional unit. This results in the covariance matrix of moment conditions becoming singular.

for both book and market leverage. This finding suggests that the Z-score may be capturing something other than distress.

If Z-score does not measure financial distress costs, it is worth investigating what type of information it actually contains. The results in table 6 show that when Z-score enters into the dynamic model, profitability becomes insignificant. This implies that Z-score captures information about the profitability of the firm. However, Z-score is likely to reflect additional information that profitability cannot convey. Z-score is defined as a function of four variables: profitability, sales, retained earnings and working capital. As a result Z-score tends to measure the ability of the firm to internally meet its financing needs. Therefore, firms with higher Z-score would be reluctant to finance their investment opportunities with external financing, something that would generate the relationship we observe between leverage and Z-score. To further investigate this possibility, we independently sort the data into quintiles based on the estimated probability of financial distress (PROBFD), Z-score and on profitability (PROF). If PROBFD and Z-score are measuring the same thing, we would expect strong positive correlation between PROBFD in the highest PROBFD quintile and Z-score in the lowest Z-score quintile. Similarly, the correlation between PROBFD in the lowest PROBFD quintile and Z-score in the highest Z-score quintile should also be strongly positive. Table 7 reports Pearson and Spearman correlation coefficients across the highest and lowest quintiles of PROBFD, Z-score and profitability. The estimated probability of financial distress in the highest quintile (PROBFD_H) is negatively correlated with the Z-score in the lowest quintile (Z-SCORE_L), the Pearson and Spearman correlation coefficients being -0.18 and -0.21, respectively. In addition, there is no correlation between the estimated probability of financial distress in the lowest quintile (PROBFD_L) and the Z-score in the highest quintile (Z-SCORE_H). There is, however, a statistically significant positive correlation between Z-score and profitability.

4 Summary and conclusions

In this paper we have examined the relationship between corporate tax, financial distress and leverage allowing for the marginal corporate tax rate and financial distress to be endogenous.

We use a before-financing measure of the marginal corporate tax rate which overcomes the endogeneity problem associated with this variable. Unlike other studies in the literature, we use the probability of financial distress estimated from a hazard model as a proxy for financial distress. We find that irrespective of whether we allow for leverage dynamics in the regression model, there is a positive relationship between the before-financing tax rate that we use and both book and market leverage. These findings lend support to the trade-off theory of capital structure. However, when there are no leverage dynamics in the model, the probability of financial distress has a significantly positive coefficient, suggesting that increases in the probability of financial distress increase leverage. This result seems counter-intuitive. Moreover, this finding is not a result of the choice of measure of financial distress, for the same finding arises if we use the Z-score in place of the probability of financial distress. When we use a dynamic model that accounts for leverage dynamics, however, we find that the sign on the probability of financial distress flips and there is a significant negative relationship between the probability of financial distress and leverage, that is, an increased probability of financial distress reduces leverage. Interestingly, the flip in sign does not occur when we use Z-score instead of the probability of financial distress. This suggests that either the Z-score is not a good measure of financial distress relative to the probability of financial distress estimated from a discrete choice model, or that it is capturing other behavior such as profitability. Overall, our results suggest that in the context of a dynamic empirical model of leverage, tax and the probability of financial distress are important determinants of leverage. Our findings seem to lend support to the predictions of the trade-off theory of capital structure, albeit in a dynamic setting.

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Appendix

Variable Construction

This Appendix details the construction of the variables used. All numbers in parentheses refer to the Compustat code.

Total Debt = Debt in Current Liabilities (34) + Long–term Debt (9)

Book Leverage = $\frac{\text{Total Debt}}{\text{Total Debt+Stockholders' Equity (216)}}$

Total debt = Debt in current liabilities (34) + Long–term debt (9)

Book Leverage = $\frac{\text{Total debt}}{\text{Total debt+Stockholders' equity (216)}}$

Market value of equity = Stock Price (199) $*$ Shares outstanding (54)

Market Leverage = $\frac{\text{Total debt}}{\text{Total debt+Market value of equity (mcap)}}$

EBIT = Pretax income (170) + Interest expense (15)

