Information Disclosure and Corporate Governance*

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April 19, 2008

Abstract

Disclosure is widely assumed to play an important role in corporate governance. Yet governance has not been the focus of previous academic analyses of disclosure. We consider disclosure in the context of corporate governance. We argue that disclosure is a two-edged sword. On one side, disclosure of information permits principals to make better decisions. On the other, it can create or exacerbate agency problems: The release of information has the potential to harm agents (*e.g.,* management) either through the actions the principals take as a consequence (*e.g.,* dismiss the agent) or because the agents care about how they are perceived (*e.g.,* the agents have career concerns or hold equity in the firm). This can lead agents to pursue actions that are not in the principals' interests. Moreover, these problems become worse, the more precise the principals' information. We present a series of models formalizing this idea. These models lead to a number of empirical implications, both for disclosure-increasing regulations and for the relation between disclosure and governance.

Keywords: Corporate governance, corporate disclosure.

JEL numbers: G3, L20, D82, D83, M42.

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*Formerly titled "Transparency and Corporate Governance." The authors thank seminar and conference participants at the University of California, the University of Chicago Law School, the University of Illinois, La Trobe University (Bundoora), London Business School, Max Planck Institute (Bonn), MIT Sloan, the University of Queensland, RMIT, Yale Law School, the Swedish Institute for Financial Research Conference, Stockholm, the Olin Business School's Second Annual Conference on Corporate Governance, the Stanford Accounting Conference, the 2006 FRA Conference, and the 2007 ASSA Meetings. The authors are grateful to Philip Bond, Christian Leuz, Roberta Romano, Ken Shaw, Jeroen Swinkels, and, especially, an anonymous referee, Denis Gromb, Matt Spiegel, and Jeff Zwiebel for their comments and suggestions.

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1 Introduction

A response to recent corporate governance scandals, such as Enron and Worldcom, has been to increase disclosure requirements. For example, Sarbanes-Oxley (SOX) requires detailed reporting of off-balance sheet financing and special purpose entities. Additionally, SOX increases the penalties to executives for misreporting. In the public's (and regulators') view, better disclosure equates to better governance.

Yet most academic discussions of disclosure have nothing to do with governance. The most commonly discussed benefit of disclosing information is that it reduces asymmetric information, and hence lowers the cost of trading the firm's securities and the firm's cost of capital.[1] Because firms do not engage in complete disclosure, one presumes there are costs to disclosure; typically these are taken to be the direct costs of disclosure. Some commentators have also noted disclosure could be harmful insofar as it could advantage product-market rivals by providing them valuable information.[2] While both of these factors are undoubtedly important considerations in firms' disclosure decisions, they are not particularly related to corporate governance.

In this paper, we consider disclosure in the context of corporate governance. We argue that disclosure is a two-edged sword. On one side, disclosure of information permits principals to make better decisions. On the other, it can create or exacerbate agency problems: The release of information has the potential to harm agents (*e.g.,* management) either through the actions it might induce the principals to take (*e.g.,* dismiss the agent) or because they care about how they or the enterprise is perceived (*e.g.,* the agents have career concerns or hold equity in the firm). Consequently, agents can be led to pursue actions that are not in the principals' interests.[3] Moreover, these problems become worse, the more precise the principals' information. Even if agents take no actions or their actions do not directly cost the principals, they will need to be compensated for the harm caused them by disclosure; hence, an increase in compensation is the price of an increase in disclosure.

[1] Diamond and Verrecchia (1991) were the first to formalize this idea. For empirical evidence, see Leuz and Verrecchia (2000), who document that firms' cost of capital decreases when they *voluntarily* increase disclosure. The idea that asymmetric information can harm trade dates back to at least Akerlof's (1970) "lemons" model.

[2] See Leuz and Wysocki (2006) for a recent survey of the disclosure literature. Feltham et al. (1992), Hayes and Lundholm (1996), and Wagenhofer (1990) provide discussions of the impact of information disclosure on product-market competition.

[3] In a private conversation, a prominent Silicon Valley CEO claimed that the Sarbanes-Oxley changes in reporting rules were adversely affecting decision making in the Valley, making people less likely to take long-term risks. Two recent studies also suggest that SOX has had consequences for corporate behavior (Bargeron et al., 2007 and Litvak, 2007).

We formalize this argument by extending the career-concerns framework of Holmstrom (1999) to allow for endogenous decisions about how or what information is disclosed. Section 2 lays out a basic model, in which the principal (here, called the owners) chooses the quality (precision) of the information that it will later receive and on which it bases a decision. As will be shown, the more precise the information will be, the lower will be the agent's (here, called the CEO) expected utility, so he will be have to be paid more to meet his reservation utility. The principal, therefore, faces a tradeoff between the benefits and costs of better information. In equilibrium, this tradeoff can lead the owners to choose not to maximize the precision of their information. As we discuss in Section 2, the model applies to many potential decisions that the principal might make and there are a number of different channels through which more precise information can be shown to adversely affect the agent.

Anticipating the uses that may be made of information, the CEO has incentives to interfere with the transmission of this information. This, then, can create an agency problem. In Section 3, we allow the CEO to take actions that can distort the owners' information.[4] We show, first, that the CEO's ability to distort the signal can cost the owners even if the distorting activity is not *per se* harmful to them. The source of this indirect cost is the CEO's disutility from engaging in distortion. Given that the CEO cannot commit not to distort information, he must be compensated for his disutility from doing so. It is also possible that the distorting actions directly harm the owners (*e.g.,* as in Section 3.3, where distortions arise from myopic management as in Stein, 1989).

One response, as in recent legislation, to the possibility of the CEO's distorting information is to penalize him for doing so. Hence, we also evaluate penalties for distorting information. Such penalties can be desirable if they are sufficiently severe to curtail this effort; however, relatively minor penalties can be counterproductive. The reason they can be counterproductive is that, if they fail to curtail this effort, then they can raise the CEO's compensation insofar as he still must be compensated for his efforts at distortion and, now, also the expected cost of the penalties he might suffer.

A question related to *how much* information a firm should disclose is *what kind* of information it should disclose. In Section 4, we also consider the circumstances under which

[4]Inderst and Mueller (2006), Singh (2004), Goldman and Slezak (2006), and Song and Thakor (2006) are four other recent papers concerned with the CEO's incentives to distort information. Like us, the first is concerned with inferences about the CEO's ability. Inderst and Mueller's approach differs insofar as they assume the CEO possesses information not available to others, which others, thus, need to induce the CEO to reveal. There is no uncertainly about the CEO's ability in Singh's model; he is focused on the board's obtaining accurate signals about the CEO's actions. Goldman and Slezak are concerned primarily with the design of stock-based compensation. In addition, unlike us, they treat disclosure rules as exogenous, whereas we derive the profit-maximizing rules endogenously. Song and Thakor deal with the incentives of a CEO to provide less precise signals about the projects he proposes to the board.

it makes sense for owners to disclose, in addition to information about firm performance, direct information about the CEOs actions. Specifically, we consider the possibility that the owners can reveal information about the projects that the CEO chooses to undertake. We show that disclosing the CEOs choice of project can be detrimental to the owners in some circumstances, although it can be beneficial to them in others. The idea is that how the public updates its beliefs about the CEO's ability depends on what they see him do. This creates an agency problem with respect to the CEO's choice of projects because he is motivated, in part, by a desire to influence this updating process. Although certain forms of contracting can change these conclusions (see Section 4.1), we show that if the owners are able to use incentive contracts contingent on profits, then this ability will tend to bias them away from disclosure.

In Section 5, we discuss some of the possible shortcomings of our model. Two in particular warrant attention upfront: (i) if it is the *public* release of information that is harmful to the CEO, perhaps the owners (or the board of directors, more realistically) should keep information within the firm, but make sure they are using internally the highest precision information possible; and (ii) if it is the risk that the release of information represents for the CEO that is the source of the problem, then the owners could simply insure the CEO against this risk. Both could, in some contexts, be reasonable points. On the other hand, as we discuss in Section 5, it is not necessarily the publicness of information that adversely affects the CEO. In addition, in many contexts, it really is the owners who are making decisions about their agents (*e.g.,* the board). Furthermore, the actions of the principals in response to their private information could become a public signal of that information (*e.g.,* dismissal of the CEO is a public event). With regard to point (ii), it is true that we sometimes see *partial* insurance for the CEO (*e.g.,* golden parachutes as insurance against dismissal), but for moral hazard reasons it is highly unlikely that the owners would wish to *fully* insure the CEO: Full insurance means the CEO's compensation gets bigger the worse he does. The obvious perverse incentives that would create clearly rule it out as a realistic solution. Moreover, as we discuss, there could be other reasons that such contingent contracts are infeasible, for example having to do with the difficulties of actually contracting on the information (the information could, for instance, be difficult to describe *ex ante*, making contracting difficult).

In Section 6 we discuss some of the empirical implications of our model. As we discuss, the model suggests a number of empirical tests. Section 7 contains a summary and conclusion. Proofs not given in the text can be found in the appendix.

2 The Model

We are concerned with situations in which a firm's owners (more generally, a principal) wish to take an action, a, based on information about the firm or its CEO, $s \in \mathbb{R}$. As will be shown, the owners want more precise information, while the CEO (more generally, an agent) prefers that information be less precise.

2.1 Timing of the Model

The model has the following timing and features.

STAGE 1. The owners of a firm fix the degree of disclosure or reporting quality, q.[5] The owners also hire a CEO from a pool of *ex ante* identical would-be CEOs. Assume the owners make a take-it-or-leave-it offer to the CEO. Let α denote a measure of the CEO's ability or the quality of the strategy he adopts. We assume α is an independent random draw from a normal distribution with mean 0 and known variance $1/\tau$ (τ is the *precision* of the distribution).[6] Normalizing the mean of the distribution to zero is purely for convenience and is without loss of generality.

STAGE 2. After the CEO has been employed for some period of time, a public signal, s, of α is realized. The signal is distributed normally with a mean equal to α and a variance equal to $1/q$. Letting the precision, q, of the distribution be the same as the quality of reporting or degree of disclosure, q, is without loss of generality because we are free to choose whatever metric we wish for reporting quality or degree of disclosure.

STAGE 3. Based on s, the owners update their belief about α; let $\hat{\alpha}$ be their posterior expectation of α. Based on their posterior beliefs, the owners choose $a \in \mathcal{A} \subset \mathbb{R}$. Denote the owners' cost of action as $c(a)$.

