Dynamic Governance

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Abstract

We model long-run dynamics of corporate governance, management compensation, and firm performance in framework where governance policy is determined by a shareholder-value-maximizing board in a nonstationary enviornment. We show that firm performance, managerial compensation and governance policies which can only be rationalized by managerial influences in a single period context naturally arise in this dynamic setting. For example, even when managers have no influence over governance or compensation policy, high management compensation and lax governance is likely to be associated with poor firm performance. Substantial variation in management pay is generated by luck and managerial diversion of firm resources for private consumption is likely to accompany stock price reversals which follows sustained increases in shareholder value. Further, we demonstrate that optimal governance structures vary with the legal system and asset characteristics of the firm, with passive "do-nothing" boards being an ex ante rational response to rising firm valuations.

JEL Classification Codes: G20, G34; *Keywords*: governance, institutional design

1. Introduction

Researchers have extensively investigated the relation between managerial compensation, corporate governance and firm performance.[1] Most of the theoretical literature has considered these issues in a static or at least stationary context.[2] At the same time, most empirical research has focused on the cross sectional relations between these variables. However the actual relation between compensation, governance, and performance evolves dynamically in nonstationary world. Researchers have recognized that these dynamic relationships cannot easily be estimated using simple cross-sectional tests (see, for example, Coles, Lemmon, and Meschke (2006)). However, further progress awaits the development of formal dynamic models of the compensation-governance-performance relation.

This paper is a first attempt to develop such a dynamic model. We model a firm owned by shareholders and managed by a professional manager. The manager is responsible for day-to day operations of the firm. In addition the manager participates in making occassional strategic decisions with long-term implications.[3] A shareholder appointed board has all the bargaining power in the manager-board relation and acts in the interest of shareholders. The board is responsible for setting management compensation and monitoring the asset base of the firm. The board may also decide to exert control or advise the manager with respect to long-term strategy.

The firm has an uncertain life span and its financial condition evolves over time. Survival requires that the manager perform his supervisory duties and the shareholders continue to fund the firm. However, this alone may not be sufficient for the firm to continue. At crucial junctures the firm can only survive if it adopts the correct strategy. Managers have a comparative informational advantage in making these strategic choices but may be conflicted. The manager's

[1]For example, Jensen and Murphy (1990) and Murphy (1985) document the relation between CEO pay and firm performance, while Murphy (1999) surveys the literature on executive compensation. Core, Holthausen and Larcker (1999) provide evidence on the relations between governance, management compensation, and firm performance. Bhagat and Black (1999) survey the an extensive literature on the relation between boards and firm performance.

[2]See, for example, Hermalin and Weisbach (1991)

[3]Holmstrom and Milgrom (1991) also develop a principal-agent model where agents perform multiple tasks. However, their model examines the principal agent relationship in a static context. Dow and Raposo (2005) develop a model of managerial strategic decision making. In contrast to Dow and Reposo, we consider the long run dynamics of the manager-firm relation and allow the firm to audit as well as incentivize the manager via compensation. Further, Dow and Reposo allow for the firm to precommit to restricting management compensation while we do not allow the firm to make any commitments regarding future compensation.

advantage in making strategic decision arises from two sources. First, as in Hennessey, Livdan, and Miranda (2006), managers have a one period-ahead informational advantage, i.e., they know the state of the firm one period before this information becomes common knowledge. Second, because of their familiarity with the firm's operations, managers are better able to gauge the merits of strategies. Ex ante, the importance of strategic decision making for the firm's survival is not known by either the manager or the board. However, as times passes, firm performance provides more and more information regarding the importance of strategic decisions. This new information gives the board an opportunity to review both its supervision of operations and its role in formulating strategy.

Just as Hennessey and Whited (2005) and Hennessey, Livdan, and Miranda (2006) show that, in the context of corporate capital structure, introducing dynamic considerations into the firm's choice of financing policy fundamentally alters the implications of capital structure theory, our analysis shows that much of the conventional wisdom regarding the relation between managerial compensation, corporate governance, and firm performance is invalid in a dynamic setting. First, the traditional belief that a strong a positive pay-to-performance relation is a mark of good governance is incorrect. In fact, shareholder-value-maximizing policies in a dynamic context can engender a strong negative relation between changes in pay and changes in performance. This follows because the total value of the manager-firm relation not current compensation drives managerial performance. In our dynamic setting, the total value of the manager firm relation is only weakly related to current compensation because only a fraction of this value comes from short-term compensation. Moreover, the level of pay is also not always increasing in firm profitability. In fact, compensation is highest for firms with the best and worst investment opportunity sets.

We show that in a non-stationary dynamic setting, large swings in managerial compensation may be triggered by changes in firm performance which all agents know are unrelated to changes in managerial actions. In other words, a strong pay to luck relation is observed even though managers have no control over boards or the compensation decision. This result provides a new perspective on the discussion regarding CEO pay for luck (see, e.g., Bertrand and Mullainathan (2000)). Changes in compensation occur because, in our nonstationary setting, even events unrelated to managerial performance can provide information abut the firm's survival and thus the manager's valuation of his relationship to the firm as well as the firm's valuation of the marginal product of the manager. This information leads a shareholder-value-maximizing board to reassess governance and compensation policies. Among these polices is the intensity of monitoring the firm's day to day operations. This changed monitoring intensity, which is unrelated to shifts in managerial performance, changes the tradeoff which fixes managerial compensation.

The board's participation in strategy formulation can also change over time. The board's level of involvement in strategy formulation varies with the magnitude of the manager's valuation of his relation with the firm and with the likelihood that strategic decisions will be crucial for the firm's survival. When the manager's valuation of the relation is sufficiently high, swamping any private benefit from strategy choices, the board always plays a passive role. As the manager's valuation falls, the board becomes more active if the board believes that the need for strategic realignment is sufficiently high. When the manager's valuation of his relation with the firm is moderately high, the board restricts itself to an advisory role. When the manager's valuation of his relationship with the firm falls even further, the board takes charge of corporate strategy.

In summary, our results regarding board activity shows that, lax boards, that is, boards that monitor with low intensity and are passive in formulating strategy are associated with high managerial compensation. However, this link between weak boards and rich managers has nothing to do with managerial capture of the board. The link is firmly based on shareholder wealth maximization in a dynamic setting.

Our results provide insights for interpreting existing empirical research and guiding future research on corporate governance, management compensation and firm performance. For example Core, Holthausen, and Larcker (1999) interpret the connection they find between lax governance and poor performance as an indication of managerial influence. In our setting, firms with a high liklihood of becoming distressed, will, for shareholder-value-maximizing reasons, choose higher compensation. This higher compensation, in turn, will lead managers to make strategic decisions more in line with shareholder interests, which will lead boards, rationally, to relax their vigilance over strategy. Thus, while our results are consistent with the empirical findings of Core, Holthausen, and Larcker (1999), in our framework these results have completely different explanation. Similarly Hermalin and Weisbach (1998) develop a model where managerial bargaining power leads to a positive relation between managerial compensation and managerial influence over corporate decisions. We show that the same relation between influence over corporate decisions and compensation can hold when the manager has no bargaining power. Our results also have some implications for research projects that employ indices of democratic governance, such as that of Gompers, Ishii, and Metrick (2001), as measures of good governance. First, our results show that optimal governance mechanism are firm-specific in that the appropriate mix of auditing, information production by the board, and the level of managerial compensation vary with the legal system, the firm's history, and its asset type. Thus, while democratic governance may be optimal for some firms at some points in heir history, it need not be universally optimal.[4]

The remainder of the paper proceeds as follows: In Section 2 we develop the framework of our model. Section 3 contains our solution of th emodel. In Section 4 we describe the results of tests designed to examine the relationship between management compensation and firm performance generated by simulations of our model. Section 5 is devoted to our analysis of the strategic role of the board. We present some concluding remarks in Section 6.

2. Model

Consider a firm owned by risk-neutral shareholders and managed by a risk-neutral manager. The risk free rate of interest is constant across time and the per period discount factor is represented by ρ. At the start of each period, the firm can be in one of two states—Healthy (H) or Dead (D). If the firm is in state D it is inoperable during the period in that it cannot generate any cash flow during the period and it is always starts the next period in state D. During the period, the firm can transition to one of three possible operating states—H, S,

[4]Our results, also complement other theoretical research into governance and compensation. For example, Povel, Singh and Winton (2005) model the relation between economic conditions and the opportunity to divert resources. They show that opportunism is most to likely to occur when agents are fairly but not too optimistic regarding future prospects. We reach a similar conclusion: distress is most likely to result in diversion after a sequence of positive shocks to the firm's value. Like Dow and Raposo (2001) we also focus on the manager's strategic role, rather than managerial effort provision and find that strategic uncertainty raises the value of managerial compensation. Similar to Harris and Raviv (2006), we show that in some instances the board might choose to share information with the manager and delegate decisions to him while in others it might make the decisions unilaterally.

or D. The operating state for the current period is observed by the manager when it occurs. Shareholders observe the operating state at the end of each period. Thus, both at the beginning and end of the period the firm's state is common knowledge. However, the manager has an informational advantage when the operating state first occurs during each period. The firm starts at time zero in state H.

If the firm's intial state in a period is H, the firm has a project that requires an investment of $k < 1$ dollars. The financing for this investment is provided by shareholders before the operating state for the period is realized. The investment is made after the manager observes the operating state. A failure to invest in the project in any state results in a cash flow of zero and transitions the firm to state D. Similarly, a failure by the manager to supervise the project results in a cash flow of zero and transitions the firm to state D. In operating state H, if the manager supervises the project, the investment of $\$k$ generates a certain end-of-period cash flow of $1 + c$, the manager receives a private benefit of β, and the firm begins the next period in state H. If operating state S is realized and the manager supervises the project, the investment of k generates a cash flow identical to that realized in operating state H. However, as described below, the likelihood that the firm will begin the next period in state H is determined by the strategic choice made by the firm, and the strategic choice also affects the manager's private benefit.

