The Risk-Adjusted Cost of Financial Distress*

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Abstract

We argue that risk premia affect the valuation of financial distress costs, because these costs are more likely to be incurred in bad times. We compute the NPV of distress costs using risk-adjusted default probabilities that are derived from corporate bond spreads. Because credit spreads are large, the magnitude of the risk-adjustment is substantial. For a firm whose bonds are rated BBB, our benchmark calculations show that the risk-adjusted NPV of distress is 4.5% of pre-distress firm value. In contrast, a valuation of distress costs that ignores risk premia produces an NPV of distress of 1.4%. The risk adjustment also increases the marginal effect of leverage on distress costs. We show that risk-adjusted, marginal distress costs can be of similar magnitude as the marginal tax benefits of debt derived by Graham (2000). Thus, distress risk premia can help explain why firms appear rather conservative in their use of debt.

Key words: Financial distress, corporate valuation, capital structure, default risk, credit spreads, debt conservatism.

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1 Introduction

A large literature shows that financial distress has direct and indirect costs (Warner, 1977, Altman, 1984, Franks and Touros, 1989, Weiss, 1990, Ofek, 1993, Asquith, Gertner and Scharfstein, 1994, Opler and Titman, 1994, Sharpe, 1994, Denis and Denis, 1995, Gilson, 1997, Andrade and Kaplan, 1998, Maksimovic and Phillips, 1998). However, there is much debate as to whether such costs are high enough to matter for corporate valuation practices and capital structure decisions. Direct costs of distress, such as those entailed by litigation fees, are relatively small.[1] Indirect costs, such as loss of market share (Opler and Titman, 1994) and inefficient asset sales (Shleifer and Vishny, 1992), are believed to be more important, but they are also much harder to quantify. Andrade and Kaplan (1998) estimate losses in value given distress, and report numbers of the order of 10% to 23% of pre-distress firm value for a sample of highly leveraged firms.[2]

Irrespective of their exact magnitudes, however, ex-post losses due to distress must be capitalized in order to assess their importance for ex-ante capital structure decisions. The existing literature argues that even if ex-post losses amount to 10%-20% of firm value, ex-ante distress costs are modest because the probability of financial distress is very small for most public firms (Andrade and Kaplan, 1998, Graham, 2000). In this paper, we propose a new way of calculating the NPV of financial distress costs. Our results show that the existing literature has substantially underestimated the magnitude of ex-ante distress costs.

A standard method to calculate ex-ante distress costs is to multiply Andrade and Kaplan's (1998) estimates of ex-post costs by historical probabilities of default (Graham, 2000, Molina, 2005). This calculation ignores capitalization and discounting. Other papers assume risk-neutrality, and discount the product of historical probabilities and losses in value

[1] Warner (1977) and Weiss (1990), for example, estimate costs of the order of 3%-5% of firm value at the time of distress.

[2] Altman (1984) finds similar cost estimates of 11% to 17% of firm value on average, three years prior to bankruptcy. However, Andrade and Kaplan argue that part of these costs might not be genuine financial distress costs, but rather consequences of the economic shocks that drove firms into distress. An additional difficulty in estimating ex-post distress costs is that firms are more likely to have high leverage and to become distressed if distress costs are expected to be low. Thus, any sample of ex-post distressed firms is likely to have low ex-ante distress costs.

given default by a risk-free rate (e.g., Altman (1984)).[3] This calculation, however, ignores the fact that distress is more likely to happen in bad times. Thus, risk-averse investors should care more about financial distress than what is suggested by risk-free valuations. Our goal in this paper is to quantify the impact of distress risk premia on the NPV of distress costs.

Our approach is based on the following insight: to the extent that financial distress costs occur in states of nature in which bonds default, one can use corporate bond prices to estimate the distress risk adjustment. The asset pricing literature has provided substantial evidence for a systematic component in corporate default risk. It is well-known that the spread between corporate and government bonds is too high to be explained only by expected default, and that it reflects in part a large risk premium (Elton, Gruber, Agrawal and Mann, 2001, Huang and Huang, 2003, Longstaff, Mittal, and Neis, 2005, Driessen, 2005, Chen, Collin-Dufresne, and Goldstein, 2005, Cremers, Driessen, Maenhout and Weinbaum 2005, Berndt, Douglas, Duffie, Ferguson, and Schranz, 2005).[4]

Our new methodology, like the standard calculations, takes as given the estimates of ex-post distress costs provided by Andrade and Kaplan (1998) and Altman (1984), but, unlike those calculations, it uses observed credit spreads to back out the market-implied, risk-adjusted (or "risk-neutral") probabilities of default. Such an approach is common in the credit risk literature (i.e., Duffie and Singleton, 1999, and Lando, 2004). Our calculations also take into account tax and liquidity effects (Elton et al., 2001, Chen, Lesmond, and Wei, 2004), and use only the fraction of the spread that is likely to be due to default risk.

Our estimates imply that risk-adjusted probabilities of default and, consequently, the risk-adjusted NPV of distress costs, are considerably larger than, respectively, historical default probabilities and the non risk-adjusted NPV of distress. Consider for instance a firm whose bonds are rated BBB. The historical 10-year cumulative probability of default

[3] Structural models in the tradition of Leland (1994) and Leland and Toft (1996) are typically written directly under the risk neutral measure. Others (e.g., Titman and Tsyplakov (2004), and Hennessy and Whited (2005)) assume risk-neutrality and discount the costs of financial distress by the risk free rate. In either case, these models do not emphasize the difference between objective and risk-adjusted probabilities of distress.

[4] See also Pan and Singleton (2005), for related evidence on soverign bonds.

for BBB bonds in our data is 5.22%. However, in our benchmark calculations the 10-year cumulative risk-adjusted default probability implied by BBB spreads is 20.88%. This large difference between historical and risk-adjusted probabilities translates into a substantial difference in NPVs of distress costs. Using the average loss in value given distress from Andrade and Kaplan (1998), our NPV formula implies a risk-adjusted distress cost of 4.5%. For the same ex-post loss, the non risk-adjusted NPV of distress is only 1.4% for BBB bonds.

Our results have implications for capital structure. In particular, they suggest that marginal, risk-adjusted distress costs can be of the same magnitude as the marginal tax benefits of debt computed by Graham (2000). For example, using our benchmark assumptions the increase in risk-adjusted distress costs associated with a change in ratings from AA to BBB is 2.7% of pre-distress firm value.[5] To compare this number with marginal tax benefits of debt, we derive the marginal tax benefit of leverage that is implicit in Graham's (2000) calculations, and use the relationship between leverage ratios and bond ratings recently estimated by Molina (2005). The implied gain in tax benefits as the firm moves from an AA to a BBB rating is 2.67% of firm value. Thus, it is not clear that the firm gains much by increasing leverage from AA to BBB levels.[6] These results suggest that the large distress costs that we estimate may help explain why many US firms appear to be conservative in their use of debt, as suggested by Graham (2000).

The paper proceeds as follows. We start in the next section by presenting a simple example of how our valuation approach works. The general methodology is presented in section 3. In section 4, we present our empirical estimates of the NPV of distress costs. Section 5 discusses the capital structure implications of our results, and section 6 concludes.

[5] For comparison purposes, the increase in marginal, non risk-adjusted distress costs is only 1.11%.

[6] This conclusion generally holds for variations of the assumptions used in the benchmark valuations. The results are most sensitive to the estimate of losses given distress. See section 5.1.3.

2 Using Credit Spreads to Value Distress Costs: A Simple Example

In this section, we explain our procedure with a simple example. The purpose of the example is both to illustrate the intuition behind the general procedure that we explain in section 3, and to provide simple "back-of-the-envelope" formulas that can be used to value financial distress costs. The formulas derived in this section are easy to implement, and provide a reasonable approximation to the more precise formulas derived later. We start with a one-period example, and then present an infinite horizon example.

One-period example

Suppose that we want to value distress costs for a firm that has issued an annual-coupon bond maturing in exactly one year. The bond's yield is equal to r^D, and the bond is priced at par. The bond's recovery rate, which is known with certainty today, is equal to ρ. Thus, if the bond defaults, creditors recover $\rho(1+r^D)$. The bond's valuation tree is depicted in Figure 1. The value of the bond equals the present value of expected future cash flows, adjusted for systematic default risk. If we let q be the risk-adjusted (or risk-neutral), one-year probability of default, we can express the bond's value as:

$$1 = \frac{(1-q)(1+r^D) + q\rho(1+r^D)}{1+r^F}, \tag{1}$$

where r^F is the one-year risk free rate. The idea behind this valuation formula is that the probability q incorporates the default risk premia that is implicit in the yield spread $(r^D - r^F)$. If investors were risk neutral, or if there was no systematic default risk, q would be equal to the expected probability of default (call it p). If default risk is priced, then the implied q is higher than p. Equation 1 can be solved for q:

$$q = \frac{r^D - r^F}{(1+r^D)(1-\rho)}. \tag{2}$$

Notice that the extent of the risk adjustment implicit in q is a direct function of the yield spread.

The basic idea of our paper is that we can use the risk-neutral probability of default q to do a risk-adjusted valuation of financial distress costs. Consider again Figure 1, which also depicts the valuation tree for distress costs. Let the loss in value given default be equal to ϕ, and the present value of distress costs be equal to Φ. For simplicity, suppose that ϕ is known with certainty today. If we assume that financial distress can only happen at the end of one year, but never again in future years, then we can express the present value of financial distress costs as:

$$\Phi = \frac{q\phi + (1-q)0}{1+r^F}. \tag{3}$$

Formula 3 is similar to that used by Graham (2000) and Molina (2005) to value distress costs. The key difference is that while Graham (2000) and Molina (2005) use *historical* default probabilities, equation 3 uses a risk-adjusted probability of financial distress that is calculated from yield spreads and recovery rates using equation 2.

Infinite horizon example

In order to provide a more precise estimate of the present value of financial distress costs, we must recognize that if financial distress does not happen at the end of the first year, it can still happen in future years. If we assume that the marginal risk-adjusted default probability (q) and the risk free rate (r^F) do not change after year one,[7] then the valuation tree becomes a sequence of one-year trees that are identical to that depicted in Figure 1. This implies that if financial distress does not happen in year one (an event that happens with probability $1-q$), the present value of future distress costs at the end of year one is again equal to Φ. Replacing 0 with Φ in the valuation equation 3 and solving for Φ we obtain:

$$\Phi = \frac{q}{q+r^F}\phi. \tag{4}$$

Equation 4 provides a better approximation to the present value of financial distress costs than equation 3. Notice also that for a given q (that is, irrespective of the risk-adjustment), equation 3 substantially underestimates the present value of distress costs.