ATRBF = $\frac{\text{(Income tax (16)+(Interest expense}*\text{Top Statutory Tax Rate))}}{\text{EBIT}}$

PROBFD = Estimated probability of financial distress from a hazard model

Working Capital = Current assets(4) − Current liabilities

Z-Score = $3.3\frac{\text{EBIT}}{\text{Total Assets}} + 1.0\frac{\text{Sales(12)}}{\text{Total Assets}} + 1.4\frac{\text{Ret.Earnings(36)}}{\text{Total Assets}} + 1.2\frac{\text{Working Capital}}{\text{Total Assets.}}$

Size = Natural logarithm of Sales, where net sales are deflated by the GDP deflator

Tangibility = $\frac{\text{Property, plant and equipment (8)}}{\text{Book value of assets (6)}}$

Profitability = $\frac{\text{Operating income before depreciation (13)}}{\text{Book value of assets}}$

Market to book = $\frac{\text{Book value of assets}-\text{Common equity (60)+Market value of equity}}{\text{Book value of assets}}$

Ind_LEV = the median industry book leverage, based on the SIC four-digit code

Table 1: Descriptive Statistics

The Compustat-CRSP Merged (CCM) contains 11,501 firms and 107,068 firm-year observations from 1950–2002. All variables except market leverage, size and the probability of financial distress are winsorized at the 0.5^{th} and $99.5^{\ th}$ percentiles. Book leverage is book value of debt divided by book value of debt plus book value of stockholders' equity. Market leverage is book value of debt divided by book value of debt plus market value of equity. Lagged book leverage is the book leverage in year t-1. Lagged market leverage is market leverage in year t-1. The before-financing tax rate, ATRBF, is measured as total income tax plus interest expense multiplied by the top statutory tax rate, all divided by earnings before interest and tax (EBIT). PROBFD is the estimated probability of financial distress. Z-score is defined as 3.3 multiplied by EBIT plus sales plus 1.4 multiplied by retained earnings plus 1.2 multiplied by working capital all divided by total assets. SIZE is the natural logarithm of net sales (in millions). TANG is the ratio of fixed assets to total assets. PROF is earnings before tax,interest, depreciation and amortization divided by total assets. MTB is the market value of assets divided by the book value of assets. IND_LEV is the median industry book leverage based on the SIC four-digit code.

Variable	Mean	Median	Std.dev	Min	Max
Lagged Book Leverage	0.32	0.30	0.28	0.00	2.02
Lagged Market Leverage	0.26	0.20	0.24	0.00	1.00
ATRBF	0.36	0.38	0.32	0.00	2.72
PROBFD	0.01	0.00	0.01	0.00	0.43
Z-score	1.52	2.12	3.15	-26.88	6.78
SIZE	4.96	5.02	2.25	-6.91	12.37
TANG	0.32	0.27	0.22	0.00	0.93
PROF	0.08	0.12	0.23	-1.76	0.47
MTB	1.78	1.25	1.74	0.24	17.14
IND_LEV	0.29	0.30	0.16	0.00	0.80

Table 2: Tobit and Fixed Effect Estimation Results, Book Leverage

The dependent variable is book leverage which is book value of debt divided by book value of debt plus book value of stockholders' equity. Model 1 includes the probability of financial distress as a measure of financial distress costs. The sample consists of 110,384 firm-year observations from 1950-2002. Model 2 includes Z-score instead of the probability of financial distress as a measure of financial distress costs. The sample consists of 130,254 firm-year observations from 1950-2002. The sample in model 1 consists of fewer firm year observations as data availability for the probability of financial distress is less than that of Z-score. This is because our probability of financial distress is estimated using lagged independent variables. The before-financing tax rate, ATRBF, is measured as total income tax plus interest expense multiplied by the top statutory tax rate, all divided by earnings before interest and tax (EBIT). PROBFD is the estimated probability of financial distress. Z-score is defined as 3.3 multiplied by EBIT plus sales plus 1.4 multiplied by retained earnings plus 1.2 multiplied by working capital all divided by total assets. SIZE is the natural logarithm of net sales. TANG is the ratio of fixed assets to total assets. PROF is earnings before tax, interest, depreciation and amortization divided by total assets. MTB is the ratio of the book value of assets less the book value of equity plus the market value of equity all divided by the book value of assets. Industry leverage is the median industry book leverage, where industries are classified according to the SIC four-digit code. Two different estimation techniques are used. The regression is estimated using a Tobit model censoring at zero at the lower end and one at the upper end and a Fixed effects(FE) model. The estimated model 1 is: $Leverage_{it} = \alpha + \beta_1 ATRBF_{it} + \beta_2 PROBFD_{it} + \beta_3 SIZE_{it} + \beta_4 TANG_{it} + \beta_5 PROF_{it} + \beta_6 Market\ to\ book_{it} + \beta_7 IND\_LEV_{it} + \epsilon_{it}$. Model 2 uses Z-score instead of PROBFD. ***,** and * denote significance at the 1, 5 and 10 percent level respectively.