The manager incurs a non-pecuniary cost of c from supervising. To compensate the manager for his services, the firm pays the manager a fixed wage of $w + c$, where w represents the manager's compensation in excess of his costs from supervising operations.[5]

Once the financing for a project has been raised and the manager has observed the operating state, the manager can choose to either invest in the project or divert the funds for personal consumption. If the manager diverts funds for his personal consumption, no investment is made in the project, and therefore as described above, the firm transitions to state D. The manager's ability to benefit from the diversion of these funds is dependent on the vigilance of the board. The board's level of vigilance is determined by the intensity of its auditing, α, where $0 \leq \alpha \leq 1$. Given auditing intensity α, the manager is unable to divert $\alpha\, k$ of the funds. The remaining

[5]In contrast to Chang (1993) in our model the manager can divert the firm's asset base before investing but cash flows from investing are verifiable and the manager is forced to pay out this cash flow to shareholders at the end of the period.

funds amounting to $(1-\alpha)\,k$ are divertible. Board auditing is costly and the cost of auditing is given by $\frac{1}{2}\,\gamma\,\alpha^2$. We assume that $\gamma > k$. This ensures that the auditing intensity α will never equal its maximum value of one.

For every dollar diverted by the manager, he incurs a personal cost of $1-\phi$, leaving him with $\phi\,(1-\alpha)\,k$. This personal cost captures the fact that manager has to disguise his actions. This cost is likely to vary with factors such as the quality of the legal system, the fungability of the firm's assets, and the intensity of scrutiny by the media and financial analysts.

In every period where the operating state is S, the manager has to decide on the firm's strategy. This decision can only be made once the investment for the time period has been made and the manager has received private information regarding the effects of his strategy choice on both his private benefit and the firm's survival. There are two strategic alternatives and their effectiveness is independent of both the history of the firm and the manager's private information upto the current date. Thus, based on prior information in the current period each of the two choices is equally effective. The manager's private information consists of a perfectly informative signal of the effect of his choice on his private benefit, and a noisy signal that informs him of the effect the strategy alternatives have on the likelihood of the firm's survival. If the manager makes the "correct" choice, the firm transits to state H in the subsequent period. Otherwise, the firm transits to state D in the next period.

More formally, the manager chooses between the two alternatives, Right (R) and Left (L). The manager realizes a private benefit β from one of the remedies. The remedy that yields the private benefit is determined at random each time the firm enters state S. The manager's private information perfectly reveals which choice yields the private benefit. The prior probability that remedy R generates the private benefit is given by $\frac{1}{2}$. The manager's noisy signal regarding the correctness of the choices, σ_M, has the following properties

$$
\begin{aligned}
P[\text{Right is signaled} \mid \text{Right is correct}] &= \mu > \frac{1}{2}; \\
P[\text{Left is signaled} \mid \text{Right is correct}] &= 1-\mu < \frac{1}{2}. \qquad (1)
\end{aligned}
$$

Given the manager's prior over the correctness of the choices, from Bayes rule, his posterior probabilities regarding the correctness of the choices are as follows:

$$\begin{aligned} P[\text{Right is correct} \mid \text{Right is signaled}] &= \mu > \frac{1}{2}; \\ P[\text{Left is correct} \mid \text{Right is signaled }] &= 1-\mu < \frac{1}{2}. \end{aligned} \tag{2}$$

Note that the manager's two private signals, his signals regarding the private benefits and the likelihood of survival associated with the two choices, can either indicate the same choice or different choices. When they indicate the same choice, for example, the private benefit signal indicates that the manager will receive β if he chooses R and the signal regarding the strategy choice indicates that the choice of R produces the survival probability of μ, then it is obvious the manager will pick the policy indicated by both signals. When the signals indicate different policies, for example if the signals indicate that the manager will receive β if he chooses R and the choice of R produces the survival probability of $1-\mu$, the manager might either choose R or L. If he follows the policy of maximizing his private benefit, we say the manager follows the Bad (B) policy. If the manager follows the policy of maximizing the probability of survival, we say that the manager follows the Good (G) policy.

To summarize, this framework allows us to consider the two roles of top management: supervision and control of the firm's day-to-day operations including control of its asset base, and infrequent but major long-term strategic initiatives aimed at refocusing the firm. At the same time, the framework permits consideration of two critical incentive problems with the separation of ownership and control of firms. The first being the blatant misappropriation of funds for personal gain, and the second being the distortion of long-term strategic decisions to protect private benefits. The framework also allow us to consider both the role of auditing in verifying cash flows and the role of legal system in making the diversion of unaudited funds more costly.

2.1. The source of non stationarity

The evolution of the firm's state depends on its type: Invulnerable (IVN) or Vulnerable (VN). The firm's type is never observed directly by either shareholders or the manager. If the firm is of type IVN, if the firm starts starts a period in state H, its operating state is H with probability one. Given our other assumptions, this implies that a type IVN firm will always remain in state H. In contrast, if the firm is of type VN and is in state H at the beginning of a period, the probability of the operating state H occuring is $1-\delta$, the probability of operating state S occuring is $\delta\, s$, and the probability of state D occuring is $\delta\,(1-s)$. Thus, δ represents the degree of vulnerability of a type VN firm, and s captures the importance of the manager's long-term strategy decision to the firm's survival.

At the start all agents believe that the firm is type VN with probability π. At the first instance when agents observe the firm in either state S or state D, that is the firm is "distressed," they learn that the firm is of type VN. In all subsequent periods their posterior probability assessment of the firm being type VN is one. If, prior to date t the firm has never been in state D or S, then the date t the posterior probability that it is type VN is given by Bayes rule, that is

$$p'' = \frac{(1-\delta)\, p'}{1-\delta\, p'} \tag{3}$$

where p'' represents the posterior probability of the firm being type VN and p' represents the prior probability that the firm is of type VN.

This framework for firm dynamics ensures that the value of future cash flows is sensitive to the firm's history. This relationship between firm history and firm value can lead to complex dynamics for both executive compensation and corporate governance.

3. Solving the model

We solve the model in three steps. First we solve the model under the assumption that the firm's type is known to be VN. This solution obtains whenever the firm has been distressed in the past (i.e., the firm has been in state S in the past). We call this solution the "stationary solution." Next we solve the model under the assumption that the firm is know to be of type IVN. This solution never obtains exactly but is approached as the length of the sequence of uninterrupted realizations of state H increases. We call this solution the "asymptotic solution." Finally, using the previous solutions as boundary points, we solve the model for histories where the firm' type has not been revealed. We call this the "non-stationary solution."

3.1. Stationary solution

The firm's objective in designing the governance mechanism is to ensure supervision of the project, limit diversion of cash flows by the manager, and influence the manager's strategy choice. The tools available to shareholders are their auditing decision and the manager's compensation. The audit decision directly affects the manager's diversion decision, and indirectly, through its effect on the manager's continuation value, influences both his incentive to supervise and his incentive to divert cash flows. Current compensation influences the manager's diversion incentive but has no influence on his choice of long-term strategy. The manager's continuation value, however, is determined by future compensation and influences both his diversion and strategy choices.

Note also that, in state D, given the structure of the model, because the project cannot generate any cash flow and there are no future cash flows, diversion by the manager is the dominant strategy. Thus, the governance mechanism must focus on controlling the manager's behavior in states S and H. Given that the problem is stationary in that, conditional on survival, the shareholders and manager face the same problem at the start of each period, optimal policies will be time independent. Thus, policies that are optimal in any one period will be optimal in all periods.

We solve this stationary problem in three parts. First we describe the optimal governance mechanism when shareholders permit the manager to divert in both states H and S. We call this governance policy the "Permissive policy." Then we describe the optimal governance mechanism that permits diversion only in state S. We label this policy the "Deterrent governance policy." Finally, we identify the optimal governance mechanism when the firm's type is known to be VN, by comparing the payoffs to shareholders from these two governance mechanisms.

3.2. Permissive governance policy

Let V_o represent the present value of the manager's future payoff stream under his optimal policy if the firm transitions to state H in the next period. Then the firm's problem is minimize the expected cost of its governance structure subject to the following constraints:

$$\phi\, k\,(1-\alpha) \geq w + c - c + \max(\frac{1}{2}\,\beta + \rho\,\mu\,V_o, \beta + \rho\,\frac{1}{2}\,V_o) \tag{4}$$

$$w + c - c + \rho\,V_o + \beta \geq \phi\,k\,(1-\alpha). \tag{5}$$

The first expression ensures that, in state S, the manager prefers diversion, which results in a payoff to him of $\phi\,k\,(1-\alpha)$, to investing in the project and adopting his most preferred strategy choice. The second constraint ensures that the manager prefers to undertake and supervise the project in state H.

Note that the manager's expected continuation value is always strictly higher in state H than it is in state S. Further the manager's current period payoff is always weakly higher in state H than it is in state S. Thus, the left hand side of (5) is always greater than the right hand side of (4). This implies that in any solution (5) will be the binding constraint. That is, when the manager is indifferent to diverting in state H he will better off diverting in state S. Because (5) binds, the manager's optimal compensation in excess of his cost of supervisory effort,

$$w = \phi\,k\,(1-\alpha) - \beta - \rho\,V_o. \tag{6}$$

Further, the current period payoff to the firm is

$$(1-\delta)(1 + c - \phi\,k\,(1-\alpha) + \beta + \rho\,V_o - c) + \delta\,\alpha\,k - k - \frac{1}{2}\,\gamma\,\alpha^2. \tag{7}$$

Differentiating this expression with respect to α, it follows that the optimal monitoring policy α_o^- must satisfy

$$(1-\delta)\,\phi\,k + \delta\,k - \gamma\,\alpha_o^- = 0, \tag{8}$$

or equivalently

$$\alpha_o^- = \frac{k\,(\phi + \delta\,(1-\phi))}{\gamma}. \tag{9}$$

Next note that the continuation value function for the manager, V_o^-, must satisfy

$$\begin{aligned} V_o^- &= (1-\delta)\,\left[\phi\,k\,(1-\alpha_o^-) - \beta - \rho\,V_o^- + \beta\right] + \delta\,\phi\,k\,(1-\alpha_o^-) + (1-\delta)\,\rho\,V_o^- \\ &= \phi\,k\,(1-\alpha_o^-) \end{aligned} \tag{10}$$

Using this expression for V_o^- we obtain the following expression for w_o^-

$$w_o^- = (1-\rho)\,\phi\,k\,(1-\alpha_o^-) - \beta. \tag{11}$$

Similarly, we can solve for the firm's value function U_o^-

$$\begin{aligned} U_o^- &= (1-\delta)\,\left[1 + c - (1-\rho)\,\phi\,k\,(1-\alpha_o^-) + \beta - c\right] + \delta\,\alpha_o^- k - k - \frac{1}{2}\gamma\,\alpha_o^{-2} + \rho\,(1-\delta)\,U^- \\ &= \frac{(1-\delta)\,(1+\beta) - \frac{1}{2}\gamma\,\alpha_o^{-2} - k[1 + (1-\delta)\,(1-\rho)\,\phi - \alpha_o^-\,(\delta + (1-\delta)\,(1-\rho)\,\phi)]}{1-\rho\,(1-\delta)} \end{aligned} \tag{12}$$

This expression is employed later to solve for the stationary solution.