The assumptions that q and r^F do not vary with the time horizon are counter-factual. The general procedure that we describe later allows for a term structure of q and r^F. For

[7] In a multi-period model, the probability q_t should be interpreted as the *marginal*, risk-adjusted default probability in year t, *conditional* on survival up to year $t-1$. In this simple example we assume that $q_t = q$ for all t.

the purpose of illustration, however, suppose that q and r^F are indeed constant. In the appendix, we spell out the conditions under which equation 2 can be used to obtain the (constant) risk-adjusted probability of default q.

To illustrate the impact of the risk-adjustment, take the example of BBB-rated bonds. In our data, the historical average 10-year spread on those bonds is approximately 1.9%, and the historical average recovery rate is equal to 0.41.[8] As we discuss in the next section, the credit risk literature suggests that this spread cannot be attributed entirely to default losses, because it is also affected by tax and liquidity considerations. Essentially, our benchmark calculations remove 0.51% from this raw spread.[9] The difference (1.39%) is what is usually called the "default component" of yield spreads. Using this default component, a recovery of 0.41, and a long term interest rate of 6.7% (the average 10-year treasury rate in our data), equation 2 gives an estimate for q equal to 2.2%. Using historical data to estimate the marginal default probability yields much lower values. For example, the average marginal default probability over time horizons from 1 to 10 years, for bonds of an initial BBB rating, is equal to 0.53% (Moody's, 2002). The large difference between risk neutral and historical probabilities suggests the existence of a substantial default risk premium.

As discussed in the introduction, the literature has estimated ex-post losses in value given default (the term ϕ) of 10% to 23% of pre-distress firm value. If we use for example the mid-point between these estimates ($\phi = 16.5\%$), the NPV of distress for the BBB rating goes from 1.2% (using historical probabilities), to 4.1% (using risk-adjusted probabilities). Clearly, incorporating the risk-adjustment appears to make a large difference to the valuation of financial distress costs. We now turn to the more general model to see if this conclusion is robust.

[8] See section 4.1 for a detailed description of the data.

[9] This adjustment factor is the historical spread over treasuries on a one-year AAA bond. In section 4.2 we discuss alternative ways to adjust for taxes and liquidity, and we argue that most (but not all) of them imply similar default component of spreads.

3 The General Valuation Formula

As discussed above, since the costs of distress tend to occur in states in which the firm's debt is in default, distress costs can be valued using risk-adjusted default probabilities. Figure 2 illustrates the timing of the general model that we use to value financial distress costs. Our goal is to calculate Φ, the NPV of distress costs, at an initial date (date 0). In the Figure, ϕ_t is the deadweight loss that the firm incurs if distress (default) happens at time t, where $t = 1, 2....$ We think of ϕ_t as a one-time cost paid in case of distress. After default, the firm might reorganize, or it might be liquidated. If the firm does not default at time t it moves to period $t + 1$, and so on.

We let q_t be the risk-adjusted, marginal probability of distress (default) in year t, conditional on no default until year $t - 1$. Unlike in section 2, we now allow q_t to vary with the time horizon. We also define $(1 - Q_t) = \prod_{s=1}^{t}(1 - q_s)$ as the risk-adjusted probability of surviving beyond year t. Conversely, Q_t is the cumulative, risk-adjusted probability of default before or during year t. The probability that default occurs exactly at year t is thus equal to $(1 - Q_{t-1})q_t$. Throughout the paper, we will maintain the following assumption:

Assumption A1: *The deadweight loss ϕ_t in case of default is constant, $\phi_t = \phi$.*

In particular, this assumption implies that there is no systematic risk associated with ϕ. Assumption A1 could lead us to underestimate the distress risk adjustment if the deadweight losses conditional on distress are higher in bad times, as suggested by Shleifer and Vishny (1992). However, it is also possible that deadweight losses are higher in good times, because financial distress might cause the firm to lose profitable growth options (Myers, 1977). Under A1, we can write the NPV of financial distress as:

$$\Phi = \phi \sum_{t \geq 1} B_t(1 - Q_{t-1})q_t \ , \tag{5}$$

where B_t is the price at time zero of a riskless zero-coupon bond paying one dollar at date t. Equation (5) gives the ex-ante value of financial distress as a function of the term structure of distress probabilities and risk free rates. In section 4.4, we estimate the average value of

Φ using the historical average term structures of B_t and Q_t, and in section 4.5.6 we discuss the impact of time variation in the price of credit risk.

3.1 Credit Spreads and Risk Neutral Probabilities of Financial Distress

As in section 2, we use observed corporate bond yields to estimate the risk-adjusted default probabilities that enter equation 5. Specifically, suppose that we observe at date 0 an entire term structure of yields for the firm whose distress costs we want to value, that is, we know the sequence $\{r_t^D\}_{t=1,2...}$, where r_t^D is the yield on the corporate bond that matures t years from now. In addition, suppose we know the coupons $\{c_t\}_{t=1,2...}$ associated with each bond maturity.[10] For now, we assume that the entire spread between r_t^D and the reference risk free rate is due to default losses, and relegate the discussion of tax and liquidity effects to section 4. By the definition of the yield, the date-0 value of the bond of maturity t, V_t, is

$$V_t = \frac{c_t}{(1+r_t^D)} + \frac{c_t}{(1+r_t^D)^2} + ... + \frac{1+c_t}{(1+r_t^D)^t} \ . \tag{6}$$

3.1.1 Bond Recovery Assumptions

We let $\rho_{\tau,t}$ be the dollar amount recovered by creditors if default occurs at date $\tau \leq t$, for a bond of maturity t. As discussed by Duffie and Singleton (1999), in order to obtain risk neutral probabilities from the term structure of bond yields, we need to make specific assumptions about bond recoveries. Our benchmark valuation uses the following assumption:

Assumption A2: Constant recovery of treasury (RT). *In case of default, the creditors recover $\rho_{\tau,t} = \rho P_{\tau,t}$, where $P_{\tau,t}$ is the price at date τ of a risk-free bond with the same maturity and coupons as the defaulted bond, and ρ is a constant.*

The RT assumption is due to Jarrow and Turnbull (1995). The idea behind the assumption is that default does not change the *timing* of the cash flows promised by the corporate bond. If default occurs, the creditor receives a fraction of the cash flows they would have

[10] For simplicity, we use a discrete model in which all payments (coupons, face value and recoveries) that refer to year t happen exactly at the end of year t.

received otherwise. In section 4.5.2, we discuss other assumptions commonly used in the credit risk literature and we show that our results are robust. The assumption that ρ is constant is similar to our previous assumption that ϕ is constant. However, there is some evidence in the literature that recovery rates tend to be lower in bad times (Altman et al., 2003, and Allen and Saunders, 2004). We verify in section 4.5.1 the robustness of our results to the introduction of recovery risk.

3.1.2 Deriving Risk-Neutral Probabilities

Our next task is to derive the term structure of risk-neutral probabilities from observed bond prices. We do so recursively. Under assumption A2, the price V_1 of a one-year bond must satisfy

$$V_1 = [(1 - Q_1) + Q_1\rho]\,(1 + c_1)B_1. \tag{7}$$

This equation gives Q_1 as a function of known quantities. Given $\{Q_\tau\}_{\tau=1..t}$, we show in the appendix that the value of a bond with maturity $t + 1$ is

$$\begin{aligned} V_{t+1} \;\; = \;\; & \sum_{\tau=1}^{t}[(1 - Q_\tau) + Q_\tau\rho]c_{t+1}B_\tau + \\ & + [(1 - Q_{t+1}) + Q_{t+1}\rho]\,(1 + c_{t+1})\,B_{t+1}. \end{aligned} \tag{8}$$

This equation can be inverted to obtain Q_{t+1}. Therefore, we can recursively derive the sequence of risk-adjusted probabilities $\{Q_t\}_{t=1,2...}$ from $\{V_t\}_{t=1,2...}$, $\{c_t\}_{t=1,2...}$, $\{B_t\}_{t=1,2...}$, and ρ. This procedure allows us to generalize equation (2). The risk-adjusted probabilities can then be used to value distress costs using equation (5).

4 Empirical Estimates

We start by describing the data used in the implementation of equations (8) and (5).

4.1 Data on Yield Spreads, Recovery Rates and Default Rates

We obtain data on corporate yield spreads over treasury bonds from Citigroup's yield book, which covers the period 1985-2004. The data is available for bonds rated A and BBB, separately for maturities 1-3, 3-7, 7-10, and 10+ years. For bonds rated BB and below, the data is available only as an average across all maturities. Since the yieldbook records AAA and AA as a single category, we rely on Huang and Huang (2003) to obtain separate spreads for the AAA and AA ratings. Table 1 in Huang and Huang reports average 4-year spreads for 1985-1995 from Duffee (1998), and average 10-year spreads for the period 1973-1993 from the Lehman's bond index. For consistency, we calculate our own averages from the yield book over the period 1985-1995, but we note that average spreads are similar over 1985-1995 and 1985-2004.[11] For all ratings, we fill out the maturities between 1 and 10 years that are not available in the raw data by linearly interpolating the spreads. We assume constant spreads across maturities for BB and B bonds. The spread data that we use is reported in Table 1.

Our benchmark valuation is based on the average historical spreads in Table 1. Thus, the resulting NPVs of distress should be seen as *unconditional* estimates of ex-ante distress costs, for each bond rating. We discuss the implications of time-variation in yield spreads in section 4.5.6.

We also obtain data on average treasury yields and zero coupon yields on government bonds of different maturities, from FRED and from JP Morgan. Because high expected inflation in the 1980's had a large effect on government yields, we use a broad time period (1985-2004) to calculate these yields.[12] Treasury data is available for maturities 1, 2, 3, 5, 7, 10 and 20, and zero yields are available for all maturities between 1 and 10. Again, we use a simple linear interpolation for missing maturities between 1 and 10.

Finally, we obtain historical cumulative default probabilities from Moody's (2002). The data is available for 1-year to 17-year horizons, for bonds of initial ratings ranging from AAA to B, and refer to averages over the period 1970-2001. These default data are similar to those used by Huang and Huang (2003).[13]While these data are not used directly for

[11] For example, the average 10+ spread for BBB bonds in the yieldbook data is 1.90% for both time periods. Average B-bond spreads are 5.45% if we use 1985-1995, and 5.63% if we use 1985-2004. In addition, we note that, for comparable ratings and maturities, the yield book data and the Huang and Huang data are similar. For example, the 10 year spread for BBB bonds is 1.94% in Huang and Huang.

[12] Some average treasury yields that we use are 5.74% (1-year), 6.32% (5-year), and 6.73% (10-year).

[13] The default probabilities are calculated using a cohort method. For example, the 5-year default rate for

the risk-adjusted valuations, they are useful for comparison purposes. Moody's (2002) also contains a time series of bond recovery rates for the period 1982-2001.[14] In most of our calculations we assume a constant recovery rate, which we set to its historical average of 0.413.

