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Management Compensation and Earnings-Based Covenants in Resolving Adverse Selection in Credit Markets

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Abstract

A firm seeks to raise capital in credit markets to fund risky operating activities. The firm has private information about the future cash flows from such activities. Firm owners delegate operating decisions to a manager who privately learns further information about the distribution of those cash flows subsequent to contracting. Those decisions include the selection of which operating activities to pursue and how much hidden effort to exert. At issue in the first part of this paper is the efficient design of the manager’s compensation as a device for signaling private information to lenders as well as for inducing operating decisions. Our results provide conditions under which a Bayesian Nash separating equilibrium satisfying the Cho-Kreps intuitive criterion exists. Broadly speaking, these results suggest that contracts that resolve internal adverse selection and moral hazard problems may contribute to the resolution of external adverse selection problems. In the second part, we show how earnings-based debt covenants and the selection of conservative accounting methods may eliminate signaling costs altogether.

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I. Introduction

In this paper, we consider two signaling devices that while ubiquitous and plausible have not received much formal attention. First, it seems natural that publicly disclosed compensation contracts employed to induce desired actions by managers also convey information to capital suppliers concerning the operating risks the firm faces. Second, oftentimes latent in discussions of accounting choices is the notion that such choices influence the cost of capital even when those choices are unaccompanied by cash flow effects.

Models of signaling to financial markets typically suppress incentive contracting within the firm. Either no distinction is made between firm owners and managers, or managers’ objective functions are *ad hoc*. A notable exception is Dybvig and Zender (1991) who demonstrate how optimal compensation contracts might resolve investment distortions arising from information asymmetries that otherwise prompt signaling through capital structure. However, apart from the role that adverse selection may or may not play in determining capital structure, there is the interesting question of whether compensation contracts that address information asymmetries between firm owners and managers might also resolve adverse selection between the firm at large and capital suppliers. We provide an answer in this paper by showing how compensation contracts that motivate optimal risky operating decisions may also be used to signal default risk to prospective creditors.

Previous efforts to link accounting choices to signaling generally characterize accounting choices as money burning devices. For example, Hughes and Schwartz (1988) show how the loss of tax savings associated with the choice of the LIFO rather than the FIFO method of valuing inventory could signal more favorable future cash flows. The novelty in our treatment of accounting choices as a signaling device lies in showing how accounting choices in tandem with debt covenants that rely on accounting measures influenced by such choices might make it possible to avoid signaling costs altogether. In particular, we explore the prospect of improving upon the efficiency of compensation contracts through the selection
of conservative accounting methods for determining earnings in the application of earnings-
based debt covenants.

Given that executive compensation contracts are described in filings with the Security
and Exchange Commission (SEC),\textsuperscript{1} it is difficult to imagine that capital suppliers would
not monitor those contracts. Indeed, the mere fact that the SEC requires public disclosure
of such contracts clearly suggests that investors at large find useful information regarding
future decisions that firm managers might make to be contained in those disclosures. Like-
wise, firm principals would have to be naïve not to anticipate the prospect that investors
would draw inferences from these disclosures.\textsuperscript{2}

The setting we consider is one in which the firm is capital rationed and seeks to fund
its future operating activities by borrowing from competitive creditors. There are adverse
selection problems between the firm and creditors stemming from the firm’s private informa-
tion about future cash flows from alternative operating activities, and between firm owners
and a manager who has access to further private information about those cash flows and
the level of effort he supplies to enhance the firm’s prospects. The optimal (second-best)
compensation contract is invertible in the decision rule that the owner wishes the manager
to follow and, in turn, that rule is invertible in the firm’s private information. Thus, the
contract effectively becomes a (dissipative) device for signaling that information to prospec-

\textsuperscript{1}Section 64022 Item 402 of SEC Regulation S-K requires disclosure of compensation components, option
and other stock-based awards under long-term incentive plans, employment agreements, compensation poli-
cies, and the relationship of executive compensation to corporate performance for named executive officers.
In general, the requirements encompass all plan as well as non-plan compensation awarded to officers and
directors. While the regulations are not entirely clear on what elements of future compensation arrangements
need be disclosed, there is a prospective content where formal agreements or plans exist. It is also evident
that even retrospective compensation data is informative regarding the form that compensation will likely
take in the future. For example, stock options, phantom stock grants, and restricted stock grants typically
vest either with passage of time or satisfaction of performance criteria and, hence, are part of the incentive
compensation commitments influencing management behavior.

\textsuperscript{2}In a completely different context, Fershtman and Judd (1987) suggest that compensation contracts might
be used to convey a first-mover advantage in oligopolistic product markets.
tive lenders.\textsuperscript{3} Note that debt contracts need not explicitly refer to observable commitments contained in compensation contracts in order for such commitments to affect borrowing terms. It suffices that compensation contracts are common knowledge.

Notwithstanding the highly stylized structure employed to achieve our results, the convexity (in outcomes) of second-best compensation in our analysis corresponds to characteristics of executive compensation contracts documented by Murphy (2000) and many others. While an empirical exercise in relating executive compensation to borrowing rates would impose data gathering requirements well beyond the scope of this study, our results offer the prediction that compensation for managers of better type (less credit risk) firms is likely to have a smaller component that is contingent (e.g., bonus or stock options) and a larger base salary than that for worse type (higher credit risk) firms, all else held constant. Thus, we might expect that firms with a smaller contingent component to face lower borrowing costs.

Having characterized signaling through compensation contracts, we extend the devices available to the firm for signaling to include debt covenants based on accounting earnings and related commitments to accounting methods. The availability of these covenants in our model eliminates the need to rely on compensation contracts for signaling purposes. As a consequence, there is no longer a need to distort operating decisions in order to signal a better type and signaling becomes non-dissipative. While this portrayal is extreme, the notion that lesser types might be unable to mimic earnings covenants set by better types under similarly conservative accounting methods has considerable intuitive appeal.

