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Bonuses and Non-Public Information in Publicly Traded Firms

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Abstract. Recent research in accounting explores how firms use "individual" or "non-financial" measures of performance in executive compensation contracts. We model a firm that conditions bonus payments to executives on information that is not available to those outside the firm. This raises two issues. First, market participants may use the magnitude of such payments to infer the non-public information. Second, because information that is non-public is, by extension, non-verifiable, the firm cannot write explicit contracts based on it. Combining the relational incentive contracts and financial signaling literatures, we examine equilibria of a signaling game in which bonus payments from a firm to a manager convey non-public information regarding the firm's future cash flows. Our main result is that increases in corporate myopia can, under some conditions, lead to increased profits. This finding is contrary to that typically found in financial signaling models.

Keywords: CEO compensation; Implicit contracts; Financial signaling

JEL Classfication: J33, M52

Administering performance measurement and reward systems for top managers is a primary task of corporate boards of directors. Meetings of the full board, committee meetings, and direct communication with the firm's employees give board members a more complete view of managers' actions and opportunities than that available to outsiders. As better performance measurement can improve the provision of incentives, directors should presumably make use of all information—including market- and accounting-based measures of firm performance, but also information gained through direct monitoring that may not be publicly available—in assessing a manager's performance.

Compensation committee reports contained in firms' proxy statements frequently indicate that managers' bonus amounts depend on subjective or strategic factors that are not revealed to outsiders. Sun Microsystems, for example, bases managers' pay on performance measures that are "competitively sensitive," while Thermo Electron applies a "subjective evaluation of the contributions of each executive that are not captured by operating measures but are considered important to the creation of long-term value." Recent empirical research in accounting assesses whether use of such information conforms to contract theory. Bushman et al. (1996) and Ittner et al.

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(1997) use survey responses and proxy disclosures, respectively, to study how managerial pay depends on individual-based or non-financial performance measures that may not be available to those outside the firm.

In this paper, we focus on two issues arising from the use of non-public information in managerial compensation contracts. First, if boards of directors gather non-public information to measure and reward the performance of top managers, then market participants may use the magnitude of payments made to managers to infer the non-public information. Given this, boards may face an incentive to choose wage payments strategically, in order to affect market assessments of the firm's prospects. Second, because information that is non-public is, by extension, non-verifiable, firms cannot base explicit incentive contracts on it. Rather, firms must rely on relational contracts to enforce payments based on these non-public measures.

We proceed by combining two lines of existing research, one each from labor economics and finance. The possibility that incentive contracts may be based on information observed by only the contracting parties is the subject of a growing literature in labor economics on relational incentive contracts. While much research on incentive contracting focuses on performance measures that can be verified by external third parties, work on relational contracts emphasizes the role of reputation as an alternative enforcement mechanism (see Bull, 1987). If reputation, rather than recourse to the legal system, governs contracts, then performance measures need not be verifiable by, or even observable to, outsiders. Baker et al. (1994) and Levin (2003) study reputation-based incentive contracting when some performance measures are not verifiable. MacLeod (2003) builds on this literature by examining the case where both principal and agent receive private (and hence "subjective") measures of the agent's performance. Hayes and Schaefer (2000) provide empirical evidence consistent with the hypothesis that firms use non-public information in rewarding top managers. They show that variation in current managerial pay that is unexplained by current firm performance is useful in predicting future firm performance.

Similarly, a large literature in finance examines ways in which various corporate actions can convey information to financial markets. If there is a one-to-one mapping from private information to corporate actions, then market participants may attempt to infer the information upon observing the action. This then implies a mapping from actions to short-run market valuation, which may give firms an incentive to try to manipulate outsiders' perceptions by choosing actions strategically. Ross (1977) and Leland and Pyle (1977), for example, study signaling models of capital structure, while Bhattacharya (1979) and Miller and Rock (1985) develop dividend-signaling models. More recently, Stein (1988, 1989) studies links between takeover pressure and managerial share ownership, respectively, and corporate short-termism, while Kanodia and Lee (1998) examine information transmission through investment and the role of periodic performance reports in mitigating incentives for inefficient signaling.

We build on these literatures by embedding a simple agency model in a repeated-game-based model of reputation, and then asking how relational incentive contracts are affected when market participants base inferences regarding the firm's future cash flows on the magnitude of a payment made to the agent. In the stage game, a board of directors seeking to maximize the weighted average of short- and long-term share prices contracts with a manager whose hidden effort increases the likelihood that the firm's project is successful. Immediately after the manager's effort choice, the board and the manager privately observe the project outcome. The board chooses whether to pay the manager a bonus, and the magnitude of this payment is observed by market participants. A round of trading in the firm's stock follows. After this round of trading, the outcome of the firm's project is publicly revealed, and the payoff from the project is paid out to shareholders. This stage game is repeated infinitely, and the board and manager are allowed to condition current actions on the past history of play.

This framework imposes two constraints—beyond the normal individual rationality and incentive compatibility constraints—on the solution to the agency problem. A *no-mimic constraint* arises from the fact that, in equilibrium, a firm with a failed project must not find it worthwhile to attempt to fool market participants by paying the bonus associated with success. A *reputational governance constraint* arises because equilibrium bonus payments cannot be so large that the firm prefers to renege on its commitment to pay the bonus, thereby surrendering its reputation for following through on such promises. Our inquiry focuses on how these two constraints interact in determining equilibrium bonus contracts. We structure the analysis by developing each constraint in isolation, and then merging these cases into a single model. In the merged model, we characterize how the set of feasible bonus contracts varies with the firm's degree of concern for short-term share prices.

Our primary finding is that greater concern for short-term share prices has a non-monotonic effect on profits. This result stands in sharp contrast to the conclusion from standard financial signaling models. In the standard model, greater concern for short-run share prices leads to a greater temptation for bad types to take actions to mimic good types. Good types must therefore distort their equilibrium actions to separate, which leads to lower *ex ante* expected firm profits.

The key to this non-monotonicity is the role of the no-mimic constraint as an alternative to reputation as a means for contract enforcement. To see the intuition, consider first a setting in which the firm places a sufficiently high value on its reputation that it can use a relational contract to enforce a promised bonus payment. In this case, the degree of the firm's concern for short-run share prices affects the contracting environment the parties would face if the firm were to renege on its promised bonus. If the firm has a very strong preference for keeping short-run share prices high, then it can commit to paying bonuses for project success, even if it has previously reneged on a relational contract. As a result, the value to the firm of maintaining its reputation is *smaller* when the firm's preference for high short-run share prices is *greater*. The reputational governance constraint therefore tightens as the firm's preference for high short-run share prices grows, which implies smaller equilibrium bonus amounts and lower firm profits.

Consider next a setting in which the value of the firm's reputation is not sufficiently large to allow it to use reputation to enforce a promised bonus payment. Here, the no-mimic constraint provides the *only* means of contract enforcement. Greater concern for short-run share prices means good types can credibly commit to paying larger bonuses in equilibrium; if the resulting bonus is less than the second-best, then increases in the firm's concern for short-run share prices can lead to higher profits. Our analysis therefore demonstrates that the mechanism by which bonus payments can convey information to market participants is quite different from that associated with dividends, financial structure, or other corporate actions.

We highlight two additional contributions of this work. First, we believe the model adds to the understanding of firms' choices over the mix of compensation instruments used for top managers. As Murphy (1999) notes, equity-based instruments comprise by far the largest source of variation in firm-related wealth for top managers. Given that equity prices are well known to be affected by many factors that are beyond managers' control, this heavy reliance on stock and options is somewhat puzzling. Why, for example, could boards of directors not improve on the incentives provided by stock and options by using cash grants alone? Boards could presumably combine data on the firm's stock-market performance with other (non-public, potentially) sources of information. Our analysis identifies two key difficulties with cash alternatives to equity-based pay: (1) market participants may attempt to infer value-relevant information from the magnitude of such payments, and (2) firms may face a temptation to renege on cash payments if they are based on non-verifiable information.[1]

Second, we identify a subtle interplay between two forms of firms' timing-related preferences. In our model, an impatient firm takes actions to shift the *timing* of cash flows from the future into the present. A myopic firm, on the other hand, tries to boost short-term share prices by conveying *information* to the market about future cash flows without changing the timing of those cash flows. Greater impatience reduces the efficacy of reputational governance, causing the magnitude of the largest feasible bonus payment to shrink. Conversely, myopia can cause equilibrium bonus payments to increase, as firms with successful projects pay larger bonuses to signal. In our model, a patient firm can use its reputation to commit to paying a bonus, but an impatient firm must rely on its myopia to enforce a bonus payment.

We proceed by first developing the no-mimic (Section 1) and reputational governance (Section 2) constraints in isolation. We combine these models in Section 3, and characterize the equilibrium of this merged model. We offer a discussion and conclusion in Section 4.

1. First Benchmark Model: The Stage Game with Signaling

We begin by studying a one-period model in which wage payments to a manager may convey information to market participants. Consider a publicly traded firm that hires a manager to exert effort. Decisions regarding the manager's employment contract are delegated to the firm's board of directors.[2] The firm's activity consists of a project that can either succeed or fail. If the project succeeds, the firm earns π_s, while if the project fails, the firm earns $\pi_f < \pi_s$. Let the probability of success, p, be a function of the manager's unobserved effort, e, and let $p(e)$ be continuously differentiable with $p(0) = 0$, $p'(e) > 0$ and $p''(e) < 0$.

We assume the firm's shareholders are risk neutral, while the manager is risk and effort averse. Let the manager's utility function for wealth be denoted by $u(w)$, where u is increasing and strictly concave. We assume the manager has reservation utility $\bar{u}$. Let the manager's cost of effort be $c(e)$, where c is continuously differentiable, increasing, and strictly convex. A contract is a pair (s, b), where s is a salary to be paid immediately after the contract is agreed upon and b is a bonus paid in the event that the firm's project is successful.

1.1. The Second-Best Incentive Contract

We first establish properties of the second-best incentive contract when the outcome of the firm's project is observable to all parties (the board, the manager, the firm's shareholders, and outsiders) simultaneously. We begin by analyzing the manager's choice of effort conditional on the contract selected. We assume the underlying structure of the problem is such that it is profitable for the firm to hire the manager and the firm is strictly better off if it induces the manager to take a positive level of effort. Since the manager's objective function is continuously differentiable and strictly concave in effort, his optimal effort choice, e^*, is characterized by the following first-order condition:

$$p'(e^*)(u(s+b) - u(s)) = c'(e^*). \tag{1}$$

Using the implicit-function theorem, we define $e^*(s,b)$ as the solution to (1). Effort is increasing in b and decreasing in s.

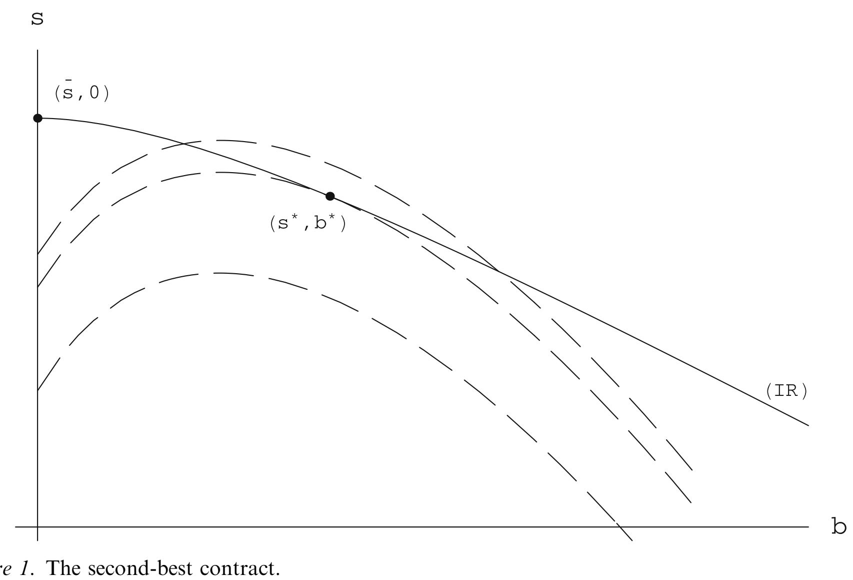

Figure 1. The second-best contract.

