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The Economics of Earnings Manipulation and Managerial Compensation

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LEADING IN THOUGHT AND ACTION

The Economics of Earnings Manipulation and Managerial Compensation

Keith J. Crocker*
and
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August, 2006

Abstract

This paper examines managerial compensation in an environment where managers may take a hidden action that affects the actual earnings of the firm. When realized, these earnings constitute hidden information that is privately observed by the manager, who may expend resources to generate an inflated earnings report. We characterize the optimal managerial compensation contract in this setting, and demonstrate that contracts contingent on reported earnings cannot provide managers with the incentive both to maximize profits, and to report those profits honestly. As a result, some degree of earnings management must be tolerated as a necessary part of an efficient agreement.

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"*In [a] case against…four Qwest executives, the government contends they rushed $34 million in revenue…on their books in 2001….Prosecutors say they did it in knowing violation of accounting standards so they could meet quarterly targets that they believed were essential to their bonuses and careers*."

Wall Street Journal (Young, 2004, p. C1)[1]

1. Introduction

The explosive growth of performance-based executive compensation was a notable characteristic of the late 20th century economic scene, and was for the most part applauded by economists as a way to align the incentives of managers with the interest of the shareholders. The accounting scandals of the early 21st century highlighted a darker side of performance-based compensation plans: they provided managers with the incentive to misrepresent the company's true performance. In a special report on corporate governance, *Business Week* referred to this phenomenon as an example of the "law of unintended consequences:" performance-based compensation, often received in the form of stock options or direct stock grants, was designed to remedy the problem of widely dispersed ownership, but ended up exacerbating it, leading to "borderline accounting and in some cases, outright fraud" (Byrne, 2002). These scandals have caused a reconsideration of corporate governance and the role of enforcement agencies such as the Securities and Exchange Commission, eventually leading to the Sarbanes-Oxley bill of 2002, which is arguably the single most important piece of legislation affecting corporate governance, financial disclosure and the practice of public accounting since the U.S. securities laws of the early 1930s.

The economics and finance literatures have developed elegant theoretical models that analyze the optimal contract between the shareholders and the manager of a firm. In the traditional framework, as developed in the seminal paper of Holmstrom (1979), the underlying problem is that the shareholder (principal) cannot observe, and therefore cannot contract upon, actions taken by the manager (agent) that affect profitability even though the consequences of these actions ultimately affect the shareholders' returns. The action, which provides disutility for the agent, together with a random state of nature determines the observable profit of the firm. The issue in contract design is to provide the agent with the incentive to take the (privately costly) action. A risk-neutral principal could, of course, eliminate the incentive problem by making the agent the residual claimant of the profit, but the agent is risk-averse and so shifting the risk to her entails an efficiency cost. The optimal contract, therefore, reflects a trade-off between the incentive benefit of conditioning the agent's compensation on the observed level of profit and the cost of inefficiently allocating the risk to the risk-averse party.

As the recent accounting scandals make clear, however, this standard model ignores a critical feature of the relationship between the principal and agent: the agent may also possess private information about the true profit of the firm and may, by incurring some cost, falsify that information in his report to the principal. Recent experiences suggest that an optimal contract between the principal and the agent should be designed not only to provide the agent with an incentive to take actions that enhance the actual profitability of the firm, but also to minimize the agent's incentive to falsify earnings reports.

There is empirical evidence linking the character of executive compensation with earnings manipulation and fraud. With regard to earnings manipulation, Ke (2001) finds that firms whose CEOs have relatively high amounts of equity incentives, in the form of unrestricted stock and immediately exercisable options, are more likely to engage in earnings management by reporting small earnings increases more than small earnings decreases, and also by reporting long strings of increasing earnings. Gao and Shrieves (2002) find that earnings management intensity, as measured by the absolute value of discretionary accruals, is increasing in the amount of options and bonuses and decreasing in salaries. Cheng and Warfield (2005) find an association between the extent of stock-based compensation and the magnitude of abnormal accruals. They also find a lower earnings coefficient in a regression equation explaining earnings for firms that use higher stock-based compensation, suggesting that earnings are less informative in these settings.

Other empirical studies address the relationship between the form of executive compensation and accounting fraud. Here the evidence is mixed. Based on a sample composed predominantly of companies from high-growth industries, Dechow et al. (1996) find no evidence of a link between executive compensation (specifically, whether the firm had an earnings-based bonus plan) and SEC enforcement actions. More recently, Johnson, Ryan, and Tian (2003) find, based on univariate comparisons between executives of firms accused of fraud and executives of firms of similar size and industry, that the former group had higher financial incentives to increase stock price than the latter group. Erickson, Hanlon, and Maydew (2006) find that, controlling for the financing needed and governance characteristics of the firm, the probability of accounting fraud is increasing in the percent of total executive compensation that is stock-based.[2]

The paper proceeds as follows. In the next section, we develop a model of managerial compensation in an environment in which a manager may take a *hidden action* that impacts on firm profits, and in which the actual realization of that profit is *hidden information* known only to the manager. Our modeling approach is to follow Holmstrom (1979) to deal with the hidden action aspects of the contracting problem, and to apply the costly state falsification framework developed by Crocker and Morgan (1998) to address the issues resulting from the hidden information. In a setting where the risk-neutral manager can incur a cost to falsify the earnings reports observed by the risk-neutral shareholders, we characterize the optimal managerial compensation arrangement and show that the form of such a contract reflects a tension between the need to provide an incentive for the manager to engage in the hidden action to maximize profit, while mitigating the manager's incentive to exploit her hidden information by falsifying earnings reports. Section Three discusses the intuition behind our primary result, which is that compensation contracts contingent on reported earnings cannot provide managers with the incentive both to maximize profits and to report those profits honestly. Section Four provides a closed form solution to a specific parameterization of the compensation problem. A final section discusses some recent corporate episodes that provide support for our key modeling choices.

2. Model

We begin by describing the notation of the model, and then turn to a description of the informational structure. A firm owner (the principal) is contracting with the firm's manager (the agent). We denote the *actual* profit of the firm as x, which is distributed on the interval $[\underline{x}, \overline{x}]$ according to the distribution $F(x|a)$, where a is an action taken by the agent which effects the distribution of firm profitability. We assume that F is a convex function of the action a, and that higher values of the action a shift the distribution of profitability outcomes to the right, in the sense of first-order stochastic dominance, so that $F_a \leq 0$.[3] The owner of the firm can observe neither a nor x. Instead, the owner observes a report, R, about the firm's earnings. This report comes from the manager, and it need not be accurate. We define the extent of falsification of the report as e, where $e \equiv R - x$.