Although we are accustomed to thinking of earnings as a measure of past performance, earnings are increasingly an expectation of future cash flows conditioned by decisions the

\textsuperscript{3}It is dissipative because the second-best compensation contract induces a distortion in operating decisions from those that would be made if firm type were observable to creditors. In other words, the incentive compatibility constraint on the choice of a second-best compensation contract to deter mimicking by a lesser type is binding.
manager has yet to make. Familiar examples include credit sales where future collections depend on the collection practices managers choose to follow; asset depreciation or amortization charges based on projections of future benefits that depend on managers’ subsequent operating decisions; warranties expenses based on estimated future claims that depend on managers recall or settlement decisions; and construction projects where income is recognized in advance of uncertain costs and collections both of which depend on managers' decisions. In each case, there is uncertainty and there are decisions yet to be made at the time either income, revenue, or expense is recognized for accounting purposes. Thus, notwithstanding the historical content of earnings, it seems clear that the elements that allow earnings to play a signaling role are often present.

The intuition behind the effectiveness of accounting method choice given earnings-based debt covenants as a signaling device is that by irrevocably choosing a publicly reported conservative accounting method of determining earnings, it is impossible for lesser types to meet the earnings threshold specified by a better type. Generally accepted accounting principles provide limited scope for influencing earnings numbers through flexibility in the choice of accounting methods.\(^4\) A sufficiently conservative accounting method combined with a sufficiently high threshold would force a lesser type into technical default that we assume is prohibitively costly. Placing this view of accounting in the context of the times, some commentators suggest that the recent spate of accounting scandals relate to efforts to maintain credit ratings through accounting choices that go beyond the bounds of generally accepted principles.\(^5\) Also at an anecdotal level, we note the recent popularity of performance-based

\(^4\)From a modeling standpoint, this restriction translates into a moving support for earnings. Datar, Feltham, and Hughes (1991) consider accounting disclosure of firm values subject to audits that limit over- or under-statement as a complement to ownership retention in signaling firm type in a Leland and Pyle (1977) framework.

\(^5\)A less recent case suggesting signaling as a factor in accounting method choice, recounted by Healy and Palepu (1995), is CUC's change from an aggressive to conservative method of income recognition which accompanied their leverage recapitalization.
debt covenants.\textsuperscript{6}

A specific accounting choice with the potential for signaling through a combination of compensation and accounting choice is a firm’s decision whether or not to recognize the expense of stock options on their income statement. A firm choosing to expense stock options as recommended (but not required) by SFAS 123 will report lower earnings than a firm that avoids an earnings reduction by following APB 25. We note that several firms, including Coca-Cola, have recently announced plans to recognize the costs of options granted as an expense against earnings. A reasonable conjecture is that recent public scrutiny of executive compensation has diminished the costs\textsuperscript{7} of this accounting choice as a signaling device to the point where firms may now be expensing options to separate from riskier firms.

Many commitment devices have been considered for signaling firm type to financial markets including ownership retention (Leland and Pyle 1977), capital structure (Ross 1977), dividend policy (Miller and Rock 1985), convertibles conversion strategy (Harris and Raviv 1985), and underpricing (Welch 1989).\textsuperscript{8} Given suitable dimensionality to firm type, such as both mean and variance, signaling devices may be multi-dimensional (Grinblatt and Hwang 1989). More closely related to this paper, Myers and Majluf (1984) show how new investment strategies where investment requires outside financing can signal higher values of assets in place. Dybvig and Zender (1991) extend Myers and Majluf (1984) by endogenizing management compensation and use this feature to recover capital structure and dividend irrelevance in adverse selection settings. In their setting, however, there is no value to early release of information (signaling) by a firm. Hughes (1986) shows how accounting disclosures (rather than underpricing) could complement ownership retention in signaling.

\textsuperscript{6}For a rich description of performance-based debt covenants employed in practice, see Dichev and Skinner (2001)

\textsuperscript{7}We infer from the almost universal preference of firms not to include options expense in determining income prior to recent events that they perceived a cost to making that choice. However, it is unclear just what that cost might have been in a rational expectations equilibrium.

\textsuperscript{8}See Riley (2001) for an excellent survey of the signaling literature.
firm type when type consists of the variance as well as the mean of future cash flows and firms are required to be truthful. While in the usual case signaling is costly, Brennan and Kraus (1987) lay out general conditions under which signaling is non-dissipative.

The remainder of this paper is organized as follows: Section II describes our basic model; Section III provides characterizations of separating equilibria when operating policies are observable and Section IV characterizes separating equilibria of second-best compensation contracts that reveal those policies when they are not observable per se; Section V adds earnings-based debt covenants and accounting method choices to the picture and shows how these devices eliminate signaling costs; and Section VI offers some concluding thoughts.

II. Basic Model

A firm seeks to borrow funds to finance operating activities requiring an outlay denoted $I$. For example, these funds could be used to meet the working capital requirements of product development, manufacturing, and distribution. We assume that at the time of borrowing there are operating decisions yet to be made that affect the distribution of cash flows ultimately realized from that activity. We model these decisions as a choice between a risky and a riskless operating alternative. The risky alternative yields an uncertain net (of the investment $I$) cash flow, $x$, which can be high, medium or low, the support for which depends on private information $\theta \in \{G,B\}$, also referred to as the firm’s “type.” If the firm observes $G$, i.e., “good credit news”, then $x(G) \in \{L,M,H\}$, whereas if the firm observes $B$ (i.e., “bad credit news”), $x(B) \in \{L/\alpha, \alpha M, H/\alpha\}$, $\alpha \in (0,1)$ where $L < 0 < M < H$. The riskless alternative for type $G$ ($B$) yields the certain payoff $M(\alpha M)$.

We assume that probability distribution of $x$ is defined by a single parameter, $p$, repre-

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9It is important to point out that the labels “good” and “bad” news are from the lender’s perspective only. A firm of type $\theta = B$ might have higher expected cash flows, making it more appealing to an owner. However, as we demonstrate in equation (3), a type $B$ firm has a higher default risk, and because $\alpha < 1$, a lower default value.
senting the probability of the negative outcome $L(\theta)$ for firm type $\theta$, where the probability of $M(\theta)$ and $H(\theta)$ are each $\frac{1-p}{2}$. Under this structure, the expected value of the risky alternative is decreasing in $p$, and the two alternatives cannot be ordered by first-order stochastic dominance. At the time of contracting with a lender, the parameter $p$ is a random variable distributed uniformly over the unit interval.