Under the assumption that the firm holds all the bargaining power in the relationship, the second-best contract maximizes the firm's profits while satisfying the manager's individual rationality constraint with equality. We represent the solution to the firm's problem graphically in Figure 1. Placing b on the horizontal axis and s on the vertical axis, we plot (with a solid line) the set of contracts that satisfy the manager's individual rationality constraint with equality. This curve begins at the full-insurance contract $(\bar{s}, 0)$, where $\bar{s}$ is defined by $u(\bar{s}) = \bar{u}$. As b increases, the manager takes more effort and is exposed to more risk. To compensate the manager for these costs, the expected level of pay must increase. Dashed lines in the figure are the firm's iso-profit curves. The point marked (s^*,b^*) denotes the second-best contract; it is the point where an iso-profit curve is tangent to the manager's individual rationality constraint.

1.2. Signaling with Perfect Governance

We enrich this simple framework to explore properties of equilibrium incentive contracts when the board and the manager observe the outcome of the project before market participants. (We use the term "market participants" to refer to both the firm's non-insider shareholders and outsiders who do not hold any shares.) The assumption that only corporate "insiders" receive payoff-relevant information is common in the literature on corporate disclosure policies (see, for example, Baiman and Verrecchia, 1996). We further assume that board members and the manager are prohibited by insider-trading restrictions from using this informational advantage to trade. Here, we consider a case in which an (unmodeled) governance mechanism is sufficiently strong to ensure the second-best contract is always feasible. This allows us to focus attention on the effects of the board's incentives to choose wage payments strategically.

A timeline for this game is shown in Figure 2. Market participants observe the payment from the board to the manager, and a round of trading ensues. The "short-term" market value is therefore a function of this bonus payment, but it does not depend directly on the outcome of the firm's project, as this information is known only to the board and the manager. After this initial round of trading, returns from the firm's project are realized, and the firm is liquidated. The firm's "terminal" value therefore does reflect the actual outcome of the firm's project.

Following the large literature on signaling to financial markets, we assume the board chooses its contract and bonus payment to maximize a weighted average of

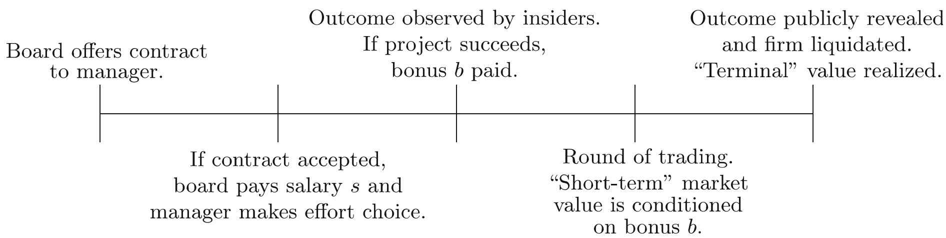

Figure 2. Timeline.

the firm's short-term market value and its terminal value.[3] In other work, this objective function has been justified in a variety of ways. Miller and Rock (1985) assume that shareholders have exogenously differing time horizons. Fraction k of shares are sold after the firm's dividend policy is announced but before the firm's terminal value is realized, while fraction $1-k$ are held until the firm's terminal value is realized. Shareholders are *ex ante* identical, and learn their specific time horizons after the firm's dividend policy is chosen (see their footnote 11). To maximize expected shareholder wealth, insiders choose the dividend policy that maximizes a weighted sum of short-term and terminal value.[4]

An alternative justification for this weighted-average objective function is given in Stein (1988). Suppose a corporate raider considers purchasing all of the firm's shares immediately after a corporate action is taken, but before the terminal payoff. The value of the firm to the raider is its terminal value plus a "synergistic gain" v, which is randomly drawn from a density with cumulative distribution function F. Assuming the raider can capture the full synergistic gain and the cost of executing a takeover is c, the probability of a takeover is $1-F(c)$. The expected payoff to current shareholders is therefore the weighted sum of short-term share price and terminal value, with weights $1-F(c)$ and $F(c)$, respectively. With this formulation, a lower value of c implies a higher likelihood of takeover, and hence a greater concern for short-term share prices. In our analysis, we follow Stein (1989) by suppressing the precise reasons underlying this short-termist behavior on the board's part.[5] We assume that the board places weight k on short-term firm value and $1-k$ on terminal value.[6] Following the literature, we refer to a firm that places some value on high short-run share prices as suffering from "myopia." The variable k parameterizes the firm's myopia, with higher values implying a greater concern for short-term share prices.

This concern for short-term share prices suggests the board may wish to alter its payments to the manager in order to affect the market's beliefs regarding the project's outcome.[7] In particular, a board with an unsuccessful project may wish to pay the manager the bonus associated with success. Equilibrium, of course, requires that such attempts to fool the market must fail. Thus, equilibrium wage contracts must satisfy a no-mimic constraint: the "low" types—the firms with failed projects—must not find it worthwhile to mimic the "high" types. If a firm with a failed project elects to pay no bonus, then the market correctly infers the firm's project has failed. Hence, the short-term and terminal firm values are the same, and the weighted average of these values is

$$k(\pi_f - s) + (1 - k)(\pi_f - s) = \pi_f - s.$$

If, however, this firm elects to mimic a firm with a successful project, then the weighted average of short-term and terminal value is

$$k(\pi_s - s - b) + (1 - k)(\pi_f - s - b).$$

Our *no-mimic constraint* is therefore given by

$$b - k(\pi_s - \pi_f) \geq 0. \tag{NM}$$

We use graphs similar to Figure 1 to identify types of equilibrium contracts and compare welfare under each. *Efficient separating contracts* feature a one-to-one mapping from project outcomes to bonus payments and second-best effort and risk sharing. *Inefficient separating contracts* have a one-to-one mapping from outcomes to bonuses, but induce higher effort and place more risk on the manager, compared to the second-best contract. *Pooling contracts* have the property that wages do not depend on the project outcome; that is, no output-contingent bonuses are paid. In the text, we offer a graphical analysis to convey the main intuition for our results; a full characterization of this signaling game is contained in the appendix.

In Figure 3, we show a setting where k, the weight placed on short-term share prices, is low. The diagram is identical to Figure 1, except that we have added the (NM) constraint as a solid line. This constraint requires that b is sufficiently high that firms with failed projects do not mimic firms with successful projects. All contracts to the right of the line satisfy this constraint, so for low values of k the equilibrium features an efficient separating contract. In these cases, the manager's incentive constraint induces a larger bonus than is necessary to signal—the board's myopia therefore does not affect the contracts offered to managers.

Figure 4 features a setting with a higher value of k. Since the board cares more for high share prices in the short term, the temptation for firms with failed projects to mimic those with successful projects is greater. This means b must be even higher to satisfy the no-mimic constraint. The (NM) line in Figure 4 is shifted to the right of that depicted in Figure 3. There are two candidates for the equilibrium contract here. The first is the highest-profit contract satisfying both (NM) and (IR), denoted by (s',b'). The second is the pooling, full-insurance contract $(\bar{s}, 0)$. Iso-profit lines that are lower on the figure mean higher profits, so the firm prefers (s',b') to $(\bar{s}, 0)$. For this value of k, the manager's incentive constraint does not induce a sufficiently large

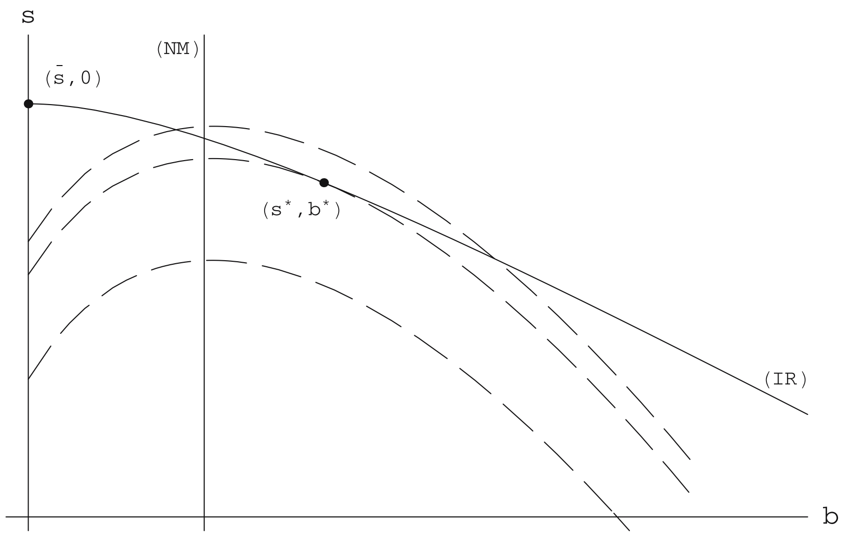

Figure 3. An efficient separating contract.

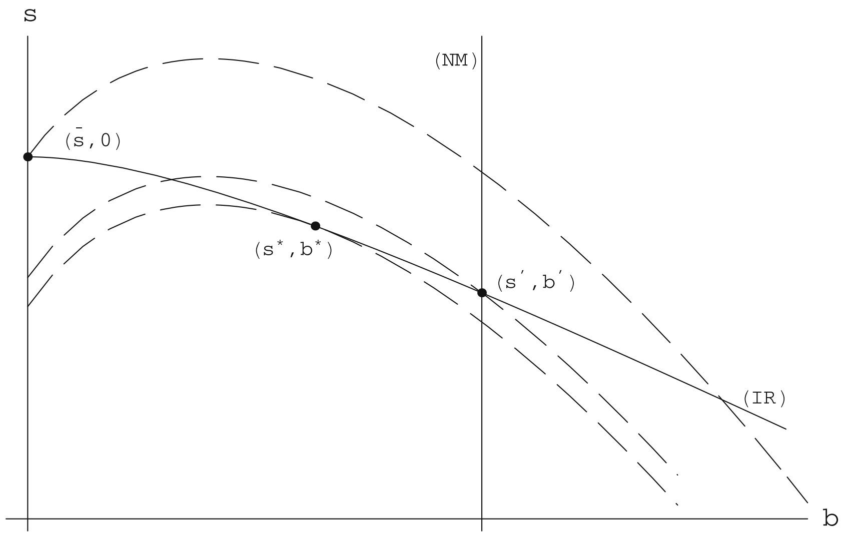

Figure 4. An inefficient separating contract.

bonus to permit firms with successful projects to separate. In a separating equilibrium, firms must therefore offer a contract that features a larger bonus than in the second best.

