Seniority and maturity of debt contracts

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This paper provides a model of how borrowers with private information about their credit prospects choose seniority and maturity of debt. Increased short-term debt leads lenders to liquidate too often. It also increases the sensitivity of financing costs to new information, although better-than-average borrowers desire information sensitivity. The model implies that short-term debt will be senior to long-term debt, and that long-term debt will allow the issue of additional future senior debt. The model also has implications on the structure of leveraged buyouts and on how various types of lenders respond to potential defaults.

1. Introduction

This paper provides a model of how highly-levered borrowers with private information about their credit prospects choose the seniority and maturity of their debt. The seniority and maturity of debt influence the terms that the borrower can offer to a competitive debt market when refinancing, and thus affect how the borrower is treated by lenders. The choice of debt contract controls two things that are important to borrowers: the ability of lenders to remove the borrower from control and the degree to which public information arriving in the near future influences the borrower’s cost of capital. The analysis assumes a competitive debt market and does not rely on any imperfections in reaching a renegotiated agreement between existing lenders. The main result is that short-term debt will be senior to long-term debt. In addition, the long-term

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debtholders will allow the issue of additional future debt even if it dilutes the
value of their long-term debt. [This finding extends Diamond (1991), where the
choice of short- and long-term debt for borrowers with control rents is examined
in a setting in which priority does not matter.] The model can be interpreted
either as the structure of an initial financing or as a refinancing in a leveraged
buyout. In fact, it is shown that many leveraged buyouts in the 1980s fit the
model.

Borrowers have private information and do not wish to choose debt contracts
which suggest that their credit rating will soon be lowered. As a result, bor-
rowers must use contracts that are desired by better-than-average borrowers,
unless they wish to reveal that they are worse than average. Short-term debt is
repriced based on new information when it is refinanced, which helps better-
than-average borrowers who, on average, receive an increased credit rating.
However, even a better-than-average borrower can receive unfavorable news. If
unfavorable news arrives, the borrower cannot repay the debt in full. The lender
can then remove the borrower from control by selling assets or replacing the
borrower with another manager (termed a liquidation). A greater proportion of
short-term debt in the capital structure makes this possible loss of control more
likely.

Liquidation has beneficial effects and ought not to be eliminated. Lenders,
however, are too prone to liquidate because they ignore that part of the future
return of a project that can accrue only to the borrower (the control rent). By
ignoring lost control rents, lenders can inefficiently choose to liquidate bor-
rowers that are illiquid but still solvent when control rents are included in the
solvency value. There are many interpretations of nonassignable control rents,
some of which are discussed in section 2. Basically, control rents exist if the
borrower has any future bargaining power, either because the borrower is
critical to running the firm or because he might take an unobserved action and
must be provided with proper incentives.1 For simplicity, control rents are
assumed to exist, without making them endogenous.

Making short-term debt senior and writing the junior long-term debt contract
so as to allow additional senior debt increases the sensitivity of finance costs to
new information for a given protection of managerial control. Making future
debt senior allows more short-term debt to be refinanced, reducing the amount
of long-term debt and yielding increased information sensitivity. The result that

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1The most obvious motivation for control rents is moral hazard. If outsiders receive 100 percent of
future cash flows, then management will not act properly if its interests conflict with those of
outsiders. The future cash flows that must be pledged to management to provide incentives cannot
be assigned to outside investors [see Diamond (1991)]. Similarly, if the manager cannot commit to
stay with the firm in the future, he will have bargaining power that puts a state-contingent floor on
the manager’s compensation [see Hart and Moore (1991)]. This future bargaining power could also
be possessed by the borrower’s workers and their unions.
borrowers prefer information sensitivity appears to depend on borrowers who have private information when they choose debt contracts. Similar results on information sensitivity arise when there is moral hazard. In the latter case, borrowers must be provided with incentives to take proper actions. For incentive purposes, desirable contracts lead to early punishment for borrowers who are downgraded and larger rewards for those who are upgraded in credit rating, suggesting that the model can apply even when private information about the credit rating is not present.

The structure of current debt contracts influences liquidation decisions, although the borrower and various lenders can freely renegotiate in the future. To simplify exposition and to show that the results do not arise from bargaining frictions between the initial lenders, it is assumed that one lender owns all of the initially-issued debt, both long-term and short-term (which is equivalent to assuming strip financing, with several initial lenders who each own the same portfolio of debt claims). If there are no constraints on bargaining, the outcome with a single initial lender is an equilibrium when different initial lenders own different debt claims. As with a single lender, multiple lenders maximize their collective payoff because they reach an efficient outcome. The decisions and the structure of debt contracts obtained are also an equilibrium when initial lenders own different claims, and no future renegotiation is possible.

The results are useful in reconciling two views of debt that might appear contradictory. The first is the dire consequences view, in which debt disciplines managers who take actions to avoid default because of the dire consequences to the manager if there is a default. The second is the efficient restructuring view, which suggests that if there are no impediments to restructuring debt, lenders will make concessions rather than liquidate or change management, provided they cannot find a management that is more competent. In other words, defaulting on debt will not lead to dire consequences if the current management is as capable as the best alternative, so that debt provides only weak discipline.

The existence of control rents makes debt provide more discipline, because lenders might remove the management from control, destroying the control rents, even when the current management is the best available. The implication is that default can have dire consequences. When there is a default, there is a bias favoring liquidation (asset sales or management change). However, if the borrower defaults, and the value of the future cash flows that can be pledged to investors exceeds the liquidation value, there will be efficient restructuring. The initial debt contract structure determines whether liquidation or restructuring is relevant in particular circumstances.

Borrowers who receive very low future credit ratings are liquidated; these are the insolvent borrowers. Other borrowers receive moderately low future credit ratings and are not liquidated. For these solvent-but-illiquid borrowers, it is in the existing lender’s interest to liquidate the borrower’s project, although the total economic value, including control rents, is higher without liquidation.
When these borrowers refinance with new competitive lenders, the value of existing (long-term) claims is diluted. There would be dire consequences of liquidation, but the debt is structured so that liquidation is avoided in this circumstance. The remaining borrowers receive high future credit ratings; they are able to refinance without diluting existing debt.

The model's implications about the structure of leveraged buyouts are presented in the conclusion. There are implications on debt priority and maturity, and predictions on the pricing of the various classes of debt. The model also predicts the type of debt restructuring expected to occur if a borrower experiences economic distress. The implications are consistent with the evidence in Kaplan and Stein (1991) and Asquith, Gertner, and Scharfstein (1991). Some related papers on the effects of debt structure on control are Aghion and Bolton (1992), Harris and Raviv (1990), Hart and Moore (1989, 1990, 1991), Jensen (1989), Jensen and Meckling (1976), and Titman (1984). Flannery (1986) examines the effect of debt maturity on information sensitivity. There do not appear to be any previous studies relating maturity and priority.

Section 2 presents the model with a single initial lender. Section 3 shows how debt contracts influence the lender's decision to liquidate. Section 4 examines borrower's preferences for debt contract structures. Section 5 describes debt renegotiation when there are multiple initial lenders. Section 6 examines callable and puttable debt and shows that the qualitative results are the same. Section 7 shows how the model's results depend on the ability of the borrower to refinance in a competitive market by contrasting with the results when the initial lender is the only source of refinancing. Section 8 shows that the equilibrium satisfies a well-known criterion for reasonable equilibria in games. Section 9 concludes the paper.

2. The model

The model incorporates three dates, 0, 1, and 2. Long-term debt is issued on date 0 and matures on date 2, with no coupon payment on date 1. Short-term debt is single period. Both types of debt can be used. The results do not depend on a zero-coupon assumption because only the total required payment on each date matters. The face value of short-term debt is then the sum of any required date-1 coupons and the value of date-1 maturing debt. To keep units simple, assume that riskless interest rates are zero. Borrowers and lenders are risk-neutral and consume on date 2. Lenders will then lend at an expected rate of return of zero. (To be concrete in a simple way, lenders are assumed to use a constant returns-to-scale investment technology that returns one per unit invested per period.) The model abstracts from unexpected changes in riskless interest rates. One interpretation is that the borrower hedges these changes using interest rate futures, options, or swaps. Because borrowers have no private
information about future riskless interest rates, they can hedge these risks without revealing any information about themselves.

