When Do Firms Default? A Study of the Default Boundary

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Abstract

This paper investigates whether default is triggered by low asset values or by liquidity shortages using a sample of US firms with observed market values of assets. The market value of assets is a very powerful default predictor, and some firms default at low asset values despite abundant liquidity. However, temporary liquidity shortages can trigger default at relatively high asset values when frictions preclude access to outside financing. The market value of assets at default varies widely in the cross-section, and depends on balance sheet liquidity, asset volatility, and tangibility. Moreover, there are many low-value and low-liquidity firms that are able to avoid default. The boundary asset value of 72 percent of the face value of debt correctly predicts the probability of default on average. However, as many as one third of defaults happen above this boundary, while an equal number of firms below it avoid default for at least a year. Thus, even if boundary-based models can be calibrated to predict the average probability of default, they are still likely to lack accuracy in the cross-section.

Keywords: Default boundary; Default; Distress; Reorganization; Bankruptcy.

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I. Introduction

The default decision is central both to understanding financial reorganization and to modelling credit risk. Some condition that specifies when firms default is always assumed either explicitly or implicitly whenever risky debt is an issue. Yet, despite their prominence in the debt-pricing literature, existing assumptions regarding what triggers default for distressed firms have rarely been evaluated empirically. Moreover, studies of distressed reorganizations rarely measure the single most important variable in credit-risk models – the market value of the firm's assets. This paper uses a sample of low-grade US firms with observed market values of both debt and equity to investigate whether default is triggered by low asset values or by liquidity shortages. It finds that, while in general both value and liquidity are significant factors, their relative importance depends on whether frictions make it difficult for a particular firm to raise outside financing in times of need. Firms with high costs of outside financing may be pushed into default by a transitory cash shortage while their value is still relatively high. By contrast, some low-value firms default despite abundant liquidity. Moreover, as neither value nor liquidity predicts default perfectly, there are many low-value and low-liquidity firms that are able to avoid default, limiting potential accuracy of boundary-based default predictions. Taken together, these findings suggest a much more complex picture of financial distress than that of the world in which only the most distressed firms default.

Understanding what makes firms in distress default early rather than late is crucial not only for credit-risk modelling, where the default boundary is one of the main building blocks, but also for corporate-finance studies of financial distress. Existing empirical papers often select distressed firms of a particular type, such as low-liquidity or low equity-return companies (Asquith *et al.* 1994; Gilson *et al.*, 1990; Gilson, 1990). It is not clear how often low-liquidity and low equity-return firms are distinct, and whether findings documented for one type of distress are applicable more generally. This paper shows that it is important to look at all firms with a significant default probability, as default may be caused by either low liquidity or low asset values, and their relative importance depends on the firm's characteristics. A number of papers simply take default as given and focus on the process and outcome of restructuring conditional on being in default (e.g. Franks and Torous, 1989, 1994; LoPucki and Whitford, 1990; Betker, 1995). However, as the default decision is typically controlled by the firm and depends on its characteristics, it is important to also study firms that chose not to be in the defaulted sample. This paper finds a large number of distressed firms that are able to avoid default owing to their particular characteristics. Finally, existing papers rarely measure the market value of assets at default. The market asset value is an indicator of the firm's economic prosperity or distress, and may have profound implications not only for the decision to default, but also for the likely outcome of restructuring conditional on default, such as the choice of reorganization procedure and the investors' recovery rates.[1] These considerations underscore the importance of understanding the determinants of the default decision.

[1] For example, the model in this paper shows that firms that are unable to renegotiate with their creditors out of court optimally delay filing for bankruptcy until later stages of distress, and may eventually recover and avoid default

Several default triggers have been proposed in structural models of debt pricing. Most models assume that a firm defaults when the market value of its assets falls below a certain boundary (Black and Cox, 1976; Leland, 1994). This default boundary may correspond to an exogenous net-worth covenant, or to the endogenously determined threshold at which equityholders are no longer willing to service their debt obligations. Should the firm find itself in a liquidity crisis while its asset value is still above the boundary, equityholders in these models will always be willing and able to avoid default by raising outside financing. This approach contrasts with the assumption that firms default when current assets fall short of current obligations, due to either a minimum cash-flow covenant, or market frictions precluding the firm from raising sufficient new external financing (Kim *et al.*, 1993; Anderson and Sundaresan, 1996). Models incorporating both value- and liquidity-based defaults are rare, and little empirical evidence is available to motivate the choice of a particular trigger. If, in reality, default is triggered by different factors for different firms, existing models are likely to lack accuracy in predictions.

This paper shows that the importance of liquidity shortages for a particular firm depends on the firm's costs of external financing. It develops a simple model of the default decision with financing frictions and renegotiation. In a setup similar to Bulow and Shoven (1978) and Gertner and Scharfstein (1991), equityholders face a choice between continuing operations under the current regime and substantially reorganizing in bankruptcy. For the firm to continue, its current liabilities must be met or renegotiated, and non-negative cash reserves maintained. External financing can be raised if needed, but market frictions make this costly. Current debt can be renegotiated in an informal workout, as long as this yields a positive net surplus. The model's predictions are as follows. First, firms with low costs of external financing default when the continuation value of assets is low. By contrast, if external funds are costly, a liquidity crisis may force reorganization even if the going-concern surplus is still substantial. The polar assumptions of purely value-based and liquidity-based defaults arise as special cases. Second, firms with high renegotiation costs default by filing for bankruptcy, while firms with easily-renegotiable debt prefer informal workouts, initiating them at higher asset values. Third, for low renegotiation costs firms default strategically at asset values that positively depend on the bargaining power of equity. In addition, the model predicts that the default boundary depends on the liquidation value of the firm's assets, on factors affecting debt-equity agency conflicts, on the costs of financing possible liquidity shortages, and on renegotiation costs and bargaining power. The model emphasizes the importance of the costs of external financing for the relevance of liquidity as a default trigger.

Factors triggering default for distressed firms are then studied empirically using a sample of 797 speculative-grade US bond issuers for which monthly market prices of debt and equity are observed. The sample includes 188 firms that defaulted on their public bonds between 1997 and 2003 by missing a payment, completing a distressed exchange, or filing for bankruptcy. Collected from a

altogether. This contrasts with the traditional interpretation (Gilson *et al.*, 1990) that, conditional on default, high market-to-book firms choose out-of-court workouts over bankruptcy to preserve a high going-concern surplus.

variety of sources, the database contains details of firms' bonds, bank debt, covenants, managerial compensation, equity ownership structure, and financial characteristics, as well as recovery data for defaulted companies.

Empirical analysis shows that defaulting firms do indeed have either a low asset value, or experience a liquidity shortage, or both. The two factors are distinct: 13.2 percent of defaults happen at low asset values despite sufficient liquidity (the quick ratio above one), while for 9.9 percent of defaulted firms the economic networth is positive (the market asset value exceeds book debt) but there is a cash shortage. Logit regressions of the default decision for all sample firms identify the ratio of the market value of assets to the face value of debt as the single most important predictor of default, easily outperforming any other variable used. In particular, whenever it is added to empirical models of default, such as Altman's (1968) z-score or the accounting-based model of Zmijevski (1984), it subsumes most other variables, and dramatically increases the model's predictive ability. As found in previous studies (Shumway, 1997), the much more easily observable market value of equity is also a strong default predictor; however, it performs considerably worse than the market value of debt, and loses significance altogether when the total asset value is controlled for. Conventional measures of balance sheet liquidity, such as the quick ratio, generally come up as the second most important explanatory variable.

The model's predictions regarding which factors are likely to be important for the default decision are then tested empirically. The predictive ability of the model exceeds that of the ad-hoc ratio-based models, even when they include the market value of assets. Controlling for the asset value, high asset volatility and balance sheet liquidity make default less likely. Crucially, the relevance of liquidity shortages depends on variables related to costs of external financing. The paper proxies firm-specific financing costs by the unencumbered 'hard' assets that can be used as collateral, by whether there are covenants precluding new borrowing, and by authorized but undrawn credit lines. It also documents the importance of the conditions prevailing in the distressed loan market, as measured by the aggregate annual par amount of new junk loans made. A closer look reveals that the costs of external financing are a significant factor for high-value firms in a liquidity crisis, but are less important for low-value firms. This is consistent with the hypothesis that financing costs make liquidity-triggered default more likely for viable firms, while unconstrained distressed firms default at low asset values.

The paper then investigates whether the default-predicting ability of the market value of assets can be characterized as a threshold effect. It shows that relying on this assumption is likely to result in a considerable number of type II errors. In particular, a large majority of low-liquidity firms never default, indicating the limited importance of the debt overhang problem. Moreover, a significant proportion of firms with low asset values also avoid default for extended periods of time. For example, as many as 54 percent of negative economic-net-worth firms (with market assets below the face value of debt) do not default for at least a year, and 38 percent never default throughout the sample period. Type II errors are frequent even for low assumed values of the boundary, corresponding to high probabilities of a type I error. The boundary value of assets for which the number of 'false alarms' is offset by an equal number of 'missed calls' is approximately 72 percent of the face value of debt. This choice may be best for an 'average' firm, resulting in the total number of firms below the boundary being equal to the total number of defaulted firms; it is very close to the base-case value of 73.1% which in Leland (2004) produces a good fit of model-predicted default probabilities with observed frequencies. Notwithstanding this agreement of theory and evidence *on average*, in the cross-section more than one-third of firms default at asset values above this level, while an equal number of firms below it successfully avoid default. Using firm-specific boundary values obtained from a study of defaulted firms hardly changes this result, as a roughly similar number of firms do not default below their predicted boundary.

Treating the default boundary for non-defaulted firms as unobservable, the paper then focuses on the boundary for firms that do actually default. Practical applications of credit-risk models require knowledge of levels and cross-sectional determinants of the boundary. A frequently used approach to estimating the market value of assets is to infer it from the observed equity price using a particular debt-pricing model. For example, Hillegeist *et al.* (2004) show that default predictors based on this principle outperform accounting-based empirical models. Implementations of this approach must rely on a particular assumption about the level of the default boundary, on which there has been little empirical guidance. Huang and Huang (2003) assume that the boundary is 60 percent of the face value of debt; Leland (2004) uses a model-implied level of 73 percent. The industry-standard KMV model assumes that default happens if at maturity the value of assets is lower than short-term debt plus 50% of long-term debt, measured at book values (Crosbie and Bohn, 2002). As the KMV model is proprietary, this choice of the boundary is not explained. It is an interesting question whether adjusting the level of the boundary to accord with empirically observed levels may improve the performance of model-implied predictors.

For the sample of defaulted firms, the median market value of debt plus equity immediately before default is found to be 63.3 percent of the face value of debt.[2] This ratio exhibits substantial variability, ranging from 27.1 to 123 percent at the 5-th and 95-th centiles, respectively. Consistent with the proposed model of the default decision, Heckman self-selection-corrected regressions show that the boundary is positively correlated with the firm's liquidation value (measured by its 'hard' collateralizable assets), and with the proportion of bank debt, which is related to renegotiation costs. Also, distressed exchanges correspond to higher asset values relative to bankruptcies. The default boundary is negatively correlated with asset volatility, which is related to the real-option value of continued operations. Finally, firms with higher balance sheet liquidity default when the

[2]For comparison, the dollar KMV 'boundary' over a one-year horizon corresponds to 104 percent of the observed market value of debt plus equity at default for a median firm, while the mean is 124 percent. Note that because the KMV approach does not assume that default happens the first time the asset value falls below a certain level, its 'boundary' is not directly comparable to those of first-passage boundary models. To match the average observed default frequencies (if not the cross-section), the KMV default trigger must be somewhat higher than the first-passage boundary to account for value paths that fall below the boundary but recover before the maturity date.

market value of assets is lower. The value of assets at default does not depend on the costs of external financing, even though the *default decision* itself strongly depends on them for constrained firms. These results provide empirical guidance regarding the value-based boundary for credit risk models, to the extent that default is indeed triggered by a low value of assets.

Taken together, these results present considerable challenges to credit risk modeling. First, if the relevance of liquidity depends on firm characteristics and on the debt-market conditions, then even incorporating both value- and liquidity-based defaults does not ensure accuracy if the costs of external financing for a particular firm at a particular time are not simultaneously taken into account. Second, unless our understanding of the determinants of the default boundary is improved significantly, large classification errors are likely to limit the ability of boundary-based models to explain the cross-section of defaults. Overall, the apparent inability of structural models to predict default probabilities and spreads especially over short horizons[3] may not be surprising, given that their simplifying assumptions regarding the default trigger are not fully supported by the data.

The remainder of the paper is organized as follows. The next section discusses default triggers commonly employed in debt pricing, and presents a model of the default decision used to analyze the determinants of the default boundary. Section III discusses the construction of empirical proxies, describes the data set, and reports default statistics. Section IV presents main empirical results. Section V concludes. Technical details are provided in the Appendix.

II. Modelling the default decision

A. Default boundaries in debt-pricing literature

One of the central assumptions of any debt-pricing model is that regarding the default-triggering condition. Different default triggers imply different states in which default happens, and therefore generally different default probabilities, recovery rates, and debt values. The approach used most often in structural models assumes that default happens when the market value of firm's assets for the first time falls below a certain threshold level, referred to as the *default boundary.* Building on the work of Merton (1974), this approach was introduced by Black and Cox (1976) and extended by Leland (1994).[4] The level of the boundary may be specified exogenously by existing covenants, typically in relation to the face value of debt. Commonly assumed in the literature is the negative economic net-worth boundary, which assumes that default happens the first time the market value of assets falls below the face value of debt. In other models, the boundary is determined endogenously by the firm's equityholders as the value of assets at which default for the first time becomes their

[3]See Jones *et al.* (1984), Eom *et al.* (2004), and Leland (2004).