Next, consider an even higher value of k, as shown in Figure 5. In this figure, the profit-maximizing separating contract, denoted by (s'', b''), is on a lower iso-profit

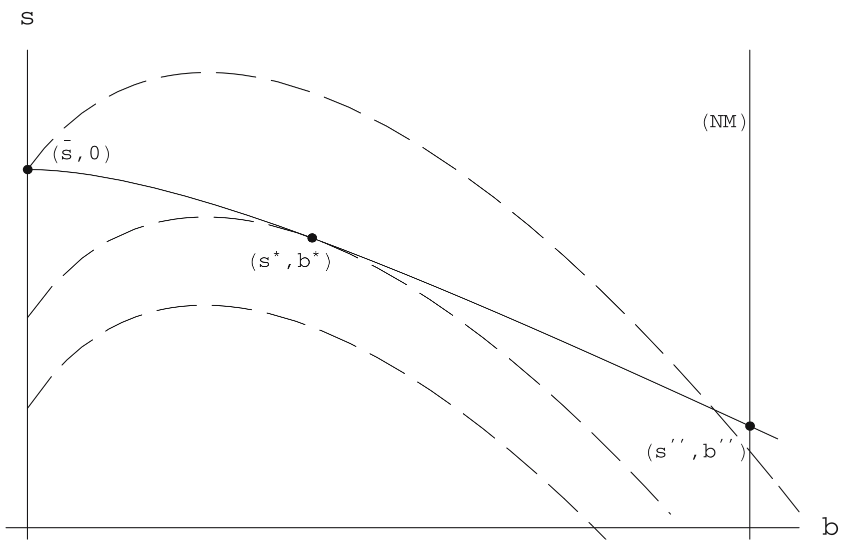

Figure 5. A pooling contract.

curve than the full-insurance contract. Offering a separating contract here is quite costly because it places excessive risk on the manager. These costs are so great that the firm is not willing to offer such a contract; rather, the firm offers a full-insurance, pooling contract.[8]

The welfare implications of this model are straightforward. In all equilibria, the manager receives his reservation utility and the market's valuations of the firm are correct. Hence, the welfares of the manager and the market participants do not vary as the equilibrium changes. The firm's iso-profit lines are therefore identical to iso-welfare lines. Profits are weakly decreasing with k. When the firm is more myopic, the firm must make the manager's pay more sensitive to performance in order to separate. Since the manager must be compensated for bearing additional risk and effort costs, the firm's expected wage bill increases, leading to lower *ex ante* expected profits. Eventually separation becomes too costly, and the firm prefers the pooling, full-insurance contract. Our findings here are very similar to what is typically found in the financial signaling literature. Greater myopia leads to greater incentive for low types to mimic high types. This causes the equilibrium actions of high types to be more distorted away from efficiency, in order to credibly signal their type. This leads to lower *ex ante* expected profits.

2. Second Benchmark Model: Relational Incentive Contracts without Signaling

The premise of the analysis thus far is that bonus payments to managers can be based on information that is not held by those outside the firm. Given this, it is natural to ask how such contracts are to be governed. Since non-public information is inherently non-verifiable, such contracts cannot be enforced by external third parties.[9] Hence, we briefly consider a model in which the firm has no incentive to boost short-term share prices, but must rely on a reputational mechanism (which we model in a repeated-game framework) to enforce its contract offer. Our analysis here is very similar to a benchmark case studied by Baker et al. (1994), who expand on this benchmark by considering how the presence and quality of a verifiable performance measure affect the firm's ability to use a subjective measure of performance as part of a relational contract. In the next section, we combine the signaling and reputation models to study how the firm's incentive to choose wage payments strategically affects the efficacy of reputation as a contract enforcement mechanism.

Several modeling difficulties immediately arise when moving from the stage game studied above to the supergame-theoretic framework considered here. First, supergame models commonly have many equilibria, which means that definitive predictions as to outcomes are not feasible. Second, the folk theorem suggests that as long as the future is sufficiently important to the players, any individually rational payoffs can be supported as an equilibrium. We address these difficulties in a manner similar to Baker et al. (1994), by assuming that the firm's discount factor is strictly less than one, and by focusing on the set of equilibria that can be supported using "trigger strategies" in which players agree to trust each other as long as neither player has violated that trust in the past. Such strategies have the virtue of being easy to analyze, but ignore issues relating to optimal punishments and renegotiation.[10]

We embed the stage game introduced in the previous section in a repeated-game framework. In each period, the board offers the manager a contract (s, b) and the manager decides whether to accept employment. If the contract is accepted, the board pays salary s and the manager selects an effort level e. The board and the manager then observe the project outcome and the board chooses what bonus (if any) to pay. Market participants then observe the bonus payment from the firm to the manager. To develop this benchmark model, we eliminate the firm's incentive to act myopically by assuming the firm simply maximizes the net present value of dividend payments. Finally, project outcomes are revealed, and profits from the current period's project are paid as dividends. (We retain the assumption that these dividends are not contractible.) This stage game is repeated infinitely, with all parties discounting the future at rate $\delta = 1/(1+r) < 1$.

We assume that if the firm deviates from the terms of the contract, the manager alters his behavior in all subsequent periods according to a trigger strategy. If the firm reneges on its promise to pay bonus b if the project succeeds, then the manager punishes the firm by refusing to trust the firm's contract offers in all subsequent periods. Since, in this case, there is no alternative to reputation as a governance mechanism, the best the firm can do in the periods after it reneges is to offer the full-insurance contract or shut down. We assume here that if the firm offers a contract with $b > 0$ and reneges by paying no bonus when the project has succeeded, then all market participants observe this breach prior to the round of trading.

We start by introducing some notation. Denote by $V(b)$ the value of the firm's net cash flows in the current period if the firm commits to paying a bonus b for project success. Since profit maximization implies the manager's incentive and individual rationality constraints will bind, a given b implies unique choices of salary s and effort e. Denote these salary and effort levels as a function of b by $s(b)$ and $e(b)$. We write V as

$$V(b) = p(e(b))(\pi_s - b) + (1 - p(e(b)))\pi_f - s(b).$$

Under the assumptions on the functions $p(e)$, $c(e)$ and $u(w)$ made in the previous section, it is the case that V is differentiable and strictly concave.[11]

Suppose the board offers a contract (s, b) and then observes project success. If the board reneges on the contract, then the firm keeps the current period's bonus payment b. However, the manager then punishes the firm in all subsequent periods by refusing to trust the promise to pay performance-based bonuses. Since, in this event, there are no alternative contractual enforcement mechanisms, the firm's two choices are to offer a full-insurance contract in subsequent periods and earn profits $V(0)$ or to shut down, earning zero profits. If the board chooses to pay the bonus, then the firm retains its reputation for upholding the terms of its relational contract, which means that the manager will continue to trust the firm's promises of bonus payments in the future.[12] If the board pays the bonus, then the net present value of firm profits is given by

$$\pi_s - b + \sum_{\tau=1}^{\infty} \delta^{\tau} V(b) = \pi_s - b + \frac{1}{r} V(b).$$

If the board does not pay the bonus, then profits are

$$\pi_s + \frac{1}{r} \max[0, V(0)].$$

Our *reputational governance constraint* is therefore given by

$$V(b) - \max[0, V(0)] \geq rb. \qquad \text{(RG)}$$

The board chooses to pays the bonus b only if it is smaller than the value of the firm's reputation. Hence, the largest b satisfying (RG) is the largest bonus that the manager is willing to trust the board to pay. If the board offers a larger bonus, the manager will expect the board to renege on its promise and will exert no effort, expecting no bonus to be paid. Note that, in general, there exists a continuum of bonuses smaller than the largest feasible bonus that are also equilibria; as in most supergame-theoretic models, we are able to identify only a range of possible equilibria. If the second-best bonus does not satisfy (RG), then the largest bonus that satisfies (RG) is the pareto-best equilibrium.

Figure 6 provides a graphical illustration. We assume $V(0) < 0$ and plot b on the horizontal axis. The largest credible bonus is the largest b where the $V(b)$ and rb curves intersect. For $r = 0.1$, the firm can achieve the second-best bonus, b^*, but as r increases the largest credible bonus falls. For r sufficiently large ($r = 0.3$, in the

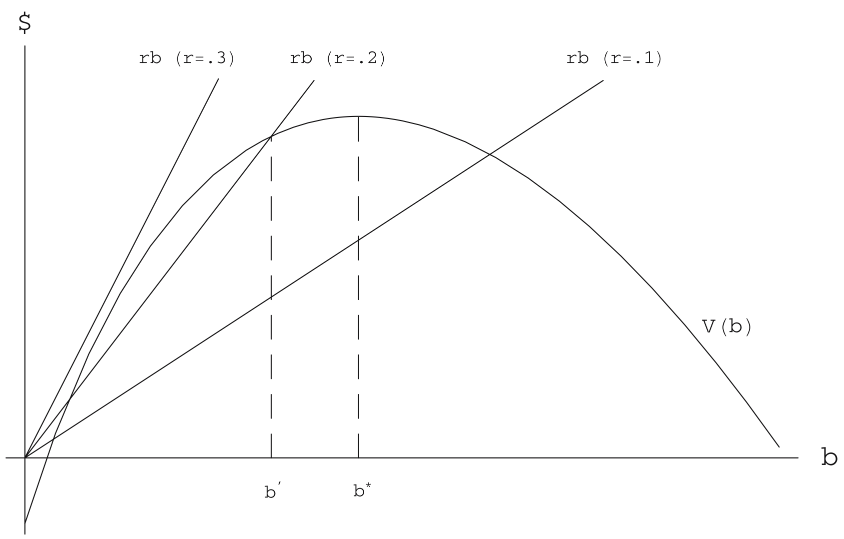

Figure 6. The largest credible bonus shifts downward as r increases.

figure), no bonus offer is credible. The figure makes clear that the inefficiency here is related to the rate at which the firm discounts future cash flows. If the future is sufficiently important, then the second best can be reached. However, as the firm's discount rate falls, the temptation to renege on the second-best bonus payment is too great for this contract offer to be credible. We refer to this source of inefficiency as "impatience," and argue that this is distinct from the "myopia" that led to departures from the second-best in the previous section. In our model, a myopic firm (that is, one with a high value of k) takes actions intended to boost short-term share prices by conveying information about future cash flows without changing the *timing* of those cash flows. An impatient firm (one with a low δ) takes actions to shift the actual timing of cash flows from the future into the present.

While both myopia and impatience are forms of timing-related preferences, the two notions stem from different sources. Impatience arises from the fact that the marginal participant in a capital market prefers current to future consumption, and must earn a positive return to compensate for deferring consumption to the future. If capital markets are perfect, then a firm's shareholders will agree that the firm should act to maximize the net present value of cash flows, discounted at the firm's market-determined δ (see Brealey and Myers, 2003, Chapter 2). Shareholders can then satisfy their own preferences regarding the timing of consumption by borrowing or lending at the market rate, and therefore do not need the firm to adjust its actions to meet those preferences. A key point regarding impatience, therefore, is that it arises *independently* of the firm's shareholders' own preferences regarding the timing of consumption.

Myopia, on the other hand, arises only when (1) there are information asymmetries in capital markets, and (2) at least some of the firm's shareholders might be forced to sell their shares for exogenous reasons in the near term. Under these conditions, the firm can maximize shareholder value by adjusting its actions to speed the transmission of good news to capital markets. In the next section, we show how the firm's incentives for myopic behavior can either exacerbate or mitigate inefficiencies arising from impatience.