3.3. Deterrent governance policy

Once again, let V_o represent the manager's continuation payoff under his optimal policy. Then, the firm's problem is minimize the expected cost of its governance structure subject to the following constraints:

$$\phi\,k\,(1-\alpha) \leq w + c - c + \max(\frac{1}{2}\,\beta + \rho\,\mu\,V_o, \beta + \rho\,\frac{1}{2}\,V_o) \tag{13}$$

$$w + c - c + \beta + \rho\,V_o \geq \phi\,k\,(1-\alpha) \tag{14}$$

The first constraint above ensures that the manager prefers investing in the project and supervising it to diverting cash in state S. The maximum reflects the manager's ability to choose between two strategies yielding different expected private benefits and expected continuation values in state S. The second constraint ensures that the manager prefers not to divert in state H. Once again note that the left hand side of (14) is greater than the right hand side of (13). Thus, constraint (13) will bind in any solution to the firm's problem. It follows that the manager's wage must satisfy

$$w = \phi\, k\,(1-\alpha) - \max(\frac{1}{2}\,\beta + \rho\,\mu\,V_o, \beta + \rho\,\frac{1}{2}\,V_o). \tag{15}$$

Using this expression for the manager's wage, the firm's current period payoff must equal

$$(1-\delta+\delta\,s)(1-\phi\,k\,(1-\alpha) + \max(\frac{1}{2}\,\beta + \rho\,\mu\,V_o, \beta + \rho\,\frac{1}{2}\,V_o) + \delta\,(1-s)\,\alpha\,k - k - \frac{1}{2}\,\gamma\,\alpha^2. \tag{16}$$

Note that, in state S, if the manager does not divert he will always choose the strategy that maximizes his expected payoff. Because his choice is made after he observes both the signal indicating his private benefit and the signal indicating the survival probability resulting from a given policy, the manager's policy choice, Bad or Good, will be dictated by the sign of the following expression

$$w + \beta + \rho\,(1-\mu)\,V_o - (w + \rho\,\mu\,V_o) \tag{17}$$

When the above expression is positive, the manager will choose the Bad (B) policy. Otherwise he will choose the Good (G) policy. Thus, the manager will choose policy B if and only if

$$\frac{\beta}{\rho\,(2\mu-1)} > V_o. \tag{18}$$

3.3.1. Implementing policy G

Suppose that (18) is violated. Then the solution must implement policy G. However, if a solution implements policy G, it must be the case that

$$w = \phi\, k\,(1-\alpha) - \frac{1}{2}\,\beta - \mu\,\rho\,V_o, \tag{19}$$

and the firm's current period payoff must be

$$(1-\delta+\delta\,s)(1-\phi\,k\,(1-\alpha) + \frac{1}{2}\,\beta + \rho\,\mu\,V_o) + \delta\,(1-s)\,\alpha\,k - k - \frac{1}{2}\,\gamma\,\alpha^2 \tag{20}$$

Differentiating this expression with respect to α, it follows that the optimal monitoring policy α_o^+ must satisfy

$$(1-\delta+\delta\, s)\phi\, k + \delta\,(1-s)\, k - \gamma\, \alpha_o^+ = 0, \tag{21}$$

which implies that

$$\alpha_o^+ = \frac{k\,(\phi + \delta\,(1-\phi)\,(1-s))}{\gamma} \tag{22}$$

Using this expression for α_o^+, it follows that the manager's continuation value satisfies

$$\begin{aligned} V_o^+ &= (1-\delta)\left[\phi\, k\,(1-\alpha_o^+) - \frac{1}{2}\,\beta - \mu\,\rho\, V_o^+ + \beta\right] \\ &+ \delta\, s\left[\phi\, k\,(1-\alpha_o^+) - \frac{1}{2}\,\beta - \frac{1}{2}\,\rho\, V_o^+ + \frac{1}{2}\,\beta\right] + \delta\,(1-s)\,\phi\, k\,(1-\alpha_o^+) \\ &+ (1-\delta+\mu\,\delta\, s)\,\rho\, V_o^+ \\ &= \frac{\phi\, k(1-\alpha_o^+) + \frac{1}{2}\,(1-\delta)\,\beta}{1-\rho\,(1-\delta)\,(1-\mu)} \end{aligned} \tag{23}$$

Using this expression for V_o^+ we obtain the following expression for w_o^+

$$w_o^+ = \phi\, k\,(1-\alpha_o^+)\left(1 - \frac{\mu\,\rho}{1-\rho\,(1-\delta)\,(1-\mu)}\right) - \frac{1}{2}\,\beta\left(1 + \frac{1-\delta}{1-\rho\,(1-\delta)\,(1-\mu)}\right). \tag{24}$$

Similarly, we can solve for the firm's value function U_o^+, where

$$\begin{aligned} U_o^+ &= (1-\delta+\delta\, s)\left[1 - \phi\, k\,(1-\alpha_o^+)\left(1 - \frac{\mu\,\rho}{1-\rho\,(1-\delta)\,(1-\mu)}\right)\right] \\ &+ (1-\delta+\delta\, s)\,\frac{1}{2}\,\beta\left[1 + \frac{1-\delta}{1-\rho\,(1-\delta)\,(1-\mu)}\right] \\ &+ \delta(1-s)\alpha_o^+ k - k - \frac{1}{2}\gamma\, \alpha_o^{+^2} + \rho\,(1-\delta+\mu\,\delta\, s)\, U^+ \\ &= \frac{(1-\delta+\delta\, s)}{1-\rho\,(1-\delta+\mu\,\delta\, s)}\left[1 - \phi\, k\,(1-\alpha_o^+)\left(1 - \frac{\mu\,\rho}{1-\rho\,(1-\delta)\,(1-\mu)}\right)\right] \\ &+ \frac{(1-\delta+\delta\, s)}{1-\rho\,(1-\delta+\mu\,\delta\, s)}\,\frac{1}{2}\,\beta\left[1 + \frac{1-\delta}{1-\rho\,(1-\delta)\,(1-\mu)}\right] \\ &+ \frac{1}{1-\rho\,(1-\delta+\mu\,\delta\, s)}(\delta(1-s)\alpha_o^+ k - k - \frac{1}{2}\gamma\, \alpha_o^{+^2}), \end{aligned} \tag{25}$$

which is employed later to solve the stationary problem.

3.3.2. Implementing policy B

Now suppose that (18) is satisfied. Then the manager will choose policy B in state S. Note from (13) and (18) it follows that if a solution involves implementing policy B

$$w = \phi\, k\,(1-\alpha) - \beta - \frac{1}{2}\,\rho\, V_o. \tag{26}$$

Using this expression for the manager's wage, the firm's current period payoff equals

$$(1-\delta+\delta\, s)(1-\phi\, k\,(1-\alpha)+\beta+\frac{1}{2}\,\rho\, V_o)+\delta\,(1-s)\,\alpha\, k - k - \frac{1}{2}\,\gamma\,\alpha^2 \tag{27}$$

This implies that the optimal monitoring policy, α_o^+, must satisfy

$$(1-\delta+\delta\, s)\,\phi\, k + \delta\,(1-s)\, k - \gamma\,\alpha_o^+ = 0, \tag{28}$$

which implies that

$$\alpha_o^+ = \frac{k\,(\phi+\delta\,(1-s)\,(1-\phi))}{\gamma} \tag{29}$$

This implies that the value function for the manager, V_o^+, must satisfy

$$\begin{aligned} V_o^+ &= (1-\delta+\delta\, s)\left[\phi\, k(1-\alpha_o^+) - \beta - \frac{1}{2}\,\rho\, V_o^+ + \beta\right] + \delta\,(1-s)\phi\, k\,(1-\alpha_o^+) + (1-\delta+\frac{1}{2}\,\delta\, s)\rho V_o^+ \\ &= \frac{\phi\, k\,(1-\alpha_o^+)}{1-\frac{1}{2}\,\rho\,(1-\delta)} \end{aligned} \tag{30}$$

Using this expression for V_o^+ we obtain the following expression for w_o^+

$$w_o^+ = \phi\, k\,(1-\alpha_o^+)\left(1 - \frac{\frac{1}{2}}{1-\frac{1}{2}\,\rho\,(1-\delta)}\right) - \beta. \tag{31}$$

Similarly, we can solve for the firm's value function, U_o^+,

$$
\begin{aligned}
U_o^+ &= (1-\delta+\delta\, s)\left[1-\phi\, k\,(1-\alpha_o^+)\left(1-\frac{\frac{1}{2}}{1-\frac{1}{2}\,\rho\,(1-\delta)}\right)+\beta)\right] \\
&+ \delta\,(1-s)\,\alpha_o^+\, k - k - \frac{1}{2}\,\gamma\,\alpha_o^{+^2} + \rho\,(1-\delta+\frac{1}{2}\,\delta\, s)U^+ \\
&= \frac{(1-\delta+\delta\, s)}{1-\rho\,(1-\delta+\frac{1}{2}\,\delta\, s)}\left[1-\phi\, k\,(1-\alpha_o^+)\left(1-\frac{\frac{1}{2}}{1-\frac{1}{2}\,\rho\,(1-\delta)}\right)+\beta)\right] \\
&+ \frac{1}{1-\rho\,(1-\delta+\frac{1}{2}\,\delta\, s)}(\delta\,(1-s)\,\alpha_o^+\, k - k - \frac{1}{2}\,\gamma\,\alpha_o^{+^2}).
\end{aligned} \tag{32}
$$

3.3.3. Comparative statics of the stationary solution

In all three solutions characterized above the likelihood of distress (δ) and the manager's personal cost of diversion ($1-\phi$) have common implications for the optimal level of auditing. An increase in the likelihood of distress results in increased auditing and the sensitivity of auditing to the change in the likelihood of distress is increasing in the manager's cost of diversion. The value of the project relative to the required investment, $1/k$, which captures the profit opportunities from investment in the project, is also a key determinant of monitoring policy.

