Asymmetric Information, Debt Capacity, And Capital Structure*

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Asymmetric Information and Capital Structure

Abstract:
We analyze a model of financing under asymmetric information that includes debt covenants. Asymmetric information creates an incentive to use debt financing. The use of debt financing, however, distorts the continuation decision of equity holders. Debt covenants become a valuable contracting device in this environment. The model offers several predictions regarding the use of debt covenants and their relationship with the capital structure decision of the firm.
The tradeoff theory of capital structure is the predominant theory of capital structure choice in the literature. It is built on the fundamental intuition that one finds an optimum at the equality of marginal costs and marginal benefits for a given choice variable; in this case the amount of leverage utilized by a firm. Commonly, this optimum has been characterized on a “value” basis; a ratio between the values of the firm’s existing debt and of the firm itself (the value of all the firm’s forecasted future cash flows) or the ratio between the values of the debt and the firm’s equity. By implicitly assuming that existing debt may be rolled over or renegotiated if there is ever a need, this characterization ignores the timing of the expected future firm cash flows as compared with the required debt service. Viewing the MM propositions as a version of the Coase Theorem the importance of the assumption of efficient and costless renegotiation of the financial contracts is clear. We develop a model that explicitly considers a friction that encourages the use of debt financing but that may impede the renegotiation of these contracts, specifically asymmetric information between the firm and its lenders, as the primary factor in capital structure choice.

Assuming that renegotiation of debt contracts is not friction free, one may obtain a theory of leverage based on the information available concerning the firm’s ability to service its debt, publicly available information concerning future cash flow, and the difficulty of renegotiating restrictive covenants associated with the debt. Empirically, the main tensions in the model can be measured either by examining proxies for the asymmetry of information and the nature of the uncertain cash flows or by considering the market’s response to the presence of the asymmetric information; most visibly the
change in the nature and the strictness of bond covenants and the firm’s ability to renegotiate covenants that become binding as leverage is increased.

The theory is based upon a model of a firm with an uncertain cash flow generation process and asymmetric information between the firm and the market concerning this process. Given the asymmetry of information and the need to make a continuation versus liquidation decision at an intermediate date, covenants, which delegate the right to make the liquidation decision, may be attached to the bond contract when insiders cease to have appropriate incentives. As will be shown, the optimality of the use of restrictive covenants is closely tied to the firm’s ability to renegotiate these covenants when they restrict the firm from taking efficient actions.

The model is an extension of Myers and Majluf’s (1984) classic model. While Myers and Majluf consider the implications of asymmetric information between the firm and providers of capital at the time of financing, this model considers that the informational asymmetry extends to a future decision making date. A tension between the implications of asymmetric information at the two dates develops. As Myers and Majluf demonstrate, the use of debt is motivated by the presence of asymmetric information at the time of financing. However, because debt alters the incentives of the insiders in their decision making, covenants that transfer control rights to the lender become valuable additions to the debt contracts. The lender’s has inferior information implies this transfer of control will be costly in some states of nature. Primary tensions in the capital structure decision are the impact of debt on the decision making incentives of insiders and the firm’s ability to renegotiate the restrictive covenants when the cost of uninformed decision making is high. The two consequences of the informational
asymmetry in the model allow us to derive an optimal amount of leverage for a firm. Our model is also closely related to that of Garleanu and Zwiebel (2009) who consider the design and renegotiation of debt covenants under asymmetric information. Our approach differs from theirs in that we also address capital structure choice.

One perspective on the nature of these results is that the model has developed an endogenous measure of “debt capacity” that complements the pecking order of financing discussed by Myers (1984). Another perspective is that a more complete recognition of the impact of asymmetric information on the choice of financing identifies a balancing cost of debt financing under asymmetric information, placing the analysis back in the traditional tradeoff theory framework.

Relative to the predictions of the standard pecking-order theory, the model provides a conservative optimum. The main issues limiting the use of debt in the model are the firm’s liquidation value and the market’s inferior information concerning the firm’s quality. Debt levels are appropriately compared to the level of guaranteed cash flow (liquidation value in the model) based on the market’s information. As liquidation value is dependent upon the state of the overall economy we obtain the important empirical implication that firms will tend to use more debt in economic expansions than in contractions. The model also derives other interesting empirical predictions concerning leverage choice and the nature of covenants associated with the firm’s debt.

1. The Model with a Binary Public Signal

In this model, an entrepreneur/manager seeks funding for a firm. The entrepreneur’s type or quality is assumed to be known precisely and privately by the
entrepreneur (we will alternatively talk about an entrepreneur’s type or the type of the firm run by the entrepreneur). External investors (the market) know only that entrepreneur’s type is drawn from a distribution $F(t)$; where $F(t)$ is defined on the interval $[B, G]$, with $0 < B < G$, and $F(t)$ has a well defined mean, $E(t)$. Entrepreneurs with types in this interval are assumed to be observationally equivalent to the external market at time 0. For simplicity, in this version of the model, we assume there are only two types and that types are drawn from the set $\{B, G\}$ where the ex ante probability of a good (type $G$) firm is $\theta$.