STAGE 4. The CEO gets a payoff (utility) that is—ultimately—a function of $\hat{\alpha}$; let $u(\cdot)$ denote that function. Assume it is increasing. A random variable, r, is also realized. Assume

[5]Section 2.5 *infra* offers one possible interpretation of q in terms of the owners' decision as to which dimensions of performance to disclose and which to have concealed; the more dimensions made public, the greater is q. Other measures or interpretations of q are discussed in Section 6 *infra*.

[6]Ability, α, is fixed throughout the stages of the model. One concern might, then, be that learning over time about the CEO's ability (as *e.g.,* in repeated version of this model) would be quite rapid. As, however, Holmstrom (1999) shows, one can eliminate rapid learning by allowing α to follow a random walk across different periods. In fact, as Holmstrom shows, there can be stationarity across periods, so that one might view our game as just one period of a stationary multi-period game.

$r \sim N(\alpha, 1/h)$. Finally, the return to the owners is $rv(a)$. Assume the functions $v(\cdot)$ and $c(\cdot)$ are at least twice differentiable if $\mathcal{A}$ is an interval.

Although bare bones, this model encompasses a number of situations. For instance, suppose that $\mathcal{A} = \{0, 1\}$—fire or keep the CEO—and the CEO has either career concerns or gains a control benefit from retaining his job. Here $v(a) = a$ and $c(a) = (1 - a)f$, where $f > 0$ is a firing cost. If the CEO is risk averse and his future pay is an affine or concave function of estimated ability, then the composite payoff function $u(\cdot)$ will be increasing (and exhibit diminishing marginal utility). If the CEO enjoys a control benefit of $b > 0$ if he retains his job and gets no benefit if fired, then, under the optimal firing rule for the owners, his payoff is $b\mathbf{1}_{\{\hat{\alpha} \geq -f\}}$, which is an increasing function of $\hat{\alpha}$.

As a second example, suppose that $\mathcal{A} = \mathbb{R}$ and that a denotes a change in firm size. Let K be the firm's starting size. Without loss of generality, normalize the opportunity cost of funds to zero.[7] Let $v(a) = K + a$ and $c(a) = a^2/2$ (*i.e.*, quadratic adjustment costs). Given the posterior expectation of r is $\hat{\alpha}$, the owners' optimal choice of how much to take out ($a < 0$) or invest further in the firm ($a > 0$) is readily shown to be $a = \hat{\alpha}$. Suppose the CEO's utility, $\tilde{u}(\text{size})$, is increasing (he prefers to manage a larger empire to a smaller one; he can skim more the more resources under his control; etc.). Then $u(\hat{\alpha}) = \tilde{u}(K + \hat{\alpha})$. Note, in this second example, the variable α could be interpreted either as the CEO's ability or the quality of the strategy he has employed.

2.2 Information

We follow Holmstrom (1999) by assuming that the CEO, like all other players, knows only the *distribution* of his ability or the quality of his strategy. We justify this assumption by assuming either (i) that both the CEO and potential employers learn about his ability from his actual performance (*i.e.*, no one is born knowing whether he'll prove to be a good executive or not); or (ii) that both the CEO and the owners (more precisely, the board of directors) likely hold similar beliefs about how well a given strategy will work because, if their beliefs differed too much, the CEO and the board wouldn't agree to that strategy.

After the signal, s, is observed, the players update their beliefs about α. The posterior estimates of the mean and precision of the distribution of the CEO's ability are

$$\hat{\alpha} = \frac{qs}{q + \tau} \text{ and } \hat{\tau} = \tau + q\,, \tag{1}$$

[7] One can think of the firm's true returns being $r + R_0$, where R_0 is the return available to the owners from alternative investments (so putting a into the firm costs $R_0 a$ and taking a out returns $R_0 a$). It can readily be seen that setting $R_0 = 0$ is without loss of generality for the analysis at hand.

respectively (see, *e.g.,* DeGroot, 1970, p. 167, for a proof). The posterior distribution of α is also normal.

We assumed that the distribution of the signal s given α is normal with mean α and variance $1/q$; hence, the distribution of s given the *prior* estimate of α, 0, is normal with mean 0 and variance $1/q + 1/\tau$.[8] Let H denote the precision of s given the prior estimate of ability, 0; it follows, therefore, that

$$H = \frac{q\tau}{q+\tau}\,.$$

Observe, for future reference, that

$$\hat{\alpha} = \frac{H}{\tau}s\,.$$

2.3 The Owners' Choice of Action

We assume the owners are risk neutral. Their optimization program can be written as

$$\max_{a\in\mathcal{A}} \mathbb{E}\{rv(a)|\hat{\alpha}\} - c(a) \equiv \max_{a\in\mathcal{A}} \hat{\alpha}v(a) - c(a)\,. \tag{2}$$

We limit attention here to $\mathcal{A} = \{0,1\}$ or $\mathcal{A}$ as an interval. In the former case, as a convention, we take $a = 1$ to mean maintaining the *status quo*, which has no direct cost (*i.e.,* $c(1) \equiv 0$) and yields the owners r (*i.e.,* $v(1) = 1$). Action $a = 0$ means a change (*e.g.,* firing the CEO) and yields a constant net return $\bar{r}$ (*i.e.,* $v(0) = 0$ and $c(0) = -\bar{r}$).[9] Denote the solution to (2) by $a^*(\hat{\alpha})$. Observe, when $\mathcal{A} = \{0,1\}$, that

$$a^*(\hat{\alpha}) = \begin{cases} 0\,, & \text{if } \hat{\alpha} < \bar{r} \\ 1\,, & \text{if } \hat{\alpha} \geq \bar{r} \end{cases}\,. \tag{3}$$

When $\mathcal{A}$ is an interval, we assume $v(\cdot)$ is strictly increasing. We further assume

- For all $\hat{\alpha} \in \mathbb{R}$, program (2) is strictly quasi-concave in a.
- For all $\hat{\alpha} \in \mathbb{R}$, program (2) has a finite solution; by the previous assumption, it is unique. As before, denote it by $a^*(\hat{\alpha})$.

[8]The random variable s is the sum of two independently distributed normal variables $s - \alpha$ (*i.e.,* the error in s) and α; hence, s is also normally distributed. The means of these two random variables are both zero, so the mean of s is, thus, 0. The variance of the two variables are $1/q$ and $1/\tau$ respectively, so the variance s is $1/q + 1/\tau$.

[9]For instance, $\bar{r}$ could equal the expected value of a replacement CEO (*i.e.,* $a = 0$ implies firing the incumbent) less a firing cost, f.

- There exists $\hat{\alpha}$ and $\hat{\alpha}' \in \mathbb{R}$, $\hat{\alpha} \neq \hat{\alpha}'$, such that $a^*(\hat{\alpha}) \neq a^*(\hat{\alpha}')$.

Define the maximized value of (2) given $\hat{\alpha}$ as

$$V(\hat{\alpha}) \equiv \hat{\alpha} v\big(a^*(\hat{\alpha})\big) - c\big(a^*(\hat{\alpha})\big) .$$

Lemma 1 *Under the assumptions given above and for both the case in which $\mathcal{A}$ is $\{0,1\}$ and the case in which it is an interval, the following hold:*

(i) $a^*(\cdot)$ is a non-decreasing function; and

(ii) $V(\cdot)$ is a convex, but not affine, function.

Observe that Lemma 1(ii) is essentially stating that the owners find information to be valuable; that is, the action they take, a^*, potentially varies with their posterior estimate of α. If it did not vary, then $V(\cdot)$ would be a straight line. Because it does vary and maxima are unique, $V(\cdot)$ must lie above—over at least some interval—its tangency line at any specific point; that is, it must be convex.

A consequence of Lemma 1 is that the owners are risk *loving* in $\hat{\alpha}$. Hence, if one distribution over $\hat{\alpha}$ is a mean-preserving spread of a second, then the owners strictly prefer the first to the second. Recall that the prior distribution of the signal, s, is normal with mean zero and variance $1/H$. From (1), it follows that the prior distribution of $\hat{\alpha}$ is normal with mean zero and variance

$$\mathrm{Var}(\hat{\alpha}) = \frac{q^2}{(q+\tau)^2}\,\mathrm{Var}(s) = \frac{H}{\tau^2} .$$

It is readily seen that H is increasing in q. Recalling that a mean-preserving spread of a normally distributed random variable is equivalent to an increase in its variance, we have established:

Proposition 1 *The firm's owners strictly prefer a greater precision in the signal (a larger q) to a lesser precision (a smaller q),* ceteris paribus*.*

2.4 The CEO's Preferences

We now turn to the CEO. We consider two possible sets of assumptions about the CEO's preferences.

In the first, we assume that $\mathcal{A} = \{0,1\}$ and the CEO loses $\ell > 0$ if the owners don't maintain the *status quo* (*i.e.*, choose $a = 0$). For instance, ℓ could represent lost status, lost benefits of control, or the reduction in future salary if the owners fire the CEO (choose $a = 0$). Consequently, in this case

$$u(\hat{\alpha}) = \begin{cases} -\ell\,, & \text{if } \hat{\alpha} < \bar{r} \\ 0\,, & \text{if } \hat{\alpha} \geq \bar{r} \end{cases} \tag{4}$$

plus, possibly, an additive constant, which we are free to ignore. Note the use of (3) in deriving (4). Recall that the prior distribution of $\hat{\alpha}$ is normal with mean zero and variance H/τ^2. For this case, this means that

$$\mathbb{E}\{u(\hat{\alpha})\} = -\ell\Phi\left(\frac{\tau\bar{r}}{\sqrt{H}}\right)\,, \tag{5}$$

where $\Phi(\cdot)$ is the distribution function for a standard normal random variable (*i.e.,* one with mean zero and variance one). Differentiating the righthand side of (5) with respect to q yields

$$\frac{d\mathbb{E}\{u(\hat{\alpha})\}}{dq} = \ell\phi\left(\frac{\tau\bar{r}}{\sqrt{H}}\right)\frac{\tau}{H^{3/2}}\bar{r} \times \frac{\partial H}{\partial q}\,, \tag{6}$$

where $\phi(\cdot)$ is the density function of a standard normal. The sign of (6) is the same as the sign of $\bar{r}$ (recall H is increasing in q). It is natural to think of $\bar{r} < 0$—the *status quo* is what the owners maintain absent any information (*i.e.,* $\hat{\alpha} \equiv 0$). If $\bar{r} < 0$, then (6) reveals that the CEO's utility falls as the signal becomes more precise. This makes intuitive sense: Absent information, the owners take no action; but as the signal becomes informative, the CEO is increasingly vulnerable to the owners' acting on this information and losing ℓ. This establishes part (i) of Proposition 2 below.