Lemma 1 *For any fixed governance policy, the level of auditing, α, is increasing in the likelihood of distress, δ, and decreasing in both the manager's cost of diversion, $1-\phi$, and profitability, $1/k$. Further the rate of increase in auditing with respect to the liklihood of distress is positively related to the manager's cost of diversion, $1-\phi$.*

Proof: These claims follows directly from the relevant derivatives of α_o^- and α_o^+.

For a fixed governance policy, auditing has two effects, first, it lowers the manager's incentive to divert; second, in states where diversion does occur, it limits shareholder losses. Compensation, in contrast, lowers the manager's incentive to divert but does not benefit the firm in states where diversion occurs. As δ increases, the liklihood of states producing diversion increases. Thus, the tradeoff between incentivizing through compensation and monitoring through auditing tilts more and more towards monitoring as the liklihood of distress increases. Profitability affects monitoring because low profitability firms use a large asset base to produce a given output. The larger asset base makes diversion and thus auditing more attractive.

As the manager's cost of diversion increases, the marginal reduction in managerial payoff from an increase in auditing falls. Thus, an increase in cost of diversion faced by the manager lowers the gain from auditing in non diversion states. However, this increase in the cost of diversion does not affect the firm's payoff in diversion states because this payoff is independent of the manager's cost of diversion. Consequently, when the manager's cost of diversion is high, auditing becomes more attractive as the likelihood of distress, which increases the likelihood of diversion, increases.

These tradeoffs also help explain variation in the levels of auditing across different policies. First, because the permissive governance policy results in a higher likelihood of diversion, auditing is more effective, and thus the board monitors more intensely under this policy. This higher likelihood of diversion under the permissive policy also underlies the higher sensitivity of auditing to increases in the likelihood of distress. Finally, because the lower the likelihood of diversion, the larger the fraction of the benefit from auditing arising from its deterrent effect. However, because only the deterrent effect of auditing is leveraged by ϕ, auditing is more sensitive to ϕ under the deterrent governance policy.

Lemma 2 *The level of auditing, α, is higher under permissive governance policy. Further, the rate of increase of auditing with respect to the likelihood of distress, δ, is also greater under permissive governance policy. Finally, the rate of increase in auditing with respect to the manager's cost of diversion, $1 - \phi$ is higher for deterrent governance policies.*

Proof: These claims follow directly from the relevant derivatives of α_o^- and α_o^+.

In addition to influencing the level of monitoring by shareholders, the likelihood of distress also influences the manager's compensation. As the likelihood of distress increases, so does the likelihood of the firm entering state D. Under the deterrent policy, this tends to decrease the manager's continuation value. However, this effect of the likelihood of distress on the manager's continuation value is absent under the permissive policy because the firm enters state D subsequent to any period in which it encounters distress. The increased likelihood of distress also impacts the manager's continuation value and current compensation indirectly through its effect on auditing intensity. Because it induces an increase in monitoring, an increase in the likelihood of distress tends to lower the manager's payoff from diversion. This both reduces his payoff in states in which diversion occurs and lowers his expected payoff in states in which diversion is deterred. This indirect effect of the likelihood of distress is present under both governance policies described above.

Because only the indirect effect of the likelihood of distress is operational under the permissive governance policy, both the manager's current period wage and his continuation value decline as δ increases. Under the deterrent governance policy, the direct effect is strong enough to ensure that the manager's continuation value is always decreasing in δ. However, as the data in Table 1 demonstrates, in some instance this decrease in the manager's continuation value may be sufficiently strong to require an increase in the manager's current wage to deter him from diverting.

Lemma 3 *The manager's continuation value is always decreasing in the likelihood of financial distress, δ. Under the permissive governance policy, the manager's current compensation is also decreasing in δ. Under the deterrent governance policy, the manager's current period compensation may be increasing in δ.*

Proof: The first claim follows directly from the relevant derivatives of V_o^- and V_o^+. The second claim follows directly from the relevant derivatives of w_o^-, and the last claim is established by the data in Table 1.

Profitability also affects managerial compensation and the manager's continuation value in two ways. First, decreasing profitability increases the size of the asset base subject to diversion. This increases the manager's payoff both in states in which he diverts as well as states in which he does not divert. At the same time, decreasing profitability increases the gains from monitoring and thus the level of monitoring. This effect lowers the manager's continuation value and current compensation. Thus, depending on relative magnitudes of these two effects, the manager's continuation value and compensation may increase or decrease in profitability.

Lemma 4 *Both the manager's current compensation and his continuation value are non-monotone, convex functions of firm profitability. The manager's current compensation and his continuation value are highest for firms whose profitability tends to be very high or very low.*

Proof: The proof follows by noting that, given the functional forms of α_o^- and α_o^+, the functions w_o^-, w_o^+, V^- and V^+ are of the form $A\,k\,(B - c\,k)$, where A, B, and C are positive constants.

This implies that their derivatives with respect to k are of the form $A(B - 2Ck)$, implying that the managerial compensation is increasing in k until $k = \frac{B}{2C}$ and decreasing in k after that. The proof is concluded by noting that profit is decreasing in k.

3.3.4. Choosing between stationary governance policies

Once the firm has experienced distress, the market assesses a fixed probability of one to the firm being type Vulnerable (VN). At this point, the board can choose to either implement the permissive governance policy or the deterrent governance policy. The board's choice between these two alternatives is dictated by trading off the higher likelihood of long-run survival from the deterrent policy again the possible lower cost of implementing the permissive policy.

The cost advantage of the permissive policy arises because, as demonstrated earlier, the deterrent policy involves less intensive auditing and higher compensation for the manager. This higher compensation provides the manager with a greater incentive to prolong the life of the firm. However, this incentive may still not be sufficient to ensure that the manager implements the Good policy when making strategic decisions in state S. Raising the manager's current compensation even further will not lead to better strategic decisions because current compensation has no effect on the manager's relative payoff from his two strategy choices. This relative payoff depends only on future compensation, which the firm cannot commit to in the current period. Ironically, the very fact that it is easy to deter managerial diversion in state S may make the firm unwilling to deter diversion. This follows because, when deterring diversion is inexpensive, the manager's continuation value is low and thus his incentives vis a vis strategy choices are poor. This makes the value of deterring diversion low and may thus lead the firm to choose the permissive policy.

The tradeoff between the costs and benefits of the deterrent policy leads to a rich set of outcomes. Equilibria exists that support both the permissive policy and the deterrent policy. Further, in some instances the manager may be paid enough to induce him to choose the Good policy and in other cases it may be optimal to induce him to choose the Bad policy. Examples of parameter values that support these alternatives are presented in Table 2 below.

Lemma 5 *Following the realization of state S optimal governance policies may involve de-*

terring diversion in future realizations of state S or permitting diversion in state S. When diversion is deterred, governance policies may induce either private benefit-boosting Bad policies or firm value-maximizing Good strategic policies.

The firm's choice of governance policies is closely tied to the both the probability of distress and the likelihood of the manager being able to add value through his strategic decisions. Because the firm doesn't know the current state when it fixes the manager's current compensation, it must pay the manager the incentive payment even in states in which the incentive payment would not otherwise be necessary. The greater the likelihood the incentive payment will influence the manager's behavior, the more likely it is that the firm will be willing to make such a payment. Thus, incentive payments associated with the deterrent policy are more likely when the prospect of distress is high and the prospect that the manager has the opportunity turn the firm around is high.

3.4. Asymptotic solution

This solution obtains if the market believes that the firm is of type INV with probability one. This solution is approached as an uninterrupted sequence of H states lengthens. Given the market's belief that the firm is type INV, it will assess a probability of zero to the firm being distressed, that is, it assesses a probability of zero to the firm entering either state S or state D. When distress is not possible, the only governance policy that is viable for the firm is to pay the manger just enough to avoid diversion in the only possible state—H. In this case the firm's current payoff is

$$1 - k - w - \frac{\alpha^2 \gamma}{2}. \tag{33}$$

In the asymptotic case, any policy adopted by the firm that ensures that the manager does not divert produces the same continuation value, which we term U_{inf}. Thus the compensation and monitoring policy will be the solution to the problem of maximizing

$$1 - k - w - \frac{\alpha^2 \gamma}{2}. \tag{34}$$

Subject to the constraint that

$$w + \beta + \rho\, V_{\infty} + \geq k\, \phi\, (1 - \alpha)\,, \tag{35}$$

where V_{∞} is the manager's asymptotic payoff. Using the fact that the reservation constraint binds, we see that the optimal policy for the firm is given by

$$\alpha_{\infty} = \frac{k\, \phi}{\gamma} \tag{36}$$

$$w_{\infty} = k\, (1 - \rho)\, \phi\, (1 - \alpha_{\infty}) - \beta. \tag{37}$$

Substituting these expressions into the recursive equations defining the continuation value to the firm and manager yields,

$$V_{\infty} = k\, \phi\, (1 - \alpha_{\infty}) \tag{38}$$

and

$$\begin{aligned} U_{\infty} &= (1 - (1 - \rho)\, \phi\, k\, (1 - \alpha_{\infty}) + \beta) - \frac{1}{2}\, \gamma\, \alpha_{\infty}^2 - k + \rho\, U_{\infty} \\ &= \frac{(1 + \beta) - \frac{1}{2}\, \gamma\, \alpha_{\infty}^2 - k\, (1 - \phi\, (1 - \rho)(1 - \alpha_{\infty}))}{1 - \rho} \end{aligned} \tag{39}$$

The solution to the asymptotic problem is similar to that of the permissive policy solution for the stationary problem. This follows because the binding constraints in both problems are identical.