[4]The assumption of an exogenous value-based boundary is used, among others, by Brennan and Schwartz (1980), Nielsen, Saá-Requejo, and Santa-Clara (1993), Longstaff and Schwartz (1995), and Collin-Dufresne and Goldstein (2001). The endogenous boundary is modelled in Leland (1998), Leland and Toft (1996), and Acharya and Carpenter (2002); Fan and Sundaresan (2000) also allow for strategic default.

preferred outcome. In endogenous-default models the firm's operating cash flows may at times fall short of required current debt payments. In such situations equityholders will meet debt obligations by covering the cash shortage by selling newly issued equity, as long as their limited-liability option is worth more than the required debt payment (in other words, the post-issuance equity value is positive). Below that point, the hopes of recovering become so remote that new funds cannot be raised no matter how much dilution existing owners are prepared to suffer. It follows that endogenous default may only happen at times when a payment is due and the firm faces a cash crisis.

A range of boundary levels can be supported by models with exogenous (covenant-triggered) default. For a given firm, the lowest feasible exogenous boundary is that below which equity value becomes negative; this level coincides with the endogenous boundary choice. Once the 'exogenous' covenant is set at the 'endogenous' level, the exogenous-boundary model becomes undistinguishable from its endogenous-boundary counterpart, as default happens in exactly the same states of the world.[5] Two conclusions follow. First, models with exogenous covenants incorporate endogenous-boundary models as special cases. Second, these special cases are such that imply *maximum distress* compatible with a non-negative equity value at the time of default.

While used most often, asset value is not the only default trigger employed in the literature. Some models are based on the assumption that default happens when the firm's instantaneous cash flow is insufficient to service current obligations (Kim, Ramaswamy, and Sundaresan (1993), Anderson and Sundaresan (1996)). Such models necessarily assume that external financing is altogether unavailable, or that there is a minimum cash-flow or liquidity covenant. This in effect makes default an exogenous event rather than a consequence of shareholders' optimizing behavior. It transpires from the previous discussion that in models with an endogenous asset-value-based boundary default happens only if there is a cash crisis present. Absent covenants, where value-based and liquidity-based models differ is the presence of frictions preventing firms from raising new external funds: while a pure cash-based default corresponds to the case when new investors are not accessible no matter how attractive the investment, an endogenous default happens when such investors are accessible at zero cost, but unwilling to contribute any funds.

In a rare model that allows for both endogenous value-based and exogenous liquidity-based defaults, Fan and Sundaresan (2000) allow for sales of new equity but specify an exogenous covenant on the minimum cash flow. Because instantaneous cash flows in their model (and most other models) are perfectly correlated with the firm's value, this specification implies that for a given dividend policy any firm will either always or never default because of a liquidity crisis. A more general setting is adopted by Acharya *et al.* (2004), who endogenize a firm's cash management policy, and allow for renegotiation in the presence of costs of external equity financing, providing a multitude of new insights. Unfortunately, due to the complexity of the setup, the Acharya *et al.* model appears

[5] See Leland (2004), who modifies the exogenous boundary in the Longstaff and Schwartz (1995) model to coincide with that predicted endogenously by the Leland and Toft (1996) model.

too complex to be implementable for general capital structures. An important empirical question is, whether modelling default under such general assumptions is nevertheless necessary despite the high computational costs imposed.

Finally, a number of models assume that the firms' physical assets can be redeployed elsewhere, and as their value within the firm falls, there may be an optimal abandonment time at which the assets should best be sold to competitors. Unlike previous model, liquidation in these models optimally occurs at a positive asset value even without debt. If the value of assets in the best alternative use is random, the firm's liquidation boundary may be stochastic. Hsu, Saá-Requejo, and Santa-Clara (2002) assume that liquidation occurs exogenously at the socially optimal value of the boundary. Other papers employ the real-option framework and endogenize equityholders' optimal shutdown decision in the presence of debt-equity agency conflicts.[6]

B. A model of the default decision

B.1. Model setup and the optimal liquidation policy

To illustrate how the relevance of value and liquidity may depend on the firm's characteristics, this section develops a model of the default decision. The model's setup is similar to that of Bulow and Shoven (1978) and Gertner and Scharfstein (1991). A firm possesses productive assets whose market value in the current use is V. The firm is also characterized by its accumulated cash reserves x, which must be non-negative to enable the firm to continue operations beyond the current period.[7] Alternatively, the firm can be 'liquidated' by changing the way it is operated, in which case the value of the assets becomes L. Such a liquidation, also called reorganization or abandonment, may consist of a substantial business transformation, a sale of the capital stock to the firm's competitors, or a sale of assets with or without shutting the firm down. There are no taxes, and the management of the firm acts in the best interest of the firm's shareholders.

Consider first the case of an equity-financed firm. At a given point in time the firm's owners face a decision of whether to liquidate the firm, or to maintain the status quo by continuing operations under the current regime, also referred to as going concern.[8] To continue, the firm must be able to maintain a non-negative cash reserve. If there is a shortage of cash, the firm also has an option of raising outside funds by way of selling new claims on the (post-issuance) value of the firm. Such issuance is costly: to raise m dollars, existing owners must surrender $(1 + \delta)m$ dollars of the post-issuance firm value, where the parameter $\delta \geq 0$ measures the costs of accessing external financing.

[6] See, for example, Mello and Parsons (1992), Mella-Barral (1999), and Morellec (2000).

[7] The parameter x should be understood more broadly than simply cash. It can instead be the firm's working capital, consisting of cash and receivables net of accounts payable, which must be non-negative for the firm to be able to continue dealing with its suppliers.

[8] 'Going concern' vs. 'liquidation' in this model is not equivalent to survival of the firm vs. piece-meal breakup. Rather, a status quo regime is contrasted with a significant business transformation, in which the business may also survive.

These costs could be deadweight costs; alternatively, they may be due to the fact that new equity can only be sold at a discount relative to its fair value, thus diluting existing shareholders' stakes. Without a loss of generality, the new claims are taken to be senior to existing equity; their seniority relative to existing debt is discussed below.

If the amount of external funds raised m is sufficient to continue going-concern operations ($m \geq \max\{-x, 0\}$), the firm can continue, with the value of the existing owners' claims being $V - \delta m$. Denote the 'liquidation costs' of switching from the going concern regime to liquidation as $\Delta V \equiv V - L$, and let m^* be the minimal amount of external funds that enables the firm to avoid liquidation: $m^* = \max\{-x, 0\}$. The second-best optimal operating policy in the presence of financing costs is to liquidate the firm if:

$$\Delta V \equiv V - L \leq \delta m^* \tag{1}$$

Equation (1) shows that liquidation is optimal when the current liquidation value is higher than the going concern value, or when liquidation costs are lower than the costs of raising external funds in the presence of a cash shortage. It demonstrates that while firms with easy access to capital markets ($\delta = 0$) are liquidated when the going-concern *asset value* V falls below the liquidation value L, firms with very high costs of external financing ($\delta \to \infty$) will be forced into liquidation by any exogenous and perhaps transitory *cash shortage* despite any going-concern surplus there might be.

B.2. Introducing debt in the capital structure

At a given point in time t_0, the existing capital structure of the firm consists of equity (the residual claim) and debt with a face value of B. A part of the debt with face value $S < B$ matures at t_0 (current debt), while the remaining debt is only due at a later date. Unless the debt contract is suitably renegotiated, a failure of the firm to repay the current debt at t_0 in full results in a (bankruptcy) reorganization, whereby all non-matured debt is accelerated, the firm is liquidated (substantially reorganized), and its liquidation value L is realized and distributed.

Market values of equity and debt under continuation (C) and liquidation (L), denoted E_i and D_i (where $i = C, L$) are related as follows:

$$E_C = V - D_C - \delta m \tag{2}$$

$$E_L = L - D_L \tag{3}$$

where m is the amount of external financing raised if continuation is chosen.

At this point, a discussion of the *seniority* of the new securities when $m > 0$ is warranted. As mentioned before, these securities are taken to be senior to existing equity. The case when they rank *pari passu* with existing equity amounts to re-scaling the equivalent cost parameter δ upwards, implying more dilution for existing equityholders. More delicate is the question of the seniority of these securities relative to the existing debt. When the long-term portion of the debt under continuation is risky, issuing new senior or equally-ranked securities makes it even riskier and results in a wealth transfer from creditors. This means that in this case D_C in Equation (2) will depend on m and on the seniority of the new securities issued. This also implies that if the choice of seniority is left to equityholders, their optimal policy will be to issue the most senior securities allowed, as this will maximize the value transfer from existing creditors. However, protective covenants are likely to restrict such opportunistic behavior. To maintain notational tractability, it will therefore be assumed that, while senior to existing equity, the newly issued securities are junior to existing debt. This restriction will result in the model predicting more liquidations than in the general case.[9] The benefit of this choice is that it makes the value of existing debt under continuation D_C independent of the amount of the securities issued.

If shareholders choose liquidation while creditors would like the firm to continue under the current regime, the debt contract can be renegotiated through a distressed exchange (private workout) at a fixed cost of l.[10] Upon successful renegotiation liquidation can be avoided if the post-renegotiation current debt portion is repaid in full, and non-negative cash reserves are maintained. Existing debt and equity are then exchanged for new securities whose value is determined in a Nash bargaining game. In particular, the net surplus R from renegotiation, equal to $R = V - \delta m - L - l$, is split between equity and debt according to their bargaining power θ and $1 - \theta$, where $0 \leq \theta \leq 1$.[11] Thus, shareholders and creditors in a distressed exchange receive securities worth, respectively, $E_R = E_L + \theta R$, and $D_R = D_L + (1 - \theta)R$. Finally, it is assumed that in renegotiations all creditors act cohesively in their common interest. Thus, all debt is renegotiable at a fixed cost l.[12]

B.3. Strategies and equilibrium

If the firm is not liquidated at t_0 and the current debt is paid at its face value S, then creditors in the model do not have a decision node.[13] If the debt is not paid in full, then creditors may propose an informal renegotiation as described above; this indeed will be their equilibrium strategy whenever the renegotiation surplus R is positive. Since shareholders are also better off renegotiating under exactly the same conditions, creditors' optimization problem is trivial: they always renegotiate

[9] Gertner and Scharfstein (1991) provide an extensive discussion of the related issues.

[10] Such costs may include not only the out-of-pocket costs of renegotiating with diverse debtholders, but also the economic costs associated with a distressed debt restructuring. Note that renegotiation costs are distinct from the costs of liquidation, which equal $V - L$.

[11] Technically, θ defines the sharing rule in the bargaining game; it is referred to as bargaining power for brevity.

[12] At little expense, the model can be extended to the case when the costs of renegotiation are a function of the debt to be renegotiated, allowing in particular for non-renegotiable fractions of debt, as well as to non-proportional costs of external financing. The present simple model is chosen because it is easier to interpret empirically.

[13] An extension of the model would be to introduce covenants, which could be waived by creditors if violated.

when shareholders choose to do so.[14] Shareholders' optimization problem, on the other hand, is to choose the amount of external funds to raise and the regime of operation, subject to the appropriate cash flow constraints.

Let ΔD denote the wealth transfer to creditors if continuation rather than liquidation is chosen, and let Δm be the maximum reduction in the need for outside finance the parties can achieve through renegotiation:

$$\Delta D \equiv D_C - D_L, \quad \Delta m = \max\{S - x, 0\} - \max\{-x, 0\}. \tag{4}$$

The following Proposition describes the conditions under which shareholders will optimally decide not to continue under the status quo, triggering default on the debt contract.

Proposition 1. *If liquidation costs are strictly increasing in the continuation value of assets V, then the firm defaults when V falls below the boundary level V_b, which equals:*

$$V_b = L + \Delta D + \delta S \max\{1 - \frac{x}{S}, 0\} + \frac{\theta}{1-\theta} \max\{\Delta D + \delta \Delta m - l, 0\}. \tag{5}$$

Furthermore, if:

$$\Delta D + \delta \Delta m > l, \tag{6}$$

then upon default debt renegotiation is chosen; otherwise the firm is liquidated.

Equation (5) predicts how the asset-value default boundary depends on particular firm characteristics. It extends the analyses of Bulow and Shoven (1978) and Gertner and Scharfstein (1991), who generally focus on insolvent cash-constrained firms, by considering a wider range of distress conditions. A comparison of Equation (5) with the socially optimal liquidation decision given in (1) reveals that, as in the earlier models, agency conflicts result in general in a suboptimal choice of the the liquidation policy: both asset substitution ($V_b < L + \delta m^*$) and debt overhang (liquidation at $V_b > L + \delta m^*$) are possible, depending on the debt wealth transfer ΔD.

Proposition 1 shows that for low or negative liquidation costs shareholders choose default and liquidation, while continuation is chosen when the going-concern surplus is high. If renegotiation costs are low enough for (6) to hold, there is an intermediate region where the debt contract is renegotiated and the firm is preserved as a going concern with a reduced level of current debt service. Under Condition (6) shareholders prefer renegotiation not only to liquidation, but also to the status quo going concern. Equation (5) also shows that if $\theta > 0$, the renegotiation-triggering value of assets is strictly higher than that triggering liquidation when renegotiation is unprofitable (high l). In other words, when $\theta > 0$, equityholders initiate renegotiation early not because otherwise liquidation would follow, but *strategically* in order to force concessions from creditors by threatening

[14] Note that this is a consequence of the reduced-form bargaining game assumed, and is not equivalent to the case of shareholders making take-it-or-leave-it offers to creditors unless $\theta = 1$.

costly liquidation. The range of liquidation costs that support such strategic debt service depends positively on the bargaining power of equity. Only if $\theta = 0$ in the presence of debt overhang is renegotiation at V_b purely efficiency-enhancing, motivated by the possibility to save on the costs of external financing in a liquidity crisis by deferring current debt service until a later date.