	Dependent Variable=Book leverage			
	Model 1	Model 2	Model 1	Model2
	Censored Tobit		FE	
Constant	-0.0940***	0.0169***	-0.0742***	-0.0157***
	(-33.93)	(6.66)	(-12.50)	(-3.07)
ATRBF	0.1046***	0.1125***	0.0542***	0.0597***
	(45.16)	(50.16)	(24.61)	(27.34)
PROBFD	8.3310***		5.2009***	
	(255.46)		(62.60)	
Z-score		-0.0211***		-0.0308***
		(-57.50)		(-71.25)
SIZE	0.0247***	0.0175***	0.0377***	0.0368***
	(64.76)	48.11	(38.83)	(42.31)
TANG	0.1573***	0.1165***	0.2019***	0.2055***
	(45.20)	(32.95)	(27.84)	(29.22)
PROF	-0.1904***	-0.0339***	-0.3251***	-0.0417***
	(-50.95)	(-6.86)	(-66.92)	(-7.38)
MTB	-0.0140***	-0.0184***	-0.0042***	-0.00795***
	(-29.55)	(-44.54)	(-7.68)	(-17.05)
IND_LEV	0.6449***	0.6907***	0.4988***	0.5367***
	(133.18)	(143.06)	(67.26)	(72.82)
Number of observations	110,384	130,254	110,384	130,254

Table 3: Tobit and Fixed Effects Estimation Results, Market Leverage

The dependent variable is market leverage which is book value of debt divided by book value of debt plus market value of equity. Model 1 includes the probability of financial distress as a measure of financial distress costs. The sample consists of 110,291 firm-year observations from 1950-2002. Model 2 includes Z-score instead of the probability of financial distress as a measure of financial distress costs. The sample consists of 129,885 firm-year observations from 1950-2002. The sample in model 1 consists of fewer firm year observations as data availability for the probability of financial distress is less than that of Z-score. This is because our probability of financial distress is estimated using lagged independent variables. The before-financing tax rate, ATRBF, is measured as total income tax plus interest expense multiplied by the top statutory tax rate, all divided by earnings before interest and tax (EBIT). PROBFD is the estimated probability of financial distress. Z-score is defined as 3.3 multiplied by EBIT plus sales plus 1.4 multiplied by retained earnings plus 1.2 multiplied by working capital all divided by total assets. SIZE is the natural logarithm of net sales. TANG is the ratio of fixed assets to total assets. PROF is earnings before tax, interest, depreciation and amortization divided by total assets. MTB is the ratio of the book value of assets less the book value of equity plus the market value of equity all divided by the book value of assets. Industry leverage is the median industry book leverage, where industries are classified according to the SIC four-digit code. Two different estimation techniques are used. The regression is estimated using a Tobit model censoring at zero at the lower end and one at the upper end, and a Fixed effects (FE) model. The estimated model 1 is: $Leverage_{it} = \alpha + \beta_1 ATRBF_{it} + \beta_2 PROBFD_{it} + \beta_3 SIZE_{it} + \beta_4 TANG_{it} + \beta_5 PROF_{it} + \beta_6 Market\ to\ book_{it} + \beta_7 Ind\_LEV_{it} + \epsilon_{it}$. Model 2 uses Z-score instead of PROBFD. ***,** and * denote significance at the 1, 5 and 10 percent levels respectively.