Initial capital, $I$, is required to initiate an investment project and establish a firm. The realized value of the investment project, its time 2 payoff, is assumed to depend upon the entrepreneur’s type and the value of a signal $w$ that is publicly observable (and verifiable) at time 1, where the signal, $w \in [w, \overline{w}]$ has a distribution $H(w)$. In this section, we consider the case of a binary signal where, $w \in \{w_1, w_2\}$, and $\text{prob}(w = w_1) = p$, and $w_1 > w_2 > 0$. The realized signal can be considered an ex post indication of the strength of the overall economy or the industry (where $w_1$ is termed a “strong” market and $w_2$ as a weak market) as it will affect the fortunes of all observationally equivalent firms. The expected signal $p w_1 + (1 - p)w_2$ serves as an ex ante measure of expected economic conditions. If the project is funded and allowed to continue until time 2 it generates a cash flow of $H$ or $L$ where $H > L > 0$. The “high” cash flow $H$ (success) is generated at time 2 with probability given by the product of the firm’s type and the realization of the public signal, $\text{Prob}(\text{cash flow} = H | \text{type} = t \text{ and signal} = w) = tw$, and the “low” cash flow $L$ (failure) is realized with the complementary probability, $1 - tw$. For internal
consistency we must further assume that $Gw_1 < 1$ and $Bw_2 > 0$. The random variables $t$ and $w$ are assumed to be independent.

An alternative, available at time 1, to allowing the project to continue is that the project may be liquidated (or “quit”). Liquidation of any firm will generate a time 1 cash flow of $Q$ with certainty. The timing of the model is such that the liquidation decision is made dependent upon the realization of the public signal $w$. Because $w$ is verifiable it can also be used as the basis for a bond covenant that allocates the control over the time 1 liquidation decision. In this sense we model the inclusion of a proscriptive covenant that requires, for example the maintenance of certain accounting ratios, failure to satisfy the requirements results in default on the debt contract. The structure of the model implies that if the bondholders are allocated the liquidation decision, they will be making this choice based on inferior information. Initially we will assume that renegotiation of this covenant is not possible (renegotiation is infinitely costly). We will then consider the nature and impact of renegotiation.

In the model the entrepreneur/manager is assumed to own the rights to the project but has no capital. The required investment, $I$, may be raised by issuing equity or debt. More precisely, the manager chooses the face value of debt, $F$, the level of the public signal (if any) at which to transfer control of the liquidation decision to the bondholders, $w'$, and the proportion of the firm’s equity to be sold externally, $\alpha$, in order to maximize the value of his/her retained equity, $(1 - \alpha)$. Note that this is equivalent to assuming that

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1 Note that the firm can be liquidated either as a going concern or piece-meal. To the extent that it is more likely to be liquidated as a going concern in a strong economy the level of $Q$ will be related to the business cycle and is not likely to be constant across time. This is not an issue in our static version of the model, however, it will influence the empirical predictions derived from the model.
the manager acts in the interest of shareholders (given his/her superior information).  

Intuitively, the effect of this assumption is to generate an agency problem, one that increases with the amount of debt financing used by the firm. The asymmetric information at the time of financing motivates the use of debt (Myers and Majluf (1984)) and the bond covenant is used to (imperfectly) control the resulting agency problems and provides the implications for the asymmetric information at the time of the liquidation decision.

The First Best

We begin by examining the first best decision making within the model. The time zero informed (assuming knowledge of the entrepreneur’s type) value of the firm can be written (using an indicator variable for continuation $\phi(w^*)$ which takes the value 1 if the realized signal $w \geq w^*$ and zero otherwise) as:

$$V^*_1 = E_w \left\{ (twH + (1-tw)L)\phi(w^*) + Q(1-\phi(w^*)) \right\}$$

$$= \text{prob}(w \geq w^*)(tE(w|w \geq w^*)H + (1-tE(w|w \geq w^*))L) + \text{prob}(w < w^*)Q.$$ 

If we assume a continuous public signal, by maximizing this value with respect to $w^*$, it is straightforward to find the value of the public signal below which it is efficient for a firm of a given type to be liquidated. This signal value is $w^*_i = \frac{Q-L}{t(H-L)}$. The “cutoff” level of the public signal has natural properties. It decreases in the entrepreneur’s/firm’s type ($w_b^* > w_g^*$); “good” firms should be continued in “worse” economic environments than should “bad” firms. The cutoff level increases in $Q$; all else equal, the more attractive is liquidation the more frequently you want to liquidate firms. Finally the

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2 We will leave for future work the incorporation of an optimal incentive contract in this type of a model (see for example, Garleanu and Zwiebel (2008) as compared to Dybvig and Zender (1991)).
cutoff level is decreasing in the difference between the continuation values for success \((H)\) and failure \((L)\); the greater is the upside potential the more often you want to allow firms to continue.

In order to capture the major tensions of the more robust model but enjoy the simplicity of the binary signal we will assume that in good times, if \(w = w_1\), both types of firms should continue \((w_i > w^*_b > w^*_g)\) while if \(w = w_2\) only a good type firm should continue \((w^*_g > w_i > w^*_b)\).

The Agency Problem

It is straightforward to examine the liquidation decision of an unconstrained (no covenant) entrepreneur with debt outstanding who operates a firm of type \(t\). The entrepreneur acts to maximize the informed value of his retained shares for a given face value of debt. Assuming \(L \leq F \leq Q\), using the liquidation decision to maximize the informed equity value reveals that the manager of a type \(t\) firm will continue if the public signal is greater than or equal to \(w^*_t = \frac{Q - F}{t(H - F)}\) and will liquidate the firm otherwise.

