THE RISK-ADJUSTED COST OF FINANCIAL DISTRESS

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ABSTRACT

In this paper we argue that risk-adjustment matters for the valuation of financial distress costs, since financial distress is more likely to happen in bad times. Systematic distress risk implies that the risk-adjusted probability of financial distress is larger than the historical probability. Alternatively, the correct valuation of distress costs should use a discount rate that is lower than the risk free rate. We derive a formula for the valuation of distress costs, and propose two strategies to implement it. The first strategy uses corporate bond spreads to derive risk-adjusted probabilities of financial distress. The second strategy estimates the risk adjustment directly from historical data on distress probabilities, using several established asset pricing models. In both cases, we find that exposure to systematic risk increases the NPV of financial distress costs. In addition, the magnitude of the risk-adjustment can be very large, suggesting that a valuation of distress costs that ignores systematic risk significantly underestimates their true present value. Finally, we show that marginal distress costs computed using our new formula can be large enough to balance the marginal tax benefits of debt derived by Graham (2000), and we conclude that systematic distress risk can help explain why firms appear rather conservative in their use of debt.

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1 Introduction

There is a large literature that argues that financial distress can have both direct and indirect costs (Warner, 1977, Altman, 1984, Weiss, 1990, Ofek, 1993, Asquith, Gertner and Scharfstein, 1994, Opler and Titman, 1994, Sharpe, 1994, Gilson, 1997, and Andrade and Kaplan, 1998). However, there is much debate as to whether such costs are high enough to matter much 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), for example, estimate losses of the order of 10% to 23% of firm value at the time of distress for a sample of highly leveraged firms. However, they also argue that part of these costs might actually not be genuine *financial* distress costs, but rather consequences of the economic shocks that drove the firms into distress. They suggest that, from an ex-ante perspective, distress costs are probably small, specially in comparison to the potential tax benefits of debt.[2] In contrast, Opler and Titman (1994) argue that distress costs can be large for certain types of firms, such as those that engage in substantial *R&D* activities.[3]

While the previous literature has analyzed in detail the nature of distress costs, and has attempted to estimate the loss in value upon distress, it has devoted much less attention to the proper capitalization of financial distress costs. For example, Molina (2005) calculates the ex-ante cost of distress as the historical probability of default multiplied by Andrade and Kaplan's (1998) estimates of the loss in firm value given default. This calculation ignores the capitalization and discounting of distress costs. Other papers do incorporate

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[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, it is not clear that all such costs can be attributed to genuine financial distress (Opler and Titman, 1994, and Andrade and Kaplan, 1998).

[3] Not all the literature agrees with the proposition that distress only has costs. Wruck (1990) argues that the organizational restructuring that accompanies distress might have benefits, and Ofek (1993) suggests that leverage might force firms to respond more quickly to poor performance. In addition, Eberhardt, Altman and Aggarwal (1997) find that firms appear to do unexpectedly well post-bankruptcy.

some form of discounting. The usual approach in the literature is to assume risk-neutrality, and discount the product of historical probabilities and losses in value given default by a risk-free rate (e.g., Altman (1984)).[4]

In this paper we develop a methodology to value financial distress costs. Like the existing literature, we take as given the estimates of losses in value given distress provided by Andrade and Kaplan (1998) and Altman (1984). We suggest a simple way to capitalize these losses into a NPV formula for (ex-ante) distress costs, which takes into account time variation in marginal probabilities of financial distress, and the shape of the term structure of interest rates.[5] Most importantly, we argue that the common practice of using *both* historical probabilities of distress and risk free rates to value distress costs is wrong.

The problem with the traditional approach is that the incidence of financial distress is correlated with macroeconomic shocks such as major recessions,[6] generating a systematic component to distress risk. In fact, the asset pricing literature on credit yield spreads 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.[7] The literature also presents direct evidence for a default risk premium implicit in corporate bond spreads (Elton, Gruber, Agrawal and Mann, 2001, Huang and Huang, 2003, Longstaff, Mittal, and Neis, 2004, Driessen, 2005, Chen, Collin-Dufresne, and Goldstein, 2005).[8] This systematic component of default risk raises the possibility that investors might care more about default (and thus financial distress) than what is implied by risk-free discounting. In particular, this insight suggests that in order to value distress costs correctly, either the discount rate or the probability of distress must be adjusted for risk. If historical probabilities are used to compute expected

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[4]Recent models of dynamic capital structure that incorporate distress costs also assume risk-neutrality, and thus implicitly discount the costs of financial distress by the risk free rate (e.g., Titman and Tsyplakov (2004), and Hennessy and Whited (2005)).

[5]There is evidence that marginal default probabilities increase over time for firms rated investment-grade, but show the opposite pattern for firms whose debt is rated junk (Duffie and Singleton, 2003).

[6]See Denis and Denis (1995) for some evidence that the incidence of distress is related to macroeconomic conditions.

[7]Jones, Mason and Rosenfeld (1984) provide some early evidence on this.

[8]See also Collin-Dufresne, Goldstein and Martin (2001), who examine the determinants of movements in credit spreads.

distress costs, then these costs must be discounted by a rate that is *lower* than the risk free rate. Alternatively, if the risk free rate is used in the valuation, then the probability of distress must be *higher* than the historical one in order to account for distress risk.[9] Either way, this insight suggests that the existing corporate finance research has underestimated the total cost of financial distress.

We propose two methods to derive the risk adjustment. First, we exploit the fact that distress costs tend to happen when the firm is in default, and derive a formula for risk-adjusted (risk neutral) probabilities of distress as functions of bond yield spreads, recovery rates and risk free rates.[10] Our approach incorporates recent insights of the literature on credit yield spreads, which suggests that one should not attribute the *entire* yield spread to default risk, because of tax and liquidity effects (Elton et al., 2001, Chen, Lesmond, and Wei, 2004). Our estimates use only the fraction of bond yield spreads that is likely to be due to default. Because there is some disagreement in the literature as to what is the exact fraction of the spread that can be attributed to default, we use several approaches to transform yield spreads into risk neutral default probabilities (Huang and Huang, 2003, Longstaff et al., 2004, Driessen, 2005, and Chen et al, 2005). Our estimates imply that the risk neutral probability of default and, consequently, the risk-adjusted NPV of distress costs, are considerably larger than, respectively, the true probability and the non risk-adjusted NPV of distress. However, the exact size of these differences depend on the fraction of the yield spread that is due to default.

To give an example of our findings using this first approach, consider a firm whose bonds are rated BBB. The historical 4-year cumulative probability of default for BBB bonds is 1.44%, and the average spread between 4-year BBB bonds and 4-year treasury yields is 1.7%. Longstaff et al. (2004), and Chen et al. (2005) suggest that up to 70% of the spread could be due to default risk. In contrast, Huang and Huang (2003) attribute only 25% of the spread to default risk.[11] If we use Huang and Huang's numbers to adjust for risk, we end up

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[9]In other words, the risk-neutral probability of financial distress should be larger than the historical one.
[10]This derivation is based on Lando (2004).
[11]The estimates in Driessen (2005) lie between these two extremes.

with risk neutral probabilities that are twice as large as the historical ones.[12] However, the Longstaff et al. and Chen et al. numbers suggest a risk neutral 4-year cumulative default probability of 7.5%, approximately *five* times the historical probability. Using an estimate of 15% for the loss in firm value given distress,[13] these numbers translate into NPVs of distress of 2.5% of firm value for the Huang and Huang numbers, and 6% of firm value for the Longstaff et al. and Chen et al. numbers. While even the Huang and Huang numbers generate an NPV that is substantially larger than the non-risk adjusted NPV of 1.34%, it is clear that financial distress is more costly to the extent that yield spreads reflect actual default risk, rather than liquidity or taxes.

Our second approach to derive the risk-adjustment is to price distress risk directly from standard asset pricing models, such as the consumption CAPM and the Fama-French factor model. In this set up, the magnitude of the bias implied by the lack of risk adjustment is proportional to the covariance between expected distress costs (that is, the product of the probability of distress times the loss in value given distress), and the economy's asset pricing kernel. Because we lack time series data on losses given default, we calculate the risk-adjustment by correlating the asset pricing kernels with the probability of distress only. We create a time series for the probability of distress using either annual default rates in the high yield bond market from Altman, Brady, Resti, and Sironi (2003), or an accounting measure of distress that is based on Asquith, Gertner and Scharfstein (1994) and Andrade and Kaplan (1998).

The results provide direct evidence for a systematic component in distress risk. The correlation between the probability of distress and the various asset pricing kernels is uniformly positive, suggesting that it is indeed the case that distress is more likely in bad times. These results are qualitatively consistent with those of the former approach. However, the magnitude of the risk adjustment suggested by the asset pricing models is substantially smaller than that the one suggested by the yield spread method. The highest risk ad-

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[12] The 4-year cumulative probability of default is the total probability that the firm has defaulted between years 1 and 4. In other words, the historical probability that a BBB-rated firm survives 4 years is 98.56%.

[13] This estimate is inside the range of 10%-23% estimated by Andrade and Kaplan (1998). We also provide comparative statics' results on this key parameter in section 5.2.3.

justment suggested by the asset pricing models is in the order of 20%. Thus, referring back to our previous example, this alternative approach would suggest a risk neutral 4-year cumulative probability of default for BBB bonds that is at most 20% higher than the historical probability of 1.44%. We believe this difference in the results is not surprising given the limitations of this approach, when compared to the first one. It is well known that standard pricing kernels such as the one based on consumption growth have a hard time explaining the entire risk premium that is observed in asset prices. In contrast, the bond yield approach does not require the direct specification of a pricing kernel. Thus, the risk adjustment suggested by the asset pricing models should be seen as a lower bound to the true risk adjustment.