The firm’s owners are risk neutral and seek to maximize expected net cash flow. They delegate operating decisions to the manager. For now we suppress the owners’ problem in designing the manager’s compensation and simply assume that the manager acts in the owners’ best interests. The manager knows $\theta$ and learns $p$ after contracting and before making an operating decision. An optimal operating decision policy takes the form of a hurdle rate for $p$ above which the manager chooses the riskless operating alternative, and below which the manager chooses the risky alternative. Given a hurdle rate $\bar{p}$, it is easily checked that for $\theta \in \{G, B\}$, the ex ante probabilities of outcomes $L(\theta)$, $M(\theta)$ and $H(\theta)$ are $\frac{\bar{p}^2}{2}, \frac{\bar{p}(2-\bar{p})}{4} + (1-\bar{p})$ and $\frac{\bar{p}(2-\bar{p})}{4}$, respectively. Holding aside compensation and borrowing costs, the hurdle rate that maximizes expected net operating cash flows before borrowing costs and the manager’s compensation given $\theta$ of

$$\bar{p}^*(\theta) = H(\theta) - M(\theta)$$

(1)

can be expressed as follows:

$$\bar{p}^*(\theta) = \frac{H(\theta) - M(\theta)}{M(\theta) + H(\theta) - 2L(\theta)}.$$  

(2)

It is evident that $\bar{p}^*(\theta)$ is increasing in $H(\theta)$ and $L(\theta)$ and decreasing in $M(\theta)$, implying a higher hurdle rate for a bad type:

$$\bar{p}^*(G) = \frac{H - M}{M + H - 2L} < \frac{H/\alpha - \alpha M}{\alpha M + H/\alpha - 2L/\alpha} = \bar{p}^*(B).$$

(3)

Observe that the hurdle rate for a bad type is decreasing in $\alpha$ and from equation (1) expected net operating cash flows are convex in $\alpha$. Hence, the lower the value of $\alpha$, the
greater the difference in first best hurdle rates for good and bad types. Note further that, depending on the parameters specified, the firm’s expected net operating cash flows may be greater for bad types than for good types. However, both the default risk and default value are higher for a good type implying a lower borrowing rate if type was known to lenders.

Prospective lenders are risk neutral and require an interest rate \( r \) which delivers an expected payment of \( (1 + r^f) \) per dollar loaned, where \( r^f \) is the rate required on a default-free loan. Thus, for a given \( \theta \) and hurdle rate \( \bar{p} \),

\[
(1 + r^f)I = \left( \frac{\bar{p}^2}{2} \right) (I + L(\theta)) + \left( 1 - \frac{\bar{p}^2}{2} \right) (1 + r)I
\]  

(4)

With no loss in generality, we assume that \( r^f = 0 \). Solving equation (4) for \( r \), we obtain (recall \( L(\theta) \) is negative)

\[
r(\theta, \bar{p}) = \frac{-\bar{p}^2 L(\theta)}{I(2 - \bar{p}^2)}. \]  

(5)

In the case where lenders costlessly observe firm type, types would select their first best hurdle rate and lenders would require a rate based on type and the optimal hurdle rate for that type.\(^{10}\) Since firm type is not common knowledge, the owners for a good type may have incentive to find some means of signaling their type. In the next section, as a benchmark case, we assume that only hurdle rates (rather than types) are observable, holding aside the design of the manager’s compensation. We then show that management compensation contracts can communicate hurdle rates that, in turn, signal the firm’s type.

### III. Signaling Through Hurdle Rates

In the games that follow, the firm offers a contract to lenders who then accept or reject that contract. We begin with contracts that take the form of a pair \((R, \bar{p})\), where \( R \) and \( \bar{p} \) denote

\(^{10}\)Notwithstanding the option characteristic of residual firm equity in the presence of debt and the incentives that provide for inducing a higher hurdle rate, the fair pricing of debt implies the higher default risk that may result is precisely offset by a higher interest rate. Hence, given no adverse selection problem in borrowing, the optimal hurdle rate is still provided by equation (2).
the borrowing and hurdle rates, respectively. For now, we assume that the firm is able to publicly commit to \( \bar{p} \). Later, we relax this assumption and allow lenders to infer \( \bar{p} \) from their observation of the firm’s commitment to an endogenously determined compensation contract. As mentioned previously, perfectly competitive lenders accept contract offers for which they expect to receive at least their required return of \( r^f \) which we now normalize to zero. Otherwise, they reject and receive nothing.

The equilibrium concept we employ is Bayesian Nash. Lenders have common priors on firm type, where \( Pr(G) = Pr(B) = 0.5 \). Lenders form their posterior beliefs, \( Q(R, \bar{p}) \), that the firm’s type is \( G \) using Bayes’ theorem whenever possible. Off equilibrium beliefs will be specified as appropriate. We only characterize pure strategy equilibria. Accordingly, an equilibrium is defined as (i) a borrowing and hurdle rate pair for each type such that given lenders’ accept/reject regions, the pair maximizes the firm’s expected net operating cash flows; and, (ii) given the strategies specified by the firms, lenders’ accept/reject regions provide them with their required rate of return. Figure 1 presents a time line for the games that follow in this section.