There are many potential lenders who all observe the same information. As a result, borrowers face a competitive loan market on each date: lenders will lend if they get a competitive (zero) expected rate of return. On date 0, it is assumed that a single lender owns all maturities of debt then issued (which is equivalent to all date-0 lenders owning the same portfolio of debt issues), although section 5 shows that the results hold without this assumption if renegotiation is unconstrained. The borrower faces a competitive debt market at date 1, and the new date-1 potential lenders include many who are not date-0 lenders.

There is no outside equity: all equity is owned by the borrower (or more generally, by those in control). This assumption helps to focus on the effects of debt on transfer of control, thus avoiding consideration of takeovers as another way of transferring control. The debt contracts give the lender the right either to force liquidation of the borrower's project or to receive a claim on all of the project's unpledged future cash flow if a payment is not made in full. The contracts in the model resemble the structure of a leveraged buyout. It is assumed that the debt has no put or call options granted to either borrower or lender. (This assumption is relaxed in section 6, although the qualitative results remain the same.)

To focus on the refinancing risk of short-term debt, and the effect on the borrower's ability to retain control, projects are assumed to produce cash flows only on date 2. All short-term debt issued on date 0 must then be refinanced at date 1. On date 2, each project produces cash flows that can be assigned to lenders as well as a nonassignable control rent to the borrower of \( C > 0 \), provided that the borrower has control at date 2. (There is also, implicitly, a control rent associated with having control from date 0 to 1, but all borrowers who can borrow at date 0 get this. It is therefore a 'sunk benefit' and is not explicitly introduced.)

Borrowers have private information on date 0, i.e., they know the probability distribution of date-2 cash flows of their own investment project. Lenders do not have this information. Lenders receive additional public information about each borrower's project on date 1, although this information cannot be used in contracts because the information is not verifiable and is not observed by any court of law. The two types of projects are described as follows, where \( I \) is the initial investment:\(^2\)

**Type G.** The project returns a certain cash flow of \( X > I \) at date 2 and is thus a positive net present value project.

\(^2\)At a cost in complexity, the model's results can be derived assuming an arbitrary cash flow distribution where type-G distribution has first-order stochastic dominance over that of type B.
Type B. The project returns a cash flow of $X$ with probability $\pi$ and returns zero with probability $1 - \pi$. The project thus has a negative net present value: $\pi X < I$.

Borrowers know the type of their project on date 0. For example, a type-G borrower has a type-G project. Lenders know on date 0 that a borrower’s project is of type G with probability $f \in (0, 1)$. On date 1, all lenders will observe additional information about the type of each borrower. The new information, with realization $f_1$, is the conditional probability that a borrower is of type G. Given date-0 public information, $f_1$ is a continuous, unimodal, random variable, with unconditional density $H(f_1)$ and support $[0, 1]$. Type G’s are underrated by the market at date 0, and type B’s overrated. A type G expects that, on average, the date-1 information will be more favorable (expected $f_1 > f$ for a type G). Because higher values of $f_1$ are higher fractions of type G’s, the larger the signal $f_1$, the more likely that it is a type G that receives it. It is possible, however, that the realized date-1 information will be unfavorable ($f_1 < f$ is possible, even for a type G).

Hereinafter, $f$ will be referred to as the initial credit rating of a borrower and $f_1$ as the date-1 credit rating of a borrower. The probability that a borrower’s project will succeed (return $X$) on date 2, given a probability $f$ of being of type G, will be denoted by $q(f)$, where $q(f) = f + \pi(1 - f)$.

All projects can be liquidated at date 1 for a liquidation value of $L < I$ (partial liquidation is not possible). Liquidation value is the maximum value in alternative use of the assets [see Diamond (1991, sect. IV)]. A type-G project yields a higher return when not liquidated at date 1 because $L < I < X$. A type-B project yields a higher expected cash flow when liquidated because $L > \pi X$. Therefore, a lender will prefer to liquidate a project at date 1 for a sufficiently low value of $f_1$ (a sufficiently high probability that the project is of type B). For high values of $f_1$, the lender will not want to liquidate, but will instead prefer a sufficiently large claim on date-2 cash flow. The value to the borrower of retaining control until date 2, $C$, is large enough that there will never be voluntary liquidation when lenders do not have the control right to force liquidation, because borrowers would turn down any deal that lenders would offer. This disagreement about the desirable ex post liquidation policy is mediated by the choice of initial contract and assignment of control rights.

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3The density of date-1 credit ratings for a type G is $G(\tilde{f}_1) = \tilde{f}_1 H(\tilde{f}_1)/f$, while $H(\tilde{f}_1)$ is the density for the average borrower. This implies that the type G’s density function, $G(\tilde{f}_1)$, stochastically dominates that of the average borrower, $H(\tilde{f}_1)$, and that of type B, $(1 - f) H(\tilde{f}_1)/(1 - f)$.

4The lowest possible value of expected cash flow is $\pi X$ and liquidation yields $L$. Assuming that $C > L - \pi X$, then borrowers can never be bribed to voluntarily give up control. Without this assumption, borrowers might negotiate a deal to liquidate at date 1 independent of the debt structure.
One view of the control rents is that they represent the value of accumulated knowledge that can give the borrower an advantage over alternative management. As of date 0, only the borrower can undertake his project. As of date 1, the total return produced with the borrower as manager exceeds the return available from that project without the manager (without liquidation). The control rent is this difference between the return with and without the borrower, because there is no way to force the borrower to pay the excess to lenders: even replacing the borrower at date 1 or date 2 will not yield the control rent to lenders. If there is not a much better use for the assets, the borrower can keep control by pledging part of the future cash flow to lenders (if the lender has control at date 1, the borrower will be forced to pledge all of the cash flow, $X$, or be replaced). The only borrowers who are in danger of losing control at date 1 are those for whom the value of the assets in alternative uses exceeds the value of what can be pledged to lenders; such borrowers have date-1 credit ratings, $f_1$, below some number strictly less than one.

Borrowers want to choose contracts to allocate control and to influence how date-1 information affects the payments that lenders receive. It turns out that there are no contracts that separate type-B from type-G borrowers (see section 4). The result is that all borrowers choose the contract preferred by type-G borrowers (because otherwise a type-B borrower would be revealed and would not be able to raise capital). To protect control rents, type-G borrowers want less liquidation than lenders would choose. They do not want to eliminate liquidation, however. For very low future credit ratings ($f_1 \rightarrow 0$), the increased return received by lenders from liquidation, $L - q(f_1)X$, is large. In addition, given a future credit rating $f_1$, the borrower is of type G with probability $f_1$, and type-G borrowers care only about their own lost control rents (and not those lost by type B's). Liquidation given $f_1$ destroys expected type-G control rents of $f_1C$. By choosing contracts that lead to liquidation for low values of $f_1$, type-G borrowers reduce the finance costs of those who get high date-1 credit ratings (high $f_1$) and are not liquidated, which is preferable because the higher the future rating $f_1$, the higher the probability that the borrower obtaining it is of type G. The ex ante desirable contracts do not eliminate liquidation. They do not protect the insolvent ($f_1 \rightarrow 0$) borrowers, but generally do protect the solvent-but-illiquid borrowers by producing less liquidation than a lender would prefer.

Borrowers have no initial capital (they are liquidity-constrained), and lenders have capital. Borrowers must then raise initial capital of $I$ from lenders at date 0, choosing a mix of short- and long-term debt contracts. The contracts depend only on the amount that borrowers repay (repayments from issuing additional debt at date 1 are allowed). To avoid unneeded complexity, it is assumed that the borrower does not retain any claims that are senior to the debt contracts issued. (In section 6, it is shown that a borrower will not choose to retain any such senior claims.)
2.1. Debt contracts

Contracts that raise capital on date 0 can include required payments on date 1 and on date 2. Control over liquidation decisions can depend on the payment made: there will be liquidation only when the lender has control. To obtain date-1 liquidation for some values of \( f_1 \), but not for all values that the lender prefers, there must be a positive date-1 debt payment that allows the borrower to keep control. Let \( r_1 \) be the face value of short-term debt maturing on date 1. This is the required date-1 debt payment. Let \( \rho \) be the face value of zero-coupon long-term debt maturing on date 2. There is also a covenant in the long-term debt that restricts the amount and priority of new debt issues on date 1. The covenant constrains the amount that the borrower can pay a new date-1 lender when refinancing. Let \( Y \) denote the largest date-2 payment that the borrower can promise to new date-1 lenders (there will be long-term debt with face value \( \rho \) already in place). If \( r_2 \) is the face value of debt issued on date 1 and maturing on date 2, the constraint is \( r_2 < Y < X \).

