Performance-Based Contracts, Monitoring and Fraud

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May 10, 2016

PRELIMINARY AND INCOMPLETE.

Abstract

We characterize the optimal contract between the risk-neutral owner of a firm and a manager, whose effort affects firm's (long-term) performance, and who can also manipulate short-term earnings reports to influence the stock price. We show that if the owner cannot commit to a contract or an auditing policy (which are interim suboptimal), the efficient contract involves a *fixed* wage for the manager and a grant of options and stock shares with a long vesting period. Misreporting and thus short-term stock price manipulation happens with positive probability at the equilibrium.

Keywords: Optimal contracts, Performance-based pay, Financial reporting, Auditing, Fraud

1 Introduction

Performance-based pay has become a popular compensation scheme intended to alleviate the moral hazard problem and align the incentives of top management with those of the rest of shareholders. Following the recent accounting scandals at Enron, WorldCom and other corporations, the practice

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has been heavily criticized for encouraging managers to manipulate information. Starting with (Healy 1985) and followed by more recent work by (Bergstresser and Philippon 2006), (Burns and Kedia 2006), (Johnson, Ryan, and Tian 2009), and (Kedia and Philippon 2009) the empirical research indicates that this is indeed a double-edged sword, as the stock-based executive compensation appears to be associated with earnings management, misreporting and restatements of financial reports. Ke (2001) shows that the CEO-s of firms with relatively high amounts of equity incentives are more likely to engage in earnings management by reporting small earnings increases more often than decreases. Gao and Shrieves (2002) show 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. Bruner, McKee, and Santore (2008) run an experimental study which shows that the amount of fraud is positively correlated with the amount of equity-based compensation and negatively correlated with the probability of detection and the subjects' risk aversion.

Our paper investigates the benefits of a more sophisticated performance-based pay that involves random internal auditing as well as long- and short-term incentive-pay schemes, in the context of a principal-agent problem with both hidden actions and hidden information. We consider the contracting problem between a manager and a firm, when the manager's actions affect the value of the firm but they are not fully verifiable by the firm's owners. In addition, in the short-run, the manager has superior information about the true value of the firm, which he can either reveal truthfully, or strategically hide from the owners by issuing a misleading report, in an attempt to manipulate the stock market price.

Since the stock market price can be manipulated in the short-run, but the manipulation is harder to maintain over a longer period, the "informativeness principle" would suggest that the compensation package for the manager should be tied to long-term firm performance indicators. However, if the manager is risk-averse or more impatient than the owner, deferring payments later in the future is costly for the owner. In addition, a contract involving long-term payments may not be stable to renegotiation and thus it may not be credible.

On the other hand, making the manager's short-term reporting more informative via auditing carries its own cost. In addition, to be effective, the auditing policy has to be communicated to the agent *before* the reporting decision is taken. On the other hand, the actual auditing is carried on *after* the report is issued. This lag between the moment the policy is designed and the moment it is implemented creates a time-inconsistency problem. If a particular auditing policy is successful in deterring fraud, then from an ex-post perspective the principal has no incentives to audit. On the other hand, to serve as a deterrent, it must be credible that the policy will be implemented. Much of the literature on auditing bypasses this time-inconsistency problem by assuming that the principal can *commit* to an auditing policy and thus the policy will be implemented even when it is not ex-post optimal. However, commitment of this sort seems unrealistic. In particular, if the stated ex-ante audit probability is positive but not equal to 1, it is hard to monitor whether the principal is actually adhering to the contract or not. Even when monitoring entails repeated interaction and thus there is a reputational aspect to it which might act as an enforcing mechanism, if one looks at monitoring as a quality-differentiated (or "thoroughness-differentiated") commodity, it is still hard to assess the compliance with the contract. The problem persists even when the owner side-contracts with a third party to perform the monitoring.

Here we assume, as in (Khalil 1997), that the auditor cannot commit to an auditing policy.Without commitment, an auditing policy is credible (and can serve as a deterrent) only if implementing it is interim incentive compatible for the principal. This restricts the class of auditing policies that can be implemented.

We analyze the implications of this restriction on the design and performance of the optimal compensation packages, as well as the incentives for fraud and misreporting of a manager, and contrast the cost of monitoring to the cost of offering long-term contracts.

There are two types of fraud that the manager can commit. One is simply "cooking the books" by inflating the firm's earnings, with the sole purpose of manipulating the investors' perception of the firm and thus increase the stock price and the received bonus. In our model, this type of fraud is captured by the manager not reporting truthfully the realization of the signal he observed. The second type of fraud typically involves making suboptimal investments or stealing. In our model this type of fraud is stylized as the manager not exerting the highest level of effort. Since lack of effort increases the probability of a bad outcome and also increases the manager's utility, it can be interpreted either as making bad investments or as appropriating firm's resources. To induce the manager to report truthfully, the firm offers him a contract that specifies a certain level of (internal) auditing, in addition to a compensation package that is tied to the performance of the firm via a combination of short- and long-term payments. We show that monitoring can improve, but cannot eliminate the incentives to manipulate earnings generated by the short-term compensation, and that the ex-ante optimal contract should consist of a fixed wage and grants of options and stocks with a long vesting period.

2 The Model

We consider a hidden-action and hidden-information model with costly state verification, in which a firm owner (the principal) is contracting with a manager (the agent) for a one-time project. There are three time periods, $t = 0, 1, 2$. The contract between the owner and the manager is initiated at date 0 and the project pays off at date 2. The project's payoff depends in part on the effort level exerted by the manager. Let π denote the project's payoff and let e denote the manager's effort choice. We start with a very simple model in which there are only two effort levels, $e \in \{0, 1\}$, and two possible payoffs, $\pi \in \{y, 0\}$, with $y > 0$. If the manager exerts effort at $t = 0$ then the probability of obtaining a positive project payoff at $t = 2$ is $\rho > 0$. If the manager exerts no effort, then the project's payoff at date $t = 2$ will be 0 with certainty. That is $\text{Prob}(\pi = y|e = 1) = p > 0$, $\text{Prob}(\pi = y|e = 0) = 0$.