We believe that the main contribution of our paper is methodological: we show how one should compute the NPV of financial distress costs, in the presence of systematic distress risk. In addition, the magnitude of the distress risk adjustment that we find under some of our specifications implies that financial distress costs can have a bigger impact on corporate policies than previous literature has suggested. For example, Graham (2000) estimates marginal tax benefits of debt, and conjectures that marginal distress costs are too small to overcome potential tax benefits of increased leverage, in the context of a static trade-off model of capital structure. He concludes that firms are probably too conservative in their use of debt. In order to verify whether this conclusion continues to hold after using our formula for the NPV of distress costs, we compare the marginal tax benefits of debt derived by Graham (2000) with our estimates for marginal, risk-adjusted distress costs.[14]

Our results suggest that marginal distress costs can be of the same magnitude of marginal tax benefits of debt, specially if the fraction of the yield spread that is due to default risk is large, as suggested by Longstaff et al. (2004), and Chen et al. (2005). In this case, our results show that, if the loss in value given distress is in the 10%-20% range estimated by Andrade and Kaplan, the marginal gains in tax benefits of moving away from the highest

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[14]Like we do in this paper, Graham (2000) uses Andrade and Kaplan's (1998) estimates of losses in value given distress to calculate the costs of financial distress. Thus, the main difference between our estimates, and Graham's estimates for the NPV of distress, is the risk-adjusted NPV formula that we derive.

ratings such as AAA or AA can be lower than the associated increase in distress costs. If the fraction of the spread that is due to default is smaller (as suggested by Huang and Huang (2003)), or under no risk-adjustment, then marginal tax benefits of debt tend to be higher than marginal distress costs at least until the firm reaches a rating of A to BBB. There results suggest that the large distress costs that we estimate can help explain why many US firms appear to be conservative in their use of debt.[15]

The paper proceeds as follows. In the next section, we develop our valuation formula and we discuss the main intuition. In section 3, we show how the information in yield spreads can be used to derive the distress risk adjustment. Section 3.2 contains a simple version of our NPV formula that assumes away the term structure of interest rates and default probabilities, and that might be useful for teaching purposes. In section 4, we use asset pricing models to calculate the risk adjustment and to value distress costs. Section 5 discusses the capital structure implications of our results, and section 6 concludes.

2   The General Approach

Let ϕ_t be the deadweight losses that the firm incurs in case of default at time t. We think of ϕ_t as a one time cost paid in case of distress. After distress, the firm might reorganize, or it might be liquidated. In case it does not default, the firm moves to period $t + 1$, and so on. Figure 1 illustrates the timing of the model. We let p_t be the marginal probability of default in year t. The assumption of no-arbitrage guarantees the existence of a pricing kernel, m_t, and the general formula to compute the ex-ante costs of financial distress is

$$\Phi = E\left[\sum_{t \geq 1} m_t d_t \phi_t\right],\tag{1}$$

where d_t is an indicator of default at time t. Throughout the paper, we will maintain the assumption that ϕ_t is idiosyncratic.

Assumption A1: *The deadweight loss ϕ_t in case of default is uncorrelated with the*

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[15]Nevertheless, the full explanation for debt conservatism probably involves more than a static trade-off model, given Graham's (2000) finding that firms that are likely to have the lowest costs of financial distress seem to be the most conservative in their use of debt.

pricing kernel, cov $(m_t, \phi_t) = 0$, and its unconditional mean is constant over time, $E[\phi_t] = \phi$.

There is much debate in the literature on how to estimate the actual cash flow losses that are exclusively due to financial distress. In particular, while the literature does provide some estimates of the *average* deadweight costs of distress (i.e., Andrade and Kaplan, 1998), no paper has attempted to estimate a time series of these deadweight costs that would allow us to estimate their covariance with the pricing kernel. Because of this difficulty, our estimates will be based only on the systematic risk in the *probability* that financial distress occurs.

Assumption A1 could lead us to underestimate the risk adjustment if the dead-weight 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). While it would be theoretically straightforward to relax assumption A1, there is no data that would allow us to estimate the covariance between m and ϕ.

Under A1, we can rewrite equation (1) as

$$
\begin{aligned}
\Phi &= \phi \sum_{t \geq 1} \left(E[m_t] E[d_t] + cov[m_t, d_t] \right) \\
&= \phi \sum_{t \geq 1} \left(B_t E[d_t] + cov[m_t, d_t] \right) ,
\end{aligned}
\tag{2}
$$

where $B_t = E[m_t]$ is the price at time zero of a riskless zero-coupon bond paying one dollar at date t.

The first term in equation (2) is the fair compensation for default losses, which has been the focus of the literature so far. Our contribution is to estimate the second term of the equation. If default is more likely to happen when m_t is high – in bad times – then the covariance is positive, and the ex-ante costs of financial distress are larger than suggested by the fair compensation alone. We will describe two ways to implement the risk adjustment of equation (2). The first implementation, in section 3, argues that d can be replicated using a riskless government bond and the firm's risky debt. This implementation does not require

the specification of the pricing kernel m_t. The second implementation, in section 4, starts from a standard kernel and directly estimates the covariance term from historical data.

3   Implementation with Corporate Bond Yields

Our first strategy to value the costs of financial distress starts from the observation that the costs of distress tend to occur in states in which the firm's debt is in default. As we show below, this argument implies that given an estimate for the loss in firm value given distress, the net present value of distress costs can be obtained from data on the risk free rate, the firm's yield spread and the bonds' recovery rate.

To proceed, we must now introduce some notation to describe default events and default rates. Let $Q_t = \prod_{s=1}^{t}(1 - p_s)$ be the cumulative historical survival rate, i.e., the probability of not defaulting between 0 and t. By convention, $Q_0 = 1$. The probability that default occurs exactly at date t is equal to $Q_{t-1}p_t$ (see Figure 1). We also let $P_t = 1 - Q_t$ denote the cumulative probability of default up to time t. We can now rewrite equation (1) as

$$\Phi = \phi \sum_{t \geq 1} Q_{t-1}p_t E\left[m_t | \, d_t = 1\right] \ . \tag{3}$$

The credit risk literature uses risk adjusted probabilities to estimate default risk premia. Equation (3), written with risk adjusted probabilities, becomes

$$\Phi = \phi \sum_{t \geq 1} B_t \tilde{Q}_{t-1}\tilde{p}_t \ , \tag{4}$$

where $\tilde{p}_t$ is the marginal *risk-neutral* probability of default at time t. Note that $\frac{\tilde{Q}_{t-1}\tilde{p}_t}{Q_{t-1}p_t} = \frac{E[m_t | \, d_t=1]}{E[m_t]}$, and that $\widetilde{Q}_{t-1}$ is the *risk-neutral* probability that the corporation does not default before time t. We now explain how to recover $\tilde{Q}_{t-1}$ and $\tilde{p}_t$ from corporate bond yields.

3.1   Credit Spreads and the Risk Neutral Probability of Financial Distress

Let ρ_t be the recovery rate on defaulted bonds. We use the strategy proposed by Lando (2004), who makes the following assumption about recovery rates:

Assumption A2: *The recovery rate on defaulted bonds ρ_t is uncorrelated with the pricing kernel. In case of default at time t, the creditors get back a fraction ρ_t of the discounted value of a similar, but risk-free, bond. $E[\rho_t]$ is constant and equal to ρ.*

Under assumption A2, the price at date 0 of a zero-coupon corporate bond paying at date t is

$$V_t = [\rho(1 - \widetilde{Q}_t) + \widetilde{Q}_t]B_t \ . \tag{5}$$

Most fundamentally, assumption A2 implies that there is no systematic recovery risk. As discussed in Lando (2004), an additional assumption required to derive equation (5) is that the present value (at date 0) of recovery of the corporate zero paying at date t does not depend on whether recovery happens exactly at year t, or before. We discuss assumption A2 in section 3.2.

V_t and B_t can be computed from the term structure of interest rates and yield spreads. We have

$$B_t = \frac{1}{(1 + r_t^F)^t} \ , \text{ and} \tag{6}$$

$$V_t = \frac{1}{(1 + r_t^D)^t} \ , \tag{7}$$

where r^F is the risk free rate and r^D is the promised yield on the bond. Thus, given an estimate for ρ, $\widetilde{Q}_t$ can be estimated for all maturities for which we have both interest rates and yield spreads. Finally, we note that the probabilities $\widetilde{p}_t$ can be backed from the sequence $\widetilde{Q}_t$ recursively, using

$$\widetilde{Q}_{t+1} = \widetilde{Q}_t(1 - \widetilde{p}_{t+1}) \ . \tag{8}$$

The risk neutral probabilities of distress can be inferred from the term structure of interest rates and yield spreads. Equation (4) will then give an estimate for the NPV of distress costs, which incorporates the default risk adjustment that is implicit in bond yield spreads. Below we discuss issues related to the estimation of the key parameters, and provide some estimates of the NPV of distress costs calculated separately for each bond rating.

3.2 A Simple Example with Flat Term Structures

Before we move on to the empirical section, it is useful to illustrate the procedure for the simple case in which the term structure of risk free rates and the term structure of default risk are both flat.[16] We will also use this simple case to discuss the potential issues with the two assumptions (A1 and A2) that we have made. If r^F and $\tilde{p}$ are constant, equation (4) collapses to:

$$\Phi = \frac{\tilde{p}}{\tilde{p} + r^F} \phi \ . \tag{9}$$

In this case, it is also easy to derive an explicit formula for the risk neutral probability of distress. Using equation (5), we obtain:

$$\tilde{Q}_t = \frac{\frac{\left(1+r^F\right)^t}{\left(1+r^D\right)^t} - \rho}{1 - \rho} \ , \tag{10}$$

and thus:

$$\tilde{p} = \frac{r^D - r^F}{\left(1 + r^D\right)\left(1 - \rho\right)} \ . \tag{11}$$

Formulas (9) and (11) are useful to illustrate the intuition of the risk adjustment implied by the general procedure. First, notice that the true probability of distress does not appear in the formulas derived above. In particular, ϕ is the loss in value that the firm incurs *conditional* on the event of distress. The formulas also imply that if we define r^ϕ as the correct rate to discount the term $p\phi$ (the ex-ante expected distress costs), we obtain:

$$r^\phi = \frac{p}{\tilde{p}} r^F \ . \tag{12}$$

In other words, if the risk-neutral probability of distress is *larger* than the true probability of distress, then the correct rate to discount distress costs must be *lower* than the risk-free rate.[17] A similar intuition holds for the general case in which the term structure of interest rates and yield spreads is not flat.

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[16] We are not assuming that the default rate is constant, in which case there would be no adjustment. We are only assuming that the term structure of marginal default risk is flat, so $\tilde{p}$ is constant, and the NPV formula can be solved by hand.

[17] Using the expected return on the firm's debt to discount the costs of financial distress, as is sometimes advocated, is worse than simply using the risk free rate. In fact, it is easy to show that the correct discount rate for the costs of financial distress is less than the risk free rate if and only if the expected return on debt is more than the risk free rate.

Notice also that the extent of the risk adjustment implied by our procedure is a direct function of the yield spread $r^D - r^F$.[18] Larger spreads translate directly into large risk neutral probabilities of distress. However, the procedure assumes that the yield spread is due entirely to the losses that bondholders expect to incur in the event of default. By contrast, in the real world, the yield spread is also affected by taxes and liquidity. In the empirical section below we discuss this issue in detail, and adjust our estimates for tax and liquidity effects.