Note that for any \(F > L\) this value is less than \(w^*_t\) and that the difference between \(w^*_t\) and \(w^*_M\) increases in \(F\); in other words the agency problem (risk seeking) introduced by the use of debt financing increases in the debt’s face value. Clearly for \(F < L\) (riskless debt) the manager follows the first best policy and if \(F \geq Q\) the manager will always continue (equity receives a payoff only if the firm continues and is successful). Similarly, defining the agency problem to be the difference \(w^*_t - w^*_M\), for a given \(F\), the agency problem is negatively related to firm type.
In this model, assuming the initial investment level is large enough, it will never be optimal to choose debt with a face value less than $L$; this is simply Myers and Majluf’s result that firms use financial slack or riskless debt as the first choice for financing. Furthermore, there is no benefit to using debt with a face value larger than $Q$. This is because issuing debt with $F > Q$ is, at the margin, equivalent to issuing external equity (they have the same informational sensitivity). When we examine the implications of the asymmetric information on a liquidation decision, for an initial financing decision or for any incremental financing decision, asymmetric information between the firm and its lenders does not provide a motivation to issue debt in excess of the liquidation value. This result is discussed more completely below.

Finally it is useful to examine the behavior of the bondholders. If the bondholders were informed and in control of the liquidation decision they would act to maximize the value of their claim on the firm’s cash flow.

$$D^I_t = E_w \{ (tw \min(F, H) + (1-tw) \min(F, L)) \varphi(w^p_t) + \min(F, Q)(1-\varphi(w^p_t)) \}$$

$$= \text{prob}(w \geq w^p_t) \left( tE(w|w \geq w^p_t) \min(F, H) + (1-tE(w|w \geq w^p_t)) \min(F, L) \right)$$

$$+ \text{prob}(w < w^p_t) \min(F, Q).$$

If $F \leq L$ debtholders are indifferent between continuation and liquidation. If $L < F \leq Q$, debtholders always prefer to liquidate the firm; the limit on the upside potential of their claims causes the standard preference for certainty. Finally if $F > Q$ (never optimal in this model) it is straight forward to show that $w^p_t = \frac{Q}{t(F-L)}$. In other words for high enough values of the public signal debtholders will prefer to continue and have a chance of capturing some of the upside potential; at this point the debt effectively becomes junk debt.
As is standard in pooling models, a manager of the highest type firm type (type $G$) chooses his preferred action taking into account the informational asymmetry and its impact on the outcomes of his choices. Bad firms mimic these choices. For a “good” firm, the manager’s decision problem can be written in terms of the expressions derived above. Furthermore we have assumed that the required funding is sufficiently high that the firm cannot be financed entirely with risk free debt.

**The Decision Problem – No Renegotiation**

For a type $G$ firm, the manager’s problem can then be written as:

$$\max_{w,F,\alpha} (1-\alpha)S^l_G(F,w')$$

subject to

$$\alpha E_r(S^l_1(F,w')) + E_r(D^l_1(F,w')) = I$$

We can further define the uninformed equity and debt values as:

$$S^U(F,w') = E_r(S^l_1(F,w'))$$ and $$D^U(F,w') = E_r(D^l_1(F,w'))$$.

The type $G$ manager selects the level of external debt (described by the face value and a covenant transferring control of the liquidation decision to the debtholders for realizations of the public signal less than $w'$) and the proportion of the firm’s equity to sell externally in order to maximize the (informed) value of his retained equity, subject to the constraint that the required capital $I$ is raised. Strictly speaking the capital constraint should be written as a weak inequality, however given that the manager of a good firm sells securities under asymmetric information it will never be optimal to raise more than is required. Finally, with the constraint written as an equality, we can solve it for the necessary level of external equity:

$$(1-\alpha) = \frac{S^U(F,w') + D^U(F,w') - I}{S^U(F,w')}.$$
The manager’s objective function is simply this expression times the informed value of equity:

\[ \text{Obj}(F, w') = \frac{S_U^L(F, w') + D_U^L(F, w') - I}{S_U^L(F, w')} \cdot S_0^L(F, w'). \]

In the binary signal version of the model the optimal choices given the problem faced by the manager of a good firm are most simply derived by comparing the value of the manager’s objective function for different \( F \) and \( w' \). By doing so we are able to illustrate the basic tensions underlying the model.

A first result to note is that the value the objective function for a the manager of a good firm \( \text{Obj}(F, w') \), in the absence of any state contingent transfer of control rights to the lender (\( w' = w_2 \)) is larger at \( F = F_L \) than it is at \( F = L \); \( \text{Obj}(F_L, w_2) > \text{Obj}(L, w_2). \)

The value \( F_L = \frac{Q - w_2 B H}{1 - w_2 B} < Q \) is defined to be the level of the face value of debt at which a bad firm would be indifferent between liquidation and continuation when \( w = w_2 \) is observed (in other words, the highest level of risky debt at which there is no cost associated with the bad manager’s incentive problem given \( w_2 \)).

This result illustrates that this model captures the standard pecking order notion that the manager is better off issuing risky debt rather than equity. The qualification is that this is a general prescription on financing choice only as long as it does not alter the incentives of a bad entrepreneur by “too much.” If we ignore the impact of debt financing on decision making we derive a limit on the use of debt financing.