Overall, Proposition 1 implies that (1) the default boundary is positively related to the liquidation value of assets; (2) liquidity can be a default trigger only to the extent that there is a liquidity crisis and external financing is costly; otherwise firms default when the market value of assets is is low; and (3) firms with low renegotiation costs default while their asset values are still relatively high by initiating a distressed workout, while high renegotiation-cost firms file for bankruptcy at later stages of distress.

C. Asset value measurement

The value of assets in continuation V which influences the decision to default is the unlimited-liability value of an un-levered (all-equity) firm. In particular, the default boundary V_b is the value of V below which the firm defaults, and the combined payoffs to its equityholders and creditors become L rather than V. In the presence of debt the continuation value of assets is not directly measurable, because observable market values of claims on the firms's assets (debt and equity) at any time reflect not only the value of assets under the current regime, but also the possibility of default. This implies debt and equity payoffs that do not sum up to the continuation value.

This subsection shows to what extent the observed values of debt and equity can be used to empirically estimate the continuation value of assets for firms at the default boundary. To simplify exposition, in this subsection it will be assumed that renegotiation is never profitable, because renegotiation costs are so high that Condition (6) is violated. Thus, the only alternative to status quo is liquidation.[15] If investors are fully informed about V and V_b at all times, and default is about to occur in the next instant ($V \leq V_b$), then it must be the case that the values of debt and equity sum up to the liquidation value: $E + D = L$. In other words, if default is certain and imminent, then observed claims reflect their expected 'recovery rates', and not the continuation value of assets.

Duffie and Lando (2001) argue that strictly positive credit spreads for short maturities are not consistent with perfect information. The existence of a strong price reaction to default events, confirmed in the empirical section of this paper, also indicates a considerable information content of the default announcement. Jarrow and Protter (2004) argue that claims are more likely to be priced on the basis of investors' incomplete information set, rather than on that of managers, who are more informed about the firm's characteristics. If one assumes that investors are unsure about

[15] The case when a firm does choose renegotiation in default is identical, except the term 'renegotiation' should be used instead of 'liquidation', and $V + \delta M^* - l$ instead of L. This follows from the fact that the analysis relies on total payoffs, and not on individual parties' payoffs or incentives.

the value of the firm or its default boundary, and as a result default at any time is neither certain nor ruled out, then debt and equity prices contain valuable information about the continuation value of assets, but indirect methods are necessary to infer it from these observed prices. One such method can be derived as follows.

Assume that all parties are risk-neutral, and that both the value of assets in liquidation L and the value of the default boundary V_b are common knowledge. By contrast, as in Duffie and Lando (2001), investors are uncertain about the current continuation value of assets due to information imperfections. In particular, they receive a noisy signal $\hat{V}$ about V, such as a noisy accounting report, which is conditionally unbiased and normally distributed. Appendix B shows that under these assumptions for modest noise levels the sum of observed market values of debt and equity for firms at default is on average close to the mid-point between the boundary and the liquidation value, adjusted for the possibility that V may actually turn out to be higher than V_b. This result shows that, even though the values of debt and equity for distressed firms are contaminated by recovery expectations, they are still informative about the default boundary expressed in term of the continuation value of assets. Therefore, in empirical tests the sum of debt and equity is used to proxy for the value of assets under current regime. Appendix B derives equations that can be used to construct a direct estimator of V_b as a benchmark for boundary-based models in which V is the state variable that triggers default.

III. Data Description

A. Independent variables

This subsection describes empirical variables used to proxy for various model parameters that influence the default decision as described in Proposition 1.

The market value of assets, V. The market value of assets under continuation is proxied by the sum of the total market equity value and the total market value of debt, based on observed monthly bond prices. The market value of bank debt is not observed, but is approximated by applying the contemporary index yield spread between high-yield loans and bonds. Thus, at a given date the same spread is used for all firms in the sample. Of note, this measure of V ignores preferred equity and results in downward-biased estimates of the total value of assets. However, given that at default market leverage is found to be very high, preferred equity, when it exists, is unlikely to contribute much to the overall asset value. To facilitate comparisons, the value of assets is expressed as a fraction of the face value of total long-term debt; most other variables below are similarly normalized by total debt.

Costs of external financing, δ. Borrowing from banks, which are the most likely potential providers of external financing to distressed firms, is easier when the firm has valuable tangible assets not yet pledged as collateral. Hence, a proxy for financing costs is the proportion of *pledged assets*, equal to the ratio of secured debt to total 'hard' assets, estimated as the sum of the net property, plant, and equipment, and current assets. The existence of nominally authorized but undrawn credit lines may indicate better prospects of obtaining additional cash. Even if these undrawn amounts are not committed and in fact cannot be directly used because of, for example, an insufficient borrowing base, the fact that the authorized limits are high may indicate that the firm may be more likely to persuade the banks to actually extend the loans if needed. Thus, a second proxy used is *undrawn credit lines*, which is one minus the outstanding loan amounts divided by the total authorized loan limits. Another proxy is a dummy variable which equals one if there are *debt covenants* restricting senior borrowing. Direct loan arrangement costs are measured by the *arrangement fees* for the last extended loan, provided it was made available no more than two years before the observation date. Finally, the conditions in the distressed-loan market may influence the firm's ability to borrow. To control for this possibility, the annual aggregate par amount of *new junk loans* is used.

Liquidation value of assets, L. The value of the firm's assets in default depends on their specificity and tangibility, as well as on the general industry conditions. The primary proxy used is *pledgeable assets*, estimated as the sum of the net property, plant, and equipment, and current assets. This is a measure of the value of 'hard' assets which are not very firm-specific, and therefore do not greatly drop in value upon default, and can be pledged as collateral. *Intangible assets* is another related proxy. Finally, attempt is made to control for the firm's industry conditions. Shleifer and Vishny (1992) argue that these affect the value of assets in default; consistent with this hypothesis, Acharya *et al.* (2004) find that debt recovery rates are significantly lower when the whole industry is in crisis. Their measure, *Industry in crisis*, is a dummy variable which equals one if the median annual equity returns for firms in the same 3-digit SIC industry are below -30%, and zero otherwise; this indicator variable is also employed here.

Debt wealth transfers, ΔD. The difference between the value of debt in continuation relative to liquidation equals the face value of current debt plus the market value of long-term debt minus creditors' likely recovery value in default. High asset *volatility* reduces market value of long-term debt, increases the option value of equity, and is expected to be negatively correlated with ΔD. Accordingly, the main proxy used is the median equity volatility for firms in the same 3-digit SIC industry. Also, creditors may be better protected in continuation if there are *debt covenants* in place that either limit shareholders' ability to undermine long-term lenders by fire-selling assets, or give creditors the power to bankrupt the company if its performance falls below acceptable levels.

Liquidity position, x/S. Common measures of balance sheet liquidity are employed to identify a possible cash crisis. The primary proxy used in this paper is the *quick ratio*, which equals the sum of cash and near-cash plus accounts receivable divided by current liabilities. Another proxy is the *current ratio*, which is similar to the quick ratio, but also includes inventories and other current assets in the numerator; it is calculated as the ratio of current assets to current liabilities. Because the value of inventories of firms in decline is likely to be limited, this ratio is expected to be less informative than the quick ratio. Finally, the *interest coverage ratio*, equal to EBIT over current interest, is also used in robustness checks. All these ratios are negatively correlated with liquidity shortages the firm may be experiencing.

Renegotiation costs, l. Variables used to measure renegotiation costs include the *number of bond issues* and the *number of syndicated loans* for the firm and its wholly owned subsidiaries that are at least partially outstanding, as well as the number of different *lending banks*. As in Gilson, John, and Lang (1990), the logarithms of these three variables are normalized by total book debt, to measure debt structure complexity per dollar of debt. Also used are the ratio of *public to total debt*, equal to the face value of all outstanding bonds divided by total debt, and the *Herfindahl indexes* of outstanding bonds and bank loans.

Equityholders' bargaining power, θ. The main proxy for equityholders' incentives to be tough in renegotiations, increasing the bargaining power of equity vis-à-vis other claimants, is *managerial shareholding*. It is the ratio of the number of common shares in the company owned by the five highest-paid executives to the total number of shares outstanding. *Institutional shareholding*, which is the percentage of total equity held by institutional investors, is another related proxy. Presumably, better coordinated and more sophisticated institutional investors can bargain more efficiently and induce larger deviations from absolute priority than less sophisticated investors.

B. The definition of default

Default is a failure to meet financial obligations. Debt defaults are either *payment* defaults (failures to fully meet payments on time) or *technical* defaults (failures to comply with other conditions of the debt contract, i.e. covenant violations). Of primary interest for valuation are payment rather than technical defaults, as covenant violations as such do not change debtholders' cash flows. What technical defaults do is give creditors the right to force reorganization without a payment being missed. This does not change creditors' cash flows if they do not exercise this right, but merely allows them to move the default boundary, if they so wish, so that default is triggered earlier in distress.

For these reasons, while covenants are used in this study as a determinant of the default boundary, their violation per se is not taken to be a default event; only payment defaults are considered. This accords with Moody's definition of default as "any missed or delayed disbursement of interest and/or principal, bankruptcy, receivership, or distressed exchange, where (i) the issuer offered bondholders a new security or package of securities that amount to a diminished financial obligation (such as preferred or common stock, or debt with a lower coupon or par amount), and (ii) the exchange had the apparent purpose of helping the borrower avoid default."(Keenan, Shtogrin, and Sobehart (1999), p. 10) This definition by Moody's is the base case definition adopted by this study. Standard and Poor's also excludes covenant violations from their definition of default, which is essentially that of Moody's, except that Moody's includes grace period defaults (when the company misses a scheduled payment but makes the payment later) and preferred stock payment omissions, while S&P does not. Because S&P's defaults are a subset of Moody's' defaults, adopting the wider definition makes possible sensitivity analysis with respect to inclusion of grace period defaults and preferred stock payment omissions.

Finally, it should be noted that this paper is limited to *public bond* defaults, and does not consider firms with no public bonds outstanding. Moreover, firms are only classified as defaulted if they underperformed on a bond contract. This implies that unsuccessful bond exchange attempts are not considered a default event unless followed by a missed payment or bankruptcy, as they do not change bondholders' cash flows. Also, firms that restructured their private debt but continued uninterrupted bond service are not deemed to have defaulted. While the paper does not attempt to describe reorganization triggers for all distressed firms, it does include all defaults on public bonds, which credit risk studies typically focus on.

C. Data sources and sample selection

Empirical tests utilize a sample of bond issuers with a speculative-grade rating for which monthly observations of debt and equity prices are available. The sample includes 797 firms over the period between December 1996 and December 2003. The sample includes 196 defaults on public bonds, where default events are recorded using Moody's definition of default, and include missed payments, bankruptcy filings, and distressed bond exchanges.

A variety of data sources were used to construct the database. While the primary focus of the project is on defaulting companies, a control sample of risky non-defaulted firms was employed to examine the decision *not* to default. Bank loan data, covenant information, equity ownership structure, and balance sheet and share price data were also collected from a variety of sources. Information from all data sources was manually merged into a single database, taking account of mergers, name and business structure changes, and parent/subsidiary relationships.

To isolate firms with a high default probability, the study focuses on issuers of public bonds with a speculative-grade rating. In particular, it uses Moody's-rated non-financial US firms that were included in the Merrill Lynch US High Yield Master II Index at some point between December 1996 (the month the index was created) and December 2003. The index consists of speculative-grade bonds with par amount of at least 100 million dollars and the remaining maturity of at least one year. The bond price database consists of monthly bid quotes from Merrill Lynch bond trading desks. Descriptive bond information is obtained from the Fixed Income Securities Database (FISD) provided by LJS Global Information Systems. Loan Pricing Corporation's *DealScan* is used as a primary source of information regarding bank loans, bank covenants, and the structure of banking syndicates that extend lending to firms under study, as well as for the aggregate statistics describing the conditions of the high-yield loan market. Market values of bank debt are estimated using information on junk bond/loan rate spreads from the same source. Also used is information on the stock and option holdings of the five most highly paid executives of each company from Executive Compustat, as well as institutional equity ownership data from CDA/Spectrum supplied by Thompson Financial. Quarterly Compustat files are used as a primary source of accounting data; in a few cases where quarterly files were unavailable, annual data were used instead. Finally, monthly equity market prices were obtained from CRSP. For some firms not in CRSP quarterly market equity prices were obtained from Compustat where available; these were also used for some firms that were removed from CRSP due to an unacceptably low share price. Thus obtained, quarterly market share prices were extrapolated to yield monthly prices using a simple linear approximation.

A second major set of data for the study comprises information on firms that defaulted on their public bonds during the studied period. The master list of defaults compiled for the study is based on the March 2004 issue of the Moody's Default Risk Service (DRS) database. DRS reports detailed information on all defaults of firms with Moody's-rated public bonds, including missed payments, completed distressed exchanges, and bankruptcy filings. Information provided includes dates and types of default, bankruptcy (if any), and resolution, and a short story behind each case. The DRS master default list was cross-checked for omissions against the Standard & Poor's *LossStats* and *CreditPro* databases and FISD default records. In a few cases defaults reported in these databases were missing from DRS. In 12 cases these could be confirmed from other sources and used in the study; where they could not be confirmed, the firm was excluded from the sample.