**INSERT FIGURE 1 ABOUT HERE**

For a good type to obtain a more favorable interest rate than the average rate for good and bad types together, it could attempt to signal its type by choosing a sufficiently low hurdle rate. At this lower hurdle rate, a bad type would prefer not to mimic and, instead, choose the optimal hurdle rate for its type \( (\bar{p}^*(B)) \), despite a higher borrowing rate. This is the classic dissipative signaling approach introduced by Spence (1973). In particular, a good type firm’s owners would solve the following program:

\[
\begin{align*}
\text{max}_{\bar{p}} & \quad \bar{p} \left( \frac{2 - \bar{p}}{4} \right) (M + H) + (1 - \bar{p})M - \left( \frac{2 - \bar{p}^2}{2} \right) Ir(G, \bar{p}) \\
\text{s.t.} & \quad \bar{p}^*(B) \left( \frac{2 - \bar{p}^*(B)}{4} \right) \left( \alpha M + H/\alpha \right) + (1 - \bar{p}^*(B))\alpha M - \left( \frac{2 - \bar{p}^2(B)}{2} \right) Ir(B, \bar{p}^*(B))
\end{align*}
\]
\[ \geq \tilde{p} \left( \frac{2 - \tilde{p}}{4} \right) \left( \alpha M + H/\alpha \right) + (1 - \tilde{p})\alpha M - \left( \frac{2 - \tilde{p}^2}{2} \right) Ir(G, \tilde{p}) \]  

(7)

The constraint given by 7 ensures that a bad type has no incentive to mimic by choosing the same hurdle rate as a good type, given the alternative of choosing an optimal hurdle rate for its type.

We now state our first proposition:

**Proposition 1** Given that commitments to hurdle rates are publicly observable, a separating equilibrium exists and results in weakly inferior expected net operating cash flows less borrowing costs for a good type by comparison to the case in which type is costlessly observable to lenders.

**Proof:** See Appendix.

The off-equilibrium beliefs described in the proof to the above proposition are plausible in the sense of satisfying Cho and Kreps (1987) “intuitive criterion.”\textsuperscript{11} Loosely translated, any defection to a hurdle rate that would benefit a good type by comparison to the proposed equilibrium would also benefit a bad type for some beliefs. Hence, a bad type cannot be ruled out by a hurdle rate greater than that for a good type. Alternatively, the separating hurdle rate has the property that no matter what beliefs lenders may hold any lower rate is dominated for a bad type by its optimal (first best) hurdle rate. For low \( \alpha \), the bad type’s first best hurdle rate is significantly higher than the good type’s and the good firm may be able to separate using its optimal hurdle rate. That is, the losses to the bad firm by lowering its hurdle rate to \( \tilde{p}^* (G) \) would not be offset by the more favorable borrowing rate associated with a good type.

---

\textsuperscript{11}Pooling equilibria exist for some parameterizations; however, none satisfy the intuitive criterion.
IV. Signaling Through Management Compensation Contracts

Next, we step back and consider the problem the firm owners face in designing compensation contracts for risk and work-averse managers to whom they delegate operating decisions. There is adverse selection in that only the manager learns the parameter $p$ describing the distribution of outcomes under the risky alternative. As is standard, we also assume a moral hazard in that the manager’s effort is unobservable, and that effort affects the probability of the low outcome from the risky operating alternative. What we will show is that apart from the implicit cost of a second-best solution to the compensation problem, the signaling problem is qualitatively unchanged when publicly observable compensation contracts replace operating decision rules as the signaling device.

Specifically, we assume the manager’s utility function is

$$U(w, e) = \sqrt{w} - c(e),$$

where $w$ and $e$ denote the manager’s income and effort level (or action), respectively. Effort is binary: high effort $e = h$ for which $c(h) = K$ and low effort $e = l$ for which $c(l) = 0$. High effort implies a probability $p$ of the low outcome where, as before, $p$ is uniform on the unit interval and parameterizes the three-point distribution of operating payoffs. Low effort implies a probability of one for the low outcome. We further assume the manager can obtain a reservation utility $\bar{U}$ from other employment. Without loss of generality, we set $\bar{U} = 0$.

If owners could observe both the manager’s effort and private information, then they could induce the high effort when the risky project is chosen through compensation arrangements in the form of a step function such that the manager receives $K$ when $p < \bar{p}^*(\theta)$, where $\bar{p}^*(\theta)$ is the desired hurdle rate, and effort $e = h$ is observed and receives 0 otherwise. Since owners’ cannot observe either $p$ or $e$, they base compensation on the realized operating cash flow. Figure 2 contains a time line for the full game, including the firm owners’ choice of a compensation contract.
In addition to choosing a hurdle rate $\bar{p}$, the firm chooses a vector of outcome contingent compensation payments, $w(\theta) = [w(L(\theta)), w(M(\theta)), w(H(\theta)); \theta \in \{G, B\}]$, that serve to induce both high effort and appropriate operating decisions from managers. Lenders no longer observe $\bar{p}$. However they do observe compensation arrangements which, as we will show, are invertible in $\bar{p}$. In order to separate, a good type determines the set $(\bar{p}, v(G))$ that solves the program described next, where $v = \sqrt{w}$:

$$
\max_{\bar{p}, v} \quad \bar{p} \left( \frac{2 - \bar{p}}{4} \right) (M - v^2(M) + H - v^2(H)) \\
\quad + (1 - \bar{p})(M - v^2(M)) - \left( \frac{2 - \bar{p}^2}{2} \right) \text{Ir}(G, \bar{p}) \\
\text{s.t.} \quad \bar{p} \left( \frac{\bar{p}}{2} v(L) + \left( \frac{2 - \bar{p}}{4} \right) (v(M) + v(H)) - K \right) + (1 - \bar{p})(v(M)) \geq 0 \tag{8}
$$

$$
\bar{p}v(L) + \left( \frac{1 - \bar{p}}{2} \right) (v(M) + v(H)) - K \geq v(M) \quad \forall \bar{p} \leq \bar{p} \tag{9}
$$

$$
\hat{p}v(L) + \left( \frac{1 - \hat{p}}{2} \right) (v(M) + v(H)) - K \leq v(M) \quad \forall \hat{p} \geq \bar{p} \tag{10}
$$

$$
\hat{p}v(L) + \left( \frac{1 - \hat{p}}{2} \right) (v(M) + v(H)) - K \geq v(L) \quad \forall \hat{p} \leq \bar{p} \tag{11}
$$