The contracting problem is to design a compensation arrangement for the manager. Managerial compensation is comprised of both salary and equity components. The salary received by the manager consists of a base wage, w, which is a lump-sum transfer, and a bonus schedule, $B(R)$, that is conditioned on the observable, but potentially falsified, report R.[4] The magnitude of equity stake is exogenously determined, consisting of the claim on future profits of $\overline{\alpha}x$.[5] We assume that, prior to the contracting decision, the manager is required to purchase an equity stake in the firm, and that the actual value taken by $\overline{\alpha}$ reflects a known budget constraint on the part of the manager. We also assume that the manager has insufficient resources to purchase the entire firm, so that $\overline{\alpha} < 1$.[6] This compensation contract is set before the manager chooses his action and before the firm's level of earnings is determined. The return to the risk neutral manager is denoted as

$$V \equiv B + \overline{\alpha}\, x - g(e) - h(a) + w \tag{1}$$

where h represents the manager's disutility from taking actions that increase profitability, and g is the cost to the manager of falsifying the earnings report by announcing a value of R that exceeds actual earnings, x. The expression $g(e)$ covers all the costs to the manager of concocting and camouflaging the falsification, including the expected value of any penalties imposed by the SEC on the manager. We assume that $g(0) = g'(0) = 0$, $g' > 0$, and $g'' > 0$, so that there are no costs to correct reporting. The marginal cost of falsifying a report is zero when evaluated at correct reporting, and is increasing in the magnitude of the falsification. The expression $h(a)$ represents the dollar-equivalent disutility cost of taking the profit-enhancing action a, where we have simplified the manager's objective function to be additively separable and satisfying $h(0) = h'(0) = 0$, $h' > 0$, and $h'' > 0$.

We now turn to the informational structure of the model, which is illustrated by the sequence of events depicted in Figure 1. At the beginning (denoted Date 0), the equity position $\overline{\alpha}$ of the manager is observed, after which the salary contract for the manager, $\{B(R),w\}$, is selected in anticipation of what follows. At Date 1, the selection of an action, a, is delegated to the manager. This is a *hidden action*, since its value is never observed by the owner of the firm. Moreover, the manager selects a before he has any information about the realized value of the firm's profit, x, although the distribution F, including how it depends on a, is common knowledge. Next, at Date 2, the manager observes the actual profit of the firm, x. Since the value of x is never observed by the owner, this constitutes *hidden information.* At Date 3, after the selection of a and the observation of x have occurred, the manager chooses the earnings report R, which implicitly determines the extent of earnings falsification, e. Finally, at Date 4 the compensation contract $\{B(R),w\}$ is implemented and the manager is paid.[7]

Because the compensation contract is implemented after the manager possesses private information, the *revelation principle* (Myerson, 1979) is applicable. This approach recognizes explicitly the constraints on the implementation of contracts imposed by the private information environment. The solution technique is to condition the contract on the private information, $\{B(x), R(x), w\}$, and to recognize that any implementable contract must satisfy the incentive constraint

$$V(B(x), R(x), w \mid x) \geq V(B(\hat{x}), R(\hat{x}), w \mid x) \quad (2)$$

for every $x, \hat{x} \in [\underline{x}, \overline{x}]$. When this incentive constraint is satisfied, a manager who possesses the private information x would always prefer the contract $\{B(x), R(x), w\}$ over the alternatives $\{B(\hat{x}), R(\hat{x}), w\}$ for every $\hat{x} \neq x$. The bonus schedule $B(R)$ is then recovered from $\{B(x), R(x)\}$ by inverting $R(x)$ and substituting the resulting expression into B.[8]

This approach is sometimes cast in the context of a "direct revelation mechanism," which is a two-step process where in the first stage the informed agent sends a message $\tilde{x}$ regarding her type, and in the second stage is assigned the contract $\{B(\tilde{x}), R(\tilde{x})\}$. In order for type-$x$ agent to reveal truthfully her type (so $\tilde{x} = x$), the assigned contracts must satisfy the incentive constraint (2). Note that the direct revelation mechanism is a theoretical construct used to characterize the optimal contract of interest, $B(R)$. Dye's (1988) claim regarding the inapplicability of the revelation principle in this setting is a result of his assumption that the manager's *message*, $\tilde{x}$, must necessarily be the same as her *earnings report*, $R(\tilde{x})$. A similar assumption led Lacker and Weinberg (1989) to argue that the revelation principle did not apply in an insurance setting, an assertion that was demonstrated to be incorrect by Crocker and Morgan (1998). Gresik and Nelson (1994) encounter a similar issue in their analysis of the optimal transfer price regulation of a multinational.[9]

After observing the actual earnings of the firm, the manager selects the earnings report that maximizes her expected utility.[10] The resulting decision is depicted in Figure 2 as the tangency of a type-x manager's indifference curve, $\overline{V}(x)$, and the compensation frontier $B(R) + w$. Because the efficient contract satisfies the incentive constraint (2), the manager's optimizing choice is necessarily $\{B(x), R(x)\}$.

Constraint (2), in conjunction with the envelope theorem, implies that

$$\frac{dV}{dx} = V_x \tag{3}$$

where, from (1), $V_x = \overline{\alpha} + g'(R(x) - x)$.[11] The second-order condition for the maximization problem (2) may be written as

$$\frac{\partial^2 V}{\partial x \partial \hat{x}} = g''(R(x) - x)R'(x) \geq 0 \tag{4}$$

at $\hat{x} = x$ which, as a result of the concavity of *g*, requires that *R* be monotonically increasing.[12]

An efficient contract between the owner and the manager is a solution to the problem that maximizes the expected payoff to the risk-neutral owner

$$\underset{B(x),R(x),a,w}{Max} \int_{\underline{x}}^{\overline{x}} \Pi(B(x), R(x), w|x) f(x \mid a) dx \tag{5}$$

where profits, denoted *Π,* are equal to $x - B - \overline{\alpha}x - w$ and *f* is the density function associated with the distribution *F*, subject to the incentive compatibility constraint (2), a participation constraint for the manager, and the fact that the selection of *a* has been delegated to the manager.[13]

Because the contract is designed at a time when there is no private information (i.e., the manager has not yet learned the value of *x*), the manager must be assured, ex ante, of receiving a reservation value of utility that we, without loss of generality, assume to be zero. Thus, the participation constraint has the form

$$\int_{\underline{x}}^{\bar{x}} V(B(x), R(x), w) f(x \mid a) dx \geq 0 \,. \tag{6}$$

Because the manager selects her action, *a*, before she observes the value of actual profits, *x*, she will select an action to maximize her expected utility

$$\underset{a}{Max} \int_{\underline{x}}^{\bar{x}} V(B(x), R(x), w|x) f(x \mid a) dx \,, \tag{7}$$

the first-order condition for which may be written as

$$\int_{\underline{x}}^{\bar{x}} [Vf_a - h'(a) f] dx \; = \; 0 \,. \tag{8}$$

The marginal cost to the manager of increasing effort is $h'(a)$, while the marginal benefit is the expected increase in managerial utility resulting from the effect of the action in changing the distribution of the actual profit, *x*.

Note that we are following Holmstrom's (1979) first-order approach to the *hidden action* aspects of the contracting problem. As noted by Laffont (1989), however, this may be invalid unless certain sufficiency conditions are satisfied. The most commonly invoked sufficiency conditions are those identified by Mirrlees (1975) and Rogerson (1985), which are the monotone likelihood ratio condition (f_a $/f$ is increasing in *x*) and the convexity of *F* as a function of the action *a* ($F_{aa} > 0$). Jewitt (1988) derives a somewhat different set of sufficient conditions that relaxes the requirement that *F* be convex. Our problem, however, is substantially different. Differentiating the left-hand side of (8) with respect to *a* indicates that the hidden action problem will be concave in *a* if $\int_{\underline{x}}^{\bar{x}} [B - g(e)] f_{aa} dx - h'' < 0$. Integrating by parts, and noting that $F_{aa}(\underline{x}) = F_{aa}(\overline{x}) = 0$, yields $-\int_{\underline{x}}^{\overline{x}}[B' - g'R' + g']F_{aa}dx - h''$, which because of the first-order condition noted in footnote 11 reduces to $-\int_{\underline{x}}^{\overline{x}} g' F_{aa} dx - h''$. Convexity of *F* guarantees that this expression is negative as long as *g'* > 0, which will follow from conditions (i) and (ii) of the Theorem below. Accordingly, we have assumed *F* to be a convex function of *a.*

Before proceeding, it is useful to address the import of the assumption of manager risk neutrality in conjunction with the ex ante participation constraint (6), and how our environment differs from those considered in traditional analyses of situations either with only hidden actions or with only hidden information.