**Proposition 1:** Asymmetric information at the time of financing (time \( t_0 \)) implies that, all else equal, there is a pecking order for external financing in that the entrepreneur prefers
to issue first riskless debt to the extent possible \((F = L)\) and then risky debt to its point of informational equality with external equity \((F = Q)\). Once this level of debt financing is reached, the entrepreneur is indifferent between issuing more debt or external equity.\(^3\)

**Proof:** See the appendix

From Proposition 1 we immediately see that by changing the model to include a liquidation decision a version of the “debt capacity” discussed by Myers (1984) is endogenously derived. At the point \(F = Q\) there is no longer any motivation derived from asymmetric information between the firm and the market to use risky debt rather than external equity. An interesting aspect of liquidation value as a ceiling for debt capacity is that this value is state contingent. During economic expansions, firms in financial distress will be more likely to be liquidated as a going concern then piece-meal. Thus liquidation value may be very near firm value, implying a high ceiling. During contractions liquidations will be more likely to be piece-meal, selling the firm for the highest value of its assets in an alternative use, which may be quite low. When the costs related to the distortion of incentives from the use of debt financing and the assignment of control rights to inferiorly informed debtholders are considered, the optimal level of debt, in this simple version of the model, is below this ceiling.

The innovative feature of this model is that we also consider the implications of the asymmetric information between the firm and the market at the time (time \(I\)) of the liquidation decision. There are two concerns to discuss. First is that the use of risky debt in the initial financing of the firm distorts the incentives of the entrepreneur/manager of both a good and bad type firm in the time \(I\) liquidation/continuation decision. Second is

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\(^3\) Note that the assumption that \(I > Q\) implies that firms in this model will always find it optimal to issue some amount of external equity.
that debt covenants, state contingent changes in the control of the liquidation decision, can help to limit the cost of the distorted incentives. The use of bond covenants cannot perfectly control the incentive problem because the lender always prefers liquidation to continuation if the debt is risky (they have their own distorted incentives) and because the lender makes decisions based upon inferior information. The net cost of the incentive distortion associated with debt financing must be balanced against the adverse selection benefits to the initial sale of debt (rather than external equity) in determining the firm’s optimal capital structure.

Given our assumptions, there are only two potential value added assignments of the ownership of the liquidation decision. The first is equivalent to the absence of a covenant; because of how we have defined \( w' \), the manager owns the liquidation decision whenever \( w \geq w' \) this is written, \( w' = w_2 \). This arrangement will tend to be preferred if low levels of debt are used, \( F \leq F^L \) as well as for high debt levels if the cost of uninformed decision making by the lender is larger than is the distorted decision making by informed insiders.

Because we have assumed that it is efficient for both good and bad type firms to continue in a strong market (\( w_i \)) and debtholders will always want to liquidate, it will never be efficient to allocate control of the liquidation decision to the lender in this state. Therefore, only an allocation of control that sets \( w' = w_i \), leaving the manager in control of the liquidation decision in a strong market and allocating this decision to the lender in a weak market, is a second potentially optimal level of the debt covenant.

Similarly, in the model with a binary signal the potentially optimal levels for the face value of debt are limited. A low level of debt (\( F = F^L \)) may be optimal if the cost
of inefficient decision making is large. By choosing the low debt level the incentives of
insiders of both good and bad firms remain efficient in the sense that they will make the
right decision in both a strong and a weak market (with the manager of a bad firm being
just indifferent to continuation and liquidation in a bad market). For any face value of
debt above $F^L$ the manager of a bad firm will always wish to continue, even in a weak
market. The manager of a good firm will also always wish to continue, however, this is
efficient. Therefore, if $F > F^L$ is chosen, there is no additional expected cost in added
incentive problems and (as shown above) a strict gain in lowering the discount for a good
firm from issuing added debt. Therefore, if any $F > F^L$ is chosen it will be optimal to
issue debt with a face value of $Q$. We will label this the high debt level.

**Proposition 2:** If a low debt level is chosen, it is optimal to set $w' = w_2$. This
arrangement keeps control of the liquidation decision in the hands of informed insiders
and the low debt level, $F^L$, ensures efficient decision making in both a weak and a strong
market.

**Proof:** Obvious from the discussion above.

**Proposition 3:** Assuming a high debt level is chosen, $F = Q$, it will be optimal to
allocate the liquidation decision to the lender in a weak market if parameter values are
such that it is efficient for an “average” firm, $\bar{t} = \theta G + (1 - \theta)B$, to liquidate when
$w = w_2$ (if $w^*_T > w_2$). If it is efficient for a firm of the average type to continue in a weak
market then it is optimal to allocate control of the liquidation decision to the manager in
all both states. $\text{Obj}(Q, w_1) > \text{Obj}(Q, w_2)$ if $w^*_T > w_2$ and $\text{Obj}(Q, w_1) < \text{Obj}(Q, w_2)$ if
$w^*_T < w_2$. 
Proof: See the appendix

The tensions that influence the time 0 capital structure decision in the model are now clear. The time 0 adverse selection faced by the good type firm provides a motivation for the use of debt financing. The implied agency costs, net of any benefits derived by the use of optimal bond covenants, introduce a cost of debt. Given the “lumpiness” of the model with a binary public signal, we will not expect a smooth tradeoff to determine the optimum but rather expect to see parameter values for which there is a low debt optimum ($F = F^L$, when the net agency cost of debt is large relative to the adverse selection benefit) and values that indicate a high debt optimum ($F = Q$, when the reverse is true). The simple structure of this model with a binary public signal, however, does not capture both possibilities.

Proposition 4: In the version of the model with a binary public signal and infinitely costly renegotiation of debt covenants, it is always optimal for the good firm to choose debt with a face value of $F^L$ and to assign control of the liquidation decision to the manager in both states of nature. It is never optimal to choose a high level of debt.