Interestingly, a number of existing models show that corporate myopia can cause firms to place too large a discount on future cash flows relative to current, thus causing firms to act in an overly impatient manner. Stein (1989), for example, studies a model in which a myopic firm transmits information to the capital market by (inefficiently) shifting cash flows from the future to the present. The key to understanding whether myopia will affect a firm's impatience is the precise mechanism by which the firm transmits information regarding its future prospects. In our model, information is transmitted through the payment of bonuses for project success; this *reduces* the firm's current cash flows, but credibly conveys that the firm's future prospects are good.

3. Signaling and Relational Incentive Contracts

The benchmark cases considered so far suggest opposing effects: myopia leads the firm to offer higher bonuses in Section 1, while impatience can lead to smaller bonuses in Section 2. We now combine the analyses of the previous two sections to study the interaction among these effects.

Our primary finding is that the relation between myopia and firm profits is non-monotonic, and depends on the firm's impatience. If the firm is sufficiently patient that reputation-based bonuses are feasible, then increases in myopia can reduce the largest feasible bonus payment by making the fallback contracting environment—that is, the environment facing the parties in the event that the relational contract has been breached—more attractive. This reduces profits. If the firm is so impatient that reputation-based bonuses are not feasible, then increases in myopia can lead to larger bonuses, as the no-mimic constraint provides an alternative governance mechanism. If the resulting bonus is not greater than the second-best bonus amount, then increases in myopia lead to increases in firm profits.

Our model here is identical to that of the previous section, except that we assume the board maximizes a weighted average of short-term and end-of-period share prices. The timing is as follows. In each period, the board first offers the manager a contract (s, b) and the manager decides whether to accept or reject. If the contract is accepted, the board pays salary s and the manager selects an effort level e. The board and manager then observe the project outcome and the board chooses what bonus (if any) to pay. Market participants then observe the bonus payment from the firm to the manager, and condition their beliefs about firm value on this payment. We refer to firm value at this point in time as the "short-term" value. The outcome of the firm's project is then revealed publicly, and proceeds are paid to shareholders. (For consistency, we refer to the firm value after the project outcome is revealed as "terminal" value, although there of course is no "termination" of this infinitely repeated game.) This stage game is repeated infinitely, with common discount rate δ.

We assume that if the firm reneges on its contract offer by paying no bonus when the project has succeeded, then market participants observe this breach immediately. Results similar to the ones we present below can be derived under the assumption that market participants observe a breach just after the first round of trading. Note that in order to make a relational contract with the manager at all feasible, we must assume that market participants observe a breach at some point. Otherwise, the market value of the firm would never fall as a result of the breach.

We assume that if the board deviates from the terms of the relational contract, the manager alters his behavior in all subsequent periods according to a trigger strategy. Here, the firm's deviations can take two forms: first, as noted above, the firm may elect to pay no bonus when the project has succeeded, and second, the firm may pay a bonus when the project has failed. In the first case, we assume that if the firm reneges on its agreement to pay bonus b if the project is successful, then the manager punishes the firm by refusing to trust the firm's relational contract offers in all subsequent periods. In subsequent periods, the best the parties can do is to rely on contractual enforcement mechanisms other than reputation. An alternative governance mechanism is provided here by the successful firm's incentive to pay a sufficiently large bonus to distinguish itself from a firm with a failed project.[13] If, instead, the firm deviates from the agreement by paying the manager a bonus after the project has failed, we again assume the manager changes his behavior in all subsequent periods. In this case, the manager assumes that there is no relationship between project outcomes and bonus payments, so he exerts zero effort in all subsequent periods.[14]

We structure the analysis by considering how each side of the reputational governance constraint in (RG) is affected by the firm's myopia. We focus first on how increases in k affect the value of the firm's reputation by changing the contracting environment faced by the parties in the event that the relational contract has been breached. Then, we ask how the gains from reneging vary with k. This allows us to characterize the relationship between k and the largest feasible bonus.

3.1. The Value of Reputation

We begin by examining the fallback contracting environment faced by the parties. The key insight is that even after breaching a relational contract, a firm with a successful project still wants to distinguish itself from a firm with a failed project. Hence, we derive the associated no-mimic constraint. Let b be the largest bonus that a firm can credibly offer when using the no-mimic constraint to enforce the contract. If a firm with a failed project pays no bonus, then the net present value of its profits is

$$\pi_f + \frac{1}{r} V(b). \tag{2}$$

Suppose, on the other hand, a firm with a failed project pays b in an attempt to mimic a firm with a successful project. When the firm makes a non-zero bonus payment for a failed project, it forfeits its credibility in paying zero bonus for failed projects in the future. The manager's trigger strategy, as described above, stipulates that all future bonus offers will be ignored, so the best the firm can do in the future is to offer the full-insurance contract or shut down, earning profits $(1/r)$ $\max[0, V(0)]$. The short-term value of the firm is $\pi_s - b + (1/r)\ V(b)$, since the market believes a firm paying b has a successful current project and expects to earn profits of $V(b)$ in all future periods. The actual outcome of the firm's project then becomes known publicly prior to the end of the period. Hence, the terminal value is $\pi_f - b + (1/r)\ \max[0, V(0)]$, since the market knows the firm will be unable to make credible bonus offers in the future. The weighted average of short-term and terminal value is

$$k\left(\pi_s - b + \frac{1}{r} V(b)\right) + (1-k)\left(\pi_f - b + \frac{1}{r}\max[0, V(0)]\right). \tag{3}$$

Since, in equilibrium, attempts to fool the market must be unprofitable, we combine (2) and (3) to obtain a new no-mimic constraint:

$$b \geq k(\pi_s - \pi_f) - \frac{1-k}{r}(V(b) - \max[0, V(0)]). \tag{NM'}$$

The bonus that allows a firm with a successful project to distinguish itself from a firm with a failed project is the smallest solution to this inequality.[15]

We use this no-mimic constraint to characterize the bonus offers that are credible in the fallback position. We define $b^{\text{fall}}(k)$ as the largest bonus offer the firm can make when the relational contract has been breached, but the firm still wants to signal its success to the market. If $V(0) < 0$ and k is small, then it is possible that the largest bonus made credible by the no-mimic constraint is too small to result in positive profits for the firm. This occurs if

$$k < \frac{b_0}{\pi_s - \pi_f},$$

where b_0 is defined implicitly as the smallest solution to $V(b) = 0$. Now let $k_0 = b_0/(\pi_s - \pi_f)$ if $V(0) < 0$ and zero otherwise. We have $b^{\text{fall}}(k) = 0$ for $k \in [0, k_0)$.

Alternatively, if k is very large, then it is possible that the bonus made credible by the no-mimic constraint is *too large* to result in positive profits for the firm. This occurs if the solution to (NM′) is greater than the largest b solving $V(b) = \max[0, V(0)]$. In the appendix, we show that there exists a $k_2 \leq 1$ such that if $k > k_2$, then the smallest bonus that allows a successful firm to identify itself is so large that the firm prefers to offer the pooling contract $(\bar{s}, 0)$ (which yields profits $V(0)$), or shut down (if $V(0) < 0$). We therefore have $b^{\text{fall}}(k) = 0$ for $k \in [k_2, 1]$.

For intermediate values of k, the bonus offer made credible by the no-mimic constraint does result in non-negative profits for the firm. In the event that the relational contract is breached, the firm can credibly offer the smallest bonus that satisfies (NM′).[16] Hence, if $k \in [k_0, k_2)$, $b^{\text{fall}}(k)$ is given by the smallest solution to (NM′). Note that $b^{\text{fall}}(k)$ is strictly increasing in k over this interval. Since $V(b) - \max[0, V(0)] > 0$ for $k \in [k_0, k_2)$, the right-hand side of (NM′) is strictly increasing in k. Increases in k shift the right-hand side upward, which means that b must increase to preserve the inequality.[17]

To summarize this characterization of $b^{\text{fall}}(k)$, we have that if $V(0) < 0$ and k is small, then the bonuses made credible by the no-mimic constraint are too small to result in positive profits. For larger values of k, the no-mimic bonuses are large enough to yield positive profits, which allows the firm to credibly commit to a positive bonus if the relational contract is breached. The function $b^{\text{fall}}(k)$ increases with k on this region. For very large k, the no-mimic bonuses may be too large to result in positive profits, so again $b^{\text{fall}}(k) = 0$.

In determining whether to renege on its relational contract, the board compares the foregone value of its reputation to the immediate gains from reneging. The fallback bonus, $b^{\text{fall}}(k)$, determines the value of the firm's reputation: if b is the bonus that can be sustained using reputational governance, then the value to the firm of its reputation is

$$\frac{1}{r}\left(V(b) - \max\left[0, V(b^{\text{fall}}(k))\right]\right). \tag{4}$$

3.2. The Gains from Reneging

To quantify the gains from reneging, we first need to ask what payment a firm would make to the manager in the event that it elects to renege. Recall from Section 2 that when $k=0$, a firm that reneges simply withholds the entire bonus payment. When $k > 0$, however, a firm with a successful project that reneges on a relational contract may still be willing to pay the manager enough to distinguish itself from a firm with a failed project. Thus, in order to understand the gains to reneging, we first need to specify the market's beliefs as to the outcome of the firm's current-period project conditional on observing an out-of-equilibrium bonus payment. Since reneging is off the equilibrium path, the market's beliefs as to the success of the firm's current project after observing a payment other than the equilibrium bonus or zero are not tied down by Bayes' Rule. We defer discussion of this point for a moment by defining b^{rn} to be the smallest bonus a successful firm can pay to the manager and still distinguish itself from a firm with a failed project.[18]

The gains to the firm from reneging are therefore given by $b - b^{rn}$, where b is, as above, the bonus that can be sustained using reputational governance. Combining this with (4), we obtain the following reputational governance constraint:

$$V(b) - \max\left[0, V(b^{\text{fall}}(k))\right] \geq r(b - b^{rn}). \qquad (\text{RG}')$$

The largest bonus that can be credibly offered using reputational governance is the largest b satisfying (RG′).[19]

3.3. Characterization of Equilibrium Bonuses

To characterize how bonus amounts vary with k, we again apply the Intuitive Criterion to specify market beliefs when observing off-equilibrium play. We show (in the appendix) that if $b^{rn} > 0$, then there exists an equilibrium that fails the Intuitive Criterion. Therefore, the only beliefs that do not generate an equilibrium failing this criterion assess probability one to project success conditional on observing any $b > 0$, and probability zero to success otherwise.[20] In the analysis below, we assume that $b^{rn} = \epsilon > 0$. The reputational governance constraint in this case is given by

$$V(b) - \max\left[0, V(b^{\text{fall}}(k))\right] \geq r(b - b^{rn}). \qquad (\text{RG}'')$$

As in Section 1, we make use of intuitive arguments in the text and offer proofs in the appendix. Suppose first that $V(0) < 0$ and let $k < k_0$. In this case, $b^{\text{fall}}(k) = 0$, which implies that the firm's best option is to shut down if the relational contract is breached. Hence, over this region of k, the constraint in (RG″) reduces to that derived for the benchmark case (RG). Define δ_0 as the smallest discount factor for which there exists a b such that $V(b) \geq rb$ is satisfied. For $k \in [0, k_0)$ and $\delta \in [\delta_0, 1]$, a reputational bonus is feasible. This bonus weakly increases with δ and does not vary with k. For $k \in [0, k_0)$ and $\delta \in [0, \delta_0)$, no reputational bonus is possible, so the firm shuts down.