Consumption takes place at dates 1 and 2. We assume that both the manager and firm's owner are expected utility maximizers and they are both risk-neutral, but the manager is more impatient than the owner. The manager's discount factor is $\beta \in (0, 1)$, while the owner's discount factor is 1. Manager's utility over consumption (at dates 1 and 2) and effort is given by $U(c_1, c_2, e) := E_0(c_1) + \beta E_0(c_2) - \Phi(e)$, where $\Phi(1) = \phi > 0$, while $\Phi(0) = 0$ (that is, effort reduces the manager's utility). The manager's reservation utility is $\bar{u}$. All this information is common knowledge.

At $t = 0$, the owner offers the manager a take-it-or-leave-it contract which will be specified below. If accepted, the manager then has to decide on an effort level e, which is exerted between periods 0 and 1 and it is not observed by the owner. At $t = 1$ the manager receives an early signal about the project's payoff, $m \in \{H, L\}$ and may issue a report R to the owner (or publicly[1]) declaring the observed realization. The signal is imperfect, in the

[1] If the report is public then, following the report R, the market price of the stock

sense that it reveals the true payoff with probability $\delta \in \left(\frac{1}{2}, 1\right]$. That is, $\text{Prob}(m = H|\pi = y) = \text{Prob}(m = L|\pi = 0) = \delta$. The role of the parameter δ is to capture the degree of manipulation uncertainty that is characteristic to some industries, for which there is more scope for different interpretations of the facts. For example, the message is more likely to be noisier (that is, δ is lower) in high-growth, high-tech industries with more intangible assets (such as patents) which are harder to value. The ex-ante informativeness of the signal is public knowledge (that is, δ is known to everyone), but the actual realization of the signal is observed only by the manager. At $t = 2$ (which is understood as the long-run) the payoff of the project becomes public knowledge.

Since neither the effort nor the realization of the date-1 signal are observable to the owner, the manager may choose to exert a low effort level and manipulate the report to his/her advantage. The owner thus attempts to design an employment contract to avoid or reduce such moral hazard by tying the compensation to the performance of the firm and penalizing the manager upon the discovery of misreporting. We assume that the owner has access to a monitoring technology (internal auditing) which allows him to verify the accuracy of manager's date-1 report at a cost C. If misreporting is detected, the manager has to pay a penalty.

The contract for the manager can be designed to have short- and long-term payments, and it can also specify a monitoring intensity (in the form of a probability of auditing). Date-1 transfers and intensity of monitoring can be made contingent on the report issued by the manager (or, alternatively the stock price); date-2 payments are contingent on the realized, observable payoff of the project and, possibly, the report at date 1.

Note first that if there are no asymmetries of information, the manager has to be paid only at date 1 a wage of $\hat{w} = \bar{u} + \phi$ and required to exert the high level of effort. Throughout the paper we maintain the assumption that the disutility of effort is low enough, so that $0 < \phi < \rho \cdot y - \bar{u}$, and therefore exerting high effort is optimal in the absence of asymmetric information.

adjusts to its equilibrium value, $p(R)$, and the manager is paid according to the agreed upon contract, which would target a specific stock price level.

3 Optimal contract without monitoring

We analyze first the optimal contract the owner should offer in the absence of the monitoring technology.

When managers have some preference for early consumption (because of a lower discount factor or risk-aversion), it is hard to commit to long-term contracts even when they are ex-ante optimal. After a manager has exerted the effort induced by a long-term contract, the contract no longer serves any incentives purpose. If the manager is more impatient (or more risk-averse) than the owner, it is in the interest of both to advance payments.

If the manager cannot manipulate the short-term signal (that is, if the signal is observed by both the manager and the owner), no long-term contract is renegotiation-proof, so all contracts must be short-term in this case.

If the manager can manipulate the short-term signal (the owner does not observe the signal), this has two effects on the optimal contract. On the one hand, it is impossible to provide incentives to the manager to exert high effort with a short-term contract (and no monitoring). On the other hand, the manipulation creates a lemons problem at the renegotiation stage, which makes the long-term contracts more likely to be stable to renegotiation.

In this Section we make these ideas precise. The results are very similar to those of (Axelson and Baliga 2009).[2]

3.1 Optimal contract with commitment

We analyze first the optimal contracts the owner would offer if it were possible to commit to long-term payments (that is, commit not to renegotiate).

To begin, assume that the signal at date 1 is observed by both the owner and the manager, and thus the manager cannot manipulate it. In this case, the owner should offer the manager a vector of transfers, contingent on the realizations of the interim signal and final production, $(t_1^m, t_2^\pi)_{m\in\{H,L\},\pi\in\{0,y\}}$. The contract is designed such that it is individually rational for the manager to accept it, and it provides incentives to exert the high effort. Standard arguments imply that at the optimum contract $t_1^L = t_2^0 = 0$ and thus the efficient contract consists of two transfers, $t = (t_1, t_2)$, with t_1 being received

[2]In their model, the manager owns the technology and makes an offer of transfers to an investor in exchange for some required initial capital. Here we assume that the principal owns the technology and designs the contract of the manager to operate it.

at date 1 contingent on the observation of the high signal, and t_2 received at date 2 contingent on the realization of y.

