The Optimal Concentration of Creditors*

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Abstract

Our model assumes that creditors need to expend resources to collect on claims. Consequently, because diffuse creditors suffer from mutual free-riding (Holmstrom (1982)), they fare worse than concentrated creditors (e.g. a house bank). The model predicts that measures of debt concentration relate positively to creditors' (aggregate) debt collection expenditures and positively to management's chosen expenditures to resist paying. However, collection activity is purely redistributive, so social waste is larger when creditors are concentrated. If borrower quality is not known, the best firms choose the most concentrated creditors and pay higher expected yields.

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Coordination failure among multiple claimants, be they creditors or owners, is a subject well-studied in the academic literature. Such coordination failures can lead to takeover failures (Grossman and Hart (1980)) or bank-runs (Diamond and Dybvig (1983), Obstfeld (1996); Morris and Shin (1998); Morris and Shin (1999)), or generally reduce the probability of successful renegotiation to a proposed reorganization plan when renegotiation requires simultaneous assent by many claimants (Preece and Mullineaux (1996); Hege (1997); Berglöf, Roland, and von Thadden (2000)). In many of these models, the coordination failures aid the dispersed claimants. In a sense, multiple claimants' cooperation has to be purchased with an offer that is attractive enough for each and every claimant to choose to collaborate. Thus, coordination failure can suggest that dispersed creditors or owners can receive higher settlements than their hypothetically more concentrated but otherwise identical counterparts.

Zingales (1995) uses this insight to show that an entrepreneur may prefer to sell a firm to dispersed owners in an IPO, who in turn can later obtain a higher price for the shares from a potential acquiror than this entrepreneur could have obtained by herself.[1] However, dispersion can also have more subtle effects, as modelled, e.g., in Bolton and Scharfstein (1996).[2] (Because Bolton and Scharfstein (1996) is similar to our model in a number of respects and in its focus, it is discussed in great detail in Section III.)

Yet, it is possible to draw an even stronger conclusion from the fact that dispersed creditors cannot easily coordinate. Dispersed creditors are first and foremost unable to be proactive. Thus, even though they are at an advantage when positive assent to a relief plan is required from every creditor, they are at a *disadvantage* when active opposition to management's relief plan is required. In this case, mutual free-riding incentives weakens the overall outcome for dispersed claimants. A good example of how dispersion can facilitate bondholder expropriation are Gertner and Scharfstein (1991) and Bernardo and Talley (1996), in which management can use exchange offers to expropriate wealth from uncoordinated creditors.

[1] Of course, it could be that being public raises the probability that this firm will appear on the radar screen of potential acquirors.

[2] Rajan (1992), Repullo and Suarez (1998), and others consider the tradeoff between a concentrated creditor's ability to collect information and decide intelligently, and his worse ability to negotiate a better settlement due to lower concentration.

In our model, creditors do not automatically receive their due but have to negotiate with the entrepreneur in case of financial distress. (Our paper uses “management,” “equity”, and “entrepreneur” interchangeably.) Collection costs can stem from the costs of filing a claim, following up through the bankruptcy process, investigating the firm’s true resources, communicating and negotiating with and pressuring management, hiring lawyers, bringing motions to the court, etc. Ex-post, management will want to establish procedures which will make it difficult for its creditors to prove and recover their claims. Management can also hire lawyers to outright oppose termination and/or APR (absolute priority rule). Indeed, a casual inspection of bankruptcy records shows that it is not difficult to find examples of creditors who did not find it in their interest to go through the legal hoops necessary even to file, much less to collect relatively modest claims. Further, civil liability claims are commonly dismissed by the bankruptcy court altogether.

Because our creditors must proactively seek to enforce their claims, lobbying and collection activities allow more proactive claimants to achieve better outcomes for themselves—even if these activities are purely redistributive when incurred. Our main focus is the role of creditor dispersion in determining the collective creditor actions. In his seminal paper, Holmstrom (1982) points out that team members have incentives to free-ride, because they bear all effort costs but enjoy only a fraction of their marginal contribution to output. In Holmstrom, team effort is socially desirable, so a socially good solution with little freeriding occurs when the number of team members is small. In contrast, in our model, lobbying and collection expenses are only redistributive and socially unproductive. Consequently, it is free-riding among creditors to reduces overall creditor “team collection effort” that is socially desireable.

Team freeriding *not only* reduces deadweight rent-seeking, *but also* compromises creditors’ collection abilities—a given number of creditors determines both the *ex-post* distribution of cash flows in distress *and* the socially inefficient costs of claim collection. Our model posits that, given a fixed level of debt, a distressed firm with a million uncoordinated small creditors is less likely to be forced to pay its obligations than a firm with one creditor or a firm with creditors that have a coordinating organ (e.g., a trustee for financial bonds). The strongest application of our model applies to idiosyncratic, small credit (such as *small* trade credit [Biais and Gollier (1997), Petersen and Rajan (1997)]). To a lesser extent, our model could also apply to highly dispersed public debt which is not fully coordinated (though in formal bankruptcy, public debt often becomes more coordinated through the appointed creditor committee) or even to civil legal claims brought by product customers and other stakeholders.

Both deadweight lobbying and collection are lower when there are more creditors on the team, which allows us to derive an *ex-ante* optimal concentration of creditors. An entrepreneur who chooses a large number of creditors *ex-ante* assures herself of better bargaining ability against creditors in case of financial distress *ex-post*. Although this minimizes deadweight lobbying costs, we show that in equilibrium the *ex-post* ability to expropriate creditors costs the entrepreneur a higher interest rate when raising the debt *ex-ante*.[3] In contrast, an entrepreneur who chooses a single creditor *ex-ante* will be forced to extensively (and expensively) negotiate with this creditor in case of financial distress, and this single creditor will likely be relatively more successful in enforcing her claim. Although this maximizes deadweight lobbying costs, in equilibrium, such an entrepreneur will also enjoy a lower interest rate when raising the debt *ex-ante*. Putting this all together, the model shows that measures of debt dispersion (the number of creditors) correlate positively with the entrepreneur's retention of the firm in bankruptcy (fewer creditors ⇒ worse outcome for management in financial distress), and negatively with the in-equilibrium claims collection costs (fewer creditors ⇒ more collection efforts, costs, and waste).

In this, our simplest framework, the only deadweight cost of credit is the in-equilibrium spending on conflict. Thus, by itself, this "number of creditors" tradeoff in financial distress—in which more creditors in financial distress have lesser ability to wrestle the firm from management—has an *ex-ante* first-best outcome, in which the number of creditors is infinitely large (dispersed). Zero deadweight collection costs would be incurred in financial distress, and perfectly dispersed creditors receive proper ex-ante compensation (higher interest rates) for their anticipated perfect ex-post expropriation.

However, this model is too naïve. Management that commits itself to fully expropriate creditors in financial distress would likely suffer *ex-ante* from anticipated agency costs and signaling costs. For example, empowering creditors in financial distress may induce management to work harder to avoid it. Or, if only the manager knows that the firm is of high-quality, choosing fewer creditors can signal higher confidence that the firm will not

[3] This can manifest itself in lower product prices. Customers recognize their lower ability to file civil suit in case widely-sold, small products turn out to be defective lateron.

go bankrupt and incur ex-post collection waste. As a result, many firms will find it in their interest to choose a small number of creditors, which trades off in-bankruptcy collection deadweight costs against pre-bankruptcy deadweight agency or signaling costs.

Our paper develops a signaling model in more detail, which has an especially interesting implication. At times, we identify the most concentrated debt, i.e., a single creditor, as a house bank. Although banks doubtlessly perform other functions, they do tend to assume debt in a more concentrated fashion than public creditors. Hence, lack of dispersion is a good characterization of *one* of the differences between public creditors and banks. In the signaling version of our paper, when concentration (the most efficient signal) is exhausted, the intrinsically highest-quality creditors have to resort to paying excess rents to banks to assure separation. Thus, the signaling variant of our model can predict that bank debt earns a higher *expected* (not just promised!) yield than public debt.

The impact of creditor concentration is best seen as one force among others. There are many substitute and complement mechanisms to control agency/signaling concerns. These mechanisms can range from different types of credit arrangements, to debt contract features (seniority, timing, etc.), to other creditor characteristics, to shareholder concentration, to choice of shareholder types, to formal and informal corporate governance mechanisms, to different formal and informal contracting schemes, to type of asset choice, to formal and informal disclosure mechanisms, to bonding mechanisms, to financial constraints (Aghion and Bolton (1992), Pagano and Roell (1998)), and so on. Moreover, the effects of dispersion have also received theoretical attention in other contexts. For example, there are literatures that focus on the roles of concentration among shareholders (e.g., Pagano and Roell (1998) and Burkart, Gromb, and Panunzi (1997)), and on concentration among bank relationships (e.g., Petersen and Rajan (1995), Greenbaum, Kanatas, and Venezia (1989)).[4]

We shall now proceed as follows: Section I describes the conflict game played between N creditors and management in financial distress. This section solves the dynamic optimization from the perspective of management. The result of this section is that there

[4]Welch (1997) models the conflict between existing bank debt and public debt and comes to the conclusion that *if* a company has already issued both kinds of debt, and it now must decide which to make senior, it is the bank debt which should be the senior security. (There is neither a role for equity, nor a role for multiple creditors with *equal* fighting ability, nor explicit free-riding among creditors of equal seniority, nor an endogenous determination of the number of creditors or type of credit or excess interest rate.)

is a monotonically positive relation between debt concentration and in-equilibrium waste. Section II grafts onto this base model a signaling case in which higher-quality managers signal their confidence by choosing fewer creditors. We also show that after concentration signaling is exhausted (i.e., the firm has only 1 creditor, a "house" bank), entrepreneurs must resort to yield signaling. The section also outlines variant models (agency, continuation, marketing) that similarly lead to an interior optimal creditor concentration. Section III discusses our empirical implications, contrasts them with Bolton and Scharfstein (1996), and describes some evidence that is relevant to our argument. Section IV concludes briefly.