Lemma 6 *The comparative statics for the effect of profitability, $1/k$, and the manager's cost of diversion, $1 - \phi$, on auditing intensity, α, are the same in the asymptotic case as they are in the stationary solution. Further, comparative statics for the effect of profitability, $1/k$, on the manager's compensation, w_{infty}, and his continuation value, V_{infty}, are the same as in the stationary solution.*

The only difference between the asymptotic solution and the permissive stationary solution is that the possibility of distress influences the governance structure in the permissive stationary solution. This possibility of distress leads to a higher level of monitoring and consequently lower compensation and a lower continuation value for the manager under the stationary permissive solution. Similarly, the higher likelihood of diversion by the manager leads to a higher level of monitoring in the stationary deterrent solution than in the asymptotic solution. However, the comparison between managerial compensation and continuation value between the asymptotic solution and the stationary deterrent solution is more subtle. On the one hand, the higher intensity of monitoring under the stationary deterrent solution tends to depress compensation and the manager's continuation value. On the other hand, the fact that the stationary solution deters diversion in a state in which expected continuation value is relatively low tends to inflate compensation.

Lemma 7 *Auditing intensity α is always lower in the asymptotic solution than it is in the stationary solution. Managerial compensation and the manager's continuation value in the asymptotic solution may be either higher or lower than in the stationary solution.*

Proof: The proof of the first claim follows by noting that α_o^- and α_o^+ are of the form $\frac{k\,(\phi+A)}{\gamma}$ where A is a positive constant, while $\alpha_\infty = \frac{k\,\phi}{\gamma}$. Because, $\alpha_o^- > \alpha_\infty$ and the similarities in the functional forms of both current compensation and the manager's continuation value under the stationary permissive solution and the asymptotic solution, it follows that managerial compensation and continuation value is lower under the stationary solution than under the asymptotic solution. The data presented in Tables 4, 5 and 6 establish that compensation and continuation value may be lower in the asymptotic solution than in the stationary deterrent solution.

3.5. Non-stationary solution

The stationary and the asymptotic solutions represent the boundary values for the continuation value functions for the firm and the manager. Once distress occurs, the continuation value functions transition to the stationary solution; otherwise, the continuation value functions approach the asymptotic solution. At any date, their values will depend on a single state variable, π, which represents the market's assessment of the probability that the firm is vulnerable. The value functions are fixed by the recursive equations of dynamic programming which link value given the current state of the system to possible values of the state variable at the next date.

Because this state variable representing beliefs changes over time, the solution evolves.

In order to simplify our analysis it is useful to use the probability of the realization of state H, which we term x, as our state variable instead of π. In any given period, $x = 1 - \pi\,\delta$. Bayesian updating stated in terms of x is given by the following transformation:

$$x' = 1 - (1-\delta)\left(\frac{1}{x} - 1\right) \tag{40}$$

where x' is the next period's assessment of the probability of state H. Note that if $x = 1$ then $x' = 1$. This holds because x can only equal one if $\pi = 0$, in which case Bayes rule implies that beliefs are fixed. Similarly, if $x = 1 - \delta$, then $x' = 1 - \delta$. Note that this follows because x can only equal $1 - \delta$ if $\pi = 1$. The state variable x will thus always take on values between $1 - \delta$ and one. Let $V(x)$ and $U(x)$ represent the continuation values for the manager and the shareholders, respectively, given that the market believes that the probability of the firm being in state H in the current period is x.

As we did for the stationary solution, we solve the non-stationary problem in parts. First, we characterize equilibria where the firm adopts a policy that permits diversion by the manager in state S. Once again we call this policy the permissive governance policy. Next we characterize equilibria when the firm chooses to deter diversion, i.e., we characterize the deterrent governance policy. Note that we can solve these problems "myopically," maximizing current payoffs and taking future payoffs as given. This approach characterizes globally optimal solutions because current governance policies and managerial decisions only affect future values through their effect on the continuation probability, and because all governance policies that result in the same managerial policy produce the same continuation probability.

3.5.1. Permissive solution

The firm's problem is to minimize the expected cost of its governance structure subject to the following constraints:

$$\phi\,k\,(1-\alpha) \geq w + \max(\frac{1}{2}\,\beta + \rho\,\mu\,V_o, \beta + \rho\,\frac{1}{2}\,V_o) \tag{41}$$

$$w + \rho V(x) + \beta \geq \phi k (1 - \alpha). \tag{42}$$

The first constraint ensures that the manager diverts in state S while the second ensures that the manager does not divert in state H. Note that the left hand side of (42) is always greater than the right hand side of (41) so long as

$$V(x) \geq \max(\frac{1}{2} V_o, \mu V_o - \frac{1}{2} \beta). \tag{43}$$

Note that if this condition not satisfied there is no way to implement the permissive policy as the manager will prefer to divert in state H so long as he prefers to divert in state S. Thus, assuming (43) is satisfied, in any solution where the firm is trying to minimize costs, (42) will be the binding constraint. Given the (42) binds,

$$w = \phi k (1 - \alpha) - \beta - \rho V(x). \tag{44}$$

Further, the current period payoff to the firm,

$$x (1 - \phi k (1 - \alpha) + \beta + \rho V(x)) + (1 - x) \alpha k - k - \frac{1}{2} \gamma \alpha^2. \tag{45}$$

It follows that the optimal monitoring policy, $\alpha^-(x)$, is given by

$$\alpha^-(x) = \frac{k (1 - x (1 - \phi))}{\gamma}. \tag{46}$$

and the optimal managerial compensation, $w^-(x)$, satisfies

$$w^-(x) = \phi k (1 - \alpha^-(x)) - \beta - \rho V(x). \tag{47}$$

3.5.2. Deterrent solution

First we consider the optimal governance policies when (43) is satisfied. Then we consider the optimal policies when this condition is reversed. When (43) is satisfied, to deter diversion in state S and to ensure that the manager does not divert in state H, it must be the case that

$$\phi\, k\,(1-\alpha) \leq w + \max(\frac{1}{2}\,\beta + \rho\,\mu\,V(x), \beta + \frac{1}{2}\,\rho\,V_o) \tag{48}$$

$$w + \rho\,V(x) + \beta \geq \, \phi\, k\,(1-\alpha) \tag{49}$$

Given that (43) is satisfied, it implies that (48) is the binding constraint. Now, suppose that

$$\frac{\beta}{\rho\,(2\mu-1)} \leq V_o. \tag{50}$$

Then

$$w = \phi\, k\,(1-\alpha) - \frac{1}{2}\,\beta - \rho\,\mu\,V_o. \tag{51}$$

Using this expression for the manager's wage, the firm's current period payoff

$$(1-(1-x)\,(1-s))(1-\phi\,k\,(1-\alpha) + \frac{1}{2}\,\beta + \mu\,\rho\,V_o) + (1-x)\,(1-s)\,\alpha\,k - k - \frac{1}{2}\,\gamma\,\alpha^2 \tag{52}$$

Differentiating this condition with respect to α and solving for the optimal monitoring policy yields the optimal auditing policy

$$\alpha^{+}(x) = \frac{k\,(\phi + (1-\phi)\,(1-x)\,(1-s))}{\gamma}, \tag{53}$$

and the optimal wage

$$w^{+}(x) = \phi\,k\,(1-\alpha^{+}(x)) - \frac{1}{2}\,\beta - \rho\,\mu\,V_o. \tag{54}$$

Now suppose that (48) continues to be satisfied but (50) is reversed. Then it must be the case that

$$w = \phi\,k\,(1-\alpha) - \beta - \frac{1}{2}\,\rho\,V_o, \tag{55}$$

and the firm's current period payoff is given by

$$(1-(1-x)\,(1-s))(1-\phi\,k\,(1-\alpha) + \beta + \frac{1}{2}\,\rho\,V_o) + (1-x)\,(1-s)\,\alpha\,k - k - \frac{1}{2}\gamma\,\alpha^2 \tag{56}$$

Differentiating this expression with respect to α and solving for the optimal auditing policy, we obtain

$$\alpha^{+}(x) = \frac{k(\phi + (1-\phi)\,(1-x)\,(1-s))}{\gamma}, \tag{57}$$

and the optimal compensation

$$w^{+}(x) = \phi\, k\,(1-\alpha^{+}(x)) - \beta - \frac{1}{2}\,\rho\, V_o, \tag{58}$$

This completes our characterization of the non-stationary solution when (43) is satisfied. We now characterize the solution to the non-stationary problem when (43) is violated. In this case, the binding constraint switches from (48) to (49). This implies that the manager's current period wage must satisfy

$$w = \phi\, k\,(1-\alpha) - \beta - \rho\, V(x). \tag{59}$$

Using this expression for the manager's wage, the firm's current period payoff

$$(1-(1-x)\,(1-s))(1-\phi\, k\,(1-\alpha) + \beta + \rho\, V(x)) + (1-x)\,(1-s)\,\alpha\, k - k - \frac{1}{2}\gamma\,\alpha^2 \tag{60}$$

Differentiating this expression with respect to α and solving for the optimal auditing policy and compensation, we obtain

$$\alpha^{+}(x) = \frac{k\,(\phi + (1-\phi)\,(1-x)\,(1-s))}{\gamma} \tag{61}$$

$$w^{+}(x) = \phi\, k\,(1-\alpha^{+}(x)) - \beta - \rho\, V(x). \tag{62}$$

Note that as x increases, for any fixed policy, auditing intensity falls and the manager's continuation value rises. For the deterrent policy, when the binding constraint is preventing diversion in state S, compensation always increases. Compensation may also increase under other policies. Whether compensation increases or decreases will depend on whether the positive effect of the reduced auditing induced by an increase in x dominates the negative effect of the increased continuation value. Note that, analogous to the stationary solution, the sensitivity of compensation to changes in x is proportional to the cost of diversion $1-\phi$.