Notice also that the higher the recovery rate, the *higher* the risk adjustment implied by equation (11). The intuition is that if recovery is high, the fraction of the yield spread that can be attributed to the probability of default increases. This intuition also suggests that assumption A2 may lead us to *overestimate* the risk adjustment implied in yield spreads. Because there is evidence that recovery rates tend to be lower in bad times (Altman et al., 2003, and Allen and Saunders, 2004), the yield spread should also reflect recovery risk. Thus, one cannot attribute the entire difference between $\widetilde{p}$ and p to financial distress risk. In the empirical analysis, we verify the robustness of our results to the introduction of recovery risk.[19]

3.3 Empirical Estimates

We start by describing the data that we use to implement the formulas above. We then proceed to discuss the calculation of risk-neutral probabilities of default. Finally, we present our estimates of the NPV of distress costs using yield spreads to derive the distress risk adjustment.

3.3.1 Data on Yield Spreads, Recovery Rates and Default Rates

We obtain data on corporate bond yields from Citigroup's yield book, which reports average yields over the period 1985-2004. The data is available separately for bonds rated A and

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[18]To be more precise, the spread is $\frac{1+r^D}{1+r^F} - 1$, which is close to $r^D - r^F$ if both r^D and r^F are small.

[19]We note, however, that the evidence for systematic recovery risk is not uncontroversial. For example, Acharya, Bharath and Srinivasan (2004) relate recovery rates to Fama-French factors, GDP growth and the SP 500 return, and do not find significant relationships, even without controlling for industry variables. See Allen and Saunders (2004) for a broader review of the literature.

BBB, and 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 for all maturities. The yieldbook also reports data for AAA and AA bonds as a single category. Instead of using this single category, we chose to use Huang and Huang's (2003) yield spread data for these two ratings, from Lehman's bond index (Table I in Huang and Huang). Huang and Huang's data cover a different period (1973-1993), but their spread estimates are very close to those reported in Citigroup's yield book, for ratings and maturities that are available in both data sets. For example, the average spread for BB-rated bonds is 3.20% in Huang and Huang's data, and 3.08% in the yield book data. Huang and Huang report data for 4- and 10-year maturities for AAA and AA bonds.

Data on average treasury yields is also obtained from the yield book, for the same time period (1985-2004) and maturities as above. The average treasury yields are, respectively, 5.71%, 6.31%, 6.70%, and 7.08% for maturities 1-3, 3-7, 7-10 and 10+ years. These numbers are virtually identical to those obtained from the FRED website for the same time period.

We interpolate linearly the data on treasury and investment-grade corporate bond yields to fill out all maturities between 1 and 10 years. For bonds rated BB and below (high yield), we assigned the average reported yield to maturity 8, and then fill out the remaining maturities by assuming a constant yield spread across maturities.[20] Table 1 reports the yield spread data that we use, for a few select maturities and for the different bond ratings.

Table 1 also shows some of our data for average cumulative default probabilities, which we obtain from Moodys, for the period 1970-2001. The cumulative default rates are available from one year following the issuance of the bonds, up to 17 years following issuance.[21] The default probabilities are very close to those in Huang and Huang's Table 1. Moodys also reports a time series of bond recovery rates for the period 1982-2001. In most of our calculations we assume a constant recovery rate, which we set to the average value in the Moodys' data (0.413). This value is lower than the one used by Huang and Huang (0.513). As discussed above, our use of a lower recovery rate will reduce our estimate of the distress

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[20] Citigroup reports an average maturity close to 8 years for high yield bonds in their sample.

[21] The credit rating of the bonds refers to that of the time of issuance.

risk adjustment. Below (see section 4.4) we also use the whole time series of recovery rates to address the impact of recovery risk in our calculations.

3.3.2 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 the yield spread, vis-a-vis other potential explanations such as lower liquidity, and the state tax disadvantage of corporate bonds. 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). While the literature agrees that not all the yield spread is due to default, there is controversy as to the specific fraction that one should attribute to default losses.

A number of papers have attempted to estimate the fraction of the yield spread that should be attributed to the risk of default. Huang and Huang (2003) use a structural credit risk valuation model calibrated to historical default rates, and argue that credit risk accounts for only a small fraction of the spread, specially for investment-grade bonds. In contrast, Longstaff et al. (2004) and Chen et al. (2005) argue that credit risk has much more explanatory power than Huang and Huang's results suggest. In Table 2, we summarize the findings of these three recent papers.[22] Huang and Huang provide estimates for 4- and 10-year maturities, while Longstaff et al. and Chen et al. consider only one maturity (5-years, and 4-years, respectively).[23] In addition, Chen et al. consider only BBB bonds in their analysis. They show that the entire spread between BBB and AAA bonds can be explained by credit risk, while assuming that the spread between AAA and treasury bonds

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[22]Actually, Huang and Huang (2003) and Longstaff et al. (2004) report not only the fractions reported in Table 2, but also other fractions calculated under different assumptions. Because Huang and Huang provide the lowest fraction estimates, we chose the highest fractions suggested by their paper (from Table 7). The ratio of the default component to the total spread for Longstaff et al. (2004) comes from their Table IV, which, according to the authors, reports results for their preferred specification.

[23]Longstaff et al. (2004) use data from the credit default swap market to estimate the fraction of credit spreads that is due to default. In particular, they argue that the swap premium is free of tax and liquidity effects, and thus can be used as a direct measure of spreads that are due to default losses. The default swaps in their data have a typical maturity of 5 years.

is entirely due to tax and liquidity considerations. As one can see from Table 2, the results in Longstaff et al. and Chen et al. suggest a larger role for credit risk in explaining the yield spread. Because of this disagreement, our empirical analysis will use all of these alternative approaches.

Given the fractions in Table 2, we can apply formula (5) above to estimate the cumulative risk-neutral probabilities of default at different horizons. Instead of using the entire observed yield spread $r^D - r^F$ in these calculations, we use only the fraction that is likely to be due to default according to the estimates in Table 2. The numbers are in Table 3, which reports both the cumulative risk neutral probabilities of default ($\widetilde{P}_t = 1 - \widetilde{Q}_t$, in the notation above), and the ratio between risk-neutral and historical probabilities (those reported in Table 1). According to the Huang and Huang estimates, this ratio fluctuates between 2 and 3.5 for the investment-grade bonds (BBB and higher), and goes down to approximately 1.2 to 1.4 for the high yield bonds. The Huang and Huang estimates also suggest that the ratio between risk-neutral and historical probabilities does not appear to vary that much with maturity, for a given bond rating. The cumulative risk-neutral probabilities of default are much higher when we use Longstaff et al. and Chen et al. estimates, as the other columns of Table 3 show. For example, the 4-year risk neutral cumulative probability of default for BBB bonds is 7.58% according to Chen et al.'s estimates, but it is only 2.80% according to Huang and Huang's numbers.[24]

Our valuation equation (4) requires the entire term structure of risk neutral probabilities. Given the evidence in Table 3, a reasonable way to extrapolate the results of Table 3 into other maturities is to assume (for each rating) a constant ratio between risk neutral and historical probabilities for all maturities, and use the historical probabilities (which are available for all maturities) to estimate the term structure of default probabilities. More formally, our assumption is

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[24] We also obtained the data on risk neutral probabilities and ratios between risk neutral and historical probabilities from Driessen (2005), who analyzes bonds rated AA, A and BBB. His ratio estimates are close to Huang and Huang (2003) for AA and A bonds, and are slightly higher than those in Huang and Huang for BBB bonds. Because his estimates are generally between those in Huang and Huang and Longstaff et al. / Chen et al., we focus on these two extreme cases hereinafter.

Assumption A3: *The ratio between risk neutral and historical cumulative default probabilities is the same for different maturities t within each rating j*

$$\widetilde{P}_{j,t} = k_j P_{j,t} \ , \tag{13}$$

In the valuation exercise below, we use the ratios k_j depicted in Table 3. In particular, when using the Huang and Huang's estimates, we average k_j across the 4- and the 10-year maturities. Because the data suggests that k does vary with the bond rating, we chose not to extrapolate across ratings. For example, if we use the Chen et al.'s estimates in Table 3, we can only provide a valuation of distress costs for the AAA and the BBB bond ratings.

3.3.3 Valuation of Distress Costs

Despite our assumption of a constant risk-adjustment across maturities, we cannot assume a constant risk-neutral *marginal* probability of default, because the historical marginal probabilities (p_t) do vary over the life of the bond. In particular, and consistent with previous literature (i.e., Duffie and Singleton, 2003), in our data p_t increases (decreases) with the horizon for investment-grade (high yield) bonds. This pattern might be due to mean-reversion in leverage ratios (Collin-Dufresne and Goldstein, 2001). For example, for BBB bonds the marginal (yearly) default probability starts at 0.30% two years following issuance, but goes up to approximately 0.85% at year 10. In contrast, for B-rated bonds the 2-year marginal probability is approximately 8%, while the 10-year marginal is approximately 3%. The general formula (4) allows for a term-structure of default probabilities. Nevertheless, to better illustrate the procedure we start with the simple time-invariant case developed in section 3.2.

The flat term structure example   Assuming that the marginal risk neutral probability of default and the risk free rate are constant over time, we can use formula (9) to value financial distress. The average risk-free rate in our time period is 6.45%. If we average the marginal (historical) probabilities of default across years 1 to 17 we obtain the following values for ratings AAA to B, respectively: (0.11%, 0.13%, 0.23%, 0.67%, 2.43%, 4.85%). We

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assume that the risk neutral marginal probabilities for each rating are equal to the fractions k_j depicted in Table 3, times these historical probabilities.[25] For example, for the BBB rating the risk-neutral marginal probability would be approximately equal to 3.5% if we use the Chen et al. (or Longstaff et al.)'s numbers, but it would be approximately equal to 1.3% according to the Huang and Huang risk-adjustment.

In order to translate these risk-neutral probabilities into NPV of distress costs we only need to add an estimate for ϕ. The papers discussed in the introduction suggest that the term ϕ should be of the order of 10% to 23% of pre-distress firm value. For a loss of 15% of value in the event of distress, equation (9) suggests a NPV of financial distress of 1.41% of firm value for BBB bonds if we use the historical marginal probability of 0.67% (this is $\frac{0.67\%}{0.67\%+6.45\%} * 15\%$). If we incorporate Huang and Huang's risk adjustment the NPV goes up to 2.5% of firm value, and it goes up to 5.30% of firm value under the Chen et al.'s risk adjustment. These numbers suggest that the distress risk adjustment has a first order effect on the valuation of distress. In addition, the cost of distress becomes substantially higher under the assumption that the yield spread is largely due to default risk, as the Chen et al.'s numbers suggest. The following analysis will show that these conclusions carry over to the more general case with time variation in default probabilities and risk free rates.