Consider first the case of a pure hidden action model, as in the "sharecropping" scenario investigated by Holmstrom (1979) in which the agent's (privately costly) action affects the probability distribution of the observed crop size. In such a setting, the optimal contract reflects a tension between incentivizing the agent to take the costly but productive action by making the wage depend on the observed crop, on the one hand, and the allocative inefficiencies that result when a risk-averse agent receives an uncertain payment from a risk-neutral principal, on the other. It is well known (Shavell, 1979) that, if the agent is risk-neutral with an ex ante participation constraint, then the optimal contract entails a lump sum payment from the agent to the principal, and giving all of the observed crop to the agent. This would result in the agent selecting the first-best action, denoted a^*, and all of the expected surplus exceeding that which is required by the participation constraint could be extracted by the principal through *w*.[14] The applicability of this approach in our model, however, is limited by the constraint on the manager's equity stake, $\overline{\alpha}$. When budgetary limitations preclude the manager from purchasing the firm in its entirety, so that $\overline{\alpha} < 1$, managerial compensation can only be based partially on claims to future earnings. The balance of the compensation package can be conditioned only on the (potentially falsified) earnings report, *R*.[15]

Now consider a pure hidden information environment, as in the costly state falsification model of Crocker and Morgan (1998). In their sharecropping scenario, the risk-neutral agent receives the actual crop, which is private information, and can expend resources to hide part of that crop from the principal. In a setting with an ex ante participation constraint, they demonstrate that the optimal contract entails the payment of a lump sum to the principal, which induces no falsification (i.e., is first-best) by the agent and permits the principal to extract the entire surplus.[16] The analogous approach in our model would be the payment of a lump sum to the agent, which would result in no falsification and permit the full extraction of surplus by the principal. Unfortunately, such a contract would not be optimal, as we show below, because it would also provide the agent with no incentive to take any of the costly action, *a*, that increases expected profits.

The Hamiltonian expression associated with the problem of maximizing (5) subject to (2), (6), and (8) may be written as

$$\mathrm{H} = \Pi f + \phi(x) V_x + \mu[V f_a \ -h'f] + \lambda V f, \tag{9}$$

where R is the control variable, $V(x) \equiv V(B(x), R(x), w \mid x)$ is the state variable, μ and λ are the Lagrange multipliers associated with constraints (8) and (6), respectively, and $\phi(x)$ is the costate variable for the equation of motion V_x.

<u>*Theorem*</u>*:* A solution $\{V(x),\ R(x),\ \phi(x),\ \mu,\ w,\ a\}$ to the optimal control problem solves the following necessary conditions:

(i) $-fg' + \phi g'' = 0$;

(ii) $\phi(x) = -\mu F_a$;

(iii) $\int_{\underline{x}}^{\bar{x}} V(B(x), R(x), w) f(x \mid a) dx = 0$;

(iv) $\int_{\underline{x}}^{\bar{x}} (x-g) f_a dx - h' + \mu\left[\int_{\underline{x}}^{\bar{x}} V f_{aa} dx - h''\right] = 0$;

(v) $\int_{\underline{x}}^{\bar{x}} V f_a dx - h'(a) = 0$; and

(vi) $V_x = \overline{\alpha} + g'(R-x)$.

Proof: Solving equation (1) for B and substituting the result into (9) yields

$$H = [x - V - g(R\text{-}x) - h(a)]f + \phi(x)[\,\overline{\alpha} + g'(R-x)\,] + \mu[Vf_a \ \text{-}h'f] + \lambda Vf \tag{10}$$

since $V_x = \overline{\alpha} + g'(R-x)$. The Pontryagin (necessary) conditions for a maximum are $\frac{d\phi}{dx} = -\frac{\partial H}{\partial V}$ and H_R $= 0$. Differentiation yields

$$\frac{d\phi}{dx} = (1-\lambda) f - \mu f_a \tag{11}$$

and

$$-g'(R-x) f + \phi(x) g''(R-x) = 0\,. \tag{12}$$

Now, because w and a do not depend upon x, their optimal values are solutions to the point-wise maximization[17]

$$\underset{a,\,w}{Max} \int_{\underline{x}}^{\bar{x}} \left[\Pi f + \mu\left[Vf_a - h' f\right] + \lambda Vf\right] dx\,. \tag{13}$$

The first-order condition for the optimal value of w is

$$\int_{\underline{x}}^{\bar{x}} (\Pi_w f + \mu V_w f_a + \lambda V_w f) dx = 0\,, \tag{14}$$

where the subscripts denote partial derivatives. Taking the appropriate derivatives, and noting that $\int_{\underline{x}}^{\bar{x}} f_a dx = 0$, yields the result that λ = 1, so the participation constraint (6) holds with equality and (11) reduces to $\dfrac{d\phi}{dx} = -\mu f_a$. Integrating both sides of this expression, in conjunction with the transversality condition $\phi(\bar{x}) = 0$, implies that $\phi(x) = -\mu F_a$. Similarly, the owner's first-order condition for a may be written as[18]

$$\int_{\underline{x}}^{\bar{x}} (x-g) f_a dx - h' + \mu \left[\int_{\underline{x}}^{\bar{x}} V f_{aa} dx - h'' \right] = 0\,. \tag{15}$$

QED.

Conditions (i) and (ii) of the theorem characterize the optimal reporting function *R*, (iii) is the manager's participation constraint, (iv) identifies the optimal owner action, (v) is the delegation constraint, and (vi) is the marginal information rent received by the manager. The equity stake plays a role in the last four conditions of the theorem since, by (1), the utility of the manager depends on $\bar{\alpha}$.

While the Theorem characterizes necessary conditions, those conditions will not be sufficient unless the second-order conditions for incentive compatibility are satisfied as well.[19] As noted earlier in (4), these conditions are satisfied if the report, *R*, characterized by the Theorem is monotonically increasing in the underlying profitability of the firm, *x*.[20] If, alternatively, the solution to the necessary conditions were not to satisfy $R'(x) > 0$, then the "ironing" techniques described in Mussa and Rosen (1978) would be required in order to characterize an optimum.

Finally, we may use the conditions identified in the Theorem to recover the optimal bonus schedule, $B(x)$, by noting that the total surplus, x-g-h, must be divided between the owner and the manager.

<u>Corollary 1</u>. The optimal bonus schedule is given by $B(x) = g(R-x) + \int_{\underline{x}}^{x} g'(R(t)-t)dt$.

Proof: We may write

$$(1-\overline{\alpha})x - B(x) - w = x - g - h - [\int_{\underline{x}}^{x} V_x(t)dt + \overline{\alpha}\,\underline{x} - h + w] \tag{16}$$

where the term on the left-hand side is the utility of the owner, and the term in brackets on the right-hand side is the utility of the manager.[21] Substituting for V_x, integrating, and rearranging terms yields the desired result.