Proof: See the appendix

There is no high debt optimum in this version of the model. The model’s structure implies that the low debt optimum is a corner solution. Intuitively, one would expect that when the adverse selection benefit from issuing lots of debt (the total benefit of issuing debt with $F = Q$ rather than $F = F^L$) was larger than the net agency cost of the distorted incentives there would be a high debt optimum. By choosing parameter values that made the continuation decision of the bad type firm truly marginal it would seem possible to obtain high debt as the optimal solution. However in this model, what
determines the importance of the bad firm’s continuation versus liquidation decision important is the liquidation value, \(Q\). In other words, when the efficiency of the liquidation decision by the bad firm is not important (\(Q\) is low) there is also little total benefit from the use of risky debt rather than external equity in the initial financing decision.\(^4\)

The current model shows that when we extend a model of financing choice under asymmetric information to consider the costs associated with the use of risky debt, a good firm’s incentive to use debt is limited by the distortion to the incentives of the bad type firm. Because the firms are observationally equivalent, the market, anticipating the distorted incentives associated with large amounts of debt for a bad firm, will “charge” a good firm for the anticipated inefficient decision-making. This makes the use of large amounts of debt suboptimal. In this version of the model, there is a pecking order for financing choices but the point at which firm’s turn to external equity, \(F^c\) the firm’s debt capacity, is very low.

**Renegotiation of Covenants**

Consider a good firm which has issued debt including a covenant transferring control of the liquidation decision in a weak market. Within the existing model there is an intuitive renegotiation strategy that a good firm may use to separate itself from bad firms in a weak market (if \(w = w_2\) is realized). A good firm is willing to offer to increase the time 2 payment to the lender in exchange for the lender waiving the covenant (not liquidating the firm). For simplicity we will assume that the firm makes a take-it-or-leave-it offer to the lender in all renegotiations and faces any costs of renegotiation. We

\(^4\) The continuous signal version of the model does not share this feature and so allows the development of interesting empirical implications for capital structure choice under asymmetric information.
examine the renegotiation strategy in what follows and derive the associated capital structure implication.

In this model the covenants serve to mitigate the costs of high debt levels. When renegotiation is not allowed or is infinitely costly, high debt levels, were they beneficial, would take full advantage of the low information sensitivity of debt and set the face value of debt equal to the liquidation value \((F = Q)\). However, if a good type firm anticipates a separating renegotiation strategy in a weak market it will not set \(F = Q\). This is because at this debt level there is no way for a good firm to make a restructuring offer that the bad firm will not mimic (at \(F = Q\) a manager of a bad firm receives nothing in liquidation and therefore will mimic any strategy that will waive the covenant). If, however, at time \(0\) the manager of a good firm sets \(F^H < Q\) then because a good firm’s cash flow distribution in continuation stochastically dominates that of a bad firm there is always a separating restructuring offer, \(F^S > F^H\), that a bad firm will not choose to mimic and that the lender will accept. The equity value for a bad firm will be higher receiving \(Q - F^H\) in liquidation with certainty rather than taking a small chance on \(H - F^S\) from continuation in a weak market.

**Proposition 4:** Consider a good type firm faced with the violation of a covenant in a weak market. If the face value of debt, \(F^H\), chosen at time \(0\) is such that

\[
Q > F^H > \frac{\frac{G}{G_B}Q - Gw_2H - (1 - Gw_2)L}{\frac{G}{G_B} - 1}
\]

there is a renegotiation offer

\[
F^S (F^H) = H - \frac{(Q - F^H)}{Bw_2}
\]

which a bad firm will not mimic and the lender will accept to waive the covenant.
Proof: See the appendix

Interestingly, rather than there being a strict benefit to issuing debt instead of external equity, as long as the initial face value of debt chosen at time $0$ satisfies the inequality given in Proposition 4, the manager of a good firm is indifferent to a set of initial debt levels that are strictly less than $Q$. In other words, there is no optimal $F^H$. Intuitively, for initial levels of debt financing larger than $F^H$ the savings a good firm receives on the ex ante adverse selection problem from the use of more debt is just balanced by the cost (in the form of a higher renegotiation offer) imposed on the firm ex post by the need to separate from bad firms.

Proposition 5: When renegotiation of a bond covenant is costless a manager of a good firm is indifferent between any initial debt level $F^H$ such that:

$$Q > F^H > \frac{G}{B}Q - Gw_zH - (1 - Gw_z)L \frac{G}{B} - 1.$$  

Proof: See the appendix.

We are now able to examine the full capital structure implication of the existence of a costless and fully separating renegotiation in a weak market. Interestingly, in the case of costless renegotiation, asymmetric information does not provide a motivation for the use of debt financing. Rather a good firm is indifferent between low debt ($F = F^L$) with no covenant and high debt ($F = F^H$) with a covenant that assigns control of the liquidation decision to the lender in a weak market (anticipating the good firm will renegotiate in a bad market). The benefit associated with initially issuing a large amount of debt is just balanced by the cost to a good firm of separating from bad firms in the event of a weak market.
Proposition 6: When the renegotiation of bond covenants is costless firms are indifferent to choosing high debt, \( F \geq F'' \) with a bond covenant initially transferring control of the liquidation decision to the lender in a weak market, and low debt, \( F = F^L \) where the manager retains control of the liquidation decision in both states. If high debt is chosen, in a weak market, good firms will renegotiate the covenant choosing \( F = F^S \) while bad firms will liquidate.

Proof: See the appendix.