In the second set of assumptions about CEO preferences, we simply assume that $u(\hat{\alpha})$, the CEO's payoff if the posterior estimate of α is $\hat{\alpha}$, exhibits diminishing marginal utility. That is, *ex ante*, the CEO is risk averse with respect to $\hat{\alpha}$. This, for instance, would be the case if the CEO is risk averse over income and his future salary is an affine or concave function of his estimated ability (*e.g.,* the model is a career-concerns model along the lines of Holmstrom, 1999). The CEO is risk averse and, as shown above, an increase in q corresponds to a mean-preserving spread of $\hat{\alpha}$, These two facts imply part (ii) of the following proposition.

Proposition 2 *Under the assumptions of the model,*

(i) if the CEO's utility is given by (4) and $\bar{r} < 0$; or

(ii) if $u(\cdot)$ exhibits diminishing marginal utility,

then the CEO *strictly prefers a less precise signal (lower q) to a more precise signal (higher q),* ceteris paribus.

Propositions 1 and 2 together imply that the owners and CEO are at odds about the quality of reporting in the firm; the owners prefer greater quality and the CEO less.

It may, at first, seem counter-intuitive that a more precise signal about α increases risk. Wouldn't a risk-averse CEO prefer a more precise signal about his ability or the quality of his strategy to a less precise signal? The reason the answer is no is that the CEO's future payoff is a function of a weighted average of the prior estimate of α (*i.e.,* 0), which is fixed, and the signal, s, which is random. Being risk averse, the CEO prefers more weight be put on the fixed quantity than on the random quantity (recall $\mathbb{E}\{s\} = 0$). The *less* precise the signal, the more weight is put on the prior estimate, making the CEO better off.

A consequence of these opposing preferences is that, in order to induce the CEO to accept employment, the owners will need to offer greater compensation to the CEO the greater the quality of reporting or the degree of disclosure they choose (*i.e.,* the greater is q). The owners, therefore, face a tradeoff between the benefits of obtaining more informative signals and the implied cost, in terms of CEO compensation, from more informative signals.

For example, suppose that a is the change in firm size, K. Let $v(a) = K + a$ denote firm size post change and $c(a) = a^2/2$ the adjustment cost. It is readily seen that $a^*(\hat{\alpha}) = \hat{\alpha}$ and $\mathbb{E}\{V(\hat{\alpha})\} = \frac{1}{2}\operatorname{Var}(\hat{\alpha})$. Suppose that the CEO's utility is $w - \beta\exp(-a)$, $\beta \in (0,1)$; that is, he values compensation, w, and prefers to grow the firm rather than shrink it, *ceteris paribus.* Observe $u(\hat{\alpha}) = -\beta\exp(-\hat{\alpha})$ and, therefore, that

$$\mathbb{E}\{u(\hat{\alpha})\} = -\beta\exp\left(\frac{1}{2}\operatorname{Var}(\hat{\alpha})\right).$$

Suppose the owners make a take-it-or-leave-it offer to the CEO concerning employment and normalize the CEO's reservation wage to 0. Hence, the owners must offer $w = -\mathbb{E}\{u(\hat{\alpha})\}$. Given that $\operatorname{Var}(\hat{\alpha})$ is an increasing function of q, the owners' problem can be expressed as choosing $\operatorname{Var}(\hat{\alpha})$ to solve

$$\max_{\operatorname{Var}(\hat{\alpha})} \mathbb{E}\{V(\hat{\alpha})\} - w \equiv \max_{\operatorname{Var}(\hat{\alpha})} \frac{1}{2}\operatorname{Var}(\hat{\alpha}) - \beta\exp\left(\frac{1}{2}\operatorname{Var}(\hat{\alpha})\right) \tag{7}$$

subject to $\operatorname{Var}(\hat{\alpha}) \leq 1/\tau$. Expression (7) is strictly concave and the program has a unique solution of $\operatorname{Var}(\hat{\alpha}) = \min\{-2\log(\beta), 1/\tau\}$ implying optimal signal informativeness is

$$q^* = \frac{-2\log(\beta)\tau^2}{1 + 2\log(\beta)\tau}$$

if $\beta > \exp(-\frac{1}{2\tau})$ and $= \infty$ otherwise. Hence, if the CEO is sufficiently sensitive to the change in firm size (*i.e.,* $\beta > \exp(-\frac{1}{2\tau})$), there is a limit to how transparent the owners optimally wish to make the firm.

2.5 An Alternative Interpretation of q

As noted earlier, q can also be interpreted as the amount of information disclosed. To see this, suppose the owners can require certain information to be revealed through the reporting requirements they impose. How much information would the owners force to be disclosed? To be concrete, suppose there are N dimensions on which information could be reported. Let the information on the nth dimension be denoted s_n and suppose that $s_n \sim N(\alpha, 1/\psi_n)$. Define

$$S_{\mathcal{I}} = \frac{\sum_{n \in \mathcal{I}} \psi_n s_n}{\sum_{n \in \mathcal{I}} \psi_n} \text{ and } q = \sum_{n \in \mathcal{I}} \psi_n \,, \tag{8}$$

where $\mathcal{I}$ is a specific index set with cardinality less than or equal to N (*e.g.,* if $N = 5$, then a possible $\mathcal{I}$ could be $\{1, 3, 4\}$). Observe there are $2^N - 1$ possible $\mathcal{I}$ (one for each subset of the N indices except the empty set).

As the notation in (8) is meant to suggest, the owners' problem of choosing the dimensions on which to require reporting yields an equivalent analysis to that analyzed above.[10] In particular, because of the consequences for the CEO's utility and, therefore, his willingness to accept employment, the owners face a tradeoff—improving information by requiring reporting on more dimensions means increasing the CEO's compensation. It follows, in light of the preceding analysis, that the owners could rationally limit the dimensions on which information is revealed.

3 CEO Efforts to Distort the Signal

So far we have ignored any effort that the CEO might undertake. In this section, we explore how the CEO's efforts could be affected by reporting quality. In particular, we focus on efforts that distort the signal.

[10]See DeGroot, p. 167, for a proof that $\hat{\alpha}$ and $\hat{\tau}$ would still be given by (1) when $S_{\mathcal{I}}$ is substituted for s and using q as defined here.

3.1 Assumptions

Denote the CEO's effort by $x \in \mathbb{R}_+$. We assume such effort enhances the signal; specifically, assume the observed signal is $\tilde{s} = s + x$. How much effort the CEO expends is his private information, although, as we will show, the owners will correctly infer what the CEO does on the equilibrium path.

What we seek to capture by such effort are actions that the CEO might take to boost the numbers. These include activities such as the timing of earnings announcements, aggressive accounting, and actually "cooking the books." For the moment, we assume that such effort has no direct effect on profits.

Assume that the CEO chooses x prior to the realization of the signal. Assume he finds such effort costly and let $d(\cdot)$ denote the cost of effort (his disutility of effort). In addition, assume that this cost enters the CEO's utility function additively; that $d(\cdot)$ is twice differentiable on $\mathbb{R}_+$; that no effort is "free" (*i.e.*, $d(0) = 0$); that there is a positive marginal cost to effort (*i.e.*, $d'(\cdot) > 0$ on $(0, \infty)$); and that this marginal cost is rising in effort ($d''(\cdot) > 0$). Finally, assume $\lim_{x\to\infty} d'(x) = \infty$.

Ignoring compensation, the CEO's utility is, therefore,

$$u(\hat{\alpha}) - d(x)\,. \tag{9}$$

3.2 Equilibrium

We focus on pure-strategy equilibria. In a pure-strategy equilibrium, the CEO doesn't fool anyone on the equilibrium path: owners infer the x he chooses and use $s = \tilde{s} - \hat{x}$ as the signal, where $\hat{x}$ is the value of x that they infer. Given that $\hat{x}$ is inferred effort and x is actual effort, the CEO chooses x to maximize

$$\int_{-\infty}^{\infty} u\left(\frac{H}{\tau}\big(s + x - \hat{x}\big)\right)\sqrt{\frac{H}{2\pi}}\exp\left(-\frac{H}{2}s^2\right)ds - d(x) \tag{10}$$

Observe that (10) is globally concave in x; hence, the solution to (10) is unique.

In equilibrium, the inferred value and the chosen value must be the same. Hence, the equilibrium value, x_E, is defined by the first-order condition for maximizing (10) when $\hat{x} = x_E$:

$$\begin{aligned} 0 &\geq \int_{-\infty}^{\infty} \frac{H}{\tau}u'\left(\frac{H}{\tau}s\right)\sqrt{\frac{H}{2\pi}}\exp\left(-\frac{H}{2}s^2\right)ds - d'(x_E) \\ &= \int_{-\infty}^{\infty} \tau Q^2 u'(Qz)\phi(z)dz - d'(x_E)\,, \end{aligned} \tag{11}$$

where $x_E = 0$ if it is an inequality (note the change of variables $z = s\sqrt{H}$ and $Q = \sqrt{H}/\tau$). Lemma A.2 in the Appendix rules out the possibility that the integral in (11) is infinite. Consequently, because $d'(x) \to \infty$ as $x \to \infty$, it follows that $x_E < \infty$.

We have the following comparative statics:

Proposition 3 *If the coefficient of absolute risk aversion for the* CEO*'s utility function is non-increasing, then*

(i) the CEO*'s efforts to exaggerate performance are non-decreasing in reporting quality and strictly increasing if $x_E > 0$; and*

(ii) the CEO*'s efforts to exaggerate performance are non-increasing in the precision (i.e., τ) of the prior α and strictly decreasing if $x_E > 0$.*

Why attitudes to risk matter can be seen intuitively by considering expression (11). Note that an increase in Q increases marginal utility for $z < 0$, but decreases marginal utility for $z > 0$. If this second effect were strong enough than it could dominate the first effect and the direct effect (*i.e.,* the terms preceding $u'(Qz)$) of increasing Q. Assuming the coefficient of absolute risk aversion to be non-increasing rules out that possibility. It is a common contention in economics that individuals exhibit non-increasing coefficients of absolute risk aversion (see, *e.g.,* the discussion in Hirshleifer and Riley, 1992).

The intuition behind Proposition 3(i) is as follows. An increase in the precision of the signal, s, increases the weight placed on the signal with respect to constructing the posterior estimate, which means the CEO's utility is more sensitive to the signal. Hence, the CEO's incentives to exaggerate the signal are greater. Similar intuition lies behind Proposition 3(ii) because an increase in the precision of the prior estimate of ability, τ, *reduces* the weight placed on the signal with respect to constructing the posterior estimate.

3.3 Managerial Myopia

Here we apply the ideas of this section to the fear that managers behave myopically. To so, we extend our a model to incorporate ideas from Stein (1989).

