Who Pulls the Plug? Theory and Evidence on Corporate Bankruptcy Decisions

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Abstract

We offer a model and evidence on firms' optimal bankruptcy decisions. In the model, both the borrower and bank lenders can trigger a bankruptcy filing. We show that debt composition has significant influence on corporate bankruptcy decisions. For example, firms with a small share of bank debt as a fraction of total debt tend to voluntarily file for bankruptcy. When a firm depends heavily on bank debt, the bankruptcy boundary is more likely to be determined by the bank. Our results highlight the control rights of large private creditors in distressed firms.

Keywords: Voluntary bankruptcy; Forced bankruptcy; Bankruptcy boundary; Debt structure; Creditor control.

JEL classification codes: G33, G32, G21

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I Introduction

What are the circumstances under which a firm is forced into bankruptcy rather than files for bankruptcy voluntarily? Understanding corporate bankruptcy decisions is key to models of financial contracting, credit risk and capital structure. A large body of theoretical corporate finance research assumes or concludes that firms can, and sometimes do, file for voluntary bankruptcy. On the other hand, it is widely known that banks monitor firms closely and can sometimes accelerate their loans, which usually forces the borrower into bankruptcy. Apparently, a model that investigates the bankruptcy decisions of both the borrower and the lender has yet to be developed. There also seems to be little or no empirical evidence on the determinants of who makes a firm's bankruptcy decision. This paper fills some of this gap. We demonstrate that in a model with three classes of claimants, the composition of debt is an important determinant of the bankruptcy boundary. Our empirical evidence confirms the predictions of the model and shows that effects of creditor composition on corporate bankruptcy decisions are economically and statistically significant. In particular, our evidence shows that bank lenders are more likely to set the bankruptcy boundary when (1) the firm depends heavily on bank debt, (2) the bank receives a small fraction of the firm's total interest payments, (3) the average bank-debt interest rate is high, (4) the firm has highly concentrated public bonds, (5) the firm has highly concentrated bank debt, and (6) the expected time in bankruptcy is long. In addition, banks are also more likely to force bankruptcy during periods of bad macroeconomic performance.

We adopt a structural approach to modeling the conflicts of interests regarding bankruptcy decisions among three classes of claimants, namely the equity holders, bondholders, and bank lenders. In our model, a firm's debt composition is given and fixed and the bank debt is senior to the bond. Equity holders can file for bankruptcy voluntarily. Bank debt has covenants that give banks the right to force a distressed firm into bankruptcy, even if the firm has made all debt payments.[1] Bonds do not have such covenants.

Our model, though stylized, provides rich predictions about firms' bankruptcy triggers. We show that if a bank triggers a bankruptcy, the firm's asset value at the time of filing, excluding costs, is just enough to repay the bank debt in full; this is not the case for bankruptcies triggered by the equity holders. We exploit this result to guide our empirical analysis. Moreover, the assumption of multiple classes of debt in a firm's debt structure allows us to examine the relation between bankruptcy decisions and debt composition, which has only recently been considered in the literature on structural models of default. Earlier models have assumed a single class of debt. Our model predicts that both macroeconomic conditions and firm characteristics have significant influences on the bankruptcy boundary. Firm-specific factors include the bank-debt share of total debt, bank-debt concentration, public-debt concentration, the bank-debt share of total interest payments, the weighted average bank-debt interest rate, and the time spent in bankruptcy. For example, our model predicts that firms with a small ratio of bank debt to total debt tend to file for bankruptcy voluntarily, and that when a firm depends heavily on bank debt, the bankruptcy boundary is more likely to be determined by the bank.

[1] In the literature, it is common to assume such a strong loan covenant to capture banks' strong control when the borrower is in distress. See, for example, Gorton and Kahn (2000).

To empirically test our hypotheses, we construct a measure that is related to which party, the borrower or the bank lender triggers a bankruptcy. Following our model, a bankruptcy is triggered either by the bank or by the equity holders once the asset value of the firm falls to a threshold level, the bankruptcy boundary. We proxy this boundary value of assets, excluding bankruptcy costs, by the firm-wide default recovery, which is the total amount of repayments of the firm to all its creditors. We then divide the firm-wide recovery by the total bank-debt principal to construct a normalized realization of the bankruptcy boundary (NRBB). The model predicts that if the bank lender triggers a bankruptcy, then the expected after-cost recovery of the firm should be just enough to cover the bank-debt principal amount. Based on this result, the value of NRBB should be 1 for bank-triggered bankruptcies and should deviate from 1 for voluntary bankruptcy filings. The larger is $|NRBB - 1|$, the more likely is a bankruptcy to be filed voluntarily, according to our theoretical model. In our empirical analysis, we therefore use $|NRBB - 1|$ as a proxy for the likelihood of a voluntary bankruptcy filing.

Our paper contributes to the literature on creditor control rights. Until recently, the prevailing view in the literature is that the role of creditors in corporate governance is negligible outside of bankruptcy or before a payment default. Recent empirical evidence has shown that creditors, through the channel of loan covenants, influence both firm investment policy [Chava and Roberts (2008) and Nini, Smith, and Sufi (2009)] and firm financial policy [Roberts and Sufi (2009a) and Sufi (2009)] even when the borrower is solvent. Our paper adds to the literature by showing that large private creditors have significant influence on when a distressed firm files for bankruptcy. Moreover, our results highlight the role of debt composition in determining the control power of private creditors.

Much of the existing theory of defaultable corporate debt focuses on equity holders' optimal default policy. Using a contingent-claims framework, Black and Cox (1976) and Geske (1977) value coupon-paying debt and solve for the equity holders' optimal default policy when asset sales are restricted. Fischer, Heinkel, and Zechner (1989), Leland (1994), Leland and Toft (1996), Leland (1998), and Goldstein, Ju, and Leland (2000) examine the optimal default policy in the problem of optimal capital structure. Some existing theory focuses on the banks' role in firms' bankruptcy decisions. In a two-period model, Bulow and Shoven (1978) show that conflicts of interests among asymmetrical claimants imply that there are circumstances under which it is optimal for the bank creditor to force bankruptcy, even though bankruptcies are associated with real costs. Carey and Gordy (2007) provide a model in the spirit of Black and Cox (1976), and derive the optimal bankruptcy threshold value of asset value below which a forced bankruptcy occurs. They conclude that banks play a key role in the bankruptcy decisions.

Our research extends the literature by examining the effect on bankruptcy decisions of explicitly expanding the strategy space open to both equity holders and bank lenders. Unlike the above-mentioned existing theories that consider a single class of debt, with the exception of Carey and Gordy (2007), our model involves multiple classes of debt, which allows us to examine the effect of debt composition on bankruptcy decisions.

Our results are also related to the literature on recovery rates, as determined by a firm's value at the time of bankruptcy filing and by negotiations during the bankruptcy process. Carey and Gordy (2007) show that bank-debt share is an important determinant of firm-wide recovery rates. Covitz, Han, and Wilson (2006) find no significant influence on recovery rates of time spent in bankruptcy. By contrast, Acharya, Bharath, and Srinivasan (2007) find that there is a statistically significant, negative relationship between bond recovery rates and the time spent in bankruptcy. Zhang (2009) documents that macroeconomic conditions are an important determinant of firm-wide recovery rates, both through covenant setting at the time of loan origination, and at the time of default. In this paper, we show that bank-debt share, time spent in bankruptcy and macroeconomic conditions all have a significant influence on firms' bankruptcy decisions.

The rest of the paper is organized as follows. Section II describes our theoretical model and solves for optimal bankruptcy strategies. Section III presents testable hypotheses. Section IV describes the data, discusses our choice of independent variables, and reports sample statistics. Section V presents our main results. Section VI concludes. Proofs of propositions are given in Appendices A and B.

II Structural Model

In this section, we describe a model of corporate bankruptcy. The solution to this model motivates our empirical study. In particular, the solution implies that, in a bank-triggered bankruptcy, the firm's asset value at the bankruptcy filing is just enough to repay the bank in full after paying for bankruptcy costs.

We model the bankruptcy decisions of borrowers and lenders. We focus on conflicts of interests among three classes of claimants on the assets and income flows of the firm: equity holders who run the firm, bondholders, and a bank lender. The equity holders can file for voluntary bankruptcy, and will do so when the asset value of the firm is so low that the costs of making payments to creditors outweighs the benefits of running the firm as a going concern, with the option to default later. In the mean time, the loan contracts include covenants that permit the bank to foreclose on the borrower and force repayment through the bankruptcy process. The incentive for the bank to do so is to preserve assets of the borrower. A high recovery of principal is more important than interest payments to the bank when the borrower is at the brink of collapse. The bondholders are assumed to have no rights to force bankruptcy. This follows a common assumption in the prior literature that compared with bank lenders, dispersed bondholders have poor monitoring ability and high coordination costs. Moreover, empirical evidence has shown that covenants in bank loan contracts are significantly tighter than those in bond contracts.

We adopt a time-homogeneous framework, following Leland (1994). Under this assumption, the optimal bankruptcy policies of the borrower and the bank lender are both of a threshold type. That is, a bankruptcy is triggered when the market value of the firm's assets falls to or below an endogenous threshold.[2] Our attention, however, is focused on endogenizing bankruptcy decisions of the firm and the bank

[2] We focus on bankruptcy boundary of asset value following Black and Cox (1976), Gilson, John, and Lang (1990), Leland (1994), and Longstaff and Schwartz (1995), rather than on bankruptcy boundary of liquidity as in Asquith, Gertner, and Scharfstein (1994), Kim, Ramaswamy, and Sundaresan (1993), and DeAnglo, DeAnglo, and Wruck (2002). For a study on whether default is triggered by low market asset values or by liquidity shortages, corresponding to economic versus financial distress, see Davydenko (2007).

lender. We thus assume that the debt structure is exogenous, and that all debt service must be met by issuing new equity. This limitation implies that the optimal capital structure choice is not endogenized in this paper.

A Model Setup

Consider a firm, operated by equity holders, with a rate δ_t of cash flow given by a geometric Brownian motion with proportional drift μ and volatility σ. That is,

$$d\delta_t = \mu\delta_t \, dt + \sigma\delta_t \, dW_t. \tag{1}$$

where W is a standard Brownian motion with respect to the probability space and information filtration common to all agents.

All agents in the model are risk-neutral and discount cash flows at a fixed market interest rate r. The asset value of the firm is thus given by

$$V_t = E_t\left[\int_t^{\infty} e^{-r(s-t)}\delta_s \, ds\right] = \frac{\delta_t}{\kappa}, \tag{2}$$

where $\kappa \equiv r - \mu$ and E_t denotes expectation given $\{\delta_s : s \leq t\}$. Here we assume that $r > \mu$. It follows that

$$dV_t = \mu V_t \, dt + \sigma V_t \, dW_t$$

The firm is financed by debt and equity, and has a tax rate of θ. Without loss of generality by normalization of V_0, we assume that the total face value of debt is 1. This unit of debt is divided into a single loan with face value λ and a single class of bonds with face value $(1-\lambda)$. The bond is junior to the loan. For simplicity, only the loan has covenants that permit foreclosure. The loan receives interest at a continuous interest rate of c.[3] The bond receives cash flows at a rate of c'. The total interest payment rate is $C \equiv c + c'$.

A bankruptcy can be triggered either by the equity holders' voluntary default, or by the bank's decision to accelerate its loan. The cost of bankruptcy is a fraction $(1-\beta)$ of the total firm value, V_t, at the time of filing. The bankrupt firm's value is divided among its creditors according to absolute priority. That is, the bank gets $\min\{\lambda, \beta V_t\}$. The bondholders get any remainder.

A bankruptcy policy is a stopping time τ_E chosen by equity holders and a stopping time τ_B chosen by the bank. A bankruptcy is filed at the earlier of these two stopping times, $\underline{\tau} \equiv \min\{\tau_B, \tau_E\}$. At any time t before $\underline{\tau}$, the market value of equity is

$$S_t(V_t, \tau_E, \tau_B) = E_t\left(\int_t^{\underline{\tau}} e^{-r(s-t)}\left(\kappa V_s - (1-\theta)C\right)ds\right).$$

The market value of the loan is

$$L_t(V_t, \tau_E, \tau_B) = E_t\left(\int_t^{\underline{\tau}} e^{-r(s-t)} c\, ds + e^{-r(\underline{\tau}-t)}\min\{\lambda, \beta V_{\underline{\tau}}\}\right).$$

For a given bankruptcy policy τ_B of the bank, equity holders maximize the market

[3]Throughout the model, we focus on the case where $c/r > \lambda$, because if the bank-debt interest payment, c is so low that $c/r \leq \lambda$, the bank will force bankruptcy immediately to get a high recovery entitled by the high face value of bank debt, λ.

value of equity by solving

$$S_0^*(v_0, \tau_B) \equiv \sup_{\tau_E \in \mathcal{T}} S_0(v_0, \tau_E, \tau_B), \tag{3}$$

where $\mathcal{T}$ is the set of stopping times, with solution denoted $\hat{\tau}_E(\tau_B)$. Similarly, given the policy τ_E of equity holders, the bank solves

$$L_0^*(v_0, \tau_E) \equiv \sup_{\tau_B \in \mathcal{T}} L_0(v_0, \tau_B, \tau_E), \tag{4}$$

with solution $\hat{\tau}_B(\tau_E)$.