Such a contract must solve:

$$\min_t \{P(H|1)t_1 + P(y|1)t_2\} \tag{1}$$

$$P(H|1)t_1 + \beta P(y|1)t_2 - \phi \geq P(H|0)t_1,$$
$$P(H|1)t_1 + \beta P(y|1)t_2 - \phi \geq \bar{u}.$$

We impose a couple of conditions on the parameters. First, we require that the manager is sufficiently patient, so that:

$$\beta > 1 - \frac{P(H|0)}{P(H|1)} = \frac{\rho(2\delta - 1)}{\rho\delta + (1-\rho)(1-\delta)}.$$

If the condition is violated, then optimal contracts must be short-term ($t_2 = 0$) and the problem is less interesting in this case. Second, we assume that it is possible for the owner to offer the manager an individually rational contract that pays only at date 2 (that is, the expected profit from such a contract is non-negative). This amounts to:

$$\rho y - P(y|1)\frac{\phi + \bar{u}}{\beta P(y|1)} \geq 0,$$

or, equivalently, $\phi + \bar{u} \leq \beta\rho y$.

Under these two conditions, the solution of problem (1) depends on whether the following inequality is satisfied or not:

$$\frac{\bar{u}}{\phi} < \frac{1}{\frac{P(H|1)}{P(H|0)} - 1} = \frac{1-\delta}{\rho(2\delta - 1)}. \tag{2}$$

If (2) is satisfied (that is, the manager's outside options are limited or disutility of work is high), then it is optimal to offer the manager a long-term contract with the following characteristics:

$$t_1 = \frac{\bar{u}}{P(H|0)} = \frac{\bar{u}}{1-\delta},$$
$$t_2 = \frac{\phi + \bar{u}}{\beta\rho} - \frac{P(H|1)}{\beta\rho}t_1.$$

The expected cost to the owner in this case is

$$c = \frac{\phi + \bar{u}}{\beta} - \bar{u}\frac{1-\beta}{\beta} \cdot \frac{\rho\delta + (1-\rho)(1-\delta)}{1-\delta} > \phi + \bar{u}. \tag{3}$$

If (2) is not satisfied (good outside options or low disutility of work), then the optimal contract is short-term:

$$\begin{aligned} t_1 &= \frac{\phi + \bar{u}}{P(H|1)} = \frac{\phi + \bar{u}}{\rho\delta + (1-\rho)(1-\delta)}, \\ t_2 &= 0, \end{aligned}$$

and the cost to the owner is $c = \phi + \bar{u}$. That is, the first best is achieved.

With zero transparency (i.e., only the manager observes the earnings signal), the set of feasible contracts is smaller (for example, short-term contracts contingent on the signal can no longer induce high effort) and thus, under full commitment, full transparency dominates zero transparency. This is typically the main argument used to support more transparent reporting.

3.2 Optimal contract with no commitment

We assume now that the owner cannot commit to long-term payments and thus all contracts have to be stable to potential renegotiation at date 1.

If both the owner and the manager observe the signal at date 1, then no long-term contract is renegotiation-proof: at date 1, the owner and the manager will agree to advance payments. If only short-term contracts are renegotiation-proof, then the owner will offer a payment

$$t_1 = \frac{\phi}{P(H|1) - P(H|0)} = \frac{\phi}{\rho(2\delta - 1)} \tag{4}$$

if (2) is satisfied, and a payment

$$t_1 = \frac{\phi + \bar{u}}{P(H|1)} = \frac{\phi + \bar{u}}{\rho\delta + (1-\rho)(1-\delta)}, \tag{5}$$

otherwise. Recall that if (2) is not satisfied, the optimal contract was a short-term transfer even when commitment was possible, so it is not surprising that the same contract is optimal here (and the first best is achieved).

When (2) is satisfied, the cost to the owner is

$$c = \phi \frac{\rho\delta + (1-\rho)(1-\delta)}{\rho(2\delta - 1)}. \tag{6}$$

In this case, lack of commitment leads to a loss of total welfare. As proved before, long-term contracts would be optimal in this case, but lack of commitment prevents the parties from signing such contracts.

We show next that lack of transparency can be advantageous, because it can make long-term contracts stable to renegotiation and improve efficiency. Of course, this holds only if (2) is satisfied.

Assume thus that only the manager observes the earnings signal. The owner offers the manager a menu of contracts $t = (t_1^R, t_2^{R\pi})_{R\in\{H,L\},\pi\in\{0,y\}}$, each consisting of date-1 and date-2 transfers, where date-1 transfers can depend on the report issued by the manager, and date-2 transfers can depend on both the date-1 report and the observed realization of the projects' payoff. If the contract induces the manager to exert high effort at date 0, then the expected cost to the owner is:

$$\begin{aligned} E(t_1^R + t_2^{R\pi}) = P(L|1)t_1^L + P(H|1)t_1^H + P(y,L|1)t_2^{Ly} + \\ P(0,L|1)t_2^{L0} + P(y,H|1)t_2^{Hy} + P(0,H|1)t_2^{H0}. \end{aligned}$$

The contract is designed such that it minimizes the expected cost to the owner while inducing the manager to report truthfully at date 1 and exert the high level of effort at date 0. In addition, the contract has to be stable to renegotiation at date 1.

To understand the restrictions imposed by this last requirement, denote by $\bar{u}_L$, respectively $\bar{u}_H$ be the date-1 continuation utility, according to a contract signed at date 0, of the manager who received the signal L, respectively H. *If* the original contract is to be renegotiated at date 1, then it would be renegotiated to a contract that satisfies the incentive compatibility and individual rationality constraints for both types (of signals) but, since the effort has already been exerted, the new contract need not provide incentives for high effort. Therefore, the renegotiated contract would solve:

$$\min_t E(t_1^R + t_2^{R\pi}) \qquad \text{RP}(\bar{u}^L, \bar{u}^H)$$

$$t_1^L + \beta \left(P(y|L,1)t_2^{Ly} + P(0|L,1)t_2^{L0}\right) \geq t_1^H + \beta \left(P(y|L,1)t_2^{Hy} + P(0|L,1)t_2^{H0}\right), \quad \text{(ICL)}$$

$$t_1^H + \beta \left(P(y|H,1)t_2^{Hy} + P(0|H,1)t_2^{H0}\right) \geq t_1^L + \beta \left(P(y|H,1)t_2^{Ly} + P(0|H,1)t_2^{L0}\right), \quad \text{(ICH)}$$

$$t_1^L + \beta \left(P(y|L,1)t_2^{Ly} + P(0|L,1)t_2^{L0}\right) \geq \bar{u}^L, \quad \text{(IRL)}$$

$$t_1^H + \beta \left(P(y|H,1)t_2^{Hy} + P(0|H,1)t_2^{H0}\right) \geq \bar{u}^H. \quad \text{(IRH)}$$