If a borrower does not pay the amount specified in the debt contract, the old lender has the right to take control and either liquidate for \( L \) or take claim to the date-2 cash flow, in exchange for forgiving the short-term debt. The lender and borrower can renegotiate on date 1 the three terms that define initial debt contracts: \( r_1 \), \( \rho \), and \( Y \).

If the long-term debt prohibits debt that is senior to it, but places no other restrictions, then \( Y = X - \rho \), whether the initial long-term debt is junior or senior to the original short-term debt. Alternatively, if \( Y \) exceeds \( X - \rho \), the long-term debt allows some additional debt to be senior to it. Refinancing with \( r_2 > X - \rho \) dilutes the value of existing debt. At the other extreme, if the long-term debt limits future junior and senior debt, then the limit \( Y \) is less than \( X - \rho \).

The limit on new debt is an important part of the debt contract structure. Some debt contracts prohibit new senior debt. Others explicitly allow new senior debt, although sometimes with a limit in amount. Another way to allow new senior debt is to allow future debt issues to be collateralized, using collateral not previously pledged. The collateralized debt then has priority over existing unsecured debt [see Stulz and Johnson (1985)]. If new collateralized issues are prohibited, there is a complete negative pledge clause, prohibiting issues that are indirectly senior. [Allowing new senior debt has some additional effects on investment incentives (overinvestment versus underinvestment), as discussed in Hart and Moore (1990) and Berkovitch and Kim (1991).]

Another way for new debt to dilute the value of old debt is to allow the new debt to have the same priority as the old debt. The new debt is weakly senior to the old, because it dilutes the value of old debt whenever both receive less than the promised amount. Since there is only one positive realization of date-2 cash flow, the model cannot distinguish between dilution from allowing new senior
Debt and dilution from allowing sufficient new equal-priority debt, although this distinction is possible in a more general model with many date-2 cash flow realizations. In order for the results on weakly-senior debt to apply to strictly-senior debt, it is sufficient (but not necessary) for type-G borrowers’ projects to stochastically dominate those of type B (higher realizations have at least weakly higher probabilities than those of type B). It therefore seems useful to refer to contracts allowing $Y > X - \rho$ as allowing new debt to be senior, without stating that it is weakly senior.

If future short-term debt can be strictly senior to existing long-term debt, the initial short-term debt must be senior as well. If one adds more time periods and if future debt can be senior to long-term debt with $Y > X - \rho$, then long-term debt is, in effect, junior to short-term debt. The borrower would refinance the supposedly junior short-term debt with debt that is senior to the long-term debt, thus reducing the total face value of debt and increasing the borrower’s date-2 residual claim. If the short-term debt is senior, refinancing it with the same amount of debt senior to the long-term debt does nothing. In this case, the only way to dilute the value of existing long-term debt is to increase the total amount of debt above $X - \rho$. Debt contracts with $Y > X - \rho$ make short-term debt senior. Debt contracts with $Y \leq X - \rho$ have their original priority protected and can be of either initial priority.

3. Debt structures and liquidation decisions

Given the right to continue, borrowers never want liquidation at date 1, while lenders sometimes prefer liquidation. Projects deliver cash too late to repay date-1 maturing debt. Issuing additional debt to refinance is the only way to repay short-term debt and remove the lender’s right to liquidate. With a single initial lender (or when there are no bargaining frictions between multiple initial lenders), the effect of the initial date-0 debt contract structure is to determine how much debt must be refinanced and to constrain the terms that the borrower can offer to new competitive lenders when refinancing. Whenever the borrower can repay the short-term debt, liquidation will be avoided. The conditions under which the debt can be refinanced are developed below, first by describing the liquidation decision chosen by the lender when the debt cannot be refinanced.

When the borrower cannot repay all of the short-term debt with a new issue with face value $r_2 \leq Y$, the old lender can either liquidate the project for $L$ or take a total claim on future cash flow (including the long-term debt with face value $\rho$) or $X$, worth $q(f_1)X$. The lender chooses to liquidate when $L > q(f_1)X$ or when $q(f_1) < L/X$.

Equivalently, if the limit on new debt is $Y \geq X - \rho$ and liquidation is not in the lender’s interest [$q(f_1) \geq L/X$], the borrower can offer the old lender $q(f_1)Y$
at date 1 by selling new short-term debt with face value $Y$. The old lender will accept this offer in return for forgiving the short-term debt. If $Y < X - p$ (and even junior debt is restricted by the initial long-term bond) and liquidation is not in the lender's interest, the old lender will waive the covenant on new debt (increase $Y$ to $X - p$), and the borrower will be able to offer the old lender $q(f_1)(X - p)$ at date 1 and avoid liquidation. If liquidation is in the old lender's interest because $q(f_1) < L/X$, the old lender will not allow $Y$ to be increased. As a result, even if the old lender cannot extend the maturity of his debt, there is liquidation when date-1 debt is not repaid in full if and only if $q(f_1) < L/X$.

The borrower can raise up to $q(f_1)Y$ from new lenders on date 1. The old lender will have the right to take control when an amount less than $r_1$ is paid. The borrower will be able to refinance the date-1 maturing short-term debt without requesting an increase in $Y$ if and only if $r_1 \leq q(f_1)Y$ or $q(f_1) \geq r_1/Y$. There will therefore be no liquidation when $q(f_1) \geq r_1/Y$, because the borrower prefers to continue. Since it has been shown that when maturing debt is not fully repaid, liquidation is avoided if and only if $q(f_1) \geq L/X$, there will not be liquidation if $q(f_1) \geq \min\{L/X, r_1/Y\}$, and there will be liquidation otherwise.

When liquidation is avoided because the maturing debt is paid in full [$q(f_1) > r_1/Y$], the date-2 total face value of debt is $p + r_1/q(f_1)$, if this is less than $X$. If the maturing debt cannot be refinanced in full, but liquidation is dominated by continuation [$q(f_1) \geq L/X$], then there is liquidation, and the total face value of date-2 debt is $X$. Lemma 1 restates these results.

**Lemma 1.** A debt structure of short-term debt with face value $r_1$, long-term debt with face value $p$, and a limit $Y$ on payments to future debt issues leads to liquidation for all date-1 credit ratings, $f_1$, with repayment probabilities $q(f_1) = f_1(1 - \pi) + \pi$, less than the smaller of $L/X$ and $r_1/Y$. A borrower who avoids liquidation [$q(f_1) \geq \min\{L/X, r_1/Y\}$] has total date-2 debt payments equal to the smaller of $X$ and $p + r_1/q(f_1)$.

Lemma 1 shows how the debt structure influences both the liquidation decision and the effect of date-1 information on total date-2 debt when there is no liquidation. Full repayment of short-term debt requires $r_1 \leq q(f_1)Y$ or $q(f_1) \leq r_1/Y$. The ratio $r_1/Y$ determines the values of $f_1$ for which maturing debt can be fully repaid. Low values of $Y$ reduce the amount that the borrower can raise at date 1. Holding $r_1/Y$ constant, a lower value of $Y$ requires that additional long-term debt be issued (increasing its face value, $p$). The implied high value of $p$ and low value of $r_1$ make the cost of finance depend little on date-1 information $f_1$, because the cost of financing is the smaller of $X$ and $p + r_1/q(f_1)$.
3.1. All long-term debt

Although borrowers generally choose a combination of maturities, it is useful to begin by examining the effects of choosing either maturity alone. A contract of all long-term debt has \( r_1 = 0, \rho > 0, \) and \( Y = X - \rho. \) There is no required date-1 payment, implying no date-1 liquidation and no influence of date-1 information on date-2 debt payments. Based on date-0 information, a borrower repays long-term debt of face value \( \rho \) with probability \( q(f) = f(1 - \pi) + \pi, \) and pays zero otherwise. Raising initial capital of \( I \) requires long-term debt with face value \( \rho = I/q(f), \) if this does not exceed \( X. \) Because borrowers can repay at most \( X, \) the borrower cannot borrow long-term if \( I/q(f) \) exceeds \( X \) because the lender would receive a subnormal return.