4.2 Estimating the Fraction of the Yield Spread That is Due to Default Risk

There is an ongoing debate in the literature about the role of default risk in explaining yield spreads such as those reported in Table 1. Because treasuries are more liquid than corporate bonds, part of the spread should reflect a liquidity premium (see Chen et al., 2004). Also, treasuries have a tax-advantage over corporate bonds because they are not subject to state and local taxes (Elton et al., 2001). These arguments suggest that we cannot attribute the entire spreads reported in Table 1 to default risk.

Several papers have attempted to estimate the default component of corporate bond spreads, using a number of different strategies. Huang and Huang (2003) use a calibration approach and find that the default component predicted by many structural models is relatively small.[15] In contrast, Longstaff et al. (2005) argue that credit default swap (CDS) premia are a good approximation of the default components, and suggest that the default component of spreads is much larger than that suggested by Huang and Huang. Chen et al. (2005) use structural credit risk models with a counter-cyclical default boundary, and show that such models can explain the entire spread between BBB and AAA bonds when calibrated to match the equity risk premium. Cremers et al. (2005) add jump risk to a structural credit risk model that is calibrated using option data, and generate credit spreads that are much closer to CDS premiums than those generated by the models in Huang and Huang. We summarize these recent findings in Table 2. With the exception of Huang and Huang, the findings in these papers appear to be reasonably consistent with each other.

AA bonds in year t is calculated using a cohort of bonds that were initially rated AA in year t-5.

[14] More specifically, the data refer to cross-sectional average recoveries for original issue speculative grade bonds.

[15] In particular, Huang and Huang's results imply that the distress probabilities in Leland (1994) and Leland and Toft (1996) incorporate a relatively low risk-adjustment.

Unfortunately, these papers report default components only for a subset of ratings and maturities.[16] Thus, to implement formulas (8) and (5), we must first estimate the default component across all ratings and maturities. We now present two ways to do so.

4.2.1 Method 1: Using the 1-year AAA spread

Following Chen et al. (2005), we assume that the component of the spread that is *not* given by default can be inferred from the spreads between AAA bonds and treasuries. Chen et al. use a 4-year maturity in their calculations, but our data on historical default probabilities suggest that, while there has never been any default for AAA bonds up to a 3-year horizon, there is already a small probability of default at a 4-year horizon (0.04%). Thus, it seems appropriate to use a shorter spread to adjust for taxes and liquidity.[17] The 1-year spread in Table 1 is 0.51%, and we calculate the default components for rating i and maturity t as

$$(\text{Default component})_{i,t} = (\text{spread})_{i,t} \; - 0.51\%. \tag{9}$$

Notice that formula 9 allows us to construct spread default components for all ratings and maturities. Table 2 reports some of the fractions implied by this procedure, for select maturities. By construction, the 4-year BBB fraction is virtually identical to that estimated by Chen et al.. Most of the other fractions are very close to those estimated by Longstaff et al. (2005) and Cremers et al. (2005), suggesting that method 1 produces default components that closely approximate CDS premia. The only real discrepancy is with respect to Huang and Huang (2003), who estimate lower fractions for investment-grade bonds.

4.2.2 Method 2: Using Spreads Over Swaps

As discussed above, Longstaff et al. (2005) argue that CDS premia are a good approximation for the default component of yield spreads. In addition, Blanco et al. (2005) show that the spread over swaps tracks CDS premia very closely. These results suggest that one can use

[16] Chen et al. consider only BBB bonds in their analysis, while Longstaff et al. do not provide estimates for AAA and B bonds. In addition, Huang and Huang provide estimates for 4- and 10-year maturities only, while Longstaff et al. and Chen et al. consider only one maturity (5-year, and 4-year, respectively). Cremers et al. report 10-year credit spreads for ratings between AAA and BBB.

[17] In any case, the difference between 1-year and 4-year AAA spreads (0.04%) is negligible, so using the 4-year spread would produce virtually identical results.

spreads over swaps to estimate the default component. Unfortunately, data on swap rates start only in 2000. Therefore, we cannot use Huang and Huang's spread data (which refers to 1985-1995), and consequently can only provide fraction estimates for A, BBB, BB and B-rated bonds. Using swap data for 2000-2004, we calculate the average default component for rating i and maturity t as

$$(\text{Fraction due to default})_{i,t} = \frac{(\text{spread})_{i,t} \; - (\text{swap}_t - \text{treasury}_t)}{(\text{spread})_{i,t}}. \tag{10}$$

Table 2 shows that this alternative approach gives fractions due to default that are very close to those obtained using the AAA spread of method 1.[18] Given these results, it seems safe to choose method 1 as our benchmark approach to calculate default components. An important advantage of method 1 is that it allows us to present valuations for all bond ratings, from AAA to B.

4.3 Estimating Risk Neutral Probabilities

Starting from the spreads reported in Table 1, we use equation (9) to estimate the default components, and then we use the default components to derive a term structure of risk-adjusted default probabilities. Each bond yield r_t^D is computed as the sum of the default component and the corresponding treasury rate. We must make an assumption about coupon rates in order to use equation (6). Our baseline calculations assume that the corporate bonds trade at par, so that $c_t = r_t^D$ and $V_t = 1$ for all t. We then use equation (8) to generate a sequence of cumulative probabilities of default $\{Q_t\}_{t=1,2..10}$.

Table 3 reports the risk-adjusted cumulative default probabilities for select maturities. For comparison purposes, we also report the historical cumulative probabilities of default from Moody's. The risk-adjusted, market-implied probabilities are larger than the historical ones for all ratings and maturities, and substantially so for investment-grade bonds. For instance, the 5-year historical default probability of BBB bonds is 1.95%, while the risk-neutral one is 11.39%. The ratio between risk-neutral and historical probabilities (averaged

[18] In fact, AAA spreads are very close to the difference between swap and treasury rates (see Feldhutter and Lando (2005) for some additional evidence on this point). Thus, it is not surprising that both methods give similar results.

over maturities) ranges from 3.57 for AAA-rated bonds to 1.21 for B-rated bonds. These ratios indicate the presence of a large credit risk premium. Interestingly, the ratios are highest for investment-grade bonds, specially for the AA, A and BBB ratings. One possible interpretation for this pattern is suggested by Cremers et al. (2005). If the default risk premium is associated with a jump risk premium, it is perhaps not surprising that the risk premium is lower for bonds that are quite likely to default (BB and B ratings).

4.4 Valuation

We can now use the term structure of risk-neutral probabilities computed in section 4.3 in the valuation equation (5). Because we only have cumulative default probabilities up to year 10, we compute a terminal value of financial distress costs at year 10 (details in the appendix). The terminal value is computed by assuming constant marginal risk-adjusted default probabilities and yearly risk free rates after year 10. Thus, the formula is very similar to that derived in the infinite horizon example of section 2. As in Section 2, we use $\phi = 16.5\%$ in our benchmark calculations. Graham (2004) and Molina (2005) use numbers in this range to compare tax benefits of debt and costs of financial distress.

The second column of Table 4 presents our estimates of the risk-adjusted cost of financial distress for different bond ratings. For comparison, we report in the first column the same valuations using the historical default rates.[19] Confirming the results of section 2, we find that risk is a first order issue in the valuation of distress costs. For instance, distress costs for the BBB-rating increase from 1.40% to 4.53% once we adjust for risk. In order to provide some evidence on the marginal increase in distress costs as the firm moves across ratings, we also report the difference in distress costs between the BBB and the AA rating. An increase in leverage that moves a firm from a AA to a BBB increases the cost of distress by 2.7%. In contrast, the increase is only 1.11% if we use historical probabilities. Thus, risk adjustment also matters for marginal distress costs.

[19] Notice that equation 5 only requires default probabilities and risk free rates to translate ϕ-estimates into NPV estimates. We assume that the historical marginal default probability is fixed after year 10 for each rating to compute a terminal value, and estimate the long term marginal default probability as the average marginal between years 10 and 17.

4.5 Robustness checks

The estimates in Table 4 rely on a set of assumptions about bond recoveries, coupon rates, and deadweight losses given distress. We now check the sensitivity of our results to these assumptions.

4.5.1 Recovery Risk

Following assumption A2, the benchmark valuation in column II of Table 4 uses $\rho = 0.413$ in equation (8). The use of an average historical recovery is common in the credit risk literature. Huang and Huang (2003), Chen et al. (2005), and Cremers et al. (2005), for example, use average historical recoveries of 0.51 in their calibrations. However, there is some evidence in the literature of a systematic component of recovery risk (Altman et al., 2003, and Allen and Saunders, 2004). As discussed by Berndt et al. (2005) and Pan and Singleton (2005), a standard way to incorporate recovery risk into credit risk models is to use a constant *risk-neutral* (as opposed to average historical) recovery rate. Berndt et al. (2005) use a risk-neutral recovery rate of 0.25, which is the *lowest* cross-sectional sample mean of recovery reported by Altman et al (2003). According to Pan and Singleton (2005), this is a common industry standard for the risk-neutral recovery rate.[20]

We note that the lower the recovery rate plugged into equation (8), the lower the implied risk-neutral probabilities. Low recoveries increase a creditor's loss given default, and thus for a given spread the implied probability of default is higher (see, for example, equation 2). Column III of Table 4 reports the results of decreasing the recovery rate to 0.25, without changing the estimate for ϕ. As expected, the risk-adjusted costs of financial distress decrease.[21] For example, the point estimate for the BBB rating goes from 4.53% to 3.70% if bond recovery goes from 0.41 to 0.25. Nonetheless, the risk adjustment is still large, and assuming a lower recovery does not affect the estimated *marginal* costs of distress

[20] Pan and Singleton (2005) use the term structure of sovereign CDS spreads to separately estimate risk-neutral recoveries and default intensities, and estimate recovery rates that are larger than the commonly used value of 0.25.

[21] Recall, however, that we are also assuming a constant ϕ. If the reason for a low value of ρ in bad times is precisely a high value of ϕ, then it is less clear that using historical ρs and ϕs leads us to overestimate distress costs.

much. For example, if bond recovery is 0.25, the increase in distress costs for a firm moving from AA to BBB is 2.2%, which is only slightly lower than the corresponding margin when recovery is 0.41 (2.7%). We conclude that our results are robust to the introduction of recovery risk.

4.5.2 Recovery of Face Value

Equation 8 is derived under the assumption that recovery is a fraction of a similar risk-free bond (RT assumption). Another commonly used assumption is that recovery is a fraction of the face value of the bond, with zero recovery of coupons (assumption RFV). In the appendix, we show how to derive the term structure of risk-neutral probabilities from the default component of the spreads under assumption RFV. Column IV of Table 4 shows the valuation results with this alternative assumption. The implied risk neutral probabilities of default are lower, and thus the valuation results are slightly lower than those that obtain under RT. However, it is clear from column IV that the two assumptions generate very similar costs of financial distress. The AA minus BBB margin, for example, goes from 2.69% (under RT) to 2.47% (RFV). We conclude that the valuation is robust to alternative recovery assumptions.

