Contract Horizon and Turnover

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Abstract

This paper develops a model in which a principal hires agents whose fit with the firm changes over time. To infer such changes, the principal relies on firm performance and the optimal design of compensation, severance pay, and contract length. The paper rationalizes the use of renewable fixed-term contracts as a mechanism that periodically switches away from relying on severance pay to relying on firm performance (at renewal dates). The model's results concerning the determinants of contract horizon, turnover, and agents' age help explain various stylized facts, such as the apparent lack of relative performance evaluation in executive turnover.

Keywords: voluntary and forced turnover, renewable contracts, contract length, CEO age, asymmetric information.

JEL Classification: G30, G34, D82

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1 Introduction

When principals hire agents, a first-order problem is that even high-quality agents might not be the best fit for the organization. This is probably nowhere as relevant as in the context of boards appointing CEOs. For example, Ronald Boire's was considered an "ideal chief executive for Barnes & Noble," when he was hired in 2015, but he stepped down a year later because he "was not a good fit for the organization."[1] What nurtures such concerns is that "fit" reflects the complex match between an agent's collection of skills and the organization's assets and growth options (Lazear, 2009), and the quality of this match could deteriorate in a dynamically changing environment. An agent's fit might change also because of inadequate firm-specific human capital investments, family or health issues, or conflicts with subordinates. No matter the cause, such changes might impact the organization's performance. This gives rise to the question how to evaluate and replace agents who have better information how their fit with the firm changes over time.

There are at least two reasons why this question is interesting both from a theoretical and empirical perspective. First, recent evidence suggests that "involuntary" turnover exhibits a lack of relative performance evaluation (Jenter and Kanaan, 2015). This runs counter to received theory that agents should not be punished for bad luck outside their control. However, what could help better understand this evidence is that seemingly "voluntary" departures could also result from a deteriorating fit, but the promise of a generous severance payment ($10.5m in Mr. Boire's case) could mitigate the desire to hide it to avoid termination. In particular, a key open question is when such severance promises are offered and when they are effective in a dynamically evolving relationship. Second, more than 45% of CEO contracts in practice take the form of renewable fixed-term contracts (Gillan et al., 2009), but there is barely any theory explaining their use. Mr. Boire had a three-year contract that could then renew for another two years. But what characteristics determine the length of such contracts? And why does turnover, which often happens before renewal, become performance sensitive mainly close to renewal (Cziraki and Groen-Xu, 2015)? By analyzing a setting in which the agents' fit changes over time, this paper relates the above stylized facts and derives a number of novel implications concerning optimal contract horizon, hiring, and replacement decisions.

The model considers a principal that repeatedly appoints agents. Once hired, an agent can increase the likelihood of being a good fit by investing in firm-specific human capital. However, only the agent observes the extent of such investments and how they impact her

[1] "Barnes & Noble Says CEO Boire 'Not a Good Fit' and Will Step Down," WSJ, 16 August 2016. See also "Is Leo Apotheker a Good Fit as H-P's New CEO?" WSJ, 30 September 2010.

fit. The paper's main results arise from asking whether the principal should rely on noisy performance measures or on incentives for truthful reporting to identify agents whose fit has deteriorated, given that the principal cannot commit not to (renegotiate to) replace a bad fit.[2] Though relevant in various settings, it is useful to interpret the model in what follows in terms of a board hiring managers, as the availability of evidence for this setting allows to flash out the model's implications.

The first key insight, illustrated in Figure 2, is that it is optimal to abstain from offering incentives for truthful reporting (in the form of severance pay) in regular intervals. In practice, this can be implemented with renewable fixed-term contracts, which are costless to terminate at renewal dates. The result is due to the following trade-off. On the one hand, if the manager is incentivized to report her fit truthfully, she does not have to be evaluated based on the firm's noisy cash flow performance. This is beneficial, as a good fit today increases the likelihood of a good fit tomorrow. On the other hand, a policy of always offering incentives for truthful reporting creates strong incentives to lie, as the board retains managers it believes to be a good fit even if they generate low cash flows. As a result, the longer potential tenure a manager can look forward to, the more reluctant would she be to reveal that her fit has deteriorated, as she is paid an "efficiency" wage for her firm-specific human capital investments in every period she is on the job. Hence, the manager's severance package must increase in her potential remaining tenure, and it compensates her as if she would stay until the contract's end.[3] The cost of such compensation stands in a stark mismatch with the benefits of offering incentives for truthful reporting in some future period t, which are only realized if the manager is still with the firm at this point.