Financing with exclusively long-term debt results in too little liquidation and has no sensitivity of finance cost to new information: type B and type G pay the same amount when not liquidated.

3.2. All short-term debt

A contract of entirely short-term debt has \( r_1 > 0, \) \( \rho = 0, \) and \( Y = X. \) If liquidation is avoided, the date-2 payment will be \( \min\{r_1/q(f), X\} \), which is worth at most \( r_1 \) on date 1. When there is liquidation, the lender will get \( L < I, \) implying that \( r_1 \geq I > L \) to induce a lender to lend \( I. \) As a result, there will be liquidation whenever \( q(f) < L/X, \) and date-2 payments will be \( \min\{r_1/q(f), X\} \) otherwise. Financing entirely with short-term debt results in more sensitivity of finance cost to new information than for any mix of short- and long-term debt, but allows the lender to liquidate whenever it is in the lender’s interest. If control is sufficiently valuable (\( C \) sufficiently large), there is a superior combination of debt contracts that reduces liquidation.

4. Borrowers’ desires

The maturity and priority structure of debt preferred by type-G borrowers is chosen by all borrowers. Type-G borrowers prefer some short-term debt; type-B borrowers would prefer all long-term debt, if the choice did not reveal information, but the choice of all long-term debt would reveal that a borrower was type B, and then no loan would be made. Section 7 discusses the reasonable borrower beliefs that support this outcome. Here, the preferred contract structure of a type-G borrower is analyzed, but these are the contracts offered by all borrowers; type-B borrowers receive nothing if their type is revealed, so that there are never any separating equilibria where B’s and G’s offer different contracts. The equilibrium satisfies the usual game-theoretic refinements used to verify that an equilibrium is reasonable.
To protect large control rents, type-G borrowers want less liquidation than lenders would choose, but they do not want to eliminate liquidation for very low values of date-1 credit rating, $f_i$. For higher values of $f_i$, for which the benefit to lenders from liquidation is small, the lost control rents of type-G borrowers exceed the lenders’ benefit from liquidation. This situation occurs when $f_i$ is just below that with $q(f_i) = L/X$ because the lenders’ gain from liquidation is $L - q(f_i)X$. Here, type-G borrowers prefer no liquidation because expected loss in type-G control rents equals $f_iC$. When control is sufficiently valuable, type G’s prefer less liquidation than lenders would desire. Moreover, for sufficiently large value of control, $C$, type G’s do not want all short-term debt. A mix of short- and long-term debt will be used, to control the lender’s right to liquidate. [When callable debt is allowed, borrowers choose some long-term debt when control value is greater than zero.]

From Lemma 1, a debt structure that avoids liquidation for a conditional repayment probability $q(f_i)$ below $L/X$ has short-term debt with face value $r_1/Y$ less than $L/X$, and leads to liquidation for all $q(f_i)$ less than $r_1/Y$. For example, setting $r_1$ equal to $\pi Y$ (and raising the balance of initial capital with long-term debt) would eliminate liquidation, because the debt could be repaid given the worst date-1 news [$f_i = 0$ and $q(0) = \pi$]. However, type G’s do not want to eliminate liquidation, implying that face value $r_1$ exceeds $\pi Y$.

Compare two debt structures that result in liquidation for the same set of date-1 credit ratings. Type-G borrowers prefer the one with payments that decline more rapidly in $f_i$, because they expect high values of $f_i$ (a type G’s distribution of $f_i$ stochastically dominates that of a type B). Contracts that have the same ratio $r_1/Y > \pi$ yield the same liquidation policy. A contract with higher values of both $r_1$ and $Y$ is better for type G. The optimal value of $Y$ is $X$, and all date-1 refinancing is senior to the existing long-term debt. Increasing $Y$ and $r_1$ raises more short-term funds, but yields the same amount of liquidation. For $q(f_i) > r_1/Y$, total date-2 payments to lenders are fixed at $X$ until $q(f_i)$ exceeds $r_1/(X - \rho)$, and then payments are equal to $\rho + r_1/q(f_i)$. Because the maximum $r_1$ that avoids liquidation is higher when $Y$ is higher, payments are more steeply decreasing in $f_i$. More of the initial capital can be raised short-term and less long-term. Fig. 1 shows total date-2 promised payments for debt contract structures with $Y = X$, with $Y = X - \rho$, and with a value of $Y$ between these two levels. The payment function with long-term debt that allows $Y = X$ crosses the function implied by $Y < X$ only once, and payments are lower for high $f_i$. Because type-G borrowers are the most likely to get high values of $f_i$, they prefer $Y = X$ to all other contracts; this structure is offered by all borrowers. Proposition 1 states this result.

**Proposition 1.** Borrowers who choose both maturities select senior short-term debt and junior long-term debt. The long-term debt allows new issues of debt that dilute its value or are senior to it on date 1, and the value of $Y$ is $X$. 
Proposition 1 describes the debt structure, but not the mix of the debt maturities. Proposition 2 provides the mix of short- and long-term debt contracts identified in Proposition 1.

**Proposition 2.** Borrowers choose all short-term debt if control rents, $C$, are sufficiently low or if liquidation (whenever it is in interest of the lender) is necessary for lenders to receive the required return on their capital, i.e., the project's net present value is near zero.

If the lender's required return can be met with liquidation occurring less often than the lender prefers, borrowers choose both short-term and long-term debt for sufficiently large control rents, $C$. The short-term debt must be fully repaid to avoid
liquidation, implying that when both maturities are used, short-term lenders never make concessions to avoid liquidation.

Proof. See the appendix.

If control rents are zero, then lenders do not liquidate too often, leading borrowers to choose all short-term debt to maximize the sensitivity of finance cost to new information. If control rents exist, but are small, then all short-term debt will still be the choice because there is a minimum required reduction in the face value of short-term debt needed to reduce the right to liquidate below that implied by all short-term debt; to reduce liquidation, the face value, \( r_1 \), must be less than the liquidation value, \( L \). A small increase in the probability of retaining control then requires a large reduction in information sensitivity. For sufficiently large values of control, \( C \), protecting control is worth the reduced information sensitivity. Borrowers always choose some short-term debt, to lead to information sensitivity and to produce liquidations for large downgrades (low \( f_1 \)). Evidence on the unwillingness of short-term lenders to make concessions when there is long-term debt is discussed in the conclusion.

If the borrower’s project has a net present value near zero, then raising capital requires that sufficient short-term debt be used, \( r_1 \geq L \), to give the lender the right to liquidate whenever it is in his interest. The borrower will choose all short-term debt, because further increases in \( r_1 \) do not influence liquidation, and the borrower’s goal is then to maximize the information sensitivity of the cost of capital. With all short-term debt, the lender will make concessions to avoid liquidation when the value of future cash flow, \( q(f_1)X \), exceeds \( L \) but is less than \( r_1 \).

The following corollary describes the effect of the magnitude of control rents and the amount of initial capital required on the mix of debt maturity. Increasing the initial capital reduces the net present value of the project.

Corollary 1. If both long-term and short-term debt are used, the fraction of short-term debt is a decreasing function of control rents, \( C \). For sufficiently large \( C \), if the total face value of debt \( (p + r_1) \) is less than the debt capacity, \( X \), then an increase in the amount that the borrower must raise, \( I \), decreases the fraction of funds raised short-term.

Proof. See the appendix.

Increased control rents make borrowers more concerned with protecting control at the expense of information sensitivity. An increase in required initial capital, \( I \), implies that the sum of funds raised in all maturities must rise. If protecting control is sufficiently important, the borrower will be more willing to sacrifice information sensitivity than control rents (and will generally sacrifice some of each). This result on the effect of increased \( I \) applies to a borrower who
has not exhausted his debt capacity. However, for projects with nearly-zero net present value (high value of initial capital, other things equal), the borrower will nearly exhaust his debt capacity. Once all of the cash flow is pledged to lenders when there is not liquidation, further increases in I must be financed by increased probability of liquidation, implying that marginal borrowers will use mainly (or exclusively) short-term debt. The implication that borrowers who have not used all of their debt capacity will use more long-term debt as I increases is consistent with results in Kaplan and Stein (1991) and is discussed below in the conclusion.