4.5.3 Coupon Rates

The risk neutral probabilities in Table 3 are derived under the assumption that the bond coupons are equal to the adjusted bond yields (the default component of the yield plus the corresponding treasury rate). To show the robustness of our results, Table 4 contains the valuations assuming that coupons are equal to 0.5 times the adjusted yields (in column V), or 1.5 times the adjusted yields (in column VI). Risk-adjusted probabilities, and thus risk-adjusted distress costs, are higher with higher coupons. However, it is clear from the Table that the results are relatively robust to variations in coupon rates. The BBB minus AA margin, for example, goes from 2.64% (when coupons are 0.5 times the yield) to 2.77% (when coupons are 1.5 times the yield). Thus, changes in assumed coupon rates have small effects on the marginal costs of financial distress.

4.5.4 Using Huang and Huang's (2003) fractions

As discussed in section 4.2, Huang and Huang (2003) estimate smaller default components of spreads than the ones we have used to construct Tables 3 and 4. Not surprisingly, using Huang and Huang's fractions leads to lower costs of financial distress, as shown in column VII. The difference is more pronounced for ratings between AAA and BBB. The BBB minus AA margin, for example, decreases to 1.65%. This margin is close to that calculated using historical probabilities. These results highlight the importance of more recent papers such as Longstaff et al (2005), Chen et al. (2005), and Cremers et al. (2005), which suggest that credit risk can explain a larger fraction of spreads.

4.5.5 Changes in ϕ

Columns I and II assume that ϕ=16.5%, the midpoint of the 10-23% range reported in Andrade and Kaplan (1998). In Panel B of Table 4 we report valuation results for the endpoints of this range.[22] Not surprisingly, direct changes in ϕ have a large impact on the valuations, both for historical and risk-adjusted probabilities. For example, the risk-adjusted BBB valuation goes from 1.95% (if $\phi = 10\%$), to 6.32% (if $\phi = 23\%$). Because the impact of changes in ϕ is higher if default probabilities are high, the effect on the margins is also large, specially when compared with the other assumptions in Table 4. The AA-BBB margin goes from 1.63% to 3.75% as ϕ goes from 10% to 23%. Thus, it is important to consider a range of values for ϕ in the capital structure exercises of the next section. On the other hand, the difference between historical and risk-adjusted valuations remains substantial, irrespective of ϕ. For example, if $\phi = 10\%$, the increase in the BBB-valuation that can be attributed to the risk-adjustment is still equal to 1.90%. Thus, ignoring the risk-adjustment substantially undervalues the costs of distress, for all ϕ-values in this range.

[22] Notice that unlike the robustness checks above, which only affect risk-adjusted probabilities, these variations also impact the valuation using historical probabilities.

4.5.6 Time Variation in Spreads[23]

We have conducted our analysis using average historical spreads to calculate risk-adjusted probabilities. Conceptually, we have answered the question: what are the costs of financial distress for an average firm about to be created, assuming that aggregate business conditions are and will remain at historical averages?

In reality, however, the market price of credit risk (as captured by credit spreads) varies over time (see Berndt et al. (2005), and Pan and Singleton (2005)). This insight has two important implications for this paper. First, the (conditional) NPV of financial distress costs will change over time as credit spreads move around. Second, we might underestimate the size of the risk adjustment, because a risk-adjusted ex-ante valuation should put more probability weight on episodes of high spreads than on those of low spreads.

In order to understand these points more clearly, consider Figure 3. We want to compute the value of financial distress at time 0. At time 1, an aggregate shock is realized, which affects the price of credit risk, and thus changes credit spreads. We assume that the probability of each time-1 aggregate state, under the *historical, objective* measure (the "P-measure") is 0.5. If spreads are high, the analysis above suggests that the risk-adjusted probability of distress will also be high. That is, q_H is higher than q_L. At time 2, the firm learns whether financial distress occurs or not.

The risk-adjusted valuation that we perform in section 3 uses historical average spreads to compute risk-adjusted probabilities of distress. In the context of Figure 3, the NPV of distress using the methodology of section 3 would be:

$$\Phi_P = \frac{0.5q_H + 0.5q_L}{(1+r_F)^2}\phi = \frac{E^P(q)\phi}{(1+r_F)^2}, \tag{11}$$

where $E_P(q) = 0.5q_H + 0.5q_L$ is the date-0 expectation of the (time-varying, conditional) probability of financial distress, *under the P-measure.* This valuation formula incorporates systematic risk, because it uses the risk-adjusted conditional probabilities of distress q_H and q_L. However, this formula also assumes that investors are risk-neutral towards the risk of

[23]We thank our referee for suggesting this discussion to us.

variation over time in spreads. In reality, investors should also attribute a risk-premium to the uncertainty about spreads,[24] or in other words, the risk-adjusted date-0 expectation of future default probabilities should be higher than that calculated under historical averages:

$$E^Q(q) > E^P(q) \tag{12}$$

Clearly, a valuation that incorporates the difference between $E^Q(q)$ and $E^P(q)$ will yield even higher NPVs of financial distress than those depicted in Table 4. This argument suggests that our ex-ante estimates are likely to be conservative estimates of true (average) distress costs.

This argument still pertains to unconditional estimates of distress costs. Figure 3 also suggests that conditional (date 1) distress costs will depend on the particular realization of date 1 spreads. To get some sense of the impact of time-variation in spreads on conditional distress costs, we perform a simple exercise. As described in section 4.1, we have monthly time-series data between 1985-2004 for all ratings between A and B. We use these data to compute the standard deviation in spreads separately for each rating and maturity, as a fraction of average 1985-2004 spreads for that rating/maturity. These ratios range from 50% to 80% for A bonds (depending on maturity), 36% to 70% for BBB bonds, 38% for BB bonds and 33% for B bonds. We then scale our benchmark average spreads, which are calculated using 1985-1995 data, uniformly up and down using these ratios. Under the assumption that all spreads move together over time, these scaled spreads represent typical scenarios of high and low spreads (one standard deviation higher or lower than the mean).

Using these scaled spreads, we repeat the valuation exercises of sections 4.3 and 4.4.[25] The results are reported in Table 5. Clearly, the extent of time-variation in spreads appears to be large enough to generate substantial fluctuations in the NPV of financial distress costs. For example, for BB bonds the NPV of distress goes from 4.73% (low spreads) to 8.38% (high spreads). The impact of time-variation on margins, however, is less clear.

[24] See Pan and Singleton (2005) for evidence on the risk premium associated with time-variation in default probabilities for sovereign bonds.

[25] In these exercises, we keep all parameters fixed at their benchmark values, including recovery rates (0.41), losses given distress (0.165), and risk-free rates.

The difference in distress costs between A and BBB bonds, for example, is highest when spreads are low. However, the difference between A and BB bonds shows the opposite pattern. While these results show that time-variation in the price of credit risk can have significant effects on spreads, more research is required to establish its exact impact on marginal distress costs and capital structure choices.

5 Implications for Capital Structure

The existing literature suggests that distress costs are too small to overcome the tax benefits of increased leverage, and thus that corporations may be using debt too conservatively (Graham, 2000). This quote from Andrade and Kaplan (1998) captures well the consensus view:

> "[..] from an ex-ante perspective that trades off expected costs of financial distress against the tax and incentive benefits of debt, the costs of financial distress seem low [..]. If the costs are 10 percent, then the expected costs of distress [..] are modest because the probability of financial distress is very small for most public companies." (Andrade and Kaplan, p. 1488-1489).

In other words, using estimates for ϕ that are in the same range as those used in Table 4 should produce relatively small NPVs of distress costs, *because the probability of financial distress is too low.* In this section, we attempt to verify whether this conclusion continues to hold if we compare marginal, risk-adjusted costs of financial distress to marginal tax benefits of debt.

Naturally, the calculations that we perform in this section are subject to the limitations of the static trade-off model of capital structure. Our point is not to argue that this model is the correct one, nor to provide a full characterization of firms' optimal financial policies. We simply want to verify whether the magnitude of the distress costs that we calculate is comparable to that of tax benefits of debt.

5.1 Estimating the Effect of Distress Risk on Capital Structure

In order to compare the distress costs displayed in Table 4 with the tax benefits of debt, we need to estimate the tax benefits that the average firm can expect at each bond rating. To do this, we follow closely the analysis in Graham (2000), who estimates the marginal tax benefits of debt, and Molina (2005), who relates leverage ratios to bond ratings.

5.1.1 The Marginal Tax Benefit of Debt

Graham (2000) estimates the marginal tax benefit of debt as a function of the amount of interest deducted, and calculates total tax benefits of debt by integrating under this function. The marginal tax benefit is constant up to a certain amount of leverage, and then it starts declining because firms do not pay taxes in all states of nature, and because higher leverage decreases additional marginal benefits (as there is less income to shield). Essentially, we can think of the tax benefits of debt in Graham (2000) as being equal to $\tau^* D$ (where τ^* takes into account both personal and corporate taxes) for leverage ratios that are low enough such that the firm has not reached the point at which marginal benefits start decreasing (see footnote 13 in Graham's paper). Graham calls this point the *kink* in the firm's tax benefit function. A firm with a kink of 2 can double its interest deductions, and still keep a constant marginal benefit of debt.

Graham calculates the amount of tax benefits that the average firm in his sample foregoes. The average firm in COMPUSTAT (in the time period 1980-1994) has a kink of 2.356, and a leverage ratio of approximately 0.34. Graham also estimates that the average firm could have gained 7.3% of their market value if it had levered up to its kink. In addition, because the firm remains in the flat portion of the marginal benefit curve until its kink reaches one, these numbers allow us to compute the implied marginal benefit of debt in the flat portion of the curve (τ^*). If we assume that the typical firm needs to increase leverage by 2.356 times to move to a kink equal to one, we can back out the value of τ^* as 0.157. Tax benefits of debt can then be calculated as 0.157 times the leverage ratio, assuming leverage is low enough that we remain in the flat portion. To the extent that the approximation is not true for high leverage ratios, we are probably overestimating tax benefits of debt for these leverage values.[26]

5.1.2 The Relation Between Leverage and Bond Ratings

To compute the tax benefits of debt at each bond rating, we need to assign a typical leverage ratio to each bond rating. As discussed by Molina (2005), the relationship between leverage and ratings is affected by the endogeneity of the leverage decision. In particular, because less risky and more profitable firms can have higher leverage without increasing much the probability of financial distress, the impact of leverage on bond ratings might appear to be too small.