Standard arguments imply that, at such a contract, the following must be true:

$$t_2^{Ly} = t_2^{L0} = t_2^{H0} = 0$$
$$t_1^L = t_1^H + \beta P(y|L,1)t_2^{Hy}.$$

Therefore, the optimal renegotiation-proof contract solves:

$$\min_t \left\{ P(L|1)t_1^L + P(H|1)\left(t_1^H + P(y|H,1)t_2^{Hy}\right) \right\}$$

$$t_1^L \geq t_1^H + \beta P(y|L,1) \cdot t_2^{Hy}, \tag{7}$$

$$t_1^H + \beta P(y|H,1)t_2^{Hy} \geq t_1^L, \tag{8}$$

$$P(L|1)t_1^L + P(H|1)\left(t_1^H + \beta P(y|H,1)t_2^{Hy}\right) - \phi \geq t_1^L, \tag{9}$$

$$P(L|1)t_1^L + P(H|1)\left(t_1^H + \beta P(y|H,1)t_2^{Hy}\right) - \phi \geq \bar{u}, \tag{10}$$

$$t_1^L = \bar{u}^L, \tag{11}$$

$$t_1^H + \beta P(y|H,1)t_2^{Hy} = \bar{u}^H, \tag{12}$$

$$\left(t_1^L, t_1^H, 0, 0, t_2^{Hy}, 0\right) \text{ solves } (\mathrm{RP}(\bar{u}^L, \bar{u}^H)). \tag{13}$$

It is immediate to see that $t_1^H = 0$ at the optimum, and thus the owner should offer the manager a menu of two contracts: $\{(t_1, 0), (0, t_2)\}$, with the first one intended for the manager who receives the low signal, L, at date 1 and the second for the manager who receives the high signal, and the payment t_2 being made contingent on the observation of the positive payoff realization for the project at date 2.

Again, the solution is a two-step function, depending on the inequality:

$$\frac{\bar{u}}{\phi} < \frac{1-\delta}{(1-\rho)(2\delta-1)}. \tag{14}$$

If (14) is satisfied, the unique vector of transfers that satisfies inequalities (7), (8), (9) and (10) is:

$$t_1 = \frac{\phi P(y|L)}{P(H|1)\left[P(y|H,1) - P(y|L,1)\right]} = \frac{\phi(1-\delta)}{(1-\rho)(2\delta-1)}, \tag{15}$$

$$t_2 = \frac{\phi}{\beta P(H|1)\left[P(y|H) - P(y|L)\right]} = \frac{\phi}{\beta\rho} \cdot \frac{\rho(1-\delta) + (1-\rho)\delta}{(1-\rho)(2\delta-1)}. \tag{16}$$

If (14) is not satisfied, the unique vector of transfers that satisfies inequalities (7), (8), (9) and (10) is:

$$t_1 = (\phi + \bar{u})\frac{1-\delta}{\rho(1-\delta) + (1-\rho)\delta}, \tag{17}$$

$$t_2 = \frac{\phi + \bar{u}}{\beta\rho}. \tag{18}$$

A contract of this form, (t_1, t_2) with $t_1 = \beta P(y|L,1)t_2$, is renegotiation-proof if and only if it also solves $(\mathrm{RP}(\bar{u}^L, \bar{u}^H))$. That is:

$$(t_1, 0, t_2) \in \operatorname{argmin}_{t_1^L, t_1^H, \bar{t}_2} \left\{P(L|1)t_1^L + P(H|1)t_1^H + P(y|H,1)\bar{t}_2\right\}$$

$$t_1^L \geq t_1^H + \beta P(y|L,1)\bar{t}_2, \tag{ICL}$$

$$t_1^H + \beta P(y|H,1)\bar{t}_2 \geq t_1^L, \tag{ICH}$$

$$t_1^L \geq t_1, \tag{IRL}$$

$$t_1^H + \beta P(y|H,1)\bar{t}_2 \geq \beta P(y|H,1)t_2. \tag{IRH}$$

It can be shown that the incentive constraint for the low type must be binding, while that for the high type is slack and thus can be omitted. With these observations, the problem becomes:

$$(0, t_2) \in \operatorname{argmin}_{t_1^H, \bar{t}_2} \left\{t_1^H + \left(\beta P(y,L|1) + P(y,H|1)\right)\bar{t}_2\right\}$$

$$t_1^H + \beta P(y|L,1)\bar{t}_2 \geq \beta P(y|L,1)t_2,$$

$$t_1^H + \beta P(y|H,1)\bar{t}_2 \geq \beta P(y|H,1)t_2.$$

This happens if and only if

$$\frac{1}{\beta P(y|H,1)} < \frac{1}{\beta P(y,L|1) + P(y,H|1)},$$

or, equivalently, if and only if

$$\frac{1-\beta}{\beta} < \frac{1}{\delta} \cdot \frac{(1-\rho)(2\delta-1)}{\rho\delta + (1-\rho)(1-\delta)}. \tag{19}$$

Therefore, optimal renegotiation-proof contracts exit only if the manager is patient enough. For an impatient manager (whose discount violates (19)), every contract with a long-term component will be subject to renegotiation at date 1 and thus, without commitment, such contracts are not credible as of date 0. On the other hand, since the signal is not observable by the owner at date 1, it is impossible to induce high effort with a short-term contract, and thus a stable, effort-inducing contract does not exit in this case.