When both maturities are used, short-term debt is fully repaid whenever liquidation is avoided. Under the assumption that liquidation value is constant, short-term debt is also fully repaid when there is liquidation. In other words, the model predicts riskless short-term debt, with the amount of short-term debt adjusting to offset differences in borrower risk.

4.1. Nonconstant liquidation value

Suppose that instead of a constant liquidation value, L, the liquidation value depends on the date-1 information. Suppose that a project known to be of type B could be liquidated by selling it for \( L_B \) and a project known to be of type G could be liquidated by selling it for \( L_G \). On date 1, a given project can be sold for \( f_1 L_G + (1 - f_1) L_B \) because the lender and the buyers of the project believe that it is of type G with probability \( f_1 \).

Suppose that \( L_B > \pi X \) and \( L_G < X \), implying that it is in the lender's interest to liquidate only for sufficiently low \( f_1 > 0 \). Here, borrowers choose both short-term and long-term debt; the long-term debt is junior with \( Y = X \), and there is liquidation for a sufficiently low date-1 credit rating. However, the short-term debt will generally be risky, because for all \( r_1 > L_B \), the short-term debt is not paid in full for low values of \( f_1 \). For all \( f_1 \) for which there is no liquidation, the short-term debt is repaid in full. For \( f_1 \) leading to liquidation, the senior short-term debt is paid the smaller of \( r_1 \) and the proceeds of liquidation. The short-term lender generally receives less than \( r_1 \) for low values of \( f_1 \), but is paid in full given the highest values of \( f_1 \) leading to liquidation.

This generalization implies that the difference between two borrowers' risk will be only partly reflected in the difference in the risk and promised yield of their short-term debt. The remainder of the difference is reflected in the amounts that they raise in each maturity. Short-term interest rates are somewhat insensitive to differences in credit prospects, with higher-risk borrowers (those with lower \( f \)) who have not exhausted their debt capacity (total debt below \( X \)) choosing less short-term debt. As is true with constant liquidation value, if there is long-term debt, short-term debt will be fully repaid whenever liquidation is avoided. Short-term lenders will not make any concessions to avoid liquidation.
 Callable and puttable debt

A justification for examining noncontingent contracts, such as debt contracts, is that date-1 information is not verifiable by a court and cannot be written directly into contracts. Even with this restriction, borrowers or lenders can be given the right on date 1 to choose an alternative constant payment on date 1, or an alternative constant promised payment on date 2. If the borrower has this right, the contract is callable; if the lender has the right, the contract is puttable.

Callable debt improves on the straight debt contracts in this model, although puttable debt does not [this uses a well-understood benefit of callable bonds; see Robbins and Scratzberg (1986) and the references therein]. Callable debt allows the total cost of financing as a function of the date-1 credit rating to decline as rapidly as with all short-term debt whenever the total date-2 payment is below its maximum, X. This is accomplished by making the long-term bond callable at the price for which a noncallable bond would sell given the highest date-1 credit rating where the total date-2 face value of debt (long-term plus short-term) is equal to X. If called at this point, all of the firm's capital will be refinanced at date 1. This is the f₁ such that the short-term debt can be refinanced by an issue with face value of X - ρ. The power to force long-term lenders to take cash on date 1 helps borrowers who receive high date-1 credit ratings. Callable contracts are not useful if the borrower does not know the lender's information in time to choose whether to call at date 1, corresponding to a long notice period to implement a call.

Apart from making the long-term debt callable, the structure of the debt contracts is the same as before. The callable long-term debt allows additional debt senior to it, with limit Y = X. To avoid liquidation for all q(f₁) < θ, the face value of the short-term debt must be r₁ = θX. The callable long-term debt has the smallest face value, ρ, that raises I - r₁ with a call price of pr₁/(X - ρ). Fig. 2 compares the total debt payments as functions of q(f₁), for callable and noncallable long-term debt that lead to liquidation for the same date-1 credit ratings.

It is not useful to give the lender the right to put the debt back to the borrower at a constant put price. Avoiding liquidation that is in the old lender's interest then requires that the constant proceeds from putting the bond back to the borrower, plus the value of any other date-1 maturing claims of lenders, be less than the proceeds from liquidation, L. Otherwise, the lender can force liquidation whenever the project is worth less than L. For a given liquidation policy, puttable debt cannot make the cost of capital decrease in a more rapidly than short-term debt plus callable long-term debt. The best puttable debt contract is equivalent to short-term debt, because it should be callable, and will be called whenever it is not put back to the borrower. To avoid liquidation, the borrower must refinance to raise funds to repay debt that is put at date 1, plus any date-1 maturing debt. This requires that there also be a second long-term debt contract for that is not puttable, is junior to the puttable debt, and allows issues senior to it with Y = X.
Callable debt contracts allow increased information sensitivity when there is not liquidation, and provide the amount of control protection desired by type G's. A sufficiently large positive value of control rents, C, is required for a borrower to choose some noncallable long-term debt. Any positive value of C is sufficient to lead to some callable long-term debt, except in the case in which all liquidation that is in the lenders’ interest is needed to provide lenders a normal rate of return.

Some contracts that would improve on callable debt, but which are not explicitly considered in this paper, are claims with contingencies that depend on the date-1 market prices of claims on the firm. Most such claims will allow contracts equivalent to those directly contingent on the information $f_1$, as in Diamond and Verrecchia (1982). Payment and liquidation can then depend directly on $f_1$, implying no need to allocate control. Ruling out these contracts draws a distinction between getting information by measuring how much money the borrower can raise (which this paper allows) versus the requirement

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I thank Martin Hellwig for raising the issues discussed in this paragraph.
of a centralized exchange where one can obtain competitive price quotes that cannot be manipulated by the borrower or the lender (raising some interesting questions about contract design that go beyond the scope of this paper). This paper also rules out the ability for the firm to create a simulated market for its claims by requiring contingent future contracts with third parties who could create all possible claims contingent on whether the borrower repays debt on date 2 [one could view this as a generalization of Maskin (1992)]. The ability for competitive lenders to create such claims and to require their creation by competitive lenders in the future can potentially replicate complete contracting on date-1 market prices [see Ross (1976)].

The role of refinancing is not to produce a verifiable signal for complete contracting. To clarify the role of refinancing, the next section shows the importance of allowing access to competing new lenders. It contrasts the case of a single lender with a monopoly on lending.

6. The role of competing new lenders

When liquidation is in the existing lender's interest, the only way to avoid liquidation is for maturing debt to be fully refinanced, removing the lender's right to liquidate. If the borrower can get a new lender at date 1 to lend enough to repay the short-term debt, the preferences of the existing lender are not relevant. The borrower has the right to continue when the lender has no right to liquidate. The borrower prefers to continue and can contract with any lender at date 1. This competitive outcome is the limit of an implicit game of coalition formation. If the borrower were to offer slightly above a normal return to a new date-1 lender, the new lender would get a small profit. To deter every lender from making the small profit, the existing lender would need to pay this small amount, $\epsilon > 0$, to each potential lender. There are many potential lenders ($N \to \infty$), and the existing lender cannot bribe them all (at cost $\epsilon N$) to prevent each from making a profitable loan. At the limit, where $\epsilon \to 0$, the competing new lenders get a normal rate of return. This competitive limit is not critical. The ability to go to a set of new lenders is the key; it allows the borrower to retain control for a sufficiently high date-1 credit rating, $f_1$, because the amount raised in refinancing is increasing in $f_1$.

If, instead, the initial lender were the only source of funds at date 1, these contracts would not protect the borrower from liquidation. An initial lender would not advance funds that dilute the value of his claim. With a monopolist lender, only inferior contracts are available. The best available contracts with a monopolist lender involve the borrower retaining a claim senior to the lender. Understanding why these are inferior is useful because it also explains why such contracts are not used when the borrower can refinance in a competitive market.
When the only source of funds for refinancing is the old lender, the only way to influence the liquidation decision without eliminating liquidation is to affect the lender's incentive to liquidate by limiting the lender's access to liquidation proceeds. The lender can reach a deal with any other party who has the right to claim part of the liquidation proceeds. The only way to keep the lender from getting all of $L$ when liquidating is to assign part of it to the borrower through the borrower's retaining a claim that is senior to the lender. Let the borrower's senior claim be denoted by $z$. If there is liquidation, the lender then has a claim on $L - z$. The borrower is free to waive his senior claim on date-2 cash to avoid liquidation at date 1. As a result, liquidation will be avoided whenever the value of future cash flow exceeds $L - z$, or $q(f_1) \geq (L - z)/X$. The senior claim retained by the borrower serves as a golden parachute when there is liquidation and deters liquidation.