The leverage data that we use is reported in Table 6. Column I reports Molina's predicted leverage values for each bond rating, from his Table VI (Molina (2005), p.1445). This Table associates leverage ratios to each rating, using Molina's regression model in Table V, and values of the control variables that are set equal to those of the average firm with a kink of approximately two in Graham's (2000) sample. According to Molina, these values give an estimate of the impact of leverage on ratings for the average firm in Graham's sample. In order to verify the robustness of our results, we also use the simple descriptive statistics in Molina's (2005) Table IV (p. 1442). Molina's data, which corresponds to the ratio of long term debt to book assets for each rating in the period 1998-2002, is reported in column II of Table 6. As discussed by Molina, despite the aforementioned endogeneity problem the rating changes in these summary statistics actually resemble those predicted by the model. In addition, we report in column III the relation between leverage and ratings that is used by Huang and Huang (2003). These leverage data come from Standard and Poor's (1999), and have been used by several authors to calibrate credit risk models (i.e., Cremers et al., 2005).

[26] A related point is that these tax benefit calculations ignore risk adjustments. We derive a risk-adjustment in a previous version of the paper, assuming perpetual debt. If D is taken to be the market value of debt, the risk-adjustment does not have a substantial effect on Graham's formula, because it is already incorporated in D. In fact, with zero recovery rates the interest tax shields are exactly a fraction τ of the cash flows to bondholders in all states, and thus by arbitrage the value of tax benefits must be exactly equal to τD. With non-zero recovery, there is a risk-adjustment that reduces tax benefits, but it is quantitatively small.

5.1.3 Comparing Tax Benefits of Debt and Marginal Distress Costs

Table 7 depicts our estimates of the tax benefits of debt for each bond rating. If we use the leverage ratios from Molina's (2005) regression model (Panel A), the increase in tax benefits as the firm moves from the AA to the BBB rating is 2.67%. Under the benchmark valuation of distress costs (see Table 4), this marginal gain is of a similar magnitude as marginal *risk-adjusted* distress costs (2.69% according to Table 4). The analysis of Table 4 also shows that the similarity between marginal tax benefits of debt and marginal financial distress costs holds irrespective of our specific assumptions about coupons and recoveries, as long as we use the benchmark assumption of $\phi = 16.5\%$.

In order to further compare marginal tax benefits and distress costs, Table 7 also reports the difference between the present value of tax benefits and the cost of distress for each bond rating. Under the static trade-off model of capital structure, the firm is assumed to maximize this difference. Because the specific assumption about ϕ substantially affects marginal distress costs (see Panel B of Table 4), we report results that obtain for $\phi = 10\%$ and $\phi = 23\%$, as well as for the benchmark case of $\phi = 16.5\%$.

The first conclusion that is obvious from the results in Table 7 is that the distress risk-adjustment substantially reduces the net gains that the average firm can expect from levering up. For example, if $\phi = 16.5\%$, and if we ignore the risk-adjustment (column II), the firm can increase value by 3% to 4% if it levers up from zero leverage to somewhere around a BBB bond rating. However, once we incorporate the distress risk-adjustment, the net gain from levering up never goes above 1%. The gains from levering up are higher if ϕ becomes closer to 10%, as shown in columns III and IV. However, the distress risk adjustment substantially reduces the gains from levering up, even for these lower values of ϕ. For values of ϕ closer to 23% (columns V and VI), marginal distress costs are uniformly higher than marginal tax benefits.

The second, and related conclusion, is that the distress risk-adjustment generally moves the optimal bond rating generated by these simple calculations towards higher ratings. For example, if $\phi = 16.5\%$, and if we ignore the risk adjustment, a firm should increase leverage until it reaches a rating of A to BBB, since this rating is associated with the largest differences between tax benefits and distress costs. However, after incorporating the distress risk adjustment, the difference becomes essentially flat or decreasing for all ratings lower than AA. Naturally, the result is even stronger for higher values of ϕ.

Naturally, both conclusions are driven by the basic finding that marginal risk-adjusted distress costs are very close to marginal tax benefits of debt. Figure 4 gives a visual picture of these results. In Figure 4 we plot the difference between tax benefits and distress costs for the benchmark case ($\phi = 16.5\%$), both for non risk-adjusted and risk-adjusted distress costs. Clearly, the marginal gains from increasing leverage are very flat for any rating above AA, if distress costs are risk-adjusted. The visual difference with the inverted U-shape generated by the non-risk adjusted valuation is very clear.

In Panel B, we vary the relationship between leverage and ratings, for the benchmark case of $\phi = 16.5\%$. The net gains from levering up are even lower than those in Panel A if we use Molina's summary statistics to compute marginal tax benefits of debt (column I). However, if we use historical probabilities to value financial distress costs, the firm can still gain around 3% in value by moving from zero leverage to a BBB rating (column II). These gains go away once distress costs are risk-adjusted (column III). Marginal tax benefits are higher if we use the leverage ratios from Huang and Huang (column IV), resulting in large net gains from leverage if distress costs are not risk adjusted (column V). However, column VI shows that the difference between tax benefits and risk-adjusted distress costs is relatively flat, even for these leverage ratios. This difference goes from 1.73% (AAA rating) to a maximum of 2.26% for the BBB rating. We conclude that the results are robust to variations in the ratings-leverage relationship.

5.2 Interpretation and comparison with previous literature

Table 7 and Figure 4 show that risk-adjusted costs of financial distress can counteract the marginal tax benefits of debt estimated by Graham (2000). These results suggest that financial distress costs can help explain why firms use debt conservatively, as suggested by

Graham (2000). We note, however, that Graham's evidence for debt conservatism is not based only on the observation that the average firm appears to use too little debt. It is also the case in his data that firms that appear to have low costs of financial distress have lower leverage (higher kinks). Our results do not address this cross-sectional aspect of debt conservatism.

Molina (2005) argues that the bigger impact of leverage on bond ratings and probabilities of distress that he finds after correcting for the endogeneity of the leverage decision can also help explain why firms use debt conservatively. However, Molina does not perform a full-fledged valuation of financial distress costs like we do in this paper. His calculations are based on the same approximation of marginal costs of financial distress used by Graham (2000), which is to write $\Phi = p\phi$, where p is the 10-year cumulative historical default rate. As we discuss in Section 2, this formula underestimates the NPV of financial distress costs, irrespective of the risk-adjustment issue.[27] Thus, we believe the results on Table 7 and Figure 4 provide a more precise comparison between the NPV of distress costs and the capitalized tax benefits of debt.

6 Final Remarks

We develop a methodology to estimate the present value of the costs of financial distress, which takes into account the systematic component in the risk of distress. Our formulas are easy to implement (particularly those in Section 2), and should be useful for research and teaching purposes. We find that the traditional practice of using historical default rates severely underestimates the average value of distress costs, as well as the effects of changes in leverage on marginal distress costs. The marginal distress costs that we find can help explain the apparent reluctance of firms to increase their leverage, despite the existence of substantial tax benefits of debt.

[27] In addition, there are two differences between our calculations and those performed by Molina. First, his marginal tax benefits of debt are smaller than the ones we use, because he uses more recent data from Graham that implies a τ^* of around 13%. Second, when comparing marginal tax benefits with marginal costs of distress (Table VII) he uses the *minimum* change in leverage that induces a rating downgrade. In contrast, we use *average* leverage values for each rating in Table 7.

One caveat is that we risk-adjust distress costs using historical average bond spreads. There is evidence, however, of significant variation in credit risk premia over time (Berndt et al. (2005), Pan and Singleton (2005)). Time variation in distress costs could lead firms to optimally reduce their leverage in times when credit spreads are high, as emphasized in the market timing literature.

The large risk-adjusted NPVs of distress that we find are a direct consequence of the fact that bond yields spreads are too large to be explained by historical default rates. Thus, the fact that investors seem to require large risk premia to hold corporate bonds might justify firms' aversion to lever up, if the firm's goal is to maximize the wealth of these risk-averse investors. In other words, our results suggest that bond spreads and capital structure decisions are mutually consistent. In addition, Cremers et al. (2005) show that implied volatilities and jump risks, measured via option prices, can explain credit spreads across firms and over time. In other words, corporate bonds spreads and option prices are also consistent with each other. Taken together, these results suggest that risk aversion in financial markets may be high, but does not appear to be arbitrary. Market participants, from options and bonds traders to corporate managers, seem to respond similarly to the price of risk.

References

Acharya, V., S. Bharath and A. Srinivasan, 2004, Understanding the Recovery Rates of Defaulted Securities. Working paper, London Business School and University of Michigan.

Allen, L. and T. Saunders, 2004, Incorporating Systemic Influences Into Risk Measurements: A Survey of the Literature, forthcoming, *Journal of Financial Services Research*.

Altman, E., 1984, A Further Empirical Investigation of the Bankruptcy Cost Question, *Journal of Finance* 39, 1067-1089.

Altman, E., B. Brady, A. Resti, A Sironi, 2003, The Link between Default and Recovery Rates: Theory, Empirical Evidence and Implications. Working paper, New York University.

Andrade, G. and S. Kaplan, 1998, How Costly is Financial (not Economic) Distress? Evidence from Highly Leveraged Transactions that Become Distressed. *Journal of Finance* 53, 1443-1493.

Asquith, P., R. Gertner and D. Scharfstein, 1994, Anatomy of Financial Distress: An Examination of Junk Bond Issuers. *Quarterly Journal of Economics* 109, 625-658.

Berndt, A., R. Douglas, D. Duffie, M. Ferguson, and D. Schranz, 2005, Measuring Default Risk Premia from Default Swap Rates and EDFs, working paper.

Blanco, R., S. Brennan and I. Marsh, 2005, An Empirical Analysis of the Dynamic Relation between Investment-Grade Bonds and Credit Default Swaps , Journal of Finance 60, 2255-2281.

Brennan, M. and E. Schwartz, 1980, Analyzing convertible bonds, Journal of Financial and Quantitative Analysis 15, 907-929.

Chen, L., D. Lesmond, and J. Wei, 2004, Corporate Yield Spreads and Bond Liquidity. Working paper, Michigan State University and Tulane University.

Chen, L., Collin-Dufresne, P and R. Goldstein, 2005, On the Relation Between Credit Spread Puzzles and the Equity Premium Puzzle. Working paper, Michigan State University, U.C. Berkeley and University of Minnesota.

Collin-Dufresne, P., R. Goldstein and P. Martin, 2001, The Determinants of Credit Spread Changes. *Journal of Finance* 56, 2177-2208.

Cremers, M., J. Driessen, P. Maenhout, and D. Weinbaum, 2005, Individual Stock-Option Prices and Credit Spreads. Working paper, Yale University, University of Amsterdam, INSEAD and Cornell University.

Denis, D. and D. Denis, 1995, Causes of Financial Distress Following Leveraged Recapitalizations. *Journal of Financial Economics* 37, 129-157.