Assume the CEO holds stock in the firm; so he gets some fraction of the returns. Assume that fraction is relatively small. Beyond that, the fraction itself is immaterial because it can be folded into the CEO's utility function. Let $U(y) = -e^{-y}$ denote the CEO's utility function when the firm's payout is y (setting the coefficient of absolute risk aversion to 1 is merely for convenience; it has no impact on the analysis). The owners are risk neutral, so their payoff is simply y.

Assume the following timing. After Stage 1, but prior to Stage 2, the CEO takes actions that raise the signal by x (*e.g.,* he takes actions to boost orders). These actions reduce, however, final payout by $x^2/2$ (*e.g.*, orders have been boosted by offering secret rebates to major customers). After Stage 2, but prior to Stage 4, an outside firm could make a bid for the firm in question.[11] Assume this happens with probability ρ, $0 < \rho < 1$. The bid is for 100% of the shares and the total value of the bid equals the expected payout of the firm were it not taken over. Given the owners' indifference between keeping and selling their shares, we can assume that they sell; that is, should there be a takeover bid, it will be successful.

As before, let $\hat{x}$ denote the anticipated value of x. The CEO's expected utility is, thus,

$$\rho\mathbb{E}\left\{U\big(\frac{H}{\tau}(s+x-\hat{x})-\frac{\hat{x}^2}{2}\big)\right\}+(1-\rho)\mathbb{E}\left\{U\big(r-\frac{x^2}{2}\big)\right\}. \tag{12}$$

Dividing both sides of (12) by ρ does not change the CEO's optimization problem. Hence, we can define

$$d(x)=-\frac{1-\rho}{\rho}\mathbb{E}\left\{U\big(r-\frac{x^2}{2}\big)\right\}.$$

It is readily verified that $d'(0)=0$, $d'(x)>0$ if $x>0$, and $d''(x)>0$, as previously assumed.

Substituting in for $U(\cdot)$, the CEO chooses x to maximize

$$-e^{-\frac{H}{\tau}(x-\hat{x})}e^{\hat{x}^2/2}e^{\frac{H}{2\tau^2}}-\frac{1-\rho}{\rho}e^{x^2/2}e^{\frac{1}{2}\sigma_r^2}, \tag{13}$$

where σ_r^2 is the prior variance of r and where we've made use of the fact that $\mathbb{E}\{e^{-\zeta}\}=e^{\frac{1}{2}\operatorname{Var}(\zeta)}$ if ζ is a mean-zero normal random variable. Differentiating (13) with respect to x yields the first-order condition

$$\frac{H}{\tau}e^{-\frac{H}{\tau}(x-\hat{x})}e^{\hat{x}^2/2}e^{\frac{H}{2\tau^2}}-x\frac{1-\rho}{\rho}e^{x^2/2}e^{\frac{1}{2}\sigma_r^2}=0\,. \tag{14}$$

It is readily seen that the second-order conditions are met; indeed, that (13) is globally concave in x. The solution to (14) is unique and, in equilibrium, it must be $\hat{x}$; hence, rearranging and canceling common terms, the equilibrium value of x, x_E, is

$$x_E=\frac{\rho}{1-\rho}\frac{H}{\tau}e^{\frac{1}{2}\left(\frac{H}{\tau^2}-\sigma_r^2\right)}\,. \tag{15}$$

It is quickly verified that x_E is increasing in H and, thus, in q, the quality of reporting (signal informativeness).

[11]As Stein notes (p. 659), there are other interpretations of his model beside managerial stock ownership and a takeover threat. One alternative is a need for funds that necessitates issuing new stock. See Stein for a complete discussion.

The owners' *a priori* expected payoff in equilibrium is $-x_E^2/2$ (to be technical, proportional to that given the CEO holds some shares). It follows that the owners want x_E to be as small as possible. From (15) that implies they want q to be as small as possible; in fact, ideally, they would want to make the signal infinitely noisy or, equivalently, to commit to suppressing it all together.

To summarize

Proposition 4 *Under this model of managerial myopia, the cost to the owners of managerial myopia is increasing in reporting quality (i.e., q).*

A full analysis of the managerial-myopia problem would, of course, model the benefit to the owners of better reporting quality, which presumably offsets to some degree the cost identified in Proposition 4. Given the relative straightforwardness of that task, we omit such an analysis for the sake of brevity. In any case, the conclusion such an analysis would reach is clear: a benefit from improving the quality information about the firm needs to balanced against the worsening of the managerial-myopia problem that such an improvement entails.

3.4 Penalizing Managers' Distortions

In light of the potential costs to information distortion (*e.g.,* as above when it led to costly myopic behavior), it is worth considering the consequence of directly penalizing information distortion. To do so, we extend the model to allow the disutility of effort to depend on a parameter γ; specifically, denote the CEO's disutility of x units of effort as $d(x, \gamma)$. Assume an increase in γ raises the CEO's *marginal* disutility of effort; that is, using subscripts to denote partial derivatives, assume $d_{12}(x, \gamma) > 0$.

The parameter γ should be interpreted as reflecting the level of controls—imposed either by the owners or by regulators—that affect the CEO's decisions about distorting information. For example, if $d(x, \gamma)$ is interpreted as the *expected* penalty imposed on a CEO caught distorting information, then γ can be thought of as either related to the size of the penalty imposed on the CEO if caught or related to the probability he is caught. Another interpretation is that γ reflects regulatory requirements, such as the signing certificates required under SOX.

Our first result is the usual result that increasing the marginal cost of an activity causes a reduction in the amount of that activity.

Proposition 5 *The CEO's efforts to exaggerate performance are non-increasing in the level of control (i.e., γ) and strictly decreasing if he is engaged in such efforts (i.e., if $x_E > 0$).*

Recall the CEO requires compensation for his effort, x_E. Hence, increasing γ can reduce the CEO's compensation, which benefits the principals *ceteris paribus.* On the other hand, if

γ directly raises the the CEO's disutility of effort (*i.e.,* $d_2(x,\gamma) > 0$), then this benefit may be offset by this direct effect. As a general rule, it is indeterminate which effect dominates, as the following example illustrates.

> Let $d(x,\gamma) = \gamma x + x^3/3$ and $u(\hat{\alpha}) = -e^{-\hat{\alpha}}$. The CEO's first-order condition (11) is, therefore,
>
> $$0 = \int_{-\infty}^{\infty} \tau Q^2 \exp(-Qz)\phi(z)dz - \gamma - x_E^2 = \underbrace{Q^2 \tau \exp\left(\frac{Q^2}{2}\right)}_{\equiv I} - \gamma - x_E^2\,.$$
>
> Hence,
>
> $$x_E = \sqrt{I - \gamma}\,.$$
>
> The total change in the CEO's compensation per unit change in γ is, therefore,
>
> $$\frac{d}{d\gamma} d(x_E,\gamma) = x_E + \left(\gamma + x_E^2\right)\frac{dx_E}{d\gamma} = \sqrt{I-\gamma} - \frac{I}{2\sqrt{I-\gamma}}\,,$$
>
> which has the same sign as $I - 2\gamma$. Hence, because $I > 0$, the CEO's pay is first increasing in γ and, then, decreasing in γ (changing direction at $\gamma = I/2$).
>
> Suppose there is a cost to the owners of $c\gamma$, $c \geq 0$, if the level of control is γ. The owners want to choose γ to minimize
>
> $$\gamma x_E + \frac{1}{3}x_E^3 + c\gamma = \gamma\sqrt{I-\gamma} + \frac{1}{3}(I-\gamma)^{3/2} + c\gamma\,. \tag{16}$$
>
> It is readily seen that (16) is *concave* in γ, which means the minimum occurs at one of the two corners, $\gamma = 0$ or $\gamma = I$. It follows, therefore, that the owners would choose $\gamma = I$ if $c \leq \sqrt{I}/3$ and $\gamma = 0$ otherwise.

Given that γ could be (i) exogenous (*i.e.,* it reflects prevailing regulation, such as SOX); or (ii) endogenous, but it is not optimal for the owners to set it high enough to block distortion; it follows that the CEO can be engaging in a positive amount of distortion in equilibrium (*i.e.,* $x_E > 0$). If this is the case, one might ask what this does to the optimal reporting quality, q. If the conditions of Proposition 3 are met, then $\partial x_E/\partial q > 0$, which means the marginal cost of higher reporting quality is higher than it would be were there no scope for the CEO to distort information. We can, therefore, conclude:

Proposition 6 *If the coefficient of absolute risk aversion for the* CEO*'s utility function is non-increasing, if the* CEO *is not blocked from distorting information, and if there is no direct benefit to the owners from such distortion, then the optimal reporting quality for the owners to choose is less than if the* CEO *were incapable of distorting effort.*

4 Information About Actions

Based on performance signals, market participants draw inferences about the CEO's underlying abilities and, where relevant, his actions. So far, decisions about disclosure have concerned the precision of such signals. Alternatively, choices over what to disclose could concern whether or not to make visible the actions the CEO actually takes. In this section, we consider the costs and benefits of such disclosure; in particular, we focus on some of the perverse incentives that can be created if the CEO's actions are visible to market participants.

In particular, we look at whether revealing details about what the CEO is doing—revealing details about the project he chooses—can adversely affect the owners. To do so, we modify our earlier model as follows:

STAGE 1. The owners of a firm decide whether the details of the project the CEO will choose will be made publicly available (disclosed) or kept secret. As before, the owners also hire a CEO from a pool of *ex ante* identical would-be CEOs and make a take-it-or-leave-it offer to him. As before, the CEO is of unknown ability.

STAGE 2. The CEO selects a project p from set of potential projects $\mathcal{P}$. What is revealed publicly about this project depends on the owners' choice of disclosure regime.

STAGE 3. The owners' return, r, is realized. This is the basis of the posterior estimate of the CEO's ability, $\hat{\alpha}$. Assume

$$r = \alpha + \mu_p + \varepsilon_p \, ,$$

where μ_p is the intrinsic mean return from project p and ε_p is an error term associated with project p. Assume $\varepsilon_p \sim N(0, 1/h_p)$. Note

$$\mathrm{Var}(r) = \frac{1}{\tau} + \frac{1}{h_p} = \frac{h_p + \tau}{h_p \tau} \, .$$

Observe there is no signal s in this version of the model.