Dependent Variable=Market leverage				
	Model 1	Model 2	Model 1	Model2
	Censored Tobit		FE	
Constant	-0.0309***	0.1261***	-0.0068	0.1211***
	(-11.84)	(49.61)	(-1.58)	(30.92)
ATRBF	0.1026***	0.1102***	0.0490***	0.0487***
	(49.64)	(49.59)	(30.69)	(29.38)
PROBFD	8.4798***		4.7204***	
	(105.86)		(77.83)	
Z-score		-0.0279***		-0.0253***
		(-74.77)		(-75.39)
SIZE	0.0229***	0.0109***	0.0303***	0.0182***
	(64.45)	(30.02)	(43.02)	(27.52)
TANG	0.1222***	0.0682***	0.1729***	0.1417***
	(38.81)	(19.37)	(32.87)	(26.44)
PROF	-0.2183***	0.0027	-0.2509***	0.0063
	(-61.94)	(0.54)	(-70.93)	(-1.45)
MTB	-0.0527***	-0.0578 ***	-0.0311***	-0.0336***
	(-117.46)	(-134.10)	(-79.01)	(-95.23)
IND_LEV	0.5623***	0.6166***	0.3756***	0.3952***
	(127.79)	(128.59)	(69.88)	(70.71)
Number of observations	110,291	129,885	110,291	129,885

Table 4: Arellano-Bond Estimation Results, Book Leverage

The dependent variable is book leverage which is book value of debt divided by book value of debt plus book value of stockholders' equity. Model 1 includes the probability of financial distress as a measure of financial distress costs. The sample consists of 97,821 firm-year observations from 1963-2002. Model 2 includes Z-score instead of the probability of financial distress as a measure of financial distress costs. The sample consists of 104,495 firm-year observations from 1963-2002. The sample in model 1 consists of fewer firm year observations as data availability for the probability of financial distress is less than that of Z-score. This is because our probability of financial distress is estimated using lagged independent variables. Lagged book leverage is the book leverage in year t-1. The before-financing tax rate, ATRBF, is measured as total income tax plus interest expense multiplied by the top statutory tax rate, all divided by earnings before interest and tax (EBIT). PROBFD is the estimated probability of financial distress. Z-score is defined as 3.3 multiplied by EBIT plus sales plus 1.4 multiplied by retained earnings plus 1.2 multiplied by working capital all divided by total assets. SIZE is the natural logarithm of net sales. TANG is the ratio of fixed assets to total assets. PROF is earnings before tax, interest, depreciation and amortization divided by total assets. MTB is the ratio of the book value of assets less the book value of equity plus the market value of equity all divided by the book value of assets. Industry leverage is the median industry book leverage, where industries are classified according to the SIC four-digit code. We also include year dummies (not reported) in the dynamic specification. The estimated model 1 is: $Leverage_{it} = \alpha + \beta_1 Leverage_{i,t-1} + \beta_2 ATRBF_{i,t} + \beta_3 PROBFD_{i,t} + \beta_4 SIZE_{i,t} + \beta_5 TANG_{i,t} + \beta_6 PROF_{i,t} + \beta_7 Market\ to\ book_{i,t} + \beta_8 IND\_LEV_{i,t} + \eta_i + \eta_t + \epsilon_{it}$. The model is estimated as a dynamic panel data model using the Arellano-Bond two-step GMM estimator with Windmeijer's correction to the standard errors. ***,** and * denote significance at the 1, 5 and 10 percent level respectively. Model 2 uses Z-score instead of PROBFD. ***,** and * denote significance at the 1, 5 and 10 percent level respectively.