QED.

We now turn to a discussion of our results.

3. Discussion

The principal methodological innovation of this theoretical formulation of the principal-agent problem is that it embodies both the hidden action and hidden information aspects of the contract design problem for managerial compensation. This is apparent in equation (9), as the multiplier μ reflects the shadow cost of the *delegation* constraint associated with the selection of a by the manager, while the costate variable $\phi(x)$ embodies the distortion effects of the *incentive compatibility* constraint that results from the manager's private information regarding x. The optimal compensation contract reflects a tradeoff between two objectives: providing an incentive to the manager to select his action to increase firm profits, and providing a disincentive for the manager to incur cost to falsify the earnings report she makes. As long as the monotonicity condition ($R'(x) > 0$) is satisfied, compensation contracts that pay bonuses based on reported firm profitability (so $B'(R) > 0$) will induce the manager at Date 1 to incur a cost, h, of actions that increase actual expected firm profitability, x. But, such a compensation contract also provides the manager with the incentive at Date 3 to incur a cost, g, of inflating reported earnings through falsification. The optimal contract reflects an efficient balancing of these opposing effects.

This tension is clear in the extreme cases where one or the other objective is not an issue. As part (ii) of the Theorem indicates, when there is no reason to incentivize the manager, either because his actions do not impact on firm profitability ($F_a = 0$), or if the incentive constraint is not binding ($\mu = 0$) on the manager's choice, then the optimal value of the costate variable, ϕ, is uniformly zero. In such a case, part (i) of the Theorem and the assumption that $g'(0) = 0$ together imply that $R = x$: there is no inflation of earnings by the manager and Corollary 1 implies that the bonus schedule is uniformly zero. In this case, the optimal contract simply involves a lump-sum payment high enough to ensure that the manager's participation constraint (6) is satisfied. Put differently, if the manager's choice of action does not impact on firm profits, then there is no reason to make the manager's compensation depend on reported profits and thereby provide an incentive to falsify earnings.

Alternatively, in the absence of hidden information, which occurs when true earnings are transparent to the owner, the value of the costate variable ϕ would be uniformly zero, and the contract design problem would reduce to a standard hidden action problem. As is well known in a setting with risk-neutral agents, the optimal contract induces the first-best level of effort, a^*, by making the manager the residual claimant. In this case, the manager's compensation would be set equal to his (truthful) report of earnings, x, minus the lump-sum payment $\int_{\underline{x}}^{\bar{x}} xf(x \mid a^*) - h(a^*)$.

We now consider the effect of the manager's equity stake, $\overline{\alpha}$, on the form of the optimal compensation contract $\{B(x), R(x), w\}$. As indicated by Corollary 1, the bonus schedule, B, does not depend directly on the equity stake but, rather, only on the falsification costs g and the degree of falsification $R(x) - x$. Moreover, the amount of falsification, R, which is characterized by conditions (i) and (ii) of the Theorem, does not depend directly on $\overline{\alpha}$. The effect of the equity stake is manifested through its impact on the multiplier, μ, associated with the delegation constraint and the choice of action, a, which are jointly determined by conditions (iv) and (v) of the Theorem. In the extreme case where the manager owns the whole firm, there is no need to provide incentives through the bonus schedule and the first-best outcome can be achieved.

<u>*Corollary 2*</u>: If $\overline{\alpha} = 1$, then an efficient contract satisfies

(i) $B(R) = 0$;

(ii) $R(x) = x$;

(iii) $a = a^*$; and

(iv) $\mu = 0$.

Proof: Substituting for V from (1), we may write condition (v) of the Theorem as

$$\int_{\underline{x}}^{\bar{x}} [B - g] f_a dx + \{ \overline{\alpha} \int_{\underline{x}}^{\bar{x}} x f_a dx - h' \} = 0 \quad . \tag{17}$$

When $\overline{\alpha} = 1$, the term in braces equals zero when $a = a^*$. Then it follows that we must have $\int_{\underline{x}}^{\bar{x}} [B - g] f_a dx = 0$, which is satisfied if $B(x) = 0$ because in this situation it must be true that $R(x) = x$ and $g = 0$. Finally, turning to condition (iv) of the Theorem, when $g = 0$ the first two terms on the left-hand side necessarily sum to zero at a^*, which implies $\mu = 0$ as well.

Q.E.D.

The intuition is that the incentives provided by the manager's equity stake relax the delegation constraint and reduce the magnitude of the associated Lagrange multiplier, μ. Because there is less need to incentivize the manager to take the profit-enhancing action, the effect of the equity stake is to flatten the optimal bonus schedule, with a concomitant decrease in the amount of earnings manipulation by the manager. And, as Corollary 2 indicates, the equity stake is the superior tool for managerial compensation. But, in the event that the manager does not have the resources to buy the entire firm, so that $\overline{\alpha} < 1$, the second-best approach is to supplement the equity stake with bonuses predicated on reported earnings, albeit at the cost of increased incentives for socially costly earnings manipulation.

Finally, we turn to the liquidation of the manager's equity stake. As noted earlier, shares in the firm have a well-defined value at Date 0 because, conditional on the compensation package $\{B(R), w, \overline{\alpha}\}$, the market can forecast the action, a, that will be taken by the manager and, hence, the probability distribution of future firm profits. These shares also have a well-defined value at Date 4 that depends on the manager's earnings announcement. As long as the reporting function, R, is monotonic, the market participants can always ascertain the actual profit of the firm by observing the manager's (falsified) report.[22] Thus, with fully rational market participants, earnings manipulation in our model does not distort the market value of the firm's equity, and the manager of the firm can expect to obtain no capital gains from holding the firm's stock. Alternatively, one could imagine a setting with a more "gullible" market for which the value of the stock depended directly on the earnings report. This would affect the manager's reporting strategy, with implications for the form of the optimal contract. It is straightforward to show that, were the market to be completely gullible and value the equity stake at $\overline{\alpha}R$ rather than $\overline{\alpha}x$, then the optimal bonus schedule $B(R)$ would be flatter than in the case of the fully rational market.[23]

4. An example

To illustrate our formulation of the problem, we now derive closed-form solutions to the optimal compensation problem for a specific example. We let $F(x|a) = x^a$ for $x \in [0,1]$ and $a > 0$. This implies that $f(x|a) = ax^{a-1}$, $f_a = x^{a-1}(1+a\ln(x))$, $F_a = x^a\ln(x)$, $E(x) = a/(1+a)$, and $E_a = 1/(1+a)^2$. Note that, because the support of F is independent of the value chosen for a, F_a equals 0 at both $x = 0$ and $x = 1$. Since f_a is negative (positive) when $\ln(x) < -1/a$ ($\ln(x) > -1/a$), a higher level of the action by the manager decreases the probability of bad earnings outcomes and increases the probability of good outcomes.[24] Finally, we let $g(R\text{-}x) = (R\text{-}x)^2/2$, and $h(a) = a^3/3$.

Before proceeding, and as a benchmark for the analysis that follows, note that the *first-best* level of the manager's action (that is, when the firm's owner can select the action a, and when the actual value of firm profitability, x, is freely observable) maximizes total surplus, $\Pi + V$. This occurs when $E_a = h'(a)$, which in the current example occurs when a is equal to 0.618034. At the first-best outcome $R = x$, so that there are no falsification costs ($g = 0$) and the total expected surplus ($a/(1+a) - a^3/3$) is equal to 0.303277.