Equations (3) and (4) form a stochastic game with symmetric information. An equilibrium of this game is a pair of default policies (τ_E^*, τ_B^*) that solves

$$\begin{aligned} \hat{\tau}_E(\tau_B^*) &= \tau_E^* \\ \hat{\tau}_B(\tau_E^*) &= \tau_B^*. \end{aligned} \tag{5}$$

B Solution

To solve the model, we first define strategies in terms of hitting boundaries.

Definition 1 *A hitting-boundary strategy is defined as the first time the firm's asset value falls to or below a threshold level. That is,* $\tau_E = \inf\{t : V_t \leq v_E^*\}$ *for the equity holders, and* $\tau_B = \inf\{t : V_t \leq v_B^*\}$ *for the bank lender, where* v_E^* *and* v_B^* *are time-invariant boundary values of assets.*

Armed with hitting-boundary strategies, our model is simplified tremendously. A solution is stated in the following proposition.

Proposition 1 *Suppose there exists an equilibrium characterized by constant hitting boundaries, $v_E^*(v_B)$ for the equity holders and $v_B^*(v_E)$ for the creditors. Assume that the optimal boundaries are characterized by the smooth-pasting condition, i.e., the first derivatives, with respect to V_t, of the market values of the equity and the bank loan at the optimal boundaries are 0. Then:*

(i) Given any bankruptcy threshold, v_B, for the bank, the equity holders have a weakly dominant bankruptcy strategy, which is to file for bankruptcy as soon as the firm value falls to $\bar{v}_E \equiv \frac{(1-\theta)\gamma}{\gamma+1}\frac{C}{r}$, where $\gamma = \frac{1}{\sigma^2}\left[\left(\mu - \frac{\sigma^2}{2}\right) + \sqrt{\left(\mu - \frac{\sigma^2}{2}\right) + 2r\sigma^2}\right]$. Therefore, the optimal bankruptcy strategy for the equity holders is $v_E^*(v_B) = \bar{v}_E$.

(ii) Let $v_B^m \equiv \frac{1}{\beta}\frac{\gamma}{\gamma+1}\frac{c}{r}$. Given any bankruptcy threshold, v_E, for the equity holders, the bank's optimal bankruptcy threshold is:

$$v_B^*(v_E) = \begin{cases} v_E, & \text{if } \bar{v}_B < v_B^m \\ \bar{v}_B, & \text{if } v_B^m \leq \min\{v_E, \bar{v}_B\} \\ \arg\max_{v \in \{v_E, \bar{v}_B\}} \tilde{L}_t(V_t, v_E, v), & \text{if } \bar{v}_B > v_B^m > v_E, \end{cases}$$

where $\bar{v}_B \equiv \lambda/\beta$ and $\tilde{L}_t$ is the market value of the loan defined as $\tilde{L}_t(V_t, v_E, v_B) \equiv L_t(V_t, \tau_E, \tau_B)$, with $\tau_i = \inf\{t : V_t \leq v_i\}$, $i \in \{E, B\}$.

The equity holders' bankruptcy threshold coincides with the endogenous liquidation boundary found by Leland (1994). Although forward-looking equity holders have the option of conditioning their bankruptcy decision on the bank's bankruptcy policy, they never use it. Equity holders file for voluntary bankruptcy whenever they are unable to raise funds by issuing more equity. By contrast, the bank's optimal bankruptcy policy is affected by that of the equity holders.

We can solve (5) by using Proposition 1.

Proposition 2 *In the equilibrium described by Proposition 1, the optimal bankruptcy threshold is*

$$\bar{v}^* = \begin{cases} \bar{v}_E, & \text{if } \bar{v}_B < v_B^m \text{ or } \bar{v}_E \geq \bar{v}_B \geq v_B^m \\ \bar{v}_B, & \text{if } \bar{v}_B \geq \bar{v}_E \geq v_B^m \\ \arg\max_{v \in \{\bar{v}_E, \bar{v}_B\}} \tilde{L}_t\left(V_t, \bar{v}_E, v\right), & \text{if } \bar{v}_B > v_B^m > \bar{v}_E. \end{cases}$$

The solution is better understood in Figure 1. In equilibrium, a firm's optimal bankruptcy threshold value of assets is not always the higher of $\bar{v}_E$ and $\bar{v}_B$. Banks sometimes do not foreclose their loans even when the firm value has fallen to or below the threshold level $\bar{v}_B$. In particular, banks delay forcing a firm into bankruptcy when (1) the loan interest rate is high (that is, if $\bar{v}_E < \bar{v}_B < v_B^m$), and (2) the equity holders' threshold value of firm assets for voluntary bankruptcy is sufficiently low (that is, if $\tilde{L}_t\left(V_t, \bar{v}_E, \bar{v}_E\right) > \tilde{L}_t\left(V_t, \bar{v}_E, \bar{v}_B\right)$ and $\bar{v}_B > v_B^m > \bar{v}_E$). However, if $\bar{v}_E$ is higher than $\bar{v}_B$, then the bankruptcy threshold value of assets is set by the equity holders.

III Testable Hypotheses

The most critical implication of our structural model is that if a bank triggers a bankruptcy, the firm's asset value at the time of filing, excluding costs, is just enough to repay the bank debt in full. This is not the case for bankruptcies triggered by the equity holders. We will discuss how to exploit this implication in our empirical study in Section IV B.

In addition, our structural model has a number of testable implications for bankruptcy decisions that we now briefly discuss. We focus on factors that determine who (the bank or the equity holders) triggers the bankruptcy. Six factors are highlighted, namely bank-debt share in total debt, bank-debt interest rate, bank-debt share of interest payments, bank-debt concentration, public-debt concentration, and time spent in bankruptcy.

A Bank-debt share of total debt

First, as discussed in the introduction, our model implies that the composition of the firm's debt, in particular the bank-debt share in total debt at the time of bankruptcy, is a significant determinant of the bankruptcy decision. For firms with a small share of bank debt, bankruptcy is more likely to be triggered by equity holders. In contrast, for firms with a large share of bank debt, a bank's decision to force bankruptcy is more determinative.

Intuitively, banks monitor their borrowers closely and usually set tight bankruptcy thresholds in order to protect their principal.[4] The more the bank debt, the more assets are needed for the bank to allow the firm to continue, and hence the more likely is the bank's bankruptcy threshold to exceed that of equity holders. In

[4]Empirical evidence has been established in the literature (e.g. Gupton, Gates, and Carty (2000), Van de Castle, Keisman, and Yang (2000), Schuermann (2004), Acharya, Bharath, and Srinivasan (2007), and Carey and Gordy (2007)) that bank-debt recovery rates are very high. For example, Van de Castle, Keisman, and Yang (2000) reports that, between 1987 and 1996, the average recovery rate for bank loans is about 85%, significantly larger than the average recovery rate of 39% for all bonds in the same period.

addition, a high bank-debt share in total debt suggests strong dependence of the borrowing firm on bank financing, which may strengthen the control and bargaining position of the bank.[5] For a firm with a high bank-debt share of total debt, bankruptcy is more likely to be triggered by the firm's bank lender.

This is also clear from our model. A higher bank-debt share (λ) implies a higher $\bar{v}_B$, which means that a bankruptcy at $\bar{v}_B$ is more likely to give a higher loan value than a bankruptcy at $\bar{v}_E$ (see the top graph in Figure 1).

This is summarized as follows.

Hypothesis 1 *Holding other parameters constant, the higher is the bank-debt share, the more likely is the bankruptcy threshold value of assets to be set by the bank lender.*

B Bank-debt share of interest payments

A firm's cash flows are distributed to claimants via dividends and debt interest payments. The bank lender receives the fraction, c/C, of the total interest payment of the firm. The lower is the bank-debt share of interests, the more cash flows will be diverged to bondholders if the bank chooses not to force bankruptcy, which makes it more likely that the bank terminates the firm early by setting a high bankruptcy threshold, other things equal.

Proposition 2 indicates that the bank is in control if, in addition to a high bank-debt share, the bank-debt share of interests is small, that is, if $c/C \leq \beta(1-\theta)$.

[5] For example, empirical evidence from Houston and James (1996) suggests that the management decisions of a firm that borrows from a single bank are strongly influenced by that bank. Carey and Gordy (2007) suggest that the positive relationship between recovery rates and bank-debt share comes from the high bankruptcy thresholds set by banks for those borrowers with more bank debt.

Hypothesis 2 *All else equal, the bankruptcy threshold is more likely to be determined by the bank for firms with a smaller bank-debt share of interests.*

C Bank-debt interest rate

In order to determine the optimal bankruptcy threshold, the bank balances between more loan interests and a higher default recovery of principal. Here, two competing effects of bank interest rates are at play. On the one hand, higher interest payments for the bank would motivate the bank to allow the firm to survive longer by setting a low bankruptcy threshold, in which case equity holders are more likely to control bankruptcy timing. This follows directly from our model. Proposition 2 suggests that, everything else being equal, the effective bankruptcy boundary is more likely to be set by the equity holders if the bank interest payment rate is high, that is, if $c > r\lambda(1 + 1/\gamma)$. On the other hand, interest rates reflect a bank's *ex ante* expectation about the firm's default and recovery risk. For example, firms paying high loan interests may have low tangible loan collateral, and hence high bankruptcy costs and low β. This implies a high level for $\bar{v}_B$, and makes it more likely that the bank sets the bankruptcy boundary. Because our theory does not model the *ex ante* pricing of the loan but rather focuses on the *ex post* bankruptcy decisions, which of the two effects dominates is an empirical question. The following hypothesis summarizes.

Hypothesis 3 *If raising bank interest expense raises the likelihood of bankruptcy boundary to be set by equity holders, then the benefits of receiving interest payments dominate the benefits of default recovery. In contrast, if raising bank interest expense* *lowers the likelihood that the bankruptcy boundary is set by equity holders, then the benefits of default recovery dominate the benefits of receiving interest payments.*

D Bank-debt concentration

Bank-debt concentration also affects the bankruptcy decision through anticipated *ex post* coordination. The intuition is that if a firm is borrowing from only one bank, the bank's coordination costs are low during the bankruptcy process. A sole bank lender can monitor and negotiate more efficiently. Moreover, a sole bank lender has stronger bargaining power relative to the firm, because the firm's financing depends heavily on the bank. Ex-post bankruptcy costs are thus lower for firms with high bank-debt concentration. Foreseeing this, the bank would set a bankruptcy boundary that is sufficiently low so that it can collect as much interest payments as possible. Hence, the effective bankruptcy boundary is likely to be set by the firm in this case.

This is not a direct prediction of our model, which considers a firm that borrows from only one bank. One might, however, suppose that coordination costs are captured by the recovery parameter β. That is, if bank debt is concentrated, leading to lower *ex post* coordination costs, the frictional cost of bankruptcy α is smaller, implying a larger β. The bank's optimal bankruptcy threshold, $\bar{v}_B$, is inversely related to β. It is thus more likely for the equity holders to determine the bankruptcy boundary if β is large.

Hypothesis 4 *Everything else being equal, the equity holders are more likely to set the bankruptcy boundary in firms with highly concentrated bank debt.*

E Bond concentration

The effect of concentrated public bonds on bankruptcy boundaries is twofold. On the one hand, more concentrated public bondholders would incur less *ex post* coordination costs, which, following an argument similar to that for bank-debt concentration, causes the bank to set a lower bankruptcy boundary. On the other hand, high concentration among public bondholders gives bondholders stronger *ex post* bargaining power, which may help them extract more recovery from the banks. Foreseeing this, the bank may implement a higher bankruptcy boundary *ex ante,* and hence it is more likely that the bankruptcy boundary is determined by the bank, opposite to the prediction of the other effect. Which of these two effects dominates is an empirical question.

Hypothesis 5 *If firms with a high concentration among public bondholders are more likely to have a bankruptcy boundary set by equity holders, then the effect of reduced coordination costs among bondholders dominates, leading to a low bankruptcy boundary set by the bank. If, in contrast, firms with a high concentration among public bonds are more likely to have a bankruptcy boundary set by their bank lender, then the effect of increasing the bargaining power of bondholders through concentration dominates, leading to a high bankruptcy boundary set by the bank.*

F Time in bankruptcy

As argued by Jensen (1989) and Hart (2000), claimholders' strategies, and thus a firm's bankruptcy boundary, are endogenously affected by bankruptcy costs. Conventional wisdom holds that the time spent in bankruptcy is an important measure of deadweight bankruptcy costs. This is supported by the fact that the direct costs of restructuring – such as fees for retaining investment bankers, attorneys and restructuring professionals – increase with time, as well as by the belief that shorter workouts can lower the indirect costs of bankruptcy by limiting the impact of bankruptcy on a firm's reputation, can free valuable management time from drawn-out negotiations, and can reduce the extent to which firms forego valuable investment opportunities.[6] So, if bank creditors expect a long time in bankruptcy, they may set a high bankruptcy boundary to cover the higher frictional costs, implying a higher likelihood that the bank determines the effective bankruptcy boundary.[7]

This follows naturally from our model. A longer time in bankruptcy means more costs, lower β, and hence higher $\bar{v}_B$. Based on Hypothesis 3, we know that it is more likely as β declines that the bank's boundary is the effective default boundary.