Empirical Estimates for the General Model We incorporate term structure effects into the analysis by allowing the historical default probabilities and the risk free rate to vary with maturity. To compute equation (4), we must first calculate a terminal cost of financial distress. For that purpose, we assume that the risk-free rate is constant after year 10, and equal to r_{10}^F (which is 7.08% in our data). In addition, we use the *average* marginal probability of default between years 10 and 17 as the long term marginal default probability. We choose to use an average probability, because individual probabilities are likely to be estimated with error, and because the valuation is very sensitive to the calculation of the

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[25]Notice that this assumption implies a constant ratio of the marginal probabilities for each rating, which is slightly different than having a constant ratio of the *cumulative* probabilities, as in Assumption A3. We make this assumption in this section to illustrate the procedure in a simple way, but we work with assumption A3 in the general case below (Section 3.3.3).

terminal value. We thus assume that the marginal probability of default is constant after year 10, that is, $p_t = p_{10-17}$ for $t \geq 10$, where p_{10-17} is the average marginal between years 10 and 17, according to the Moodys data.[26] Finally, equation (13) allows us to go from historical to risk neutral probabilities, for each bond rating. As explained above, we use three different approaches to go from historical to risk neutral probabilities (Huang and Huang (2003), Longstaff et al. (2004), and Chen et al. (2005)).

Given these assumptions, our valuation equation is:[27]

$$\Phi = \phi \left[\sum_{t=1}^{10} B_t \tilde{Q}_{t-1} \tilde{p}_t \right] + \Phi_{10} \; , \tag{14}$$

where:[28]

$$\Phi_{10} = \phi \frac{\tilde{p}_{10-17}}{\tilde{p}_{10-17} + r_{10}^F} \; . \tag{15}$$

Table 4 shows our estimates of the risk-adjusted cost of financial distress, for different bond ratings and for each of the three approaches to go from historical to risk-neutral probabilities. We also show the non-risk-adjusted cost of distress, computed using historical probabilities. We use a value of $\phi = 15\%$ throughout. As explained above, the risk-adjustment is not available for all ratings in all of the approaches.

If we use historical probabilities to value financial distress, the cost of distress goes from approximately 0.25% for AAA/AA bonds to up to 7.70% for B-rated bonds. The risk-adjustment has a substantial impact in these costs, specially if the ratio between risk neutral and historical probabilities is large. For example, an increase in leverage that moves a firm from an AAA to a BBB rating increases the cost of distress by 1.11% if we use historical probabilities, by 1.83% if we use Huang and Huang, and by 5.88% if we use the risk adjustment implicit in the results of Chen et al. (2005). Thus, the marginal effect of a

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[26]Specifically, we use p_{10-17} to construct the cumulative probability P_{10} as $1 - Q_9(1 - p_{10-17})$, instead of using the historical P_{10}.

[27]Assumption A3 implies that $\tilde{Q}_{t-1}\tilde{p}_t = k_j Q_{t-1}p_t$. We use the k_j in Table 3 to go from historical to risk-neutral probabilities, for each rating and maturity.

[28]The risk-neutral marginal probability in the terminal value formula is computed from the cumulative risk neutral probabilities $\tilde{P}_9$ and $\tilde{P}_{10}$, which in their turn are computed from the cumulative probabilities P_9 and P_{10} using assumption A3.

decrease in rating on the cost of distress can be quite large. In section 5 we explore these marginal effects in the context of a static trade-off model of capital structure.

Notice also that the risk adjustments in Chen et al (2005) and Longstaff et al. (2004) appear to generate similar costs of distress, reflecting their conclusion that the fraction of the yield spread that is due to credit risk is likely to be large. In contrast, the Huang and Huang estimates are closer to the historical values than to those of the other two approaches.

4   Implementation using Asset Pricing Models

In this section, we show how one can adjust for the systematic risk of financial distress by using standard asset pricing models. While limited in some respects, this approach is useful for three reasons. First, the approach allows us to provide *direct* qualitative evidence for the existence of a systematic component of financial distress risk. Second, it allows us to look at a broader measure of financial distress, for which we do not need to assume that distress states and default states are the same. Third, it provides us with a way of incorporating recovery risk in the analysis of the previous section, where we assumed that recovery rates were constant.

We define ε_t such that

$$m_t \equiv B_t \left(1 + \varepsilon_t\right) \ .$$

Note that $E\left[\varepsilon_t\right] = 0$. We then rewrite equation (2) for a particular rating j as

$$\Phi_j = \phi \sum_{t \geq 1} B_t \left(E\left[d_{j,t}\right] + cov\left[\varepsilon_t, d_{j,t}\right]\right) \ .$$

Under assumption A3, it is easy to show that[29]

$$\Phi_j = k_j \Phi_j^o \ , \tag{16}$$

where Φ_j^o is the value of financial distress without the risk adjustment:

$$\Phi_j^o = \phi \sum_{t \geq 1} B_t Q_{j,t-1} p_{j,t} \ . \tag{17}$$

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[29]Here is a sketch of the proof. We assume that $\tilde{P}_{j,t} = k_j P_t$, and we want to show that $\Phi_j = k_j \Phi_j^o$. Given the valuation formula, it is enough to show that $\tilde{Q}_{j,t-1}\tilde{p}_{j,t} = k_j Q_{j,t-1} p_{j,t}$. This is turn follows from the recursive equation for Q: $\tilde{Q}_{j,t-1}\tilde{p}_{j,t} = \tilde{Q}_{j,t-1} - \tilde{Q}_{j,t} = \tilde{P}_{j,t} - \tilde{P}_{j,t-1}$ and by assumption $\tilde{P}_{j,t} - \tilde{P}_{j,t-1} = k\left(P_{j,t} - P_{j,t-1}\right) = k_j Q_{j,t-1} p_{j,t}$.

and where

$$k_j = 1 + \frac{cov\left[\varepsilon_t, d_{j,t}\right]}{E\left[d_{j,t}\right]}, \tag{18}$$

Equation 18 shows that the risk-adjustment k_j is a direct function of the covariance between the pricing kernel and the distress indicator. In particular, if distress is more likely to happen in bad times this covariance is positive, implying that $k_j > 1$ and that $\Phi_j > \Phi_j^o$. We now use some standard pricing kernels to estimate this covariance.

4.1 Pricing Kernels

To compute the risk adjustment in equation 18, we need to take a stand on the pricing kernel of the economy. There is no agreement as to what this kernel is, so we will illustrate our approach with the most commonly used kernels.

4.1.1 Consumption-Based Models

We use aggregate consumption growth to define the pricing kernel m_t. The consumption $CAPM$ with $CRRA$ preferences is simply

$$m_t = \delta \left(\frac{c_t}{c_{t-1}}\right)^{-\gamma}, \tag{19}$$

where c_t is the sum of the consumption of non-durables and services, in real terms, and γ is the degree of risk-aversion of the representative agent. Another popular model is based on habit formation. Here, we follow Campbell and Cochrane (1999), and define the pricing kernel as

$$m_t = \delta \left(\frac{s_t}{s_{t-1}}\frac{c_t}{c_{t-1}}\right)^{-\gamma}, \tag{20}$$

where the surplus consumption ratio follows

$$\log s_{t+1} = (1 - \varphi)\log \bar{s} + \varphi \log s_t + \lambda\left(s_t\right)\left(\log \frac{c_{t+1}}{c_t} - g\right), \tag{21}$$

and the market price of risk follows

$$\lambda\left(s_t\right) = \frac{\sqrt{1 - 2\log \frac{s_t}{\bar{s}}} - \bar{s}}{\bar{s}}. \tag{22}$$

The consumption data that is required to compute the pricing kernels described above come from the NIPA.

4.1.2 Factor Models

A factor model gives the expected return on any asset i as

$$E\left(r^i\right) = r^F + \lambda'\beta^i \ , \tag{23}$$

where $\lambda = E\left(f\right) - r^F$. Our discussion of how to move from a factor representation to a kernel representation follows Cochrane (2001, p 108). Given that the pricing kernel is defined by $E\left[m\left(1+r^i\right)\right] = 1$, we can look for a representation of the form

$$m = E\left(m\right) \times \left[1 + b'\left(f - E\left(f\right)\right)\right] \ , \tag{24}$$

so that $E\left(r^i\right) = \frac{1}{E(m)} - b'cov\left(r^i, f\right)$, and

$$b = -var(f)^{-1}\left(E\left(f\right) - r^F\right). \tag{25}$$

Given the vector b, we can construct the stochastic process

$$\varepsilon_t = 1 + b'\left(f_t - E\left(f\right)\right). \tag{26}$$

We will use the CAPM (with the market return as the only factor) and the 3-factor model of Fama and French.

4.2 Estimation Strategy

Equation (18) implies that the risk-adjustment depends on the covariance between ε_t and $d_{j,t}$. Because of data limitations, however, we cannot estimate k_j for different ratings. Instead we compute an average estimate of $cov\left[\varepsilon_t, d_t\right]$ using the time-series covariance between the probability of financial distress and the pricing kernel, and we estimate $E[d_t]$ as the average probability of financial distress.

In order to compute a time-series for the probability of financial distress, we follow two alternative strategies. Our first strategy is to use the annual default rates in the high yield bond market from Altman, Brady, Resti, and Sironi (2003). These authors compute the weighted average default rate on bonds in the high yield bond market, where weights are

based on the face value of all high yield bonds outstanding each year and the size of each defaulting issue within a particular year. They have data for the period of 1982-2003.

Our second strategy is to relax the assumption that default states and distress states coincide exactly. For instance, key employees may choose to quit when they anticipate that the firm will face severe liquidity problems, which may happen before any actual default, and even if the firm manages to avoid default altogether. We follow the previous literature, and say that a firm-year is financially distressed if the firm's operating income (EBITDA) is less than a certain percentage of its yearly interest expense. Asquith, Gertner and Scharfstein (1994) use 90% as the percentage cutoff to define financial distress. Andrade and Kaplan (1998) require that EBITDA be lower than interest expense (corresponding to a 100% cutoff), but also use other more qualitative criteria to define an event of distress. To verify robustness, we use cutoffs of 85%, 90%, 95%, 100% and 105%.

We start from the universe of manufacturing firms (SIC 2000–3999) with data available in COMPUSTAT on operating income (EBITDA) and interest expenses. We restrict the sample period to 1982–2003 to allow comparison with the first method. For each year t, our estimate of d_t is simply the fraction of firms that are in distress in this particular year. Finally, we use the series d_t to compute the statistics required in equation (18).[30]

4.3 Results from the Pricing Models

Figure 2 shows the time series of ε_t for the different pricing kernels described above, the default rate and the 95% accounting measure of distress from COMPUSTAT. Table 5 presents our estimates of $\frac{cov[\varepsilon_t, d_t]}{E[d_t]}$ in equation (18). The covariance of distress probabilities with asset pricing kernels is positive for all the models, but the magnitude of the risk-adjustment varies from 2% to 17%. It is strongest if we use the simple consumption CAPM (column 1), and weakest if we use the factors models together with the COMPUSTAT accounting

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[30]One issue we face is that the sample changes over time, with the entry of young firms that have very small or negative profits. We therefore eliminate the firm-year observations for which operating income is negative. We then estimate the probability of distress in two ways, first using a balanced panel of firms, and second using the full panel, but including firms fixed effects. Both make the d_t series stationary and lead to similar results.

measure. One possible explanation for this pattern is that the factor models are based on market data, which tend to move much faster than the accounting data on which we base our accounting measure of distress. The estimated bias is more consistent across pricing kernels when we use the default rate on high yield bonds.