Now we consider the optimal compensation arrangement in the presence of the hidden action and the hidden information. By part (ii) of the Theorem, we know that $\phi(x) = -\mu x^a \ln(x)$, and part (i) implies

$$R = x - \frac{\mu}{a} x\ln(x) \, . \tag{18}$$

Turning to Corollary 1, substituting for R from (18) yields

$$B \quad = \quad \frac{1}{2}\left(\frac{\mu x\ln(x)}{a}\right)^2 - \frac{\mu}{a}\left(\frac{x^2\ln(x)}{2} - \frac{x^2}{4}\right). \tag{19}$$

As a result, conditional on a and μ, the necessary conditions for the optimal compensation contract $\{B(x), R(x), w\}$ are equations (18), (19) and, for the flat wage portion of the contract w, the binding participation constraint from part (iii) of the Theorem.

In order for these conditions to be sufficient to characterize a maximum, the earnings report, R, must be a monotonically increasing function of the underlying profit, x. Taking the appropriate derivative yields

$$R'(x) \quad = \quad 1 - \frac{\mu}{a}(\ln(x) + 1)\,, \tag{20}$$

which is strictly positive on the interval [0, 1] only if, at a solution to (5), the optimal values of μ and a satisfy $\mu < a$.[25]

To characterize the optimal values of a and μ, we turn to conditions (iv) and (v) identified by the Theorem. Part (v) reduces to

$$\frac{\overline{\alpha}}{(1+a)^2} + \frac{2\mu}{a(2+a)^3} = h'(a)\,, \tag{21}$$

while part (iv) yields

$$\left[\frac{1}{(1+a)^2} - \frac{\mu^2 4(1-a)}{2a^2(2+a)^4}\right] - h'(a) + \mu\left[-\frac{2\overline{\alpha}}{(1+a)^3} - \frac{6\mu}{a(2+a)^4} - h''(a)\right] = \quad 0. \tag{22}$$

Substituting for h' and h'', and solving (21) and (22) simultaneously, yields a and μ, the values of which for various $\overline{\alpha}$ are presented in Table 1. In this example, $\mu < a$ for every value of $\overline{\alpha}$, so the monotonicity condition on R is satisfied and we have therefore characterized the optimal contract. Note that the value of a that solves (5) is strictly less than the first-best level for every $\overline{\alpha} < 1$, and the expected total surplus generated is less than the first-best benchmark as well. As the equity stake of the manager increases, the action taken by the manager increases towards the first-best value, and the distortion caused by the delegation constraint, μ, declines.

The optimal compensation contract $B(R)$ implied by conditions (18) and (19) is plotted as $B(R)$ in Figure 3 for the various values of $\overline{\alpha}$. The effect of increasing the equity stake is to reduce the need to incentivize the manager through the bonus mechanism, with the result that the optimal bonus scheme flattens out. Because the incentive constraint (2) is satisfied, the indifference curve of a manager who possesses the private information x is tangent to the compensation function $B(R) + w$ at $\{B(x), R(x)\}$, as depicted in Figure 2. Finally, the amount of falsification, R-x, associated with the optimal compensation contract for the manager is plotted as a function of the actual profit, x, in Figure 4, and declines as the manager's equity stake increases.

5. Conclusions

Our model's assumption that the compensation contract can condition on reported earnings, but not on true earnings, is crucial, and some recent real-world episodes shed light on its appropriateness. Consider the case of the Canadian telecommunications company Nortel, formerly known as Northern Telecom. At Nortel, executives were assigned a cash bonus target. If Nortel delivered one quarter of quarterly profit (pro forma earnings from continuing operations) before year-end 2003, the executive would be awarded 20 percent of the bonus target. For the executive to earn the next 40 percent, Nortel would have to have profits in two straight quarters. The final 40 percent would be payable if the company achieved profits in four straight quarters by year-end 2004. In addition, there were stock option grants based on achieving four separate "return on sales" targets.

After posting a first-half 2003 profit, the company paid out more than $50 million in bonuses to select officers. However, in April, 2004, Nortel announced a downward restatement of earnings focused largely on profits from continuing operations, and fired its chief executive; in August, they fired seven more top executives "for cause," saying that they ought to have been aware that the accounting numbers were not in accordance with generally accepted accounting principles (GAAP). A press release issued on August 20, 2004 said that the company "would demand repayment by these individuals of payments made under Company bonus plans..." In addition, the press release mentioned a class proceeding that had commenced against the company and former officers and directors, alleging that the bonus payments were paid based on falsely reported financial performance and diverted profits that ought to have been shared with the shareholders. In January, 2005, when it released restated financial statements for 2001 through 2003, Nortel announced that a dozen executives who are still with the company and who received bonuses on the original financial statements, but who were not implicated with the manipulation, would voluntarily repay $8.6 million of cash bonuses and give back certain restricted stock previously received as a bonus. In February of 2005, Nortel filed suit against three former executives who may have been responsible for the prior manipulation, seeking to recover $10.4 million in prior bonus payments (see Newman, 2005; Austen, 2005). This suit has not yet been resolved.

In the most recent sign of a changing legal landscape, in January, 2006 an Alabama County Circuit judge ordered Richard Scrushy, former chief executive of HealthSouth Corporation, to repay $47.8 million in bonuses he received in 1997 to 2002, on the grounds that they were undeserved because they were based on erroneous financial reports. In April, 2006 the Alabama Supreme Court upheld this ruling.[26]

In the United States, shareholders can file a derivative action, which is a lawsuit brought on behalf of the corporation. There is also now a recourse under Section 304 of the Sarbanes-Oxley Act passed in 2002, by which CEOs and CFOs are required to return any bonus or profits from stock sales should their companies be involved in a financial restatement due to misconduct. But the law is limited to only these two types of corporate officers, and requires them to return the money even if they are not deemed responsible for the misconduct. Although its effect is yet to be determined, preliminary indications are not encouraging. As Boyle (2006) notes, “Sanjay Kumar, the ousted CEO of Computer Associates…pled guilty to charges that he had inflated the company’s sales….but it’s unclear whether he will ever have to return more than $300 million in bonuses he received that were based in part on fraudulent reports. So, why is nothing happening? First, because the law stinks. Section 304 of Sarbanes-Oxley states that claw backs would occur in case of ‘misconduct’ but fails to spell out what constitutes misconduct or specify whose misconduct qualifies. … ‘For a statute that contains a lot of inartfully drafted provisions, this is among the most inartful’ says… a Stanford Professor of law and business. It gets worse. Two U.S. district courts have ruled that Section 304 does not provide a ‘private right of action,’ a legal term that means shareholders cannot sue under 304.”

In principle, corporate board could include “clawback” provisions in employment contracts that require executives to return money if they discover that the measures used to evaluate the executives were based on fraudulent data, but these are almost never invoked. All in all, Beck (2004) concludes that “most companies haven’t gotten any bonus money back.”