Hypothesis 6 *If the expected time in bankruptcy is lengthened, it is more likely for the bank to set the bankruptcy boundary, ex ante, to cover higher ex post bankruptcy costs, controlling for other factors.*

[6] The evidence in the literature, however, is not conclusive. Thorburn (2000) finds that the costs of bankruptcy increase with the time in default. However, Andrade and Kaplan (1998) find that time spent in restructuring does not influence the costs of financial distress. In addition, Maksimovic and Phillips (1998) find a nonlinear impact of time spent in bankruptcy, with productivity declines observed only in those firms that exit immediately from bankruptcy and that are in bankruptcy for more than four years.

[7] Alternatively, banks may ex ante charge higher interest payment rates if they expect long time in bankruptcy, which implies that they do not necessarily adjust the bankruptcy boundaries. However, time in bankruptcy is sensitive to the state of the economy at bankruptcy [see Covitz, Han, and Wilson (2006)]. So bankruptcy boundaries are a more flexible way for banks to adjust accordingly than the ex ante-fixed interest payment rates.

IV Data and Measures

Our objective is to test the determinants of which party, the bank or the equity holders, triggers bankruptcy. Toward this end, we proxy for the generally unobservable bankruptcy boundary by a normalized realization of the bankruptcy boundary (NRBB), constructed from default recoveries. In particular, NRBB is defined as the ratio of the total recovery of a defaulted firm to its total bank-debt principal amount. It follows from our model that the expectation of NRBB for a bank-triggered bankruptcy is 1, and that the value deviates from 1 if the bankruptcy is triggered by equity holders. Hence, $|\text{NRBB} - 1|$ is a measure of the likelihood of a bankruptcy being triggered by equity holders. We then test hypotheses regarding bankruptcy decisions by a regression analysis.

A Data

The sample of recovery rates is a March 2008 extract of the Ultimate Recovery Database (URD) of Moody's, covering the period from April 1987 to July 2007.[8] In addition to security-level ultimate recovery rates for each default event, the URD also provides a detailed descriptive information of each defaulted security of the firm, including the instrument type, the principal amount outstanding at default, and the relative ranking in the company's debt structure.

We manually merge the recovery data with firm accounting information from COMPUSTAT, complemented when possible by SEC filings.[9] To measure macro-

[8] The ultimate recovery rate for a defaulted security is the eventual repayment to holders of this defaulted security, as a fraction of principal.

[9] Our final sample involves bankrupt private firms, whose accounting information is not available

economic performance, we use the trailing 12-month average (across firms and time) firm-wide recovery rate from the URD, the trailing 12-month number of default events from URD, and the trailing 12-month aggregate default rate of speculative-grade corporate bonds from Moody's.

For the years from 1987 to 2007, the URD contains 741 firm-default events, involving 3,678 defaulted debt instruments. We exclude all firms with no bank debt at default. We eliminate firms whose NRBB is too high. This yields a final sample of 576 firms with 2,918 defaulted debt instruments.[10]

B Variables

This subsection defines variables used in our regression analysis.

B.1 Normalized Realized Bankruptcy Boundary

The key challenge to empirically studying bankruptcy decisions is the lack of a measure of the bankruptcy boundary, which is generally unobservable.[11] We solve this problem by employing the ultimate recovery rates of debt instruments of defaulted

from COMPUSTAT. Where possible, we extract the accounting information for these firms from their SEC filings.

[10] Out of the 165 firms excluded from the original sample in the URD, 128 do not have a bank credit facility at default. This large fraction of firms financing only through public debt is consistent with the empirical evidence of Cantillo and Wright (2000) that firms are more likely to issue either public or private debt, rather than a mixture of the two. The rest of the firms, 37 in number, have NRBBs higher than 10. We exclude these from our sample in order to address the concern that our results may be driven by outliers. However, our results are essentially unchanged if we relax the allowed maximum NRBB from 10 to 50.

[11] One may argue that when a firm files for bankruptcy petition, they usually indicate whether it is voluntary or forced. This paper, however, focuses on the driving party of a bankruptcy case, not just what it seems on the surface. In fact, many of the firms filing for voluntary petitions enter bankruptcy because they fail to renegotiate with creditors, which are considered as forced bankruptcy cases in this paper.

firms, and by assuming that the realized total recovery of a defaulted firm is an unbiased, after-cost estimate of the firm's bankruptcy threshold value of assets. Specifically, we measure the realized bankruptcy boundary by the total recovery of a default firm. We normalize the recovery by the firm's total bank-debt principal amount. The normalized realization of the bankruptcy boundary (NRBB) for firm i is defined as

$$NRBB_i = \frac{\sum_{j \in \phi_i^{All}} R_i^j P_i^j}{\sum_{k \in \in \phi_i^{Bank}} P_i^j},$$

where R_i^j is the recovery rate of security j in firm i, P_i^j is the principal amount of security j in firm i, ϕ_i^{Bank} is the set of bank debt instruments of firm i, such as bank loans and revolving lines of credit, and ϕ_i^{All} is the set of all debt instruments of firm i.

In the framework of our theory, the realized total recovery, $\sum_{j \in \phi_i^{All}} R_i^j P_i^j$ corresponds to $\beta \bar{v}^*$, the after-cost total firm value at default.[12] The total principal amount of bank debt, $\sum_{k \in \in \phi_i^{Bank}} P_i^j$ corresponds to bank-debt share λ. Hence,

$$NRBB_i = \beta \bar{v}^* / \lambda = \begin{cases} \beta \bar{v}_E / \lambda > 1, & \text{firm triggers,} \quad \text{if } \bar{v}_E > \bar{v}_B \\ \beta \bar{v}_E / \lambda < 1, & \text{firm triggers,} \quad \text{if } \bar{v}_E < \bar{v}_B \text{ and } \bar{v}_B^m > \bar{v}_B \\ 1, & \text{bank triggers,} \quad \text{if } \bar{v}_B > \bar{v}_E > \bar{v}_B^m \\ 1, & \text{bank triggers,} \quad \text{if } \bar{v}_B > \bar{v}_B^m > \bar{v}_E \text{ and small } \bar{v}_E \\ \beta \bar{v}_E / \lambda < 1, & \text{firm triggers,} \quad \text{if } \bar{v}_B > \bar{v}_B^m > \bar{v}_E \text{ and large } \bar{v}_E. \end{cases}$$

NRBB is directly related to a firm's bankruptcy decision. When a bankruptcy is

[12] This is because, after paying for bankruptcy costs, the firm's value at default is divided among its claimants, which is measured by the total firm-wide recovery.

triggered by the bank, $NRBB$ is theoretically one. When the bankruptcy is triggered by the equity holders, $NRBB$ deviates from one. The larger the deviation, the more likely is the bankruptcy to be triggered by the firm.

In the empirical analysis, we investigate the cross-sectional determinants of bankruptcy decisions by regressing the deviation of NRBB from one, $|NRBB - 1|$, on the factors proposed in Section III.

B.2 Independent variables

This subsection introduces the independent variables used in the empirical analysis. Their predicted effects on $|NRBB - 1|$ are summarized in Table I.

Bank-Debt Share. Bank-debt share is measured by the total principal amount of a firm's bank debt at the time of bankruptcy filing, as a fraction of its total principal amount of all defaulted debt.[13] Based on Hypothesis 1, a larger bank-debt share implies a higher threshold value of assets required by the bank, and hence a higher likelihood that the bank triggers the bankruptcy. We expect a negative relation between $|NRBB - 1|$ and bank-debt share.

Bank-Debt Share of Interests. We measure the bank-debt share of interests by the total interest expense paid to a firm's bank creditors as a fraction of its total interest payments to all creditors. So, we define

$$CpnShr_i = \frac{\sum_{j \in \phi_i^{Bank}} C_{ij} P_i^j}{\sum_{j \in \phi_i^{All}} C_{ij} P_i^j},$$

[13] Bank debt here refers to all private debt from both banks and non-bank financial institutions. Out of the 576 firms in the final sample, 29 firms borrow from non-bank financial institutions. My estimates, however, are qualitatively unaffected if we exclude these firms.

where C_{ij} is the interest rate for debt instrument j of firm i and P_i^j is the face value of the same instrument.

Based on Hypothesis 2, we expect a positive association between $|NRBB - 1|$ and bank-debt share of interests.

Bank-Debt Interest Rate. The bank-debt interest expense rate is the weighted average of a firm's bank debt payments, defined by

$$BnkCpn_i = \frac{\sum_{j \in \phi_i^{Bank}} C_{ij} P_i^j}{\sum_{j \in \phi_i^{Bank}} P_i^j},$$

where C_{ij} is the interest expense rate for debt instrument j of firm i and P_i^j is the face value of the same instrument.

Hypothesis 3 suggests that the relationship between $|NRBB - 1|$ and bank-debt interest expense rate can go either way. If the relationship is negative, we know that the benefits of receiving interest payments dominate the benefits of default recovery. If, on the other hand, the relationship is positive, we know that the benefits of high default recovery dominate.

Bank-Debt Concentration. In my empirical analysis, bank-debt concentration is measured by the Herfindahl-Hirschman (HH) index of the nominal amounts of bank debt instruments of the firm, across different lenders, defined by

$$HHI_i^{Bank} = \frac{\sum_{j \in \phi_i^{Bank}} L_{ij}^2}{\left(\sum_{j \in \phi_i^{Bank}} L_{ij}\right)^2}, \tag{6}$$

where L_{ij} is the face value at offering of the j-th loan of firm i. The HH index is one if there is a single bank loan in the capital structure, and is near zero with many lenders holding similar face values.

Following Hypothesis 4, we expect a positive relationship between $|NRBB - 1|$ and bank-debt concentration.

Public-Debt Concentration. Similar to bank-debt concentration, public-debt concentration is measured by the HH index of the nominal amounts of public debt instruments, including senior secured bonds, senior unsecured bonds, senior subordinated bonds, subordinated bonds, and junior subordinated bonds.

$$HHI_i^{Bond} = \frac{\sum_{j \in \phi_i^{Bond}} B_{ij}^2}{\left(\sum_{j \in \phi_i^{Bond}} B_{ij}\right)^2}, \tag{7}$$

where B_{ij} is the face value at offering of the j-th bond of firm i, and ϕ_i^{Bond} is the set of all public bonds of firm i.[14]

The effect of public-debt concentration on the bankruptcy boundary can go either way, as suggested by Hypothesis 5. If $|NRBB - 1|$ and HHI_i^{Bond} are positively related, we conjecture that the effect of reduced coordination costs dominates. If, in contrast, the relationship is negative, we suspect that the effect of the increased bargaining power held by bondholders dominates.

Time in Bankruptcy (*TIB*). We measure *TIB* by the number of months from a firm's bankruptcy filing to its bankruptcy resolution. Here we assume that the real-

[14]This focuses on layers of different bonds of a firm and ignores concentration of holdings within a given bond type. This is mainly because during bankruptcy, the U.S. Trustee, the bankruptcy arm of the Justice Department, appoints a committee to represent the interests of dispersed bondholders. The coordination costs associated with bond complexity is largely captured by that of different layers of bonds.

ized time in bankruptcy is an unbiased estimate of the *ex ante* expected time spent in bankruptcy. Based on Hypothesis 6, we expect a negative relationship between $|NRBB - 1|$ and TIB.

C Descriptive Statistics

Figure 2 illustrates the cross-sectional distribution of NRBB among our sample firms. The majority of the firms have NRBB concentrated around 1. Consistent with Hypothesis 1, the majority of the firms that have an NRBB near 1 are firms that borrow exclusively from banks.[15]

Table II reports descriptive statistics on NRBB for firms in our final sample. Panel A is for all firms in the sample. The mean NRBB is 1.85, with a sample standard deviation of 1.66. Panel B categorizes firms by SIC code. Industry classifications are based on the SIC manual of the U.S. Department of Labor website. Based on the summary statistics, we find no statistically significant difference in the means of NRBBs between any two industries.[16] Panel C shows the distribution of NRBB by year of bankruptcy filing. Compared to bankruptcies in the other years, those filed in 2001 have a lower average NRBB. Those filed in 2004, 2006, and 2007 have higher average NRBBs, This suggests that macroeconomic performance may affect firms' bankruptcy decisions, an issue that we investigate in Section Appendix B..

[15] Out of the 34 firms that have NRBB exactly equal to 1, 30 firms borrow only from banks.

[16] For each pair of industries, we calculate the t-statistic for the difference of their group means by $t_{ij} = (\bar{m}_i - \bar{m}_j)/\sqrt{\hat{\sigma}_i^2/n_i + \hat{\sigma}_j^2/n_j}$, where $\bar{m}_i$ and $\bar{m}_j$ are the group means, $\hat{\sigma}_i$ and $\hat{\sigma}_j$ are the group standard errors, and n_i and n_j are the number of firms in the industries. We find that t_{ij} is small for any pair of industries.