Consider, first, the case in which there is complete disclosure, so the public observes the CEO's choice of project (*i.e.,* $\langle \mu_p, h_p \rangle$ is common knowledge). From (1), the posterior estimate of ability is

$$\hat{\alpha} = \frac{h_p(r - \mu_p)}{\tau + h_p} \, .$$

The *ex ante* distribution of $\hat{\alpha}$ is, therefore,

$$\hat{\alpha} \sim N\left(0, \frac{h_p}{\tau(h_p + \tau)}\right) \, . \tag{17}$$

From (17), it follows that $\mathrm{Var}(\hat{\alpha})$ is *increasing* in h_p and that $\mathbb{E}\{\hat{\alpha}\}$ is invariant with respect to μ_p or h_p. Given that the CEO's utility is concave in $\hat{\alpha}$, this proves

Lemma 2 *Assume complete disclosure of information about project choice. Then among all the possible projects available, the* CEO *most prefers the riskiest project (i.e., the p that maximizes* $\mathrm{Var}(\varepsilon_p)$*) ceteris paribus.*

The intuition behind Lemma 2 is the same as that behind Proposition 2: As there, the CEO's future payoff is a function of a weighted average of the prior estimate of α, which is fixed, and the outcome, here r, which is random. The noisier is the outcome, the less weight is put on it. This, moreover, is precisely what a risk-averse CEO wants—he prefers that more weight be put on the non-random component than on the random component.

Consider, next, the case in which there is no disclosure and the CEO's choice of project is his private information. From (1), the posterior estimate of ability is

$$\hat{\alpha} = \frac{h_{\hat{p}}(\alpha + \varepsilon_p + \mu_p - \mu_{\hat{p}})}{\tau + h_{\hat{p}}}, \tag{18}$$

where $\hat{p}$ is the project that the public believes the CEO to have taken and p is the project he actually chooses (in equilibrium the two must be the same). The *ex ante* distribution of $\hat{\alpha}$ is, therefore,

$$\hat{\alpha} \sim N\left(\frac{h_{\hat{p}}(\mu_p - \mu_{\hat{p}})}{\tau + h_{\hat{p}}}, \left(\frac{h_{\hat{p}}}{\tau + h_{\hat{p}}}\right)^2 \left(\frac{h_p + \tau}{h_p \tau}\right)\right). \tag{19}$$

Suppose that the intrinsic mean (*i.e.,* μ) did not vary across projects. Then, as was the case with complete disclosure, all the CEO would be concerned with would be the variance of $\hat{\alpha}$. From (19), $\mathrm{Var}(\hat{\alpha})$ is decreasing in h_p; that is, contrary to the case of complete disclosure (*i.e.,* Lemma 2), when there is no disclosure, then the CEO prefers the least risky project *ceteris paribus.* To summarize

Proposition 7 *The* CEO*'s attitude towards risky projects changes depending on whether there is disclosure of project choice or not; with the* CEO *favoring more risk given disclosure and less risk absent disclosure, ceteris paribus.*

We now consider the optimal disclosure decision. The analysis when the CEO's project choice is unobservable is similar to the analysis in Section 3: All else equal, the CEO has an incentive to choose projects with high intrinsic mean returns. The problem could be, however, that it is not all else equal; in particular, higher mean returns could correspond to greater risk, which the CEO finds costly under a no-disclosure regime. To study this tradeoff, which is necessary to compare the two disclosure regimes, it is helpful to assume the CEO's utility function is the negative exponential function; that is, $u(\hat{\alpha}) = -e^{-\hat{\alpha}}$ (as before, setting the coefficient of absolute risk aversion to 1 is merely for convenience; it has no impact on the analysis). It will prove convenient to define

$$\omega_p = \frac{h_p}{\tau + h_p} .$$

Observe ω_p varies monotonically in h_p.

Following standard analysis, it follows that the CEO's expected utility is a monotonic transformation of

$$\omega_{\hat{p}}\big(\mu_p - \mu_{\hat{p}}\big) - \frac{1}{2\tau} \times \frac{\omega_{\hat{p}}^2}{\omega_p} , \tag{20}$$

when the CEO has chosen project p and the public expects him to choose $\hat{p}$. Because the CEO does not choose $\hat{p}$, the CEO's problem of maximizing (20) is equivalent to maximizing

$$\mu_p - \mu_{\hat{p}} - \frac{1}{2\tau} \times \frac{\omega_{\hat{p}}}{\omega_p} . \tag{21}$$

To understand how the CEO maximizes (21), we need to understand the tradeoff between μ_p and ω_p. To that end, assume that $\mathcal{P}$ is closed, bounded, and contiguous. A project p' therefore exists such that $\mu_{p'} \geq \mu_p$ for all $p \in \mathcal{P}$. Of all such p', let p^* be the one with the largest precision. In other words, for all $p \neq p^* \in \mathcal{P}$, $\mu_{p^*} \geq \mu_p$ and if $\mu_{p^*} = \mu_p$, then $\omega_{p^*} > \omega_p$. Define the following subset of the frontier of $\mathcal{P}$:

$$\mathcal{P}_f = \big\{p|\omega_p \geq \omega_{p^*} \text{ and } \mu_p > \mu_{p'} \text{ for all } p' \text{ such that } \omega_p = \omega_{p'}\big\} .$$

For $\omega \geq \omega_{p^*}$ define $M(\omega)$ such that $\big(\omega, M(\omega)\big)$ is a point in $\mathcal{P}_f$. Figure 1 illustrates.

Given that, *ceteris paribus*, the CEO prefers more precision to less and that, *ceteris paribus*, he prefers a higher mean to a lower mean, the CEO will only choose projects in $\mathcal{P}_f$ when there is no disclosure of his choice. To facilitate the analysis, assume that $M(\cdot)$ is concave, downward sloping, and everywhere twice differentiable. To ensure existence of a pure-strategy equilibrium, assume $\lim_{\omega \to \bar{\omega}} M'(\omega) = -\infty$, where $\bar{\omega} = \max\big\{\omega_p|p \in \mathcal{P}_f\big\}$. Given this framework, from (21), the CEO seeks to maximize

$$M(\omega) - \mu_{\hat{p}} - \frac{1}{2\tau} \times \frac{\omega_{\hat{p}}}{\omega} \tag{22}$$

with respect to ω when there is no disclosure.

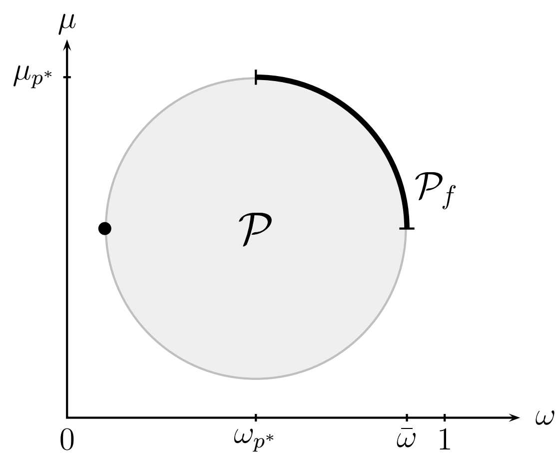

Figure 1: Set of possible projects and those that might be chosen under complete disclosure and no disclosure. $M(\omega)$ is the arc along the northeast edge of $\mathcal{P}$.

Lemma 3 *Consider the situation of no disclosure. Under the above assumptions, a pure-strategy equilibrium exists in which the* CEO *chooses a project in the interior of* $\mathcal{P}_f$*.*

From Lemma 2, when the CEO's choice of project is disclosed, the CEO chooses the riskiest project; that is, the project with the minimum ω. In Figure 1, this project is denoted by the black dot on the leftmost edge of $\mathcal{P}$. For the situation illustrated by Figure 1, this means that the project the CEO chooses under disclosure has a lower intrinsic mean return than the project he would choose absent disclosure. If, as we have been assuming, the owners are risk neutral, then this means the owners do better under a regime of no disclosure than a regime of complete disclosure. To summarize:

Proposition 8 *It is possible, ceteris paribus, that the owners do better under a regime in which the* CEO*'s choice of project is not disclosed than under a regime in which it is.*

Figure 1 is, however, only one possible scenario. Figure 2 illustrates an alternative scenario in which the owners could be better off under if the chosen project is disclosed rather than not disclosed. The project the CEO would choose under disclosure, the leftmost point of $\mathcal{P}$, could have a higher intrinsic mean that the project from $\mathcal{P}_f$ that the CEO would choose absent disclosure. An extreme version of Figure 2 would be one in which $\mathcal{P} = \mathcal{P}_f$; in this case, the CEO chooses p^*, the project with the greatest intrinsic mean return, under complete disclosure, but another project, with lower intrinsic mean return, absent disclosure.

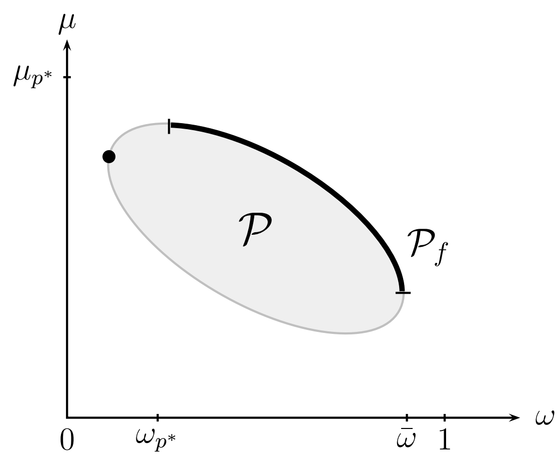

Figure 2: Situation in which complete disclosure could be better for owners than no disclosure.

4.1 Contracting

The preceding analysis ignored the issue of contracts between the owners and the CEO. If the parties could write contracts contingent on the CEO's project choice, then any project could be implemented if project choice must be disclosed. It is worth noting, however, that project is not necessarily p^*: If, as is the case in Figures 1 and 2, the frontier of $\mathcal{P}$ is concave at ω_{p^*}, then moving left from p^* along the frontier represents only a second-order loss in terms of the mean, but a first-order gain in terms of the CEO's expected utility. It follows, therefore, that the optimal contract would implement a project on the frontier of $\mathcal{P}$, but to the left of p^*; that is, the fact that the CEO's wellbeing is tied to how he is perceived creates a distortion even under complete contracting.

Of course, it is not obvious that contracts can be contingent on project choice. Projects could be difficult or costly to describe contractually, or their properties difficult to verify in case of dispute, or both. Consequently, it could well be that contracts are necessarily incomplete; even with complete disclosure, there are aspects of project choice that, although observable, are not verifiable. For instance, experts in the relevant area can look at a project *ex post* and determine its properties (*i.e.*, μ_p and h_p)—and therefore appropriately update their estimate of the CEO's ability—but the courts could lack that expertise or find it prohibitively expensive to acquire. Hence, in short, contracts contingent on project choice could be infeasible.