If the manager's discount factor satisfies (19), then the long-term contracts described above are renegotiation-proof. The expected cost of the owner at the optimal contract is:

$$c = \phi \left(1 - \delta + \frac{\delta}{\beta}\right) \frac{\rho(1-\delta) + (1-\rho)\delta}{(1-\rho)(2\delta-1)}, \tag{20}$$

if (14) is satisfied and

$$c = (\phi + \bar{u}) \left(1 - \delta + \frac{\delta}{\beta}\right) > \phi + \bar{u}, \tag{21}$$

if (14) is violated.

Note that as β decreases, the cost to the owner increases. Thus, dealing with an impatient manager is costlier to the owner.

We analyze next to what extent auditing, performed at date 1, can improve the results. As shown before, if (2) is violated, transparency leads to the first best allocation, even with lack of commitment, while a manipulable signal at date 1 generates a loss of welfare. Thus, there is a scope for monitoring in this case to increase transparency. A short-term contract and a (costly) verification of the signal at date 1 might improve efficiency. On the other hand, if (2) is satisfied, the (long-term) optimal contract under non-commitment and zero transparency is superior to the short-term optimal contract offered under non-commitment and a fully observable signal. Thus here, a short-term contract with monitoring has no chances of improving welfare. However, a long-term contract with monitoring might. We investigate each of these possibilities in the sequel.

4 Short-term contract with auditing

In this section we focus on short-term compensation schemes with monitoring at date 1.[3] As we argued before, such contracts have the potential to improve efficiency if $\bar{u} > \phi \frac{1-\delta}{\rho(2\delta-1)}$.

Assume therefore that the owner has access to a monitoring technology which can be operated at a cost C. The owner can choose to operate the technology to verify the manager's report at date 1 (thus increasing the transparency of date-1 signal). Auditing, when performed, fully reveals the signal that the manager received (not the true state of the world). This is a simplifying assumption which does not change the substance of our results.

The monitoring technology employed here can be interpreted as being either due to an internal governance mechanism, an external governmental agency responsible for enforcing disclosure laws, or a combination of the two. While the external regulatory agency is only interested in detecting those forms of manipulation that have been deemed to be illegal, the internal governance system may wish to limit or expand that set to include other manipulation activities that are costly to the firm. In addition, the extent of the penalty the internal mechanism can apply is likely to be limited to the firing of the manager whereas the external regulatory agency can add to this monetary penalty the penalty of incarceration.

We assume, as in (Khalil 1997), that the owner (or auditing agency) cannot commit to an auditing policy and thus the policy has to be ex-post incentive compatible. This restricts the class of auditing policies that can be implemented. The probability of auditing should be endogenously determined and tied to the reporting strategy of the manager. For example, the owner suspects that the manager reported truthfully, he would not have an incentive to audit.

The contract offered to the manager will now have two components: (1) a menu of transfers at date 1 together with probabilities of being audited,

[3] In particular, this implies that equity grants (with a long vesting period) cannot be part of the manager's contract.

$((t_H, \gamma_H), (t_L, \gamma_L))$, contingent on the report, and (2) a penalty, $F(t)$, incurred if misreporting is detected, which may depend on the transfer received.

The owner attempts too design the optimal contract that induces the manager to exert the high effort. For the monitoring strategy to be ex-post efficient, the monitoring probability should be linked to the manager's reporting strategy. The owner will not monitor if it believes that the manager reported truthfully.

To provide incentives for high effort, the contract must have $t_H > t_L$. We are looking for the optimal, effort inducing contract of payments and monitoring intensity, which is consistent with the manager not distorting a high earnings signal (a perfect Bayesian equilibrium of the ensuing game). Since the monitoring has to be ex-post incentive compatible for the owner, it must be the case that, the owner never uses the auditing technology upon receiving the report $R = L$ (since a manager who issues such report must be telling the truth), and thus the optimal contract must have $\gamma_L = 0$. To save on notation we will thus omit γ_L from the specification of the contract and let $\gamma_H = \gamma$.

4.1 Transfer-independent penalties

Assume first that the penalty for misreporting is a fixed fine F, which is independent of the transfer the manager received that period. We also assume that there is some limited liability clause which imposes an upper bound, $\bar{F}$ on the fine that the manager can be charged.[4]

Hence, the contract offered to the manager in this case is of the form (t_H, t_L, γ, F), with $t_H, t_L \geq 0$, $\gamma \in [0, 1]$ and $0 \leq F \leq \bar{F}$. At date $t = 1$, after observing the early signal, the manager issues a report R. As discussed above, if the signal is H, the manager will report truthfully. If the signal is L, the manager has an incentive to report truthfully only if $t_L \geq t_H - \gamma F$. For $\gamma > 0$ to be part of the optimal contract, it must be ex-post incentive compatible for the owner to monitor, and therefore it must be that the manager uses a mixed strategy for his report upon observing L. Thus he must be indifferent between reporting truthfully or not, which implies that :

$$t_L = t_H - \gamma F. \tag{22}$$

[4]Note that the form of limited liability used here allows a negative net transfer to the manager.

The owner's net expected benefit from using the monitoring technology with probability γ upon receiving the report $R = H$ is $\gamma\,(F \cdot P(L|R = H, 1) - C)$, and thus the owner chooses $\gamma > 0$ if and only if $F \cdot P(L|R = H, 1) \geq C$.