Table III gives summary statistics for all other independent variables, both for our final sample (Panel A) as well as for the full URD sample (Panel B). Except for bank debt-related variables, namely Bank-Debt Share, Bank-Debt HHI, and Bank-Debt Share of Interests, the statistics for the two samples resemble each other. Our final sample firms necessarily have bank debt, which makes it not surprising that the three bank debt-related variables are positively skewed in our sample compared with those of the full URD sample.

Compared with the URD full sample and Moody's Default Risk Service (DRS) sample, firms in our final sample are representative in terms of firm size, default type, default resolution type, and industry. This is shown in Table IV, where we compare the summary statistics of our final sample, the URD full sample, and the DRS sample.

V Empirical Results

A Empirical Methodology

The main part of our empirical analysis relates bankruptcy decisions to variables that influence the strategic actions of bank creditors and equity holders. We proxy the realized after-cost bankruptcy boundary with NRBB, the firm-wide total recovery as a multiple of the firm's total bank-debt principal amount. We assume that NRBB is an unbiased estimate of the effective after-cost asset value at bankruptcy normalized by total bank debt.

Based on our model, banks do not necessarily trigger bankruptcy when the firm's asset value hits their default threshold $\bar{v}_B$, allowing a non-monotonic relation between NRBB and bankruptcy decisions. We address this issue by using $|NRBB - 1|$, the deviation of NRBB from 1, to measure the likelihood of a bankruptcy being triggered by equity holders. This works because NRBB is equal to 1 for bank-triggered bankruptcies. Some caveats about this measure should be noted. The first concerns the consistency of estimates from an OLS regression, given that $|NRBB - 1|$ by definition is no less than 0. Therefore, in addition to OLS regressions, we also use Tobit regressions in our analysis. Second, the dependent variable is a proxy of the likelihood of a bankruptcy to be triggered by equity holders, which makes it hard to quantify the magnitude of the influence of the independent variables.

We first focus on testing the hypotheses developed in Section III, then on the effect of macroeconomic conditions on bankruptcy decisions. The influences of other claimants and the role of an alternative measure of bankruptcy decisions are considered afterwards.

B Hypothesis Testing

Table V reports results of regressions of $|NRBB - 1|$ on factors affecting bankruptcy decisions, controlling for firm size and firm leverage.

First, we consider bank-debt share. More bank debt suggests a higher bankruptcy boundary of assets, in order for the bank to better protect its principal. Hypothesis 1 predicts that firms with a high bank-debt share are more likely to have bankruptcy boundaries set by their bank creditors. This is strongly supported by the regression results. As predicted, Table V shows a significant negative relation between bank-debt share and $|NRBB - 1|$, which proxies the likelihood that the bankruptcy boundary is set by equity holders. This effect is statistically significant across different samples and regression methods. Our result contributes to an understanding of the main finding of Carey and Gordy (2007), that bank-debt share is an important predictor of firm-wide recovery rates.

Bank-debt share of interest payments, however, has the opposite effect. A smaller fraction of total interest payment paid to banks implies a lower benefit that banks achieve by lowering their bankruptcy boundary for assets. Hence, as predicted by Hypothesis 2, the bankruptcy boundary is more likely to be set by the bank in firms with a small bank-debt share of interest payments. This is supported by the results of Table V, consistently across all six regressions.

Table V shows that firms with high bank-debt interest rates are more likely to have their bankruptcy boundaries determined by bank creditors. Based on Hypothesis 3, the empirical evidence suggests that the poor firm quality regarding default recovery reflected by high bank interest payment rates dominates the benefits of receiving interest payments. That is, although banks may prefer lowering their bankruptcy boundaries on firms that pay high interests, the fact that these firm are riskier actually makes the banks impose higher bankruptcy boundaries.

More concentrated creditors have higher *ex post* bargaining power and may incur lower *ex post* coordination costs. For banks, Hypothesis 4 predicts that these two effects work together to lower their *ex ante* bankruptcy boundary, making the equity holders more likely take control. This is confirmed by the positive regression coefficient on bank-debt HH index in Table V. For bondholders, however, these two effects work against each other. Which effect takes control is an empirical question, as suggested by Hypothesis 5. Table V shows a significant negative regression coefficient on public-debt HH index, which suggests that the expected higher *ex post* bargaining power of highly concentrated bondholders dominates the effect of a reduction in coordination costs.

Banks would set high bankruptcy boundaries for firms that are expected to have long work-out periods, in order to cover the higher costs of the bankruptcy process. Consistent with the prediction of Hypothesis 6, Table V shows a significant negative coefficient on TIB. This supports the finding of Acharya, Bharath, and Srinivasan (2007) that there is a statistically significant, and negative relationship between bond recovery rates and time spent in default.[17]

Table V shows that equity holders' decisions on bankruptcy boundaries are significantly influenced by all of the factors proposed in our hypotheses. The directions of the influences are consistent across the six specifications, across different samples, and across different regression methods. This implies that, in our sample, both the bank creditors and the equity holders play a role in determining the bankruptcy boundary. Which claimant takes the lead depends strongly on the firm's debt structure and on the expected *ex post* bankruptcy costs. Thus, in capturing the determinants of timing of defaults, it may be important to incorporate both banks' influence on management and firms' bankruptcy decisions.

[17] Carey and Gordy (2007) and Covitz, Han, and Wilson (2006) study firm-wide and bond recovery rates, respectively, and they find no significant influence on recovery rates of time spent in bankruptcy. Our results do not conflict with their results either, because our Hypothesis 6 predicts that banks raise bankruptcy boundary due to high expected costs in the bankruptcy process. High bankruptcy boundary does not necessarily lead to high recovery rates, as it may be offset by the realized high bankruptcy costs.

C Influence of Macroeconomic Conditions

Panel C of Table II suggests that macroeconomic performance may affect a firm's bankruptcy decision. If banks foresee that an economic downturn is imminent, they may impose a higher bankruptcy boundary so as to compensate for the low valuation of assets in bad times.[18] If so, one expects that banks are more likely to trigger bankruptcies when macroeconomic conditions are poor.

We exploit three different measures of macroeconomic conditions in order to investigate this effect, namely the average firm-wide recovery rate, the number of default events, and the trailing 12-month aggregate default rate of speculative-grade corporate bonds. We regress $|NRBB - 1|$ on macroeconomic variables, controlling for all of the firm characteristics that were used in the baseline regression model. We also examine the effect of including year dummy variables in the baseline regression. The results are reported in Table VI. Consistent with our prediction, macroeconomic conditions have a strong positive association with $|NRBB - 1|$. The results suggest that during economic downturns, banks keep a close eye on their borrowers and are more likely to trigger bankruptcies than equity holders, and that this effect is robust across different measures of macroeconomic conditions.

Our result is consistent with the finding of Roberts and Sufi (2009b) that macroeconomic conditions influence the outcome of renegotiations. This result also complements the literature that examines how banks' lending decisions depend on macroeconomic conditions. In bad times, banks tighten lending standards and make loans

[18] Existing literature has shown that default recovery rates are low in bad times. See, for example, Frye (2000a), Frye (2000b), Altman, Brady, Resti, and Sironi (2005), Hu and Perraudin (2002), Acharya, Bharath, and Srinivasan (2007), Bruche and Gonzalez-Aguado (2008), and Zhang (2009).

available to firms with good credit quality, the so-called "flight-to-quality" effect.[19]

D Influence of Other Creditors

A key assumption of our structural model and empirical analysis is that bank creditors can monitor better than public bondholders, and can force bankruptcy when necessary. In this subsection, we investigate how our estimates would be affected if other creditors share banks' informational and coordination advantages. For example, it is a legal bankruptcy standard that banks and those creditors that are assigned equal priority by a confirmed reorganization plan are paid *pari passu*. Hence, banks may take these other creditors, usually holders of senior secured bonds, into consideration when deciding when to trigger bankruptcy.

Toward this end, we construct new measures of NRBB by replacing total bank debt amount in the denominator by the total principal amounts of different classes of debt. Figure 3 illustrates the distribution of our sample firms according to the newly implied definitions of NRBB. Panel A shows that, under the new NRBB measures, more firms are concentrated in the region where NRBB is between 0 and 1. There are two explanations for this. First, banks may be able to trigger bankruptcy at a threshold of asset value that is high enough to cover the principal of bank debt, but bondholders are unlikely to be able to do so. Second, holding the firm-wide recovery the same, including more debt in the denominator under the new measures naturally decreases NRBB. In order to distinguish between these two explanations, we plot

[19] See, among others, Rajan (1994), Lang and Nakamura (1995), Weinberg (1995), Asea and Blomberg (1998), Lown, Morgan, and Rohatgi (2000), Ruckes (2004), O'Keefe, Olin, and Richardson (2005), Dell'Ariccia and Marquez (2006), Caballero and Krishnamurthy (2008), Gorton and He (2008), Guner (2007), and Zhang (2009).

in Panel B the distributions of the newly defined NRBBs for different samples and different definitions of NRBB. Panel B shows that the majority of firms that are financed with only bank debt have NRBBs close to one, and that the firms with only bond financing spread between zero and one. Panel B indicates that after controlling for the second explanation, the first effect is still significant, which is consistent with our original hypothesis that banks have advantages over bondholders.

We also examine the determinants of the new NRBB measures by regressing them on our independent variables. The idea is that, if other creditors also play a role in firms' bankruptcy decision, the effects of the various factors that we have examined on the new NRBB measures should resemble those of Table V.

For comparison purposes, the first two columns of Table VII show estimates using our original NRBB measure. The two columns in the middle of the table include in the denominator of NRBB all debt that has the same ranking as bank debt. The last two columns include both bank debt and senior secured bonds. Except for *bank-debt share*, whose impact has a smaller magnitude on the new NRBB measures, the effects of all the other factors are either reversed or statistically insignificant. For example, in our original specification, a higher average bank interest rate is associated with a smaller likelihood of the firm triggering bankruptcy, suggesting that the information about a firm's quality that is embedded in interest rates outweighs the tradeoff between receiving interest payments and protecting principal, based on Hypothesis 3. In the new specifications, however, firms with higher average interest rates are more likely to file for bankruptcy voluntarily, which, according to Hypothesis 3, implies the opposite.

Table VII indicates that our main hypotheses are not satisfied with the new NRBB measures. This suggests that other creditors, though they may have the same claim priority as banks, do not share the role played by banks in corporate bankruptcy decisions.

E An Alternative Specification

As discussed at the beginning of this section, an empirical challenge to testing our hypotheses is how to measure the identity of the claimant that triggers the bankruptcy. This is due to strategic bankruptcy policy of banks, leading to a non-monotonic relationship between NRBB and the likelihood of the bankruptcy being triggered by the bank. We use $|NRBB - 1|$, the deviation of NRBB from the expected NRBB value of 1 for bank-triggered bankruptcies, as the dependent variable in our hypothesis testing. It is of independent interests to distinguish between the cases where NRBB>1 and NRBB<1, and to examine whether the proposed factors have similar effects in each case. This subsection considers an alternative specification to address this issue.

We stratify the sample of firms according to their NRBB values to filtering out those with a small NRBB, which are most likely to be bankruptcies triggered by equity holders at low bankruptcy boundaries. For the remaining sample, the relationship between NRBB and the likelihood of the bankruptcy being triggered by equity holders is likely to be monotonic. We then run regressions of NRBB on various factors to test our hypotheses.

Compared with the estimates from the original specification, whose dependent variable is $|NRBB - 1|$, the estimated effects of the proposed factors on NRBB, shown in Table VIII after censoring firms with NRBB less than 0.98, 0.8, and 0.5, are essentially unchanged. However, if we filter out the firms with NRBB larger than 1.2, 2, and 5, and conduct the same regression analysis, the effects of the proposed factors are gone.[20] This suggests that, in our original specification, the results are mainly driven by bankruptcies with high recovery as multiples of bank-debt face value. These cases are more likely to be equity-holder-triggered bankruptcies. For firms with small NRBB, equity holder-triggered bankruptcies are hard to distinguish from the ones that are actually triggered by banks that have a realized recovery that is less than expected.

VI Conclusion

A large body of theoretical corporate finance research assumes that firms can, and sometimes do, file for bankruptcy voluntarily. It is widely known that banks monitor firms closely and can sometimes accelerate their loans, forcing the borrower into bankruptcy. This paper is the first to model both parties' strategic bankruptcy decisions and empirically documents a selection of factors that are likely to affect which party, the firm borrower or the bank lender, determines the firm's effective bankruptcy boundary.

We show that the composition of debt is an important determinant of the bankruptcy boundary. Bank creditors are more likely to force bankruptcy filings for firms with a high bank-debt share of their total debt, highly concentrated bank debt, mul-

[20] To save space, these estimates are not reported.

tiple public bonds, a low share of total interests paid to banks, a high bank-debt interest rate, and longer expected time spent in bankruptcy. In addition, banks are also more likely to force bankruptcy during periods of bad macroeconomic performance. Our results highlight the role of large private creditor in distressed firms.