Regardless of disclosure regime, another possibility is contracts that are contingent on outcomes (*i.e.,* r). The feasibility of such contracting biases the owners toward a no-disclosure regime. The logic for this is as follows. Under complete disclosure, pushing the CEO toward a higher-mean, but less noisy project (higher ω) is costly to the owners insofar as they will have to compensate him more in expectation because he is bearing greater reputational risk. Under no disclosure, such a move *reduces* reputational risk in equilibrium. With no disclosure, the CEO's choice of project is correctly anticipated in equilibrium. Given that people know the CEO has an incentive contract based on returns, they will infer he will choose a higher-mean and noisier project than he would have absent an incentive contract. Consequently, the equilibrium project will prove to be one with a higher mean and more noise (*i.e.,* closer to p^*). Again, because no one is misled in equilibrium, $p = \hat{p}$; this means, from expression (20), that the CEO's equilibrium utility is a monotonic transformation of $-\frac{\omega_{\hat{p}}}{2\tau}$. Hence, inducing a higher-mean and noisier (lower $\omega_{\hat{p}}$) project in equilibrium raises the CEO's expected utility *ceteris paribus.*

A further factor that biases the owners toward a no-disclosure regime arises if the CEO is risk averse in compensation. In this case, a cost of using an incentive contract is compensating the CEO for making him bear risk. Because the CEO chooses a project that is noisier than p^* (to its left) under complete disclosure, but that is less noisy than p^* (to its right) under no disclosure, compensation risk is greater under a complete-disclosure regime than under a no-disclosure regime. This means the owners' cost of incentives is greater under a complete-disclosure regime than under a no-disclosure regime.

To summarize:

Proposition 9 *If the owners would prefer the CEO's project choice not be disclosed were incentive contracting (a contract contingent on* r*) infeasible, then they prefer it not be disclosed when incentive contracting is feasible.*

5 Shortcomings of the Current Model

There are undoubtedly concerns that one might have about the current model. One is that, if information revelation is so costly, because of the need to compensate the CEO for the risk revelation entails, then why reveal it *publicly?* That is, would it not make more sense to have the information revealed only to the board of directors, who could then take appropriate action, without it being revealed publicly?

To be sure, there is some truth to this and one imagines that this is a motive for keeping some information in the hands of management and directors only. But this doesn't contradict the model—indeed, the model is providing the very justification for secrecy on the part of the board. Moreover, the issues about the quality of information identified are still relevant;

albeit the concern would then be the quality of internal information rather than public information. Indeed, CEOs do have incentives to manipulate information transfers to improve the board's perception of them, and this idea has been an important factor in a number of recent studies (see, *e.g.,* Adams and Ferreira, 2007). In a number of publicized cases, boards have been kept in the dark except through their ability to access publicly disclosed documents; public information and the threat of sanctions for its misreporting could, thus, serve as means to limit the degree to which the CEO can hide information from the board.

Furthermore, while we have labeled the agent the CEO, he is more generally conceived of as being a metaphor for management or even the board of directors and management. That is, one imagines that the members of the management team have career concerns, as do directors (for evidence on director career concerns, see Kaplan and Reishus, 1990, and Farrell and Whidbee, 2000). Career concerns are typically taken to be the leading incentives for directors to perform their duties properly (see, *e.g.,* Fama, 1980, and Fama and Jensen, 1983, among others). To the extent the shareholders need to be in a position to evaluate the directors, they will require public information about how the firm is doing.

In addition, various actions that might be taken by the board, such as dismissal of the CEO, granting him a pay raise, changes to the director slate, and so forth, are themselves informative. To the extent directors can affect the sensitivity of these decisions to their private information or determine the quality of their private information, the quality of the information revealed by public acts will also vary.

Another concern is that, with the exception of Section 4.1, we have ignored the possible use of contracts between owners and the CEO to mitigate some of the tension between them. In particular, given the cost of better information is exposing the CEO to greater risk, one might naturally think of providing him insurance. Given the owners have been assumed to be risk neutral, efficiency dictates they bear all the risk—fully insure the CEO—*ceteris paribus*. Were the owners to do so, the consequence would be to eliminate any motive to have the signal be less than maximally informative. In a simple model, for instance when the owners are deciding between keeping or dismissing the incumbent CEO and $u(\cdot)$ is given by (4), then a golden parachute equal to the CEO's loss should he be dismissed is optimal and the owners should choose to make the signal maximally informative (see Proposition A.1 in the appendix).

On other hand, it seems unreasonable to predict that the owners would want to fully insure the CEO. After all, if they fully insure him, then they are in a position of paying him more the worse he performs (*i.e.,* low values of the signal are more rewarded than high values). This would create rather perverse incentives for the CEO; in particular, if there is any moral hazard at all, then full insurance would backfire on the owners. Just as moral hazard precludes full insurance in most settings (*e.g.,* automobiles, houses, etc.), it seems reasonable to imagine it precluding full insurance here.

In addition, one can conceive of situations in which the signal is observable, but not verifiable. For instance, suppose the signal reflects sensitive information, is difficult to quantify, or is difficult to describe *ex ante*. In such cases, it would be infeasible to base an insurance contract on it. Another reason the information could be private is that the agent in question is at a level at which public information is not released or is otherwise not available; he could be, for example, a plant manager and it is top management that is playing the owners' role.

6 Implications for Empirical Work

We have presented a series of models that formalize the notion that disclosure policy is fundamentally connected to firm governance. Although improved disclosure provides the principal benefits, such as improved monitoring of management, it also entails costs. These costs are both direct, in terms of greater managerial compensation, and indirect, in terms of the distortions they induce in managerial behavior (*i.e.,* management's actions aimed at obfuscation).

This idea has a number of implications for empirical analysis. First, consider a reform that increases the formal disclosure requirements on firms (such as Sarbanes-Oxley).[12] Our model predicts that, for those firms for which the reform is binding, we should observe (i) increases in their CEO's compensation; (ii) increases in their CEO's turnover rates; and (iii) a decreases in firm value.[13] In addition, we should observe an increase in actions aimed at obfuscation (a past example of such actions being, perhaps, Enron's use of special-purpose entities, which led to its financial statements being particularly uninformative). In particular, our model predicts that increased disclosure requirements would lead to an increase in myopic behavior, for instance substitution away from longer-term investments, such as R&D, toward shorter-term investments or actions that affect reported numbers sooner.[14]

Changes in disclosure requirements could also have an impact on accounting manipulations. To the extent that such reforms fail to add teeth to the punishments for manipulations, an implication of our analysis is that more manipulations will occur following reforms than occurred prior to the reforms. If, however, these reforms also increase punishments for

[12] Alternatively, rather than variation due to change in regulations over time, one could compare firms in different regulatory jurisdictions (*e.g.,* firms subject to different national laws).

[13] Work by Bayer and Burhop (2007, in press) is broadly consistent with these empirical predictions. Bayer and Burhop (in press) finds that German bank executives became more vulnerable to dismissal after a major reform in 1884, which increased reporting requirements. Bayer and Burhop (2007) finds that executive compensation also increased following this 19th-century reform. Work using more contemporaneous data is necessary to determine whether these findings apply in this day and age.

[14] See Stein (1989) for more discussion of such negative NPV investments due to managerial myopia.

managers, these punishments should reduce the amount of manipulation.

A second class of empirical implications concerns cross-sectional comparisons of similarly regulated firms. Differing underlying structures of businesses can lead to essentially exogenous differences in disclosure and transparency. For example, the relatively transparent nature of information disclosure in the mutual-fund industry means more information is available about a mutual-fund manager than is available about managers in industries where information is less clear cut and harder to assess. Our model suggests that in greater or more informative disclosure industries, managerial pay and turnover rates will greater than in industries with less or less informative disclosure.

There should also be cross-sectional variation in firm activities across industries with different inherent levels of transparency. For instance, consider again a mutual-fund manager. His job, which is to pick securities, is highly transparent. In contrast, a manager of a technology firm has a job that is fundamentally less transparent; his investments are harder to assess and often less visible. Proposition 7 suggests, all else equal, that in more transparent industries, managers should be more willing to undertake risky investments than in less transparent industries. In relatively transparent industries, observers will be able to assess that managers take "reasonable gambles." In less transparent industries, observers are more likely to infer that the manager is low ability after witnessing poor performance.

Another potential test of our model would be to test directly (i) whether firms with more disclosure or higher quality disclosure pay their executives more; and (ii) whether executives at these firms have shorter tenures once other factors have been controlled for. The amount of disclosure (information revealed) could be measured, for instance, by the amount of press coverage a firm receives or the number of analysts following a firm. The quality of the information disclosed could be measured directly as was done, for instance, by the Financial Analysts Federation's Committee on Financial Reporting.[15] Another possible measure of the quality of reporting could be the precision of analysts' forecasts; the better the quality of reporting, the less variance there should be across the forecasts of different analysts.[16]

7 Discussion and Conclusions

Corporate disclosure is widely seen as an unambiguous good. This paper, building on models of career concerns and managerial myopia, shows this view is, at best, incomplete. Disclosure can create or exacerbate agency problems and, thus, there can be an optimal limit on how

[15]See Lang and Lundholm (1993) or Shaw (2003) for examples of work using these measures of disclosure quality.

[16]The authors thank Ken Shaw for bringing this measure to their attention.

much information or the quality of information disclosed.

The model and its variations presented above reflect fairly general organizational issues. A principal desires information that will improve her decision making (*e.g.,* whether or not to fire the agent, tender her shares, move capital from the firm). This information, however, has the potential to harm the agent either directly through career concerns or indirectly through the actions it leads the principal to take. Because the principal will have to compensate the agent for this potential harm and because the agent may take undesired actions to mitigate the harm to him, the principal faces a tradeoff between the benefits of better information versus the resulting agency cost.

While the analysis provides a formal representation of a general organizational problem, its applicability varies depending on particular assumptions. By design, it is meant to speak to various issues connected to corporate disclosure. However, by suitably changing the identity of the "owners" and the "CEO," the model can be thought of as focusing on the relationship between the board and CEO, with the signal representing information transmitted to the board. Alternatively, the "CEO" could represent the entire management team, and the "owners" the shareholders, or even the market as a whole. In this interpretation, the signal could be thought of as accounting or other information that is released publicly.

The Basic Model. Table 1 summarizes the basic model and its variations, their key assumptions and results, as well as their implications. The first row illustrates the main features of the basic model, in which there is a signal about the CEO's ability, and owners get a payoff that is a function of the CEO's ability and their own action.