The auditing policy γ is ex-post incentive compatible for the owner if and only if

$$\gamma \in \text{argmax}_{\gamma' \in (0,1]} \gamma' \cdot (F \cdot P(L|R = H, 1) - C). \tag{23}$$

To induce the high effort, the contract must satisfy:

$$P(L|1)t_L + P(H|1)t_H - \phi \geq P(L|0)t_L + P(H|0)t_H,$$

which is equivalent to $(P(H|1) - P(H|0))\,(t_H - t_L) \geq \phi$ or, using (22),

$$\gamma F \cdot (P(H|1) - P(H|0)) \geq \phi. \tag{24}$$

To be accepted by the manager, the contract must satisfy:

$$P(L|1)t_L + P(H|1)t_H - \phi \geq \bar{u},$$

or, equivalently, using (22):

$$t_L + \gamma F \cdot P(H|1) \geq \phi + \bar{u}. \tag{25}$$

Let $\sigma_e \in (0, 1)$ denote the probability that the manager reports truthfully after observing L, when the previous period choice of effort was $e \in \{0, 1\}$. We find first the contract that minimizes owner's costs while inducing a given probability of truthful reporting, σ_1, and then determine the optimal probability σ_1.

Note that if the manager's strategy is to report truthfully with probability σ_1, then (23) implies

$$1 - \sigma_1 \geq \frac{C}{F - C} \cdot \frac{P(H|1)}{P(L|1)}. \tag{26}$$

If the maximum permissible fine $\bar{F}$ violates inequality (26), then the strategy σ_1 cannot be implemented via an incentive compatible auditing policy. If $\bar{F}$ is low enough so that $\frac{C}{F-C} \cdot \frac{P(H|1)}{P(L|1)} \geq 1$, then no $\sigma_1 > 0$ can be implemented. In the sequel we assume that $\frac{C}{F-C} \cdot \frac{P(H|1)}{P(L|1)} < 1$ and let $\bar{\sigma}$ be the highest value of σ_1 for which $\bar{F}$ satisfies (26). Thus, given the upper bound on the fine that the manager may be required to pay when misreporting, only strategies $\sigma_1 \leq \bar{\sigma}$ can be implemented.

Fix such a σ_1. The optimal contract that implements σ_1 must minimize costs, subject to constraints (22), (24), (23), (25) and (26). Thus, the owner's problem is:

$$\min_{t_L,t_H,\gamma,F} \{P(R=H|1)t_H + P(R=L|1)\cdot t_L + \gamma P(R=H|1)\left[C - F\cdot P(L|R=H)\right]\}$$
$$\begin{aligned}
&t_L = t_H - \gamma F,\\
&\gamma F\cdot[P(H|1) - P(H|0))] \geq \phi,\\
&t_L + \gamma F\cdot P(H|1) \geq \phi + \bar{u},\\
&\gamma \in \text{argmax}_{\gamma'\in(0,1]}\gamma'\cdot(F\cdot P(L|R=H) - C),\\
&1-\sigma_1 \geq \frac{C}{F-C}\cdot\frac{P(H|1)}{P(L|1)}.
\end{aligned}$$

The problem can be simplified to:

$$\min_{t_H,\gamma,F}\{t_L + \gamma F(1-\sigma_1 P(L|1))\}$$
$$\begin{aligned}
&\gamma F\cdot[P(H|1) - P(H|0))] \geq \phi,\\
&t_L + \gamma F\cdot P(H|1) \geq \phi + \bar{u},\\
&1-\sigma_1 \geq \frac{C}{F-C}\cdot\frac{P(H|1)}{P(L|1)}.
\end{aligned}$$

Since we assumed that $\bar{u} > \phi\frac{1-\delta}{\rho(2\delta-1)}$, the solution is

$$\begin{aligned}
t_L &= \bar{u} - \phi\frac{1-\delta}{\rho(2\delta-1)},\\
t_H &= \bar{u} + \phi\frac{\delta}{\rho(2\delta-1)},\\
F &= C\left(1 + (1-\sigma_1)\frac{\rho\delta + (1-\rho)(1-\delta)}{(1-\rho)\delta + \rho(1-\delta)}\right),\\
\gamma &= \frac{\phi}{F\rho(2\delta-1))}.
\end{aligned}$$

Clearly, the cost to the owner is decreasing in σ_1 and thus it is optimal for the owner to set $\sigma_1 = \bar{\sigma} = 1 - \frac{C}{\bar{F}-C} \cdot \frac{P(H|1)}{P(L|1)}$ and thus $F = \bar{F}$. Therefore,

$$\sigma_1 = 1 - \frac{C}{\bar{F} - C} \cdot \frac{\rho\delta + (1-\rho)(1-\delta)}{\rho(1-\delta) + (1-\rho)\delta},$$

$$\gamma = \frac{\phi}{\rho\bar{F}(2\delta - 1)}.$$

$$c = \bar{u} + \phi\frac{\rho\delta + (1-\rho)(1-\delta)}{\rho(2\delta - 1)} \cdot \frac{\bar{F}}{\bar{F} - C} - \phi\frac{1-\delta}{\rho(2\delta-1)} > \bar{u} + \phi.$$

This shows that without the ability to commit to a particular monitoring intensity, misreporting cannot be eliminated completely, even when the monitoring technology has a 100% fraud detection rate. If monitoring intensity has to be ex-post incentive compatible, then misreporting will happen with a positive probability that is decreasing in the severity of the punishment, $\bar{F}$ and increasing in the cost of monitoring, C.