The senior claim owned by the borrower requires that lenders provide some proceeds of liquidation to the borrower, which influences liquidation because the payment to the borrower makes lenders internalize some of the borrower's lost control rents when they liquidate. From a type-G borrower's point of view (and for all borrowers who wish to avoid revealing another type), this method of implementing a given liquidation policy is inferior. Compare the contract to one described in Proposition 1, in which the borrower retains no senior claim, but which leads to an identical liquidation policy. The contract in which the borrower retains a senior claim, $z > 0$, decreases net payments made by downgraded borrowers (with low $f_1$), and then must increase payments made by the upgraded borrowers (with high $f_1$). Only type-B borrowers prefer this. As a result, borrowers do not offer a contract with a senior claim retained by the borrower when they can refinance. If there is no ability to refinance from a competitive market, such a contract is the best available. This discussion illustrates one reason that borrowers prefer to deal with several sources of funding, rather than tie themselves to a single source.

7. Renegotiation

With a single initial lender, there is no scope for negotiation between existing lenders. The initial lender considers the entire portfolio of claims when dealing with the borrower. If there are no impediments to bargains between equally-informed lenders, the results with a single initial lender apply when there are several initial lenders who own differing proportions of the two maturities. The lenders reach a deal that maximizes the combined value of their claims. For example, if either of the two classes makes a take-it-or-leave-it offer to the other, a deal will be reached that maximizes the sum of the value of the lenders' claims. Alternatively, if there is a known cost of delay in bargaining between the two parties, they will reach a value-maximizing outcome without delay [see
Rubinstein (1982)]. The relative costs of delay to the two parties will determine the bargaining power, but will not cause lenders to make decisions against their collective interest: they will maximize their joint value (the details of this assertion are very standard).

The results also apply with many types of imperfect renegotiation. Diamond (1992a, b) studies imperfect renegotiation and gives additional reasons why short-term debt is senior to long-term debt. Here, it is shown why perfect negotiation is not needed when short-term debt is senior to long-term debt. When control rents are high, the best debt contracts lead to liquidation if and only if maturing short-term debt cannot be refinanced. When the borrower can fully refinance the maturing short-term debt, no lender has control rights and no renegotiation is needed. When the senior short-term debt cannot be refinanced, the short-term lender will choose to liquidate without renegotiation. The senior short-term lender receives all of $L$ when the debt cannot be refinanced. Continuation yields the lender no more than all of the future cash flow, or $q(f_1)X$. The short-term lender will then liquidate when not fully repaid, and the debt is structured so that this occurs only when liquidation is strictly more valuable than continuation. Renegotiation is not needed, because long-term debt will be diluted without its consent.

Note that the discussion of renegotiation does not impose restrictions from the bankruptcy laws. For example, the law in the United States gives the borrower the exclusive right to propose reorganization plans for a period after the bankruptcy filing. If operation in bankruptcy is costly, the borrower then has the right to impose costly delays on the lenders, giving the borrower bargaining power up to the costs of delay that can be imposed. The borrower thus has a senior claim on future returns or liquidation proceeds equal to the delay costs that he can impose. In the previous section it was shown that it is undesirable to provide the senior claim to the borrower, if competitive access to refinancing is available. The senior claim helps bad borrowers at the expense of good borrowers. Giving the borrower an implicit senior claim increases the use of short-term debt.

8. Lenders' beliefs about borrower type by contract chosen

This (technical) section describes the inferences that lenders make from off-equilibrium path actions that support the equilibrium analyzed above, and presents another (uninteresting) equilibrium in which no one ever borrows long-term. The goal of this section is to demonstrate that the equilibrium studied above is reasonable.

The equilibrium analyzed has all borrowers choosing the least-cost form of debt for a good borrower (a type $G$), where the good borrower makes the choice using a calculation which assumes that any structure of long-term and short-term debt is available, with date-0 debt priced using the date-0 credit rating, $f$, of
a borrower, instead of using a complicated inference about the type as a function of the choice made. This equilibrium is referred to as the \textit{cost-minimizing equilibrium}. Offering a contract for which there exists an alternative contract that, under the calculation, makes type G's better off and type B's worse off, is interpreted as indicating a type-B borrower, to whom no one would lend. If no such alternative contract exists, then lenders infer that the conditional type distribution is given by the credit rating $f$.

An off-equilibrium action is the choice of a maturity mix that no one offers. One should be sure that a given maturity is not off-equilibrium only because lenders are anticipated to make an unreasonable inference from its selection. The criterion used to rule out unreasonable inferences of lenders from off-equilibrium actions is the equilibrium dominance criterion of Cho and Kreps (1987) which rules out inferences from nonequilibrium actions that a particular type took an action that makes it worse off than its equilibrium action.

\textbf{Lemma 2.} The cost-minimizing equilibrium analyzed in the text satisfies the Cho–Kreps equilibrium domination criterion. Another equilibrium that satisfies the criterion is for borrowers of all credit ratings to issue only short-term debt, independent of the level of control rents, $C$. No separating equilibrium exists.

\textbf{Proof.} See the appendix.

The other equilibrium, in which all borrowers borrow with an identical maturity independent of the magnitude of control rents or date-0 credit rating, is less interesting because it has no cross-sectional predictions about maturity structure: all debt is predicted to be short-term. It is supported by the belief that only type-B borrowers would borrow at the off-equilibrium maturity, analogous to an autarchy equilibrium in a model of trade, where no one produces goods for other than their own consumption because all expect others to do the same.

\textbf{9. Conclusion}

The key implication of this model is that short-term debt is senior, with long-term debt that allows additional debt to dilute its value. Making short-term debt junior would reduce the amount of debt that can be refinanced in the future. Borrowers want to refinance as much capital as possible, subject to keeping control more often than lenders prefer to let them keep control, which is a key reason that, in practice, shorter-term debt is senior to longer-term debt (in the limit, equity is both most junior and longest-term).

The data on leveraged buyouts (LBOs) can be matched with the model's implications. LBO data are appropriate because an LBO involves no public outside equity and has the simultaneous selection of an entire debt structure. In
Particular, management buyouts (LBOs initiated by existing management) fit the model, because an incumbent manager with private information about the firm's prospects chooses the debt structure.

The data on the structure of leveraged buyouts in the middle-to-late 1980s appear consistent with the predictions on seniority of new debt. The 1989 First Boston High Yield Handbook describes the structure of the public junk bonds of the major deals. All of the 1986 deals allowed some new senior debt, and three of the five large deals that year allowed unlimited senior debt. Bank debt was the most senior claim in each case. Later 1987 and 1988 deals limited additional senior debt issues. Nearly all allow some significant amount of new senior debt to be issued after the sale of public junk bonds. The public junk bonds were of longer maturity than the bank loans, and many were zero-coupon 'payment in kind' bonds.

The empirical results in Kaplan and Stein (1991) support two other implications of the model. They show that in LBOs in the 1980s there is great homogeneity of interest rates on short-term debt across borrowers of differing total risk. This finding is predicted by the model because the mix of short-term debt will adjust to partly offset differences in risk across borrowers. Second, Kaplan and Stein argue that increased competition for the right to undertake a leveraged buyout in the late 1980s required that borrowers raise more from given future cash flows, which corresponds to an increase in required initial capital, I, in this model. They note that in the late 1980s the amount raised increased compared to current cash flow variables, and they find an accompanying increase in the fraction of long-term debt used in LBOs. The model predicts that an increased fraction of long-term debt will be used to preserve control.