Define k_1 implicitly as the solution to

$$b^{\text{fall}}(k_1) = b^*.$$

In words, k_1 is the degree of concern for short-term share prices at which the fallback bonus is equal to the second-best bonus. For $k \in [k_0, k_1)$, increases in k make the fallback position more attractive. This reduces the value of the firm's reputation. Because the gain to reneging does not depend on k, the reputational bonus falls (weakly) as k increases. As k approaches k_1, no reputational bonus is possible for $\delta < 1$. Hence, for $k \in [k_0, k_1)$ and δ sufficiently large, reputational bonuses are feasible, and get smaller as k increases. Firm profits fall with k in this region as well. For $k \in [k_0, k_1)$ and δ smaller, no reputational bonuses are feasible. In this case, bonuses increase with k, as the firm's no-mimic constraint allows it to commit to the terms of the contract. Because the no-mimic bonus is smaller than the second best, firm profits are increasing with k on this region.

For $k \in [k_1, k_2)$, no reputational bonuses are feasible. Hence, contracts are enforced by the no-mimic constraint, and bonuses are therefore increasing in k. Profits fall as k increases on this region, because bonus amounts, which are already above the second-best, increase further. For $k \in [k_2,1]$, the firm offers a pooling contract if $V(0) \geq 0$ or shuts down if $V(0) < 0$. Profits therefore do not vary with k on this region.

The comparative statics of our model are summarized in Figure 7. There, we place k on the horizontal axis and δ on the vertical. For each region of this parameter space, we indicate what governance mechanism is feasible (if any), and list comparative statics. The notations Π_x and b_x represent comparative statics of profits and equilibrium bonuses, respectively, with respect to $x \in \{k,\delta\}$. Our key finding is the

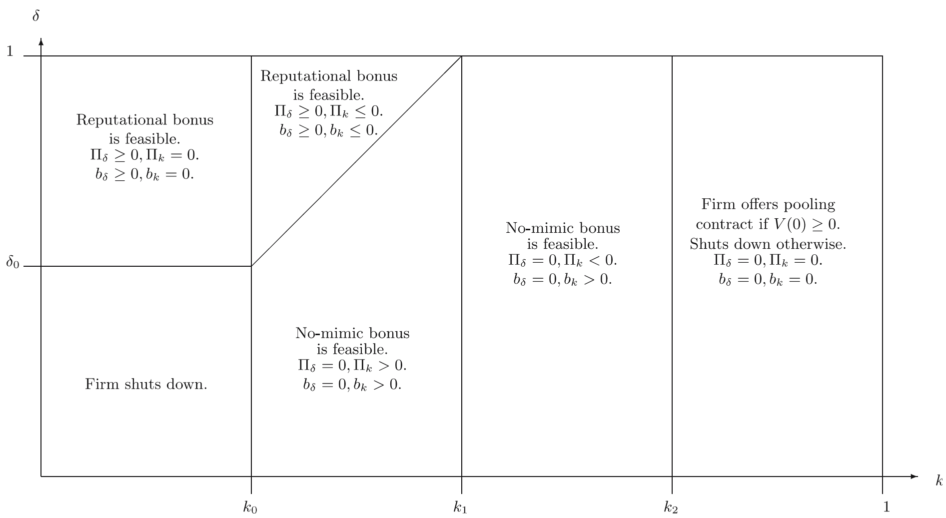

Figure 7. Comparative statics for equilibrium bonus amounts. Note that if $V(0) \geq 0$, then $k_0 = 0$ and the left-most region does not exist. Also, it is possible that $k_2 = 1$, so that right-most region may not exist.

non-monotonic relationship between the set of equilibrium bonus amounts and the degree of the firm's myopia. Of greatest interest is the region where $k \in [k_0, k_1)$. Here, changes in k affect the fallback position. If δ is large enough to permit reputational bonuses, then increases in k reduce equilibrium bonus amounts. If δ is small, then increases in k increase equilibrium bonus amounts, as the no-mimic constraint is used to enforce the contract.[21]

3.4. Comparison to Prior Signaling Models

Recall that in most signaling models featuring myopic corporate behavior, firms take actions that hurt long-term profitability in an attempt to boost short-term share prices. When firms become more focused on short-term share prices, the temptation for bad types to mimic good types becomes very strong. Good types distort their equilibrium actions more when firms are more myopic; hence, profits are decreasing in myopia.

Our model yields different results on two dimensions. First, we find that as the firm becomes more focused on short-term share prices, it may engage in *less* of the signaling activity, which in this case is paying bonuses for project success. This result obtains when the firm is patient (δ large) and not so myopic ($k \in [k_0, k_1)$.) In this case, the firm's bonus amount is determined by the reputational governance constraint, and the no-mimic constraint is slack. The effect of myopia here is not to cause the no-mimic constraint to bind, but rather to affect the fallback position in the reputational governance constraint. As the fallback position improves, the firm can commit to smaller reputational bonuses. As in more standard signaling models, increases in myopia are, in this case, associated (weakly) with reductions in profits. Our finding here parallels that of Baker et al. (1994), who show that as the quality of a verifiable performance measure improves, it may become harder to use reputation to enforce bonuses based on subjective performance measures.

Second, while we do identify conditions under which increases in myopia lead to higher levels of the signaling activity, we find that profits may actually *increase* with myopia on these regions. This result obtains when the firm is impatient (δ small) and not so myopic ($k \in [k_0, k_1)$.) In this case, reputation-based bonuses are not feasible. The no-mimic constraint binds and determines equilibrium bonus amounts; hence, increases in myopia lead to higher bonuses. This increases profits, however, because equilibrium bonuses are still below the second-best.

These differences between our model and the standard financial signaling model arise because of different assumptions regarding the firm's ability to commit to the signaling activity. In the Miller and Rock (1985) dividend-signaling model, for example, the firm always selects the efficient dividend in the event that the no-mimic constraint does not bind. As a result, myopia matters only when the efficient dividend violates the no-mimic constraint. To put this statement in the context of our notation, myopia matters in these models only when $k > k_1$. In our model, the firm may not be able to commit to the (second-best) efficient bonus when the no-mimic constraint is not binding. Further, the firm's myopia affects its ability to use reputation to commit to high bonuses, by affecting the fallback contracting environment. As a result, myopia matters even for $k \leq k_1$; that is, even when the second-best bonus *satisfies* the no-mimic constraint.

As we indicated above, one way to view our results is to contrast the different inefficiencies arising from the two forms of timing-related preference: "impatience" and "myopia." In the stage game studied in Section 1, myopic behavior on the part of the firm pushes the contract away from the second best, while in the repeated game of Section 2, it is impatience that limits the efficacy of reputation as a governance mechanism. Combining these models, we find that myopic behavior on the part of the firm can either exacerbate or mitigate inefficiencies arising from impatience. While impatience may prevent the firm from achieving the second best under reputational governance, myopia can exacerbate this problem by making the fallback position more attractive. However, if the firm is so impatient that no reputation-backed bonus offer is credible, then myopia can mitigate the problem by providing an alternative governance mechanism.

4. Conclusion

In this paper, we offer a new perspective on managerial compensation arrangements by suggesting that firms may be able to condition payments to managers on information that is not available to those outside the firm. If relational incentive contracts specify a mapping from private information to wage payments, then market participants may use the magnitude of such payments to infer the non-public information. Given this, firms may make incentive compensation decisions strategically, with an eye toward affecting outsiders' perceptions of the value of the firm. We study equilibria of a simple signaling game in which payments from a firm to a manager convey information regarding the future payoffs to the firm's shareholders. A primary finding is that the nature of the firm's contracting relationship with its manager is affected by the firm's incentive to choose wage payments strategically, and that the resulting relationship between feasible bonus amounts and the degree of the firm's myopia is non-monotonic.

One open question regarding executive compensation practices is what factors determine the mix of instruments used to reward executives. Executives are commonly paid using a wide variety of instruments, including cash bonuses, equity ownership, and options, and researchers have had only modest success in explaining firms' choices on this dimension. Our model suggests one such point of difference: whereas payments made under bonus plans can convey information to market participants, equity-based instruments do not. A firm's choice over the mix of discretionary payments vs. equity-based instruments would presumably be determined by a comparison of costs and benefits.[22] Since equity-based instruments suffer from a moral hazard in teams problem and are subject to market-based fluctuations in value, a firm may be better able to tailor rewards to the executive's actions using discretionary payments. However, if there are efficiency losses due to the firm's incentives to choose discretionary payments strategically, then a firm could potentially be better off if it can commit to provide incentives using equity-based instruments. This insight may offer a starting point for an analysis of the determinants of pay instruments.

Future research could proceed by developing this insight in more detail. Alternatively, it may be possible to combine elements of our model with that of Baker et al. (1994) to study how the interplay among public and non-public measures of managerial performance is affected by a publicly traded firm's incentive to choose wage payments strategically.

Appendix

4.1. Proofs from Section 1

We begin by defining some additional notation. Let $\tilde{q}(s,b)$ be the market's belief as to the probability the firm's project is successful when it observes the salary and bonus payments (s, b). Let Π represent the weighted average of short-term and terminal firm value when the firm offers contract (s,b), given the market's inference $\tilde{q}$ about the outcome of the firm's project after observing salary and bonus payments. Formally,

$$\begin{aligned}\Pi[s,b,\tilde{q}(s,b),\tilde{q}(s,0)] = {} & p(e^*(s,b))[k\tilde{q}(s,b)(\pi_s-\pi_f)+(1-k)(\pi_s-\pi_f)-b] \\ & +(1-p(e^*(s,b)))k\tilde{q}(s,0)(\pi_s-\pi_f)+\pi_f-s.\end{aligned}$$

We define a solution concept for the stage game outlined in Section 1 above, and then prove three propositions that characterize the relationship between equilibrium contracts and the firm's degree of myopia. An action for the firm in this game consists of a contract offer (s, b) made at the beginning of the game and a bonus payment b made after the project outcome has been privately revealed. An action for the manager consists of a participation decision based on the firm's contract offer and an effort choice. An action for the market is a mapping from observed salary and bonus amounts to a valuation of the firm's shares. In analyzing this game, we assume an unmodeled governance mechanism allows the firm to commit to paying the second-best bonus in the event of project success.

A Compensation-Signaling Equilibrium (CSE) is a perfect Bayesian equilibrium of this game satisfying two refinements. We require that the market's beliefs as to the project's success or failure cannot be affected by the salary payment s, as such payments are made prior to the realization of project uncertainty. We also require the equilibrium to satisfy the Cho and Kreps (1987) Intuitive Criterion, which eliminates all equilibria except those with the least inefficient signaling. A CSE is a pure strategy profile that satisfies the following properties:

1. Taking the mapping from observed wage payments to market values as given, paying bonus b must maximize the weighted average of short-term and terminal value conditional on project success and paying bonus 0 must maximize the weighted average of short-term and terminal value conditional on project failure.

2. Taking the mapping from wage payments to market value, the firm's choice of bonus payment conditional on project outcome, and the salary offer as given, the manager's participation and effort decisions must maximize his expected utility.

3. Taking the market's mapping from observed bonus payments to market values and the manager's participation and effort decisions as given, the wage contract offered to the manager at the beginning of the game must maximize the *ex ante* weighted average of short-term and terminal value.

4. The market's assessment of the outcome of the firm's project conditional on the bonus payment made to the manager must be correct.

5. For all b and $s \neq s'$, $\tilde{q}(s,b) = \tilde{q}(s',b)$.

6. Given a contract (s, b), for all $b' < b$ such that $\pi_f > k\pi_s + (1-k)\,\pi_f - b'$,

$$\Pi[s,b,1,0] > \Pi[s(b'),b',1,0].$$

In words, this statement says that for any $b' < b$ such that a firm with a failed project would prefer to pay its manager no bonus rather than b' even if paying b' would induce the market to believe the firm's project had succeeded, it must be that the expected profit from offering the CSE contract (s, b) is higher than the expected profit from offering ($s(b')$, b'), where the function $s(\cdot)$ is as defined in Section 2.