I The Cost of A Given Number of Creditors

We begin with a simple "creditor concentration" model. Our primary intent is to derive the in-equilibrium collection waste as a function of the number of creditors.

A The Assumptions

Insert Table 1 here
[Table of Symbols]

Table 1 lists the symbols used in our paper. In stage 1 of the game, the entrepreneur owns in-place assets worth V_{Old}. To adopt a project that provides 0 with probability π and V_{New} with probability $(1-\pi)$, the entrepreneur must raise risky external financing I ($\Rightarrow I > V_{\text{Old}}$). We also assume that the project is intrinsically worthwhile, i.e., $(1-\pi)\cdot V_{\text{New}} > I$. This financing can be in the form of debt raised from an (endogenously determined) number of creditors, N.

If the project later succeeds, creditors are paid and thus there is no issue of concern to us. If the project later fails, the firm still owns its project in place, V_{Old}. Although creditors "should" receive what the absolute priority rule (APR) promises them, collection costs (such as courts, lawyers, and "legal maneuvers") will allow management to reduce creditors' claims in financial distress by up to X. The fact that financial distress is not free or ex-ante completely contracted away (Schwartz and Watson (2000)), and that part of the function of lawyers is to influence courts and obtain rents, is reasonably realistic (Cooter and Rubinfeld (1989), Glaeser and Shleifer (2001)). However, the specific details of court and collection conflict are extremely complex, and thus our paper relies on a flexible, parameterized "black box."[5] To "fight" for X, both creditors and management can devote effort. The exact allocation of X to management (equity) is determined by the *contest success function*

$$\alpha(L_e, L_d) = \left(\frac{L_d}{N}\right) \cdot (1 - L_e) \qquad , \tag{1}$$

where α is the fraction of the contested amount X that debt recovers, if it spends $L_d \in [0,1]$ in aggregate on debt collection and management spends $L_e \in [0,1]$ on payment avoidance. (We shall call these activities "lobbying", to reflect the fact that they involve a broad range of activites). L_d is the aggregate of all creditors' efforts, $L_d = \sum_{i=1}^{N} l_i$, where N is the number of creditors, and $l_i \in [0,1]$ is each individual creditor's collection effort. When $\alpha(L_e, L_d) < 1$, APR is partly violated in favor of equity. Thus α can be considered as a probability of holding onto APR, or as a fraction of the disputed amount X that is allotted to debt in financial distress, or both. The combination of a parametrized X with a contest success function can cover a wide range of possible allocation scenarios. Moreover, the success probability is asymmetric. If equity expends the maximum amount $L_e = 1$, APR is violated with probability 1, irrespective of L_d. However, when debt expends the maximum amount, $L_d = 1$ (which requires all creditors to expend the maximum amount, i.e. $l_i = 1, i = 1, ..., N$), still APR may be violated as long as $L_e > 0$.[6]

Both equity and creditors are assumed to pay for their own lobbying expenses.[7] An amount x of lobbying (collection) effort costs $c_d \cdot x^2$ for creditors and $c_e \cdot x^2$ for equity. As required by law, management must reimburse creditors in the same class equally.[8] Thus, creditor dispersion will play a role through a variation of the team problem identified in Holmstrom (1982): each individual creditor must absorb the full cost, but will benefit only from $1/N$ of the results, of his collection efforts,

[5] Similar simplifying functional forms about underlying values and monitoring, as well as similar assumptions about an inability to write complete contracts are often made in the monitoring literature.

[6] An earlier draft entertained a different and symmetric contest success function. All conclusions were virtually identical.

[7] The insights of this paper are largely unaffected if the firm reimburses creditors and management for their legal costs (as in Chapter 11). This arrangement defacto subsidizes the legal efforts of lower-priority claimants from higher-quality claimants. However, the algebra becomes substantially more complex. See also Welch (1997) and Bris, Schwartz, and Welch (2003).

[8] If one were to allow creditors to compete with one another to collect from a limited amount of funds, and management would pay off the loudest claimants in the same class but leave other claimants dry, free-riding of creditors on one another would be mitigated. However, there would then be a conflict game among creditors, and perhaps even a "run" (Diamond and Dybvig (1983)) on the firm's assets. We focus on our simpler model only.

Neither management nor creditors can commit not to act opportunistically in case of financial distress. Capital markets are perfectly competitive, the firm is acting strategically. All participants are risk-neutral optimizers, and there is no asymmetric information in the financial distress game. (Any *ex-post* asymmetric information is assumed to be fully captured by the known contest success function. We will later introduce an *ex-ante* signaling component.)

B The Financial Distress Game

B.1 The Creditors' Problem

First consider the problem of a single creditor among N creditors if the firm enters financial distress. Under full APR, he receives ${}^{V_{\text{Old}}}/_{N}$, because $V_{\text{New}} = 0$ and this creditor has first claim to the remaining firm's assets, which are assumed to be insufficient to cover the required investment. Under maximum violation, he receives ${}^{V_{\text{Old}}}/_{N} - {}^{X}/_{N}$. He benefits from both his own lobbying, denoted l_d, and the lobbying of other creditors, denoted l_o. Thus, one single creditor maximizes with respect to l_d

$$\alpha(L_e, l_d + l_o) \cdot \left(\frac{V_{\text{Old}}}{N}\right) + [1 - \alpha(L_e, l_d + l_o)] \cdot \left(\frac{V_{\text{Old}}}{N} - \frac{X}{N}\right) - c_d \cdot l_d^2$$

$$\equiv \frac{V_{\text{Old}} - [1 - \alpha(L_e, l_d + l_o)] \cdot X}{N} - c_d \cdot l_d^2 \quad . \tag{2}$$

where $\alpha(L_e, l_d + l_o) = \left(\frac{l_d + l_o}{N}\right) \cdot (1 - L_e)$.

This creditor's first-order condition is

$$(1 - L_e) \cdot \left(\frac{X}{N^2}\right) = 2 \cdot c_d \cdot l_d \quad . \tag{3}$$

Note that all creditors are equal. Thus, a minimal equilibrium symmetry condition is that $l_o^\star = (N-1) \cdot l_d^\star$ and aggregate creditor collection effort is $L_d^\star \equiv N \cdot l_d^\star$.[9]

[9] Our specific solution assumes no redundancies in creditor activities. Introducing such wasteful expenses would only amplify the monotonic mapping from concentration/dispersion to resistance.

B.2 The Management's Problem

Unlike creditors, management does not suffer from a free-riding problem. Under APR, management receives 0. The entrepreneur maximizes with respect to L_e in financial distress (i.e., $V_{\text{Old}} - I + (1-\pi)\cdot V_{\text{New}}$ are sunk costs, and we are only investigating the bankruptcy payoffs, which occurs with probability π):

$$\alpha(L_e, L_d)\cdot 0 + [1-\alpha(L_e, L_d)]\cdot X - c_e \cdot L_e^2 \tag{4}$$

Her first-order condition is

$$\frac{X\cdot L_d}{N} = 2\cdot c_e \cdot L_e \quad . \tag{5}$$

B.3 The Joint Solution

Solving the two first order conditions, we find that the in-distress equilibrium choices are

$$L_e^\star = \frac{X^2}{4\cdot c_e \cdot c_d \cdot N^2 + X^2} \qquad L_d^\star = \frac{2\cdot c_e\cdot X\cdot N}{4\cdot c_e \cdot c_d \cdot N^2 + X^2} \tag{6}$$

In equilibrium, deadweight waste W is

$$W^\star(N) \equiv c_d \cdot \sum_{i=1}^{N} l_i^{\star 2} + c_e \cdot L_e^{\star 2} \tag{7}$$

$$= c_d \cdot \left(\frac{L_d^{\star 2}}{N}\right) + c_e \cdot L_e^{\star 2} \tag{8}$$

$$= \frac{c_e \cdot X^4 + 4\cdot c_d \cdot c_e^2 \cdot X^2 \cdot N}{(4\cdot c_e \cdot c_d \cdot N^2 + X^2)^2} \quad . \tag{9}$$

Therefore,

$$\frac{\partial W^\star}{\partial N} = \frac{4\cdot c_d \cdot c_e^2 \cdot X^2 \cdot [(1-4\cdot N)\cdot X^2 - 12\cdot c_d \cdot c_e \cdot N^2]}{(4\cdot c_d \cdot c_e \cdot N^2 + X^2)^3} < 0 \tag{10}$$

for $N \geq 1$. The waste in this conflict game is smaller when there is more asymmetry in strength between the debt and equity contestants, i.e., as N increases. Here, creditors are weakest when their number is high. Thus, a very large number of creditors can drive in-equilibrium conflict costs to zero. Asymptotically, as $N \to \infty$, waste $W^\star(N) \to 0$.[10]

In this simple model, an infinite number of creditors is first-best. Note that in financial distress, if X is large, such creditors might not receive very much, at all: creditors would effectively become more of a residual claimant than equity!

At this point, it should also be clear that vulture investors have an incentive to concentrate debt in financial distress, even though this is socially wasteful. Although vulture investors do succeed on occasion, much empirical and anecdotal evidence suggests that concentrating debt may often be more costly than resisting management's expropriation—-dispersed creditors may be difficult to locate and buy out. Of course, our stylized model really requires only some monotonic mapping of ex-ante concentration into *expected* (not uniformly *actual*) ex-post concentration in financial distress.