There is, though, one somewhat related exception. According to Danner (2004), shareholder pressure resulted in the energy company FPL Group Inc. announcing in August 2004 that it was recouping $22.25 million of bonuses awarded to eight executives five days after a merger was approved by shareholders, a merger that was called off three and a half months later after questions were raised about the finances of the proposed merger partner. No accounting fraud was involved, however, nor did the executives acknowledge any wrongdoing in the mediated settlement; the dispute revolved around whether bonuses in the executives’ long-term incentive contract triggered by a “change-in-control” event were conditioned on the consummation of the merger. Illustrating the rarity of this kind of occurrence, one of the shareholder attorneys was quoted in the Associated Press (2004) story about the settlement saying that “This is the only settlement we are aware of where executive compensation was challenged and real money will be paid back to the company.”

We conclude that our model's assumption that executive compensation contracts cannot be conditioned on actual current earnings describes well the effective regime in place in the United States, at least until very recently. Public revelations of cases such as Nortel might lead to more clawbacks in compensation agreements in the future, however, and the Sarbanes-Oxley Act may also change the interpretation of contracts that do not explicitly include such language, but the extent and effectiveness of such changes are unclear at this time. The Nortel incident also suggests just how costly accounting misstatements can be to a company. The new CEO of Nortel has said that nearly half of Nortel's 1500 financial employees were involved in the effort to compile and restate its financial results. (Bagnall, 2004)

In its special report on corporate governance written in the wake of the rash of corporate accounting scandals in 2002, *Business Week* remarked sardonically that many company boards devote far more time and energy to compensation than to assuring the integrity of the company's financial reporting systems (Byrne, 2002). This paper suggests that company boards should not treat these two concerns as unrelated issues. Rather, an optimal compensation scheme should be designed with an eye on deterring misleading reporting by the firm's officers. It should not, though, *eliminate* earnings manipulation, because doing so would excessively constrain the ability of the shareholders to incentivize the manager to take the appropriate actions that maximize profits.

A compensation structure in which the payout is contingent on reported earnings cannot simultaneously incentivize the managers to maximize profits and to report those profits honestly. Having other enforcement tools could make a difference. For example, SEC penalties for accounting fraud like those provided for in the Sarbanes-Oxley bill could reduce the private incentive of managers to misreport earnings, and thus allow the compensation contract to provide more incentive to take profit-maximizing actions at any given level of costly falsification. This raises the intriguing question of whether the appropriate regulatory regime would impose penalties on the corporation, on the manager, or both. In a slightly different context, this question was addressed by Crocker and Slemrod (2005), who show that, as a consequence of the informational asymmetry enjoyed by the manager, penalties levied directly on the manager are more likely to be effective in reducing costly tax evasion than penalties directed at the corporation's shareholders. The intuition is that the incentive effects of sanctions levied on the shareholders are imperfectly transmitted to the tax officer through a second-best compensation contract, so that penalties directly applied to the tax officer have more impact. A natural direction for future research would explore the impact and optimality of accounting regulation in a model that recognizes the existence and flexibility of compensation contracts between the owners of the firm and its decision makers.

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$\bar{\alpha}$	μ	a	Total surplus
0	.367476	.379291	.230369
.01	.362283	.381737	.232283
.1	.315737	.404015	.248015
.25	.241670	.441967	.268651
.5	.137058	.505180	290287
.75	.0584028	.564515	.300500
.99	.00203353	.616007	.303273
1.0	0.0	(first best).618034	.303277

Table 1
Example: Values of the Shadow Cost of Delegation (μ), Action (*a)*, and Total Surplus, for Various Values of $\bar{\alpha}$.