The model suggests that a short-term lender's decision to make concessions outside of bankruptcy court depends critically on the structure of the borrower's obligations. For borrowers who use both long-term and short-term debt, short-term lenders will not make concessions when the borrower cannot repay in full, and the interest rate on short-term debt will differ by less than the difference in the default risk of their total debt structure. This result follows from the requirement that maturing short-term debt be fully repaid whenever the borrower avoids a liquidation that is in the lender's interest. For sufficiently large control rents, an increase in the amount that a given borrower must raise implies an increased fraction of funds raised long-term. If, instead, only short-term debt is used (in practice, this will be only short-term bank loans), the implications are different. The short-term debt will be risky. The short-term lender will sometimes make principal or interest concessions if the borrower gets into financial distress and the debt cannot be fully repaid, but only if liquidation yields less than making a concession.

Asquith, Gertner, and Scharfstein (1991) provide some empirical support for the prediction that short-term lenders will not make concessions outside of bankruptcy when there is long-term debt in place. They also find that the
short-term lenders who delay defaults do so by diluting the value of junior claims. They do not measure maturity directly, but compare bank loans to public debt. In practice, bank loans are senior and shorter-term. The firms in their sample all have substantial amounts of long-term debt, because they examine junk bond issuers only. They find that for borrowers in economic distress [Asquith, Gertner, and Scharfstein (1991, p. 1)]:

'Outside of bankruptcy proceedings, banks almost never (there is one exception) forgive principal on their loans and they rarely provide new financing. (Banks) often waive covenants and defer principal and interest payments, but they also often force accelerated payments and increase their collateral.'

These results are in line with the predictions of the model. They do not imply that banks force bankruptcy or liquidation too often. The model suggests that the mix of long-term public debt and short-term bank debt is set such that the bank can continue to make low-risk loans, or extend maturity, over a range of credit ratings for which lenders prefer liquidation. When the bank is unwilling to continue to extend maturity, the model suggests that liquidation (including asset sales or other managerial restructuring) is in the interest of outside investors.

Appendix

Proof of Proposition 1

A type-G borrower chooses a debt structure to maximize the expected cash flows and control rents he receives, minus the required payments to lenders. Lenders require payments that give them a normal expected return on their investment.

For a fixed value of date-1 information, \( f_1 \), such that there is no liquidation, the borrower's payoff, \( \Psi \), is the value of cash flow plus control rents (\( X + C \)), minus the total date-2 payment to lenders implied by \( f_1 \). For values of \( f_1 \) that lead to liquidation, the borrower's payoff is zero. I choose a contract to minimize the expectation over \( r_1 \) of the function \( \Theta(f_1) = X + C - \Psi(f_1) \), which is equivalent to maximizing the expectation of the payoff, \( \Psi \). The interpretation of \( \Theta(f_1) \) is that it is the opportunity cost to a type G of providing a return to lenders: the cost is \( X + C \) and the return is \( L \) when there is liquidation, and both cost and return are equal to the total date-2 payment to lenders otherwise.

Define \( q_1 \equiv q(f_1) \). From Lemma 1, there is a number \( q_1 = \min\{r_1/Y, L/X\} \) such that there is liquidation for all \( q_1 < q_1 \). For all \( q_1 \geq q_1 \), there will not be liquidation. For \( q_1 \geq r_1/Y \), the maturing debt is fully repaid, implying that the total date-2 payment by the borrower is \( \rho + r_1/Y \) if \( q_1 \geq r_1/(X - \rho) \equiv q_1 \), and the total payment is \( X \) if \( Y > X - \rho \) and \( q_1 \in [r_1/Y, q_1] \).
If \( r_1/Y > L/X \), then \( q_1 < r_1/Y \) and for some \( q_1 \) maturing debt is not fully repaid at date 1, but liquidation is avoided because \( L < q_1X \). Here, there is an additional region of \( q_1 \) values for which the total date-2 payment is \( X \); for \( q_1 \in [L/X, r_1/Y) \) the total date-2 claim owed by the borrower will be \( X \) (the lender takes the larger claim rather than liquidating).

In summary, for \( q_1 \in [\hat{q}_1, q'_1] \) the total date-2 payment is \( X \), and for \( q_1 > q'_1 \) date-2 payment is \( \rho + r_1/q_1 \). It is useful to work with values of \( f_1 \) rather than \( q_1 \). One can obtain \( f_1 \) from \( f_1 = (q_1 - \pi)/(1 - \pi) \). I refer to \( \hat{f}_1 \) as the value of \( f_1 \) such that \( q(f_1) = q_1 \), etc.

In the type G's objective function, the total face value of date-2 debt is the cost of financing when liquidation is avoided. In the lender's expected return constraint, for given \( f_1 \), the expected return is the total face value of date-2 debt times \( q(f_1) \).

Let \( H(f_1) \) be the unconditional density function of date-1 credit ratings received by a borrower of unknown type (with date-0 credit rating \( f \)). Let \( G(f_1) = f_1H(f_1)/f \) be the density function of date-1 credit ratings received by type-G borrowers.

A type G chooses a debt structure to solve:

\[
\min_{Y \leq X, r_1 \geq 0, \rho \geq 0} \Theta \equiv (X + C) \int_0^{\hat{f}_1} dG(f_1) + X \int_{\hat{f}_1}^{f'_1} dG(f_1) \\
+ \int_{\hat{f}_1}^{f_1} \left[ \rho + \frac{r_1}{q(f_1)} \right] dG(f_1),
\]

subject to

\[ L \int_0^{\hat{f}_1} dH(f_1) + X \int_{\hat{f}_1}^{f'_1} q(f_1) dH(f_1) + \int_{\hat{f}_1}^{f_1} \left[ \rho + \frac{r_1}{q(f_1)} \right] q(f_1) dH(f_1) \geq 1 \]

(Lender's expected return), where \( q(f_1) = f_1(1 - \pi) + \pi \),

\[ \hat{f}_1 = \max \left\{ 0, \min \left[ \frac{r_1/Y - \pi}{1 - \pi}, \frac{L/X - \pi}{1 - \pi} \right] \right\}, \]

and

\[ f'_1 = \min \left\{ \frac{r_1/(X - \rho) - \pi}{1 - \pi}, 1 \right\}. \]

I want to show that the optimal value of \( Y \) is \( X \), which implies that the long-term debt is junior to the debt issued at date 1. First consider \( r_1 < L \), implying that liquidation is limited by the ability to fully repay maturing short-term debt, and \( \hat{f}_1 = (r_1/Y - \pi)/(1 - \pi) \). Hold a fixed value of \( r_1/Y \), implying a fixed \( \hat{f}_1 \), and increase both \( r_1 \) and \( Y \). The returns to the borrower and to lenders
as a whole are the same when \( f_1 < \tilde{f}_1 \), implying that both the objective function, \( \Theta \), and the expected return constraint are functions only of total debt face values given \( f_1 > \tilde{f}_1 \). Let the function \( Z \) denote the total date-2 face value of debt given \( f_1 > \tilde{f}_1 \): \( Z(f_1; r_1, \rho, Y) = \min\{X, \rho + r_1/q(f_1)\} \), increasing in \( r_1 \). To hold the expected return to lenders given \( f_1 > \tilde{f}_1 \) constant, \( \rho \) must fall sufficiently to allow \( Z(f_1; \bullet) \) to be lower for some \( f_1 \) than with the lower values of \( r_1 \) and \( Y \). Let \( Z^+ \) denote the payment schedule with higher \( r_1 \) and \( Y \) (and lower \( \rho \)), let \( Z^- \) denote the schedule with lower \( r_1 \), etc. If for some \( j^* \), \( Z^+(f^*) < Z^-(f^*) \), then for all \( f_1 > f^* \), \( Z^+(f_1) < Z^-(f_1) \), and these relations also hold for weak inequality. There is a single crossing point for the two schedules, and \( Z^+ \) with the higher \( Y \) leads to lower payments for higher \( f_1 \) (see fig. 1). If the two schedules provide the same expected return to lenders [they integrate to the same number when integrated with respect to \( q(f_1) H(f_1) \)], they reduce \( \Theta \), the cost to a type G of providing this return, because the type G integrates the same face values with respect to \( G(f_1) = \left[ f_1/q(f_1) f \right] q(f_1) H(f_1) \), and \( f_1/q(f_1) f \leq 1 \) and is increasing in \( f_1 \), implying that the objective function places more weight on the payments made given high date-1 credit ratings (because type G's are more likely to get those ratings).