Note when renegotiation of covenants is costless, it is no longer the case that it is optimal to include a covenant transferring control of the liquidation decision to the lender only for certain parameter values. The separating nature of the renegotiation implies that it is always optimal to include the covenant when a high debt level is chosen. This result mirrors the main result in Garleanu and Zwiebel (2009) in that covenants are optimally very restrictive and “over” assign control rights to the less informed party. Proposition 6 illustrates not only the usefulness of bond covenants in controlling the agency costs of debt but also the importance of the ability of firms to renegotiate these covenants. In the model with a binary signal, without an ability to renegotiate these covenants they will not be employed and only low debt levels are optimal. The limiting aspect of the model with a binary signal is that if the renegotiation of covenants entails a cost then the low debt solution will be a unique optimum in the model and we will not expect to see covenants used to control the incentive problems caused by the use of high debt levels.

2. The Model with a Continuous Signal
In order to develop a richer set of predictions of the model we extend the current setup by assuming the public signal \( w \) has a uniform distribution \( (w \sim U[w, \bar{w}]) \) rather than being governed simply by a Bernoulli distribution. Other than this change, the model in this section is identical to that used above. This apparently simple change increases the complexity of the representations to such an extent that we must resort to numerical solutions of the optimization problem. However, the added richness does allow us to develop situations in which firms will optimally use high levels of debt supported by the use of restrictive covenants and so more interesting predictions.

**No Renegotiation**

The representation of the problem becomes more complex when we assume that the public signal has a continuous distribution. We first present the informed equity and debt values and then discuss the change to the problem. Using the same notation as above, \( S'_i(F, w') \), the informed value of the equity for a firm of type \( t \), is given by:

\[
S'_i(F, w') = \text{prob}(w \geq \max(w^*_M(F), w'))(tE(w|w \geq \max(w^*_M(F), w'))(H - F)) + \text{prob}(w < \max(w^*_M(F), w'))(Q - F).
\]

Assuming that the public signal is uniformly distributed this becomes:

\[
S'_i(F, w') = \frac{\bar{w} - \max(w^*_M(F), w')}{{\bar{w}} - w} \left( t \frac{\max(w^*_M(F), w') + \bar{w}}{2} (H - F) \right) + \frac{\max(w^*_M(F), w') - w}{{\bar{w}} - w} (Q - F).
\]

Similarly, the assumption of a uniform public signal implies that the informed value of debt, \( D'_i(F, w') \), is given by:
Finally, the uninformed values are simply $S^U(F, w') = \theta S^I_G(F, w') + (1 - \theta) S^I_B(F, w')$ and
\[ D^U(F, w') = \theta D^I_G(F, w') + (1 - \theta) D^I_B(F, w'). \]

As is apparent from the equations for the informed security values, a complication introduced by the use of a continuous signal is the question of whether, for a given $F$, the covenant is set at a level of the public signal that is greater or less than the level at which a bad type manager will voluntarily liquidate the firm. This question was raised in the model with a binary signal but the structure made it easy to address. As was true in that model, the relationship between $w'$ and $w_B^M$ limits the search to two candidate optima.

If the covenant is optimally set so that $w' < w_B^M$ the covenant does not effectively constrain the bad type manager in the liquidation decision. In this case, it will necessarily be optimal to set $w' = w_G^*$ and to select a relatively low level of debt, $F$. If the covenant is set so as not to effectively constrain a bad type manager in the liquidation decision, then the covenant will only serve to constrain good type managers, therefore setting $w' = w_G^*$ is clearly optimal. As was true above, if the covenant is set at this level it will also be the case that $F$ is optimally set at a low level. The optimal choice of $F$ in this version of the model involves a smooth tradeoff. Fixing $w' = w_G^*$, as $F$ is raised above $L$ in the time $\theta$ financing decision, a good firm benefits from selling an informationally insensitive security. However, the good firm faces a cost due to the fact that the bad firm will now have distorted incentives in the liquidation decision and the good firm will “pay” for this...
inefficiency in the price it receives for its securities. As above we will label the low level of debt $F^L$.

On the other hand, if it is optimal for the covenant to constrain the manager of a bad firm, $w' \geq w^*_b$, the same covenant will necessarily constrain the manager of a good firm. Given that the liquidation decision for both types of firms is controlled by the (same) covenant, there is no cost associated with the incentive distortion associated with a high debt level. Assuming an inability to renegotiate the covenant, the choice of debt that maximizes the time $\theta$ benefit of selling the informationally insensitive debt rather than external equity is to set $F = Q$. Analytically, it is straightforward to show that if $F = Q$, then it is optimal to set the covenant so that control is transferred to the lender at levels of the public signal that are less than the level at which a firm of the average type would optimally liquidate, $w' = \frac{Q - L}{\bar{t}(H - L)} = w^*_r$ where $\bar{t} = \theta G + (1 - \theta)B$.

While it is clear that two time $\theta$ choices for debt structure are possibly optimal, $(F = F^L, w' = w^*_G)$ and $(F = Q, w' = w^*_r)$, at this point we have not been able analytically to derive the value $F^L$. Consequently we are also unable to provide an analytical comparison of the value of the good manager’s objective function under these debt structures for different parameter values. In what follows, we therefore derive the value $F^L$ numerically as well as numerically compare the value of the good manager’s objective function at the candidate solutions. Figures 1 – 3 demonstrate the nature of the solutions to the good manager’s optimization problem when the public signal is assumed to be uniformly distributed.
Figure 1a compares the value of the good manager’s objective function at the candidate solutions for a given set of parameter values. Immediately apparent is the result that with a continuous public signal both the debt structure that includes a low debt level and a weak covenant \((F = F^l, w^l = w^*_c)\) and the debt structure that includes a high debt level and a restrictive covenant \((F = Q, w^l = w^*_r)\) are optimal solutions to the good manager’s problem under different parameter values. In the figure the vertical axis represents the value of the objective function while the horizontal axis represents different values for \(Q\) the firm’s liquidation value. The black curve charts the value of the objective function under the high debt solution for a variety of levels of the liquidation value of the firm, \(Q\), while the grey curve charts this value at the low debt solution.