Whether or not a string of good news events, in the form of realizations of H occurs is independent of the manager's efforts. Yet managerial compensation will generally increases with a string of positive informational events. Thus, managers are "paid for luck." Moreover, the larger the costs of diversion, the greater the increase and thus the greater the sensitivity of pay to luck. Thus, in our framework the sensitivity of pay to luck is a sign of high costs of diversion which should be associated with strong rather than weak legal and social regulation of managerial behavior.

Lemma 8 *As the market's assessment of the probability of the healthy state increases, auditing intensity falls. Managerial compensation always rises when the policy is set to deter diversion in state S and*

$$V(x) \geq \max(\frac{1}{2}\, V_o, \mu\, V_o - \frac{1}{2}\, \beta). \tag{63}$$

Compensation may rise or fall for other policies.

Proof: The proof of the first claim follows directly from inspection of the derivatives of $\alpha^-(x)$ and $\alpha^+(x)$ with respect to x. The proof of the second claim follows from inspection of the derivatives of $w^-(x)$ and $w^+(x)$ with respect to x. The example presented in Table 3 establishes the final claim.

3.5.3. Dynamics of governance policies in a non-stationary environment

The dynamics of governance in our model are the product of a one-dimensional state space model. As one might expect, it is almost impossible to characterize the solution in closed form for such problems. Thus, our results in this section will be numerical characterizations for particular parameter values. Although the specific numerical results depend on the parameters selected, all of the evolutions fall into three broad categories. The first category, which we call the permissive policy dynamic involves implementation of the permissive governance policy at all dates. The policy always obtains when the stationary solution calls for a permissive governance policy. Under this dynamic, the manager's continuation value increases monotonically over time until the firm is distressed.

The second pattern, which we term the nonoscillating transition dynamic, is quite different. In this case, when the likelihood of distress is large, the deterrent policy is used, as soon as the liklihood of distress falls below a critical point the governance policy flips to the permissive policy. Thus, the value of the manager's compensation experiences a downward jump. Interestingly, this downward jump occurs within an uninterrupted series of realizations of state H. Distress which occurs after only a few consecutive realizations of state H may be corrected. After many consecutive realizations of the state H, and thus a long run of superior performance and a boom in the stock price, distress will lead to diversion and firm collapse.

The third pattern, which we term oscillatory dynamics, involves oscillation between the deterrent and permissive policy before reaching the limiting permissive policy. The value of compensation oscillates with the governance policy, rising when the deterrent policy is implemented and falling when the permissive policy is implemented. In this case, the firm may survive distress after a long series of healthy states and but fail after a shorter series.

The following tables contain examples that illustrate the three categories of dynamics described above. Each example presents the governance policies and managerial strategy choices under the stationary solution as well as for a series of consecutive realizations of state H. The length of the series in each example is determined by the number of consecutive realizations of state H that is needed for the dynamic solution to approach the asymptotic solution.

Note from Table 3 that under the permissive policy dynamic the intensity of auditing falls monotonically just as the manager's continuation value increases with each consecutive realization of state H. Current compensation, however, is not monotone. Each realization of state H increases the manager's confidence in the firm's survival, and thus increases his continuation value. Although the decrease in auditing intensity increases the manager's potential gain from diversion and thus tends to increase current compensation, the increase in his continuation value may more than offset the effect of reduced auditing.

From Table 4 we can see that the governance policy switch in the nonoscillating policy dynamic is associated with a jump in auditing intensity. This policy switch is also associated with a downward shift in the manager's current compensation. During the policy regime in which the firm adopts the deterrent governance policy, current compensation tends to rise while continuation value tends to fall. This decline in the value of compensation over the course of the deterrent regime is an artifact of the drop in compensation that accompanies the switch to the permissive governance regime. The dynamics under the deterrent policy regime contrast with wage and value dynamics in the regime where the firm implements the permissive policy, during which both the current wage and value tend to rise.

From Tables 5 and 6 we can see that some of the dynamics in the oscillating policy regime are similar to those in the nonoscillating policy regime. Namely, within each string of time periods in which the deterrent policy regime is implemented, current compensation tends to rise while the continuation value tends to fall and auditing intensity tends to decline. Note, however that auditing intensity tends to oscillate with the governance policies. Oscillations occur because the manager's continuation value under the deterrent policy can be very high. This dramatically lowers diversion incentives in healthy states occuring immediately before the expected transition to these high valuations periods, allowing the firm to use very little current compensation to deter diversion by the manager in state H. High continuation values are not as useful in incentivizing the manager is state S because of the lower probability of firm survival. Consequently, the firm is unable to reduce current compensation to nearly the same extent as it can if it is trying to merely deter diversion in state H. When this difference in the reduction in current compensation is relatively large, the firm might prefer switching to the permissive policy. Such a switch, because it reduces the continuation value to the manager, narrows the cost advantage of the permissive policy and might induce the firm to switch back to the deterrent policy.

4. Pay for performance under optimal governance policies

It is fairly clear from the dynamics considered above that optimal, firm-value maximizing governance policies need not produce a perfect correlation between managerial performance and managerial compensation. In this section we investigate the implication of these results for estimating the pay to performance relation from cross sectional firm data.

To do this, we first use our model to generate data on managerial compensation and firm performance. We employed two sets of parameter values to generate two data sets for our regressions. Each data set was generated using a single set of parameter values. Simulations employing a set of parameter values determined the payoff to the firm and the manager for each possible value of the state variable x as well as the stationary solution. The realized payoffs for the firm and the manager were determined using an algorithm to simulate the stochastic evolution of states. Each simulation generated data for 100 firms. One dataset included data on all surviving firms during a four period window. In the second database we employed a 38 period window. Each database was constructed by pooling all observations within the window.

After generating the databases we replicated the pay-for performance tests of Jensen and Murphy (1990) on our simulated data, i.e., we ran the following OLS regression relating change in firm value to changes in the manager's current compensation on each of the databases

$$\Delta U_{it} = a + b\,\Delta w_{it} + \epsilon_{it}. \tag{64}$$

Our coefficient estimates are presented in Table 7 below. Note that all coefficients are statistically significant at the one percent level. The first set of estimates demonstrates the managerial compensation can decrease (increase) on average when firm value increases (decreases). The second set of estimates shows that a positive correlation between pay and firm performance might also be observed. Note however that in both cases, as documented in Jensen and Murphy (1990) that the relationship between pay and performance is relatively weak. In the first case a \$1000 increase in firm value is on averages accompanied by a \$2.90 decrease in managerial compensation, while in the second case a \$1000 increase in firm value is accompanied by a \$45.10 increase in management compensation. Together, these results demonstrate that the estimated pay for performance relationship is sample specific with large variation in both its strength and direction.

5. A strategic role for boards

Thus far the board's role has been confined to that of setting management compensation and auditing firm operations. We now introduce an additional role for the board—influencing the strategic decisions made by the firm in state S. If, at the beginning of a period, the board chooses to become involved in strategic decisions it produces its own signal indicating the appropriate choice between the two actions Right and Left.

We assume that the board's signal is observed by both the board and the manager. This assumption reflects the fact that board members would require managerial cooperation to evaluate the firm, and would be sharing information amongst the members of the board which would make it difficult to keep the information confidential. When it produces its signal, the board also has to decide on the level of control it will exert on any strategy decision. The board has two alternatives. It can restrict itself to an advisory role and delegate the actual strategy choice to the manager or it could make the strategy decision unilaterally.

The boards's noisy signal regarding the correctness has the following

$$
\begin{aligned}
P[\text{Right is signaled} \mid \text{Right is correct}] &= \omega > \frac{1}{2}; \\
P[\text{Right is signaled} \mid \text{Left is correct}] &= 1 - \omega < \frac{1}{2}. \qquad (65)
\end{aligned}
$$

Given the board's prior over the correctness of the choices, board members' posterior probabilities regarding the correctness of the choices are as follows:

$$
\begin{aligned}
P[\text{Right is correct} \mid \text{Right is signaled}] &= \omega > \frac{1}{2}; \\
P[\text{Right is correct} \mid \text{Left is signaled }] &= 1 - \omega < \frac{1}{2}. \qquad (66)
\end{aligned}
$$

We assume that $\omega < \mu$. This assumption implies that the manager always is better informed about the firm's prospects than the board.

Let the posterior probabilities of the manager be represented as follows

$$
\begin{aligned}
P[\text{Right is correct} \mid \text{R board \& R manager}] &= \tau \\
P[\text{Right is correct} \mid \text{R board \& L manager}] &= \tau_b \\
P[\text{Right is correct} \mid \text{R manager \& L board}] &= \tau_m \\
P[\text{Right is correct} \mid \text{L manager\& L board}] &= 1 - \tau \qquad (67)
\end{aligned}
$$

By the symmetry of between the conditional and unconditional probabilities of the L and R

policies and signals, we have that

$$\begin{aligned} P[\text{Left is correct} \mid \text{R board \& R manager}] &= 1-\tau; \\ P[\text{Left is correct} \mid \text{R board \& L manager}] &= \tau_m \\ P[\text{Left is correct} \mid \text{R manager\& L board}] &= \tau_b \\ P[\text{Left is correct} \mid \text{L manager \& L board}] &= \tau \end{aligned} \tag{68}$$

Next note that by Bayes rule

$$\begin{aligned} \tau &= \frac{\mu\,\omega}{(1-\mu)\,(1-\omega)+\mu\,\omega} \\ \tau_m &= \frac{\mu\,(1-\omega)}{\mu\,(1-\omega)+(1-\mu)\,\omega} \\ \tau_b &= \frac{(1-\mu)\,\omega}{\mu\,(1-\omega)+(1-\mu)\,\omega} \end{aligned} \tag{69}$$

Our assumption that $\mu > \omega$ ensures that

$$0 < \tau_b < \frac{1}{2} < \tau_m < \omega < \mu < \tau \tag{70}$$

Let Y be the probability of survival if the manager picks a given policy based on his information and perhaps the information generated by the board. If the board generates information and delegates the strategy choice to the manager,

$$Y \in \{\tau, \tau_b, \tau_m, 1-\tau\}. \tag{71}$$

The board would prefer the manager to select a given policy whenever $Y \in \{\tau, \tau_m\}$.