Driessen, J., 2005, Is Default Event Risk Priced in Corporate Bonds?, *Review of Financial Studies* 18, 165-195.

Duffee, G., 1998, The relation between treasury yields and corporate bond yield spreads, *Journal of Finance* 53, 2225-2242.

Duffie, D. and K. Singleton, 1999, Modeling term structures of defaultable bonds, *Review of Financial Studies* 12, 687-720.

Elton, E., M. Gruber, D. Agrawal and C. Mann, 2001, Explaining the Rate Spread on Corporate Bonds. *Journal of Finance* 56, p.247-278.

Feldhutter, P. and D. Lando, 2005, Decomposing Swap Spreads. Working paper, Copenhagen Business School.

Franks, J. and W. Touros, 1989, An Empirical Investigation of US Firms in Reorganization, *Journal of Finance* 44, 747-769.

Gilson, S., 1997, Transaction Costs and Capital Structure Choice: Evidence from Financially Distressed Firms. *Journal of Finance* 52, 161-196.

Graham, J., 2000, How Big are the Tax Benefits of Debt? *Journal of Finance* 55, 1901-1942.

Hennessy, C., and T. Whited, 2005, Debt dynamics. *Journal of Finance* 60, 1129-1165.

Huang, J. Z. and M. Huang, 2003, How Much of the Corporate-Treasury Yield Spread is Due to Credit Risk?, working paper, Penn State University and Stanford University.

Jarrow, R. and S. Turnbull, 1995, Pricing options on derivative securities subject to default risk, *Journal of Finance* 50, 53-86.

Lando, D., 2004, *Credit Risk Modeling*, Princeton University Press.

Leland, H., 1994, Debt Value, Bond Covenants, and Optimal Capital Structure, *Journal of Finance* 49, 1213-1252.

Leland, H., and K. Toft, 1996, Optimal Capital Structure, Endogenous Bankruptcy, and the Term Structure of Credit Spreads, *Journal of Finance* 51, 987-1019.

Longstaff, F., E. Neis and S. Mittal, 2005, Corporate Yield Spreads: Default Risk or Liquidity? New Evidence from the Credit-Default Swap Market. *Journal of Finance* 60, 2213-2253.

Maksimovic, V. and G. Phillips, 1998, Asset Efficiency and Reallocation Decisions of Bankrupt Firms, Journal of Finance 53, 1495-1532.

Molina, C., 2005, Are Firms Underleveraged? An Examination of the Effect of Leverage on Default Probabilities, *Journal of Finance 60,* 1427-1459.

Moody's, 2002, Default and Recovery Rates of Corporate Bond Issuers - A Statistical Review of Moody's Ratings Performance.

Myers, S., 1977, "Determinants of Corporate Borrowing," *Journal of Financial Economics* 5, 147-175.

Opler, T. and S. Titman, 1994, Financial Distress and Corporate Performance. *Journal of Finance* 49, 1015-1040.

Pan, J. and K. Singleton, 2005, Default and Recovery Implicit in the Term Structure of Sovereign CDS Spreads, working paper.

Sharpe, S., 1994, Financial Market Imperfections, Firm Leverage and the Cyclicality of Employment. *American Economic Review* 84, 1060-1074.

Shleifer, A., and R. Vishny, 1992, Liquidation Values and Debt Capacity: A Market Equilibrium Approach. *Journal of Finance* 47, 1343-1365.

Standard and Poor's, 1999, Corporate Ratings Criteria.

Titman, S., and S. Tsyplakov, 2004, A Dynamic Model of Optimal Capital Structure. Working paper, University of Texas, Austin.

Warner, J., 1977, Bankruptcy Costs: Some Evidence. *Journal of Finance* 32, 337-347.

Weiss, L., 1990, Bankruptcy Resolution. Direct Costs and Violation of Priority of Claims. *Journal of Financial Economics* 27, 255-311.

Appendix.

Proof of Equation 2 in the perpetuity example of Section 2: Suppose that the promised return on a perpetual bond is constant over time, and that given default creditors recover a fraction of the bond's market value just prior to default, including the coupons that are due on the year that default occurs. This "recovery of market value" assumption is due to Duffie and Singleton (1999). In addition, we maintain the assumptions that the recovery rate is non-stochastic and that the risk free rate is constant (equal to r^F).

Let the bond's promised yearly return be equal to r^D. Without loss of generality, assume that the bond is priced at par such that the yearly coupon is also equal to r^D. Next year, if the bond does not default creditors receive a coupon equal to r^D. The value of the remaining promised payments is constant over time, and equal to one. Thus, creditors receive $(1 + r^D)$ if there is no default. The recovery of market value assumption implies that creditors will receive $\rho(1+r^D)$ if there is default in year one. Thus, the bond valuation tree is identical to that presented in Figure 1, and the bond's date zero value can be expressed by equation 1. Formula 2 then follows. Q.E.D.

Proof of equation (8): To understand the recursive formula, consider a two-year bond. If the bond defaults in year 1, we have:

$$E^Q\left[\rho_{1,2}\right] = \rho\left[c_2 + (1+c_2)B_{1,2}\right], \tag{A1}$$

where $B_{1,2}$ is the date-1 price of a zero that pays one at date 2, and $E^Q[.]$ are expectations under the risk-neutral measure. If the bond defaults in year 2, we have $E^Q\left[\rho_{2,2}\right] = \rho(1+c_2)$. We can then write the valuation equation for a two-period bond as:

$$\begin{aligned} V_2 &= (1-Q_1)c_2B_1 + Q_1\rho\left[c_2 + (1+c_2)B_{1,2}\right]B_1 + \\ &\quad + \left[(1-Q_1)(1-q_2) + (1-Q_1)q_2\rho\right](1+c_2)B_2\ . \end{aligned} \tag{A2}$$

Using the facts that $B_2 = B_{1,2}B_1$, $(1-Q_1)(1-q_2) = (1-Q_2)$, and $Q_1 + (1-Q_1)q_2 = Q_2$, we can rewrite equation (A2) as

$$V_2 = \left[(1-Q_1) + Q_1\rho\right]c_2B_1 + \left[(1-Q_2) + Q_2\rho\right](1+c_2)\,B_2\ . \tag{A3}$$

Given Q_1, we can solve (A3) for Q_2. A similar reasoning leads to equation (8). Q.E.D.

Terminal Value calculation (Section 4.4): We assume that the marginal, risk-adjusted probability of default is constant after year 10, that is:

$$q_t = q_{10} = 1 - \frac{(1-Q_{10})}{(1-Q_9)},\ \text{for } t > 10. \tag{A4}$$

Similarly, we assume that the yearly zero coupon rate is constant after year 10, that is, the yearly risk free rate after year 10 is given by:

$$r^F_{10} = \frac{B_9}{B_{10}} - 1 \tag{A5}$$

Given these assumptions, we can compute a terminal cost of financial distress at year 10. We can expand equation 5 as:

$$\Phi = \phi\left[\sum_{t=1}^{10} B_t(1-Q_{t-1})q_t + (1-Q_{10})q_{11}B_{11} + (1-Q_{11})q_{12}B_{12} + ...\right].$$

Using the assumptions that $q_t = q_{10}$ and $r^F_t = r^F_{10}$ for $t > 10$, we can write:

$$\begin{aligned} \Phi &= \phi\left[\sum_{t=1}^{10} B_t(1-Q_{t-1})q_t + (1-Q_{10})q_{10}\frac{B_{10}}{(1+r^F_{10})} + (1-Q_{10})(1-q_{10})q_{10}\frac{B_{10}}{(1+r^F_{10})^2} + ...\right] = \\ &= \phi\left[\sum_{t=1}^{10} B_t(1-Q_{t-1})q_t + \frac{B_{10}(1-Q_{10})q_{10}}{q_{10}+r^F_{10}}\right]. \end{aligned} \tag{A6}$$

Different Recovery Assumptions (Section 4.5.2): In addition to assumption A2, the credit risk literature has used the following assumptions about bond recoveries:

1. *Recovery of face value (RFV)*: $E(\rho_{\tau,t}) = E(\rho)$. This assumption has been used by Brennan and Schwartz (1980), and Duffee (1998). In words, if default happens at time $\tau < t$, creditors receive a fraction of face value immediately upon default. There is zero recovery of coupons.
2. *Recovery of market value (RMV)*: $E(\rho_{\tau,t}) = E(\rho V_{\tau,t})$, where $V_{\tau,t}$ is the market value prior to default at date τ of the corporate bond, contingent on survival up to date τ. This assumption is due to Duffie and Singleton (1999).

Duffie and Singleton (1999) compare risk-neutral probabilities that are generated by assumptions RMV and RFV, and find that the two alternative assumptions generate very similar results unless corporate bonds trade at significant premia or discounts, or if the term structure of interest rates is steeply increasing or decreasing. For simplicity, we focus only on assumption RFV for the robustness checks. Under assumption RFV, $E(\rho_{\tau,t}) = \rho$ for all τ, t, and the valuation formula becomes:

$$V_{t+1} = c_{t+1} \sum_{\tau=1}^{t} (1 - Q_\tau) B_\tau + \rho \sum_{\tau=1}^{t+1} (1 - Q_{\tau-1}) q_\tau B_\tau + (1 + c_{t+1})(1 - Q_{t+1}) B_{t+1} \quad \text{(A7)}$$

Again, this formula can be easily inverted to obtain Q_{t+1} if one has the sequence $\{Q_\tau\}_{\tau=1..t}$, and the yield on a coupon paying bond with maturity $t+1$. Notice that $Q_0 = 1$, and that $q_{t+1} = 1 - \frac{(1-Q_{t+1})}{(1-Q_t)}$.

Table 1. Term Structure of Yield Spreads

	Ratings					
Maturity	AAA	AA	A	BBB	BB	B
1	0.51%	0.52%	1.09%	1.57%	3.32%	5.45%
2	0.52%	0.56%	1.16%	1.67%	3.32%	5.45%
3	0.54%	0.61%	1.23%	1.76%	3.32%	5.45%
4	0.55%	0.65%	1.30%	1.85%	3.32%	5.45%
5	0.56%	0.69%	1.38%	1.94%	3.32%	5.45%
6	0.58%	0.74%	1.28%	1.89%	3.32%	5.45%
7	0.59%	0.78%	1.18%	1.84%	3.32%	5.45%
8	0.60%	0.82%	1.08%	1.79%	3.32%	5.45%
9	0.62%	0.87%	1.20%	1.84%	3.32%	5.45%
10	0.63%	0.91%	1.32%	1.90%	3.32%	5.45%

The spread data for A, BBB, BB and B bonds come from Citigroup's yieldbook, and refers to average corporate bond spreads over treasuries, for the period 1985-1995. The original data contains spreads for maturities 1-3 years, 3-7 years, 7-10 years and 10+ years for A and BBB bonds. We assign these spreads, respectively, to maturities 2, 5, 8 and 10, and we linearly interpolate the spreads to fill in all the maturities. The spreads for BB and B bonds are reported as an average across all maturities. Data for AAA and AA bonds comes from Huang and Huang (2003). The original data contains maturities 4 (1985-1995 averages, from Duffee, 1998), and 10 (1973-1993 averages, from Lehman's bond index). We linearly interpolate to fill in all the remaining maturities.