Because increasing \( r_1 \) and \( Y \), given \( r_1/Y \) and the expected return of lenders, makes type-G borrowers better off, the optimal value of \( Y \) is \( X \), its maximum value, if \( r_1 < L \).

If, instead, \( r_1 \geq L \), then \( \tilde{f}_1 = (L/X - \pi)/(1 - \pi) \), and liquidation is limited by the incentive to liquidate, which is independent of \( r_1 \) or \( Y \). Increasing \( Y \) to \( Y' \) and reducing \( \rho \) to \( \rho' \), to provide lenders with the same expected return, weakly increases payments for low \( f_1 < r_1/(Y' - \rho') \) and decreases them for greater \( f_1 \), and by the above argument this makes type G's better off because they are more likely than average to get upgrades. Because increasing \( r_1 \) and reducing \( \rho \), given the expected return to lenders, makes type-G borrowers better off, the optimal value of \( Y \) is \( X \), its maximum value, if \( r_1 \geq L \). Q.E.D.

**Proof of Proposition 2**

Using \( Y = X \) and \( G(f_1) = H(f_1) f_1/f \), we write the type G's problem as the following Lagrangian:

\[
\min_{r_1 \geq 0, \rho \geq 0} \Gamma = \int f \left( (X + C) \int_0^{f_1} f_1 dH(f_1) + X \int_{\tilde{f}_1}^{f_1} f_1 dH(f_1) \right. \\
+ \left. \int_{\tilde{f}_1}^{f_1} \left[ \rho + \frac{r_1}{q(f_1)} \right] f_1 dH(f_1) \right) + \hat{\lambda} \left[ L \int_0^{\tilde{f}_1} dH(f_1) \\
+ X \int_{\tilde{f}_1}^{f_1} q(f_1) dH(f_1) + \int_{\tilde{f}_1}^{f_1} \left[ \rho + \frac{r_1}{q(f_1)} \right] q(f_1) dH(f_1) \right],
\]

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where

\[ q(f_1) = f_1(1 - \pi) + \pi, \]

\[ \hat{f}_1 = \max \left\{ 0, \min \left\{ \frac{r_1/X - \pi}{1 - \pi}, \frac{L/X - \pi}{1 - \pi} \right\} \right\}, \]

\[ f'_1 = \min \left\{ \frac{r_1/(X - \rho) - \pi}{1 - \pi}, 1 \right\}. \]

First-order necessary conditions for a minimum at a differentiable point are:

\[ \frac{\partial \Gamma}{\partial r_1} = \frac{\partial \hat{f}_1}{\partial r_1} \left[ C \hat{f}_1^2 - \lambda (L - r_1) \right] H(\hat{f}_1) + \int_{f_1}^1 \left[ \frac{f_1}{q(f_1)} - \lambda \right] dH(f_1) \geq 0, \]

\[ \frac{\partial \Gamma}{\partial \rho} = \int_{f_1}^1 \left[ \frac{f_1}{f} - \lambda q(f_1) \right] dH(f_1) \geq 0. \]

The objective function \( \Gamma \) is twice \( \rho \)-differentiable and has continuous derivatives for all feasible values of \( \rho < X - r_1 \). It is twice \( r_1 \)-differentiable except at \( r_1 = \pi X \) and \( r_1 = L \). Note that if \( C \to 0 \) or if \( \partial \hat{f}_1 / \partial r_1 \to 0 \) (which occurs if \( r_1 \geq L \) or \( r_1 < \pi X \)), then \( \partial \hat{f}_1 / \partial r_1 \) approaches an expectation of \( f_1/q(f_1) f - \lambda \). Each element in the integrand in \( \partial \Gamma / \partial r_1 \) is \( f_1/q(f_1) f - \lambda \), equal to \( 1/q(f_1) \) times the element of integrand in \( \partial \Gamma / \partial \rho \). Note that \( 1/q(f_1) \geq 1 \) and is convex in \( f_1 \). This implies that \( \partial \Gamma / \partial r_1 \) is a constant greater than one multiplied by the expectation of a convex function of \( f_1/q(f_1) - \lambda \), which exceeds the function evaluated at its expectation, by Jensen's inequality. Therefore, if the optimal value of \( \rho \) is not zero, which requires \( \partial \Gamma / \partial \rho \to 0 \), the implied value of \( \lambda \) yields \( \partial \Gamma / \partial r_1 < 0 \), violating optimality. Use of long-term debt requires both sufficiently large \( C \) and \( r_1 \leq L \). If the expected return constraint cannot be satisfied with \( r_1 < L \), then \( \rho = 0 \). Consider the case where \( r_1 < L \) is feasible. For \( r_1 \in (\pi X, L) \), \( \partial f_1 / \partial r_1 = 1/(X(1 - \pi)) \). For sufficiently large \( C \), the optimum value of \( r_1 \) approaches \( \pi X \) from above and the optimum remains arbitrarily close to \( \pi X \) for an increase in \( I \). This implies that, for large \( C \), the increased funds are raised long-term (until \( \rho + r_1 \to X \)). Under the assumption that the density \( H(f_1) \) is increasing in \( f_1 \) for \( f_1 < (L/X - \pi)/(1 - \pi) \), this generalizes as follows: for all \( \delta > 0 \) and all optimal values of \( r_1 \), \( X - \rho - \delta \), there exists \( C < \infty \), such that \( r_1/I \) is decreasing in \( I \). The \( r_1 < L \) condition is required because otherwise \( r_1 \) has no effect on liquidation decisions. The \( r_1 < X - \rho - \delta \) is required because although \( \partial (r_1/I) / \partial I \) is strictly decreasing in \( C \) for \( r_1 < X - \rho \), \( C \) is multiplied by a term that approaches zero as \( r_1 + \rho \) approaches \( X \) (and the further increases in \( I \) require more liquidation to meet the expected return constraint).
Proof of Lemma 2

The Cho–Kreps criterion rules out predictions of optimal lender actions that would require lender inferences of the following form: the inclusion of a type in the group of borrowers believed to deviate to the off-equilibrium action when that type would be worse off than in equilibrium if lenders select a best response to a type distribution of borrowers that excluded that type. It rules out situations where a given type of borrower could explain a deviation to another contract by noting that the other type would have no incentive to deviate if the lender interpreted the deviation as indicating the given type, but the other type could make no such claim. For example, if a debt contract is off-equilibrium and this must be supported by beliefs that offering all short-term debt indicates some possibility of being type B, then this is unreasonable if type B's would not select the deviation (would prefer the equilibrium for borrowers of given date-0 credit rating f) if the deviation to short-term debt were interpreted as indicating type G for sure.

In the cost-minimizing equilibrium, whenever a debt structure other than all short-term debt is off the equilibrium path, it is supported by the belief that deviating to another debt contract would lead lenders to believe that the probability that the borrower is of type G is still equal to f, thus the belief includes both types. For a type to want to deviate to another contract, an inference of a higher conditional probability of being of type G would be required, thus there can be no deviations interpreted as indicating type B for sure. If, instead, a deviation is interpreted as indicating type G for sure, then the information that will arrive at time 1 is superfluous, and type B's could emulate the type G's at no risk of detection due to that information. In this case, both types would want to deviate, implying that the belief that the probability of being type G equals f passes the Cho–Kreps test.

There are not separating equilibria, because any contract offered only by type B's gives a zero payoff, and emulating type G's gives a positive payoff to a type B. There is not a partly-separating equilibrium (where the population of borrowers is split into groups with differing type proportions based on the contract offered). If all such subgroups were to include both types, then both types would have to be indifferent, and this is not possible for contracts that differ in information sensitivity because type B's prefer less sensitivity and greater protection of control rents than type G's. If, instead, one contract were offered only by type G's, then date-1 information is superfluous and ignored, implying that type B's prefer that group, which contradicts the hypothesis that it attracts only type G's. This leaves only pooling equilibria, where borrowers of a given credit rating offer the same contract whether of type G or type B.

The only other type of equilibrium is one in which a single maturity is always offered, independent of C or of the date-0 credit rating. This equilibrium passes the Cho–Kreps test if and only if the contract is entirely short-term debt,
supported by the belief that an off-equilibrium maturity mix implies that the type is B, because both types would prefer to deviate to the off-equilibrium action if interpreted as type G for sure.

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