Now note, from our earlier discussion it follows that the manager will choose a strategic policy that does not yield private benefits if and only if

$$\frac{\beta}{\rho\,(2\,Y-1)} \leq V_o. \tag{72}$$

Thus, if

$$\frac{\beta}{\rho\,(2\,\mu - 1)} \leq V_o. \tag{73}$$

then the manager will always make the firm value maximizing decision even if the decision is conditioned only on his own information. Because this is exactly what the board wants the manager to do, its information is redundant. Thus, in this case the board has no incentive to generate information.

In contrast if

$$\frac{\beta}{\rho\,(2\,\tau - 1)} > V_o. \tag{74}$$

then even if the manager has information produced by the board, he will still not make the firm value maximizing decision. It follows that in this case information production by the board is only useful if it makes the strategy choice unilaterally. Thus, when this condition is satisfied, the board can always improve on the manager's strategy choice generating a survival probability of ω.

Now suppose that

$$\frac{\beta}{\rho\,(2\,\mu - 1)} > V_o \tag{75}$$

and

$$\frac{\beta}{\rho\,(2\,\tau - 1)} \leq V_o. \tag{76}$$

Then the manager's decision will be influenced by the board's signal and the manager will pick the value maximizing policy even if it does not yield private benefits so long as both the manager and board's signals indicate the same strategy choice. This governance structure will generate the following liklihood of survival in the state S:

$$\frac{1}{2}\,(1 - \omega\,\mu) + \frac{\mu^2\,\omega^2}{\mu\,\omega + (1 - \mu)\,(1 - \omega)}. \tag{77}$$

Thus, over the region, where

$$\frac{\beta}{\rho\,(2\,\mu - 1)} > V_o > \frac{\beta}{\rho\,(2\,\tau - 1)} \tag{78}$$

the board can either unilaterally determine the firms strategy, yielding a survival probability of ω or delegate to the manager yielding a survival probability given by (77). Our assumptions that $\frac{1}{2} < \omega < \mu$ ensures that the survival probability under delegation is higher than under unilateral control when ω is small relative to μ. When ω approaches μ, unilateral control yields a higher survival probability. This follows because when the strategy choice is delegated to the manager, if both information signals do not agree on the policy choice, the manager will pick the strategy that maximizes his private benefit, yielding only a $\frac{1}{2}$ probability of survival. Thus, we have established the following proposition.

Lemma 9 *If the board produces strategic information, the difference in firm value between assuming a purely advisory role and dictating policy is constant over time. When the manager's continuation value in the stationary solution is high,* $\frac{\beta}{\rho\,(2\,\mu-1)} < V_o$, *the board will play a passive in framing strategy. When the manager's stationary continuation value is low, i.e.,* $\frac{\beta}{\rho\,(2\,\tau-1)} > V_o$ *the board will control firm strategy. The board will also control firm strategy when*

$$\frac{\beta}{\rho\,(2\,\mu-1)} > V_o > \frac{\beta}{\rho\,(2\,\tau-1)} \tag{79}$$

and ω *approaches* μ. *Otherwise, the board will produce its own information and will confine itself to a purely advisory role.*

This result establishes that the benefit from information production by the board is constant and only occurs following the realization of state S. Thus, the gain from information production by the board, conditional on state S is fixed. If information production by the board is costly and occurs at the beginning of the period, the board's willingness to produce strategic information will vary with the likelihood it assesses to realizing state S. Thus, the board will produce strategic information only if the likelihood of the occurance of state S exceeds some threshold. Each realization of state H will reduce the likelihood of the realization of state S, bringing it closer to falling below this threshold. Consequently, after a sequence of positive shocks, the board is less likely to produce strategic information and influence firm strategy. This result leads to the prediction that boards operating in shareholder interests will relax governance during periods when stock prices are rising.

6. Concluding comments

This paper initiates the analysis of the long-run dynamics of corporate governance, management compensation, and firm performance. We find that the value of the management's long-term relation with the firm is a key driver of performance compensation and governance and current compensation plays a limited role. In fact, in the time-series of the CEO firm relation, current compensation may be negatively related to both firm value and the manager's valuation of his relation to the firm. For this reason, in a dynamic world, even when firm policies are fixed by shareholder-value-maximizing boards, it is very difficult to rationalize current compensation and governance using only current performance. In fact, even when managers have no control over governance or compensation policy, high management compensation and lax governance is likely to be associated with poor firm performance, and substantial variation in management pay is generated by luck. Further, optimal governance structures vary with the legal system and asset characteristics of the firm.

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Table 1. The likelihood of distress and managerial compensation under the stationary deterrent policy. In this table we present two sets of parameter values that support the stationary deterrent governance policy. These parameters include the probability of distress (δ), the probability that firm is in state S conditional on it being distressed (s), the probability that the firm will survive if the manager chooses the correct strategy in state S (μ), the size of the manager's non-pecuniary benefit (β), the discount factor (ρ), the capital required to undertake the firm's projects (k), the scaling factor for the marginal cost of auditing (γ), and net benefit to the manager from diverting $1 of the firms assets ($\phi$). The table also presents the optimal governance policy (*Governance*), strategy choice for the manager (*Strategy*), auditing intensity (α), managerial wage (w), the managerial continuation value (V_o), and the firm's continuation value (U_o).

δ	s	μ	β	ρ	k	γ	ϕ	Governance	Strategy	α	w	V_o	U_o
0.500	0.500	0.750	0.100	0.800	0.500	1.000	0.900	Deterrent	Good	0.463	0.014	0.297	0.423
0.600	0.500	0.750	0.100	0.800	0.500	1.000	0.900	Deterrent	Good	0.465	0.021	0.283	0.294

Table 2. Stationary solutions. In this table we present three sets of parameter values and the governance policies they support. These parameters include the probability of distress (δ), the probability that firm is in state S conditional on it being distressed (s), the probability that the firm will survive if the manager chooses the correct strategy in state S (μ), the size of the manager's non-pecuniary benefit (β), the discount factor (ρ), the capital required to undertake the firm's projects (k), the scaling factor for the marginal cost of auditing (γ), and net benefit to the manager from diverting \$1 of the firms assets (ϕ). The table also presents the optimal governance policy (*Governance*), strategy choice for the manager (*Strategy*), auditing intensity (α), managerial wage (w), the managerial continuation value (V_o), and the firm's continuation value (U_o).

δ	s	μ	β	ρ	k	γ	ϕ	Governance	Strategy	α	w	V_o	U_o
0.500	0.080	0.750	0.100	0.900	0.500	2.000	0.900	Permissive	n.a.	0.238	(0.066)	0.343	0.0651
0.500	0.500	0.550	0.100	0.900	0.500	2.000	0.900	Deterrent	Bad	0.231	0.045	0.446	0.438
0.500	0.500	0.750	0.100	0.900	0.500	2.000	0.900	Deterrent	Good	0.231	0.014	0.418	0.564

Table 3. The permissive policy dynamic. In this table we present an example of the evolution of the firm's governance policy when the stationary solution involves implementation of the permissive policy. To generate this example the probability of distress (δ) was set at 0.5, the probability that firm is in state S conditional on it being distressed (s) was set at 0.5×10^{-9}, the probability that the firm will survive if the manager chooses the correct strategy in state S (μ) was set at 0.6, the size of the manager's non-pecuniary benefit (β) was set at 0.1×10^{-4}, the discount factor (ρ) was set at 0.8, the capital required to undertake the firm's projects (k) was set at 0.26, the scaling factor for the marginal cost of auditing (γ) was set at 1, and the net benefit to the manager from diverting \$1 of the firms assets (ϕ) was set at 0.75. In each row, the table presents the posterior probability assessed to the firm being in operating state H in a given period, the optimal governance policy (*Governance*), the manager's strategy choice (*Strategy*), auditing intensity (α), managerial wage (w), the managerial continuation value (V_o), and the firm's continuation value (U_o) under the assumption that the firm realizes an uninterrupted sequence of realizations of the state H until the previous period. The final row in the table presents the corresponding values of these variables under the stationary solution.

Period	x	*Governance*	*Strategy*	$V(x)$	w	α	$U(x)$
0	0.501896	Permissive	n.a.	0.150662	0.0291132	0.227377	0.393528
1	0.503778	Permissive	n.a.	0.150685	0.0290993	0.227254	0.40508
2	0.5075	Permissive	n.a.	0.150733	0.0290727	0.227013	0.427927
3	0.514778	Permissive	n.a.	0.150825	0.0290237	0.226539	0.47261
4	0.528708	Permissive	n.a.	0.151001	0.0289408	0.225634	0.558136
5	0.554298	Permissive	n.a.	0.151326	0.0288224	0.223971	0.715272
6	0.597958	Permissive	n.a.	0.151879	0.028708	0.221133	0.983399
7	0.663821	Permissive	n.a.	0.152714	0.0287015	0.216852	1.38794
8	0.746785	Permissive	n.a.	0.153766	0.0289046	0.211459	1.89758
9	0.830464	Permissive	n.a.	0.154826	0.0292812	0.20602	2.4117
10	0.897927	Permissive	n.a.	0.155681	0.0296776	0.201635	2.82627
11	0.943162	Permissive	n.a.	0.156255	0.0299801	0.198695	3.10434
12	0.969868	Permissive	n.a.	0.156593	0.0301706	0.196959	3.2686
13	0.984466	Permissive	n.a.	0.156778	0.0302781	0.19601	3.3585
14	0.992111	Permissive	n.a.	0.156875	0.0303353	0.195513	3.40573
15	0.996024	Permissive	n.a.	0.156925	0.0303648	0.195258	3.4301
16	0.998004	Permissive	n.a.	0.15695	0.0303798	0.19513	3.44267
17	0.999	Permissive	n.a.	0.156962	0.0303823	0.195065	3.44928
	Stationary	Permissive	n.a.	0.150638	0.0291275	0.2275	0.381889

Table 4. The non oscillatory policy dynamic. In this table we present an example of the non oscillitory evolution of the firm's governance policy. To generate this example the probability of distress (δ) was set at 0.5, the probability that firm is in state S conditional on it being distressed (s) was set at 0.5, the probability that the firm will survive if the manager chooses the correct strategy in state S (μ) was set at 0.75, the size of the manager's non-pecuniary benefit (β) was set at 0.1, the discount factor (ρ) was set at 0.5, the capital required to undertake the firm's projects (k) was set at 0.5, the scaling factor for the marginal cost of auditing (γ) was set at 1, and the net benefit to the manager from diverting $1 of the firms assets ($\phi$) was set at 0.9. In each row, the table presents the posterior probability assessed to the firm being in operating state H in a given period, the optimal governance policy (*Governance*), the manager's strategy choice (*Strategy*), auditing intensity (α), managerial wage (w), the managerial continuation value (V_o), and the firm's continuation value (U_o) under the assumption that the firm realizes an uninterrupted sequence of realizations of the state H until the previous period. The final row in the table presents the corresponding values of these variables under the stationary solution.