These results suggest that the *qualitative* conclusions derived in section 3 are robust to this alternative methodology. It gives direct evidence that financial distress is indeed more likely to happen in bad times. However, the size of the risk-adjustment suggested in this section is substantially smaller than the one suggested by the previous method.[31] The ratios of 1.02 to 1.17 between risk-neutral and historical probabilities that we obtain in this section look small when compared to the ratios reported in Table 3. It is not very surprising, however, that we obtain smaller risk adjustments, since it is well known that standard asset pricing kernels have a hard time explaining the entire risk premium that is observed in asset prices. By contrast, the procedure in section 3 does not require the specification of the pricing kernel. Thus, we see the results in this section as a conservative lower bound for the distress risk adjustment.

4.4   Recovery Risk

One payoff of the approach in this section is that is provides us with a way to relax our previous assumption of constant recovery (assumption A2). In the general case of random recovery, formula (5) of the previous section becomes

$$V_t = [\tilde{\rho}(1 - \widetilde{Q}_t) + \widetilde{Q}_t]B_t \ , \tag{27}$$

where

$$\tilde{\rho} = \tilde{E}[\rho] = \frac{E[m\rho]}{E[m]} \tag{28}$$

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[31] Given these estimates for k, it is straightforward to repeat the valuation exercises that we performed in section 3.3.3. In particular, one can directly use equations 14 and 15, which allow for a term-structure of default probabilities and interest rates. As suggested by Proposition 1, the risk neutral probabilities would be estimated as $\widehat{k}$ times the historical probabilities, for all bond ratings. Given the small size of the adjustment, the resulting NPVs of financial distress are very close to the historical ones in Table 4, and so we do not report them here.

is the risk neutral recovery rate. We can use the pricing kernels described above to estimate $\tilde{\rho}$ by correlating the kernels with our annual data on recovery rates from Moodys, for the period 1982-2001.

We find that the risk neutral adjustment is relatively small, compared to the benchmark recovery rate of 41%. The CAPM and the Campbell-Cochrane kernels both predict a risk neutral recovery rate of 38%. The Fama-French kernel suggests 40%, and the Consumption CAPM suggests 37%. Even making the correlation between the kernel and the recovery rate equal to minus one (-1), the risk-adjusted recovery rate does not drop below 31%. If we rerun the analysis of section 3.3.3 by replacing the average recovery rate of 41% with this extreme value (31%), we obtain costs of distress that are lower than those reported in Table 4, but not by much. For example, the cost of distress for BBB bonds using the Chen et al. or the Longstaff et al. risk adjustments becomes approximately 5.4%, instead of 6.1% as in Table 4. We conclude that recovery risk is unlikely to have a major effect on our previous estimates of the risk-adjusted cost of financial distress.

5 Implications for Capital Structure

Our results show that the costs of financial distress can become much larger once we adjust for risk. We now explore what this implies for the capital structure decision, in the context of a static trade-off model. Existing literature suggests that distress costs are too small to overcome the potential tax benefits of increased leverage, and thus corporations may be using debt too conservatively (Graham, 2000). In this section, we attempt to verify whether this conclusion continues to hold if we use our valuation formulas to calculate marginal costs of financial distress.

Naturally, these calculations are subject to the limitations of the static trade-off model. 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 costs of financial distress that we calculate is comparable to that of tax benefits of debt. We believe this is a worthy exercise, given the common belief that financial distress

costs seem to be too small to matter for capital structure.[32]

5.1 The risk adjustment in the static trade-off model

We start by showing with a simple static trade-off model that the presence of a distress risk adjustment implies a lower optimal leverage ratio for the firm. According to the static trade-off model, the firm should maximize:

$$V = V^0 + NPV(\text{tax benefits of debt}) - V^0\Phi \ . \tag{29}$$

where V^0 is the firm's unlevered value, and Φ is the NPV of financial distress. In this section, we assume for simplicity that the risk adjustment k is the same across ratings,

$$\tilde{p} = kp, \tag{30}$$

and also that the probability of default is constant over time, so we can use equation (9) to value distress costs.

In order to calculate the NPV of tax benefits of debt, we assume perpetual debt and write the tax benefit cash flow as τx, where x is the coupon that is promised to bondholders every period. However, we note that the tax benefits only accrue to the firm in the event of no default. We can thus build a valuation tree for tax benefits that is similar to that in Figure 1. Each period, there is a probability $\tilde{p}$ that the tax benefits are equal to zero. This set up implies that, assuming time invariance, the tax benefits of debt should be given by:

$$NPV(\text{tax benefits of debt}) \equiv T = \frac{1 - \tilde{p}}{\tilde{p} + r^F}\tau x. \tag{31}$$

We can show that if bond recovery is equal to zero ($\rho = 0$), this formula collapses to the standard, textbook τD formula, where D is the market value of debt.[33] Thus, one

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[32]Besides Graham (2000), Andrade and Kaplan (1998) also suggest that the NPV of financial distress might be too small to matter:

> "[..] 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).

[33]This result follows from the fact that with zero recovery the cash flows from tax benefits 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 equal to τD.

should think of equation (31) as the standard textbook formula adjusted for the fact that bond recovery is not always equal to zero. The firm's capital structure problem can then be formulated as:

$$\max_x \frac{(1-\tilde{p})}{\tilde{p}+r^F} \frac{\tau x}{V^0} - \frac{\tilde{p}}{\tilde{p}+r^F} \phi \;, \tag{32}$$

where the risk neutral probability of distress $\tilde{p}$ is equal to kp, and the true probability of distress p increases with x. We assume for simplicity that the actual probability of default p is linear in the leverage ratio $\frac{x}{V^0}$, that is: $p = a\frac{x}{V^0}$ with $a > 0$. Under those assumptions, it is straightforward to derive a closed form solution for the optimal ratio of coupon payment to unlevered equity:

$$\frac{x^*}{V^0} = \frac{\tau - ak\phi}{2ak\tau} \;. \tag{33}$$

The comparative statics are intuitive. The optimal amount of leverage increases with the corporate income tax rate and decreases with the deadweight loss in distress. In addition, an increase in the risk-adjustment k reduces the optimal amount of leverage.

A less obvious question is whether the *quantitative* effect of distress risk on optimal leverage can be large. We now turn to this question.

5.2   Estimating the effect of distress risk on capital structure choices

In section 3, we estimate the costs of financial distress for each bond rating. In order to compare these costs with tax benefits of debt, we need to estimate the typical 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.

5.2.1   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). If leverage is higher than this, then marginal benefits start decreasing. Graham calls this point the *kink* in the firm's tax benefit function. Formally, the kink is defined as:

$$kink = \frac{\text{amount of interest that causes marginal benefit to start decreasing}}{\text{actual interest expense}}, \qquad (34)$$

so that a firm with a kink of 2 can double its interest deductions, and still keep a constant marginal benefit of debt. Firms with high kinks use leverage more conservatively.

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 levers up to its kink. In addition, notice that the firm remains in the flat portion of the marginal benefit curve until its kink reaches one. Thus, these numbers allow us to compute the marginal benefit of increasing debt in the flat portion of the curve (τ^*) implied in Graham's data. 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. Because we can use the formula $\tau^* D$ in the flat portion of the curve, we can calculate tax benefits for each leverage ratio, assuming that kink is higher than one. Clearly, this approximation is no longer reasonable if leverage becomes too high. We use this approximation in the calculations below. 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.

In order to remain closer to Graham's estimates, our calculations will also ignore the non-zero recovery adjustment for tax benefits, which we derived in the previous section. If we do incorporate this adjustment, the tax benefits of debt become slightly lower, but not

by much.[34]

5.2.2 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 for each bond rating. A simple way of doing this is to collect average or median leverage ratios for each bond rating from COMPUSTAT. However, 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 if we ignore this endogeneity problem.

The leverage data that we use is summarized in Table 6. Column I reports Molina's predicted leverage values for each bond rating, from his Table VI. 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 (column II of Table 6). He reports the ratio of long term debt to book assets, for each rating in the period 1998-2002. As discussed by Molina, despite the aforementioned endogeneity problem the rating changes in these summary statistics actually resemble those predicted by the model. We have also collected average (book) leverage ratios at each rating for manufacturing firms in a broader time period (1981-2004). The relation between leverage and ratings in this broader period is similar to that in Molina (see column III), with slightly lower leverage ratios at each rating.

5.2.3 Capital structure results

Table 7 depicts our estimates of the tax benefits of debt for each bond rating. It also reports the difference between the present value of tax benefits and the cost of distress calculated

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[34]Results available from the authors upon request.

under different hypothesis about the risk-adjustment. The present value of tax benefits is calculated as 0.157 times the leverage ratio for each rating (see section 5.2.1). In column 1 we report the present value of the tax benefits of debt associated with each bond rating, and in the four subsequent columns we report the difference between tax benefits and the cost of distress, for the model with no risk-adjustment, and for the three different ways in which we calculated the risk-adjustment in section 3.[35] We use a loss in value given distress of 15% in Table 7.

Panel A reports the results using the leverage ratios from Molina's (2005) regression model (column 1, Table 6). The difference between tax benefits and the non risk-adjusted cost of distress (column 2) suggests that the average firm should benefit from increasing leverage at least until it reaches a bond rating of A to BBB. The marginal increase in value that comes from tax benefits is clearly higher than the increase in distress costs until this leverage range. However, further increases in leverage beyond a rating of BBB appear to decrease firm value because the marginal increase in distress costs is higher than the gain in tax benefits. Column 3 shows that incorporating the Huang and Huang risk adjustment does not substantially change these conclusions, in that the difference between tax benefits and distress costs still increases until the firm reaches a rating of A to BBB.[36]

Nevertheless, Columns 4 and 5 tell a very different story. If we incorporate the higher risk-adjustments implied by the results in Longstaff et al. (2004) and Chen et al. (2005), then it is no longer clear that a firm would gain much from increasing leverage, even if its current rating is as high as AAA or AA. For example, if we use Longstaff et al.'s risk adjustment (Column 4), the firm does not appear to gain much by increasing leverage from AA to A. The increase in tax benefits is substantial (2% of firm value), but the increase in distress costs is of the same magnitude (see also Table 4). The Chen et al. results (Column 5) only allow us to report costs of distress for two ratings (AAA and BBB), but

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[35] We do not use the risk-adjustment based on the asset pricing model, because, as we will see, the conclusions about capital structure are the same as those that are based on the Huang and Huang (2003) risk adjustment.