Therefore, as long as monitoring entails a positive cost (albeit small), the first best cannot be achieved. However, it is possible for such a contract to dominate the long-term, renegotiation-proof contract described in the previous section. That happens as long as the following inequality holds:

$$(\phi+\bar{u})\left(1 - \delta + \frac{\delta}{\beta}\right) > \bar{u} + \phi\frac{\rho\delta + (1-\rho)(1-\delta)}{\rho(2\delta-1)} \cdot \frac{\bar{F}}{\bar{F} - C} - \phi\frac{1-\delta}{\rho(2\delta - 1)} \quad (27)$$

Notice that the inequality is always satisfied if either β or C are small enough. Recall that an effort-inducing, renegotiation-proof, long-term contract did not exist unless the manager was sufficiently patient. Our recent results point out that for more impatient managers, a short-term contract with random auditing is the only viable option. For managers who are patient enough so that effort-inducing, long-term renegotiation-proof contracts exist, a short-term contract with random auditing may still be better if the cost of auditing is sufficiently small (or the punishment for misreporting is sufficiently high).

Notice a few characteristics of the short-term contract with monitoring. The intensity of monitoring, γ increases when it is more costly for the manager to exert high effort (that is, when disutility of effort, ϕ, increases) and decreases with the severity of the punishment. Interestingly, the intensity of monitoring is not affected by the cost of using the technology. This means that if the cost of monitoring decreases, one should expect an increase in the compliance rate *without* a change in the monitoring intensity. If the monitoring costs decrease, the owner will, ceteris paribus, have an incentive to increase the monitoring intensity. The results highlight the fact that this incentive alone serves as an effective fraud deterrent. The compliance rate increases simply because the manager tries to avoid an increase in the intensity of monitoring.

By contrast, an increase in the maximum allowable punishment for fraud triggers a higher compliance rate and a *lower* monitoring intensity. The severity of the punishment directly affects the manager's decision to report truthfully. Without a change in the intensity of monitoring, an increase in the punishment will lead to full compliance, but then monitoring will no longer be ex-post incentive compatible. Knowing that a higher punishment triggers higher compliance the owner will have an incentive to reduce the monitoring intensity.

The degree of uncertainty in the industry (that is, the magnitude of δ has a significant effect on all variables. As δ increases (that is, the signal becomes more precise and it is thus easier to separate misreporting from inherent industry uncertainty), t_H decreases. That is, the incentive pay has to be larger in more uncertain industries.

On the other hand, $1-\sigma$ is higher if δ is higher, which means that the manager has higher incentives to misreport if the firm is part of an industry with a higher degree of uncertainty (in which past performance is a poor predictor of future performance). Interestingly, the intensity of monitoring decreases as δ increases. This may seem surprising; however, σ is the probability of truthful reporting *contingent on receiving the low signal.* This is *not* the frequency with which a positive report turns out to be false. That probability is $\text{Prob}(L|R=H,1)$, which is decreasing in δ. Thus, as the signal becomes more precise, both the frequency of false positive reports and the monitoring intensity decrease.

The cost to the owner is decreasing in δ and $\bar{F}$ and increasing in the auditing cost C and the disutility of effort ϕ.

4.2 Transfer-dependent penalty

Assume now that the limited liability clause prevents the owner to extract money from the manager and thus the maximum penalty for non-compliance is the retention of the transfer. Hence, the contract offered to the manager in this case is of the form (t_H, t_L, γ), with $t_H, t_L \geq 0$, $\gamma \in [0,1]$

The manager who receives the low signal at date 1 is indifferent between reporting truthfully or not if

$$t_L = (1-\gamma)t_H. \tag{28}$$

To induce the high effort, the contract must satisfy, as before:

$$P(L|1)t_L + P(H|1)t_H - \phi \geq P(L|0)t_L + P(H|0)t_H,$$

which is equivalent to $(P(H|1) - P(H|0))(t_H - t_L) \geq \phi$ or, using (28),

$$\gamma t_H (P(H|1) - P(H|0)) \geq \phi. \tag{29}$$

The owner's problem reduces to:

$$\begin{aligned}
&\min \{t_H - \gamma\sigma_1 P(L|1)\} \\
&\quad \gamma t_H \cdot [P(H|1) - P(H|0))] \geq \phi, \\
&\quad t_H - \gamma t_H P(L|1) - \phi \geq \bar{u}, \\
&\quad 1 - \sigma_1 \geq \frac{C}{t_H - C} \cdot \frac{P(H|1)}{P(L|1)}.
\end{aligned}$$

Standard arguments imply that the third and second inequalities must bind at the optimum, and thus $t_H = \frac{\phi+\bar{u}}{1-\gamma P(L|1)}$, and $1 - \sigma_1 = \frac{C}{t_H - C} \cdot \frac{P(H|1)}{P(L|1)}$.

As before, we determine first the optimal contract that implements a fixed strategy σ_1, and then find σ_1 that minimizes the expected cost.

Fix therefore some $\sigma_1 \in [0,1]$. If $\frac{\phi+\bar{u}}{P(H|1)} > \frac{C}{P(L|R=H)}$, then $t_H \geq \frac{\phi+\bar{u}}{P(H|1)} > \frac{C}{P(L|R=H)}$, which implies that $\gamma = 1$ and thus $t_L = 0$ and $t_H = \frac{\phi+\bar{u}}{P(H|1)}$. If $\bar{\sigma} \in [0,1]$ is the solution of $\frac{\phi+\bar{u}}{P(H|1)} = \frac{C}{P(L|R=H)}$ then, to implement any $\sigma_1 < \bar{\sigma}$, auditing has to happen with certainty. In this case the cost to the owner is

$$c = \frac{\phi+\bar{u}}{P(H|1)} - \sigma_1 P(L|1),$$

which is decreasing in σ_1.

If $\sigma_1 > \bar{\sigma}$, then auditing has to happen with probability

$$\gamma = \frac{1}{P(L|1)} - \frac{\phi+\bar{u}}{C} \cdot \frac{P(L|R=H)}{P(L|1)} < 1,$$

and therefore

$$t_H = \frac{C}{P(L|R = H)},$$

and the cost to the owner is increasing in σ_1.