Not all defaults in the Moody's database are independent events. Firstly, firms often default together with their wholly-owned subsidiaries; if both a parent and its subsidiaries are separately rated by Moody's, several entries may be registered in the default database for different legal entities, even when all these entries are a consequence of one default decision taken by the parent. In such cases, it is the parent's consolidated financial information that this study uses to examine the default decision for the whole group of companies, rather than a set of separate filings by the subsidiaries. This is especially relevant for financial subsidiaries of industrial firms. Secondly, for some companies Moody's DRS database records multiple defaults within a short period of time. Because not all of these are independent, defaults for each company were combined if they happened within less than two years apart.[16]

Of all DRS default records, non-financial US-based bond issuers were selected. When the reliability of any merge between crucial databases, or of the identity of the firm controlling the default decision for parent/subsidiary combinations was in doubt, the firm was excluded to enhance the accuracy of measurement. The requirement that both market values of bonds and equity be

[16] These adjustments result in a reduction of the recorded number of defaults for US non-financial firms in the Moody's database between 1997 and 2003 from 575 defaults for 550 issuers to 501 independent defaults for 489 unique firms.

available respectively in the Merrill Lynch US High-Yield II Index and CRSP or Compustat reduces the number of unique defaulted firms to a subsample of 189 from the population of 489 defaults between 1997 and 2003. Of these, 7 firms defaulted twice during the sample period, although only in one case could the market value of assets be estimated for both occasions. In addition, the control sample consists of 608 unique constituents of the high-yield index that did not default on their bonds in the studied period and could be matched to CRSP/Compustat data. Thus, the total sample consists of 797 junk firms, with 196 defaults by 189 firms during the sample period.

D. The sample of defaults

Moody's Default Risk Service (DRS) database records start in 1970. After 1970, DRS is supposed to contain *all* defaults on Moody's-rated public bonds by companies whose rating Moody's is authorized to publish. Thus, the DRS default list is close to the *whole population* of defaults by Moody's-rated public bond issuers.[17]

Table I shows the number of independent defaults for non-financial US firms, as well as observations in the studied sample. The sample includes 196 defaults, which is 38.1% of all defaults during this period. The Table shows a dramatic increase in the number of defaults in recent years. In fact, despite the fact that DRS records started in 1970, 55.1% of defaults happened during the last 7 years that this study focuses on.

[TABLE I HERE]

The remainder of the paper analyses only defaults in the sample. Table II reports the number of defaults by the type of the default event and subsequent bankruptcy, if any. It shows that most frequently firms file for Chapter 11, either directly (with no other preceding default events) or having earlier missed a payment. Overall, 85.1% of all defaults result in a bankruptcy. Among all 166 Chapter 11 bankruptcies in the sample, 12% are prepackaged filings. 24 firms either completed a distressed exchange or missed a payment without a subsequent bankruptcy. An analysis of outcomes when they are known (not reported) shows that 9.4 percent of bankrupt firms are liquidated in Chapter 7 and 4.7 percent are acquired, while 85.9% successfully emerge from Chapter 11.

[TABLE II HERE]

[17] Cross-checks against other databases of defaults reveal that some defaults are missing from the DRS database. These are infrequent; in any case, DRS appears to be the most accurate and complete database of all examined.

IV. Empirical results

A. Descriptive statistics

Table III reports general descriptive statistics for firms at default and for the control sample of non-defaulting firm-months. The non-defaulting sample consists of all firm-months not followed by a default within at least 12 months after the observation date. For each such firm-month, the mean by firm is computed, and statistics on these firm characteristics are reported in the Table. Defaulting firms are generally slightly smaller than those in the control sample. They are also more likely to be original-issue-junk issuers rather than fallen angels (85% of defaults compared to 65% of non-defaulted). The proportion of short-term debt is 36% for firms at default, compared to only 8% for non-defaulting. This may suggest that larger current debt service makes default more likely. Major differences between defaulting and non-defaulting firms are manifested by various measures of profitability and distress. 76.3 percent of defaulting firms are loss-making, compared to only 22.9 percent of non-defaulting. 35.3 percent of firms at default are in a distressed industry, for which the median firm's equity returns over the last year are below –30 percent; this compares to only 12.6 percent for the control sample. Moreover, most firms at default (50.7%) have negative book equity; this proportion is more than five times as high as that for the control sample. Finally, for a number of firms (15% of defaults) equity is de-listed from the stock exchange some time before default, because of an unacceptably low share price level. Overall, Table III shows that, while similar in other respects, defaulting firms appear much less profitable than non-defaulting, and also have a higher proportion of debt in current liabilities.

[TABLE III HERE]

Table IV compares market asset values and various leverage and liquidity measures for defaulting and non-defaulting firms. The mean value of assets at default is on average 65.1 percent of the face value of liabilities, while the median is 63.3 percent. This compares with the median of 202 percent for all firm-months in the sample, and 285 percent for firms not defaulted for at least a year. For defaulting firms, the market value of assets, expressed as a fraction of the face value of debt, corresponds to the value of the default boundary. This boundary varies from 27.1% at the 5-th percentile to as much as 123% at the 95-th percentile. Thus, at least some firms appear to default while their net-worth is still positive, with assets being worth more than the face value of debt. The cross-sectional determinants of the value boundary are explored in more detail below.

Table IV also reports various measures of leverage. The mean market leverage at default is 88.7 percent, while the median is 93.4 percent. Interestingly, the statistics on quasi-market leverage, which uses the book value of debt rather than its market value, are not very different. Book leverage, on the other hand, underestimates true leverage for defaulting firms, and is also considerably more variable; this is not the case for non-defaulting firms, where all measures have a mean of about 50 percent. The Table documents that the median nominal dollar share price at default is only 81 cents, compared to 17.75 dollars for non-defaulting high-yield issuers. Finally, three measures of liquidity are reported. Cash reserves as a proportion of total book assets are not dissimilar, but both the quick ratio and the current ratio are on average considerably lower for firms at default. Even for non-defaulting high-yield firms, balance sheet liquidity is low by conventional standards. Table IV shows that when *all* non-defaulting firms are considered, both value and liquidity of the non-defaulting sample is significantly higher than that of the defaulting sample. However, as the non-defaulting sample is large, there is a considerable number of firms with both low value and low liquidity, implying a possibility for classification errors if default is predicted on the basis of either of the two factors. This question will be discussed in greater detail below.

[TABLE IV HERE]

For defaulted firms, Table V reports asset values and price reactions to the default event, as well as debt recovery rates. Statistics are reported separately for informal renegotiations (distressed exchanges and payment defaults not followed by a bankruptcy filing within 3 months), and for formal bankruptcies. The mean creditors' recovery rate for the whole sample is 48.7 percent, which is somewhat higher than the 42 percent documented by Acharya *et al.* (2003) for public bonds in default. If analysis is restricted to the subsample of firms with the ratio of bank to total debt less than 50%, the mean recovery becomes 42.3 percent, which is similar to that reported by Acharya *et al.* (2003), indicating that the discrepancy in observed recovery rates may be due to the lack of bank loans in their sample. Table V also shows that both asset values at default and debt recovery rates are lower, and the market leverage is higher, for firms filing for bankruptcy compared to those reorganizing out of court. This indicates that, consistent with Proposition 1, firms that are able to renegotiate with their creditors out of court do so at lower levels of distress than those that file for bankruptcy. Finally, the Table documents a large drop in debt and equity prices upon default. The mean unadjusted asset return over the month of default is -13.9%, which is within the 10–20% range identified by Andrade and Kaplan (1998) as the likely range for the costs of financial distress. For the sample of bankruptcies, which are likely to result in larger default losses, the mean asset return is as low as –25.1 percent. Given these large drops in prices in the month of default, it appears safe to conclude that for the overall sample the pre-default values of debt and equity contain information about the value of assets in continuation, rather than simply reflecting the expected recovery rate.

[TABLE V HERE]

Figure I illustrates the evolution of the market value of debt, equity, and assets for the median defaulting firm over the five years preceding the default event. It illustrates that up to about three years before default the median defaulting firm is undistinguishable from all other junk firms, with the asset value fluctuating around the overall median of 2.02 face values of debt. About three years before default the value of assets begins to decline – equity first, followed by falling debt since about two years before default. The value of assets declines to 0.633 by the time of default, at which time the value of debt is only 55 cents on the dollar.

[FIGURE I HERE]

B. Value and liquidity as default predictors

Figure II shows the combinations of market asset values v and quick ratios Q for defaulting firms (diamonds), and non-defaulting firms in the month when their asset value was at its minimum (circles). Two things stand out. First, in all but one cases firms at default either have a negative net-worth, or the quick ratio less than one, or (the majority) both. In other words, defaulting firms nearly always have either low-value or low-liquidity. Second, there are many low-value and/or low-liquidity firms that do not default at least within a year. In fact, in this graph defaulting and non-defaulting firms often appear to be in similar conditions as measured by v and Q. Of particular interest are defaulting companies with sufficient liquidity but a low value, and a considerable value but low liquidity. The first set of defaults (diamonds in the north-west region of the $(v,\ Q)$ plane) cannot correspond to liquidity shortages, and therefore are likely to be triggered by either a low value or a covenant violation. The second set (diamonds in the south-east region) consists of firms that default because of a cash shortage while their assets still have a considerable value. Also, there are many low-value and low-liquidity firms that do not default. A potential explanation of why some firms default for a particular combination of $(v,\ Q)$ while others do not, may be that non-defaulting firms have lower costs of accessing outside financing, which allows them to overcome temporary liquidity shortages. In other words, only a minority of firms end up in default because of the debt overhang problem which prevents them from raising external financing necessary to continue operations. This is consistent with findings of Franks and Sanzhar (2004), who study a considerable number of firms that had successfully overcome the debt overhang problem by issuing new equity in distress, and conclude that debt overhang is unlikely to be a common cause of default.

[FIGURE II HERE]

The analysis now turns to studying the ability of the market value of assets and of liquidity measures to predict default. Table VI shows the extent to which the market value of assets and the quick ratio can improve the performance of two well-known empirical default-predicting models: the Altman (1968) z-score model, and the accounting-ratio-based model of Zmijewski (1984). The Table reports results of regression estimates of the default decision, with the Newey-West standard error adjustment for serial correlation.[18] The Table shows that the market value of assets far

[18] Shumway (2001) shows that maximum-likelihood logit regressions estimated using all non-censored data points (firm-months) for both defaulting and non-defaulting firms produce consistent coefficients estimates, and are equivalent to multi-period hazard models.

outperforms any z-score variable, as well as all the ratios of the Zmijewski model. Augmenting the z-score model by the ratio of the market value of assets to the face value of debt increases the pseudo-R^2 from 26.4% to 40.2%, despite the fact that z-score already includes the ratio of the market value of equity to total assets. Column (3) reports that the quick ratio is the the second most powerful variable in these specifications.

Column (4) of Table VI shows that the factors in the Zmijevski (1984) model, which is based on three accounting ratios and does not use market values, show remarkable significance as default predictors. This finding is consistent with Shumway (2001), who also finds that controlling for the value of equity does not provide a significant improvement over the three accounting ratios used by Zmijevski. However, column (5) demonstrates that when the market value of assets is included in the specification, it fully subsumes the ratio of liabilities to total assets as a predictor, and considerably reduces the predictive power of net income, although the latter remains significant. Finally, using the quick ratio instead of the current ratio CA/CL in column (6) results in a slight increase in pseudo-R^2, from 39.5% to 40.8%.

[TABLE VI HERE]

Table VII reports the results of logit regressions of default on proxies for factors predicted by Proposition 1 to influence the default decision. Column (1) shows that the market value of assets alone produces a pseudo-R^2 of 38.4%, with a z-statistic as high as 21. By contrast, balance sheet liquidity as measured by the quick ratio, although a strong predictor itself, is much less powerful than the asset value. Used in conjunction with v, liquidity retains all of its predictive ability (specification (3)), suggesting that the two factors are distinct and control very different aspects of default.

Regressions (4)-(8) include in addition to v and Q proxies for the costs of external financing δ, multiplied by the dollar liquidity shortage $S \max\{1 - Q, 0\}$ (where S is current liabilities), as specified in Equation (5).[19] In specification (4) costs of external financing are proxied by the ratio of secured (bank and public) debt to the total 'collateralizable' value of the firms assets, measured as net PPE plus current assets. The Table shows that the interaction term between the liquidity shortage and the costs of outside financing is a very significant predictor of default. This indicates that for firms with high costs of outside financing a shortage of liquidity makes default more likely. The robustness of this result is further investigated using other proxies for costs of external financing, as shown in regressions (5)–(8). Both the existence of covenants which restrict senior borrowing (the proxy employed in specification (6)), and tight general conditions in the market for distressed loans (specification (8)) make obtaining external financing more difficult, and interact with cash shortages to increase the probability of default. On the other hand, in

[19] In this and subsequent regressions all nominal dollar variables entering Equation (5) are scaled by the face value of debt.

regression (7), which uses (the lack of) undrawn credit lines to proxy for financing costs, the cross-term is not significant, perhaps indicating that such undrawn lines for firms near default may in fact be uncommitted and not available to the firm, for example, because of the lack of borrowing capacity. Alternatively, the lack of significance for this variable may be due to an insufficient number of defaults for which it is available, limiting statistical power; this hypothesis is supported by generally reduced significance of other variables in this specification.