Period	x	*Governance*	*Strategy*	$V(x)$	w	α	$U(x)$
0	0.501896	Deterrent	Bad	0.575595	0.0727892	0.462453	0.214399
1	0.503778	Deterrent	Bad	0.574766	0.0728104	0.462406	0.216009
2	0.5075	Deterrent	Bad	0.573122	0.0728522	0.462313	0.219196
3	0.514778	Deterrent	Bad	0.569891	0.0729341	0.462131	0.225432
4	0.528708	Deterrent	Bad	0.563641	0.0730908	0.461782	0.237387
5	0.554298	Deterrent	Bad	0.551909	0.0733787	0.461143	0.259417
6	0.597958	Deterrent	Bad	0.53099	0.0738699	0.460051	0.297252
7	0.663821	Deterrent	Bad	0.496415	0.0746108	0.458404	0.355154
8	0.746785	Deterrent	Bad	0.443767	0.0755442	0.45633	0.430576
9	0.830464	Deterrent	Bad	0.366309	0.0764856	0.454238	0.513292
10	0.897927	Permissive	n.a.	0.245203	0.0220928	0.455104	0.595972
11	0.943162	Permissive	n.a.	0.246221	0.0228101	0.452842	0.664231
12	0.969868	Permissive	n.a.	0.246822	0.0232468	0.451507	0.704539
13	0.984466	Permissive	n.a.	0.24715	0.0234892	0.450777	0.72658
14	0.99211	Permissive	n.a.	0.247322	0.0236172	0.450394	0.738141
15	0.996024	Permissive	n.a.	0.247411	0.023683	0.450199	0.744095
16	0.998004	Permissive	n.a.	0.247455	0.0237163	0.4501	0.747179
17	0.999	Permissive	n.a.	0.247478	0.0237275	0.45005	0.748874
	Stationary	Deterrent	Bad	0.276429	0.0727679	0.4625	0.212776

Table 5. The oscillatory policy dynamic. In this table we present an example of the oscillitory evolution of the firm's governance policy. To generate this example the probability of distress (δ) was set at 0.25, the probability that firm is in state S conditional on it being distressed (s) was set at 0.5, the probability that the firm will survive if the manager chooses the correct strategy in state S (μ) was set at 0.65, the size of the manager's non-pecuniary benefit (β) was set at 0.0, the discount factor (ρ) was set at 0.8, the capital required to undertake the firm's projects (k) was set at 0.15, the scaling factor for the marginal cost of auditing (γ) was set at 6, and the net benefit to the manager from diverting \$1 of the firms assets (ϕ) was set at 0.9. In each row, the table presents the posterior probability assessed to the firm being in operating state H in a given period, the optimal governance policy (*Governance*), the manager's strategy choice (*Strategy*), auditing intensity (α), managerial wage (w), the managerial continuation value (V_o), and the firm's continuation value (U_o) under the assumption that the firm realizes an uninterrupted sequence of realizations of the state H until the previous period. The final row in the table presents the corresponding values of these variables under the stationary solution.

Period	x	*Governance*	*Strategy*	$V(x)$	w	α	$U(x)$
0	0.895998	Deterrent	Good	0.248188	0.0451113	0.02263	3.2022
1	0.912944	Deterrent	Good	0.234439	0.0451142	0.0226088	3.33858
2	0.928482	Deterrent	Good	0.219074	0.0451168	0.0225894	3.46461
3	0.94223	Deterrent	Good	0.201764	0.0451191	0.0225722	3.57747
4	0.954016	Deterrent	Good	0.181996	0.0451211	0.0225575	3.67601
5	0.96385	Deterrent	Good	0.159046	0.0451228	0.0225452	3.76056
6	0.97187	Permissive	n.a.	0.131953	0.00738416	0.0225703	3.83256
7	0.978292	Deterrent	Good	0.155711	0.0451252	0.0225271	3.88336
8	0.983358	Permissive	n.a.	0.131957	0.0263903	0.0225416	3.9339
9	0.987307	Permissive	n.a.	0.131958	0.0263908	0.0225317	3.97612
10	0.990358	Permissive	n.a.	0.131959	0.0263912	0.0225241	4.00882
11	0.992698	Permissive	n.a.	0.13196	0.0263915	0.0225183	4.03401
12	0.994483	Permissive	n.a.	0.131961	0.0263918	0.0225138	4.05335
13	0.995839	Permissive	n.a.	0.131961	0.0263919	0.0225104	4.06821
14	0.996867	Permissive	n.a.	0.131961	0.0263921	0.0225078	4.07968
15	0.997643	Permissive	n.a.	0.131962	0.0263922	0.0225059	4.0886
16	0.998228	Permissive	n.a.	0.131962	0.0263923	0.0225044	4.09565
17	0.998668	Permissive	n.a.	0.131962	0.0263923	0.0225033	4.10137
18	0.999	Permissive	n.a.	0.131962	0.0263922	0.0225025	4.10619
	Stationary	Deterrent	Good	0.166988	0.0450867	0.0228125	2.04303

Table 6. The oscillatory policy dynamic. In this table we present another example of the oscillitory evolution of the firm's governance policy. To generate this example the probability of distress (δ) was set at 0.25, the probability that firm is in state S conditional on it being distressed (s) was set at 0.5, the probability that the firm will survive if the manager chooses the correct strategy in state S (μ) was set at 0.65, the size of the manager's non-pecuniary benefit (β) was set at 0.1×10^{-3}, the discount factor (ρ) was set at 0.9, the capital required to undertake the firm's projects (k) was set at 0.15, the scaling factor for the marginal cost of auditing (γ) was set at 6, and the net benefit to the manager from diverting $1 of the firms assets ($\phi$) was set at 0.9. In each row, the table presents the posterior probability assessed to the firm being in operating state H in a given period, the optimal governance policy (*Governance*), the manager's strategy choice (*Strategy*), auditing intensity (α), managerial wage (w), the managerial continuation value (V_o), and the firm's continuation value (U_o) under the assumption that the firm realizes an uninterrupted sequence of realizations of the state H until the previous period. The final row in the table presents the corresponding values of these variables under the stationary solution.

Period	x	*Governance*	*Strategy*	$V(x)$	w	α	$U(x)$
0	0.895998	Deterrent	Good	0.22718	0.0308209	0.02263	5.95901
1	0.912944	Deterrent	Good	0.198108	0.0308237	0.0226088	6.33362
2	0.928482	Deterrent	Good	0.166285	0.0308264	0.0225894	6.67871
3	0.94223	Permissive	n.a.	0.131943	-0.0489532	0.0226444	6.98598
4	0.954016	Deterrent	Good	0.200885	0.0308307	0.0225575	7.25108
5	0.96385	Deterrent	Good	0.179142	0.0308323	0.0225452	7.47534
6	0.97187	Deterrent	Good	0.156226	0.0308337	0.0225352	7.66128
7	0.978292	Permissive	n.a.	0.131955	-0.00635148	0.0225543	7.81364
8	0.983358	Deterrent	Good	0.153563	0.0308356	0.0225208	7.92831
9	0.987307	Permissive	n.a.	0.131958	0.0130949	0.0225317	8.02832
10	0.990358	Permissive	n.a.	0.131959	0.0130952	0.0225241	8.10895
11	0.992698	Permissive	n.a.	0.13196	0.0130955	0.0225183	8.17106
12	0.994483	Permissive	n.a.	0.131961	0.0130957	0.0225138	8.21874
13	0.995839	Permissive	n.a.	0.131961	0.0130958	0.0225104	8.2553
14	0.996867	Permissive	n.a.	0.131961	0.0130959	0.0225078	8.28336
15	0.997643	Permissive	n.a.	0.131962	0.013096	0.0225059	8.30498
16	0.998228	Permissive	n.a.	0.131962	0.0130961	0.0225044	8.32175
17	0.998668	Permissive	n.a.	0.131962	0.0130961	0.0225033	8.33489
18	0.999	Permissive	n.a.	0.131962	0.0130959	0.0225025	8.34535
	Stationary	Deterrent	Good	0.172776	0.0307962	0.0228125	2.76693

Table 7. Pay versus performance. In this table we present two regression estimates of the relationship between change in pay and changes in the manager's current compensation. Each estimate is associated with its own unique databse that was generated by simulating our model. The first (second) database, on which Regression 1 (Regression 2) was estimated, was generated from a simulation using a probability of distress (δ) of 0.75 (0.15), a probability that firm is in state S conditional on it being distressed (s) of 0.5 (0.5), a probability that the firm will survive if the manager chooses the correct strategy in state S (μ) of 0.7 (0.7), the manager's non-pecuniary benefit (β) of 0.005, a discount factor (ρ) of 0.9, required capital (k) of 0.2 (0.4), the scaling factor for the marginal cost of auditing (γ) of 2, and the net benefit to the manager from diverting \$1 of the firms assets (ϕ) of 0.9. Each simulation was used to generate data for 100 firms. The first database includes all data on surviving firms during a four period window. The second databse employs a 38 period window. For each parameter estimate we also present its t-statistic. All parameter estimates are significant at the one percent level.

	$Regression1$	$Regression2$
a	-0.00436	0.1113
	(7.023)	(5.374)
b	-0.044184	0.0451
	(15.499)	(5.723)
R-squared	0.1050	0.0246
Observations	2049	1299