[36] Because the risk-adjustment implied by the asset pricing models are even smaller than that of Huang and Huang, these conclusions would have been the same under that alternative adjustment.

the limited evidence is consistent with that in Longstaff et al., given that the difference between tax benefits and costs of distress is clearly higher for the AAA rating. The firm gains approximately 5% its value in tax benefits by moving from AAA to BBB, but according to the Chen et al. estimates the associated increase in distress costs is close to 6% of firm value.

Despite the difference in leverage ratios, Panel B suggests a similar conclusion. If the cost of financial distress is not risk-adjusted, or if it is adjusted according to Huang and Huang (2003), the optimal bond rating for an average firm should be as high as A, or BBB. However, if we incorporate the risk-adjustments implied by Longstaff et al. (2004) or Chen et al. (2005), there is no evidence that the firm gains much by increasing leverage from any level, including AAA or AA.

Figure 3 gives a visual picture of our main capital structure implication. In it, we plot the differences between tax benefits and costs of distress using the Molina et al.'s (2005) leverage numbers (column I, Table 6). We do not plot the numbers based on the Chen et al. risk adjustment, since there are only two points. Clearly, while the distress costs with no risk adjustment or with the risk adjustment based on Huang and Huang generate a U-shape for the net benefits of debt that peaks at about the A to BBB rating, the risk-adjustment based on Longstaff et al. actually suggests that the optimal bond rating could be AA or higher.

These estimates assume a loss in value given default of 15%. However, we obtain similar results for any value ranging from 10% to 20%, which is roughly the range estimated by Andrade and Kaplan (1998). In order to see this, consider Figures 4 and 5. Figure 4 reports the differences between tax benefits and distress costs using Molina et al.'s (2005) leverage and assuming no risk-adjustment, for different values of the loss given distress. For all values of ϕ, the difference between tax benefits and distress costs increases until the firm reaches a rating of A/BBB, and then starts decreasing (or stays constant, if $\phi = 10\%$). In contrast, if we repeat this exercise with distress costs that are risk-adjusted according to Longstaff et al. (2004), then the difference is (roughly) flat or decreasing, suggesting that

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the firm might not lose much value by retaining a rating of AA or higher.

Interpretation and comparison with previous literature   Table 7 and Figures 3 to 5 show that risk-adjusted costs of financial distress can counteract the marginal tax benefits of debt estimated by Graham (2000). This conclusion is specially true if the fraction of the yield spread that is due to default risk is large, as suggested by Longstaff et al. (2004) and Chen et al. (2005). In this case, our results show that the marginal gains in tax benefits of moving from the highest ratings such as AAA or AA can be lower than the associated increase in distress costs. If the fraction of the spread that is due to default is lower (as suggested by Huang and Huang (2003)), then the average firm should lever up to the point at which its rating is A or BBB, but not beyond that.

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. This formula ignores discounting, risk-adjustment and term structure effects. Table 7 and Figure 3 show that the risk-adjustment has a first order effect on the marginal costs of distress, and thus on the capital structure predictions of the static trade-off model. In contrast, in our calibration, using simple summary statistics or using Molina's regression results to relate leverage to bond ratings does not seem to affect much the capital structure

predictions of the trade-off model.[37]

6 Final Remarks

We develop a methodology to estimate the present value of financial distress costs, which takes into account the systematic component in the risk of distress. Given the simplicity of our formulas and their easy implementation, we believe that they will be useful for practitioners and academics alike, for research and teaching purposes. In addition, our results show that the traditional practice of assuming risk-neutrality to value distress costs can result in severe underestimation of the total costs, specially if the fraction of the yield spread that is due to default risk is large. The large marginal distress costs that we find can help explain the apparent reluctance of firms to increase their leverage, despite the existence of positive marginal tax-benefits of debt. While large costs of financial distress are probably not the only reason why firms appear to be debt conservative, our results suggest that they can be part of the story.

The large risk-adjusted NPVs of distress that we find in some of our calculations are a direct consequence of the bond premium puzzle, namely 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 leverage, if the firm's goal is to maximize the wealth of these risk-averse investors. In other words, bond spreads and capital structure decisions appear to be consistent with each other. Recently, Cremers, Driessen, Maenhout and Weinbaum (2005) have shown that implied volatilities and jump risks, measured in 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 that it is not arbitrary. Market participants, from options and bonds traders

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[37]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 t^* 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 the *average* leverage values for each rating in Table 7.

to corporate managers, seem to respond similarly to the price of risk.

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Table 1. Yield Spreads and Cumulative Default Probabilities

	Yield spreads		Cumulative default probabilities	
Credit Rating	4-year	10-year	4-year	10-year
AAA	0.55%	0.63%	0.04%	0.80%
AA	0.65%	0.91%	0.20%	0.96%
A	1.06%	1.21%	0.35%	1.63%
BBB	1.69%	1.78%	1.44%	5.22%
BB	3.08%	3.08%	8.83%	21.48%
B	5.08%	5.08%	26.01%	46.52%
CCC	9.78%	9.78%	51.85%	77.79%

The spread data for A, BBB, BB, B and CCC bonds come from Citigroup's yieldbook, which reports average spreads for the period 1985-2004. Data for AAA and AA bonds comes from Huang and Huang (2003), and refer to the averages over the period 1973-1993. The cumulative default probabilities are from the Moody's dataset, averages over the period 1970-2001.

Table 2. Fraction of the Yield Spread Due to Default

Credit Rating	Huang and Huang (2003)		Longstaff et al. (2004)	Chen et al. (2005)
	4-year	10-year	5-year spread	4-year spread
AAA	0.030	0.208	NA	0
AA	0.121	0.200	0.51	NA
A	0.134	0.234	0.56	NA
BBB	0.245	0.336	0.71	0.67
BB	0.581	0.633	0.83	NA
B	0.976	0.833	NA	NA

This Table reports the fractions due to default of the yield spread calculated over benchmark treasury bonds, for each credit rating and different maturities. The first two columns use 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 third column uses Longstaff et al.'s (2004) Table IV, which reports model-based ratios of the default component to total corporate spread. The fourth column uses results from Chen et al. (2005), who suggests that none of the AAA spread is due to default, but the entire BBB minus AAA spread can be attributed to default. Thus, the fraction reported for BBB bonds is the ratio of the BBB minus AAA spread over the BBB minus treasury spread. NA = not available.

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

| | Huang and Huang (2003) | | | | Longstaff et al. (2004) | | Chen et al. (2005) | |
| | 4-year horizon | | 10-year horizon | | 5-year horizon | | 4-year horizon | |
Rating	Prob.	Ratio	Prob.	Ratio	Prob.	Ratio	Prob.	Ratio
AAA	0.11%	2.81	2.22%	2.79	NA	NA	0.04%	1.00
AA	0.53%	2.67	3.07%	3.20	2.56%	8.27	NA	NA
A	0.97%	2.77	4.74%	2.91	5.30%	10.38	NA	NA
BBB	2.80%	1.94	9.84%	1.89	10.30%	5.28	7.58%	5.26
BB	11.65%	1.32	29.88%	1.39	20.17%	1.77	NA	NA
B	29.97%	1.15	57.95%	1.25	NA	NA	NA	NA

This Table reports cumulative risk-neutral probabilities of default calculated from bond yield spreads, according to the fractions due to default reported in Table 2. The Table also reports the ratio between the risk-neutral probabilities and the historical ones, using the historical probabilities reported in Table 1. NA = not available.

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

Rating	Historical	Huang and Huang (2003)	Longstaff et al. (2004)	Chen et al. (2005)
AAA	0.24%	0.65%	NA	0.24%
AA	0.27%	0.78%	2.10%	NA
A	0.48%	1.32%	4.27%	NA
BBB	1.34%	2.48%	6.14%	6.12%
BB	4.30%	5.75%	7.38%	NA
B	7.70%	9.38%	NA	NA

This Table reports our estimates of the NPV of the costs of financial distress expressed as a percentage of firm value, calculated using historical probabilities (first column), and risk-adjusted probabilities (remaining columns). The magnitudes of the risk-adjustments in the second to fourth columns are as given in Table 3, and the historical probabilities are as given in Table 1. We use an estimate for the loss in value given distress of 15%. NA = not available.

Table 5: Risk Adjustment Implied by Asset Pricing Models

Distress Measures		Pricing Kernels			
		Consumption CAPM	Campbell-Cochrane	Market CAPM (one factor)	Fama-French (3 factors)
Interest Payments over Income (%)	85	0.16	0.16	0.05	0.05
	90	0.17	0.16	0.04	0.04
	95	0.17	0.17	0.04	0.04
	100	0.17	0.16	0.04	0.03
	105	0.17	0.16	0.04	0.02
Bond Default Rate		0.17	0.15	0.12	0.10

This Table reports estimates for the covariance between the the probability of distress and several asset pricing kernels, normalized by the average probability of financial distress. The sample period is 1981-2003. Compustat data includes only manufacturing firms (NAICS=3) continuously present in the sample. The first distress measure is the fraction of firms whose interest payments exceed x% of their income, with x ranging from 85 to 105. The second distress measure is the default rate on the high yield bond market from Altman, Brady, Resti and Sironi (2003). Each column presents the results for a different asset pricing kernel.

Table 6. Typical Book Leverage Ratios for Each Bond Rating

| Rating | Molina (2005) | | COMPUSTAT 1981-2004 |
	Predicted Values	Summary Statistics	
AAA	0.03	0.09	0.09
AA	0.16	0.17	0.13
A	0.28	0.22	0.16
BBB	0.33	0.28	0.21
BB	0.46	0.34	0.27
B	0.57	0.42	0.36

This Table reports typical book leverage ratios calculated for separate bond ratings. The first two columns are drawn from Molina (2005). The first column shows predicted 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 simple summary statistics in Molina's Table IV. Column III reports average leverage ratios at each rating for manufacturing firms in the period 1981-2004, from COMPUSTAT.

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

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

Rating	Tax Benefits of Debt	Tax Benefits of Debt minus Distress Costs			
		No risk adjustment	Huang and Huang (2003)	Longstaff et al. (2004)	Chen et al. (2005)
AAA	0.47%	0.23%	-0.18%	NA	0.23%
AA	2.51%	2.24%	1.73%	0.41%	NA
A	4.40%	3.91%	3.08%	0.13%	NA
BBB	5.18%	3.84%	2.70%	-0.96%	-0.94%
BB	7.22%	2.92%	1.47%	-0.16%	NA
B	8.95%	1.25%	-0.43%	NA	NA

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 the distress risk-adjustment. 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. In the second column we use historical default probabilities to estimate distress costs. In the third column we use Huang and Huang's (2003) risk adjustment. In the fourth column we use Longstaff et al. (2004) risk adjustment, and in the last column we use Chen et al. (2005).