Using eq. 6 we find that $\alpha^\star(L_d, L_e) = \frac{8\cdot c_e^2 \cdot c_d \cdot X \cdot N^2}{(4\cdot c_e \cdot c_d \cdot N^2 + X^2)^2}$, which is decreasing in N. Therefore, APR violations in favor of equity are more likely as the number of creditors increases.

C The Ex-Ante Price of Debt

As in all models of competitive credit provision, the entrepreneur internalizes these ex-post waste costs in equilibrium. Thus, without any other considerations which could induce the entrepreneur into restricting the number of creditors, having as many creditors as possible maximizes the entrepreneur's firm value.[11]

To obtain credit of I, which is assumed necessary to finance the project, an entrepreneur has to offer debt face value FV that satisfies

$$I = \pi \cdot \left[\alpha^\star \cdot V_{\text{Old}} + (1-\alpha^\star)\cdot(V_{\text{Old}} - X) - c_d \cdot \left(\frac{L_d^{\star 2}}{N}\right)\right] + (1-\pi)\cdot FV^\star \qquad , \qquad (11)$$

where $\alpha^\star \equiv \left(\frac{L_d^\star}{N}\right) \cdot (1 - L_e^\star) = \frac{8\cdot c_e^2 \cdot c_d \cdot X \cdot N^2}{(4\cdot c_e \cdot c_d \cdot N^2 + X^2)^2}$ is the in-equilibrium fraction of X that creditors expect to receive and $L_d^\star$ is given in eq. 6. The first term is the expected payoff to creditors in bankruptcy, the second term is the promised payoff to creditors outside of bankruptcy. In bankruptcy, the claimants can recover V_{Old}, the assets in place (because

[10] In the model, N is a control mechanism that translates into an effective aggregate collection strength. If c_d were a choice variable, issuers could choose specific creditors with high c_d, instead of more creditors.
[11] We are ignoring the side condition management that the entrepreneur may have to sell more than 100% of the firm to raise the necessary credit.

the value of the new project V_{New} is worthless), net of their in-equilibrium reduction due to managerial ex-post opportunism and net of their own fighting costs. We also assume that $FV^{\star} \leq V_{\text{Old}} + V_{\text{New}}$, so that the firm is able to pay off the debt in the non-bankrupt state.[12]

Solving for $FV^{\star}$, the in-equilibrium solution for the face value of debt, is

$$FV^{\star} = \frac{I - \pi \cdot \left[V_{\text{Old}} - (1-\alpha^{\star}) \cdot X - \frac{c_d \cdot L_d^{\star 2}}{N} \right]}{1-\pi} \quad . \tag{12}$$

D The Entrepreneur's Optimal Choice

The entrepreneur chooses the number of creditors, N, to maximize the equity's value (E) *ex-ante*, i.e.,

$$E \equiv \pi \cdot \left[\alpha^{\star} \cdot 0 + (1-\alpha^{\star}) \cdot X - c_e \cdot L_e^{\star 2} \right] + (1-\pi) \cdot (V_{\text{Old}} + V_{\text{New}} - FV^{\star}) \quad . \tag{13}$$

In financial distress, $E + I = V_{\text{Old}} - W^{\star}(N)$; if the project is successful, $E + I = V_{\text{Old}} + V_{\text{New}}$. The first-order condition of E with respect to N is a long algebraic expression, but it is easier to derive the sign of the comparative statics from the insight that entrepreneurs internalize all waste in a competitive capital market, i.e., from eq. 7 :

$$E^{\star} = V_{\text{Old}} + \left[-I + (1-\pi) \cdot V_{\text{New}} - \pi \cdot W^{\star}(N) \right] \quad . \tag{14}$$

The main result of Section I is that as $N \to \infty$, $E^{\star}$ converges to the first-best $V_{\text{Old}} - I + (1-\pi) \cdot V_{\text{New}}$. Absent other considerations, with enough creditors, there is no wasteful bargaining expense in financial distress. The interesting comparative statics are

Proposition 1 *The entrepreneur's objective, the ex-ante equity value $E^{\star}$,*

1. *Increases in N,*
2. *Increases in c_d,*
3. *Decreases in c_e for $c_e > \frac{X^2}{4 \cdot c_d \cdot N^{*2}}$, and*
4. *Decreases in X.*

[12]This condition holds in general, except when c_d is as high as $c_d >> V_{\text{Old}}$.

The proof is in the Appendix. The proposition implies that the entrepreneur is better off when $c_d >> c_e$, X is small, and N is large.

II Creditor Concentration and Financial Distress Conflict In a Capital Structure Model: A Signaling Model

Almost all theories of capital structure center around the effects of an increase in the expected costs of bankruptcy (probability of and waste in) when the firm takes on additional debt. Our model is no exception. It merely identifies the deadweight costs of bankruptcy as the waste of socially inefficient claims collection, and it relates this specific cost of debt to the number of creditors.

To obtain an equilibrium in which some firms are willing to incur these financial distress costs in equilibrium, there must also be some advantages to the otherwise disadvantageous debt choice to a finite number of creditors. We now discuss four different mechanisms: signaling (in some detail) in this section; and agency, optimal termination/continuation, and marketing costs in the following section.

A A Revised Model

In the prior model, there was no drawback to the use of multiple creditors. Creditors were maximally expropriated in financial distress, but compensated ex-ante for being ex-post expropriated. Now, consider a model similar to Ross (1977) with two different kinds of firms: good, high-quality (G) firms with a lower probability of bankruptcy (π_G), and bad, low-quality (B) firms with a higher probability of bankruptcy (π_B).

B Signaling With The Number of Creditors

Signaling works if there is a differentially higher cost for low-quality firms to send the signal. To deter imitation, high-quality firms therefore like *ex-ante* lower expected corporate payoffs to themselves if they enter financial distress. These payoffs are lower if [a] litigation waste upon financial distress is higher and [b] entrepreneur's relative (post-litigation) share of the firm is lower. Having fewer creditors accomplishes both objectives. Thus, signaling through creditor concentration is likely to be a relatively efficient separation mechanism.

We have set up the problem intentionally so that the signaling equilibrium is easy to construct. Because signaling equilibria are well understood, we shall be casual on formal equilibrium definitions, and just focus on the pareto-dominant signaling equilibrium. For the sake of brevity, we shall also treat integer constraints on the number of creditors rather casually.

In a separating equilibrium, the low-quality entrepreneur prefers revelation to imitation. Revelation provides the low-quality entrepreneur with her full-information first-best proceeds of

$$V_{\text{Old}} - I + (1 - \pi_B) \cdot V_{\text{New}} \quad . \tag{15}$$

To achieve this, the entrepreneur would offer highly dispersed (public) debt. Imitation would provide a potentially cheating entrepreneur with

$$\pi_B \cdot \left[\alpha^\star \cdot 0 + (1 - \alpha^\star) \cdot X - c_e \cdot L_e^{\star 2}\right] + (1 - \pi_B) \cdot (V_{\text{New}} + V_{\text{Old}} - \mathsf{FV}_G) \quad , \tag{16}$$

where the FV_G indicates that an out-of-equilibrium imitating low-quality firm can receive the high-quality firms' price of credit (based on the good firm's distress probability π_G, not the imitator's true distress probability π_B). FV_G is given in eq. 12. A reasonable signaling equilibrium emerges in which the difference in profits between a cheating and a truthful low-quality firm, i.e., the gain from imitation (GFI), are

$$\begin{aligned}
\mathsf{GFI} \;\equiv\;& \pi_B \cdot \left[(1 - \alpha^\star) \cdot X - c_e \cdot L_e^{\star 2}\right] && (17)\\
& + (1 - \pi_B) \cdot (V_{\text{New}} + V_{\text{Old}} - \mathsf{FV}_G) - [V_{\text{Old}} - I + (1 - \pi_B) \cdot V_{\text{New}}] && (18)\\
=\;& \left(\frac{\pi_G - \pi_B}{1 - \pi_G}\right) \cdot \left\{V_{\text{Old}} - X \cdot \left[1 - \left(\frac{L_d}{N}\right) \cdot (1 - L_e)\right]\right\} && (19)\\
& - \pi_B \cdot c_e \cdot L_e^2 \; - \; \pi_G \cdot \left(\frac{1 - \pi_B}{1 - \pi_G}\right) \cdot c_d \cdot \left(\frac{L_d^2}{N}\right) \; + \; \left(\frac{\pi_B - \pi_G}{1 - \pi_G}\right) \cdot I && (20)
\end{aligned}$$

is just below zero. $\partial\mathsf{GFI}/\partial N$ is a complex expression. However, we do know that larger numbers of creditors are preferred when there is no signaling, and the low-quality firm's outcome does not depend on N if it confesses its identity. (The optimal N for revealing bad firms is infinity.) In the Appendix, we prove that GFI is monotonically increasing in N, that is

$$\frac{\partial \mathsf{GFI}}{\partial N} > 0 \quad . \tag{21}$$

Thus, a potential low-quality imitator has less to gain from imitation when there are fewer creditors. This forces the relationship between $N^\star$ and the exogenous variables:

Proposition 2 *The optimal number of creditors $N^\star$ is:*

1. *Independent of the new opportunities V_{New}.*
2. *Increasing in the pre-existing firm value V_{Old}.*
3. *Decreasing in the cost of invesment I.*
4. *Non-decreasing in the disputable amount X.*
5. *Increasing in π_G, and decreasing in π_B.*
6. *Increasing in c_e, and decreasing in c_d.*

The proof is in the appendix. These comparative statics should be unsurprising to connoisseurs of signaling models. They are determined by the self-punishing mechanisms necessary to deter low-quality imitation.