Appendix A. Proof of Proposition 1

Proof. We first derive the market values of equity and the equity holders' optimal bankruptcy boundary as a function of the bank's optimal bankruptcy boundary, following Leland (1994). We then derive the market value of bank debt and solve for the bank's optimal bankruptcy boundary, conditional the equity holders' strategy.

Equity Value

Equity holders are residual claimants in bankruptcy. Bondholders and the bank have higher priority. In determining the optimal bankruptcy threshold for equity holders, the conflict of interests is between equity holders and all creditors.

In order to derive the equity value, we first calculate total debt value (D), bankruptcy costs (BC), and the value of tax shield (TS). The equity value is then given by ($V - D + TS - BC$).

The creditors receive a constant total interest payment, C, per unit of time, when the firm is solvent. It is well known (for example, Black and Cox (1976) and Leland (1994)) that the market value, $D(V,t)$, of a claim whose current cash flow rate depends on the level of V_t of the firm's assets satisfies the partial differential equation

$$\frac{1}{2}\sigma^2 V^2 D_{vv}(V,t) + \mu V D_v(V,t) - rD(V,t) + D_t(V,t) + c = 0.$$

In this time-homogeneous setting, the debt value does not depend on time explicitly.

That is, $D(V,t) \equiv D(V)$. The equation above thus reduces to

$$\frac{1}{2}\sigma^2 V^2 D_{vv}(V) + \mu V D_v(V) - rD(V) + C = 0,$$

which has a general solution of

$$D(V) = A_0 + A_1 V + A_2 V^{-\gamma}, \tag{8}$$

where

$$\gamma = \frac{1}{\sigma^2}\left[\left(\mu - \frac{\sigma^2}{2}\right) + \sqrt{\left(\mu - \frac{\sigma^2}{2}\right) + 2r\sigma^2}\right],$$

and A_0, A_1, and A_2 are determined by the following boundary conditions[21]:

$$\begin{aligned} \lim_{V\to\infty} D(V) &= \frac{C}{r}, \\ \lim_{V\to v_E} D(V) &= \beta v_E. \end{aligned}$$

Therefore,

$$\begin{aligned} A_0 &= \frac{C}{r}, \\ A_1 &= 0, \\ A_2 &= \left(\beta v_E - \frac{C}{r}\right) v_E, \end{aligned}$$

[21] Strictly speaking, the second boundary condition should be $\lim_{V\to\bar{v}_E} D(V) = \min\{\beta\bar{v}_E, 1\}$. That is, the creditors cannot get more than the total face value of debt. However, equity holders have limited liability and they can issue new equity with no costs as long as the equity value exceeds zero. It is never optimal for the equity holders to trigger bankruptcy if, after paying the creditors, there is still any residual left. As far as equity holders' optimal bankruptcy threshold is concerned, the boundary condition is reduced to $\lim_{V\to\bar{v}_E} D(V) = \beta\bar{v}_E$.

and the total debt value is

$$D(V) = \frac{C}{r} + \left(\beta v_E - \frac{C}{r}\right)\left(\frac{V}{v_E}\right)^{-\gamma}.$$

Now, consider a claim to the bankruptcy cost $(1-\beta)\, v_E$ when V_t hits v_E. This security has a current market value, denoted $BC(V)$, that reflects the market value of a claim to $(1-\beta)\, v_E$ should bankruptcy occur. Because its returns are time independent, it too must satisfy equation (8), with boundary conditions

$$\begin{aligned}\lim_{V\to\infty} BC\,(V) &= 0,\\ \lim_{V\to v_E} BC\,(V) &= (1-\beta)\, v_E.\end{aligned}$$

The solution is

$$BC(V) = (1-\beta)\, v_E \left(\frac{V}{v_E}\right)^{-\gamma}.$$

Similarly, consider a security that pays a constant interest payment equal to the tax-sheltering of interest payments (τC) as long as the firm is solvent, and pays nothing in bankruptcy. This claim is also time independent and therefore satisfies equation (8), with boundary conditions

$$\begin{aligned}\lim_{V\to\infty} TS\,(V) &= \frac{\tau C}{r},\\ \lim_{V\to v_E} TS\,(V) &= 0.\end{aligned}$$

The solution is

$$TS(V) = \frac{\tau C}{r}\left(1 - \left(\frac{V}{v_E}\right)^{-\gamma}\right).$$

The market value of equity is the residual,

$$\begin{aligned} E(V) &= V - D + TS - BC \qquad (9) \\ &= \left(V - (1-\tau)\frac{C}{r}\right) + \left((1-\tau)\frac{C}{r} - v_E\right)\left(\frac{V}{v_E}\right)^{-\gamma}. \end{aligned}$$

Equity holders maximize the market value of equity in equation (9) by choosing the bankruptcy boundary v_E. Here, we can exploit the stated assumption that smooth-pasting characterizes the optimal threshold:

$$\frac{dE(V)}{dV}|_{V=v_E} = 1 - \frac{\gamma}{v_E}\left((1-\tau)\frac{C}{r} - v_E\right) = 0,$$

which has the solution

$$\bar{v}_E = (1-\tau)\frac{\gamma}{1+\gamma}\frac{C}{r}. \qquad (10)$$

Note that

$$\frac{d^2E(V)}{dV^2}|_{V=v_E=\bar{v}_E} = \gamma(1-\tau)\frac{C}{r}\frac{1}{\bar{v}_E^2} > 0,$$

which indicates that $E(V)$ achieves its global maximum at $v_E = \bar{v}_E$.

A weakly dominant bankruptcy strategy for the equity holders is to default the first time the firm's asset value falls to $\bar{v}_E$, regardless of the strategy followed by the bank. Equivalently,

$$v_E^*(v_B) = \bar{v}_E.$$

Loan Value

Now we calculate the market value of bank debt. Denote $\tilde{L}_t(V_t, v_E, v_B) \equiv L_t(V_t, \tau_E, \tau_B)$, with $\tau_i = \inf\{t : V_t \leq v_i\}$, $i \in \{E, B\}$.

There are two ways to achieve our goal. One is to directly calculate the market value of the bank loan with the aid of Laplace transform. The bank-debt value becomes

$$\begin{aligned}
\tilde{L}_t(V_t, v_E, v_B) &\equiv E_t\left(\int_t^{\underline{\tau}} e^{-r(s-t)} c ds + e^{-r(\underline{\tau}-t)} \min\{\lambda, \beta V_{\underline{\tau}}\}\right) \\
&= \frac{c}{r} - \left[\frac{c}{r} - \min(\beta\bar{v}, \lambda)\right] E_t\left(e^{-r\underline{\tau}}\right) \\
&= \frac{c}{r} + \left[\frac{c}{r} - \min(\beta\bar{v}, \lambda)\right] (V_t/\bar{v})^{-\gamma},
\end{aligned}$$

with $\gamma = \frac{1}{\sigma^2}\left[\left(\mu - \frac{\sigma^2}{2}\right) + \sqrt{\left(\mu - \frac{\sigma^2}{2}\right) + 2r\sigma^2}\right]$ and $\bar{v} = \max\{v_E, v_B\}$, where in the last step we have used the well-known result of the Laplace transform of the first hitting time.

The other way is to use results from the above procedure in calculating equity value. The bank receives a constant interest payment, c, per instant when the firm is solvent. Since the bank debt value, $\tilde{L}_t(V_t, v_E, v_B)$, is also time-independent, it should also satisfy equation (8) with boundary conditions

$$\begin{aligned}
\lim_{V\to\infty} \tilde{L}(V, v_E, v_B) &= \frac{c}{r}, \\
\lim_{V\to v_E} \tilde{L}(V, v_E, v_B) &= \min\{\beta\bar{v}, \lambda\}.
\end{aligned}$$

This leads to the same solution

$$\tilde{L}(V, v_E, v_B) = \frac{c}{r} - \left(\frac{c}{r} - \min\{\beta\bar{v}, \lambda\}\right)(V/\bar{v})^{-\gamma}. \tag{11}$$

Now we solve the bank's optimization problem.

The bank maximizes the market value of bank debt in equation (11) by choosing the bankruptcy boundary v_B, conditional on v_E.

Claim 1 Conditional on any given v_E, $\tilde{L}(V, v_E, v_B)$ achieves its maximum at either $v_B = v_E$ or $v_B = \bar{v}_B$, where $\bar{v}_B \equiv \lambda/\beta$.

Proof If $v_B < v_E$, then the bankruptcy threshold is effectively set by the equity holders and the claim holds. So here we only consider the case where $v_E \leq v_B$. That is, we consider the cases where the bank's bankruptcy threshold actually matters.

For $v_B > \bar{v}_B$, equation (11) simplifies to

$$\tilde{L}(V, v_E, v_B) = \frac{c}{r} - \left(\frac{c}{r} - \lambda\right)\left(\frac{V}{v_B}\right)^{-\gamma}.$$

If $c/r < \lambda$, i.e., the face value is higher than the present value of a perpetual bond without default risks, $\tilde{L}(V, v_E, v_B)$ increases in v_B. In this case, the optimal strategy for the bank is to force bankruptcy as soon as possible because its recovery claim is too high. This is intuitive because when the recovery claim in bankruptcy is too high, the bank would demand an immediate repayment by forcing bankruptcy. However, this is an unrealistic case which we do not discuss further.

If, on the other hand, $c/r \geq \lambda$, $\tilde{L}(V, v_E, v_B)$ is maximized at $v_B = \bar{v}_B$.

For $v_B \leq \bar{v}_B$, equation (11) becomes

$$\tilde{L}(V, v_E, v_B) = \frac{c}{r} - \left(\frac{c}{r} - \beta v_B\right)\left(\frac{V}{v_B}\right)^{-\gamma}.$$

The first order condition is

$$\tilde{L}_{v_B}(V, v_E, v_B) = \left[(1+\gamma)\beta - \frac{\gamma}{v_B}\frac{c}{r}\right]\left(\frac{V}{v_B}\right)^{-\gamma}.$$

Setting it to 0 and solving for v_B, we get

$$v_B = \frac{1}{\beta}\frac{\gamma}{1+\gamma}\frac{c}{r} \equiv v_B^m.$$

Moreover, $\tilde{L}_{v_B}(V, v_E, v_B) > 0$ for all $v_B > v_B^m$, and $\tilde{L}_{v_B}(V, v_E, v_B) < 0$ for all $v_B < v_B^m$, implying that $\tilde{L}(V, v_E, v_B)$ achieves its minimum at v_B^m.

Therefore, $\tilde{L}(V, v_E, v_B)$ is maximized at either $\bar{v}_B$ or v_E. ■

Specifically, we have the following cases: 1) If $v_B^m > \bar{v}_B$, the market value of loan decreases monotonically in v_B. The bank's optimal bankruptcy strategy is $v_B^*(v_E) = v_E$. 2) If $v_B^m \leq \bar{v}_B$ and $v_B^m \leq v_E$, the bank's optimal strategy is $v_B^*(v_E) = \bar{v}_B$. 3) If $v_E < v_B^m < \bar{v}_B$, the maximum of loan value is reached at either $\bar{v}_B$ or v_E.

To summarize, we have

$$v_B^*(v_E) = \begin{cases} v_E, & \text{if } \bar{v}_B < v_B^m \\ \bar{v}_B, & \text{if } v_B^m \leq \min\{v_E, \bar{v}_B\} \\ \arg\max_{v \in \{v_E, \bar{v}_B\}} \tilde{L}_t(V_t, v_E, v), & \text{if } \bar{v}_B > v_B^m > v_E, \end{cases}$$

where $\bar{v}_B \equiv \lambda/\beta$ and $\tilde{L}_t$ is the market value of the loan defined as $\tilde{L}_t(V_t, v_E, v_B) \equiv L_t(V_t, \tau_E, \tau_B)$, with $\tau_i = \inf\{t : V_t \leq v_i\}$, $i \in \{E, B\}$. **QED.** ■

Appendix B. Proof of Proposition 2

Proof. The effective bankruptcy threshold, $\bar{v}^*$, is the higher of v_B^* and v_E^*, i.e. $\bar{v}^* \equiv \max\{v_B^*, v_E^*\}$. Based on results from Proposition 1, we have

- if $v_B^m > \bar{v}_B$, or equivalently $\lambda < \frac{c}{C}\frac{1}{1-\theta}\bar{v}_E$, $v_B^*(v_E) = \bar{v}_E$ and $v_E^*(v_B) = \bar{v}_E$, which means $\bar{v}^* = \bar{v}_E$;

- if $v_B^m \leq \bar{v}_B \leq \bar{v}_E$, or equivalently $\frac{c}{C}\frac{1}{1-\theta}\bar{v}_E \leq \lambda \leq \beta\bar{v}_E$, $v_B^*(v_E) = \bar{v}_B$ and $v_E^*(v_B) = \bar{v}_E$, which means $\bar{v}^* = \bar{v}_E$;

- if $v_B^m \leq \bar{v}_E \leq \bar{v}_B$, or equivalently $\frac{c}{C}\frac{1}{1-\theta}\bar{v}_E \leq \beta\bar{v}_E \leq \lambda$, $v_B^*(v_E) = \bar{v}_B$ and $v_E^*(v_B) = \bar{v}_E$, which means $\bar{v}^* = \bar{v}_B$;

- if $\bar{v}_E < v_B^m < \bar{v}_B$, or equivalently $\lambda > \frac{c}{C}\frac{1}{1-\theta}\bar{v}_E > \beta(T)\bar{v}_E$, $v_B^*(v_E) \in \{\bar{v}_B, \bar{v}_E\}$ and $v_E^*(v_B) = \bar{v}_E$.