As discussed above, for low values of \(Q\) there is little total benefit to selling informationally insensitive securities available at time \(0\) while the incentive based costs of the high debt solution remain. Under the low debt solution some of the benefit to selling informationally insensitive securities is exploited with only minimal incentive costs. Therefore, for low values of \(Q\) the low debt solution is the optimum. As the liquidation value rises, the relation between the solutions reverses. As shown in Figure 1b, the low level of debt, \(F^l\) which strikes a balance between the benefits of using risky debt rather than external equity and the incentive costs introduced by the debt, rises very slowly with increases in the liquidation value. This implies that the value of the objective function under the low debt solution will also change relatively little for increases in \(Q\). Also as discussed above, as \(Q\) rises, the total value of issuing debt rather than external equity rises. While the cost of distortions in the liquidation decision making also rise,
with a continuous public signal these costs are more appropriately managed (setting \( w' = w_T^* \)) than they are with a binary signal. Thus the value of the objective function under the high debt solution will rise relative to the value under the low debt solution.\(^5\)

Figures 2a and 2b present the same relation as in Figure 1a with a change in the value of the parameter \( \theta \), the probability of a good type firm/manager. There are two intuitive changes in these figures relative to Figure 1a. The first is the level of the curves. The value of the good manager’s retained equity decreases as the probability of a good manager drops from 0.5 to 0.3 (Figure 1a versus Figure 2a) and increases as this probability increases from 0.5 to 0.8 (Figure 1a versus Figure 2b). This effect is simply due to the effect that changing \( \theta \) has on total value. Secondly, for relatively high levels of the liquidation value, the dominance of the high debt solution relative to the low debt solution varies inversely with \( \theta \). In other words, for low \( \theta \) and high \( Q \) the high debt solution is much more valuable to a good manager than is the low debt solution, while for high \( \theta \) and high \( Q \) the high debt solution is only marginally better than the low debt solution. This difference is due to the change in the benefit of selling debt rather than external equity as the mix of observationally equivalent firms changes. When there are many good firms and only a few bad firms the adverse selection discount is relatively small. Therefore the benefit of the high debt solution is reduced. However, when there are many bad firms and few good firms the benefit received by a good firm from selling debt instead of external equity is large.

**Renegotiation of the Covenants**

\(^5\) The general shape of the curves in Figure 1a may be explained as follows. With low \( Q \) the cost of distortions in liquidation decision making are very low. As \( Q \) increases, holding the other parameters fixed, there are two effects. First the cost of the distorted incentives increases (the liquidation decision is more important). Secondly, there is more total value available (the NPV rises). The first effect is responsible for the initial decrease while the second soon becomes dominant.
3. Robustness

To be written…

4. Empirical Predictions and Analysis

To be written…

5. Conclusion

The capital structure decision is examined in a setting with asymmetric information as the sole friction. The model is an extension of Myers and Majluf (1984) where the implication of having debt in the capital structure under a condition of asymmetric information is considered at the time of financing. We demonstrate that an optimal capital structure may be derived trading off the benefits of selling debt, based on its low information sensitivity, and the costs of debt, derived from the inefficient decision making implied by transfers of control to uninformed parties.
Appendix (proofs of the propositions):

Proof of Proposition 1: The structure of the model with a binary public signal allows us to define the following values for the informed value of equity (debt) for a good (bad) firm:

$$S^I_G(F^L, w_2) = pGw_1(H - F^L) + (1 - p)GW_2(H - F^L)$$

and

$$S^I_B(F^L, w_2) = pBW_1(H - F^L) + (1 - p)(Q - F^L) = pBW_1(H - F^L) + (1 - p)BW_2(H - F^L),$$

where the second equality derives from the definition of $F^L = \frac{Q - w_2BH}{1 - w_2B}$.

Furthermore the uninformed equity value is written:

$$S^U_G(F^L, w_2) = p\bar{w}_1(H - F^L) + (1 - p)(\theta GW_2(H - F^L) + (1 - \theta)(Q - F^L)).$$

Similarly:

$$D^I_G(F^L, w_2) = pGw_1(F^L - L) + (1 - p)GW_2(F^L - L) + L$$

$$D^I_B(F^L, w_2) = pBW_1(F^L - L) + (1 - p)(F^L - L) + L$$

$$D^U(F^L, w_2) = p\bar{w}_1(F^L - L) + (1 - p)(\theta GW_2(F^L - L) + (1 - \theta)(F^L - L)) + L$$

Then $Obj(F^L, w_2) = (p\bar{w}_1(H - L) + (1 - p)(\theta GW_2(H - L) + (1 - \theta)(Q - L)) - (I - L)) \times \frac{G}{I}$

Similarly we can write

$$Obj(L, w_2) = (p\bar{w}_1(H - L) + (1 - p)(\theta GW_2(H - L) + (1 - \theta)(Q - L)) - (I - L)) \times \frac{pGw_1(H - L) + (1 - p)GW_2(H - L)}{p\bar{w}_1(H - L) + (1 - p)(\theta GW_2(H - L) + (1 - \theta)(Q - L))}$$
Direct comparison shows that \( \text{Obj}(F^L, w_2) > \text{Obj}(L, w_2) \) whenever 

\[ w_b^* = \frac{Q - L}{B(H - L)} > w_2 \text{ which is assumed (i.e. it is efficient to liquidate the bad firm in a weak market.}