$$
v(i) \geq 0 \quad i \in \{L, M, H\} \tag{12}
$$

Equation (9) ensures the manager weakly prefers employment with the firm to alternative employment opportunities. Equation (10) ensures that the manager prefers the risky project with high effort to the safe project (with low effort) whenever the probability of the low outcome is below the hurdle rate and the reverse holds by (11) when the probability of the low outcome is above the hurdle rate. By equation (12), the manager takes high effort whenever investing in the risky project. With only two possible actions, we can replace equations (10) and (11) with the following:

$$
\hat{p}v(L) + \frac{1 - \hat{p}}{2} (v(M) + v(H)) - K = v(M) \tag{14}
$$
Equation (14) makes the manager exactly indifferent between high effort and the risky project and low effort and the safe project at the hurdle rate \( \bar{p} \). For the inequalities given by (10) and (11) to hold over the entire range of \( p \), the manager’s expected utility of investing in the risky project must be decreasing in \( p \). Equation (15) formalizes this condition such that the manager optimally follows a hurdle strategy. Eliminating non-binding and redundant constraints, we have the revised program below:

\[
\begin{align*}
\max_{\bar{p}, v} & \quad \bar{p} \left( \frac{2 - \bar{p}}{4} \right) (M - v^2(M) + H - v^2(H)) \\
& \quad + (1 - \bar{p})(M - v^2(M)) - \left( \frac{2 - \bar{p}^2}{2} \right) Ir(G, \bar{p}) \\
\text{s.t.} & \quad \bar{p} \left( \frac{\bar{p}}{2} v(L) + \left( \frac{2 - \bar{p}}{4} \right) (v(M) + v(H)) - K \right) + (1 - \bar{p})(v(M)) \geq 0 \\
& \quad \bar{p}v(L) + \frac{1 - \bar{p}}{2} (v(M) + v(H)) - K = v(M) \\
& \quad v(L) \leq v(M) \\
& \quad v(i) \geq 0 \quad i \in \{L, M, H\}
\end{align*}
\]

Our next proposition characterizes the structure of second best compensation.

**Proposition 2** Compensation for the manager of either firm type provides identical payments when the low or middle operating outcomes are observed and a strictly higher payment when the high operating outcome is observed. These compensation arrangements are invertible in the equilibrium hurdle rate for each type.

**Proof:** See Appendix.

The convex form of compensation corresponds to bonus schemes or stock options ubiquitous in current practice. Invertibility allows lenders to infer the second-best hurdle rate from public disclosure of those contracts.
Proposition 3 Given that commitments to manager compensation contracts are publicly observable, a separating equilibrium exists and results in owners of each firm type receiving expected net operating cash flows, less manager compensation and borrowing costs, equal to those for the case in which hurdles rates are observable to lenders.

Proof: See Appendix.

If the types separate using compensation contracts (i.e., hurdle rates), a good type would offer a higher (non-contingent) salary \( v(L) = v(M) > v(L/\alpha) = v(\alpha M) \) but lower contingent payments than a bad type firm \( v(H) < v(H/\alpha) \). The higher contingent portion makes the risky project relatively more appealing to the manager, and thus induces a higher hurdle rate.

Thus, in brief, we have established the existence of a separating equilibrium in the presence of an embedded managerial adverse selection and moral hazard problems where compensation arrangements rather than hurdle rates are observable to lenders.

V. Signaling Through Earnings-Based Debt Covenants

We now introduce the prospect of writing debt covenants that depend on accounting earnings. In this regard, we define accounting earnings as an expectation of future cash flows. Revising the time line in Figure 1, we assume that earnings are recognized prior to the resolution of uncertainty and operating decisions that affect default risk. As discussed in the introduction, this characterization of earnings is in keeping with the accrual concept of accounting and the reliance of earnings measurement on estimates of future benefits.

For modeling purposes, we define accounting earnings, \( \mathcal{E} \), as expected operating cash flows before interest payments to lenders for a firm of type \( \theta \) as follows:

\[
\mathcal{E}(\theta, \phi) = \phi \left( \frac{\phi}{2} \right) L(\theta) + \left( \phi \left( \frac{2 - \phi}{4} \right) + (1 - \phi) \right) M(\theta) + \phi \left( \frac{2 - \phi}{4} \right) H(\theta),
\]

where \( \phi \in (0, 1) \). The parameter \( \phi \) determines the extent of conservative bias in earnings.
When \( \phi = \bar{p} \), the chosen hurdle rate, then the above measure is an unbiased expectation corresponding to equation (1).

A debt covenant is expressed as a pair \((\bar{\phi}, \bar{E})\) where \(\bar{E}\) denotes a critical value of earnings, such that for \(\mathcal{E}(\theta, \bar{\phi}) < \bar{E}\) the firm is in technical default.\(^{12}\) We assume that a firm would prefer to incur the higher borrowing rate than to violate a debt covenant. It would suffice for technical default to invoke a borrowing rate for a bad type to induce this preference. We modify our earlier description of an equilibrium to allow the contract offered by the firms to include a debt covenant along with borrowing and hurdle rate pairs.

The new program, incorporating signaling through earnings based debt covenants is:

\[
\max_{\bar{p}, v, \bar{\phi}, \bar{E}} \bar{p} \left( \frac{2 - \bar{p}}{4} \right) (M - v^2(M) + H - v^2(H)) + (1 - \bar{p})(M - v^2(M)) - \left( \frac{2 - \bar{p}^2}{2} \right) Ir(G, \bar{p}) \tag{22}
\]

s.t.  
\[
\bar{p} \left( \frac{\bar{\phi}}{2} \frac{v(L)}{\alpha} - \bar{\phi}^2 \frac{L}{\alpha^2} \right) + \left( \frac{2 - \bar{\phi}^2}{4} \right) (\alpha M - v^2(\alpha M) + H/\alpha - v^2(H/\alpha)) \right) 
+ (1 - \bar{\phi})(\alpha M - v^2(\alpha M)) - (1 - \frac{\bar{\phi}^2}{2}) Ir(G, \bar{p}) = \bar{E} \tag{27}
\]

The principal change from the early program is the inclusion of equation (27) which determines an earnings level \(\bar{E}\) and an accounting method \(\bar{\phi}\) such that a firm whose type is bad cannot achieve the earnings level using accounting method \(\bar{\phi}\) and therefore cannot mimic a good type. Because of the equality, \(\bar{\phi}\) represents the least conservative accounting method sufficient to separate.