In summary, the firm's bankruptcy threshold is as follows

$$\bar{v}^* = \begin{cases} \bar{v}_E, & \text{if } \bar{v}_B < v_B^m \text{ or } \bar{v}_E \geq \bar{v}_B \geq v_B^m \\ \bar{v}_B, & \text{if } \bar{v}_B \geq \bar{v}_E \geq v_B^m \\ \arg\max_{v \in \{\bar{v}_E, \bar{v}_B\}} \tilde{L}_t(V_t, \bar{v}_E, v), & \text{if } \bar{v}_B > v_B^m > \bar{v}_E. \end{cases}$$

QED ■

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Table I

Predicted Effects

This table summarizes the predicted effects of firm and bankruptcy characteristics on the firm's bankruptcy boundary, under various hypotheses, where "+" indicates a higher likelihood of the firm filing for bankruptcy voluntarily, and "−" indicates a higher likelihood of bank creditors forcing bankruptcy.

	Predicted Effect on $\lvert \mathrm{NRBB} - 1 \rvert$
Bank-Debt Share	−
Bank-Debt HH Index	+
Public-Debt HH Index	+/−
Bank-Debt Interest Rate	+/−
Bank-Debt Share of Interests	+
Time in Bankruptcy	−

Table II
Summary Statistics on NRBB

This table reports summary statistics on *NRBB* of the full sample (Panel A), by industry (Panel B), and by year of bankruptcy filing (Panel C). * indicates that the corresponding group has a mean that is statistically significantly different from other groups, where we determine whether the means of two groups are different by looking at the t-statistic of their difference.

	Mean	Stdev	Min	5-Prc	Meidan	95-Prc	Max	N
Panel A. All Firms								
Overall	1.85	1.66	0.00	0.24	1.28	6.22	9.81	576
Panel B. By Industry								
A: Agriculture, Forestry, Fishing	4.75	4.36	1.67	1.67	4.75	7.83	7.83	2
B: Mining	1.53	1.38	0.17	0.24	1.01	5.11	6.24	33
C: Construction	1.77	1.43	0.46	0.46	1.43	5.02	5.02	8
D: Manufacturing	1.85	1.80	0.02	0.22	1.27	6.22	9.81	203
E: Transportation, Communications, Electric, Gas, Sanitary Services	1.72	1.60	0.05	0.20	1.24	5.04	9.51	109
F: Wholesale Trade	2.23	1.89	0.43	0.51	1.67	6.62	9.37	21
G: Retail Trade	1.97	1.88	0.02	0.13	1.19	6.38	8.58	80
H: Finance, Insurance, Real Estate	2.22	2.49	0.33	0.35	1.25	8.50	8.82	18
I: Services	1.82	1.66	0.00	0.42	1.31	6.27	8.53	102
Panel C. By Year of Bankruptcy Filing								
1987	1.82	1.62	0.68	0.68	1.82	2.97	2.97	2
1988	1.53	0.28	1.24	1.24	1.44	1.98	1.98	5
1989	1.74	1.96	0.20	0.20	1.21	6.97	8.03	15
1990	1.56	1.34	0.41	0.42	1.32	5.06	5.67	16
1991	1.99	1.10	0.51	0.60	1.62	3.97	4.00	23
1992	2.23	1.56	0.39	0.65	1.82	5.40	7.86	23
1993	2.24	2.26	0.02	0.17	1.67	7.85	9.37	17
1994	2.50	1.79	0.64	0.65	2.59	6.65	7.54	15
1995	2.02	2.04	0.39	0.45	1.33	7.12	8.21	21
1996	2.09	1.96	0.21	0.22	1.37	6.89	7.83	15
1997	1.47	0.88	0.29	0.31	1.33	3.08	3.09	11
1998	1.49	1.23	0.05	0.08	1.12	3.76	3.96	19
1999	1.65	1.51	0.21	0.32	1.29	3.60	9.30	40
2000	1.51	1.21	0.15	0.22	1.11	5.07	5.50	64
2001*	1.35	1.45	0.00	0.17	1.02	5.00	8.53	84
2002	1.57	1.60	0.02	0.12	1.17	4.53	8.39	88
2003	2.10	2.13	0.26	0.30	1.43	6.56	9.81	50
2004*	2.64	2.37	0.38	0.66	1.68	7.63	8.82	34
2005	2.40	2.17	0.35	0.35	1.64	7.06	8.58	19
2006*	4.19	2.56	0.75	0.76	4.70	7.88	7.94	11
2007*	3.59	2.89	0.54	0.54	3.17	7.48	7.48	4

Table III
Summary Statistics on Independent Variables

The table below presents summary statistics on independent variables. Panel A is for defaulted firms in the final sample, which includes firms that have defaulted on their bank debt. Panel B is for the entire Moody's Ultimate Recovery Database (URD). *Total Book Assets* are derived from COMPUSTAT, complemented when possible by firms' SEC filings. *Total Debt* is the sum of the face values of all defaulted debt. *Leverage* is the ratio of *Total Debt* to *Total Book Assets*. *Bank-Debt Share* is the share of bank debt in *Total Debt*. *Bank-Debt HHI* and *Public-Debt HHI* are the Herfindahl-Hirschman indices of the nominal amounts of bank debt and public bond instruments of the firm, respectively, across different lenders. *Bank-Debt Interest Rate* is the weighted average interest rate paid by the firm to its bank creditors, *Bank-Debt Share of Interest* is the proportion of interests paid to banks in the total interests paid to all creditors, *Time to Maturity* is the weighted average number of months from a bankruptcy filing to debt maturity across all bank debt, and *Time in bankruptcy* is the number of months a firm spent in the bankruptcy process.

	Total Book Assets ($ Mil)	Total Debt ($ Mil)	Leverage	Bank-Debt Share	Bank-Debt HHI	Public-Debt HHI	Bank-Debt Interest Rate	Bank-Debt Interest Share	Time to Maturity	Time in Bankruptcy
Panel A. Final Sample (Number of Defaults=576)										
Mean	1624.61	855.20	0.86	0.46	0.68	0.62	0.07	0.40	27.21	13.67
Standard Deviation	6752.69	2381.37	0.49	0.28	0.28	0.38	0.03	0.33	18.48	13.81
Minimum	11.42	14.50	0.05	0.02	0.10	0.00	0.00	0.00	0.00	0.00
25-Percentile	181.94	147.40	0.52	0.23	0.42	0.30	0.05	0.13	13.30	3.88
Median	401.11	309.40	0.78	0.41	0.61	0.67	0.08	0.33	25.42	10.30
75-Percentile	986.73	661.36	1.07	0.63	1.00	1.00	0.10	0.59	39.13	19.08
Maximum	103803.00	33073.53	3.26	1.00	1.00	1.00	0.20	1.00	151.17	110.17
Panel B. Full URD Sample (Number of Defaults=741)										
Mean	1516.59	737.11	0.87	0.36	0.57	0.63	0.07	0.31	26.89	13.29
Standard Deviation	6246.51	2049.55	0.51	0.31	0.36	0.37	0.04	0.33	18.83	13.65
Minimum	11.42	1.98	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25-Percentile	178.33	131.94	0.51	0.08	0.33	0.33	0.05	0.00	12.17	3.33
Median	384.47	264.25	0.80	0.31	0.54	0.66	0.08	0.21	25.07	9.80
75-Percentile	947.76	599.04	1.09	0.55	1.00	1.00	0.09	0.49	38.83	18.87
Maximum	103803.00	33073.53	3.26	1.00	1.00	1.00	0.20	1.00	151.17	110.17

Table IV
Representativeness of the Sample

This table reports summary statistics of three different samples, namely our final sample, the URD full sample, and the DRS sample, by *Total Book Assets*, *Default Type*, *Default Resolution Type*, and *Industry*.

	DRS (1970-2006)	DRS (1987-2006)	URD Full (1987-2007)	URD Final (1987-2007)
Panel A. Total Book Assets ($ millions)				
Mean	1529.9	1466.0	1517.3	1624.6
Standard Deviation	6872.8	6535.2	6241.4	6752.7
Minimum	0.2	0.2	11.4	11.4
25-Percentile	151.8	168.9	179.9	181.9
Median	366.9	398.1	387.3	401.1
75-Percentile	1064.1	1106.8	964.6	986.7
Maximum	103803	103803	103803	103803
Panel B. Default Type (%)				
Missed interest payment	48.6	50.7	35.0	34.7
Chapter 11	25.7	24.7	19.4	20.5
Distressed exchange	9.7	9.2	4.9	4.3
Grace period default	2.9	3.3	0.5	0.5
Suspension of payments	2.3	2.7	0.9	0.9
Missed principal and interest payments	2.2	2.4	0.9	0.7
Prepackaged Chapter 11	1.9	2.1	1.9	1.0
Others	6.5	4.8	25.0	24.5
Not in Moody's	0.1	0.0	11.5	12.8
Panel C. Default Resolution Type (%)				
Reorganization plan confirmed	27.3	29.3	30.6	31.8
Emerged from Chapter 11	15.7	16.6	13.0	12.2
Distressed exchange	9.7	9.2	4.9	4.3
Liquidated	6.0	6.5	3.4	2.6
Acquired	4.3	4.9	2.8	2.6
Made interest payment	3.6	3.9	0.7	0.7
Emerged from bankruptcy	2.1	2.4	2.4	3.0
Others	0.7	0.8	0.1	0.2
N/A	30.5	26.4	30.6	29.9
Not in Moody's	0.1	0.0	11.5	12.8
Panel D. Industry (%)				
A: Agriculture, Forestry, Fishing	0.2	0.2	0.4	0.3
B: Mining	3.4	3.1	6.1	5.7
C: Construction	1.3	1.4	1.6	1.4
D: Manufacturing	24.0	24.6	34.4	35.2
E: Transportation, Communications, Electric, Gas, Sanitary Services	13.7	14.3	18.9	18.9
F: Wholesale Trade	2.5	2.5	4.0	3.6
G: Retail Trade	8.1	8.6	14.6	13.9
H: Finance, Insurance, Real Estate	5.6	5.8	3.1	3.1
I: Services	8.0	8.8	16.9	17.7
J: Public Administration	0.6	0.5	0.0	0.0
N/A	32.5	30.4	0.0	0.0
Number of firms (all panels)	1543	1319	741	576

Table V
Determinants of Bankruptcy Boundary

This table reports the results of regression analyses on determinants of bankruptcy boundary. The dependent variable is $|\text{NRBB-1}|$. *Log(Assets)* is the logarithm of total book assets in millions of dollars. *Leverage* is calculated as book value of total debt divided by total book assets. *Bank-Debt Share* is the total face value of bank debt divided by the total face value of all debt. *Bank-Debt HHI* and *Public-Debt HHI* are the Herfindahl-Hirschman indices of the nominal amounts of bank debt and public bond instruments of the firm, across different lenders. *Bank-Debt Interest Rate* is the weighted average interest rate paid by the firm to its bank creditors, *Bank Share of Interests* is the proportion of interests paid to the bank in the total interests paid to all creditors, *Time to Maturity* is the weighted average number of months from a bankruptcy filing to debt maturity across all bank debt, and *Time in bankruptcy* is the number of months a firm spent in bankruptcy. Columns 1 and 2 are results for all sample firms. Columns 3 and 4 are results for firms with both bank debt and public bonds. Columns 5 and 6 are results for Chapter 11 cases only. Odd-number columns are Tobit regressions, and even-number columns are OLS regressions.