Proof of Proposition 2:

Similar to the definitions in the proof of proposition 1 we can write:

\[ \text{Obj}(Q, w_2) = (p\tilde{w}_1(H - L) + (1 - p)\tilde{w}_2(H - L) - (I - L)) \times \frac{G}{I} \]

and

\[ \text{Obj}(Q, w_1) = (p\tilde{w}_1(H - L) + (1 - p)(Q - L) - (I - L)) \times \frac{G}{I} \]

It is straightforward to show that \( \text{Obj}(Q, w_2) > \text{Obj}(Q, w_1) \) iff \( \frac{Q - L}{I(H - L)} < w_2 \). In other words, if a high level of debt is chosen it is optimal to assign control of the liquidation decision to the manager in both a weak and a strong market if and only if it is efficient for a firm of average type to continue in a weak market. Similarly, it is optimal to assign control of the liquidation decision to the lender in a weak market if it is efficient for a firm of average quality to be liquidated in a weak market.

Proof of Proposition 3:

Direct comparison shows that \( \text{Obj}(F^L, w_2) > \text{Obj}(Q, w_2) \) whenever 

\[ w_b^* = \frac{Q - L}{B(H - L)} > w_2 \] and \( \text{Obj}(F^L, w_2) > \text{Obj}(Q, w_1) \) whenever \( w_b^* = \frac{Q - L}{B(H - L)} < w_2 \). Both of these conditions were assumed to hold. Intuitively the first inequality holds because if equity controls the liquidation in both weak and strong markets and a high debt level is chosen the inefficient continuation of the bad firm in a weak market will be priced into
the securities. The second holds because when the lender owns the liquidation decision in a weak market, the inefficient liquidation of the good firm in a weak market is priced into the securities.

Proof of Proposition 4: Assume that a covenant assigning control to the lender in a weak market has been included in an initial (time 0) debt contract with a face value $F = F^H < Q$, and that this covenant has been “violated,” $w = w_2$. Note that in order for a renegotiation offer, $F^S$, from a good firm to be separating it must be that $Q - F^H \leq Bw_2(H - F^S)$. We will assume that the minimal such increase in debt is offered by the good firm so that a bad firm would be indifferent to continuation and liquidation. This implies we can write the renegotiation offer as $F^S = H - \frac{(Q - F)}{Bw_2}$. The offer $F^S$ must also be acceptable to the lender, given that $w = w_2$. In other words, it must be true that $F^H \leq Gw_2(F^S - L) + L$. Substituting for $F^S$ we find

$$F^H \geq \frac{Gw_2 Q - Gw_2 H - (1 - Gw_2) L}{\frac{G}{H} - 1},$$

the requirement in Proposition 4. Note, $F^H$ may be chosen strictly less than $Q$ as long as it is efficient for a good firm to continue in a weak market. If the renegotiation offer $F^S$ satisfies the requirement that a bad firm will not have any incentive to mimic, then as long as the initial debt contract has a face value $F^H$ at least as large as specified in the above inequality the lender will accept the renegotiation offer.

Proof of Proposition 5: The proof of this proposition comes simply by writing the objective function for the manager of a good firm for an arbitrary $F^H$ and assuming that a separating renegotiation offer will be made by a good firm if a weak market is realized.
It is straightforward to show that this objective function is not dependent upon the initial choice of $F^H$. The value of the objective function for a manager of a good firm is, for an arbitrary $F^H$ and the associated $F^S(F^H)$ given renegotiation of the covenant if $w = w_2$, written as:

$$
Obj(F^H, F^S, w_i) = \left( \frac{p\bar{\theta}w_i(H-L) + (1-p)(\theta gw_i(H-L) + (1-\theta)(Q-L)) - (I-L)}{p\bar{\theta}w_i(H-F^H) + (1-p)(\theta Gw_i(H-F^S) + (1-\theta)(Q-F^H))} \right)
\times(pGw_i(H-F^H) + (1-p)Gw_i(H-F^S))
$$

Imposing the requirement for separation by substituting $Q - F^H = Bw_2(H - F^S)$ into the denominator of the first term allows us to write the objective function as:

$$
Obj(F^H, F^S, w_i) = \left( \frac{p\bar{\theta}w_i(H-L) + (1-p)(\theta gw_i(H-L) + (1-\theta)(Q-L)) - (I-L)}{G} \right)
$$

which is independent of $F^H$.

Proof of Proposition 6: Direct comparison shows that $Obj(F^H, F^S, w_i) = Obj(F^L, w_2)$. 

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References


**Figure 1a:** Value of the objective function for a good type manager against different levels of $Q$. Other parameters of the problem are held constant: $H = 4$, $L = 1$, $w = 0.15$, $\bar{w} = 1.2$, $\theta = 0.5$, $G = 0.75$, $B = 0.60$, and $I = 1.25$. 
Figure 1b: Numerical representation of the relation between $Q$ and $F^L$. Parameter values are as reported in Figure 1a.
Figure 2a: Manager’s objective function against $Q$ for the parameter values used in Figure 1a except that $\theta = 0.3$.

Figure 2b: Manager’s objective function against $Q$ for the parameter values used in Figure 1a except that $\theta = 0.8$. 
Figure 3: Manager’s objective function value versus $\theta$. 