The model highlights the fundamental relation between corporate governance and information transmittal. *Ceteris paribus*, more information about management improves profit (*e.g.,* by allowing owners to make better decisions about retaining or dismissing management). But the situation is not *ceteris paribus*, because the information structure affects managers' compensation. In equilibrium, the profit-maximizing level of information can be less than full disclosure. Regulations that require disclosure beyond this level will reduce firm value.

Table 1: Summary of Analysis

Version of Model	Assumptions	Main Results & Intuition	Implications
Basic	Timing and actions as set forth in Stages 1–4.	• Owners prefer more precise signal • CEO prefers less precise signal • Less than full disclosure can be optimal	*Mandated* increases in disclosure will lead to: • Increases in CEO compensation • Increases in CEO turnover • Decreases in firm value
CEO distorts signal	CEO adds x to observed signal at a personal cost.	• Absent any efforts to prevent distortion, ability to distort raises compensation and reduces optimal reporting quality. • If owners are able to limit or prevent distortion, they may or may not wish to do so depending on parameters.	If "distortion" corresponds to accounting manipulation or misleading statements, then greater disclosure requirements could lead to more fraud.
Managerial myopia	CEO can raise signal by x. This costs the firm $x^2/2$ in the future. x is a pure cost: it raises signal but not cash flows.	Myopia problem is greater the more precise information is.	Direct cost of disclosure: Gives managers incentives to sacrifice future profits to make today look better. Managing "quarter to quarter."
Disclosure of actions (project selection)	Instead of or in addition to observing signal of CEO's ability, can observe CEO actions	Disclosure of actions can affect inferences about CEO's ability. Can lead to undesirable distortions in action.	Firms may find "opaqueness" with respect to certain actions preferable to transparency.

Consistent with this logic is the fact that CEO salaries and CEO turnover both rose substantially starting in the 1990s. Some scholars have attributed these increases to the higher level of press scrutiny and investor activism over this period (see Kaplan and Minton, 2006). This pattern of CEO salaries and turnover is consistent with our model; more generally, it is consistent with the notion that better information about firms has both costs and benefits through its impact on corporate governance.

CEO distorts signal. An extension of the basic model is to allow managers to distort the signal. When they distort the signal, they add x to the signal at a personal cost $d(x, \gamma)$, where γ is a measure of control set either by the owners or by legislation (*e.g.,* Sarbanes-Oxley). In equilibrium, the market realizes that the manager will be distorting the signal; hence it will infer the true signal despite the CEO's efforts.

In this model, the owners' use of their ability to change γ depends on the parameters. Inducing less distortion, which is done by raising γ, benefits the owners because executive compensation is falling in the amount of distortion. On the other hand, to the extend γ directly increases $d(x, \gamma)$, an increase in γ can raise executive compensation. *A priori* the net effect is indeterminate. Holding γ fixed, if we think of signal distortion as some kind of accounting manipulation, then the model implies that requiring more accurate information be released (higher signal precision) could lead to more manipulation (more distortion). Because an increase in γ leads to less distortion, our analysis also suggests that penalties borne by managers personally for fraud, such as those included in SOX, can reduce fraud.

Managerial myopia. A particular interpretation of the distortion model is one in which the CEO engages in myopic behavior to boost his short-term numbers. Specifically, building on the model of Stein (1989), we show that the amount of myopic behavior increases monotonically in the precision of the signal. A very noisy signal provides little information about the CEO's ability to anyone evaluating the CEO, so there is little value to the CEO in trying to boost the signal at the cost of future profits. However, if the signal is informative about his ability, then it makes sense for him to do all that is possible to increase the signal, even if it involves significant reductions in the firm's future profits. In the language of practitioners, increased disclosure leads CEOs to manage "quarter to quarter," even if there are real costs to be borne in the future to make today's profits look higher.

Disclosure of specific actions. Beyond the question of how precise should information be, there is the question of what *kind* of information should be revealed? In particular, should firms reveal information about the manager's actions? Or is it better to simply report outcomes? To consider this issue, we present a version of the model in which owners decide whether the CEO's choice of project should be public or not (specifically, whether the distribution of possible returns should be revealed or not).

The key insight in our model is that knowledge of a project's true distribution can affect the future evaluation of the CEO who undertakes it. Consequently, CEOs will have incentives with regard to project choice that diverge from seeking to maximize expected returns. In particular, projects with high variance cash flows mean little weight is put on the CEO's performance, which is stochastic, and more weight is put on the prior estimate of his ability, which is fixed. Because the CEO is risk averse, he prefers more weight be put on the prior *ceteris paribus*. Consequently, with transparency with respect to actions, the CEO is biased toward high-risk projects at the expense of their expected return. Absent transparency, the signal-distortion motivation of Section 3 comes into play and the CEO is compelled to consider the expected return to a greater degree. It follows that the owners can be better off when project choice is hidden from them than when it is fully revealed. This effect is reinforced when the CEO can be given an incentive contract based on profits—with visible project choice the CEO leans towards risky projects, which increases the cost of an incentive contract due to the need to compensate the CEO for the risk he is made to bear.

Conclusion. To conclude, many corporate governance reforms involve increased disclosure. Yet, discussions of disclosure generally focus on issues other than governance, such as the cost of capital and product-market competition. The logic of how disclosure potentially affects governance is absent from the academic literature.

We provide such analysis in this paper. We present a series of models, the common element of which is owners' acting on a "signal" of managerial ability. The quality of that signal is chosen *ex ante* by the owners. More precise signals improve the optimality of the owners' actions. However, either as a consequence of these actions or due to career concerns, the greater the precision of the signals, the more risk is imposed on managers. Managers will demand and, in equilibrium, receive compensation for bearing this risk. If managers can somehow interfere with the evaluation process, they can and will do so. The cost of this interference is ultimately borne by shareholders. The net benefit of increased disclosure is not clear theoretically; what is clear is that there are both costs and benefits to alternative disclosure policies. While the benefits are clear, and are hence often discussed in policy proposals, the costs are more subtle, but not necessarily less important.

Some issues remain. We have abstracted away from any of the concerns about revealing information to rivals or to regulators that other work has raised. We have also ignored other competing demands for better information, such as to help and better resolve the principal-agent problem through incentive contracts (see, *e.g.,* Grossman and Hart, 1983, and Singh, 2004). Finally, we have ignored the mechanics of how the firm actually makes information more or less informative; what accounting rules should be used, what organizational structures lead to more or less informative information, etc. While future attention to such details will, we believe, shed additional light on the subject, we remain confident that our general results will continue to hold.

Appendix A: Technical Details and Proofs

The following result is well-known, but worth stating and proving for completeness.

Lemma A.1 *Let $f(\cdot,\cdot) : \mathbb{R}^2 \to \mathbb{R}$ be a function at least twice differentiable in its arguments. Suppose that $f_{12}(\cdot,\cdot) > 0$.*[17] *Let $\hat{x}$ maximize $f(x,z)$ and let $\hat{x}'$ maximize $f(x,z')$, where $z > z'$. Then $\hat{x} \geq \hat{x}'$. Moreover, if $\hat{x}'$ is an interior maximum, then $\hat{x} > \hat{x}'$.*

Proof: By the definition of an optimum (revealed preference):

$$f(\hat{x},z) \geq f(\hat{x}',z) \text{ and} \tag{23}$$

$$f(\hat{x}',z') \geq f(\hat{x},z')\,. \tag{24}$$

Expressions (23) and (24) imply

$$0 \leq \big(f(\hat{x},z) - f(\hat{x}',z)\big) - \big(f(\hat{x},z') - f(\hat{x}',z')\big) = \int_{\hat{x}'}^{\hat{x}} \big(f_1(x,z) - f_1(x,z')\big)dx = \int_{\hat{x}'}^{\hat{x}} \left(\int_{z'}^{z} f_{12}(x,\zeta)d\zeta\right) dx\,,$$

where the integrals follow from the fundamental theorem of calculus. The inner integral in the rightmost term is positive because $f_{12}(\cdot,\cdot) > 0$ and the direction of integration is left to right. It follows that the direction of integration in the outer integral must be weakly left to right; that is, $\hat{x}' \leq \hat{x}$. To establish the moreover part, because $f_1(\cdot,\zeta)$ is a differentiable function for all ζ, if $\hat{x}'$ is an interior maximum, then it must satisfy the first-order condition

$$0 = f_1(\hat{x}',z')\,.$$

Because $f_{12}(\cdot,\cdot) > 0$ implies $f_1(\hat{x}',z) > f_1(\hat{x}',z')$, it follows that $\hat{x}'$ does not satisfy the necessary first-order condition for maximizing $f_1(x,z)$. Therefore $\hat{x}' \neq \hat{x}$; so, by the first half of

[17] Note the convention of using subscripts to denote partial derivatives (*i.e.,* f_i denotes the partial derivative with respect to the ith argument and f_{ij} denotes the partial derivative with respect to the ith and jth arguments).

the lemma, $\hat{x}' < \hat{x}$. ■

Proof of Lemma 1: Consider part (i). If $\mathcal{A} = \{0, 1\}$, the result follows immediately from expression (3). If $\mathcal{A}$ is an interval, the result follows from Lemma A.1 given

$$\frac{\partial^2}{\partial a \partial \hat{\alpha}} \Big(\hat{\alpha} v(a) - c(a) \Big) = v'(a) > 0\,.$$

Consider part (ii). If $\mathcal{A} = \{0, 1\}$, then

$$V(\hat{\alpha}) = \begin{cases} \bar{r}\,, \text{ if } \hat{\alpha} \leq \bar{r} \\ \hat{\alpha}\,, \text{ if } \hat{\alpha} > \bar{r} \end{cases}\,.$$

This is clearly a convex, but not affine, function. If $\mathcal{A}$ is an interval, then to show $V(\cdot)$ is convex we need to show that, for any $\hat{\alpha}$ and $\hat{\alpha}' \neq \hat{\alpha}$,

$$V(\hat{\alpha}') \geq V(\hat{\alpha}) + V'(\hat{\alpha})(\hat{\alpha}' - \hat{\alpha}) \tag{25}$$

and $V(\cdot)$ continuous. By the envelope theorem, $V'(\hat{\alpha}) = v\big(a^*(\hat{\alpha})\big)$. By revealed preference

$$\begin{aligned} V(\hat{\alpha}') \geq \hat{\alpha}' v\big(a^*(\hat{\alpha})\big) - c\big(a^*(\hat{\alpha})\big) &= \hat{\alpha}' v\big(a^*(\hat{\alpha})\big) - c\big(a^*(\hat{\alpha})\big) + \Big(\hat{\alpha} v\big(a^*(\hat{\alpha})\big) - \hat{\alpha} v\big(a^*(\hat{\alpha})\big) \Big) \\ &= V(\hat{\alpha}) + v\big(a^*(\hat{\alpha})\big)(\hat{\alpha}' - \hat{\alpha}) = V(\hat{\alpha}) + V'(\hat{\alpha})(\hat{\alpha}' - \hat{\alpha})\,. \end{aligned}$$