Independent Variable	1	2	3	4	5	6
Intercept	5.890***	4.281***	5.408***	4.364***	2.622***	3.480***
	(5.004)	(5.078)	(4.394)	(4.685)	(2.815)	(4.053)
Log(Assets)	-0.060	0.008	-0.025	-0.020	0.094	-0.012
	(-0.549)	(0.104)	(-0.212)	(-0.220)	(1.086)	(-0.155)
Leverage	0.025	0.165	0.122	0.153	0.374*	0.189
	(0.111)	(0.848)	(0.506)	(0.723)	(1.890)	(1.011)
Bank-Debt Share	-6.606***	-6.504***	-6.701***	-6.452***	-5.333***	-5.062***
	(-9.111)	(-8.912)	(-8.889)	(-8.434)	(-6.068)	(-5.960)
Bank-Debt HH Index	0.712*	0.508*	0.770**	0.592*	0.345	0.415
	(1.994)	(1.657)	(2.131)	(1.816)	(1.089)	(1.393)
Public-Debt HH Index	-0.998***	-0.883***	-0.786***	-0.887***	-0.433*	-0.749***
	(-3.831)	(-3.821)	(-2.719)	(-3.405)	(-1.842)	(-3.402)
Bank-Debt Interest Rate	-14.530***	-14.576***	-14.848***	-14.933***	-7.893**	-7.601**
	(-5.056)	(-5.112)	(-4.972)	(-4.949)	(-2.437)	(-2.450)
Bank Share of Interests	2.649***	3.289***	2.657***	3.346***	2.227***	2.240***
	(3.743)	(4.653)	(3.641)	(4.537)	(2.616)	(2.741)
Time to Maturity	-0.000	-0.000	-0.006	-0.002	-0.006	-0.005
	(-1.364)	(-0.641)	(-1.291)	(-0.494)	(-1.191)	(-1.103)
Time in Bankruptcy	-0.001***	-0.001***	-0.017***	-0.018***	-0.012**	-0.012**
	(-2.944)	(-2.999)	(-2.727)	(-2.761)	(-2.089)	(-2.108)
Likelihood	-610.5	-	-577.3	-	-504.0	-
Adjusted R^2	-	0.394	-	0.372	-	0.322
Sample Size	576	576	539	539	515	515

Table VI
Macroeconomic Conditions and Bankruptcy Boundary

This table reports the results of Tobit and OLS regressions analyses of how macroeconomic conditions affect bankruptcy boundary. The dependent variable is $\left|\text{NRBB-1}\right|$, the deviation of the Normalized Realized Bankruptcy Boundary from 1. *Log(Assets)* is the logarithm of the total book assets of the default firm in millions of dollars. *Leverage* is calculated as the book value of total debt divided by the total book assets. *Bank-Debt Share* is the total face value of bank debt as a fraction of the total face value of all debt. *Bank-Debt HHI* and *Public-Debt HHI* are the Herfindahl-Hirschman indices of the nominal amounts of bank debt and public bond instruments of the firm, across different lenders. *Bank-Debt Interest Rate* is the weighted average interest rate paid by the firm to its bank creditors, *Bank-Debt Share of Interests* is the proportion of interests paid to the bank in the total interests paid to all creditors, *Time to Maturity* is the weighted average number of months from a bankruptcy filing to debt maturity across all bank debt, and *Time in bankruptcy* is the number of months a firm spent in bankruptcy. Macroeconomic conditions are measured by average firm-wide recovery rate (Recovery), the number of default events in each year (N Defaults), the default rate of Moody's-rated speculative grade bonds (Default Rate), and year dummy variable. The coefficients on year dummies are statistically significant for 1996, 2000, 2001, and 2002 at the significant levels of 10% for the Tobit regression and 5% for the OLS regression, respectively. For simplicity, coefficients on year dummies are not reported in the table.

	Tobit Regression				OLS Regression			
	Recovery	N Defaults	Default Rate	Year Dummy	Recovery	N Defaults	Default Rate	Year Dummy
Intercept	1.857*	3.718***	3.675***	4.674***	2.679***	4.580***	4.563***	5.623***
	(1.921)	(3.996)	(3.922)	(2.652)	(2.917)	(5.479)	(5.428)	(4.621)
Log(Assets)	0.089	0.125	0.109	0.078	-0.019	0.016	0.004	-0.037
	(1.064)	(1.421)	(1.235)	(0.727)	(-0.244)	(0.198)	(0.056)	(-0.443)
Leverage	0.318	0.353*	0.349*	0.288	0.140	0.171	0.171	0.097
	(1.602)	(1.728)	(1.701)	(1.282)	(0.737)	(0.888)	(0.888)	(0.496)
Bank-Debt Share	-6.613***	-6.666***	-6.676***	-6.39***	-6.153***	-6.222***	-6.225***	-5.92***
	(-8.889)	(-8.889)	(-8.849)	(-8.641)	(-8.580)	(-8.584)	(-8.547)	(-8.064)
Bank-Debt HHI	0.495	0.419	0.459	0.405	0.543*	0.470	0.504*	0.473
	(1.585)	(1.283)	(1.404)	(1.129)	(1.815)	(1.550)	(1.656)	(1.535)
Public-Debt HHI	-0.458*	-0.451*	-0.498**	-0.487*	-0.775***	-0.777***	-0.811***	-0.827***
	(-1.910)	(-1.835)	(-2.027)	(-1.905)	(-3.417)	(-3.378)	(-3.526)	(-3.567)
Bank-Debt Interest Rate	-13.393***	-15.682***	-15.380***	-11.9***	-12.733***	-15.076***	-14.945***	-11.5***
	(-4.619)	(-5.332)	(-5.199)	(-3.783)	(-4.531)	(-5.301)	(-5.229)	(-3.706)
Bank-Debt Share of Interests	3.192***	3.255***	3.236***	2.936***	3.031***	3.116***	3.093***	2.761***
	(4.436)	(4.485)	(4.432)	(4.072)	(4.379)	(4.456)	(4.402)	(3.887)
Time to Maturity	-0.001	-0.004	-0.004	-0.000	-0.001	-0.004	-0.004	-0.001
	(-0.294)	(-0.813)	(-0.826)	(-0.063)	(-0.273)	(-0.814)	(-0.869)	(-0.123)
Time in Bankruptcy	-0.014**	-0.017***	-0.017***	-0.009	-0.014**	-0.017***	-0.017***	-0.009
	(-2.299)	(-2.774)	(-2.747)	(-1.341)	(-2.269)	(-2.787)	(-2.758)	(-1.413)
Macro Variable	2.586***	-0.007***	-0.045*		2.628***	-0.007***	-0.051**	
	(3.809)	(-2.829)	(-1.988)		(4.011)	(-2.863)	(-2.342)	
Likelihood	-582.8	-585.9	-587.9	-572.6	-	-	-	-
Adjusted R^2	-	-	-	-	0.412	0.398	0.394	0.411
Sample Size	576	576	576	576	576	576	576	576

Table VII
Influence of Other Creditors

This table reports the results of Tobit and OLS regressions analyses of how macroeconomic conditions affect bankruptcy boundary. The dependent variable is $\left|\text{NRBB-1}\right|$, the deviation of the Normalized Realization of the Bankruptcy Boundary from 1. *Log(Assets)* is the logarithm of the total book assets of the default firm in millions of dollars. *Leverage* is calculated as the book value of total debt divided by the total book assets. *Bank-Debt Share* is the total face value of bank debt as a fraction of the total face value of all debt. *Bank-Debt HHI* and *Public-Debt HHI* are the Herfindahl-Hirschman indices of the nominal amounts of bank debt and public bond instruments of the firm, across different lenders. *Bank-Debt Interest Rate* is the weighted average interest rate paid by the firm to its bank creditors, *Bank Share of Interests* is the proportion of interests paid to the bank in the total interests paid to all creditors, *Time to Maturity* is the weighted average number of months from a bankruptcy filing to debt maturity across all bank debt, and *Time in bankruptcy* is the number of months a firm spent in bankruptcy.

	Bank Debt		Same Class		Senior Secured	
	Tobit	OLS	Tobit	OLS	Tobit	OLS
Intercept	5.890***	4.281***	4.592***	3.562***	5.463***	4.228***
	(5.004)	(5.078)	(4.883)	(4.403)	(5.094)	(5.016)
Log(Assets)	-0.060	0.008	-0.068	-0.057	-0.186*	-0.161*
	(-0.549)	(0.104)	(-0.737)	(-0.700)	(-1.818)	(-1.932)
Leverage	0.025	0.165	-0.084	-0.033	-0.314	-0.206
	(0.111)	(0.848)	(-0.389)	(-0.167)	(-1.493)	(-1.106)
Bank-Debt Share	-6.606***	-6.504***	-0.926***	-1.028***	-1.406***	-1.385***
	(-9.111)	(-8.912)	(-2.838)	(-3.278)	(-3.974)	(-4.100)
Bank-Debt HHI	0.712*	0.508*	-0.402	-0.677***	-0.675**	-0.763***
	(1.994)	(1.657)	(-1.470)	(-2.611)	(-2.491)	(-3.055)
Public-Debt HHI	-0.998***	-0.883***	-0.005	-0.077	0.417	0.293
	(-3.831)	(-3.821)	(-0.017)	(-0.290)	(1.355)	(1.066)
Bank Interest Rate	-14.530***	-14.576***	11.186***	10.645***	8.783***	8.242***
	(-5.056)	(-5.112)	(3.850)	(3.858)	(2.949)	(2.968)
Bank Share of Interests	2.649***	3.289***	-4.158***	-3.238***	-3.681***	-2.777***
	(3.743)	(4.653)	(-13.319)	(-10.778)	(-12.009)	(-9.397)
Time to Maturity	-0.000	-0.000	-0.010***	-0.005*	-0.012***	-0.008**
	(-1.364)	(-0.641)	(-2.848)	(-1.700)	(-3.044)	(-2.299)
Time in Bankruptcy	-0.001***	-0.001***	-0.011*	-0.008	-0.007	-0.005
	(-2.944)	(-2.999)	(-1.787)	(-1.328)	(-1.169)	(-0.928)
Likelihood	-610.5	-	-637.5	-	-584.1	-
Adjusted R^2	-	0.394	-	0.312	-	0.322
Sample Size	576	576	567	567	539	539

Table VIII Alternative Regression Specifications

This table reports the results of Tobit and OLS regressions analyses of alternative specifications. The dependent variable is (NRBB-1). *Log(Assets)* is the logarithm of the total book assets of the default firm in millions of dollars. *Leverage* is calculated as the book value of total debt divided by the total book assets. *Bank-Debt Share* is the total face value of bank debt as a fraction of the total face value of all debt. *Bank-Debt HHI* and *Public-Debt HHI* are the Herfindahl-Hirschman indices of the nominal amounts of bank debt and public bond instruments of the firm, across different lenders. *Bank-Debt Interest Rate* is the weighted average interest rate paid by the firm to its bank creditors, *Bank-Debt Share of Interests* is the proportion of interests paid to the bank in the total interests paid to all creditors, *Time to Maturity* is the weighted average number of months from a bankruptcy filing to debt maturity across all bank debt, and *Time in bankruptcy* is the number of months a firm spent in bankruptcy. The columns of *Orig. Spec.* report the results for our original specification as in Table V. $\underline{x}$ is the cutoff value of (NRBB-1) below which the firms are excluded from the regression.

	Tobit				OLS			
	Orig. Spec.	$\underline{x}$ = 0.02	$\underline{x}$ = 0.20	$\underline{x}$ = 0.50	Orig. Spec.	$\underline{x}$ = 0.02	$\underline{x}$ = 0.20	$\underline{x}$ = 0.50
Intercept	6.890***	6.159***	6.131***	5.961***	5.281***	6.159***	6.131***	5.961***
	(5.004)	(3.936)	(4.143)	(4.408)	(5.078)	(4.685)	(4.935)	(5.215)
Log(Assets)	-0.060	-0.033	-0.032	-0.057	0.008	-0.033	-0.032	-0.057
	(-0.549)	(-0.276)	(-0.280)	(-0.560)	(0.104)	(-0.320)	(-0.325)	(-0.647)
Leverage	0.025	0.089	0.101	0.044	0.165	0.089	0.101	0.044
	(0.111)	(0.334)	(0.395)	(0.191)	(0.848)	(0.355)	(0.419)	(0.203)
Bank-Debt Share	-6.606***	-6.861***	-6.870***	-6.677***	-6.504***	-6.861***	-6.870***	-6.677***
	(-9.111)	(-8.260)	(-8.486)	(-8.756)	(-8.912)	(-8.123)	(-8.348)	(-8.630)
Bank-Debt HHI	0.712*	0.697	0.628	0.662*	0.508*	0.697*	0.628*	0.662*
	(1.994)	(1.648)	(1.572)	(1.803)	(1.657)	(1.749)	(1.673)	(1.932)
Public-Debt HHI	-0.998***	-1.238***	-1.167***	-1.023***	-0.883***	-1.238***	-1.167***	-1.023***
	(-3.831)	(-3.665)	(-3.700)	(-3.693)	(-3.821)	(-3.866)	(-3.896)	(-3.870)
Bank Interest Rate	-14.530***	-14.814***	-15.372***	-14.756***	-14.576***	-14.814***	-15.372***	-14.756***
	(-5.056)	(-4.324)	(-4.622)	(-4.805)	(-5.112)	(-4.263)	(-4.557)	(-4.749)
Bank-Debt Share of Interests	2.649***	2.606***	2.733***	2.797***	3.289***	2.606***	2.733***	2.797***
	(3.743)	(3.047)	(3.294)	(3.681)	(4.653)	(3.004)	(3.253)	(3.643)
Time to Maturity	-0.000	-0.009	-0.009	-0.007	-0.000	-0.009	-0.009	-0.007
	(-1.364)	(-1.484)	(-1.552)	(-1.286)	(-0.641)	(-1.455)	(-1.522)	(-1.266)
Time in Bankruptcy	-0.001***	-0.018**	-0.018**	-0.018***	-0.001***	-0.018**	-0.018**	-0.018***
	(-2.944)	(-2.488)	(-2.519)	(-2.872)	(-2.999)	(-2.447)	(-2.477)	(-2.830)
Likelihood	-610.5	-469.3	-491.4	-558.5	-	-	-	-
Adjusted R^2	-	-	-	-	0.394	0.429	0.436	0.442
Sample Size	576	422	447	516	576	422	447	516

Figure 1. Loan and equity values

These graphs show loan and equity values as functions of the firm's effective bankruptcy boundary value of assets. The top graph illustrates that when the bank creditor's boundary v_B is larger than v_B^m, the bank's decision depends on whether v_E or v_B leads to a higher loan value. When v_B is equal to or smaller than v_B^m, as depicted in the bottom graph, loan value monotonically decreases in the bankruptcy boundary, in which case the effective boundary would be the larger of v_E and v_B.