\(^{12}\)We point out that it is not necessary for debt covenants, per se, to refer to accounting choices. It suffices for such choices to take the form of publicly observable commitments.
Our last result can be stated as follows:

**Proposition 4** Given that commitments to accounting methods and manager compensation contracts are publicly observable, a separating equilibrium exists and results in each firm type receiving expected net cash flows, less manager compensation and borrowing costs, equal to those for the case in which type is costlessly observable to lenders.

**Proof: See Appendix.**

Separation is now accomplished through an accounting method choice and earnings threshold contained in the form of a debt covenant, rather than through a distortion in hurdle rates away from optimal rates if type were revealed. The firm incurs a borrowing rate appropriate for its type and selection of a hurdle rate. The earnings threshold is set so that either type can meet its debt covenant, which is also parameterized by its accounting choice. Hence, there would be no technical default in this equilibrium.

At a technical level, the crucial element of structure driving this result is the single crossing property of $E$ as a function of $\phi$ conditional on $\theta$. In particular, given $M(B) < M(G)$ a good type can exploit the moving support on the degenerate distributions of the safe alternative to separate by setting $\phi = 0$; i.e., a good type can be certain that a bad type cannot satisfy a covenant $\bar{E} = E(G, 0)$. More notably, it may be possible to separate through an accounting choice $\phi > 0$ provided a bad type cannot attain earnings of $E$ using that $\phi$.

The single crossing property is also sufficient in cases where a bad type is not constrained to have a lower payoff for its safe operating alternative, but poses a higher default risk due to choosing the risky alternative with greater frequency. A less restrictive structure on earnings would allow for some residual uncertainty, but retain the single crossing property

---

13 Consider cash flows of a good and bad type to be $\{L, M, H\}$ and $\{L/\alpha_1, \alpha_2 M, H/\alpha_3\}$ where $\alpha_i \in [0, 1]$ and $\alpha_i$s are not constrained to be equal. As long as the $\alpha$s are such that the bad type has higher default risk and lower default value ($\alpha_1 < 1$), the single crossing property still holds. Here however, the accounting practice may not be to lower $\phi$ to zero, but rather to increase $\phi$ to make it impossible for a bad type to mimic.
in expected earnings. In such a setting, as the probability of technical default decreases, the minimum penalty for technical default to sustain separation would need to increase.

Although other separating equilibria may exist in the form of covenants that vary in the earnings threshold, all separating equilibria undominated by the equilibrium described in Proposition 4 would yield the same net expected cash flows. Moreover, there are cases in our model setting in which non-dissipative signaling can only be achieved by allowing accounting method choices to vary. Thus, debt covenants either encompassing or accompanied by accounting choices may be strictly valuable to good types in signaling their type to lenders who supply capital for funding operating activities.

Table 1 presents a numerical example. In the example, a bad type finds it profitable to mimic a good type’s choice of .32 as a hurdle rate (equivalently a compensation payment of 2.94 in a high state) in order to get the good type’s borrowing rate. To separate itself, the good type could choose a lower hurdle rate (no more than .29, which is equivalent to a compensation payment of 2.82 in a high state). However, such a distortion in the hurdle rate would lower the good type’s expected profit from 61.83 to 61.74. The alternative is to employ a debt covenant specifying any accounting policy less aggressive than (in terms

<table>
<thead>
<tr>
<th>State</th>
<th>Type Known</th>
<th>Mimic</th>
<th>Separating using $\bar{p}$</th>
<th>Earnings (Mimic)</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>L (-90/-100)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>M (50/45)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>H (200/222)</td>
<td>2.94</td>
<td>3.07</td>
<td>2.94</td>
<td>2.94</td>
</tr>
</tbody>
</table>

- $\bar{p}$
- $\phi$

| $\bar{p}$ | 0.32 | 0.35 | 0.32 | 0.29 | 0.32 |
| $\phi$    | -    | -    | -    | -    | 0.34 |
| Profits   | 61.83| 60.34| 60.74| 61.74| 60.74|
| Earnings  | -    | -    | -    | -    | 61.83|
analogous to a hurdle rate) .34 and an earnings threshold lower than 61.83. The bad type cannot meet such an accounting policy and earnings threshold without technical default. It is important to note that if the accounting method were not specified, the bad type could achieve the same earnings level as a good type simply by using more aggressive accounting (last column). The example, while a simplification, captures the essence of the accounting choice pertaining to executive stock options mentioned in the introduction. Recognition (non-recognition) of the cost of options as an expense could be said to correspond to unbiased (aggressive) accounting. It is plausible to envision that a firm with weaker earnings may not be able to meet an earnings-based covenant were it to expense options. Yet, if the firm chooses not to expense options in order to meet an earnings threshold, then disclosure of that policy reveals the firm’s type.

Plausible examples aside, it remains an empirical question whether firms do, in fact, benefit from more conservative accounting methods. If a bad type must use more liberal accounting methods to achieve the same level of earnings as a good type and those methods are disclosed, then the latter should be rewarded with a lower borrowing rate. As a expedient and crude test of this prediction, we use bond ratings provided by Standard and Poor’s system to proxy for interest rates and conduct an ordered logit with 19 bond rating categories as the dependent variable.\textsuperscript{14} Independent variables include the non-cash (accrual) component of earnings as an overall measure of conservatism in accounting methods chosen and earnings \textit{per se} and debt-to-equity ratios as controls. The Wald $\chi^2$ statistic is highly significant.\textsuperscript{15} A similar result is obtained when the particularly prominent accounting choice of LIFO (conservative) or FIFO (liberal) for valuing inventories replaces the non-cash

\textsuperscript{14}Greene (1997) provides bond ratings as an example of a multinominal choice variable that is inherently ordered.