Hence, the owner would want to induce the strategy $\bar{\sigma}$, by auditing with probability 1 and offering transfers $t_L = 0$ and $t_H = \frac{\phi + \bar{u}}{P(H|1)}$.

5 Long-term contracts with auditing

As argued before, if $\frac{\bar{u}}{\phi} < \frac{1-\delta}{\rho(2\delta-1)}$, then a renegotiation-proof long-term contract dominates a short-term contract even if in the latter case the owner can fully observe the date-1 signal. Thus, a short-term contract with auditing has no hopes of improving upon the long-term contract. We investigate next if auditing while still maintaining the long-term component of the contract improves efficiency.

To begin, fix an exogenous probability γ of auditing at $t = 1$. Assume also that if misreporting is detected upon auditing, then the entire transfer is retained. As in Section 3, the manager is offered a menu of two contracts. For each of them, the transfers are contingent on receiving a high value report from the manager. The first contract promises a transfer t_1 at date 1 and nothing at date 2, while the second promises nothing at date 1 and a transfer t_2 at date 2 contingent on the realization of the high payoff value. As before, the first contract is intended for the manager who receives the low signal, while the second is intended for the one who receives the high signal.

Clearly, under this contract, the manager will issue a high-value report irrespective of the signal received. The manager who receives the low signal prefers the short-term contract if $(1-\gamma) \cdot t_1 \geq (1-\gamma)\beta P(y|L, 1) \cdot t_2$, while the manager who receives the high-value signal prefers the long-term contract if $\beta P(y|H, 1) \cdot t_2 \geq t_1$.

The contract induces high effort if

$$(1-\gamma)P(L|1)t_1 + \beta P(H|1)P(y|H, 1)t_2 - \phi \geq (1-\gamma)P(L|0)t_1 + P(H|0)t_1, \quad (30)$$

which is equivalent to

$$\beta P(y, H|1)t_2 \geq \phi + t_1 \left[(1-\gamma)P(H|1) + \gamma P(H|0)\right], \quad (31)$$

On the other hand, the contract is individually rational if

$$(1-\gamma)P(L|1)t_1 + \beta P(y,H|1)t_2 - \phi \geq \bar{u}.$$

For a given $\gamma \in [0,1]$, the contract that minimizes owner's costs is:

$$t_1(\gamma) = \phi \frac{P(y|L,1)}{P(H|1)} \cdot \frac{1}{P(y|H,1) - P(y|L,1)\left[1-\gamma+\gamma\frac{P(H|0)}{P(H|1)}\right]}, \tag{32}$$

$$t_2(\gamma) = \phi \frac{1}{\beta P(H|1)} \cdot \frac{1}{P(y|H,1) - P(y|L,1)\left[1-\gamma+\gamma\frac{P(H|0)}{P(H|1)}\right]}, \tag{33}$$

$$\tag{34}$$

The cost to the owner is

$$c(\gamma) = (1-\gamma)P(L|1)t_1(\gamma) + P(y,H|1)t_2(\gamma). \tag{35}$$

Note that if $\gamma = 0$, the model is equivalent to the one described in Section 3 in which full manipulation of the signal is possible. Also, the transfers are decreasing in γ. That is because as γ increases, the likelihood that a manager who received the low signal will be paid decreases. Since the chances of getting the low signal are higher under low effort, this effectively serves as an additional deterrent against low effort and makes the incentive constraint for exerting high effort easier to be satisfied. Clearly, since the transfers decrease with γ, the cost is also decreasing in γ. Hence, the owner should select the highest value of γ for which the renegotiation-proof condition is still satisfied, that is,

$$\frac{1-\beta}{\beta} \leq (1-\gamma)\frac{P(L|1)}{P(H|1)}\left(1-\frac{P(y|L,1)}{P(y|H,1)}\right). \tag{36}$$

This suggests that, in principle, monitoring at date 1 could improve the efficiency of the contract. We investigate next if this outcome can indeed be implemented via an auditing policy that is ex-post efficient for the owner.

For every $\beta \geq \bar{\beta}$, let $\gamma^*(\beta)$ be the highest value of γ that satisfies inequality (36). Clearly, $\gamma^*(\bar{\beta}) = 0$. The contract described above can be supported via an ex-post efficient policy in which the manager is audited with probability $\gamma^*(\beta)$ if and only if

$$C \leq P(L|1) \cdot t_1(\gamma^*(\beta)).$$

6 Replicating the contract with stock and options

In this section we show that the contracts described before can be replicated via a compensation package consisting of stocks and options.

The manager's payments consisting of transfers (t_1, t_2) can be made contingent on the realization of the market stock price at that date. As before, the contract also specifies a probability of monitoring, γ, which is carried on if the stock price reaches a certain level.

We start by analyzing how the manager's reporting at date 1 affects the stock price. We assume that a non-negligible segment of the market consists of risk-neutral investors with a time discount factor of 1 (that is, the risk-free gross interest rate is 1). Then, the market price of any asset must be equal to the discounted expected value of its payoff. Hence, the stock price following the report $R \in \{H, L\}$ is

$$p(R) := P(y|R)y, \tag{37}$$

where $\mathrm{P}(y|R)$ is market's updated belief that the value is high, upon observing the manager's report R. At equilibrium, these beliefs have to be consistent with the manager's reporting strategy. If σ is the probability with which the manager reports truthfully upon observing the low signal, then the market beliefs can be computed as follows using Bayes' rule:

$$P(y|H) = \frac{\rho(1-\sigma(1-\delta))}{1-\sigma P(L|1)}, \tag{38}$$

$$P(y|L) = \frac{\rho(1-\delta)}{P(L|1)}. \tag{39}$$

As these formulas suggest, the owner can induce a particular reporting strategy by setting a specific target for the stock price and conditioning transfers on that price. Thus the contract would specify a target stock price level and transfers contingent on the target being reached.

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