Property (6) is a refinement similar in spirit to the Intuitive Criterion; its role is to rule out equilibria with "excessive" signaling. Such an equilibrium features a bonus contract (s, b) that satisfies the first five conditions of the CSE but imposes a higher level of risk on the manager than other contracts that satisfy the individual rationality and no-mimic constraints. This equilibrium is sustained by a market beliefs assessing probability one to a failed project if the firm makes a bonus payment below b. Given this mapping of bonus payments to market values, the firm would not offer an alternate contract ($s(b')$, b'), with $b' < b$, even if such a contract satisfies the no-mimic constraint and yields higher profits.

We now offer three propositions to characterize the relationship between equilibrium bonus contracts and the firm's degree of myopia.

Proposition 1 *For* $k \in \left[0, \frac{b^*}{\pi_s - \pi_f}\right]$*, an efficient separating CSE exists and there does not exist a contract other than the second-best that can be part of a CSE.*

Proof: We first construct a separating CSE wherein the firm offers the second-best contract. We then show that no other contract can be part of a CSE over this range of k.

To start, we specify the market's mapping from bonus payments to beliefs as to the project outcome. Suppose that if the market observes a bonus payment b^* or higher, it assesses the probability that the firm's project has succeeded to be one. Otherwise, the market assesses the probability of project success to be zero.

To establish property (1), note that a firm with a successful project is prevented by an unmodeled governance mechanism from mimicking a firm with a failed project. A firm with a failed project finds that the no-mimic constraint is satisfied, and chooses not to pay the success bonus b^*. To see this, note that, given the specified mapping from bonus payments to firm valuation, the no-mimic constraint is given by

$$b - k(\pi_s - \pi_f) \geq 0.$$

For $k \in \left[0, \frac{b*}{\pi_s - \pi_f}\right]$, this constraint is satisfied. Since bonus payments fully reveal project outcomes, the market valuations conditional on bonus payments specified above are correct. This establishes property (4). Properties (2), (3), (5) and (6) are satisfied by construction. The second-best contract and the specified mapping from bonus payments to valuations therefore constitute a CSE.

Now we show that no other contract can be part of a CSE for $k \in \left[0, \frac{b*}{\pi_s - \pi_f}\right]$. Choose an arbitrary $b < b^*$ and consider $(s(b), b)$ as a candidate for a CSE contract. There are two cases to consider. First, suppose $k \in \left[\frac{b}{\pi_s - \pi_f}, \frac{b*}{\pi_s - \pi_f}\right]$. By construction, $(s(b), b)$ cannot satisfy the no-mimic constraint, and a firm with a failed project will pay bonus b. Hence, $(s(b), b)$ violates CSE property (1). Second, suppose $k \in \left[0, \frac{b}{\pi_s - \pi_f}\right)$. Then $(s(b), b)$ cannot be an equilibrium since it fails condition (3); the firm's profits are strictly higher if it offers the second-best contract (s^*, b^*).

Now select an arbitrary $b > b^*$. Given the restriction on the market's belief imposed by the refinement in condition (6), the firm earns strictly higher profits if it offers the second-best contract (s^*, b^*). Hence, a contract offering bonus b cannot be a CSE. ■

For our second proposition, we need additional notation. Let $\hat{k}$ be defined implicitly as the k solving

$$\Pi\left[s(k(\pi_s - \pi_f)), k(\pi_s - \pi_f), 1, 0\right] = \max[0, \Pi[\bar{s}, 0, 1, 0]]. \quad (5)$$

That is, $\hat{k}$ is the value of k for which the firm's profits when offering the contract featuring the smallest bonus that satisfies the no-mimic constraint are the same as its profits when offering the full-insurance contract. Referring back to Figure 4, $\hat{k}$ is the value of k for which the (NM) line passes through the intersection of the (IR) curve and the isoprofit curve corresponding to the full-insurance contract. If the full-insurance contract yields negative profits, then the $\hat{k}$ equates the profits under the no-mimic contract to zero.

Proposition 2 *For* $k \in \left(\frac{b*}{\pi_s - \pi_f}, \min[\hat{k}, 1]\right]$*, an inefficient separating CSE exists. For a given* k*, the separating contract is unique, features bonus payment* $k(\pi_s - \pi_f)$*, and induces higher effort and places more risk on the agent than the second-best contract. As* k *increases over this interval, welfare decreases.*

Proof: We first construct the equilibrium, then show that no other contract can be part of a CSE. Suppose that if the market observes a bonus payment $k(\pi_s - \pi_f)$ or higher, it assesses the probability that the firm's project has succeeded to be one.

Otherwise, the market assesses the probability of project success to be zero. The no-mimic constraint is satisfied with equality for this bonus, so CSE condition (1) is met. Given this, the market's assessment of the project outcome conditional on the bonus is correct, so (4) is met as well. Properties (2), (3), (5) and (6) are satisfied by construction. The contract $(s(k(\pi_s - \pi_f)), k(\pi_s - \pi_f))$ and the specified mapping from bonus payments to valuations therefore constitute a CSE.

To show that no other contract can be part of a CSE, we first consider an arbitrary $b < k(\pi_s - \pi_f)$. A contract featuring this bonus does not satisfy the no-mimic constraint, so a firm with a failed project would pay the bonus and the contract violates CSE condition (1). Next consider an arbitrary $b > k(\pi_s - \pi_f)$. Such a contract violates condition (6), since the firm earns strictly higher profits if it offers the contract with bonus $k(\pi_s - \pi_f)$. Hence, no contract offering a bonus other than $k(\pi_s - \pi_f)$ can be an equilibrium.

Since bonus levels are increasing in k, it follows directly that the manager exerts more effort and is exposed to more risk. To see that welfare is decreasing in k, first note that the payoffs to the manager and the stock market participants do not vary with k. Hence, profits are the only variable component of welfare. Since the firm's objective function is concave and the bonus associated with the inefficient separating contract is both (1) greater than the second-best bonus and (2) increasing with k, profit (and hence welfare) decreases with k. ∎

Proposition 3 *If $\hat{k}$, then for $k \in (\hat{k}, 1]$, either there exists a CSE featuring pooling, or the firm shuts down.*

Proof: First note that any contract paying bonus $b < k(\pi_s - \pi_f)$ violates CSE condition (1). A firm offering a contract paying a bonus larger than $k(\pi_s - \pi_f)$ earns profits $\Pi[s(k(\pi_s - \pi_f)), k(\pi_s - \pi_f), 1, 0]$, which, by the definition of $\hat{k}$, is less than the profit it earns from offing the pooling contract $(s(0), 0)$, or shutting down. CSE condition (3) implies that the firm either offers a contract featuring zero bonus, or shuts down. ∎

4.2. Proofs from Section 3.1

We first offer some definitions. Let

$$b_0 = \begin{cases} \text{smallest } b \text{ satisfying } V(b) = 0 & \text{if } V(0) < 0 \\ 0 & \text{otherwise} \end{cases}$$

Also, let b_1 be the largest b satisfying $V(b) = V(b_0)$. In the case where $V(0) < 0$, b_1 is the bonus at which the firm is indifferent between the separating equilibrium featuring bonus b_1 and shutting down. When $V(0) \geq 0$, b_1 is the bonus at which the firm is indifferent between the separating contract featuring bonus b_1 and the pooling contract featuring bonus zero. Referring back to Equation (5), it is the case that $b_1 = \hat{k}(\pi_s - \pi_f)$. For a fixed $k \in [0,1]$, define $\tilde{b}(k)$ as the smallest b satisfying

$$b = k(\pi_s - \pi_f) - \frac{1-k}{r}[V(b) - \max[0, V(0)]]. \quad (6)$$

Note that since V is strictly concave, there are at most two solutions to this equation. Define $b^{\text{fall}}(k)$ as

$$b^{\text{fall}}(k) = \begin{cases} \tilde{b}(k) & \text{if } \tilde{b}(k) \in [b_0, b_1] \\ 0 & \text{otherwise.} \end{cases}$$

Proposition 4 *The function $b^{fall}(k)$ has the following properties:*

(i) If $V(0) < 0$, then $b^{\text{fall}}(k) = 0$ for all $k \in [0, b_0/(\pi_s - \pi_f))$.

(ii) $b^{\text{fall}}(\frac{b_0}{\pi_s - \pi_f}) = b_0$.

(iii) $b^{\text{fall}}(\frac{b_1}{\pi_s - \pi_f}) \leq b_1$.

(iv) Let $k_2 = \max\{k \mid \text{there exists } b \in [b_0, b_1] \text{ such that } b < k(\pi_s - \pi_f) - \frac{1-k}{r}[V(b) - \max[0, V(0)]]\}$. Then $k_2 \geq b_1/(\pi_s - \pi_f)$ and $b^{\text{fall}}(k)$ is strictly increasing for $k \in [b_0/(\pi_s - \pi_f), \min[k_2, 1]]$.

(v) If $k_2 < 1$, then $b^{\text{fall}}(k) = 0$ for all $k \in (k_2, 1]$.

Proof: We show (*ii*) first. Substitute $k = b_0/(\pi_s - \pi_f)$ into (6) to get

$$b - b_0 = -\frac{1-k}{r}[V(b) - V(0)], \quad (7)$$

and note that both sides equal zero when $b = b_0$. To show that this is the smallest solution, we rely on the concavity of V: since $V'(b_0) > 0$ (by the assumption that it is efficient to pay positive bonuses), the slope of the left side of (7) is greater than the slope of the right side at $b = b_0$. Since $-V$ is convex, its slope is everywhere increasing and there can be no solution to the left of $b = b_0$.

We next show (*i*). Select an arbitrary $k \in [0, b_0/(\pi_s - \pi_f))$. Note first that at this k, $b_0 > k(\pi_s - \pi_f) > 0$. Also, $\frac{1-k}{r}V(b_0) = 0$, by the definition of b_0. Hence,

$$b_0 > k(\pi_s - \pi_f) - \frac{1-k}{r}V(b_0). \quad (8)$$

Note also that since $V(0) < 0$,

$$0 < k(\pi_s - \pi_f) - \frac{1-k}{r}V(0). \quad (9)$$

Since both the right and left sides of (6) are continuous in b, (8) and (9) together imply that the smallest solution to (6) is less than b_0. Hence $b^{\text{fall}}(k) = 0$.

To show (*iii*), we substitute $k = b_1/(\pi_s - \pi_f)$ into (6) to get

$$b - b_1 = -\frac{1-k}{r}[V(b) - V(0)], \tag{10}$$

and note that both sides equal zero when $b = b_1$. If this is the smallest solution, then $b^{\text{fall}}(b_1/(\pi_s - \pi_f)) = b_1$. If not, then $\tilde{b} < b_1$, which then implies that $b^{\text{fall}}(b_1/(\pi_s - \pi_f)) < b_1$.