\textsuperscript{15}Details are available from the authors upon request. A caveat to this finding is the rejection of the specification assumption that coefficients across categories are equal. We also conducted tests on mean (numerical) ranks within quintiles of earnings and a logit using a dichotomous partition of bond ratings with consistent results.
component of earnings.\textsuperscript{16}

VI. Conclusion

In this paper, we have shown how contracts that resolve information asymmetries between owners and managers might also contribute to the resolution of information asymmetries between firms and capital suppliers. We also showed how commitments to accounting methods and recourse to accounting numbers determined pursuant to those methods in applying debt covenants might reduce signaling costs.

The context in which we obtain these results is that of a firm with private information (i.e., its "type") seeking to borrow funds to support its operating activities for which there are manager decisions yet to be made at the time of contracting with prospective lenders. Subsequent to contracting, the firm’s manager receives further private information upon which operating decisions depend and exerts hidden effort in implementing those decisions. The owners design the manager’s compensation so as to induce the manager’s compliance with a desired decision rule for choosing an operating activity. By conditioning the manager’s compensation on the firm’s type the owners’ commitment to a compensation contract serves as a signaling device to lenders in a separating equilibrium satisfying the Cho-Kreps intuitive criterion.

The firm can improve the efficiency of separation by choosing a sufficiently conservative accounting method for purposes of determining earnings applied in a debt covenant that specifies a threshold level that must be met in order to avoid costly technical default. The key element of this mechanism as a signaling device is moving support; i.e., accounting methods are assumed to shift the range of earnings that could be reported conditional

\textsuperscript{16} Our prediction and findings that LIFO signals a better type than FIFO is the opposite of Hughes and Schwartz’s (1988) prediction, which is based on a money burning signal in the form of higher taxes. Given the current tax environment, the real advantages of LIFO would appear to be small if they exist at all.
on type. While this characterization is extreme, most would agree that there are limits to how far one can bias earnings without running afoul of generally accepted accounting principles thereby incurring costs associated with auditor and regulator disapproval and related sanctions. At a minimum, we believe that the case for accounting choices to play a signaling role is strong enough to prompt a more thorough empirical inquiry than we have mounted with our look at bond ratings.

As a theoretical matter, we speculate that there are many settings in which contracts that resolve internal information asymmetries can be exploited to resolve external information asymmetries and commend exploration of this possibility to future research. It seems likely that there would be other applications (than debt pricing) for which accounting method choice and the attendant institutional machinery that restricts that choice could play a signaling role.

APPENDIX

Proof of Proposition 1:

Let lenders apply the following rate schedule:

\[
R(\tilde{p}') = \begin{cases} 
  r(G, \tilde{p}') & : \tilde{p}' < \bar{p} \\
  r(B, \tilde{p}') & : \tilde{p}' \geq \bar{p}
\end{cases}
\]  

where \(\bar{p}\) is determined by Equations 6-7.

In a separating equilibrium the good type chooses hurdle rate \(\tilde{p}\) (which is lower than it’s first best hurdle rate, \(\tilde{p}^*(G)\)) and a bad type chooses hurdle rate \(\tilde{p}^*(B)\), or the optimal hurdle rate for its type, given type is disclosed. By equation (7), the bad type prefers its optimal hurdle rate and revelation of type (i.e., the borrowing rate appropriate for a bad type). Since a good type can separate using \(\bar{p}\), it will certainly not lower its hurdle rate further. If the good type chooses a hurdle rate higher than \(\tilde{p}\), it receives the bad type’s rate. Let the best hurdle rate for a good type, receiving the bad type’s rate be \(p_{GB}\). Then,
let \( p_{GG} \) be the hurdle rate at which that a good type is indifferent between \( p_{GB} \) and the rate for a bad type and \( p_{GG} \) and the rate for a good type. The single crossing property of the isoprofit lines for the good and bad types requires that \( p_{GG} < \bar{p} \) and thus profits are necessarily higher for the good type at \( \bar{p} \).

For an arbitrary hurdle rate \( \bar{p}' \), lenders beliefs are:

\[
\gamma(G, \bar{p}) = Pr(\theta = G|\bar{p}' = \bar{p}) = 1 \\
\gamma(B, \bar{p}) = Pr(\theta = B|\bar{p}' = \bar{p}) = 0 \\
\gamma(B, \bar{p}^*(B)) = Pr(\theta = B|\bar{p}' = \bar{p}^*(B)) = 1 \\
\gamma(G, \bar{p}^*(B)) = Pr(\theta = G|\bar{p}' = \bar{p}^*(B)) = 0
\]

which are consistent with Bayes’ rule. Thus, for each hurdle rate that is chosen in equilibrium, lenders give the “correct” rate to the correct type in equilibrium. Given priors on type, where \( q = Pr(\theta = G) \) and \( 1 - q = Pr(\theta = B) \),

\[
\frac{q\gamma(G, \bar{p})}{q\gamma(G, \bar{p}) + (1 - q)\gamma(B, \bar{p})}r(G, \bar{p}) + \frac{(1 - q)\gamma(B, \bar{p})}{q\gamma(G, \bar{p}) + (1 - q)\gamma(B, \bar{p})}r(B, \bar{p}) = r(G, \bar{p})
\]

and

\[
\frac{q\gamma(G, \bar{p}^*(B))}{q\gamma(G, \bar{p}^*(B)) + (1 - q)\gamma(B, \bar{p}^*(B))}r(G, \bar{p}^*(B)) + \frac{(1 - q)\gamma(B, \bar{p}^*(B))}{q\gamma(G, \bar{p}^*(B)) + (1 - q)\gamma(B, \bar{p}^*(B))}r(B, \bar{p}^*(B)) = r(B, \bar{p}^*(B))
\]

Profits are weakly lower using \( \bar{p} \) and receiving the rate \( r(G, \bar{p}) \) as \( \bar{p}^*(G) \) with rate \( r(G, \bar{p}^*(G)) \) is the solution to the unconstrained maximization problem.