Table 2. Fraction of the Yield Spread Due to Default

	Huang and Huang (2003)	Longstaff et al. (2005)	Chen et al. (2005)	Cremers et al. (2005)	Method 1 (AAA spread)		Method 2 (spreads over swaps)	
Credit Rating	10-year spread	5-year spread	4-year spread	10-year spread	4-year spread	10-year spread	5-year spread	10-year spread
AAA	0.208	NA	0.000	0.603	0.073	0.190	NA	NA
AA	0.200	0.510	NA	0.505	0.215	0.440	NA	NA
A	0.234	0.560	NA	0.512	0.609	0.613	0.511	0.570
BBB	0.336	0.710	0.702	0.627	0.724	0.731	0.732	0.729
BB	0.633	0.830	NA	NA	0.846	0.846	0.872	0.872
B	0.833	NA	NA	NA	0.906	0.906	0.916	0.916

This Table reports the fractions of yield spreads over benchmark treasury bonds that are due to default, for each credit rating and different maturities. The first column uses Huang and Huang (2003)'s results from Table 7, which reports calibration results from their model under the assumption that market asset risk premia are counter-cyclically time varying. The second column uses Longstaff et al.'s (2005) Table IV, which reports model-based ratios of the default component to total corporate spread. The third column uses results from Chen et al. (2005). The fraction reported for BBB bonds is the ratio of the BBB minus AAA spread over the BBB minus treasury spread. The fourth column uses results from Cremers et al. (2005). The fractions reported are the ratios between the 10-year spreads in Cremers et al.'s Table 4 (model with priced jumps), and the corresponding spreads in Table 1. The fifth and sixth columns report for each rating and maturity the ratio between the default component of the spread and the total spread, where the default component is calculated as the spread minus the 1-year AAA spread. The seventh and eight columns report for each rating and maturity the ratio between the default component of the spread and the total spread, where the default component is calculated as the spread minus the difference between swap and treasury rates, for the period 2000-2004. NA = not available.

Table 3. Risk Neutral Cumulative Probabilities of Default, and Ratios between Risk Neutral and Historical Probabilities

	5-year			10-year			
Credit Rating	Historical	Risk-Neutral	Ratio	Historical	Risk-Neutral	Ratio	Average Ratio
AAA	0.14%	0.54%	3.83	0.80%	1.65%	2.07	3.57
AA	0.31%	1.65%	5.31	0.96%	6.75%	7.04	6.22
A	0.51%	7.07%	13.86	1.63%	12.72%	7.80	9.95
BBB	1.95%	11.39%	5.84	5.22%	20.88%	4.00	4.84
BB	11.42%	21.07%	1.85	21.48%	39.16%	1.82	1.86
B	31.00%	34.90%	1.13	46.52%	62.48%	1.34	1.21

This Table reports cumulative risk-neutral probabilities of default calculated from bond yield spreads, as explained in the text. The Table also reports historical cumulative probabilities of default (data from Moodys, averages 1970-2001), and ratios between the risk-neutral probabilities and the historical ones. In the last column, we report the average ratio between risk-neutral and historical probabilities across all maturities from 1 to 10.

Table 4. Risk-Adjusted Costs of Financial Distress, as a Percentage of Firm Value

Panel A

		Risk-adjusted					
Credit Rating	Historical	Benchmark	Recovery 0.25	RFV	Coupon 0.5*Yield	Coupon 1.5*Yield	Huang and Huang (2003)
AAA	0.25%	0.32%	0.25%	0.31%	0.06%	0.50%	0.49%
AA	0.29%	1.84%	1.47%	1.77%	1.52%	2.07%	0.63%
A	0.51%	3.83%	3.17%	3.66%	3.49%	4.10%	1.14%
BBB	1.40%	4.53%	3.70%	4.24%	4.29%	4.71%	2.28%
BB	4.21%	6.81%	5.59%	6.15%	6.70%	6.88%	5.52%
B	7.25%	9.54%	8.04%	8.44%	9.47%	9.58%	9.15%
BBB minus AA	1.11%	2.69%	2.23%	2.47%	2.77%	2.64%	1.65%

This Table reports our estimates of the NPV of the costs of financial distress expressed as a percentage of pre-distress firm value, calculated using historical probabilities (first column), and risk-adjusted probabilities (remaining columns). We use an estimate for the loss in value given distress of 16.5%. The valuation in column 2 (benchmark valuation) assumes recovery of treasury, a recovery rate of 0.41, bond coupons equal to the default component of the yields, and uses method 1 (1-year AAA spread) to calculate the default component of spreads. In column 3 we change the recovery rate to 0.25. In column 4 we use a recovery of face value (RFV) assumption. In column 5 we assume that coupons are one half times the default component of spreads, and in column 6 we assume that coupons are one and a half times the default component of spreads. In column 7 we use Huang and Huang's (2003) fractions due to default to calculate the default component of spreads.

Table 4. Risk-Adjusted Costs of Financial Distress, as a Percentage of Firm Value

Panel B

	ϕ = 0.165		ϕ = 0.10		ϕ = 0.23	
Credit Rating	Historical	Risk-adjusted	Historical	Risk-adjusted	Historical	Risk-adjusted
AAA	0.25%	0.32%	0.15%	0.19%	0.35%	0.45%
AA	0.29%	1.84%	0.17%	1.11%	0.40%	2.56%
A	0.51%	3.83%	0.31%	2.32%	0.71%	5.34%
BBB	1.40%	4.53%	0.85%	2.75%	1.95%	6.32%
BB	4.21%	6.81%	2.55%	4.13%	5.87%	9.50%
B	7.25%	9.54%	4.39%	5.78%	10.10%	13.30%
BBB minus AA	1.11%	2.69%	0.67%	1.63%	1.55%	3.75%

This Table reports our estimates of the NPV of the costs of financial distress expressed as a percentage of pre-distress firm value, calculated using historical probabilities (first, third and fifth columns), and risk-adjusted probabilities (remaining columns). The risk-adjusted valuations assume recovery of treasury, a recovery rate of 0.41, bond coupons equal to the default component of the yields, and uses method 1 (1-year AAA spread) to calculate the default component of spreads. In columns 1 and 2 we assume a loss given default of 16.5%. In columns 3 and 4 we assume a loss given default of 10% and in columns 5 and 6 we assume a loss given default of 23%.

Table 5. Risk-Adjusted Costs of Financial Distress and Time-varying Credit Spreads

Credit rating	Low spreads	Average spreads	High spreads
AAA	NA	0.32%	NA
AA	NA	1.84%	NA
A	2.95%	3.83%	4.64%
BBB	3.84%	4.53%	5.18%
BB	4.73%	6.81%	8.38%
B	7.60%	9.54%	10.88%
BBB minus A	0.89%	0.70%	0.53%
BB minus A	1.78%	2.98%	3.73%

This Table reports estimates of the NPV of the costs of financial distress expressed as a percentage of pre-distress firm value, calculated using risk-adjusted default probabilities. The risk-adjusted valuations assume recovery of treasury, a recovery rate of 0.41, bond coupons equal to the default component of the yields, and uses method 1 (1-year AAA spread) to calculate the default component of spreads. The second column reports the results that obtain if we use average historical spreads (1985-1995) to compute risk-adjusted default probabilities. In column 1 we scale down the average spreads uniformly by one standard deviation, and in column 3 the spreads are scaled up by one standard deviation. The standard deviations of spreads are computed using 1985-2004 data. We compute the ratio between standard deviations and averages separately for each maturity and rating for which we have time series data (1985-2004), and then multiply the 1985-1995 average spreads by these ratios. NA = not available.

Table 6. Typical Leverage Ratios for Each Bond Rating

	Molina (2005)		
Credit rating	Summary statistics	Regression model	Huang and Huang (2003)
AAA	9.00%	3.00%	13.08%
AA	17.00%	16.00%	21.18%
A	22.00%	28.00%	31.98%
BBB	28.00%	33.00%	43.28%
BB	34.00%	46.00%	53.53%
B	42.00%	57.00%	65.70%

This Table reports typical leverage ratios calculated for separate bond ratings. The first two columns are drawn from Molina (2005). The first column shows predicted book leverage ratios from Molina's Table VI. These values are calculated using Molina's regression model (Table V), with values of the control variables set equal to those of the average firm with a kink of approximately two in Graham's (2000) sample. Column II replicates the book leverage ratios in the simple summary statistics of Molina's Table IV. Column III reports average leverage ratios for firms of a given credit rating, from Huang and Huang (2003). The original source of these data is Standard and Poor's (1999).

Table 7. Tax Benefits of Debt against Costs of Financial Distress

Panel A: Leverage Ratios from Molina's (2005) regression model

		Tax benefits minus cost of distress					
		ϕ = 0.165		ϕ = 0.10		ϕ = 0.23	
Credit rating	Tax benefits of debt	Historical	Risk-adjusted	Historical	Risk-adjusted	Historical	Risk-adjusted
AAA	0.47%	0.22%	0.15%	0.32%	0.28%	0.12%	0.02%
AA	2.51%	2.22%	0.67%	2.34%	1.40%	2.11%	-0.05%
A	4.40%	3.89%	0.56%	4.09%	2.07%	3.69%	-0.95%
BBB	5.18%	3.78%	0.65%	4.33%	2.43%	3.23%	-1.14%
BB	7.22%	3.01%	0.41%	4.67%	3.09%	1.35%	-2.28%
B	8.95%	1.70%	-0.59%	4.56%	3.17%	-1.15%	-4.35%
BBB minus AA	2.67%						

This Table reports tax benefits of debt and the difference between tax benefits of debt and costs of financial distress computed using different assumptions about losses in value given default. The relation between ratings and leverage is estimated using Molina's (2005) regression model. This relation is reported in our paper in column I of Table 6. The first column depicts tax benefits of debt calculated for each leverage ratio as explained in the text. The remaining columns show the difference between tax benefits and distress costs. The risk-adjusted valuations assume recovery of treasury, a recovery rate of 0.41, bond coupons equal to the default component of the yields, and uses method 1 (1-year AAA spread) to calculate the default component of spreads. In the second and third columns we assume that losses given default are equal to 16.5%. In the fourth and fifth columns we assume that losses give default are equal to 10%, and in the sixth and seventh columns we assume a loss given default of 23%.