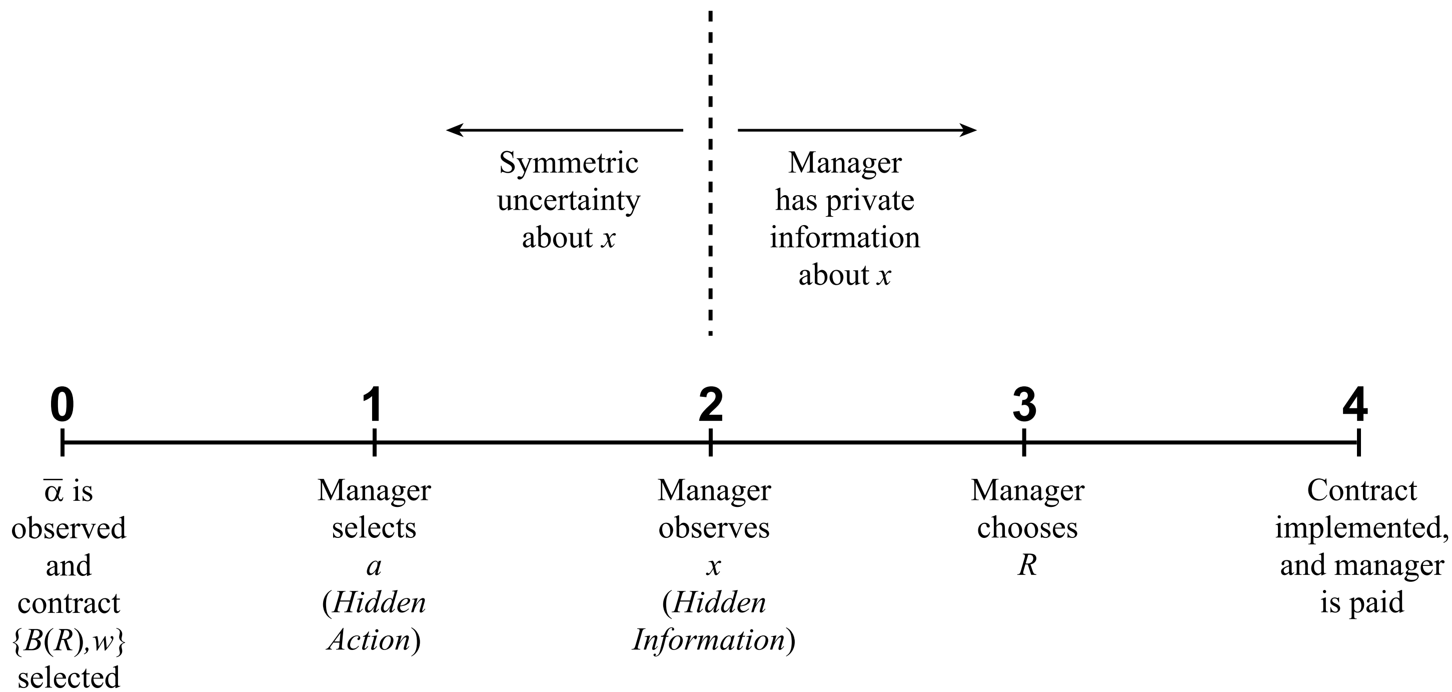

Figure 1
Sequence of Events

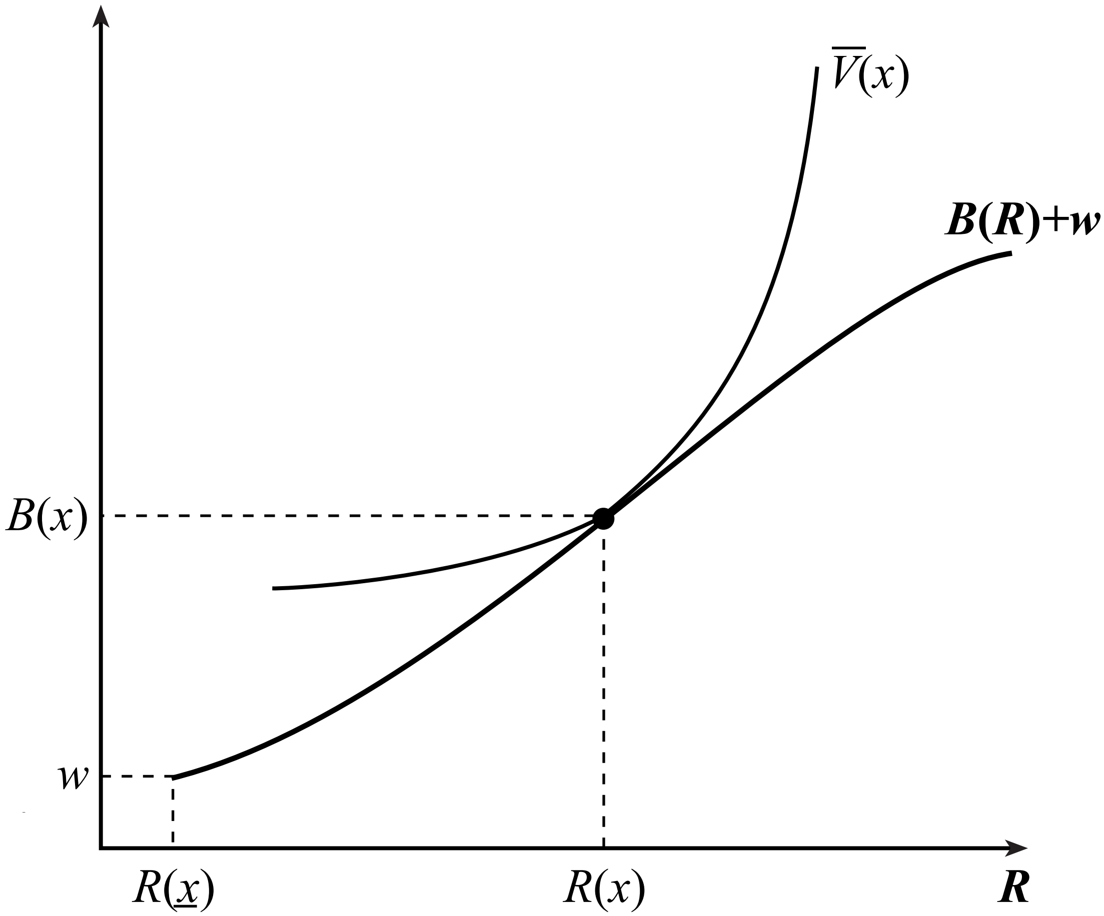

Figure 2

The Action and Transfer Chosen by a Type-x Manager

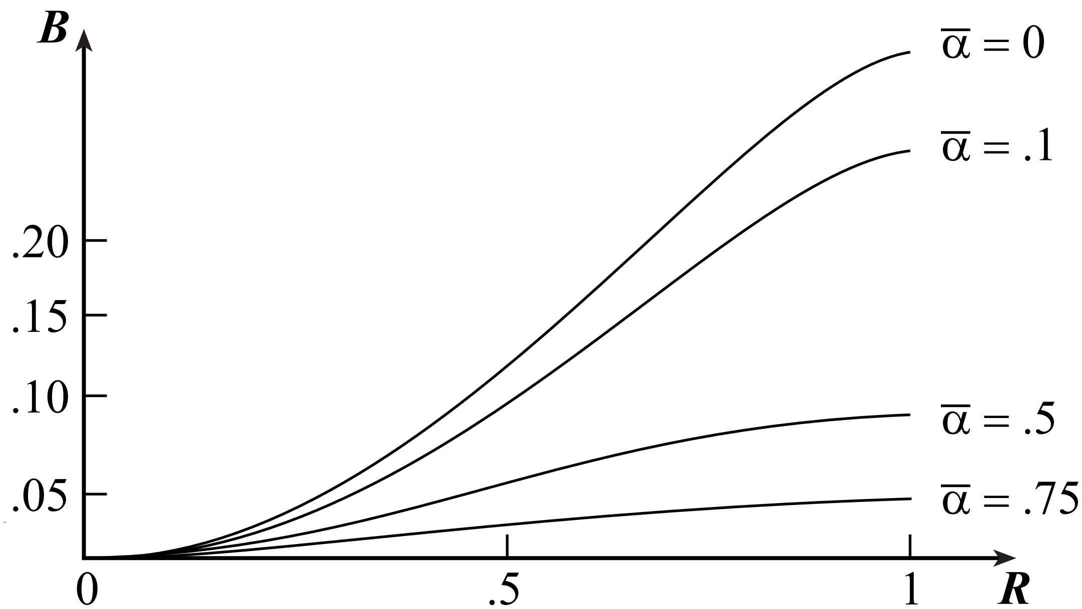

Figure 3

Example: The Optimal Compensation Contract for Various Values of $\overline{\alpha}$.

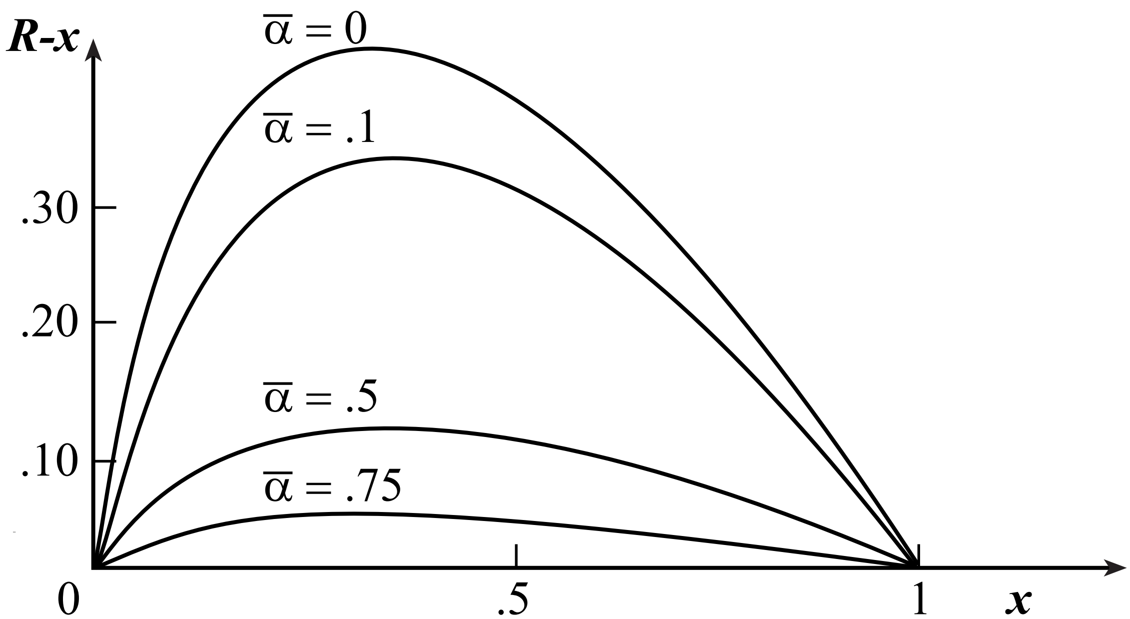

Figure 4
Example: Optimal Falsification as a Function of True Profits, for Various Values of $\overline{\alpha}$.