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

Panel B: Leverage Ratios from Molina's (2005) summary statistics

Rating	Tax Benefits of Debt	Tax Benefits of Debt minus Distress Costs			
		No risk adjustment	Huang and Huang (2003)	Longstaff et al. (2004)	Chen et al. (2005)
AAA	1.41%	1.18%	0.76%	NA	1.18%
AA	2.67%	2.40%	1.89%	0.57%	NA
A	3.45%	2.97%	2.13%	-0.82%	NA
BBB	4.40%	3.05%	1.91%	-1.75%	-1.72%
BB	5.34%	1.04%	-0.41%	-2.05%	NA
B	6.59%	-1.11%	-2.79%	NA	NA

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 the distress risk-adjustment. The relation between ratings and leverage is estimated using Molina's (2005) summary statistics. This relation is as reported in our paper in column II 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. In the second column we use historical default probabilities to estimate distress costs. In the third column we use Huang and Huang's (2003) risk adjustment. In the fourth column we use Longstaff et al. (2004) risk adjustment, and in the last column we use Chen et al. (2005).
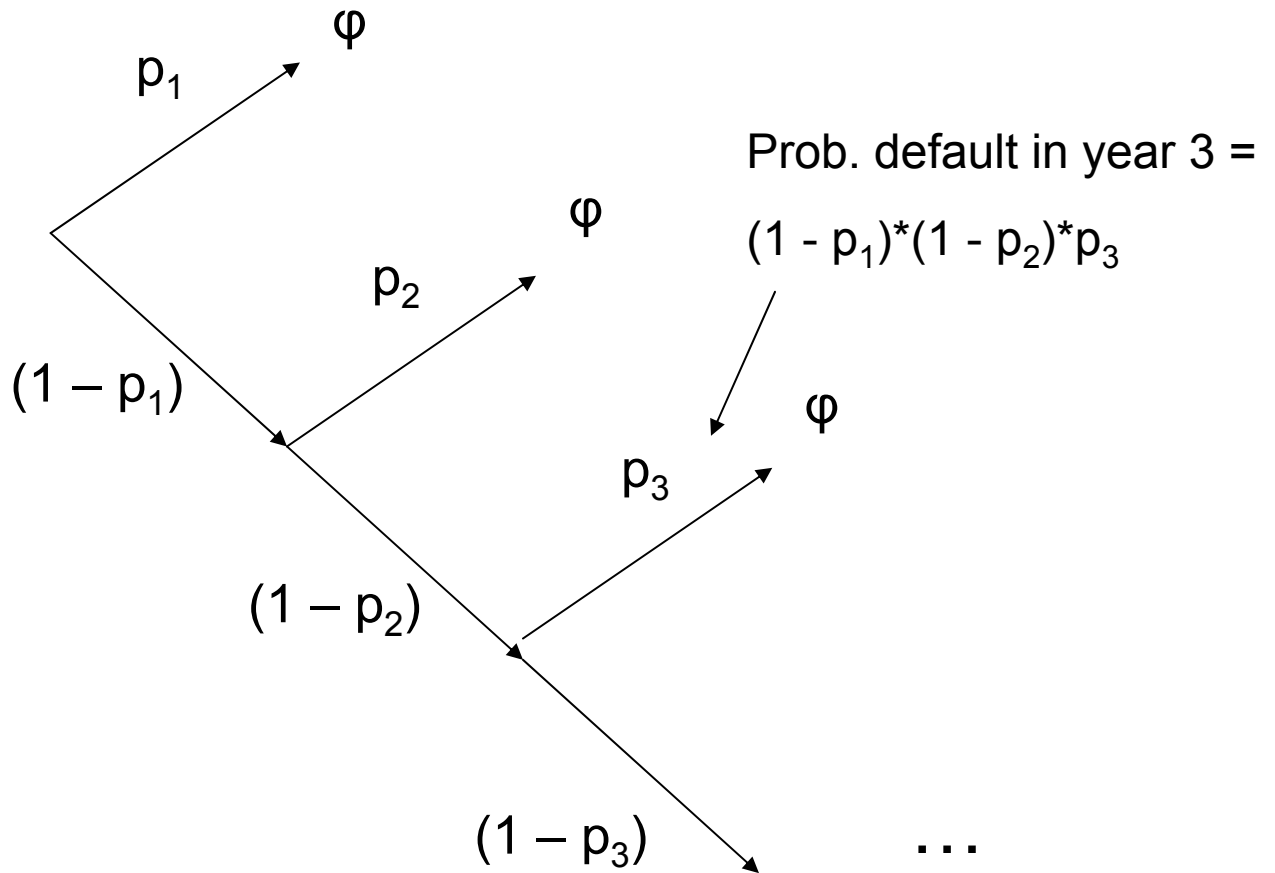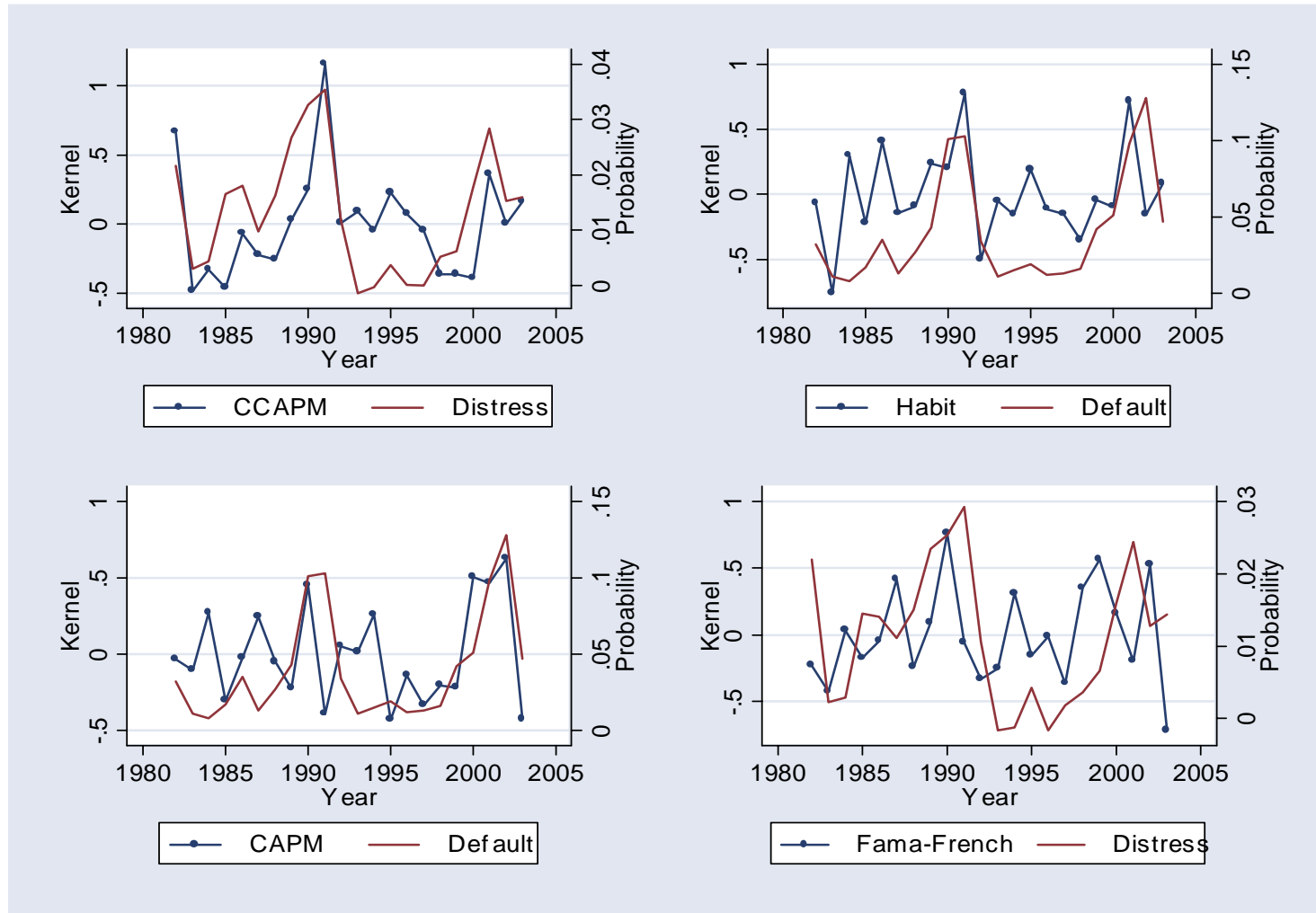
Figure 1 – Valuation tree

p_1 φ

Prob. default in year 3 =

$(1 - p_1)*(1 - p_2)*p_3$

φ

p_2

$(1 - p_1)$

φ

p_3

$(1 - p_2)$

$(1 - p_3)$ …

Figure 2. Pricing Kernels and Probability of Distress

Note: As in the text, for each kernel m, we define e by m=E[m]*(1+e). Thus e can be negative, but is always strictly more than -1. The figure shows e for the 4 different kernels. CCAPM is consumption CAPM with constant relative risk aversion of 40. Habit is Campbell-Cochrane model. CAPM is one factor (market) model. Fama-French is 3 factors model (market, size, Tobin's Q). Distress is probability that interest payments are more than 95% of operating income from COMPUSTAT. Default is default rate on high yield bonds, from Altman, Brady, Resti and Sironi (2003)