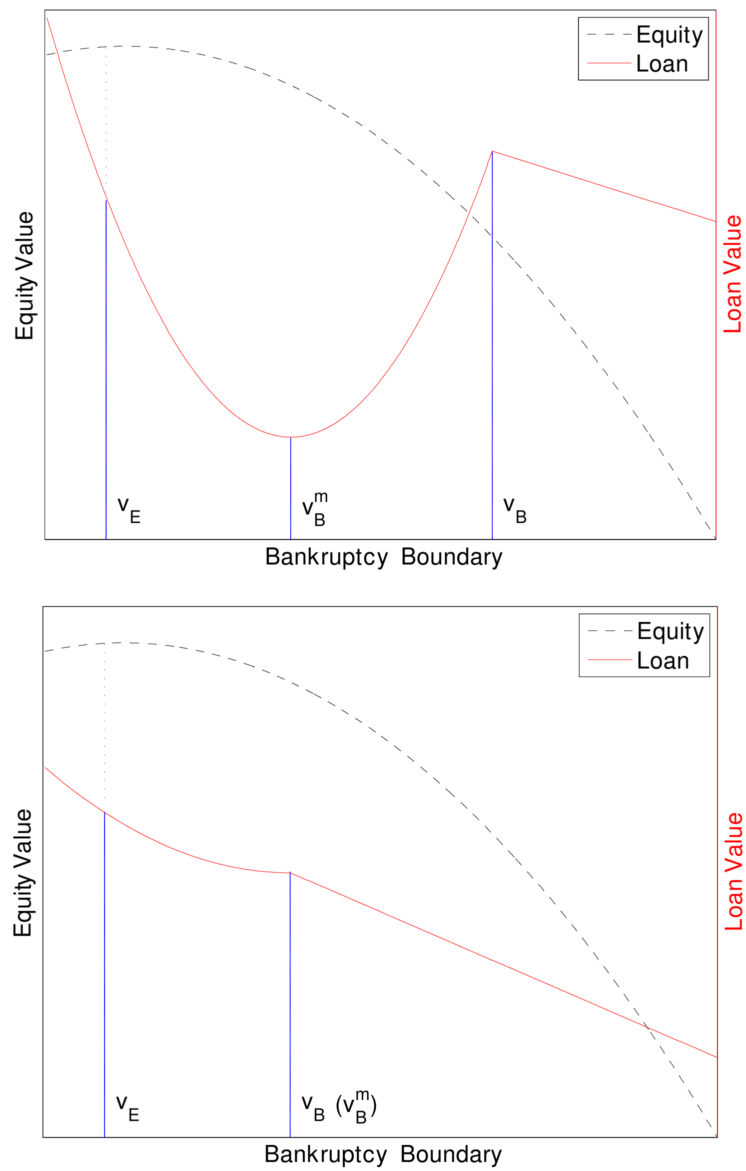


Figure 2. Distribution of sample firms by NRBB

This graph illustrates the distribution of firms in our sample by Normalized Realization of Bankruptcy Boundary (NRBB), which is calculated as the ratio of total firm-wide recovery to the total face value of bank debt.

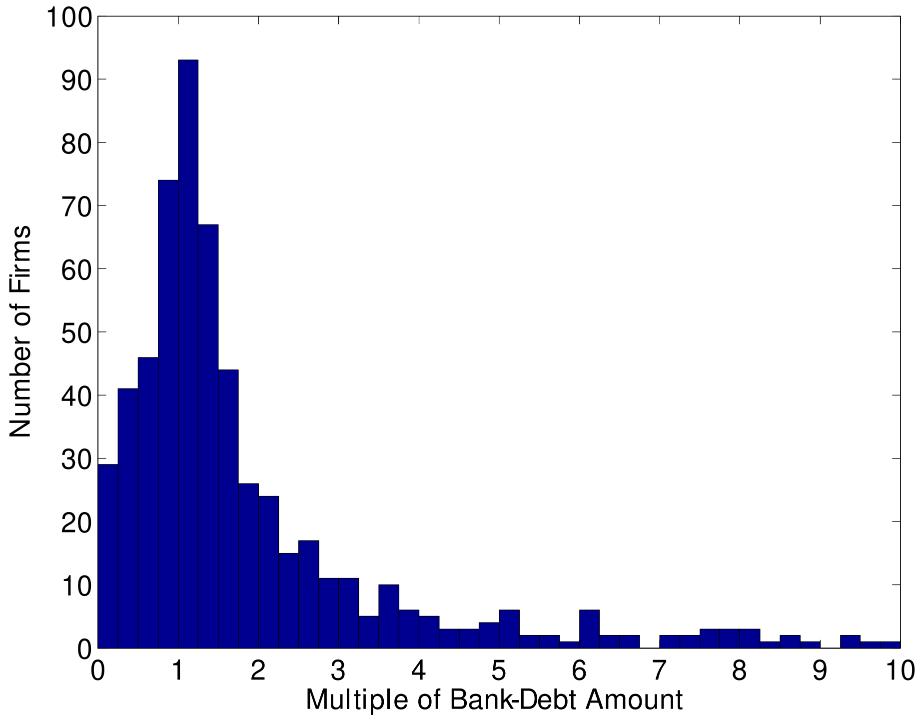
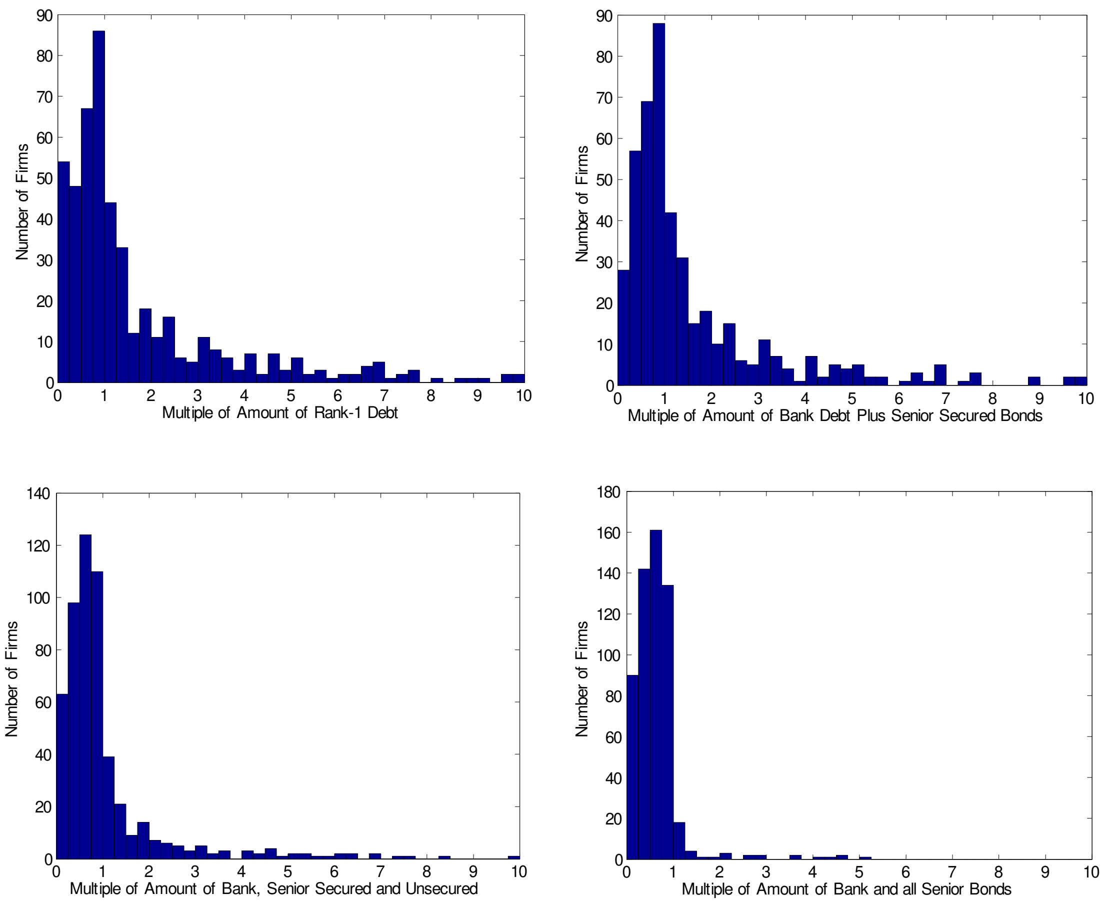


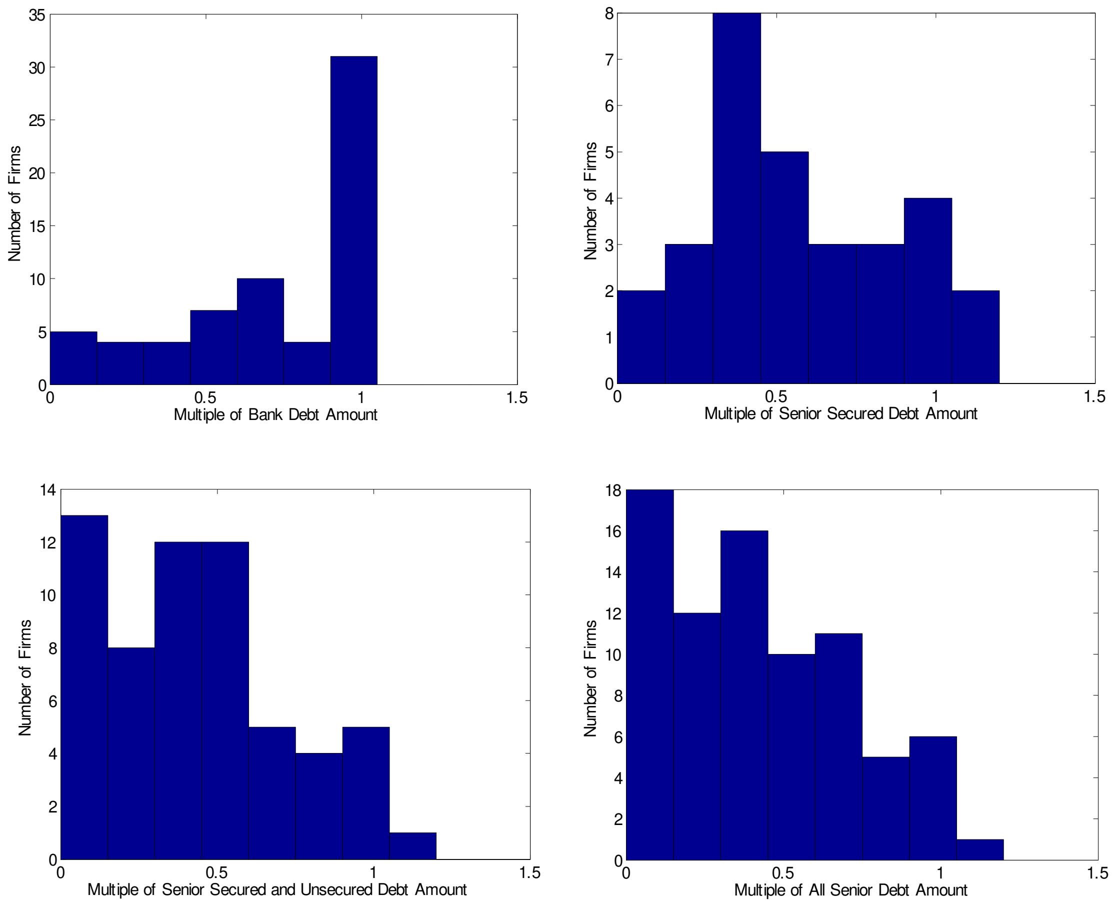
Figure 3. Distribution of firms by alternative definitions of NRBB

These graphs illustrate the distribution of sample firms by various alternative definitions of Normalized Realization of Bankruptcy Boundary (NRBB). Graphs in Panel A are for all firms in our sample. NRBB is defined as the ratio of total firm-wide recovery to a denominator, which is the total amount of bank debt and bonds in the same class (top left), the total amount of bank debt and senior secured bonds (top right), the total amount of bank debt, senior secured bonds, senior unsecured bonds (bottom left), or the total amount of bank debt and all senior debt (bottom right). Graphs in Panel B are for firms financed only with bank debt (top left) and firms financed only with public bonds (the rest three).

Panel A



Panel B


Number of Firms
Multiple of Bank Debt Amount
Number of Firms
Multiple of Senior Secured Debt Amount
Number of Firms
Multiple of Senior Secured and Unsecured Debt Amount
Number of Firms
Multiple of All Senior Debt Amount