	Dependent Variable=Book leverage	
	Model 1	Model 2
Lagged book leverage	0.5052***	0.4795***
	(19.27)	(23.33)
ATRBF	0.0490***	0.0528***
	(2.84)	(3.48)
PROBFD	-2.2111***	
	(-3.84)	
Z-score		-0.0209***
		(-6.47)
SIZE	0.0545***	0.0272 ***
	(6.26)	(3.50)
TANG	0.2675***	0.2512***
	(5.58)	(5.37)
PROF	-0.1378***	-0.0060
	(-3.82)	(-0.17)
MTB	-0.0009	0.0019
	(-0.44)	(1.08)
IND_LEV	0.2015***	0.2300**
	(6.31)	(8.01)
Number of observations	97,821	104,495
Sargan test	2181.87 ***	2185.24***
AR(1)	-15.35***	-17.20***
AR(2)	0.38	2.01**

Table 5: Arellano-Bond Estimation Results, Market Leverage

The dependent variable is market leverage which is book value of debt divided by book value of debt plus market value of equity. Model 1 includes the probability of financial distress as a measure of financial distress costs. The sample consists of 97,749 firm-year observations from 1963-2002. Model 2 includes Z-score instead of the probability of financial distress as a measure of financial distress costs. The sample consists of 104,488 firm-year observations from 1963-2002. The sample in model 1 consists of fewer firm year observations as data availability for the probability of financial distress is less than that of Z-score. This is because our probability of financial distress is estimated using lagged independent variables. Lagged market leverage is market leverage in year t-1. The before-financing tax rate, ATRBF, is measured as total income tax plus interest expense multiplied by the top statutory tax rate, all divided by earnings before interest and tax (EBIT). PROBFD is the estimated probability of financial distress. Z-score is defined as 3.3 multiplied by EBIT plus sales plus 1.4 multiplied by retained earnings plus 1.2 multiplied by working capital all divided by total assets. SIZE is the natural logarithm of net sales. TANG is the ratio of fixed assets to total assets. PROF is earnings before tax, interest, depreciation and amortization divided by total assets. MTB is the ratio of the book value of assets less the book value of equity plus the market value of equity all divided by the book value of assets. Industry leverage is the median industry book leverage, where industries are classified according to the SIC four-digit code. We also include year dummies (not reported) in the dynamic specification. The estimated model 1 is: $Leverage_{it} = \alpha + \beta_1 Leverage_{i,t-1} + \beta_2 ATRBF_{i,t} + \beta_3 PROBFD_{i,t} + \beta_4 SIZE_{i,t} + \beta_5 TANG_{i,t} + \beta_6 PROF_{i,t} + \beta_7 Market\ to\ book_{i,t} + \beta_8 IND\_LEV_{i,t} + \eta_i + \eta_t + \epsilon_{it}$. The model is estimated as a dynamic panel data model using the Arellano-Bond two-step GMM estimator with Windmeijer's correction to the standard errors. ***,** and * denote significance at the 1, 5 and 10 percent level respectively. Model 2 uses Z-score instead of PROBFD. ***,** and * denote significance at the 1, 5 and 10 percent level respectively.

Dependent Variable=Market leverage		
	Model 1	Model 2
Lagged market leverage	0.5568***	0.6329***
	(33.72)	(51.20)
ATRBF	0.0212	0.0486 ***
	(1.40)	(3.11)
PROBFD	-2.2578***	
	(-5.30)	
Z-score		-0.0111***
		(-5.11)
SIZE	0.0974***	0.0387***
	(12.56)	(6.66)
TANG	0.2397***	0.1778***
	(5.56)	(5.16)
PROF	-0.1469***	-0.1016***
	(-5.13)	(-4.30)
MTB	-0.0019	-0.0004
	(-1.14)	(-0.34)
IND_LEV	0.1612***	0.2088***
	(5.17)	(7.67)
Number of observations	97,749	104,488
Sargan statistic	3580.69***	2794.03***
AR(1)	-27.32***	-34.92***
AR(2)	-4.04 ***	-1.50