C Signaling By Debt Pricing And Debtor Concentration

When separation by choice of creditors is insufficient, entrepreneurs may have to underprice their debt, i.e., pay a relatively high interest rate. Interestingly, this has a direct implication: Even though the *required* yields on highly concentrated bank debt can be lower than those on dispersed public debts (to allow for banks superior ability to defend their APR), banks earn excess rents (positive expected returns) from their loans made. This is not to purchase bank services, but "money-burning" to assure separation. [13]

Proposition 3 *When firms can use either yields or creditor concentration for signaling, two choices emerge in equilibrium:*

[13] Necessarily, we would expect competitive banks to compete these rents away (e.g., through higher fixed costs). More importantly, we would expect a signaling equilibrium to allow some recovery of signaling costs: if good firms could recover signaling costs in the far-away future, after the bad firms have gone bankrupt and are not capable of recovering the cost, the signaling equilibrium can still remain.

1. *The firm offers fairly priced debt to a creditor base, concentrated or unconcentrated.*
2. *The firm offers good-deal debt to a single concentrated creditor (bank debt).*

In particular, the firm will not offer good-deal debt to public creditors.

The proof is in the appendix. The intuition is that signaling with creditor concentration is the more efficient signal: it inflicts pain when the firm goes bankrupt, which is more likely to happen to a low-quality firm. When the signal is exhausted, i.e. $N = 1$, which we interpret as bank debt, a high-quality firm then must pay a higher price for credit to separate. High bank debt interest rates do not arise from credit-rationing or poor quality or the purchase of monitoring services, but instead from high-quality, high uncertainty, and the need to separate from other firms! Naturally, in real life, banks probably both monitor and permit signaling.

D An Illustration of The Signaling Model

Insert Figure 1 here
[In-Signaling-Equilibrium Regions]

The appendix contains a complete numerical illustration of the signaling model. Two figures may help visualize the model. Using the numerical values from the appendix, Figure 1 shows the two regions for which it is optimal to signal with either N only, or with N and the debt yield r. For $\pi_B > 0.6$, at least the bad firm's (and possibly also the good firm's) project has a negative NPV, so a signaling equilibrium makes no sense. The upward sloping curve solves π_G as a function of π_B in (25), where $N^\star = 1$. $N^\star$ becomes larger as π_B and π_G become closer. When $r^\star > 0$, the debt yield decreases as both probabilities of default become closer.

Insert Figure 1 here
[In-Signaling-Equilibrium Promised Yields]

Figure 2 plots the promised rate of return ($\frac{FV}{I} - 1$) to creditors of the good firm for different levels of creditor concentration. For any value of N to be optimal, we let $\pi_B = 0.5$, and allow π_G to vary. As $N \to \infty$, the face value of the debt tends to \$200, and therefore the promised rate of return tends to \$200/\$100 − 1 = 100%. In the figure, the *expected* yield $r^\star$ would be zero for $N^\star > 1$. For $N^\star = 1$, the yield can range from 0% to 45%.

E Alternatives to The Signaling Mechanism

Our paper shows that asymmetric ex-ante information can lead to a situation where some firms are willing to borrow from more concentrated creditors in order to signal their higher quality. Alternative (non-signaling) mechanisms can similarly cause interior credit-concentration equilibria:

Agency Management may be better kept in check by fewer creditors. Such creditors have an incentive to invest more in monitoring activity even if the firm is not in distress. Management with more concentrated debt would not *be ex-ante* but *become ex-post* higher quality.

$$\text{Fewer Creditors} \Longrightarrow \text{Better Creditor Monitoring}$$

Optimal Continuation/Termination Fewer coordinated creditors can respond better to make an intelligent decision of whether a firm in distress should continue to operate.

$$\text{Fewer Creditors} \Longrightarrow \text{Better Termination Choices}$$

In a sense, this mechanism can be considered similar to value-enhancing agency monitoring, but *after* the firm enters financial distress.

Simple Transaction Costs It may be more expensive to market debt claims to multiple creditors than it is to market them to just a few creditors.

$$\text{Fewer Creditors} \Longrightarrow \text{Lower Marketing Costs}$$

Indeed, when our model is applied to product market liabilities/claims, it may be exceedingly expensive for the firm to alter its market from few product purchasers (imposing high distress costs) to just a few purchasers (with lower distress costs).

III Implications

A Bolton and Scharfstein (1996)

The paper most interested in the optimal concentration of creditors and thus most similar in goals to our own paper is the classic by Bolton and Scharfstein (1996). It is fair to state that their model is considerably richer than our own.

In our model, the influence of creditor dispersion is more unambigous and less subtle than in Bolton and Scharfstein (1996). By relying on the signaling model, there is no "strategic default" issue "in which the firm defaults because managers want to divert cash to themselves" (Bolton and Scharfstein (1996, p.2)). Our model works even if management is already sufficiently intrinsically motivated to avoid financial distress and bankruptcy.[14] In one sense, the outside option is a modeling device designed to obtain the same predictions as our contest success function: two creditors receive less (not more) than one creditor. Bolton and Scharfstein (1996) identify the source of creditor concentration strength. In contrast, we do not. One could therefore test whether creditor concentration still helps in situations in which the firm reorganizes (which does not occur in B&S) and there is no outside options to exert pressure on management that forces it to treat a single creditor better than multiple creditors. The main intuition and some different empirical implication of our approach are summarized in Table 2.

Insert Table 2 here
[Comparison of Implications To Bolton and Scharfstein (1996).]

B Empirical Implications

This section provides a set of *ceteris paribus* predictions that can be empirically examined.

Collection Activity $\Longrightarrow$ Outcome. The model's principal *assumption* is that more collection efforts translate into better pre-collection cost outcomes. However, future tests cannot just rely on bankruptcy records, because creditors that spend *zero* effort on

[14] Naturally, we agree that creditor structure influences the ability of management to escape bankruptcy. But, we believe that management's objective is to escape financial distress, and less so to default to capture rents.

collection may not appear in the bankruptcy records. A better test would seek to identify claimants *pre*-bankruptcy, not *in*-bankruptcy.

Although we have no direct empirical evidence relating collection activity to outcome, the fact that many creditors *do* indeed spend money on lawyers is anecdotal evidence that collection effort can pay—otherwise, why would rational parties spend money to collect in the first place?[15] There is some disagreement about the extent of the direct costs of formal financial distress. A variety of empirical studies suggest that the order of magnitude of direct court-filed fees are about 2-4% of the value of assets (20% of the market value of equity), depending on whether one includes costs of failed workouts and exchange offers. In a sample including mostly mid-size companies, Lubben (2000) finds that debtor's expenses for attorneys tend to be about $680,000 (mean), $300,000 (median). Adding accountants and investment bankers roughly doubles these figures. Creditor Committees spend about $230,000 (mean), $70,000 (median). Accountants and investment bankers add only about 50 percent more.

The remaining implications derive from the team-free riding incentive:

Dispersion $\Longrightarrow$ Less Creditor Collection Activity. This follows *immediately* from the "team free-riding" ingredient is that dispersed creditors spend less on collection than concentrated creditors. Naturally, although the model assumed equal-size creditors, we would expect the actual claim sizes ("effective dispersion") to be more related to collection activity than the simple number of creditors.

A test might relate a companies' pre-bankruptcy estimates of the number of (small) claimants to the creditors' ultimate aggregate lobbying and collection expenses (e.g., their aggregate legal representation, both quality and quantity).

Brunner and Krahnen (2001) find that coordination costs are higher when there are more creditors. (However, they do not determine if "creditor pools" improve or worsen the settlements obtained by creditors.) Lubben (2000) finds that in "ten [of twenty-two] cases in the sample the United States Trustee was unable to appoint creditors' committee, most often because of lack of interest among unsecured creditors"

[15] Signaling toughness may be one reason why collection activity may be undertaken even if collection activity does not improve outcomes. This is a *ceteris paribus* concern: it would not be an issue if one could control for a creditor's need to establish a reputation for toughness [e.g., proxied by the number of future possible bankruptcies faced by creditors and the uncertainty about the creditor type].

[p.530]. The article also points out cases in which businesses misjudged the difficulties of complying with code requirements, and thus were denied reimbursements for their claims; and lack of understanding of and frustration with the Bankruptcy Code by businessmen. (If we use Lubben's figures to calibrate our model, this implies an effective creditor diffuseness of about $N = 2.4$.)

Dispersion $\Longrightarrow$ Less Management Resistance Activity. This implication follows from the conflict: as creditors spend more on collection activities, management responds by spending more to resist. We know of no empirical evidence testing this implication.

Dispersion $\Longrightarrow$ Worse Outcome. Putting together the preceding team free-riding implication and the preceding collection-outcome assumption suggests that dispersed creditors should fare worse than concentrated creditors.[16]

A test might relate the pre-bankruptcy *estimated* number of creditors claimants to the *actual* number of claims (and their collection success) that are eventually filed,

Interestingly, this implication is opposite to the implication of papers that emphasize the Grossman and Hart (1980) effect. There is indirect evidence relating creditor concentration to the duration of the workout period. Both Frank and Torous (1989) and Thorburn (2000) use the time that firms spend in bankruptcy as a proxy for indirect bankruptcy costs, and Helwege (1999) analyzes junk bond defaults in the 1980s. Her abstract summarizes that "bondholder holdouts are not a significant problem, as firms with proportionately more bonds have shorter default spells…bargaining problems arising from contingent liabilities, lawsuits, and size delay the process, although multiple bond classes do not. Neither information problems nor firm value appear to matter." Of course, holdout time is *not* a direct measure of outcome.