Regressions reported in Table VII also include other determinants of the default decision. First, a high asset value in liquidation makes default more likely by reducing the costs of default and liquidation. Second, controlling for the value of assets, higher asset volatility results in a *lower* probability of default. This is consistent with higher wealth transfers from creditors in continuation for high-volatility firms. Alternatively, the real-option value of continued operations is higher when volatility is higher; thus, equityholders are more likely to be willing to delay default to preserve the option. Finally, the Table shows that the probability of default is generally negatively correlated with the number of outstanding bond issues, deemed to be related to the costs of renegotiation, but the relationship is not statistically significant. The influence of this and other related variables is discussed below in the subsection devoted to regressions of the asset values at default.

Overall, Table VII shows that factors identified in the default decision model of Section II are in general strong predictors of default, even when the control sample also includes some very distressed firms. These theoretically-identified factors, including in particular the interaction term between proxies for costs of external financing and liquidity shortages, predict default better than empirical ratio-based models examined in Table VI. Indeed, a three-variable model estimated in (4) produces an R^2 of 44.6 percent, which is higher than that of any of the models in Table VI, including those which already use both asset values and liquidity measures. This result notwithstanding, it should also be stressed that the market value of assets alone explains 38.4% of the variation of the dependent variable, and adding up to four other explanatory variables in current tests raises the R^2 only modestly, to up to 46.8 percent.

[TABLE VII HERE]

Table VIII further explores the power of asset values and liquidity as default triggers. It estimates specifications (5), (6) and (8) of the previous table in three different regions of the (v, Q) plane, corresponding to a cash shortage ($Q < 1$), a low asset value (v below 63.3%, its median for defaulting firms), or both. The Table shows that the importance of costs of external financing depends on whether the firm is already distressed on the value basis. In particular, the effect of the costs of external financing is the strongest for cash-constrained firms with a considerable value (regressions (4)–(6)), as predicted by the model. When the asset value is low but liquidity is sufficient (regressions (7)–(9)), neither liquidity nor costs of external financing are significant, with one exception in column (8), where the significance is considerably less than that in column (5). To conclude, consistent with the model, this evidence confirms that the importance of liquidity crises as a default trigger is moderated by the costs of accessing external funds, especially when the value of assets on its own is not sufficiently low to trigger default.

[TABLE VIII HERE]

C. Determinants of the asset value at default

Equation (5) provides direct predictions regarding the influence of various factors on the value of assets at which a firm defaults. This equation is estimated using the sample of defaulted firms, and the results are reported in Table IX. The Heckman procedure is used to control for self-selection of defaulting firms and the fact that the value of the boundary is only observed for firms that do actually default. The first-stage regression of the default propensity score is estimated using variables in the Zmijevski (1984) model as selection factors. This choice is motivated by the high significance of the factors that enter the model, and by the fact that the independent variables it uses are all accounting-based, do not enter the second-stage regression of the boundary level, and as such provide good instruments for predicting the default decision.[20] The estimated non-selection hazard (the inverse of the Mill's ratio, Heckman, 1979) is then used in the second-stage regressions of the boundary to control for the self-selection of defaulting firms.

The top panel of Table IX reports the results of second-stage regressions of the value of assets at default on variables that enter the right-hand side of Equation (5). The evidence is in general agreement with the model's predictions, as well as with the previous findings concerning factors that influence default, reported in Table VII. The level of the default boundary is positively correlated with the liquidation value of the firm's assets, and negatively – with asset volatility and balance sheet liquidity. The negative dependence of the boundary on volatility is consistent with endogenous boundary models like that of Leland and Toft (1996), where high volatility makes the option to wait more valuable, and decreases the level of the default boundary. However, Leland and Toft (1996) also predict a negative association of the boundary with debt maturity, while regressions in columns (2)–(5) show no such dependence. Unreported tests (available on request) show that neither industry crises (hypothesized to affect the liquidation value of assets, as in Shleifer and Vishny (1992) and Acharya *et al.* (2003)), are significant predictors of v at default. Table IX also reveals that, while the number of bond issues, deemed to be related to the costs of renegotiation, is not a significant default predictor, a higher proportion of bank debt causes firms to default at higher asset values. This finding is consistent in particular with the hypothesis that, because private debt is easier to renegotiate, its existence increases the probability of *strategic* default. In unreported tests no consistent evidence was found that the probability of default is influenced by

[20] Strictly speaking, the current ratio CA/CL that enters the first-stage specification is highly correlated with the quick ratio Q. In practice, the results of the tests are insensitive to the particular choice of first-stage instruments.

variables describing the equity ownership structure, such as the proportion of common equity held by managers or institutional investors.

Overall, the findings are consistent with both the model and Table VII, with one important exception: The coefficient for the cross-term between the costs of external financing and liquidity shortages has the correct sign in all but one specifications, but is statistically insignificant. Thus, even though this cross-term was found in logit regressions to separate defaulting and non-defaulting firms conditional on the value of assets, it is not a statistically significant predictor of the asset value for firms at default. This appears to be due to the noisy nature of the proxies for the costs of outside financing, and the limited sample size of defaults in the region where the cross-term is expected to be important. Thus, information about non-defaulted firms, known to be above their default boundary, helps detect the relationship which otherwise lacks statistical significance due to low power.

[TABLE IX HERE]

Regression estimates of Table IX may be used for more accurate cross-sectional calibration of the default boundary for the use in credit risk models that rely on a particular boundary value. An important question is, therefore, whether using this empirical model of the boundary may improve estimates over, for example, the standard 'one-size-fits-all' positive net-worth covenants.

D. A threshold effect?

Table IV shows that when *all* non-defaulting firms are considered, both value and liquidity of the non-defaulting sample is significantly higher than that of the defaulting sample. However, as the total number of observations for non-defaulting firms is much greater than that for defaulting, the number of low liquidity and low asset-value firms in the non-defaulting sample turns out to be comparable to the number of defaults, implying a considerable chance of a type-II error (wrongly classifying the firm as defaulting) if the classification is based on either of these measures. This point is illustrated by Figure III, which shows that for any reasonable constant value of the boundary, there are likely to be some non-defaulting firms with asset values below the boundary. For example, 54 percent of all firms whose asset values fall below the face value of debt, implying negative net-worth, do not default within the next year, and 38 percent avoid default throughout the sample period. This stands in sharp contrast with the assumption of most boundary-based models that the firm defaults as soon as its asset value falls below the applicable boundary.

[FIGURE III HERE]

The level of the boundary which is likely to yield best empirical predictions 'on average' is that for which the number of non-defaulting firms below the boundary (type II errors) is offset by an equal number of firms that defaulted while their asset value was still above this boundary (type I errors). For this boundary level, the total number of all firms below the boundary is equal to the number of defaulted firms, and therefore the proportion of predicted defaults equals the actual proportion of defaulted firms. In the sample, this corresponds to the level of the boundary of approximately 72 percent of the face value of debt. This level is in fact very similar to the base-case boundary of 73.1 percent used in Leland (2004). With this boundary and forecast horizons over five years, Leland (2004) finds that for an average firm models of Longstaff and Swartz (1995) and Leland and Toft (1996) predict default probabilities that are similar to historical default frequencies. However, the number of type I and type II errors in the sample is such that more than one third of defaulting firms never reach this boundary, while an equal amount of firms go below it without defaulting. This proportion of misclassified firms is not reduced when predicted firm-specific boundaries, constructed using regressions reported in Table IX, is used instead of a constant boundary for all firms. Thus, even if for an *average* firm models with this boundary predict default probabilities well, identifying which firms fail in the *cross-section* is likely to result in a large number of mis-classified firms.

E. Implications for credit risk modelling

The evidence presented above suggests that viewing the default as being triggered by asset value crossing a particular threshold is not consistent with the data. One possibility is that the dependence of the boundary on the relevant factors has not been modelled adequately. However, the existence of non-defaulting firms with very low asset values makes it unlikely that such boundaries could be predicted on the basis of a reasonable number of observable firm characteristics. The proportion of low asset-value firms whose *failure to default* cannot be explained by errors in the boundary modelling is likely to limit the potential ability of credit risk models to match the cross-section of defaults.

How can models of credit risk be advanced, given this evidence regarding empirical default triggers? One approach is to try to model more accurately the boundary empirically, in the hope that its value can be explained if a sufficient number of firm characteristics are included as explanatory variables. An alternative is to abandon hope of predicting default as a deterministic 'cause-and-effect' event, and assume that either the boundary or the true value of assets is unobservable. Duffie and Lando (2001), Giesecke (2004), and Çetin *et al.* (2004) consider structural models with incomplete information, and show that such settings may effectively be equivalent to those of reduced-form models where default time is inaccessible. Jarrow and Protter (2004) argue that appropriate for claim pricing is the (reduced) information set of investors, rather than that of managers who are likely to observe both the value of assets and the level of the default boundary. This assumption actually makes the reduced-form framework preferable to structural models. In contrast with the traditional reduced-form approach (Jarrow and Turnbull, 1995; Jarrow, Lando, and Turnbull, 1997; Duffie and Singleton, 1997), these models yield default intensities that do depend on the firm's fundamentals. Difficulties of modelling the boundary as a value threshold documented in this paper may suggest that accepting a degree of unpredictability of default, and extending existing models along these lines may actually be the most promising way to advance our understanding of credit risk.

V. Conclusions

This paper evaluates common assumptions regarding what triggers default for distressed firms, and reports market values of their assets. It finds a much more complex picture of financial distress than that of the world in which only the most distressed firms default. First, there is large variation in the default boundary. Second, default may be triggered by both low asset values and by liquidity shortages, and the importance of liquidity varies depending on costs of outside financing. This suggests that debt-pricing models may need to account not only for the firm's value of assets and its cash management policy, but also for factors that influence the costs of accessing outside financing. As these costs may depend on both firm-level and economy-wide characteristics, accurate modelling of all these factors may prove very difficult.

The paper also documents a large number of firms that are able to avoid default despite having a low value of assets or a poor liquidity position. The existence of such firms limits the ability of models based on the assumption of a well-defined default trigger to explain the cross-section of defaulted firms, especially for shorter time horizons, where accurate modelling of the boundary is likely to be critical. Whether abandoning the assumption of perfect information and using models like that of Duffie and Lando (2001) and Giesecke (2004) can help reduce prediction errors and improve the performance of existing models certainly appears an important and challenging question.

Appendix

A. Proof of Proposition 1

Shareholders' payoffs under each of the three regimes are:

Continuation: $E_C = V - D_C - \delta M, \quad \text{s.t. } M \geq S - x$

Liquidation: $E_L = L - D_L$

Renegotiation: $E_R = E_L + \theta R, \quad \text{s.t. } m \geq -x$, where $R = V - \delta m_R - L - l$

Clearly, for any $\delta > 1$ value-maximizing shareholders will raise the minimal amount of external funds sufficient for the preferred operating regime: $m_C = \max\{S - x, 0\}$, and $m_R = \max\{-x, 0\}$. Optimization over the possible operating regimes yields the following Proposition:

Corollary 1. *Shareholders' optimal operating policy is as follows:*

Case 1. *If* $\Delta D + \delta(M^* - m^*) \leq l$*:*

$$\begin{aligned} \textit{Liquidate if} &: \quad \Delta V \leq \Delta D + \delta M^* \\ \textit{Continue if} &: \quad \Delta V > \Delta D + \delta M^* \end{aligned}$$

Case 2. *If* $\Delta D + \delta(M^* - m^*) > l$:

$$\begin{aligned} \textit{Liquidate if} &: \quad \Delta V \le \delta m^* + l \\ \textit{Renegotiate if} &: \quad \delta m^* + l < \Delta V \le \delta m^* + l + \frac{\Delta D + \delta(M^* - m^*) - l}{1-\theta} \\ \textit{Continue if} &: \quad \Delta V > \delta m^* + l + \frac{\Delta D + \delta(M^* - m^*) - l}{1-\theta} \end{aligned}$$

where $\Delta D = D_C - D_L$, $M^* = \max\{S - x, 0\}$, *and* $m^* = \max\{-x, 0\}$.

It transpires that continuation is not chosen for values of ΔV greater than ΔV_b, where:

$$\begin{aligned} \Delta V_b &= max\{\Delta D + \delta M^*, \ \delta m^* + l + \frac{\Delta D + \delta(M^* - m^*) - l}{1-\theta}\} \\ &= \Delta D + \delta M^* + \frac{\theta}{1-\theta}\max\{\Delta D + \delta \Delta m - l, 0\}. \end{aligned}$$

Assuming that $\Delta V = V - L$ is strictly increasing in V, and taking into account that $M^* = S\max\{1 - \frac{x}{S}, 0\}$, Proposition 1 follows.