[1] It seems that the executives invested considerable effort in the alleged revenue enhancement scheme, as the prosecution argues that "…the men drew up a series of bogus letters setting up a payment schedule that would allow…revenues to register, while at the same time making a side deal that allowed [the customer] to hold off paying until equipment and other components…were delivered and installed."

[2] They do not find, however, a similar relationship with the presence of other tools used to incentivize executives. There is, in addition, a literature that examines the origins of corporate crime generally. For example, Alexander and Cohen (1999), studying 78 public firms that committed crimes between 1984 and 1990, conclude that crimes occur less frequently among firms in which management has a larger ownership stake. Hanlon, Mills, and Slemrod (forthcoming) address the cross-firm relationship between the form of executive compensation and the extent of corporate tax noncompliance.

[3] Note that, since the support of *x* does not vary with *a*, it follows that $F_a(\underline{x}) = F_a(\overline{x}) = 0$. The convexity of *F* is required to satisfy the second-order condition to the delegation problem, which is discussed in detail below.

[4] In the analysis that follows, we will close the model by normalizing the bonus associated with the lowest possible earnings report to zero.

[5] Note that the equity claims of the manager have a well-defined value. Given the managerial compensation arrangement $\{B(R), w, \overline{\alpha}\}$, the selection of the managerial action, *a*, is known, as it solves equation (8) below. Thus, the market can forecast the probability distribution function, *F*, of actual firm profits, and determine an accurate valuation of the manager's equity stake $\overline{\alpha}x$.

[6] As a result, the optimal compensation contracts that we characterize will be conditional on the manager's equity stake $\overline{\alpha}$ and, as we show below, the optimal contract permits the attainment of first best when the manager's budget constraint does not bind ($\overline{\alpha} = 1$). Thus, both parties would prefer the situation where the manager owned the entire firm, but this is not feasible if the manager faces a budget constraint that precludes the purchase of all of the firm's equity.

[7] We will discuss the liquidation of the equity stake in Section Three below.

[8] Mezzetti (2004) demonstrates that a generalized mechanism is superior when the agent receives additional private information by observing her payoff, and this information can be extracted in the second stage of the mechanism. In our case, however, the agent's private information is completely determined at Date 2, so that our use of the standard mechanism entails no loss of generality.

[9] They demonstrate that, in order to characterize an optimal (incentive compatible) transfer pricing scheme when the firm has private information regarding its costs, it is necessary to separate the message space (the report regarding the cost of the intermediate good) from the action space (the resulting transfer price). This is an application of Myerson's (1982) "generalized" revelation principle.

[10] Note that this occurs at Date 3 in Figure 1, after the manager has already selected *a*.

[11] Note that $\frac{dV}{dx} = (V_B B' + V_R R') + V_x$, and the term in parentheses is $\frac{dV(B(\hat{x}), R(\hat{x}) \mid x)}{d\hat{x}}$, which is zero at $\hat{x} = x$ as a consequence of (2). We are adopting the traditional first-order incentive compatibility approach to dealing with the *hidden information* problem, as developed by Guesnerie and Laffont (1984) and described in Fudenberg and Tirole (1991).

[12] This version of the second-order condition is noted in Fudenberg and Tirole (1991), p. 259. Alternatively, by Theorem 1 of Guesnerie and Laffont (1984), the profile *R*(*x*) is implementable only if $\frac{\partial}{\partial x}\left(\frac{V_R}{V_B}\right) \bullet \frac{dR}{dx} \geq 0$. In general, the Spence-Mirrlees "single crossing" property allows the signing of the first term. In our model, the convexity of *g* serves this purpose, as the first term reduces to g''.

[13] Note that, while we are assuming that the actual firm profit ultimately accrues to the owner, it does so at a future date sufficiently remote such that current managerial compensation cannot be conditioned upon that profit. Even so, the expected profit (5) of the owner is well defined ex ante because, given $\{B(x), R(x)\}$, the owner knows the hidden action *a* that will be selected by the manager (determined by (8) below) and, as a result, the distribution of the actual profit, *f*(*x*|*a*) is known by the owner beforehand. We discuss the practical relevance of this assumption in Section Five.

[14] The first-best action satisfies the condition $\int_{\underline{x}}^{\bar{x}} x f_a(x \mid a^*)dx = h'(a^*)$. In this particular case, the wage would be negative and equal to the expected earnings of the firm (conditional on a^*) minus the cost to the manager of taking the action, $h(a^*)$.

[15] Of course, setting the manager's bonus, *B*, equal to the earnings report, *R*, is a feasible contract, but it is not optimal, as we show below.

[16] The bulk of the analysis in Crocker and Morgan (1998) is dedicated to the case of the interim participation (i.e., "bankruptcy") constraint, which requires that the agent have a large enough crop to pay the principal for each possible realization of crop size.

[17] Note that V_x does not depend on either *a* or *w*, so that term is irrelevant.

[18] Note that, because $\lambda=1$, the maximization problem solved by *a* may be written as $\underset{a}{Max} \int_{\underline{x}}^{\bar{x}} (\Pi + V) f dx + \mu \left[\int_{\underline{x}}^{\bar{x}} V f_a dx - h' \right]$, so that the optimal choice of *a* maximizes total surplus, subject to the constraint that the selection of *a* be delegated to the manager.

[19] Recall that the first-order condition for incentive compatibility noted in footnote 11 is necessary but not sufficient to induce truthful revelation by the manager who possesses private information about the firm's actual profitability, *x*.

[20] This is generally achieved by assuming a monotone hazard rate (see Fudenberg and Tirole (1991). This, however, is not sufficient to guarantee $R' > 0$ in our setting. Instead, it is the shape of $\mu F_a / f$ which is critical, as we will see in the example presented in Section Four.

[21] Note that we have crafted (16) in a fashion that normalizes the bonus paid for the lowest earnings report to zero because, by the first two parts of the Theorem, $R(\underline{x}) = \underline{x}$.

[22] Of course, the manager can also infer the actual earnings of the firm *ex post* from the (invertible) earnings announcement of the manager. But, the point of the theorem is that it is efficient for the owner to commit to paying the manager bonuses based upon earnings announcements that are known to be inflated. This is similar to the result obtained by Crocker and Morgan (1998) in an insurance setting, who show that the optimal contract requires indemnification based upon claims that the insurer knows are partially falsified.

[23] To see this, replace $\overline{\alpha}x$ with $\overline{\alpha}R$ in the expressions for *V* and *Π.* The conditions of the theorem are unchanged, with the exception of (vi), which is now $V_x = g'(R - x)$. Then, working through Corollary 1, and again normalizing to zero the bonus paid to the lowest earnings report, yields $B(x) = g + \int_{\underline{x}}^{x} g'(t)dt - \overline{\alpha}R(x) + \overline{\alpha}\,\underline{x}$.

[24] In addition, *F* is convex in the hidden action *a* ($F_{aa} = x^a(\ln(x))^2 > 0$), so (8) is sufficient to characterize the manager's choice of hidden action.

[25] Note that the second term on the right-hand side of (18) is $\mu F_a / f$, so that the value taken by R' turns on the monotonicity of $x - \mu F_a / f$.

[26] This is in spite of the fact that in 2005 a federal jury acquitted Scrushy of all charges, including conspiracy and securities fraud, related to accusations that he oversaw the company recording as much as $2.7 billion of fake revenues on the company's books over six years, and correspondingly adjusted the balance sheets and paper trails.