Hotchkiss and Mooradian (1997) find that vulture investors became more prominent in the 1980's and 1990's. These vulture investors serve many roles, and not all of them are proactive. Still, the paper suggests that vultures can enhance not only their own claims (both for their class and for themselves), but also the firm's overall value, by actively pressuring management. The very fact that active vultures purchase large

[16] An earlier draft found that in a sample of 63 bankruptcies from 1995–2000 in NY and AZ, secured creditors had worse recovery rates when they were less concentrated and when unsecured creditors were more concentrated. However, this is not the experiment that a test of our theory would demand. The data set is explored in more detail in Bris, Welch, and Zhu (2003).

blocks in financial distress, often from dispersed claimants, seems to indicate at least that the claimant's loss of bargaining power may not be drastic and/or outweighed by the creditors' gains from "undispersing" themselves.

In sum, although there is little evidence that directly relates creditor (claimant) concentration and coordination to the ultimate settlement (except that presented above in our paper), there is good evidence that creditors often coalesce in financial distress.

Concentration $\Longrightarrow$ More Social Waste. An implication of our model is that the total conflict waste is negatively related to creditor concentration. Total waste is the sum of expenses by both management (equity) and creditors. Collection activity is a purely redistributive activity in our model, but an empirical test would benefit from stripping firm value-enhancing activities from lobbying expenses.[17]

There are good alternatives suggesting the opposite implication: Creditor coalitions could be formed to avoid a "creditor run on the firm" and thereby enhance firm value. Like the relation between concentration and outcome, contrasting implications make this an interesting empirical test.

A second set of empirical implications of our model derives from the agency/signaling model, which embeds creditor concentration in an ex-ante perspective. Better (performing) firms can accept more in-bankruptcy waste, because bankruptcy is less likely—but only to the extent that firm quality is otherwise unknown. Therefore careful control of observable measures of firm riskiness (profitability, size, and credit quality) is important. The firm signaling perspective adds richer implications to those just described.

[17] Although we believe that financial contracts can be and often are written in a way to mitigate legal costs, there are instances in which claimants' priorities change unexpectedly. In such cases, one can get an indication of the (usually) out-of-equilibrium costs of litigation. Anderson (1987, p.442) describes the Manville asbestos experience, in which customers unexpectedly received priority over creditors in bankruptcy

> An Institute for Civil Justice–Rand Corp study estimates that for every dollar paid to injured claimants, nearly two dollars are spent on litigation expenses. More specifically, of the total amount paid by producers and insurers, 37 percent was received by plaintiffs, 26 percent by plaintiffs' attorneys, and 37 percent was spent by producers and insurers on defense costs.

Even though our model has situations in which (high-quality) issuers like higher litigation costs in order to deter low-quality issuers, a calibration of our model indicates that we would not expect to see such legal costs in equilibrium. Indeed, for the most part, our model predicts relatively moderate expenses and only some APR violations. The Manville experience is supportive of our argument only insofar as it indicates that out-of-equilibrium legal costs can be quite significant, and that observed legal costs may be small *by intent*, i.e., by choice of the mechanisms considered in our and other papers.

Unknown Firm Quality $\Longrightarrow$ More Creditor Concentration In the signaling model, the issuer knows quality *ex-ante*. In an agency model equivalent, the higher quality would arise endogenously via the firm's acceptance of debt with a "higher punishment" feature (fewer creditors). The most stark form of creditor concentration relies on only a single credit provider—typically a house bank—chosen by the borrowers needing to signal highest-quality.

Although James (1987), Cantillo and Wright (2000), Sudha, Spindt, and Subramaniam (1999) and Denis and Mihov (2003) provide evidence that larger, more profitable firms, and firms with higher credit quality borrow from public sources (dispersed creditors). However, this quality may be known and not require signaling. Indeed, Sudha, Spindt, and Subramaniam (1999) and Cantillo and Wright (2000), show that many firms with more growth opportunities tend to rely more on private debt *after controlling for profitability and size*, possibly to signal quality. This result is consistent with our implication of a positive relationship between I and $N^{\star}$.

A more suggestive empirical hint comes from the differential market reaction to the announcements of bank and public debt issues. James (1987) reports that the announcement of a bank loan agreement is associated to significant +1.93% abnormal return, while the announcement of a public debt issue results in an insignificant −0.11%. Although this is consistent with more active bank monitoring, it is also consistent with a positive information revelation when firms show that they are willing to put up with the more coordinated bank creditors.

Known Firm Quality $\Longrightarrow$ Less Creditor Concentration Naturally, firms that require sending no signal or that require no managerial discipline imposed by the financial markets can avoid the costs associated with higher creditor concentration.

Instead of signaling, the alternatives sketched in Section E can predict that firms with fewer creditors suffer from fewer agency conflicts, less bad termination choices, and lower marketing costs than firms with more creditors. However, one implication arises purely in a signaling context:

Extreme Creditor Concentration $\Longrightarrow$ Higher Expected Debt Yield Unlike in Bolton and Scharfstein (1996), creditor concentration and promised yields are strategic substitutes for firms with unobservable quality in our model. Because signaling with creditor concentration is cheaper than signaling with high-yield debt, our model suggests that bank (concentrated) debt is associated with lower yields than public debt. Denis and Mihov (2003) report that yields are higher for public debt (8.24%) than for bank debt (7.14%).

IV Conclusion

Our paper has reexamined the question posed in Bolton and Scharfstein (1996). We have taken an alternative approach to offer an intuition and a set of implications that differ from those of our predecessor—not in all, but in many respects. Thus, empiricists can test Bolton and Scharfstein (1996) against our own theory: Where different, mutual alternatives are preferable to the more common unspecified straw man.

We also believe it is appealing that creditor concentration is a relatively easily empirically accessible variable. When only one single creditor is present, this creditor is often a house bank, which implies that some of our implications can relate. (And bank credit generally tends to be relatively concentrated. A variant of our model offered the specific implication that even though promised yields on bank debt may be higher or lower than comparable public debt, bank debt may offer (single) banks excess rents.) But even among public creditors, concentration and coordination measures may be relatively easy to obtain. Admittedly, as we come closer to the spirit of our model—very small creditors that may not find it worthwhile to register—empirical measurement may become more difficult. Nevertheless, we believe that our theory can be put to the test in future empirical work.

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A Proofs

A Proof of Proposition 1: Equity value in Equilibrium.

The first statement is straightforward since $W^\star(N)$ is decreasing in N. The second statement follows because $W^\star(N)$ is decreasing in c_d and increasing in c_e. To show that $E^\star$ is decreasing in c_e for $c_e > \frac{X^2}{4 \cdot c_d \cdot N^{*2}}$, we can express $W^\star(N)$ as:

$$W^\star = c_d \left(\frac{L_d^{\star 2}}{N} \right) + c_e \cdot \frac{a \cdot d}{(b \cdot c_e + d)^2}$$

where $a \equiv 4 \cdot N^{\star 2}$, $b \equiv 4 \cdot c_d \cdot N^{\star 2}$, $d \equiv X^2$. The first term in the previous expression is decreasing in c_e. Defining:

$$Z^\star = c_e \cdot \frac{a \cdot d}{(b \cdot c_e + d)^2}$$

Then:

$$\frac{\partial Z^*}{\partial c_e} = \frac{a \cdot d \cdot (d - b \cdot c_e)}{(b \cdot c_e + d)^3}$$

which is negative if $c_e > \frac{d}{b}$

Finally, to show that $E^\star$is decreasing in X, note that we can express$W^\star(N)$ as:

$$W^\star = c_e \cdot \frac{y + a}{(y + b)^2} \tag{22}$$

B Proof of Proposition 2: Comparative Statics.

The comparative statics are determined by the incentive compatibility constraint to prevent low-quality firms' imitation. The sign of the implicit differentiated $(^{\partial N^\star}/_{\partial \cdot})$ is the opposite to the sign of $(^{\partial \mathsf{GFI}}/_{\partial \cdot})$. (Using the implicit function theorem, $^{\partial N^\star}/_{\partial \cdot} = -^{\partial \mathsf{GFI}}/_{\partial \cdot} / ^{\partial \mathsf{GFI}}/_{\partial N}$. Consequently, $sign(^{\partial N^\star}/_{\partial \cdot}) = -sign(^{\partial \mathsf{GFI}}/_{\partial \cdot})$.)

It is straightforward to show that V_{New} is irrelevant, because

$$\frac{\partial \mathsf{GFI}}{\partial V_{\text{New}}} = 0 \qquad \Rightarrow \qquad \frac{\partial N^\star}{\partial V_{\text{New}}} = 0 \tag{23}$$

Similarly, if V_{Old} is relatively high, high-quality firms need to raise little debt. Thus, imitation is relatively less attractive, and N can be larger. Formally,

$$\frac{\partial \mathsf{GFI}}{\partial V_{\text{Old}}} = \frac{\pi_G - \pi_B}{1 - \pi_G} < 0 \qquad \Rightarrow \qquad \frac{\partial N^\star}{\partial V_{\text{Old}}} > 0 \tag{24}$$

Thus, $N^\star$ increases when firms have more assets in place (V_{Old}).

If V_{Old} is high relative to I, high-quality firms need to sell little debt and prefer to simply wait instead. Thus, imitation is relatively less attractive, and N can be larger. Formally,

$$\frac{\partial \mathsf{GFI}}{\partial I} = \frac{\pi_B - \pi_G}{1-\pi_G} > 0 \qquad \Rightarrow \qquad \frac{\partial N^\star}{\partial I} < 0 \tag{25}$$

$N^\star$ decreases when firms have to raise more money to take the project (I).