B. The measurement problem

Assume that all parties are risk-neutral, and that both L and V_b are common knowledge. However, investors are uncertain about V of assets due to information imperfections. They receive a noisy signal $\hat{V}$ about V, which is conditionally unbiased and normally distributed, so that:

$$V = \hat{V} + \sigma\xi, \quad \xi \sim F(\xi), \ E[\xi] = 0, \ E[\xi^2] = 1. \tag{B7}$$

Managers, on the other hand, know the true continuation value of assets V, and the firm defaults if indeed $V < V_b$. At a point in time just prior to the managers' decision whether to continue or liquidate, investors price debt and equity using the conditional distribution of V, taking into account that their payoffs will be L if $V < V_b$ and V otherwise. The total value of debt and equity, denoted as $M \equiv E + D$ is set so that :

$$\begin{aligned} M(\hat{V}; V_b, F) &= \int_{-\infty}^{\frac{V_b - \hat{V}}{\sigma}} L \, dF(\xi) + \int_{\frac{V_b - \hat{V}}{\sigma}}^{\infty} (\hat{V} + \sigma\xi) \, dF(\xi) \\ &= \hat{V} - \left[\hat{V} - L\right] F\left(\frac{V_b - \hat{V}}{\sigma}\right) + \sigma E\left[\xi | \xi > \frac{V_b - \hat{V}}{\sigma}\right]. \end{aligned} \tag{B8}$$

In particular, when the distribution of the noise is normal, $\xi \sim N[0, \sigma]$, this formula becomes:

$$M(\hat{V}; V_b, N) = \hat{V} - \left[\hat{V} - L\right]\Phi\left(\frac{V_b - \hat{V}}{\sigma}\right) + \frac{\sigma}{\sqrt{2\pi}} e^{-\frac{(V_b - \hat{V})^2}{2\sigma^2}}, \tag{B9}$$

where $\Phi(\cdot)$ is the cumulative normal distribution function. An observer faces the following measurement problem. The default boundary V_{bi} is not observed but is known to depend for each firm i on a set of firm characteristics X_i, so that $V_{bi} = v(X_i)$, but the functional form of $v(.)$ is unknown and must be estimated. The available data $\Omega = \{X_i, M_i, I_i\}$ includes firm characteristics X, market prices M, and default decisions I, where $I_i = 1$ if firm i defaulted, and $I_i = 0$ if it did not. The set $\{M_i\}$ is known to have been obtained using (B8) with some $V_{bi} = v(X_i)$, but the corresponding signals $\{\hat{V}_i\}$ are unknown.

Consider a subset of observations for which default is known to have occurred: $\Omega_1 = \{X_i, M_i\}_{I_i=1}$. For these firms,

$$\hat{V}_i = V_{bi} - \sigma_i \xi_i = v(X_i) - \sigma_i \xi_i.$$

and therefore:

$$\begin{aligned} M_i(\xi_i; v(X_i)) &= v(X_i) - [v(X_i) - L_i - \sigma_i \xi_i] F(\xi_i) + \sigma_i E[\xi | \xi > \xi_i] - \sigma_i \xi_i \\ &= v(X_i) - [v(X_i) - L_i - \sigma_i \xi_i] \Phi(\xi_i) + \frac{\sigma_i}{\sqrt{2\pi}} e^{-\frac{\xi^2}{2}} - \sigma_i \xi_i. \end{aligned}$$

which for large enough liquidation costs $v(X_i) - L > \sigma_i \xi_i$ is a strictly increasing function of ξ_i and can therefore be inverted to yield the implied noise level for each observation: $\xi_i = \phi(M_i; v(X_i))$. This result implies a straightforward maximum-likelihood estimator for V_{bi}; once the value of the boundary V_{bi} can be found, and its dependence on the firm's vector of parameters X_i can be studied. In particular, for small realizations of ξ_i:

$$\begin{aligned} \Phi(\xi_i) &\approx \Phi(0) + f(0)\xi_i = \frac{1}{2} + \frac{\xi_i}{\sqrt{2\pi}} \\ e^{-\frac{\xi^2}{2}} &\approx 1 \end{aligned}$$

and therefore:

$$M_i(\xi_i; v(X_i)) - L_i \approx \frac{v(X_i) - L_i}{2} + \frac{\sigma_i}{\sqrt{2\pi}} - \left[\frac{v(X_i) - L_i}{\sqrt{2\pi}} + \frac{\sigma_i}{2}\right] \xi.$$

References

[1] Acharya, Viral V., Sreedhar T. Bharath, and Anand Srinivasan, 2003, Understanding the Recovery Rates on Defaulted Securities, Working paper, London Business School.

[2] Acharya, Viral V., and Jennifer N. Carpenter, 2002, Corporate Bond Valuation and Hedging with Stochastic Interest Rates and Endogenous Bankruptcy, *Review of Financial Studies*, 15, 1355-83.

[3] Acharya, Viral V., Jing-zhi Huang, Marti G. Subrahmanyam, and Rangarajan K. Sundaram, 2004, When Does Strategic Debt Service Affect Debt Spreads?, Working paper, Stern School of Business, NYU.

[4] Altman, Edward I., 1968, Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy, *Journal of Finance*, 23, 589-609.

[5] Anderson, Ronald W., and Suresh M. Sundaresan, 1996, The Design and Valuation of Debt Contracts, *Review of Financial Studies*, 9, 37–68.

[6] Andrade, Gregor, and Steven N. Kaplan, 1998. How Costly Is Financial (Not Economic) Distress? Evidence from Highly Leveraged Transactions That Became Distressed. *Journal of Finance* 53, 1443-1493.

[7] Asquith, Paul, Robert Gertner, and David Scharfstein, 1994, Anatomy of Financial Distress: An Examination of Junk Bond Issuers, *Quarterly Journal of Economics*, 109, 625-658.

[8] Betker, Brian L., 1995, Management's Incentives, Equity's Bargaining Power, and Deviations from Absolute Priority in Chapter 11 Bankruptcies, *Journal of Business*, 68, 161-183.

[9] Black, Fischer, and John C. Cox, 1976, Valuing Corporate Securities: Some Effects of Bond Indenture Provisions, *Journal of Finance*, 31, 351–67.

[10] Bulow, Jeremy I., and John B. Shoven, 1978, The Bankruptcy Decision, *Bell Journal of Economics*, 9, 437–56.

[11] Collin-Dufresne, Pierre, and Robert S. Goldstein, 2001, Do Credit Spreads Reflect Stationary Leverage Ratios? *Journal of Finance*, 56, 1929–57.

[12] Crosbie, Peter J., and Jeffrey R. Bohn, 2001, Modeling Default Risk, KMV LLC.

[13] Çetin, Umut, Robert Jarrow, Philip Protter, and Yildiray Yildirim, 2004, Modeling Credit Risk with Partial Information, *Journal of Applied Probability*, 14, 1167–78.

[14] Duffie, Darrell, and David Lando, 2001, Term Structures of Credit Spreads with Incomplete Accounting Information, *Econometrica*, 69, 633–64.

[15] Duffie, Darrell, and Kenneth J. Singleton, 1997, An Econometric Model of the Term Structure of Interest Rate Swap Yields, *Journal of Finance*, 52, 1287-1323.

[16] Eom, Young Ho, Jean Helwege, and Jing-zhi Huang, 2004, Structural Models of Corporate Bond Pricing: An Empirical Analysis, *Review of Financial Studies*, 17, 499–544.

[17] Fan, Hua, and Suresh M. Sundaresan, 2000, Debt Valuation, Renegotiation, and Optimal Dividend Policy, *Review of Financial Studies*, 13, 1057–99.

[18] François, Pascal, and Erwan Morellec, 2004, Capital Structure and Asset Prices: Some Effects of Bankruptcy Procedures, *Journal of Business*, forthcoming.

[19] Franks, Julian R., and Sergey V. Sanzhar, 2004, How Do Firms Overcome the Debt Overhang Problem?, Working Paper, London Business School.

[20] Franks, Julian R., and Walter N. Torous, 1989, An Empirical Investigation of U.S. Firms in Reorganization, *Journal of Finance*, 44, 747-769.

[21] Franks, Julian R., and Walter N. Torous, 1994, A Comparison of Financial Recontracting in Distressed Exchanges and Chapter 11 Reorganizations, *Journal of Financial Economics*, 35, 349-370.

[22] Galai, Dan, Alon Raviv, and Zvi Wiener, 2003, Liquidation Triggers and the Valuation of Equity and Debt, Working paper, Hebrew University of Jerusalem.

[23] Gertner, Robert, and David S. Scharfstein, 1991, A Theory of Workouts and the Effects of Reorganization Law, *Journal of Finance*, 46, 1189–222.

[24] Giesecke, Kay, 2003, Default and Information, Working paper, Cornell University.

[25] Gilson, Stuart C., 1990, Bankruptcy, Boards, Banks, and Blockholders, *Journal of Financial Economics*, 27, 355-387.

[26] Gilson, Stuart C., Kose John, and Larry H. Lang, 1990, Troubled Debt Restructuring: An Empirical Study of Private Reorganization of Firms in Default, *Journal of Financial Economics*, 27, 315-353.

[27] Heckman James J., 1979, "Sample Selection Bias as a Specification Error," *Econometrica*, 47, 153–61.

[28] Hillegeist, Stephen A., Elizabeth K. Keating, Donald P. Cram, and Kyle G. Lundstedt, 2004, Assessing the Probability of Bankruptcy, *Journal of Accounting Studies*, 9, 5–34.

[29] Hsu, Jason C., Jesús Saá-Requejo, and Pedro Santa-Clara, 2002, Bond Pricing with Default Risk, Working paper, UCLA.

[30] Huang, Jing-zhi, and Ming Huang, 2003, How Much of the Corporate-Treasury Yield Spread is Due to Credit Risk? Working paper, Pennsylvania State University.

[31] Jarrow, Robert A., David Lando, and Stuart M. Turnbull, 1997, A Markov model for the term structure of credit risk spreads. The Review of Financial Studies, 10, 481-523.

[32] Jarrow, Robert A., and Philip Protter, 2004, Structural Versus Reduced Form Models: A New Information Based Perspective, *Journal of Investment Management*, 2, 1–10.

[33] Jarrow, Robert A., and Stuart M. Turnbull, 1995, Pricing derivatives on financial securities subject to credit risk. Journal of Finance, 50, 53-86.

[34] Jones, Philip E., Scott P. Mason, and Eric Rosenfeld, 1984, Contingent Claims Analysis of Corporate Capital Structures: An Empirical Analysis, *Journal of Finance*, 39, 611–25.

[35] Keenan, Sean C., Igor Shtogrin, and Jorge Sobehart, 1999, Historical Default Rates of Corporate Bond Issuers, 1920-1988. Moody's Investors Service.

[36] Kim, In Joon, Krishna Ramaswamy, and Suresh Sundaresan, 1993, Does Default Risk in Coupons Affect the Valuation of Corporate Bonds?: A Contingent Claims Model, *Financial Management*, 22, 117–31.

[37] Leland, Hayne E., 1994, Corporate Debt Value, Bond Covenants, and Optimal Capital Structure, *Journal of Finance*, 49, 1213–52.

[38] Leland, Hayne E., 2004, Predictions of Default Probabilities in Structural Models of Debt, *Journal of Investment Management*, 2, 5–20.

[39] Leland, Hayne E., and Klaus Bjerre Toft, 1996, Optimal Capital Structure, Endogenous Bankruptcy, and the Term Structure of Credit Spreads, *Journal of Finance*, 51, 987–1019.

[40] Longstaff, Francis A., and Eduardo S. Schwartz, 1995, A Simple Approach to Valuing Risky Fixed and Floating Rate Debt, *Journal of Finance*, 50, 789–819.

[41] LoPucki, Lynn M., and William C. Whitford, 1990, Bargaining Over Equity's Share in the Bankrupcty Reorganization of Large, Publicly Held Companies, *University of Pennsylvania Law Review*, 139, 125-96.

[42] Mella-Barral, Pierre, 1999, The Dynamics of Default and Debt Reorganization, *Review of Financial Studies*, 12, 535–78.

[43] Mello, Antonio S., and John E. Parsons, 1992, Measuring the Agency Cost of Debt, *Journal of Finance*, 47, 1887–1904.

[44] Merton, Robert C., 1974, On the Pricing of Corporate Debt: The Risk Structure of Interest Rates, *Journal of Finance*, 29, 449–70.

[45] Morellec, Erwan, 2001, Asset Liquidity, Capital Structure, and Secured Debt, *Journal of Financial Economics*, 61, 173–206.

[46] Shleifer, Andrei, and Robert Vishny, 1992, Liquidation Values and Debt Capacity: A Market Equilibrium Approach, *Journal of Finance*, 47, 1343-1366.

[47] Shumway, Tyler, 2001, Forecasting Bankruptcy More Accurately: A Simple Hazard Model, *Journal of Business*, 74, 101-24.

[48] White, Michelle, 1989, The Corporate Bankruptcy Decision, *Journal of Economic Perspectives*, 3,129-52.

[49] Zmijewski, Mark E., 1984, Methodological Issues Related to the Estimation of Financial Distress Prediction Models, *Journal of Accounting Research* (Supplement), 59–86.

Table I. Number of defaults by year

The table reports the number of unique independent defaults on Moody's rated bonds for US-based nonfinancial issuers by year of default, and the subsample used in empirical tests. Wholly-owned subsidiaries defaulting essentially together with their parent companies are not counted separately. Default events happening within two years are counted as one default. Default-triggering events are payment omissions, distressed exchanges, and bankruptcy filings. Column (1) gives for each year the total number of defaults, while column (2) shows the year's share in the total number of such defaults throughout the period. Column (3) gives the number of defaults included in the studied dataset, and column (4) shows the proportion of each year's defaults from column (1) which are included in the dataset. The number of unique firms defaulted between 1970 and 2003 is 897, of which 488 defaulted between 1997 and 2003. The number of unique defaulted firms in the subsample is 182.