Hence (25) holds. By part (i) of the lemma, if $a^*(\hat{\alpha}) = a^*(\hat{\alpha}')$, then $a^*(\cdot)$ is a constant on the interval between $\hat{\alpha}$ and $\hat{\alpha}'$. It follows that $V(\cdot)$ is continuous on this interval in that case. In light of this, the only other case we need consider is the one in which $a^*(\cdot)$ varies over the interval between $\hat{\alpha}$ and $\hat{\alpha}'$. But, given $v(\cdot)$ and $c(\cdot)$ are twice differentiable, and (2) is strictly quasi-concave, it follows that $V(\cdot)$ is continuous by the implicit function theorem. So $V(\cdot)$ is convex and we need, now, only establish it is not affine. To do so, we need to show there exists $\hat{\alpha}$ and $\hat{\alpha}'$ such that

$$V(\hat{\alpha}') > V(\hat{\alpha}) + V'(\hat{\alpha})(\hat{\alpha}' - \hat{\alpha})\,. \tag{26}$$

To this end, recall, by assumption, there exist $\hat{\alpha}$ and $\hat{\alpha}' \neq \hat{\alpha}$ such that $a^*(\hat{\alpha}) \neq a^*(\hat{\alpha}')$. Because (2) is strictly quasi-concave, it follows for such a pair that

$$V(\hat{\alpha}') > \hat{\alpha}' v\big(a^*(\hat{\alpha})\big) - c\big(a^*(\hat{\alpha})\big) = V(\hat{\alpha}) + V'(\hat{\alpha})(\hat{\alpha}' - \hat{\alpha})\,.$$

So (26) holds. ■

Lemma A.2 *Given that $u(\cdot)$ is $\mathcal{L}^2$ for any normal distribution, it follows that $u'(\cdot)$ is $\mathcal{L}$ for any normal distribution; that is, that $\mathbb{E}\{u'(z)\}$ exists (is finite) if z is distributed normally.*

Proof: We wish to show that $d\mathbb{E}\{u(\lambda z)\}/d\lambda$ is finite evaluated at $\lambda = 1$. Observe

$$\mathbb{E}\{u(\lambda z)\} \equiv \int_{-\infty}^{\infty} u(\lambda z)\frac{1}{\sigma\sqrt{2\pi}}e^{-\frac{1}{2\sigma^2}(z-\mu)^2}dz \equiv \int_{-\infty}^{\infty} u(\zeta)\frac{1}{\lambda\sigma\sqrt{2\pi}}e^{-\frac{1}{2(\lambda\sigma)^2}(\zeta-\lambda\mu)^2}d\zeta\,.$$

Hence,

$$\begin{aligned}\frac{d\mathbb{E}\{u(\lambda z)\}}{d\lambda} = -\frac{1}{\lambda}\int_{-\infty}^{\infty} u(\zeta)\frac{1}{\lambda\sigma\sqrt{2\pi}}e^{-\frac{1}{2(\lambda\sigma)^2}(\zeta-\lambda\mu)^2}d\zeta \\ + \frac{1}{\lambda^3\sigma^2}\int_{-\infty}^{\infty} u(\zeta)\zeta(\zeta-\lambda\mu)\frac{1}{\lambda\sigma\sqrt{2\pi}}e^{-\frac{1}{2(\lambda\sigma)^2}(\zeta-\lambda\mu)^2}d\zeta\,.\end{aligned}$$

The first integral is finite because $u(\cdot)$ is such that expected utility exists for all normal distributions. The second integral is the expectation of the product of two $\mathcal{L}^2$ functions with respect to normal distributions, $u(\zeta)$ and $\zeta(\zeta-\lambda\mu)$, and thus it is also integrable with respect to a normal distribution (see, *e.g.,* Theorem 10.35 of Rudin, 1964). Since both integrals are finite, their sum is finite. Hence, $d\mathbb{E}\{u(\lambda z)\}/d\lambda$ is everywhere defined, including at $\lambda = 1$. ■

Proof of Proposition 3: Let $R(\cdot)$ denote the coefficient of absolute risk aversion. By the usual comparative statics arguments and the fact that Q is monotonic in q, (i) holds if the derivative of (11) with respect to Q is positive. That derivative is

$$\int_{-\infty}^{\infty}\big(2\tau Q u'(Qz) + \tau Q^2 z u''(Qz)\big)\phi(z)dz = \tau Q\int_{-\infty}^{\infty}\big(2 - Qz\,R(Qz)\big)u'(Qz)\phi(z)dz\,.$$

Except if $Q = 0$ (in which case $x_E = 0$ and thus non-decreasing), this derivative has the same sign as

$$\int_{-\infty}^{\infty} 2u'(Qz)\phi(z)dz - Q\int_{-\infty}^{\infty} z\times R(Qz)u'(Qz)\phi(z)dz > 0\,. \tag{27}$$

Because $u'(\cdot) > 0$, the first integral is positive. The second integral is the covariance between $R(Qz)u'(Qz)$ and z.[18] The function $R(Qz)u'(Qz)$ is a non-increasing function of z, hence its covariance with z is non-positive. Consequently, the sign of the left-hand side expression in (27) is positive.

[18]Recall that $\mathbb{E}\{z\} = 0$, so $\mathbb{E}\{z\,f(z)\}$ is the covariance of z and $f(z)$.

Observe
$$\tau Q^2 = \frac{q}{q+\tau}\,.$$
Hence, the derivative of (11) with respect to τ is
$$\int_{-\infty}^{\infty}\left(\frac{-q}{(q+\tau)^2}u'(Qz)+\tau Q^2 z u''(Qz)\frac{\partial Q}{\partial \tau}\right)\phi(z)dz$$
$$= -\frac{q}{(q+\tau)^2}\int_{-\infty}^{\infty}u'(Qz)\phi(z)dz - \tau Q^2\frac{\partial Q}{\partial \tau}\int_{-\infty}^{\infty} z\,R(Qz)\big)u'(Qz)\phi(z)dz\,.$$
Given that $\partial Q/\partial\tau < 0$, the same arguments used above imply this expression is negative provided $q > 0$, which it must be if $x_E > 0$. Hence (ii) follows. ■

Proof of Proposition 5: The cross-partial derivative of (10) with respect to γ and x is negative. Following the logic of Lemma A.1, it is readily shown that this implies the CEO's choice of x is either zero or declining in γ for any $\hat{x}$. The result follows. ■

Proof of Lemma 3: Expression (22) is globally concave in ω for all $\hat{p}$. The first-order condition for maximizing (22) is therefore both necessary and sufficient. That first-order condition is
$$M'(\omega)+\frac{1}{2\tau}\times\frac{\omega_{\hat{p}}}{\omega^2}=0\,.$$
In equilibrium, the solution to the first-order condition must equal $\omega_{\hat{p}}$. Making that substitution, a pure-strategy equilibrium exists if and only if
$$M'(\omega)+\frac{1}{2\tau}\times\frac{1}{\omega}=0$$
has a solution. Rearranging, this requirement can be stated as finding a solution to
$$\omega M'(\omega) = -\frac{1}{2\tau}\,. \tag{28}$$
Recall that $M'(\cdot) < 0$. Because ω_{p^*} maximizes $M(\cdot)$, the left-hand side of (28) is 0 for $\omega = \omega_{p^*}$. The left-hand side of (28) is decreasing in ω because
$$M'(\omega)+\omega M''(\omega) < 0$$
(recall $M(\cdot)$ is concave). As $\omega \to \bar{\omega}$, $M'(\omega) \to -\infty$. Hence, there must exist a unique $\omega \in (\omega_{p^*}, \bar{\omega})$ that solves (28). ■

Proposition A.1 *Consider the model of Section 2. Suppose the (expected) payoff to the owners if they retain the incumbent* CEO *equals his ability and their payoff if they fire him is* $-f-g$*, where* $f>0$ *is a firing cost and* $g \geq 0$ *is a golden parachute. Assume the* CEO*'s utility is given by (4); that is, he loses* ℓ *if fired. Then the optimal golden parachute equals* ℓ *and the optimal precision of the signal is maximal.*

Proof: Observe

$$V(\hat{\alpha}) = \begin{cases} -f-g\,, & \text{if } \hat{\alpha} < -f-g \\ \hat{\alpha}\,, & \text{if } \hat{\alpha} \geq -f-g \end{cases} .$$

Hence,

$$\begin{aligned} \mathbb{E}\{V(\hat{\alpha})\} &= -\Phi\left(\frac{-f-g}{\sigma}\right)(f+g) + \int_{-f-g}^{\infty} \frac{\hat{\alpha}}{\sigma\sqrt{2\pi}}\phi\left(\frac{\hat{\alpha}}{\sigma}\right) d\hat{\alpha} \\ &= -\Phi\left(\frac{-f-g}{\sigma}\right)(f+g) + \sigma\phi\left(\frac{-f-g}{\sigma}\right), \end{aligned} \tag{29}$$

where $\sigma = \sqrt{\mathrm{Var}(\hat{\alpha})} = \sqrt{H}/\tau$.

The CEO's expected utility is

$$(g-\ell)\Phi\left(\frac{-f-g}{\sigma}\right) + w\,, \tag{30}$$

where w is his non-contingent compensation. For the CEO to be willing to accept employment (30) cannot be less than the CEO's reservation utility, $\bar{u}$. Because w is a pure expense, the owners optimally set it as low as possible, hence the participation constraint is binding. The owners' expected profit is, therefore,

$$-\Phi\left(\frac{-f-g}{\sigma}\right)(f+\ell) + \sigma\phi\left(\frac{-f-g}{\sigma}\right) - \bar{u}\,.$$

The first-order conditions with respect to g and σ are, respectively,

$$\frac{1}{\sigma}\phi\left(\frac{-f-g}{\sigma}\right)(f+\ell) - \frac{1}{\sigma}\phi\left(\frac{-f-g}{\sigma}\right)(f+g) = 0 \quad \text{and} \tag{31}$$

$$\left(1 + \frac{(f+g)^2}{\sigma^2} - \frac{(f+g)(f+\ell)}{\sigma^2}\right)\phi\left(\frac{-f-g}{\sigma}\right) > 0 \tag{32}$$

Clearly, the only solution to (31) is $g=\ell$. Given that solution, the left-hand side of (32) becomes ϕ, verifying the indicated inequality. Because σ is monotone in q, this implies that the optimal q is the largest possible q. ■

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