**Proof of Proposition 2:**

Setting up the Lagrangian from equations (16)-(20), we have:

\[
\mathcal{L} = \bar{p} \left( \frac{2 - \bar{p}}{4} \left( M - v(M)^2 + H - v(H)^2 \right) \right) + (1 - \bar{p})(M - v(M)^2) \\
+ \lambda \left[ \bar{p} \left( \frac{\bar{p}}{2}v(L) + \frac{2 - \bar{p}}{4} (v(M) + v(H)) - K \right) + (1 - \bar{p})v(M) - U \right] \\
+ \mu_1 \left[ \bar{p}v(L) + \frac{1 - \bar{p}}{2} (v(M) + v(H)) - K - v(M) \right] + \mu_2 \left[ v(M) - v(L) \right] \tag{2}
\]
Differentiating we get:

\[
\frac{\partial L}{\partial \bar{p}} = \frac{1 - \bar{p}}{2} \left[ M - v(M)^2 + H - v(H)^2 \right] - \left[ M - v(M)^2 \right] \\
+ \lambda \left[ \bar{p}v(L) + \frac{1 - \bar{p}}{2} \left( v(M) + v(H) \right) - K - v(M) \right] + \mu_1 \left[ v(L) - \frac{1}{2} \left( v(M) + v(H) \right) \right] 
\]

(3)

\[
\frac{\partial L}{\partial v(L)} = \frac{\lambda \bar{p}^2}{2} + \mu_1 \bar{p} - \mu_2 
\]

(4)

\[
\frac{\partial L}{\partial v(M)} = -2v(M) \left[ \frac{\bar{p}(2 - \bar{p})}{4} + (1 - \bar{p}) \right] + \lambda \left[ \frac{\bar{p}(2 - \bar{p})}{4} + (1 - \bar{p}) \right] \\
+ \mu_1 \left[ \frac{1 - \bar{p}}{2} - 1 \right] + \mu_2 
\]

(5)

\[
\frac{\partial L}{\partial v(H)} = -2v(H) \left[ \frac{\bar{p}(2 - \bar{p})}{4} \right] + \lambda \left[ \frac{\bar{p}(2 - \bar{p})}{4} \right] + \mu_1 \left[ \frac{1 - \bar{p}}{2} \right] 
\]

(6)

Using the first order conditions:

\[
\mu_2 = \frac{\lambda \bar{p}^2}{2} + \mu_1 \bar{p} 
\]

(7)

\[
v(M) = \frac{\lambda}{2} + \frac{\mu_1}{2} \left[ \frac{1 - \bar{p}}{\bar{p}(2 - \bar{p}) + (1 - \bar{p})} \right] + \frac{\mu_2}{2} \left[ \frac{1}{\bar{p}(2 - \bar{p}) + (1 - \bar{p})} \right] 
\]

(8)

\[
v(H) = \frac{\lambda}{2} + \mu_1 \left[ \frac{1 - \bar{p}}{\bar{p}(2 - \bar{p})} \right] 
\]

(9)

The multipliers $\lambda$ and $\mu_2$ are both non-negative, but $\mu_1$ can be positive or negative. Suppose $\mu_1 < 0$. Then by Equations 8 and 9, $v(M) > \frac{\lambda}{2}$ and $v(H) < \frac{\lambda}{2}$.

However, if $v(M) > v(H)$ the manager will always prefer the safe project to the risky project, violating the constraint that the manager prefers the risky project and firm specific investments in the range $[0, \bar{p}]$. Therefore, $\mu_1 > 0$. Then, by Equation 7, $\mu_2 > 0$ since it is the sum of two non-negative numbers, one of which is strictly positive.

**Proof of Proposition 3:**

Let lenders’ rate schedule be defined over underlying hurdle rates as:

\[
R(\bar{p}')(v) = \begin{cases} 
  r(G, \bar{p}') & : \bar{p}' < \bar{p}(v(G)) \\
  r(B, \bar{p}') & : \bar{p}' \geq \bar{p}(v(G)) 
\end{cases} 
\]

(10)
where \( \bar{p}(v(G)) \) is determined by setting equation 3 to zero for a good type firm.

The remainder of the proof follows from the proof of proposition (1).

**Proof of Proposition 4:**

Let lenders’ rate schedule be defined hurdle rates, accounting method choice and earnings levels as:

\[
R(\bar{p}'(v), \phi, \bar{E}) = \begin{cases} 
    r(G, \bar{p}') & : \bar{p}' \leq \bar{p}^*(G), \phi \leq \bar{\phi}, \text{and } \bar{E} \geq \bar{E}(G, \bar{\phi}) \\
    r(B, \bar{p}') & : \text{otherwise}
\end{cases}
\]  

(11)

Good type firms offer a compensation vector \( v(G) \) that induces their first best hurdle rate \( \bar{p}^*(G) \), choose accounting method \( \bar{\phi} \) and guarantee an earnings level of \( \bar{E} \). Bad type firms cannot offer the same contract as their earnings level, under \( \bar{\phi} \) would place them in technical default, by equation (27). Since the good type achieves its first best hurdle rate, separation from the bad type is costless.
References


Firm learns type. Owners contract with managers by setting compensation conditional on outcomes that, in turn, depend on firm type, $\theta$. Firm contracts with lenders to borrow funds required for operating activities. Lending contracts are conditional on public disclosure of hurdle rate or compensation contract. Manager applies hidden effort, privately learns the probability parameter, and makes operating decision. Outcomes from operating activity realized, compensation payments made, amount borrowed is repaid, or the firm defaults and lenders receive operating cash flow less manager’s compensation.

Figure 1: Timeline of events: Signaling through hurdle rate
Firm learns type.

Owners contract with managers by setting compensation conditional on outcomes that, in turn, depend on firm type. Accounting method is chosen.

Firm contracts with lenders to borrow funds required for operating activities. Lending contracts are conditional on public disclosure of compensation contract, and contain an earnings based debt covenant.

Accounting earnings are recognized. Compliance with debt covenants is determined.

Manager applies hidden effort, privately learns the probability parameter, and makes operating decision.

Outcomes from operating activity realized, compensation payments made, amount borrowed is repaid, or the firm defaults and lenders receive operating cash flow less manager’s compensation.

Figure 2: Timeline of events: Non-dissipative signaling using debt covenants and accounting choice