To establish (*iv*), we first show that if k is such that $\tilde{b}(k) \in [b_0, b_1]$, then $\tilde{b}'(k) > 0$. Since $\tilde{b}(k)$ is well-defined on the interval $[b_0/(\pi_s - \pi_f), \min[k_2,1]]$, we use the implicit-function theorem to differentiate (6) implicitly:

$$\tilde{b}'(k) = (\pi_s - \pi_f) - \frac{1-k}{r} V'(\tilde{b}(k))\tilde{b}'(k) + \frac{1}{r}\left[V(\tilde{b}(k)) - \max[0, V(0)]\right],$$

which simplifies to

$$\tilde{b}'(k) = \frac{(\pi_s - \pi_f) + \frac{1}{r}\left[V(\tilde{b}(k)) - \max[0, V(0)]\right]}{1 + \frac{1-k}{r} V'(\tilde{b}(k))}.$$

The numerator is positive for all $\tilde{b}(k) \in [b_0, b_1]$. To establish that denominator is positive as well, we note that the slope of the left side of (6) at $\tilde{b}(k)$ is one and the slope of the right side at $\tilde{b}(k)$ is $-\frac{1-k}{r} V'(\tilde{b}(k))$. Since $\tilde{b}$ is the smallest solution of (6) for this value of k and V is concave, it must be that $-\frac{1-k}{r} V'(\tilde{b}(k))$, which implies that the denominator is positive. To complete our proof of (*iv*), we next show that $\tilde{b}(k) \in [b_0, b_1]$ for all $k \in [b_0/(\pi_s - \pi_f), \min[k_2,1]]$. From (*ii*) and (*iii*), we have that $\tilde{b}(b_0/(\pi_s - \pi_f)) = b_0$ and $\tilde{b}(b_1/(\pi_s - \pi_f)) \leq b_1$. Since $\tilde{b}$ is increasing in k whenever $\tilde{b}(k) \in [b_0, b_1]$, it must be that $\tilde{b}(k) \in [b_0, b_1]$ for all $k \in [b_0/(\pi_s - \pi_f), b_1/(\pi_s - \pi_f)]$. It remains to be shown that for $k \in (b_1/(\pi_s - \pi_f), \min[k_2,1]]$, $\tilde{b}(k) \in [b_0, b_1]$. To establish this, we first note that if $\tilde{b}(b_1/(\pi_s - \pi_f)) = b_1$, then $k_2 = b_1/(\pi_s - \pi_f))$.

Suppose, on the other hand, that $\tilde{b}(b_1/(\pi_s - \pi_f)) < b_1$. Then, as we showed in the proof of (*iii*), b_1 is the largest solution to (6). Hence, when $k = b_1/(\pi_s - \pi_f)$, the the slope of the right side of (6) at $b = b_1$ is greater than the slope of the left side. Since the slope of the right side of (6) at $b = b_1$ is increasing with k, the right side of (6) is steeper than the left at $b = b_1$ for all $k > b_1/(\pi_s - \pi_f)$. Convexity of $-V$ then implies that every solution to (6) for $k > b_1/(\pi_s - \pi_f)$ must be less than b_1. We therefore have that $k_2 > b_1/(\pi_s - \pi_f)$ and $\tilde{b}(k) < b_1$.

To establish (*v*), we note that from the definition of k_2, $\tilde{b}$ is undefined for $k > k_2$. Hence $b^{\text{fall}}(k) = 0$. ■

Next, we verify that a firm with a successful project prefers to pay $b^{\text{fall}}(k)$. Suppose $b^{\text{fall}}(k) > 0$. Then the payoff to a successful firm that pays $b^{\text{fall}}(k)$ is

$$\pi_s - b^{\text{fall}}(k) + \frac{1}{r} V(b^{\text{fall}}(k)).$$

The weighted average of short-term and terminal value for a successful firm that pays zero bonus instead is

$$k\left(\pi_f + \frac{1}{r}V(b^{\text{fall}}(k))\right) + (1-k)(\pi_s + \max[0, V(0)]).$$

Hence, the firm is willing to pay the bonus if

$$(1-k)\left(\frac{1}{r}V(b^{\text{fall}}(k)) - \max[0, V(0)]\right) + k(\pi_s - \pi_f) > b^{\text{fall}}(k). \quad (11)$$

Under the assertion that $b^{\text{fall}}(k) > 0$, we have that $b^{\text{fall}}(k)$ satisfies (NM′) with equality. Thus,

$$b^{\text{fall}}(k) = k(\pi_s - \pi_f) - (1-k)\left(\frac{1}{r}V(b^{\text{fall}}(k)) - \max[0, V(0)]\right).$$

Since $(\frac{1}{r}V(b^{\text{fall}}(k)) - \max[0, V(0)]) > 0$, inequality (11) holds. A firm with a successful project always prefers to pay $b^{\text{fall}}(k)$.

4.3. Proofs from Section 3.3

An equilibrium fails the Cho and Kreps (1987) Intuitive Criterion if there is a type of sender θ that receives less than its equilibrium payoff by playing a particular action a for all possible specifications of the receiver's beliefs conditional on a and a type of sender θ′ that receives more than its equilibrium payoff when playing a as long as the receiver assesses $Pr(\theta \mid a) = 0$. (See Fundenberg and Tirole (1995) for a discussion.) We show that if the market assesses probability zero to project success after observing a non-zero bonus payment, then there exists an equilibrium that fails the Intuitive Criterion. It follows that the only beliefs for which there are no equilibria that fail the Intuitive Criterion assess probability one to project success for any non-zero bonus payment.

Proposition 5 *Fix k and let* $b^{rn} > 0$. *If the market assesses probability zero to project success when observing a bonus payment less than* b^{rn}*, then there exists an equilibrium that fails the Cho and Kreps (1987) Intuitive Criterion.*

Proof: Fix k and select an arbitrary $b^{rn} > 0$. Let the market's beliefs as to the project outcome conditional on observing the firm's bonus payment be:

$$\text{Prob}[\text{success}|b \geq b^{rn}] = 1$$
$$\text{Prob}[\text{success}|b < b^{rn}] = 0.$$

We first construct an equilibrium given these beliefs, and then show that this equilibrium fails the Intuitive Criterion. Under the assumption that reputational governance is in place, the largest equilibrium bonus payment (which we denote here as b^{**}) is given by the largest solution to

$$\frac{1}{r}\left(V(b^{**}) - \max\left[0, V(b^{\text{fall}}(k))\right]\right) = b^{**} - b^{rn}. \tag{12}$$

To apply the Intuitive Criterion, we first compare the equilibrium payoff to a firm with a failed project to the payoff when making a bonus payment $\beta = b^{rn} - \epsilon$ (where $\epsilon > 0$ is arbitrarily small) assuming the market assesses the probability of success is one conditional on observing β. The equilibrium payoff to a firm with a failed project is given by $\pi_f + (1/r)V(b^{**})$. If a firm with a failed project makes a bonus payment β and the market assesses project success, then short-term market value is that of a firm with a successful project that has broken its relational contract. The terminal value is π_f plus the future payoff associated with the inability to pay output-contingent bonuses. The weighted average payoff of short-term and terminal value is

$$k\left(\pi_s - \beta + \frac{1}{r}\max\left[0, V(b^{\text{fall}}(k))\right]\right) + (1-k)\left(\pi_f - \beta + \frac{1}{r}\max[0, V(0)]\right). \tag{13}$$

Rearranging (13), we have that a firm with a failed project prefers its equilibrium payoff to its payoff from paying β if

$$\frac{1}{r}V(b^{**}) > k(\pi_s - \pi_f) + \frac{k}{r}\left(\max\left[0, V(b^{\text{fall}}(k))\right] - \max[0, V(0)]\right) - \beta + \frac{1}{r}\max[0, V(0)]. \tag{14}$$

Consider first the case where $b^{\text{fall}}(k) > 0$. Given this, we have that

$$b^{\text{fall}}(k) = k(\pi_s - \pi_f) - \frac{1-k}{r}\left(\max\left[0, V(b^{\text{fall}}(k))\right] - \max[0, V(0)]\right). \tag{15}$$

We substitute (15) into (14), rearrange, and find that a firm with a failed project prefers its equilibrium payoff if

$$\frac{1}{r}\left(V(b^{**}) - \max\left[0, V(b^{\text{fall}}(k))\right]\right) > b^{\text{fall}}(k) - \beta. \tag{16}$$

Note that since reputational governance is in place, we have that $V(b^{**}) > \max[0, V(b^{\text{fall}}(k))]$, and hence that $b^{**} > b^{\text{fall}}(k)$. Since β can be made arbitrarily close to b^{rn}, we therefore have

$$b^{**} - b^{rn} > b^{\text{fall}}(k) - \beta. \tag{17}$$

Together, (12) and (17) imply (16), so we have that a firm with a failed project prefers its equilibrium payoff to its payoff when paying β. Hence, if we can show that a firm with a successful project prefers its payoff when paying bonus β assuming the market assesses Prob[success | β] = 1 to its equilibrium payoff, then this equilibrium fails the Intuitive Criterion. For a firm with a successful project, the equilibrium payoff is

$$\pi_s - b^{**} + \frac{1}{r} V(b^{**}),$$

while the payoff when paying β when the market assesses Prob[success | β] = 1 is

$$\pi_s - \beta + \frac{1}{r} \max\left[0, V(b^{\text{fall}}(k))\right].$$

The firm prefers the payoff from paying β if

$$b^{**} - \beta > \frac{1}{r}\left(V(b^{**}) - \max\left[0, V(b^{\text{fall}}(k))\right]\right)$$

which is implied by (12) and the fact that $\beta < b^{rn}$. Hence, a firm with a failed project prefers its equilibrium payoff to its payoff from paying β even if the market makes the most favorable possible inference based on β, and a firm with a successful project prefers to pay β if the market assesses $\text{Prob}[\text{failure}|\beta] = 0$. This equilibrium therefore fails the Intuitive Criterion.

Alternatively, suppose that $b^{\text{fall}}(k) = 0$, and recall from Section 3 that $b^{\text{fall}}(k) = 0$ only if $V(0) < 0$. Hence, (14) reduces to

$$\frac{1}{r} V(b^{**}) > k(\pi_s - \pi_f) - \beta. \tag{18}$$

Since $b^{\text{fall}}(k) = 0$, it must be the case that $V(k(\pi_s - \pi_f)) \leq 0$. As we have assumed that reputational governance is in place, we have that $V(b^{**}) > 0$, which implies $b^{**} > k(\pi_s - \pi_f)$. Also, since β can be made arbitrarily close to b^{rn}, we have

$$b^{**} - b^{rn} > k(\pi_s - \pi_f) - \beta. \tag{19}$$

Together, (12) and (19) imply (18), so we have that a firm with a failed project prefers its equilibrium payoff to its payoff when paying β. Since

$$b^{**} - \beta > \frac{1}{r} V(b^{**}),$$

a firm with a successful project prefers its payoff when paying bonus β assuming the market assesses $\text{Prob}[\text{success}|\beta] = 1$ to its equilibrium payoff. This equilibrium fails the Intuitive Criterion as well.

Since choice of $b^{rn} > 0$ was arbitrary, we have now shown that for any market beliefs characterized by $\text{Prob}[\text{success}|b \geq b^{rn}] = 1$, there must exist an equilibrium that fails the Intuitive Criterion. ■

We restrict attention to equilibria featuring trigger strategies and focus on identifying the largest bonus amounts that are feasible under reputational governance. A strategy for the firm consists of one wage contract to be offered in the event that the firm has not breached past relational contracts (so that the history of play is cooperative), and another contract to be offered otherwise. After observing the firm's contract offer, the manager chooses whether to accept the offer, and if so, what level of effort to undertake. A strategy for the manager consists of two mappings from contract offers to contract acceptance and effort decisions: one mapping is used if play has been cooperative, while another is used otherwise. The manager plays a trigger strategy in which he trusts the firm's promise to pay bonuses as part of a relational contract if and only if the firm has not breached a relational contract in the past. If the firm has breached a relational contract in the past, then the manager assumes the firm will do so again.