	All defaults		Studied sample	
Year	No. of defaults (1)	% of total (2)	No. of defaults (3)	% of population (4)
1970-1981	41	8.0%	-	-
1982	14	2.7%	-	-
1983	10	1.9%	-	-
1984	12	2.3%	-	-
1985	15	2.9%	-	-
1986	26	5.1%	-	-
1987	22	4.3%	-	-
1988	19	3.7%	-	-
1989	37	7.2%	-	-
1990	71	13.8%	-	-
1991	68	13.2%	-	-
1992	37	7.2%	-	-
1993	26	5.1%	-	-
1994	22	4.3%	-	-
1995	35	6.8%	-	-
1996	19	3.7%	-	-
1997	22	4.3%	4	18.2%
1998	42	8.2%	12	28.6%
1999	70	13.6%	26	37.1%
2000	94	18.3%	28	29.8%
2001	144	28.0%	61	42.4%
2002	87	16.9%	38	43.7%
2003	55	10.7%	27	49.1%
1997-2003	514	55.1%	196	38.1%
1970-2003	933	100.0%	196	21.0%

Table II. Sample defaults by default type and bankruptcy procedure

The table reports the number of defaults for the sample of defaulting firms with observed market asset values, by the type of default event and the subsequent bankruptcy procedure, if any. Prepack refers to a prepackaged Chapter 11 filing.

First default event	Total	Subsequent bankruptcy		No bankruptcy
		Chapter 11	Prepack	as yet
Bankruptcy	73	69	4	-
		94.5%	5.5%	
Missed payment	95	70	14	11
		73.7%	14.7%	11.6%
Distressed exchange	18	4	1	13
		22.2%	5.6%	72.2%
Other	9	3	1	5
		33.3%	11.1%	55.6%
All default types	195	146	20	29
		74.9%	10.3%	14.9%

Table III. General descriptive statistics

The table reports descriptive statistics for firms at default, and for the control sample of firm not defaulted within at least one year. Statistics for non-defaulted firms are calculated by firm by finding the mean value of each variable across all months not followed by default within a year, and then averaging the means across firms. *TA* is the book value of the total assets. *Hard assets* is the sum of net PPE and current assets. *Short/total debt* is the ratio of debt due in one year to total debt. *% in crisis industries* is the percentage of firms in industries with the median return over the previous year less than -30 percent. *% original-issue junk* is the percentage of firms that never had an investment-grade rating. *% delisted* is the fraction of firms that had their equity previously delisted from the stock exchange due to an unacceptably low share price.

	Firms at default						Non-defaulting firms					
	Mean	Median	Std.dev.	5%	95%	N	Mean	Median	Std.dev.	5%	95%	N
TA ($ Mil.)	2,689	972	5,681	176	9,494	138	2,957	1,340	4,723	260	11,793	733
Sales/TA	0.234	0.190	0.241	0.028	0.513	136	0.252	0.210	0.205	0.047	0.638	733
EBIT/TA	-0.077	-0.020	0.207	-0.348	0.017	133	0.011	0.015	0.030	-0.029	0.040	728
Hard assets/TA	0.751	0.778	0.185	0.453	0.983	133	0.709	0.738	0.207	0.268	0.974	702
Short/total debt	0.362	0.138	0.393	0	1.000	133	0.080	0.040	0.109	0	0.291	726
Bank/total debt	0.391	0.397	0.250	0	0.779	140	0.348	0.334	0.224	0	0.743	733
Bond maturity (years)	6.67	6.54	3.16	2.77	11.06	140	7.92	7.21	3.54	3.92	14.90	733
No. of bond issues	3.51	2	5.59	1	11	140	4.73	2	20.36	1	13	733
No. of lending banks	21.83	14	25.63	0	72	102	20.59	14	22.00	0	68	572
No. of loans	4.78	4	3.78	1	14	92	3.90	3	2.97	1	10	551
% in crisis industries	35.3%					136	12.6%					707
% making losses	76.3%					135	22.9%					728
% negative equity	50.7%					140	9.8%					733
% original-issue junk	85.0%					140	65.3%					733
% delisted	15.0%					140	0.9%					733

Table IV. Asset value, leverage, and liquidity measures

The table reports statistics on the market value of assets and various measures of leverage and balance sheet liquidity, for firms at default, and for the control sample of firm not defaulted within at least one year. Statistics for non-defaulted firms are calculated by firm by finding the mean value of each variable across all months not followed by default within a year, and then averaging the means across firms. *Market assets* is the sum of market values of outstanding debt and common equity. *Market leverage* is the ratio of the market value of debt to market assets. *Quasi-market leverage* is the ratio of the book value of debt to the sum of the book value of debt and the market value of common equity. *Book leverage* is the ratio of the book value of debt to the book value of total assets, *TA*. *Quick ratio* is the sum of cash and accounts receivable divided by current liabilities. *Current ratio* is the ratio of current assets to current liabilities.

	Firms at default						Non-defaulting firms					
	Mean	Median	Std.dev.	5%	95%	N	Mean	Median	Std.dev.	5%	95%	N
Market assets/Face debt	0.651	0.633	0.266	0.271	1.230	140	2.850	2.227	2.080	1.058	6.865	733
Market leverage	0.887	0.934	0.123	0.649	0.990	140	0.496	0.485	0.208	0.173	0.860	733
Quasi-market leverage	0.910	0.948	0.103	0.731	0.994	135	0.490	0.481	0.209	0.168	0.860	726
Book leverage	0.803	0.772	0.380	0.319	1.447	138	0.496	0.465	0.217	0.200	0.914	733
Share price ($)	1.326	0.813	1.737	0.128	5.085	140	21.05	17.75	14.42	3.28	49.95	733
Quick ratio	0.584	0.379	0.626	0.055	1.978	136	1.110	0.891	0.828	0.281	2.815	705
Current ratio	1.029	0.893	0.853	0.100	2.743	135	1.757	1.570	0.932	0.669	3.434	704
Cash/TA	0.053	0.027	0.072	0.00	0.204	138	0.061	0.030	0.078	0.00	0.200	733

Table V. Asset values and returns at default

For firms at default, the table reports statistics on the market value of assets, debt recovery rates, and unadjusted one-month asset, debt, and equity returns. *Market assets* is the sum of market values of outstanding debt and common equity. *Market leverage* is the ratio of the market value of debt to market assets. Both *market assets* and *market leverage* are measured at the end of the last calendar month prior to default. *Debt recovery rate* is ratio of the market value of debt to its face value, measured at the end of the calendar month immediately following default. Asset returns are calculated as the ratio of month-end market values of assets prior to and following default, minus one; debt and equity returns are computed similarly.

	Mean	Median	Std.dev.	5%	95%	N
			Panel A: All defaults			
Market assets/Face debt	0.651	0.633	0.266	0.271	1.230	140
Market leverage	0.887	0.934	0.123	0.649	0.990	140
Debt recovery rate	0.487	0.467	0.235	0.110	0.901	148
Asset return	-0.139	-0.079	0.358	-0.807	0.177	125
Debt return	-0.149	-0.080	0.320	-0.912	0.194	149
Equity return	-0.158	-0.212	0.547	-0.807	0.750	157
			Panel B: Informal renegotiations			
Market assets/Face debt	0.676	0.662	0.244	0.298	1.220	59
Market leverage	0.867	0.908	0.124	0.616	0.983	59
Debt recovery rate	0.535	0.514	0.235	0.151	0.924	63
Asset return	0.004	-0.015	0.290	-0.382	0.332	55
Debt return	-0.027	-0.028	0.294	-0.411	0.303	63
Equity return	-0.004	-0.064	0.608	-0.697	0.750	68
			Panel C: Formal bankruptcies			
Market assets/Face debt	0.632	0.588	0.281	0.181	1.240	81
Market leverage	0.902	0.945	0.122	0.706	0.991	81
Debt recovery rate	0.452	0.447	0.230	0.108	0.870	85
Asset return	-0.251	-0.166	0.368	-0.939	0.091	70
Debt return	-0.238	-0.110	0.310	-0.951	0.086	86
Equity return	-0.275	-0.298	0.466	-0.867	0.713	89

Table VI. Empirical default-predicting models and the value of assets

This table reports the results of logit regressions of the default decision on the asset value, a liquidity measure, and a set of default predictors identified empirically in Altman (1968) (columns (1)–(3)) and Zmijewski (1984) (columns (4)–(6)). The sample consists of all firm-month observations for non-defaulting firms, and of firm-months preceding default for defaulting firms. The dependent variable equals one if the firm defaulted in the following month, and zero otherwise. v is the sum of market values of equity and debt normalized by the book value of debt. Q is the quick ratio, computed as the sum of cash and receivables divided by current liabilities. WC is working capital, TA is the book value of total assets, RE is retained earnings, ME is the market value of equity, TL is the book value of total liabilities, SA is sales, NI is net income, CA is current assets, and CL is current liabilities. Standard errors were adjusted for serial correlation using the Newey-West procedure. Values of z-statistics are reported in parentheses. ***, **, and * mean that the coefficient is significant at 1%, 5% and 10% significance level, respectively.

	Based on Altman (1968)			Based on Zmijewski (1984)		
	(1)	(2)	(3)	(4)	(5)	(6)
v		-5.78***	-5.83***		-5.34***	-5.63***
		(-11.45)	(-11.81)		(-15.19)	(-14.80)
Q			-0.945***			-1.11***
			(-3.62)			(-3.96)
WC/TA	-2.75***	-3.40***				
	(-3.28)	(-4.80)				
RE/TA	-0.528*	0.595*	0.237			
	(-1.76)	(1.65)	(0.69)			
$EBIT/TA$	-8.53***	-3.35	-4.71**			
	(-5.51)	(-1.57)	(-2.23)			
ME/TL	-8.70***	0.172	0.285			
	(-3.12)	(0.26)	(0.46)			
SA/TA	-0.435	1.38*	0.436			
	(-0.57)	(1.75)	(0.55)			
NI/TA				-12.9***	-4.54***	-5.48***
				(-13.44)	(-2.88)	(-3.59)
TL/TA				2.60***	-0.239	-0.334
				(6.84)	(-0.45)	(-0.63)
CA/CL				-0.463**	-0.629***	
				(-2.36)	(-3.65)	
const.	-3.42***	0.657	1.42***	-7.47***	1.36**	1.70**
	(-8.34)	(1.55)	(3.07)	(-17.69)	(2.07)	(2.46)
Pseudo-R^2	0.264	0.402	0.402	0.123	0.395	0.408
χ^2	137.04	264.14	271.98	341.53	310.61	294.28
N	25339	25339	25393	27599	27599	27599

Table VII. Model-based default predictors

This table reports results of logit regressions of default on variables predicted by Proposition 1 to influence the default decision. The sample consists of all firm-month observations for non-defaulting firms, and of firm-months preceding default for defaulting firms. The dependent variable equals one if the firm defaulted in the following month, and zero otherwise. v is the sum of market values of equity and debt normalized by the book value of debt. Q is the sum of cash and receivables divided by current liabilities. *Cross-term*$_i$ equals $\delta_i S \max\{1-Q,0\},\ i=1..4$ normalized by the book value of debt, where S is current liabilities, and proxies for the costs of external funds δ_i are as follows: δ_1 is the sum of face values of bank debt and secured bonds divided by 'hard' collateralizable assets (net PPE plus current assets); δ_2 is the logarithm of one plus the number of covenants restricting senior and/or secured borrowing; δ_3 is one minus the ratio of authorized but undrawn credit lines to current liabilities; and δ_4 is one minus the aggregate normalized annual par amount of newly extended high-yield loans. *Liquidation value* is the sum of net PPE and current assets divided by book debt. *Volatility* is equity volatility of the median CRSP firm in the same 3-digit SIC industry. *No. of bonds* is the logarithm of the number of outstanding public bond issues divided by total debt. Standard errors were adjusted for serial correlation using the Newey-West procedure. Values of z-statistics are reported in parentheses. ***, **, and * mean that the coefficient is significant at 1%, 5% and 10% significance level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mkt.assets, v	-5.28***		-5.56***	-5.45***	-6.17***	-6.00***	-5.95***	-6.07***
	(-20.94)		(-19.07)	(-18.37)	(-16.08)	(-16.18)	(-12.65)	(-16.44)
Quick ratio, Q		-1.78***	-1.31***	-0.690***	-0.581***	-0.736***	-2.27***	-1.10***
		(-4.04)	(-4.51)	(-3.04)	(-2.85)	(-2.89)	(-4.76)	(-3.80)
Cross-term$_1$				2.41***	3.02***			
(collateral)				(7.49)	(8.78)			
Cross-term$_2$						0.991***		
(covenants)						(4.17)		
Cross-term$_3$							0.316	
(unused lines)							(0.91)	
Cross-term$_4$								0.129**
(loan market)								(2.06)
Liq. value					0.563***	0.339**	0.136	0.340**
					(4.89)	(2.20)	(0.78)	(2.35)
Volatility					-1.34**	-1.34**	-0.900	-1.23**
					(-2.34)	(-2.34)	(-1.58)	(-2.27)
No. of bonds					7.84	-7.39	-110	-54.9
					(0.10)	(-0.10)	(-1.11)	(-0.71)
const.	0.566***	-4.04***	1.81***	0.956***	1.65**	2.03***	3.43***	2.62***
	(2.82)	(-14.87)	(6.53)	(3.32)	(2.46)	(3.03)	(4.68)	(4.15)
Pseudo-R^2	0.384	0.044	0.426	0.446	0.464	0.445	0.468	0.437
χ^2	438.3	16.3	406.9	450.0	428.4	385.4	254.5	401.8
N	30567	29183	29183	28936	27755	27755	19932	27755

Table VIII. Default triggers for different firms

This table reports results of logit regressions of default for different combinations of asset values and liquidity. The sample consists of all firm-month observations for non-defaulting firms, and of firm-months preceding default for defaulting firms. The dependent variable equals one if the firm defaulted in the following month, and zero otherwise. v is the sum of market values of equity and debt normalized by the book value of debt. Q is the sum of cash and receivables divided by current liabilities. *Cross-term*= $\delta S(1-Q)$ normalized by the book value of debt, where S is current liabilities, and δ is costs of external financing, measured in different specifications as follows: δ_1 is the sum of face values of bank debt and secured bonds divided by 'hard' collateralizable assets (net PPE plus current assets); δ_2 is the logarithm of one plus the number of covenants restricting senior and/or secured borrowing; and δ_4 is one minus the aggregate normalized annual par amount of newly extended high-yield loans. *Liquidation value* is the sum of net PPE and current assets divided by book debt. *Volatility* is equity volatility of the median CRSP firm in the same 3-digit SIC industry. *No. of bonds* is the logarithm of the number of outstanding public bond issues divided by total debt. Low-v firms are those with $v < 0.633$. Low-Q firms are those with $Q < 1$. Standard errors were adjusted for serial correlation using the Newey-West procedure. Values of z-statistics are reported in parentheses. ***, **, and * mean that the coefficient is significant at 1%, 5% and 10% significance level, respectively.