Table 6: Arellano-Bond Estimation Results incorporating both PROBFD and Z-score

This table shows the Arellano-Bond estimation results when using either book leverage or market leverage as the dependent variable incorporating both probability of financial distress and Z-score in the dynamic model. Book leverage is book value of debt divided by book value of debt plus book value of stockholders' equity. The sample consists of 94,891 firm-year observations from 1963-2002 when book leverage is the dependent variable. Market leverage is book value of debt divided by book value of debt plus market value of equity. The sample consists of 94,822 firm-year observations from 1963-2002 when market leverage is the dependent variable. Lagged book leverage is the book leverage in year t-1. Lagged market leverage is market leverage in year t-1. Lagged market leverage is market leverage in year t-1. The before-financing tax rate, ATRBF, is measured as total income tax plus interest expense multiplied by the top statutory tax rate, all divided by earnings before interest and tax (EBIT). PROBFD is the estimated probability of financial distress. Z-score is defined as 3.3 multiplied by EBIT plus sales plus 1.4 multiplied by retained earnings plus 1.2 multiplied by working capital all divided by total assets. SIZE is the natural logarithm of net sales. TANG is the ratio of fixed assets to total assets. PROF is earnings before tax, interest, depreciation and amortization divided by total assets. MTB is the ratio of the book value of assets less the book value of equity plus the market value of equity all divided by the book value of assets. Industry leverage is the median industry book leverage, where industries are classified according to the SIC four-digit code. We also include year dummies (not reported) in the dynamic specification. We also include year dummies (not reported) in the dynamic specification. The estimated model is: $Leverage_{it} = \alpha + \beta_1 Leverage_{i,t-1} + \beta_2 ATRBF_{i,t-1} + \beta_3 PROBFD_{i,t-1} + \beta_4 Z - score_{i,t-1} + \beta_5 SIZE_{i,t-1} + \beta_6 TANG_{i,t-1} + \beta_7 PROF_{i,t-1} + \beta_8 Market\ to\ book_{i,t-1} + \beta_9 IND\_LEV_{i,t-1} + \eta_i + \eta_t + \epsilon_{it}$. The model is estimated as a dynamic panel data model using the Arellano-Bond two-step GMM estimator with Windmeijer's correction to the standard errors. ***,** and * denote significance at the 1, 5 and 10 percent level respectively.

	Book Leverage	Market Leverage
Lagged book leverage	0.4878***	
	(19.32)	
Lagged market leverage		0.5615***
		(35.39)
ATRBF	0.0486***	0.0066
	(3.04)	(0.46)
PROBFD	-2.4270***	-2.2742***
	(-4.40)	(-5.68)
Z-score	-0.2221***	-0.0200***
	(-5.96)	(-7.66)
SIZE	0.0408***	0.0820***
	(4.84)	(11.23)
TANG	0.2301***	0.2219***
	(4.79)	(5.37)
PROF	-0.0367***	-0.0315
	(-0.98)	(-1.10)
MTB	0.0002**	-0.0008
	(0.09)	(-0.49)
IND_LEV	0.2155***	0.1668***
	(7.03)	(5.75)
Number of observations	94,891	94,822
Sargan statistic	2344.59***	3399.45***
AR(1)	-14.95***	-29.62***
AR(2)	0.75	-4.69 ***

Table 7: Correlations across the highest and lowest quintiles of Probability of Financial Distress, Z-score and Profitability

We independently sort our sample into quintiles, ranking first on the estimated probability of financial distress (PROBFD), then on Z-score and finally on profitability (PROF). The table shows the Pearson correlation coefficient above the diagonal and the Spearman correlation coefficient below the diagonal. PROBFD_H, Z-score_H and PROF_H refer to the highest quintiles of PROBFD, Z-score and PROF respectively. Likewise, PROBFD_L, Z-score_L and PROF_L refer to the lowest quintiles of PROBFD, Z-score and PROF respectively. PROBFD is the estimated probability of financial distress, Z-score is defined as 3.3 multiplied by EBIT plus sales plus 1.4 multiplied by retained earnings plus 1.2 multiplied by working capital all divided by total assets, and PROF is earnings before interest, tax, depreciation and amortization, divided by total assets.

	PROBFD_H	PROBFD_L	Z-score_H	Z-score_L	PROF_H	PROF_L
PROBFD_H	1			-0.219***		-0.182 ***
PROBFD_L		1	0.003		-0.118***	
Z-score_H		-0.004	1		0.267 ***	
Z-score_L	-0.213***			1		0.728 ***
PROF_H		-0.118***	0.262 ***		1	
PROF_L	-0.168***			0.671***		1