We define a Relational Contract-Signaling Equilibrium (RCSE) to consist of a strategy for the firm, a strategy for the manager, and a mapping from observed bonus payments and the history of play to market values that satisfy the following properties:

1. Taking the history of play, the mapping from wage payments and history to market values, and the manager's strategy as given, the firm's contract offer and choice of bonus payment must maximize the weighted average of short-term and terminal value.

2. Taking the history of play, the mapping from wage payments and history to market values, and the firm's strategy as given, the manager's participation and effort decisions must maximize his expected utility.

3. The market's assessment of the value of the firm conditional on the observed bonus payment and the history of play must be correct.

4. Given a contract (s, b), for all $b' < b$ such that $\pi_f > k\pi_s + (1-k)\,\pi_f - b'$,

   $$\Pi[s, b, 1, 0] > \Pi[s(b'), b', 1, 0].$$

Condition (4) is a refinement that eliminates equilibria with "excessive" signaling.

The following propositions characterize how the RCSE bonus varies with k.

Proposition 6 *Suppose $V(0) < 0$. Then for $k \in [0, k_0)$, the RCSE bonus does not vary with k.*

Proof: There are two cases to consider. First, let $\delta \geq \delta_0$, where δ_0 is the smallest discount factor for which there exists a b such that $V(b) \geq rb$ is satisfied. Note that in the event that the relational contract has been breached in the past, the firm will elect not to offer a contract that will be accepted by the manager. The refinement of property (4) eliminates all equilibria with excessive signaling. Hence, the only bonus the firm can credibly offer is that characterized by the function $b^{\text{fall}}(k)$. Since (by Proposition 4) $b^{\text{fall}}(k) = 0$ when $k \in [0, k_0)$ and $V(0) < 0$, the firm is best off it does not offer a contract that will be accepted by the manager. Hence, the firm's profit in the fallback position is zero. Given this, the bonuses feasible under reputational governance are those b satisfying $V(b) \geq r\,b$. The RCSE bonus is the largest solution to this inequality or the second-best bonus, whichever is smaller. Since neither this inequality nor the second-best varies with k, the RCSE bonus does not vary with k when $k \in [0, k_0)$ and $\delta \in [\delta_0, 1]$.

Second, suppose $\delta \in [0,\delta_0)$. Here, there is no feasible relational contract. The only equilibrium is for the firm to shut down, so bonuses again do not vary with k. ■

Proposition 7 *Suppose $k \in [k_0, k_1)$. For a given k in this interval, if the RCSE bonus is greater than $b^{fall}(k)$, then the RCSE bonus is weakly decreasing in k at that point. If the RCSE bonus is equal to $b^{\text{fall}}(k)$, then the RCSE bonus is strictly increasing in k at that point.*

Proof: In the event that the relational contract has been breached in the past, the firm can rely on the no-mimic constraint as a governance mechanism. Again since the refinement of property (4) eliminates equilibria with excessive signaling, the bonus that can be credibly offered in the fallback position is given by $b^{\text{fall}}(k)$. The reputational governance constraint is $V(b) - V(b^{\text{fall}}(k)) \geq rb$, and note that, since $k_1 < k_2$, we have (from Proposition 4) that $b^{\text{fall}}(k)$ is strictly increasing with k on this interval.

Now fix δ. If δ is sufficiently large, then the reputational governance constraint is satisfied for some b. The RCSE bonus is the largest such solution or the second-best, whichever is smaller. Because $b^{\text{fall}}(k)$ is increasing, $V(b) - V(b^{\text{fall}}(k))$ decreases with k, so the largest bonus satisfying the reputational governance constraint decreases with k. We therefore have that the RCSE bonus weakly decreases with k

If δ is not so large that reputational governance constraint is satisfied, then the no-mimic constraint governs the contract. The RCSE bonus is $b^{\text{fall}}(k)$, which is increasing with k. ■

Proposition 8 *Suppose $k \in [k_1,k_2)$. The RCSE bonus is increasing in k over this interval.*

Proof: Regardless of δ, no reputational governance is feasible on this interval. Since $b^{\text{fall}}(k)$ is greater than the second-best contract, any contract that improves on the contract governed by the no-mimic constraint also violates the no-mimic constraint. As property (4) eliminates equilibria with excessive signaling, the bonus that can be credibly offered is $b^{\text{fall}}(k)$. Since $k \in [k_0,k_2)$, we have (from Proposition 4) that $b^{\text{fall}}(k)$ is strictly increasing with k on this interval. ■

Proposition 9 *If $k_2 < 1$, then for $k \in (k_2,1]$, the RCSE bonus does not vary with k.*

Proof: Again, no reputational governance is feasible here. If it is profitable for the firm to operate, then it offers the pooling, full-insurance contract (by the definition of k_2). Hence, the RCSE bonus is zero and does not vary with k. Otherwise, the firm shuts down. ■

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Notes

1. Of course, discretionary *grants* of equity-based instruments may convey information. However, since changes in an executive's wealth stemming from his pre-existing "stock" of equity-based instruments are simply a known function of publicly observable measures of firm performance, no non-public information regarding current performance is conveyed by changes in the value of these instruments.
2. For simplicity, we ignore the potential for agency conflicts between the shareholders and the board.
3. We further assume the terminal value is non-contractible. This assumption is standard in literatures on both signaling to financial markets and managerial remuneration (see, for example, Holmstrom and Tirole, 1993).
4. Note that this formulation would raise a sequential rationality problem if shareholders were informed about the outcome of the firm's project. In the event the firm's project fails but the board fools the market by paying the bonus associated with success, all shareholders would strictly prefer to sell. This would alter the no-mimic constraint in their signaling model.
5. Throughout the paper, we use the terms "board" and "firm" interchangeably when referring to decisions made by corporate insiders regarding the employment contract for the manager.
6. Stein (1989, p. 659) suggests some additional potential justifications for corporate short-termism, including a need to have high share prices in order to meet ongoing funding requirements.
7. In our stylized model, "project outcome" is intended to represent any non-public information the board uses to assess managerial performance. This could reflect information that the firm does not want to disclose (as in the case of a "competitively sensitive" performance measure) or information that the firm cannot credibly disclose (as may be the case for a "subjective evaluation" of performance). Firms convey information to markets in many ways, and our model does not require that all payoff-relevant information be transmitted through bonuses.
8. This statement presumes the firm's profits are positive when it offers the full-insurance contract. If this contract yields negative expected profits, then the firm shuts down when k is large.
9. This statement requires some qualification. It is possible that information that is non-public at date t may become public and verifiable at date $t+1$. A firm could write a contract with a manager specifying a payment to be made at date t, with enforcement provided by recourse to the courts at date $t+1$. In this case, the analysis of Section 1 still applies. We argue, however, that many aspects of managerial performance are non-verifiable, and hence that explicit consideration of reputational governance is necessary for understanding use of non-public information in firms.
10. A more thorough discussion of these issues is offered by Baker et al. (1994). Levin (2003) shows that trigger strategies are renegotiation-proof and optimal punishments in a model of relational incentive contracts with a single non-verifiable performance measure. His analysis, however, allows for contingent payments from the agent to the principal. Because "negative bonuses" are rare in the managerial compensation context, we do not consider this possibility. Levin's findings therefore do not apply to the model we study. We argue, however, that one of our main results—that there exist cases where firm profits are increasing with myopia—is likely robust to consideration of these issues. Specifically, one of our main arguments below is that when reputational governance is not feasible, the no-mimic constraint provides an alternative governance mechanism. Our trigger-strategy assumption favors reputational governance of contracts, by making it costly for a firm to renege on a promised bonus. If the manager cannot commit to a trigger strategy—that is, cannot commit not to trust the firm again if the firm has reneged—then the firm becomes *less* able to use reputation to commit to pay current bonuses. Hence, eliminating the trigger-strategy assumption will just increase the range of discount factors over which the parties must make use of the no-mimic constraint as a governance mechanism. Our finding that increases in myopia can increase profits is therefore robust.

11. Moving to the repeated game setting raises the possibility of gains from smoothing the risk-averse manager's income intertemporally. For simplicity, we ignore this possibility. This can be justified by assuming a utility function with intertemporally constant absolute risk aversion (see Fellingham et al., 1985), or by assuming the manager is risk neutral but liquidity constrained.
12. We reserve use of the term "reputation" to refer to the value the firm captures as a result of the manager's future willingness to trust the firm's bonus offers. Firms can have various types of reputations with many different constituencies (including customers, suppliers and investors), but our focus is on the firm's reputation for upholding its relational contracts with managers.
13. Baker et al. (1994) apply a similar assumption. In their model, if a firm reneges on a promise to pay a bonus based on a non-verifiable evaluation of the employee's performance, then future contracts are based only on verifiable measures of performance. The firm's promise to pay based on these verifiable measures is enforced by an external authority (such as the legal system). In our setting, the firm's promise to pay based on the project outcome is enforced by its own myopia.
14. Our main findings are robust to changes in this assumption; we obtain similar results if the manager does not change his future behavior when the firm pays a bonus following project failure.
15. Note that (NM′) is derived by showing that a firm with a failed project must not prefer to pay the bonus. We must also verify that a firm with a successful project prefers to pay the bonus. See appendix.
16. Our assertion that the firm can credibly offer only the smallest bonus satisfying (NM′) relies implicitly on application of the Cho and Kreps (1987) Intuitive Criterion. If the market believes the firm's project is a failure after observing the smallest bonus that satisfies (NM′), then larger bonuses may be credible. Such equilibria fail the Intuitive Criterion refinement, however.
17. In the appendix, we prove the claim that $b^{\text{fall}}(k)$ is strictly increasing in k when $k \in [k_0, k_2)$.
18. Here, we require $b^{rn} < k(\pi_s - \pi_f)$. The quantity $k(\pi_s - \pi_f)$ is the gain to the firm in the current period from convincing the market that its project is successful. Hence, if $b^{rn} > k(\pi_s - \pi_f)$, a firm that reneges on its relational contract would not find it worthwhile to attempt to convince the market that its current project is successful, and would pay bonus zero rather than b^{rn}.
19. We implicitly assume here that $b^{\text{fall}}(k)$ is smaller than the second-best bonus. If $b^{\text{fall}}(k)$ is larger than the second-best bonus, then the firm cannot benefit from a reputational mechanism that allows it to commit to larger bonuses. This assumption also implies that firms with failed projects never find it in their interests to mimic those with successful projects.
20. We emphasize that this specification of beliefs is not necessary for our main results. In an earlier version of this paper, we considered the case where market participants believe the probability that the firm's current project is successful to be zero if $b < b^{\text{fall}}(k)$ and one otherwise. This specification of beliefs holds some intuitive appeal, since if the relational contract has been breached in the past, a firm with a failed project would be willing to pay a bonus of up to $b^{\text{fall}}(k)$ if doing so would convince the market that the firm's project was successful. Qualitatively similar results were obtained.
21. Additional effects may be present when different specifications of market beliefs are used. For example, if the market believes probability the firm's current project is successful to be zero if $b < b^{\text{fall}}(k)$ and one otherwise, then the gains from reneging fall as k increases. In this case, it is possible that increases in k cause the largest reputational bonus to increase, as we showed in an earlier version of this paper.
22. Institutional factors may also affect this choice. In the U.S., for instance, payments to executives in excess of $1 million are not tax-deductible unless they are demonstrably performance based.

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