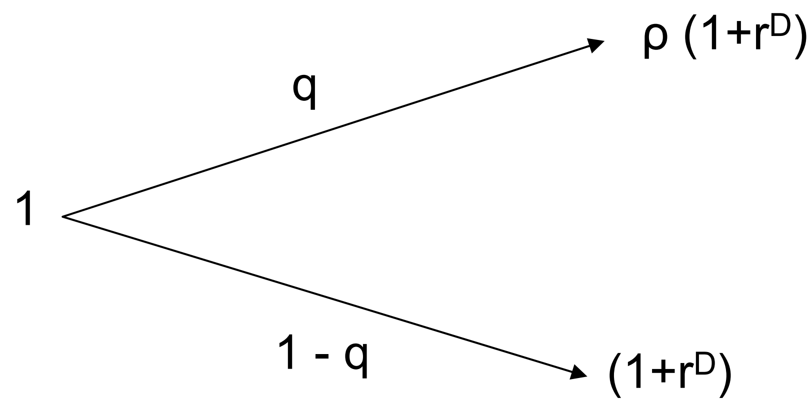
Table 7 (cont.) Tax Benefits of Debt against Costs of Financial Distress

Panel B: ϕ = 0.165, Different Leverage Ratios

	Molina's (2005) summary statistics			Huang and Huang (2003)		
		Tax benefits minus cost of distress			Tax benefits minus cost of distress	
Credit rating	Tax benefits	Historical	Risk-adjusted	Tax benefits	Historical	Risk-adjusted
AAA	1.41%	1.16%	1.09%	2.05%	1.80%	1.73%
AA	2.67%	2.38%	0.83%	3.33%	3.04%	1.49%
A	3.45%	2.94%	-0.38%	5.02%	4.51%	1.19%
BBB	4.40%	3.00%	-0.14%	6.79%	5.40%	2.26%
BB	5.34%	1.13%	-1.48%	8.40%	4.19%	1.59%
B	6.59%	-0.65%	-2.95%	10.31%	3.07%	0.77%
BBB minus AA	1.73%			3.47%		

Figure 1

One-year par bond valuation tree



One-year valuation tree for distress costs

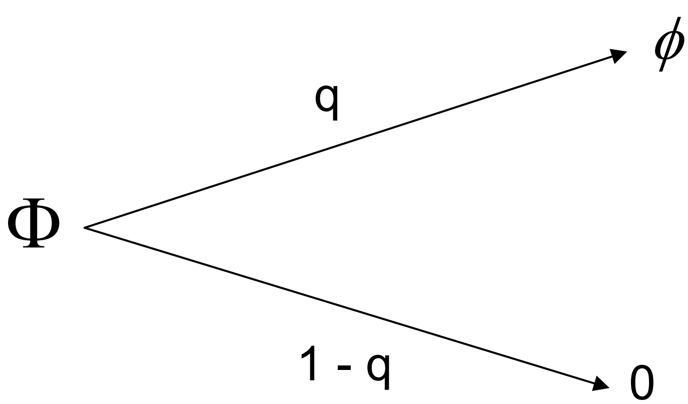


Figure 2: Valuation tree for distress costs

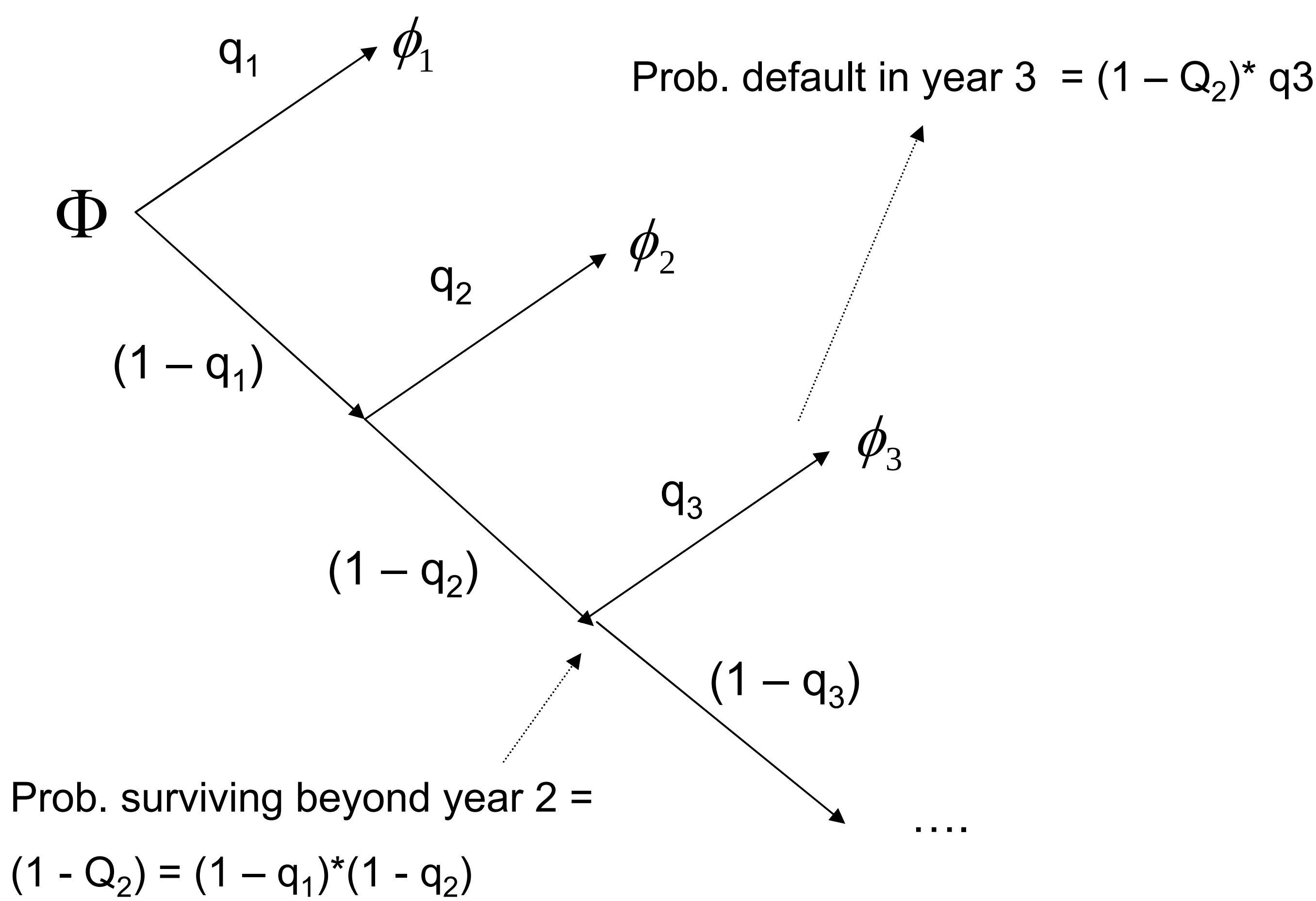


Figure 3: Time variation in the price of credit risk

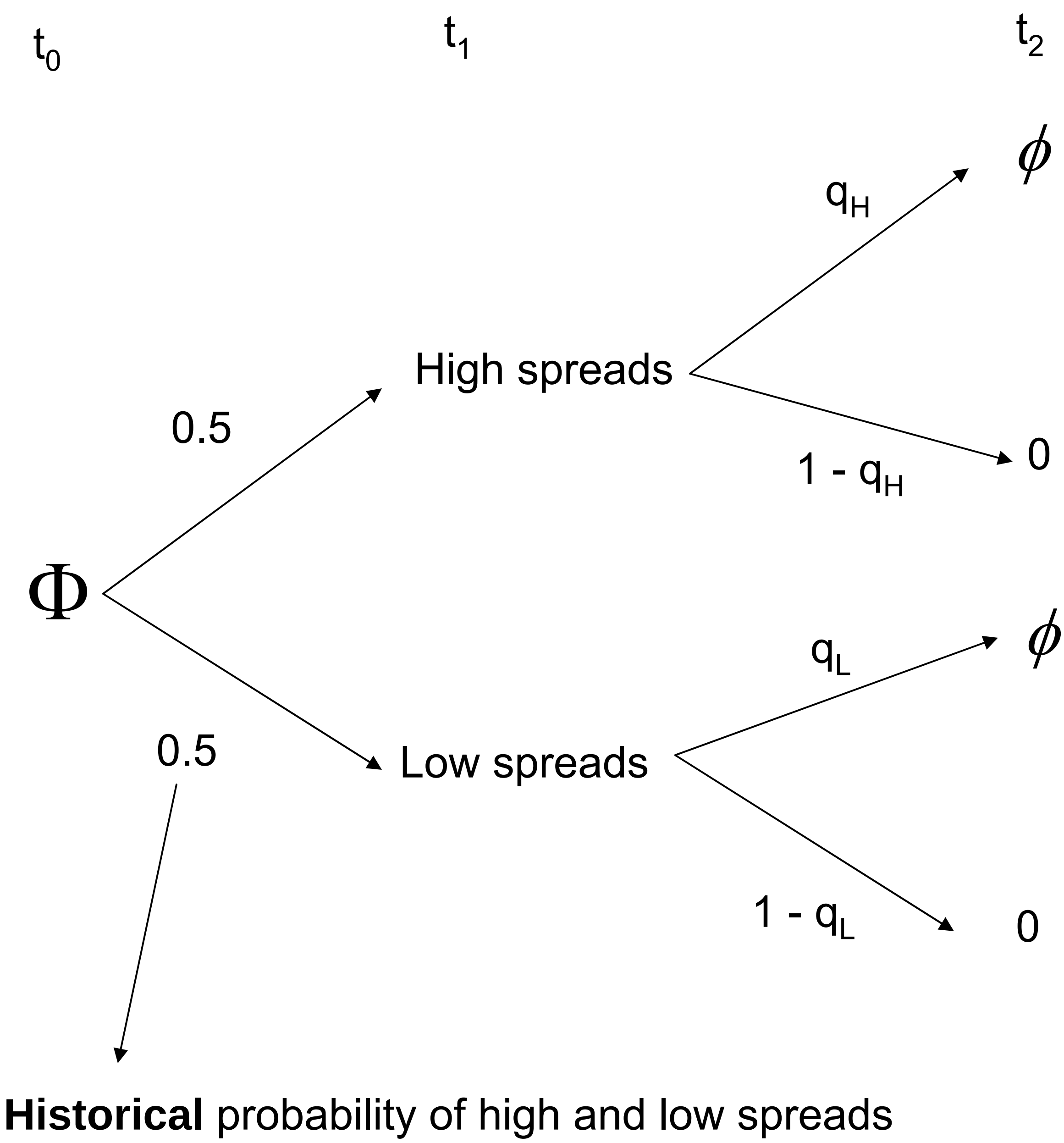


Figure 4. Tax Benefits of Debt Minus Risk-Adjusted and Non Risk-Adjusted Distress Costs