To prove the last statements, let us first show that GFI is monotonically increasing in N.From equation 20, we can express GFI as:

$$\begin{aligned} \mathsf{GFI} \quad = \quad & \frac{\pi_G - \pi_B}{1-\pi_G}(V_{Old} - I) - \frac{\pi_G - \pi_B}{1-\pi_G} X \\ & + \frac{2 \cdot c_e \cdot K \cdot X^2 \cdot N \cdot \left[N \frac{\pi_G - \pi_B}{1-\pi_G} - \pi_G \frac{1-\pi_B}{1-\pi_G} \right] - B \cdot X^4}{\left[K \cdot N^2 + X^2 \right]^2} \end{aligned} \tag{26}$$

where $K \equiv 4 \cdot c_e \cdot c_d$, $B \equiv c_e \cdot \pi_B$. Differentiating with respect to N:

$$\begin{aligned} \frac{\partial \mathsf{GFI}}{\partial N} \quad = \quad & \frac{\left(2 \cdot c_e \cdot K \cdot X^2 \cdot N \cdot \frac{\pi_G - \pi_B}{1-\pi_G} - 4 \cdot c_e \cdot K \cdot X^2 \cdot N\right)\left(K \cdot N^2 + X^2\right)}{\left[K \cdot N^2 + X^2\right]^3} \\ & - \frac{4 \cdot N \cdot K \cdot \left(2 \cdot c_e \cdot K \cdot X^2 \cdot N \cdot \left[N \frac{\pi_G - \pi_B}{1-\pi_G} - \pi_G \frac{1-\pi_B}{1-\pi_G} \right] - B \cdot X^4\right)}{\left[K \cdot N^2 + X^2\right]^3} \\ > \quad & 0 \end{aligned} \tag{27}$$

because the second term in the expression is positive, and the first term is negative, as $\frac{\pi_G - \pi_B}{1-\pi_G} < 0$.

Now note that, when $X = 0$, then $\mathsf{GFI} = \frac{\pi_G - \pi_B}{1-\pi_G}(V_{Old} - I) > 0$. Moreover, for all $X > 0$, in equilibrium $\mathsf{GFI}^\star(N^\star(X), X) = 0$. Suppose that, in equilibrium, $\frac{\partial \mathsf{GFI}^\star}{\partial X} > 0$. Therefore, because GFI is continuous in X, and $\mathsf{GFI}(N^\star(X), 0) > 0$, there must exist $X_o < X$ such that $\mathsf{GFI}^\star(N^\star(X), X_o) = 0$. However, $\frac{\partial \mathsf{GFI}^\star}{\partial X} > 0$ and $\frac{\partial \mathsf{GFI}^\star}{\partial N} > 0$ imply $\frac{\partial N^\star}{\partial X} < 0$, and therefore $N^\star(X_o) > N^\star(X) \Rightarrow 0 = \mathsf{GFI}^\star(N^\star(X), X_o) < \mathsf{GFI}^\star(N^\star(X_o), X_o)$, which is absurd because $(N^\star(X_o), X_o)$ is an equilibrium. Therefore, it cannot be $\frac{\partial \mathsf{GFI}^\star}{\partial X} > 0$. Therefore, $\frac{\partial \mathsf{GFI}^\star}{\partial X} \leq 0 \Rightarrow \frac{\partial N^\star}{\partial X} \geq 0$.

The proof for π_G and π_B is similar to the previous one, noting that, when the difference between firm types tends to zero, we know that GFI could not be positive (N here can be finite):

$$\pi_B = \pi_G = \pi \Rightarrow \mathsf{GFI} = -\left(c_d \frac{L_d^{\star 2}}{N} + c_e L_e^{\star 2}\right) \cdot \pi \leq 0$$

Therefore, for $\mathsf{GFI}^\star = 0$, for $\pi_B > \pi_G$, it must be that the gains to imitation decrease in the probability of bankruptcy for the good firm ($\partial \mathsf{GFI} / \partial \pi_G < 0$), and increase in the probability that the bad firm goes bankrupt ($\partial \mathsf{GFI} / \partial \pi_B > 0$). After all, GFI is a monotonic function of N for $0 \leq \pi_B < 1$, $0 \leq \pi_G < 1$. Consequently

$$\Rightarrow \qquad \frac{\partial N^\star}{\partial \pi_G} > 0, \qquad \frac{\partial N^\star}{\partial \pi_B} < 0 \qquad , \frac{\partial N^\star}{\partial (\pi_G - \pi_B)} > 0 \qquad . \tag{28}$$

Finally, as c_d increases, the signal becomes more costly, and so does imitation. Therefore, the good firm separates with a lower N. Conversely, as c_e increases, debt needs to concentrate less in order to extract the same amount of disputed benefits X. Formally, when $c_e = 0$, $L_e^\star = 1$ and $L_d^\star = 0$, therefore $\mathsf{GFI}(c_e = 0) = \frac{\pi_G - \pi_B}{1-\pi_G}(V_{\text{Old}} - X - I) > 0 \Rightarrow \frac{\partial \mathsf{GFI}}{\partial c_e} < 0 \Rightarrow \frac{\partial N^\star}{\partial c_e} > 0$. To show $\frac{\partial N^\star}{\partial c_d} < 0$, note that $L_d^\star(1 - L_e^\star) = \frac{4c_e^2 c_d X N^3}{(4c_e c_d N^2 + X^2)^2}$, decreasing in c_d. Moreover, $\frac{\partial L_e}{\partial c_d} < 0$, $\frac{\partial L_d}{\partial c_d} < 0$, $\frac{\partial c_d L_d^2}{\partial c_d} < 0$, therefore $\frac{\partial \mathsf{GFI}}{\partial c_d} > 0 \Rightarrow \frac{\partial N^\star}{\partial c_d} < 0$.

C Proof of Proposition 3: Signaling With Debt Pricing and Concentration.

This appendix proves that the firm prefers to use only the number of creditors for signaling, if possible, and uses interest rate signaling only after bumping against the $N = 1$ limit. We need to modify eq. 11 to accommodate non-zero debt yields:

$$I \cdot (1+r) = \pi_G \left[\alpha^\star V_{\text{Old}} + (1-\alpha^\star)\cdot(V_{\text{Old}} - X) - c_d \cdot \frac{L_d^2}{N} \right] + (1-\pi_G)\mathsf{FV}^{\mathsf{NY}} \quad , \tag{29}$$

where the superscript NY on FV reflects the fact that the good firm uses both N and the debt yield as signals. Hence

$$\mathsf{FV}^{\mathsf{NY}} = \frac{I(1+r) - \pi_G \left[V_{\text{Old}} - (1-\alpha^\star)X - c_d \cdot \frac{L_d^2}{N} \right]}{1-\pi_G} \quad . \tag{30}$$

Separation will occur as long as $\mathsf{GFI}^{\mathsf{NY}} = 0$, where GFI is, from eq. 20:

$$\mathsf{GFI}^{\mathsf{NY}} = \pi_B \left[(1-\alpha^\star)X - c_e \cdot L_e^2 \right] + (1-\pi_B)\cdot(V_{\text{New}} + V_{\text{Old}} - \mathsf{FV}^{\mathsf{NY}}) - [V_{\text{Old}} - I + (1-\pi_B)V_{\text{New}}] = 0 \tag{31}$$

Substituting $\mathsf{FV}^{\mathsf{NY}}$ with his value:

$$\begin{aligned}
\mathsf{GFI}^{\mathsf{NY}} &= \pi_B \left[(1-\alpha^\star)X - c_e \cdot L_e^2 \right] \\
&\quad + (1-\pi_B) \left\{ V_{\text{New}} + V_{\text{Old}} - \frac{I(1+r) - \pi_G \left[V_{\text{Old}} - (1-\alpha^\star)X - c_d \cdot \frac{L_d^2}{N} \right]}{1-\pi_G} \right\} \\
&\quad - [V_{\text{Old}} - I + (1-\pi_B)V_{\text{New}}] \\
&= [X(1-\alpha^\star) + I - V_{\text{Old}}](\pi_B - \pi_G) - (1-\pi_B)rI \\
&\quad - \left[\pi_B(1-\pi_G)c_e \cdot L_e^2 + (1-\pi_B)\pi_G c_d \cdot \frac{L_d^2}{N} \right] \\
&= 0
\end{aligned} \tag{32}$$

Setting this expression to zero defines the signaling equilibrium $(N^\star, r^\star)$. Solving for $r^\star$ as a function of $N^\star$:

$$r^\star = \frac{[X(1-\alpha^\star) + I - V_{\text{Old}}](\pi_B - \pi_G) - \left[\pi_B(1-\pi_G)c_e \cdot L_e^{\star 2} + (1-\pi_B)\pi_G c_d \cdot \frac{L_d^{\star 2}}{N} \right]}{(1-\pi_B)I} \tag{33}$$

$r^\star$ depends on $N^\star$ through $\alpha^\star$, $L_d^\star$, and $L_e^\star$. Substitute the value of $r^\star$ into $\mathsf{FV}^{\mathsf{NY}}$:

$$\mathsf{FV}^{\mathsf{NY}} = \frac{I}{1-\pi_B} + \pi_B(1-\alpha^\star)X - \left(\frac{\pi_B}{1-\pi_B} \right)(V_{\text{Old}} + c_e \cdot L_e^{\star 2}) \tag{34}$$