	Low v, low Q			High v, low Q			Low v, high Q		
	δ_1	δ_2	δ_4	δ_1	δ_2	δ_4	δ_1	δ_2	δ_4
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Mkt.assets, v	-4.79***	-3.29**	-3.47***	-6.97***	-7.21***	-6.99***	-7.52***	-8.51***	-8.59***
	(-3.44)	(-2.48)	(-2.71)	(-8.90)	(-8.80)	(-8.98)	(-2.97)	(-2.86)	(-2.64)
Quick ratio, Q	-0.508	-1.50	-1.94***	-1.94***	-2.53***	-3.10***	-0.627	0.516	-0.046
	(-0.57)	(-1.59)	(-2.58)	(-2.81)	(-3.66)	(-4.44)	(-1.58)	(0.96)	(-0.11)
Cross-term	2.64***	0.354	0.027	2.64***	1.18***	0.125**	-8.76	6.61**	1.17
	(3.41)	(0.88)	(0.22)	(6.02)	(4.66)	(2.07)	(-0.84)	(1.99)	(1.33)
Liq. value	0.257	0.052	0.054	0.538***	0.206	0.278	0.833	1.49**	1.55*
	(1.00)	(0.21)	(0.22)	(3.85)	(1.00)	(1.53)	(1.31)	(2.14)	(1.87)
Volatility	-1.75*	-1.46*	-1.46*	-0.744	-1.04	-0.942	-1.60	-1.90	-2.16
	(-1.95)	(-1.75)	(-1.71)	(-0.96)	(-1.27)	(-1.27)	(-0.67)	(-0.72)	(-0.80)
No. of bonds	-30.5	-45.7	-59.5	62.7	44.4	9.80	13.8	-184	-122
	(-0.21)	(-0.31)	(-0.41)	(0.63)	(0.47)	(0.10)	(0.05)	(-0.59)	(-0.42)
const.	1.60	1.72	2.18*	2.70**	3.78***	4.16***	2.16	1.73	2.29
	(1.27)	(1.25)	(1.82)	(2.52)	(3.42)	(4.13)	(0.66)	(0.50)	(0.67)
Pseudo-R^2	0.109	0.073	0.071	0.412	0.406	0.391	0.108	0.132	0.115
χ^2	25.0	17.1	14.8	172.9	134.9	139.7	14.2	13.1	13.8
N	321	321	321	17374	17374	17374	211	211	211

Table IX. Regression analysis of the asset value at default

This table reports results of regression estimates of the value of assets at default, adjusted for self-selection using the Heckman procedure. The sample consists of all firm-month observations for non-defaulting firms, and of firm-months preceding default for defaulting firms. The first-stage choice model is that of the decision to default. Selection variables that determine the default decision are those from Zmijevski (1984): TA is the book value of total assets, NI is net income, CA is current assets, and CL is current liabilities. The second-stage dependent variable is v, the sum of market values of equity and debt normalized by the book value of debt, measured for companies at default only. *Liquidation value* is the sum of net PPE and current assets divided by the book value of debt. Q is the sum of cash and receivables divided by current liabilities. *Cross-term*$= \delta_1 S \max\{1-Q, 0\}$ normalized by the book value of debt, where S is current liabilities and δ_1 is the sum of face values of bank debt and secured bonds divided by PPE plus current assets. *Volatility* is equity volatility of the median CRSP firm in the same 3-digit SIC industry. *Debt maturity* is the weighted average of remaining maturities of outstanding bonds and loans. *No. of bonds* is the logarithm of the number of outstanding public bond issues divided by total debt. *Out-of-court* is a dummy variable that equals zero if the default event was a bankruptcy filing, and one otherwise. Robust standard errors were estimated assuming independence across but not within firm-month clusters. Values of z-statistics are reported in parentheses. ***, **, and * mean that the coefficient is significant at 1%, 5% and 10% significance level, respectively.

	(1)	(2)	(3)	(4)	(5)
Model: v					
Quick ratio, Q	-0.085**	-0.091**	-0.090**	-0.072*	-0.120***
	(-2.34)	(-2.26)	(-2.28)	(-1.81)	(-2.98)
Cross-term	0.081	0.084	0.079	-0.015	0.070
	(1.42)	(1.47)	(1.32)	(-0.21)	(1.22)
Liq.value	0.133***	0.134***	0.133***	0.126***	0.154***
	(3.22)	(3.23)	(3.16)	(3.06)	(3.81)
Volatility	-0.331***	-0.329***	-0.330***	-0.297***	-0.312***
	(-4.23)	(-4.16)	(-4.23)	(-3.91)	(-3.96)
Debt maturity		0.006	0.006	0.009	0.007
		(0.60)	(0.55)	(0.89)	(0.77)
No. of bonds			-3.16		-17.6
			(-0.26)		(-1.40)
Bank/Total debt				0.229**	
				(2.01)	
Out-of-court					0.149***
					(3.44)
const.	0.652***	0.612***	0.624***	0.593***	0.531***
	(4.75)	(3.84)	(4.06)	(3.77)	(3.50)
Selection: *Default*					
NI/TA	-0.896***	-0.896***	-0.896***	-0.903***	-0.894***
	(-2.76)	(-2.77)	(-2.76)	(-2.78)	(-3.08)
TL/TA	0.789***	0.788***	0.788***	0.788***	0.788***
	(6.59)	(6.58)	(6.58)	(6.62)	(14.16)
CA/CL	-0.266***	-0.266***	-0.266***	-0.259***	-0.267***
	(-3.37)	(-3.37)	(-3.37)	(-3.28)	(-3.47)
const.	-2.97***	-2.97***	-2.97***	-2.98***	-2.97***
	(-20.60)	(-20.53)	(-20.54)	(-20.73)	(-27.76)
χ^2	41.32	40.51	41.61	50.42	69.78
N Censored	28530	28530	28530	28530	28530
N Uncensored	127	127	127	127	127

Figure I. Market values of assets of defaulting firms

This graph illustrates the evolution of the market value of debt, equity, and combined assets for the median defaulting company over five years preceding the default event. All values are normalized by the face value of the total debt outstanding. Default-triggering events are payment omissions, distressed exchanges, and bankruptcy filings.

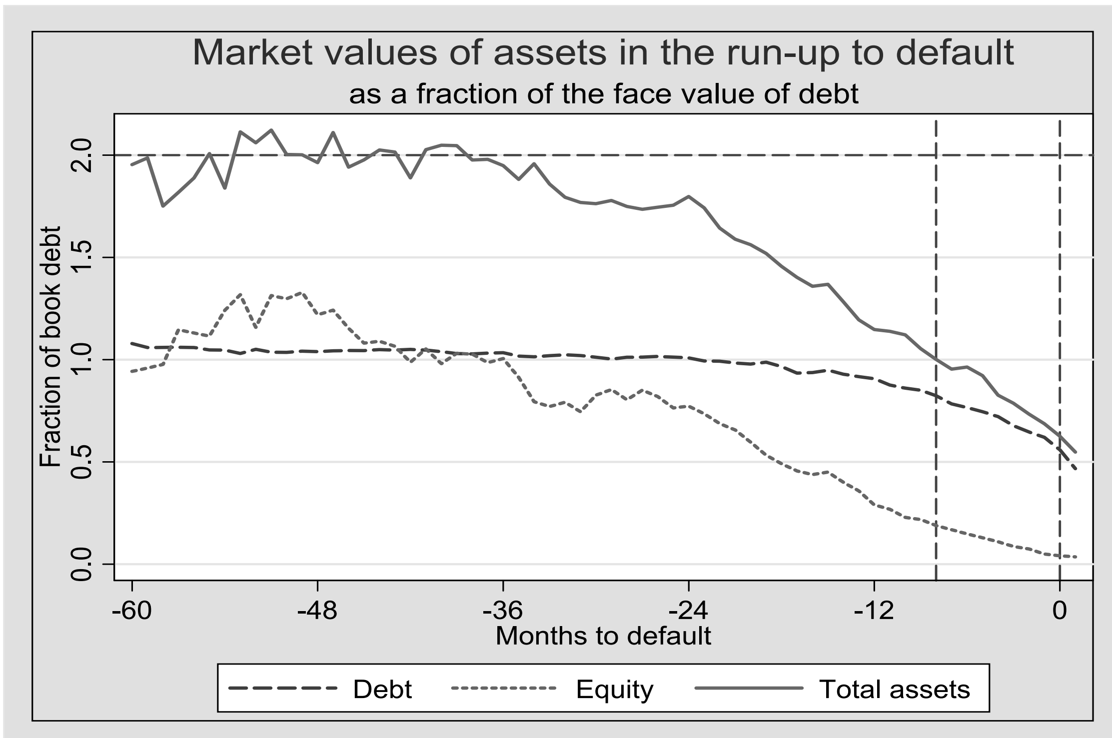

Figure II. Asset value and liquidity position of defaulting and non-defaulting firms

This plot shows observed combinations of asset values and quick ratios for firms at default (diamonds), and for firms that did not default for at least a year after the observation date (circles). Each non-defaulting firm is represented by one point, corresponding to the month-end when the ratio of its market asset value to the face value of debt was at its minimum. The market value of assets is measured as the sum of the market value of debt and equity, normalized by the book value of debt. The quick ratio is the sum of cash and near-cash and accounts receivable, divided by current liabilities.

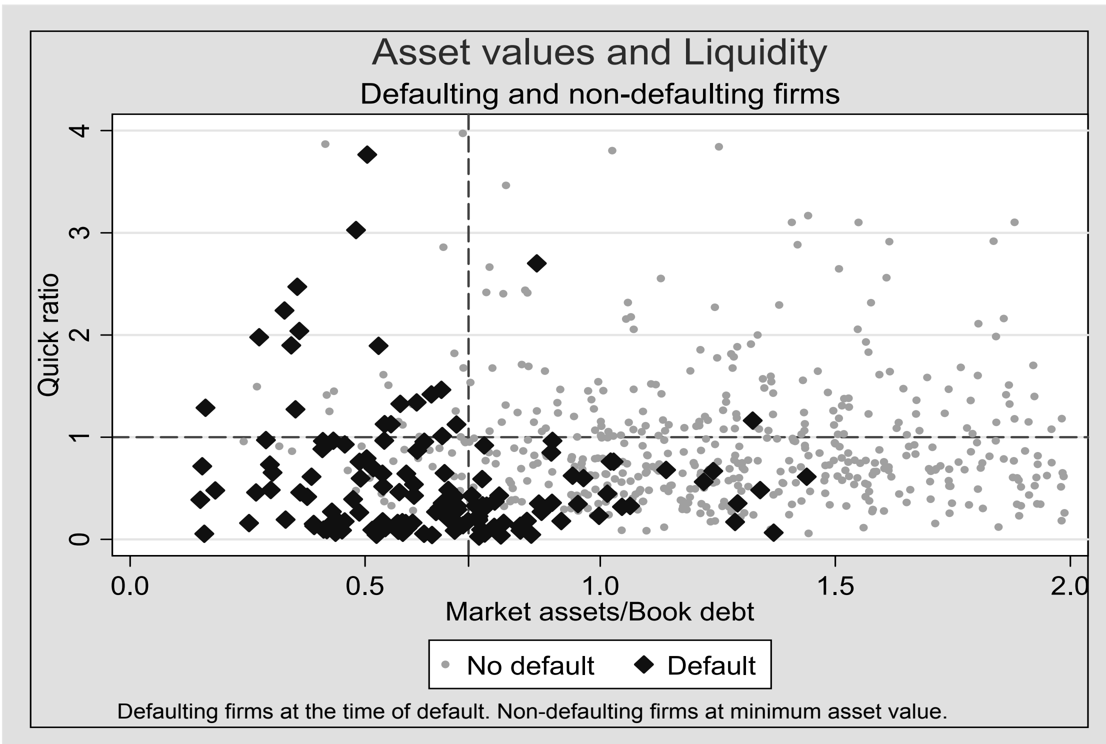

Figure III. Classification errors

For each assumed value of the default boundary, this graph gives the proportion of defaulting firms which had an asset value at default above the boundary (Type I errors), and the proportion of non-defaulting firms among all firms whose asset value at some point fell below the boundary (Type II errors). The market value of assets is measured as the sum of the market value of debt and equity, normalized by the book value of debt.