Figure 3. Tax Benefits of Debt Minus Distress Costs
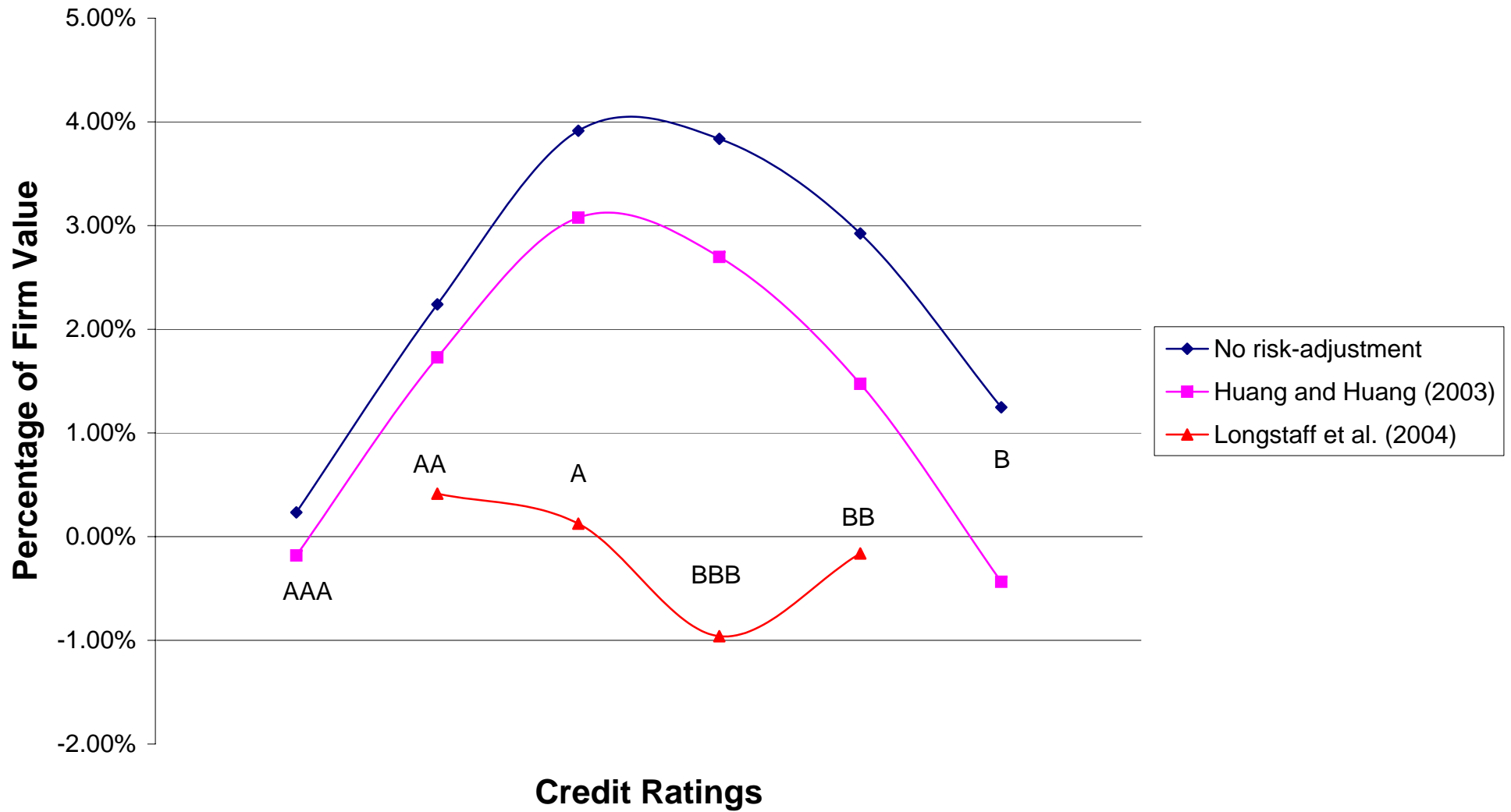
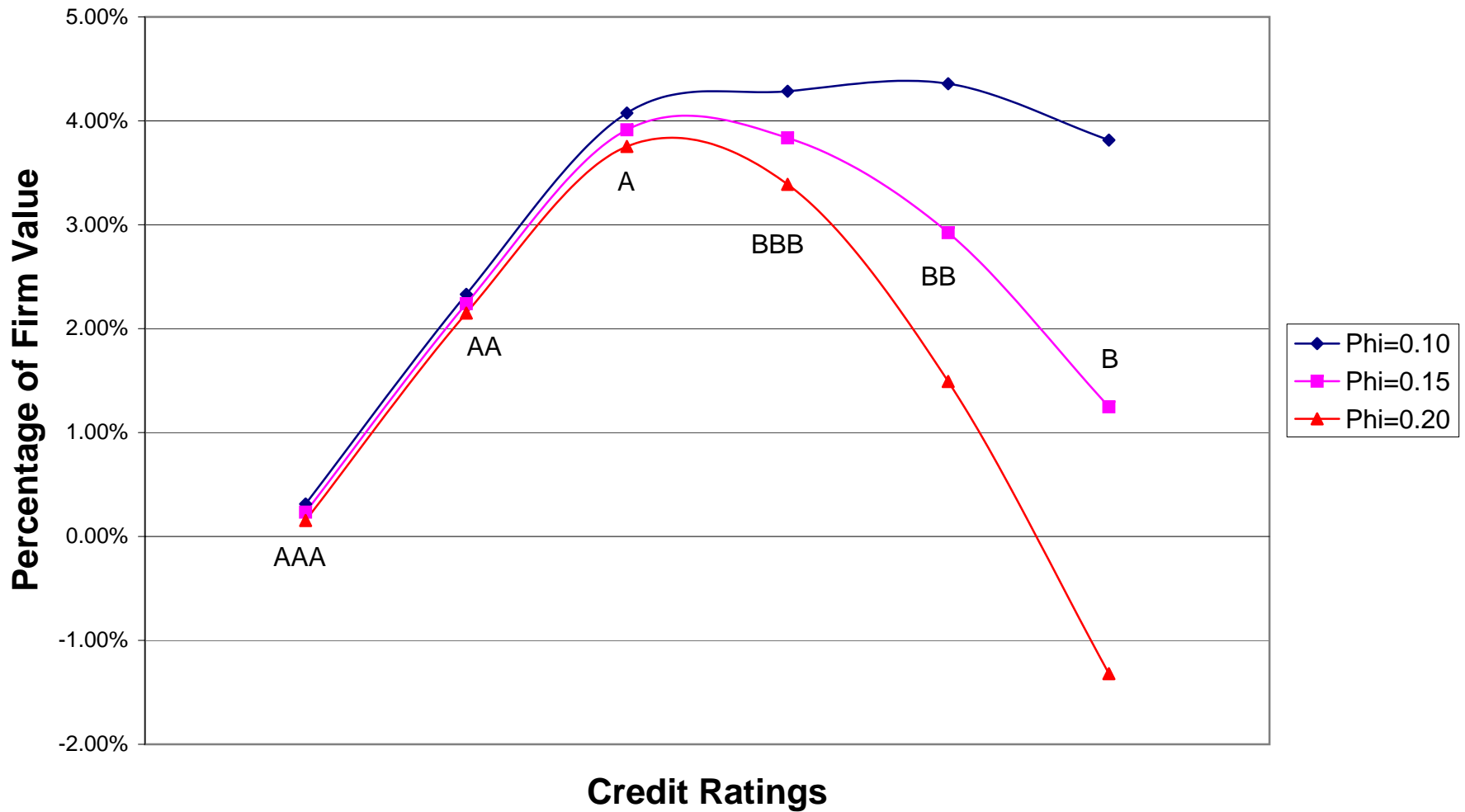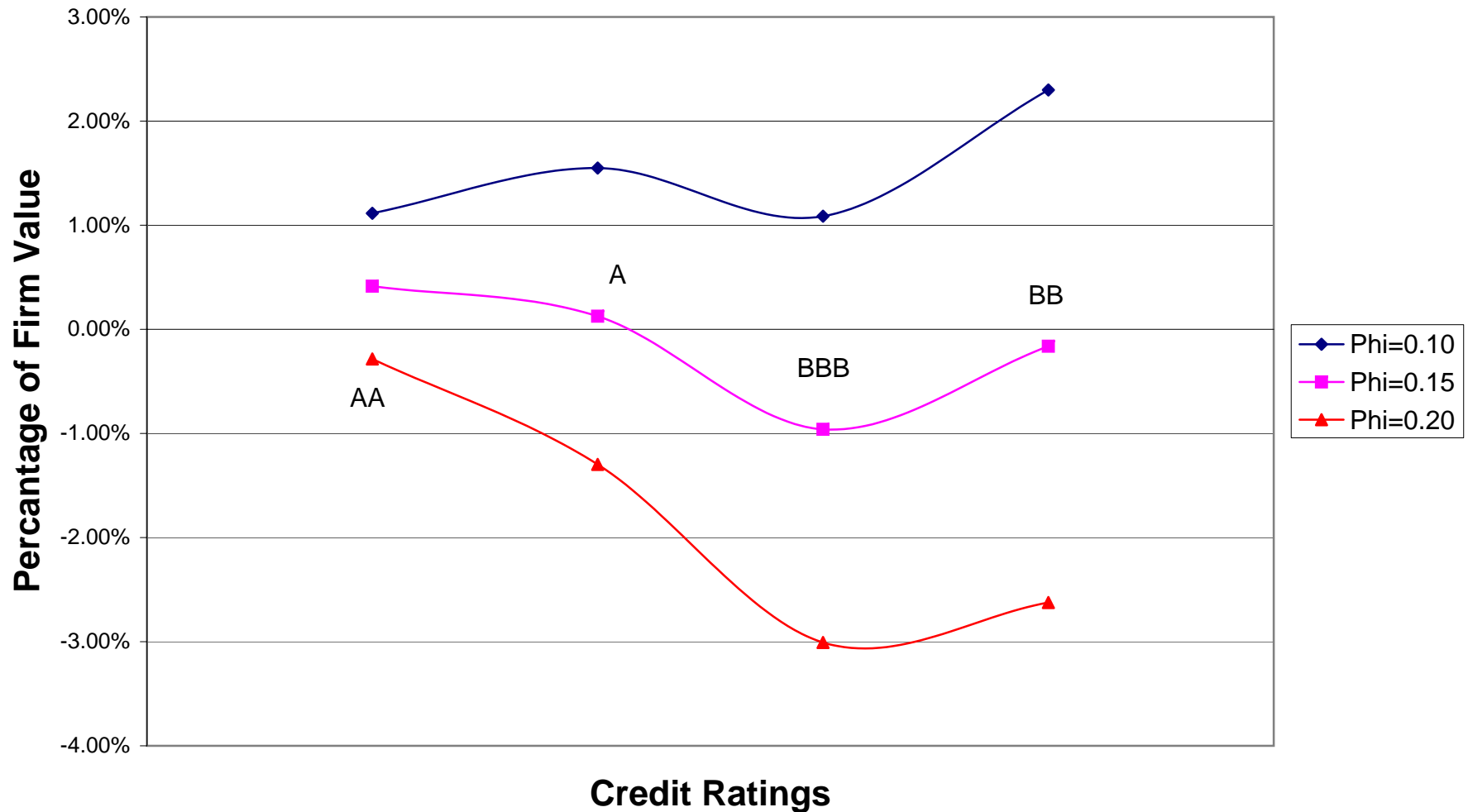**Figure 4. Tax Benefits Minus Distress Costs (No Risk Adjustment)**

Figure 5. Tax Benefits Minus Distress Costs (Longstaff et al.'s Risk Adjustment)

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