Finally, substitute $\mathsf{FV}^{\mathsf{NY}}$ into the expression for E (from equation (16?)):

$$\begin{aligned} E^{\mathsf{NY}} &= \pi_G\left[(1-\alpha^\star)X - c_e\cdot L_e^{\star 2}\right] + (1-\pi_G)\cdot(V_{\text{Old}} + V_{\text{New}} - \mathsf{FV}^{\mathsf{NY}}) \\ &= \left(\frac{\pi_B - \pi_G}{1-\pi_B}\right)\left[c_e\cdot L_e^{\star 2} - X(1-\alpha^\star)\right] + (V_{\text{Old}} - I)\left(\frac{1-\pi_G}{1-\pi_B}\right) + (1-\pi_G)V_{\text{New}} \end{aligned} \quad (35)$$

In terms of entrepreneurial proceeds, the equilibrium $(\hat{N}, r = 0)$ dominates the equilibrium $(N^\star, r^\star \neq 0)$ defined in eq. 32. This is because E^{NY} increases with $\alpha^\star$, but is indendent of r. Thus, any equilibrium with both signals is dominated by an equilibrium of the type $(N, r = 0)$, as long the latter is feasible (i.e., does not run into the $N = 1$ constraint).[18]

When $N^\star = 1$: We now consider when N alone is not sufficient for the firms to separate (i.e., even with $N^\star = 1$). We now show that the firm needs to additionally increase the debt yield to induce separation. To characterize this equilibrium, let us define

$$\alpha^1 = L_{d,N=1}(1 - L_{e,N=1}) \qquad , \quad (36)$$

that is, the value of α when $N = 1$. In this case, the entrepreneur offers debt with face value such that:

$$I(1+r) = \pi_G\left[\alpha^1 V_{\text{Old}} + (1-\alpha^1)\cdot(V_{\text{Old}} - X) - c_d\cdot\frac{L^2_{d,N=1}}{N}\right] + (1-\pi_G)\mathsf{FV}^{\star\star} \qquad . \quad (37)$$

Because $N = 1$,

$$L^\star_{e,N=1} = \frac{X^2}{4c_e c_d + X^2} \qquad L^\star_{d,N=1} = \frac{2c_e X}{4c_e c_d + X^2}. \quad (38)$$

Solving for $\mathsf{FV}^{\star\star}$:

$$\mathsf{FV}^{\star\star} = \frac{I(1+r^{\star\star}) - \pi_G\left[\alpha^1 V_{\text{Old}} + (1-\alpha^1)\cdot(V_{\text{Old}} - X) - c_d\cdot\frac{L^2_{d,N=1}}{N}\right]}{1-\pi_G} \quad (39)$$

Therefore separation will occur as long as the bad firms find the gains from separation equal to zero.

$$\mathsf{GFI}^{\star\star} = \pi_B\left[(1-\alpha^1)X - c_e\cdot L^{\star 2}_{e,N=1}\right] + (1-\pi_B)\cdot(V_{\text{New}} + V_{\text{Old}} - \mathsf{FV}^{\star\star}) - [V_{\text{Old}} - I + (1-\pi_B)V_{\text{New}}] = 0 \quad (40)$$

The last two equations define $r^{\star\star}$ as a function of the parameters in the model, together with the condition that:

$$\mathsf{GFI} = \pi_B\left[(1-\alpha^1)X - c_e\cdot L^{\star 2}_{e,N=1}\right] + (1-\pi_B)\cdot(V_{\text{New}} + V_{\text{Old}} - \mathsf{FV}_{r=0,N=1}) - [V_{\text{Old}} - I + (1-\pi_B)V_{\text{New}}] > 0 \quad (41)$$

This equation states that $N = 1$ is insufficient to separate (profits from imitation are greater than zero). That is, separation with N only is not enough, even for $N = 1$.

It is also the case that signaling with $N = 1$ and $r^{\star\star}$ is preferred to signaling with r alone: From eq. 35, $E(1, r^{\star\star}) > E(\infty, r)$, where $E(\infty, r)$ is the value of equity when the firm optimally signals with r alone.

[18] The single-crossing property also assures us that the high-quality firm prefers to adhere to the equilibrium over pretending that it is a low-quality firm.

D Numerical Illustration of the Signaling Model

For easy checking, Table 1 contains some numerical values that help gathering intuition. We use as parameters $X = \$80$, $I = \$100$, $V_{\text{Old}} = 80$, $V_{\text{New}} = \$250$, $c_d = 10$, $c_e = 50$, $\pi_B = 0.5$, and $\pi_G = 0.4$. There is no particular reason to assume $c_d < c_e$ Note that, under full APR violation (which happens with probability $1 - \alpha^\star$), creditors are fully expropriated by equityholders.

In the non-signaling case, suppose there is only one type of firms, that is $\pi = 0.5$. The optimal solution is for the firm to set $N = \infty \Rightarrow \alpha^\star = 0$. The face value of the debt equals $\mathsf{FV} = \$200$, and $L_d = L_e = 0$. Profits to equityholders are $E^\star = \pi \cdot X + (1-\pi) \cdot (V_{\text{Old}} + V_{\text{New}} - \mathsf{FV}) = \$105$, which equals the full information value $V_{\text{Old}} + (1-\pi) \cdot V_{\text{New}} - I$ (after paying off creditors).

Suppose this was the bad firm ($\pi_B = 0.5$), and there is a good firm in the market, with $\pi_G = 0.4$ now. Its full information value would be \$130 (see Table 1). The high-quality firm prefers to have a lower number of creditors. Its optimal $N^\star$ solving eq. 25 is $N^\star = 1.37$ ($\simeq 1$). This is costly, because if the high-quality firm goes bankrupt, $L_d = 1.08$ (that is, $l_i = 0.79$ per creditor), $L_e = 0.63$, $W(N^\star) = \$28.40$, and $\alpha^\star = 0.30$. However, because the firm borrows from a fewer number of creditors, $FV = \$156.81$ (creditors know now that they will recover more in the bankrupt state). Consequently, the high-quality firm's equity value is $E^\star = \$118.63$. The difference between this amount, and the full information value of the good firm, \$11.36, is the signaling cost. Note that, by imitating the good firm, the bad firm would be worth

$$\pi_B \cdot [(1-\alpha^\star) \cdot X - c_e \cdot L_e] + (1-\pi_B) \cdot [V_{\text{Old}} + V_{\text{New}} - FV^\star] = \$105 \qquad ,$$

exactly its full information value. In equilibrium, there are no incentives for the bad firm to imitate the good firm. There is no need for the good firm to signal with the debt yield r, because we know, from Proposition 1, that signaling with creditor concentration alone is preferred.

Suppose instead that the good firm is in fact very good, and $\pi_G = \frac{1}{3}$. Thus, its full information value is \$147.25. As in the previous example, the optimal $N^\star$ solves eq. (25), and $N^\star = 0.4$. This is impossible, so the firm must set $N^\star = 1$. There would still be gains from imitation for the bad firm, because by imitating the good firm with $N^\star = 1$, the bad firm pays $\mathsf{FV} = \$144.98$, $\alpha^\star = 0.226$, $L_e = 0.76$, $L_d = 0.95$, and $\mathsf{GFI} = \$3.92$. The good firm needs to additionally increase the debt yield to $r^\star = 5.25\%$. Now $\mathsf{FV}^\star = \$152.83$, with $\alpha^\star = 0.226$, $L_e = 0.76$, $L_d = 0.95$. The higher face value restrain the bad firm from imitation, because imitation yields

$$\frac{1}{2} \cdot \left[(1-0.226) \cdot \$80 - \$50 \cdot 0.76^2\right] + \frac{1}{2} \cdot (\$80 + \$250 - \$152.83) \;=\; \$105 \qquad ,$$

exactly the full information value of the bad firm. For the good firm, however, separation yields

$$\frac{1}{3} \cdot \left[(1-0.226) \cdot \$80 - \$50 \cdot 0.76^2\right] + \frac{2}{3} \cdot (\$80 + \$250 - \$152.83) \;=\; \$127.62 \qquad .$$

This is still lower than its full information value \$147.25. The cost of signalling has therefore increased to \$19.62.

Table 1. Table of Symbols

Symbol	Explanation	Example
V_{Old}	Value of Assets in Place	$V_{\text{Old}} = \$80$
V_{New}	Value of New (Extra) Project in Non-Distress (Zero in distress).	$V_{\text{New}} = \$250$
V	$V_{\text{New}} + V_{\text{Old}}$	$\rightarrow V = \$330$
X	Amount that can be lobbied for in financial distress	$X = \$80$
I	Cost of Extra Project. $V_{\text{Old}} + V_{\text{New}} > I > V_{\text{Old}}$	$I = \$100$
π	Probability of Distress, generic	$\pi = 40\%$
π_G	(Signaling Game:) Probability of Distress for Good Firm.	$\pi_G = 40\%$
π_B	(Signaling Game:) Probability of Distress for Bad Firm.	$\pi_B = 50\%$
c_e	unit cost of lobbying for equity.	$c_e = 10$
c_d	unit cost of lobbying for debt.	$c_d = 50$
	Solutions in Signaling Model for High-Quality Firm	
L_e	Lobbying Effort by Equity (Management, Entrepreneur) for X.	$\rightarrow L_e^{\star} = 0.63$
L_d	Aggregate lobbying effort by all creditors for X.	$\rightarrow L_d^{\star} = 1.08$
l_d	Lobbying effort by a single creditors for X.	$\rightarrow l_d^{\star} = 0.79$
l_o	Lobbying effort by other creditors for X.	$\rightarrow l_o^{\star} = 0.29$
α $\equiv \alpha(L_e, L_d)$	Contest Success Function, allocation of X between equity and debt, depending on exerted lobbying effort.	$\rightarrow \alpha = 0.30$ $\alpha(0.63, 1.08)$
N	Number of Creditors (Endogenous Choice Variable).	$\rightarrow N^{\star} = 1.37$
E	Entrepreneurial Profit	$\rightarrow E^{\star}(N = 1.37) = 118.63$
FV	Debt Face Value	$\rightarrow \mathsf{FV}^{\star}(N = 1.37) = 156.81$
GFI	Gains from Imitation in Signaling Model (Full Information Value: \$130 $\Rightarrow$ Cost of Signaling: \$11.36	$\rightarrow \mathsf{GFI}^{\star} = 0$
	Side Conditions	
$(1-\pi)\cdot V_{\text{New}} \geq I$	The project is worthwhile.	
$X \leq V_{\text{Old}}$	Only a part of the firm value can be lobbied for.	
$N \in \{1, 2, 3...$	There are no negative or fractional creditors.	

Figure 1. In-Signaling-Equilibrium Regions

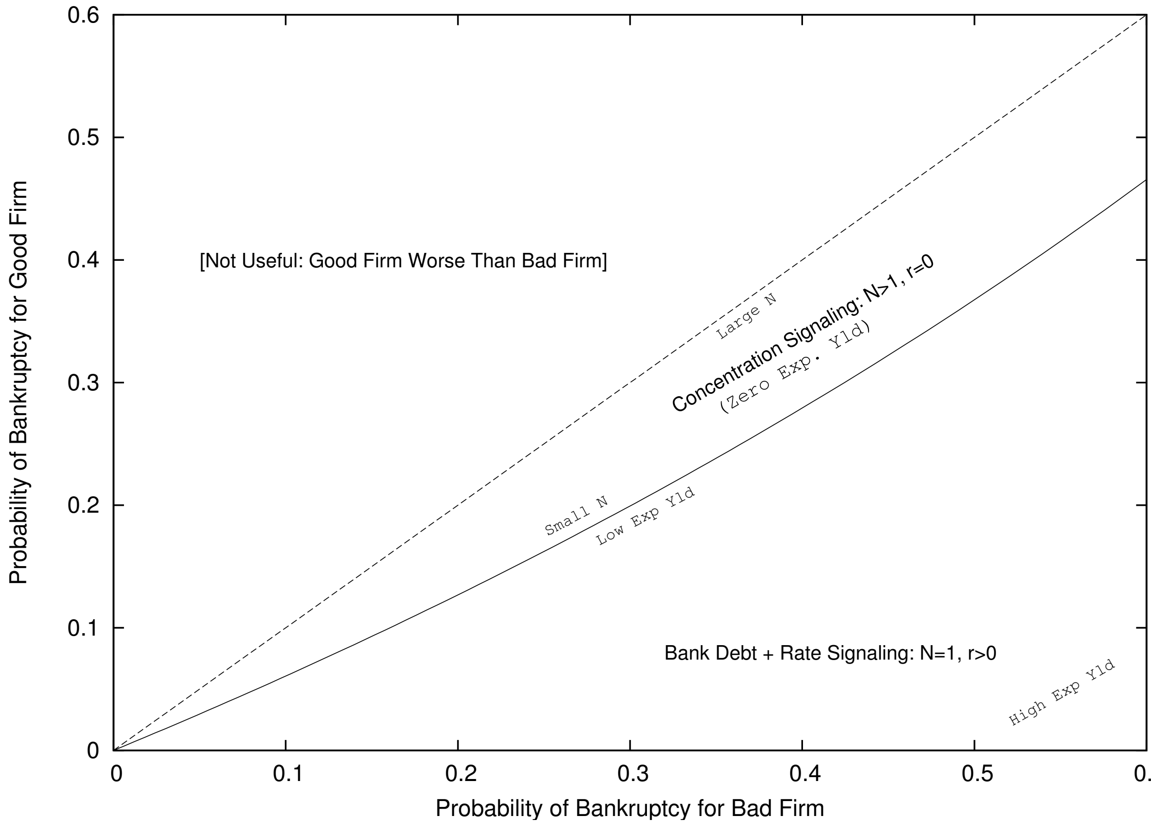

Figure 1 plots the regions in which signaling by creditor concentration alone signals creditor quality and in which signaling requires not only the ultimate concentration ($N = 1$, i.e., bankdebt), but also an expected interest above zero. The parameter values for this figure are as in our numerical examples: $V_{\text{Old}} = \$80, V_{\text{New}} = \$250, X = \$80, I = \$100, c_e = c_d = \$1$, and $\lambda = 1.5$. A positive interest rate is required when $\pi_g < {}^{2.33\pi_b}/_{4010-1680\pi_b}$. If $(1 - \pi_B) \cdot V_{\text{New}} < I$, i.e., when $\pi_B > 0.6$, the new project is not a positive NPV project.

Figure 2. Signaling Equilibrium Promised Yields

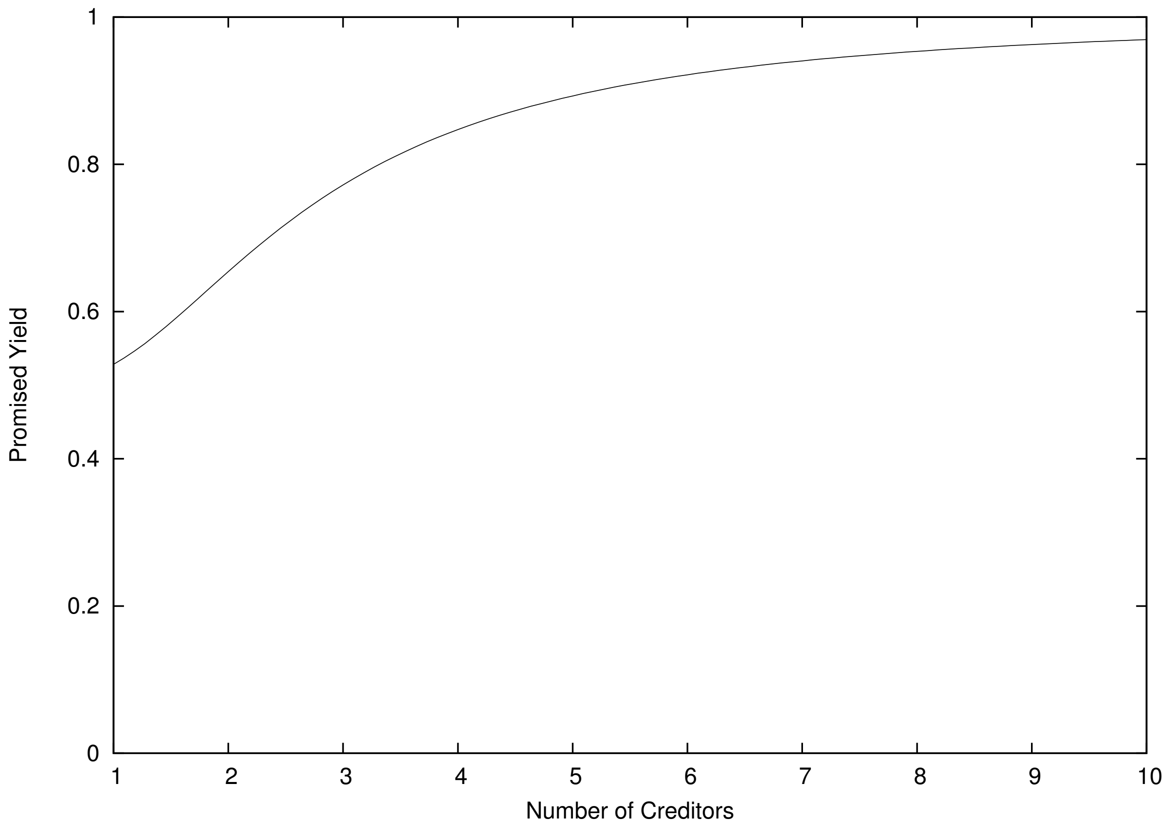

Figure 2 plots the *promised* rate of returns as a function of the optimal number of creditors. (To obtain different optimal number of creditors, we vary π_G. [Changing π_B would have the same effect.]) When $N > 1$, this is simply the yield required to offer creditors a zero expected rate of return. (For numerical convenience and to keep in-text computations easy to repeat, we are working with numbers that produce unrealistically high promised *one-year* yields.) The expected yield is always zero, except when $N = 1$. Not plotted: When $N = 1$, i.e., (house) bank debt, the *expected* yield can range anywhere from 0 to 45%. (The promised yield would thus be higher.)

Table 2. Comparison of Implications To Bolton and Scharfstein (1996).

Relationship	BS 1996	BW 2001
Creditor Concentration in Liquidations	⟵Helps Creditors⟶	
Creditor Concentration in Reorganizations	Undef	Helps Creditors more recovery
Concentration vs. Corporate Termination	Less Frequent	Undef
Concentration Vs. Promised Interest Rate	High or Undef	Low
Bank Debt Vs. Expected Interest Rate	Zero	Zero (or Positive)
Concentration Vs. Holdout (Time)	Negative	Undef
Concentration Vs. Creditor Lobbying Expenses	Undef	Higher
Concentration Vs. Lobbying Expenses of Firm	Undef	Higher
Concentration Vs. Total Lobbying Expenses	Undef	higher
Concentration Vs. Inefficient Outcome	Ambiguous	Higher (except with signaling)
Concentration Incentives for Creditors Ex-Post	Negative or Ambiguous	Positive
Lawyer Expenses	Maybe Uncover Value	Seek Rents
Public Debt vs. Known Firm Quality	Positive	Positive
Public Debt vs. Unknown Firm Quality	Undef	Negative

Note: Public Debt is assumed equivalent to highly dispersed debt. Bank Debt is assumed equivalent to highly concentrated debt.