In light of this cost-benefit mismatch, the advantage of *not* incentivizing truthful reporting is that it cuts through the manager's ability to stick with the firm by lying about her fit. Specifically, it allows dispensing with severance when replacing a manager and, even more important, it reduces the necessary severance pay in all preceding periods. The disadvantage is that the manager's fit needs to be evaluated based on the firm's noisy cash flow performance. This results in a trade-off between minimizing the risk of making the wrong replacement or retention decision and minimizing the cost of employing the manager. As illustrated in Figure 2, this trade-off is best resolved by tying turnover to firm underperformance (rather than to truthful reporting and severance pay) in regular

[2] With limited commitment, it is often suboptimal to screen out an agent's private information (Hart and Tirole, 1988; Laffont and Tirole, 1990; Malcomson, 2016). Note that none of the following arguments require that the manager agrees that someone else might be a better fit for the job.

[3] Indeed, half of S&P 1500 firms have ex ante severance agreements, with such agreements being associated with more truthful managers (Rau and Xu, 2013; Brown, 2015). Furthermore, CEOs with longer remaining tenure have higher severance agreements (Rau and Xu, 2013).

intervals. This significantly reduces the need for severance pay, while exposing the board to the relatively low risk of making inefficient replacement decisions in year six or 11, which the manager reaches only with eight and one percent probability, respectively.

An off-the-shelf implementation of the contract illustrated in Figure 2 readily exists. Renewable fixed-term contracts allow for turnover at any time, but their termination is costless at renewal dates. What makes them suitable is that the board can choose renewal to coincide with the periods in which it is optimal not to seek truthful reporting from the manager. Since the manager is not offered severance upon termination, she has no incentives for truthful reporting in such periods, and the board decides on renewal based on the firm's cash flow performance. Indeed, renewable fixed-term contracts are very common in practice (Gillan et al., 2009), and their turnover-performance sensitivity spikes close to renewal dates (Cziraki and Groen-Xu, 2015). Despite the prevalence of such contracts, however, this paper seems to be the first trying to understand their use.[4]

The paper's second contribution is to study when the board should offer severance pay or tie replacement to firm underperformance, which sheds light on the determinants of the length of renewable contracts. A key factor is the manager's outside option.[5] A manager with low-paying alternative employment opportunities would be more reluctant to voluntarily reveal information leading to her dismissal. This necessitates offering a higher severance package to such a manager. Hence, the board will offer, instead, shorter renewable contracts with which it needs to rely more often on the firm's performance to judge the manager's fit. The result would be a stronger relation between underperformance and involuntary turnover when managers' outside options are low (e.g., in downturns). Thus, Jenter and Kanaan's (2015) corresponding finding could be the result of an optimal evaluation and replacement policy rather than lack of relative performance evaluation.

A second determinant is the manager's fit persistence. The importance of incentivizing truthful reporting is lower if the manager's fit is very likely to change, such as in rapidly developing firms or firms undergoing change. Then, contracts will be shorter and turnover more closely tied to performance. Third, for large firms and firms with better growth options, there will be more at stake from having the right manager in charge. Thus, contract horizon will be longer and severance pay will be larger in such firms.

The manager's age also plays a key role. It is particularly important if the board cannot commit not to renegotiate the manager's contract at renewal periods and seek

[4] A renewable fixed-term contract is an implementation of a long-term contract with a costless termination option at renewal dates. Instead, the focus in the prior literature is on whether a given time horizon is best covered with a long-term or a series of short-term contracts (e.g., Hart and Tirole, 1988).

[5] Incumbents' outside option is typically not another CEO position, and departing CEOs take a big pay cut in their new employment following dismissal (Fee and Hadlock, 2004; Nielsen, 2017).

truthful reporting after all. Hiring older managers then automatically commits the board to a shorter contract horizon. Thus, the board will offer lower severance packages to older managers, which is in line with the findings of Rau and Xu (2013). Furthermore, the board will hire older managers if the managers' outside options are low (as in downturns), as then incentivizing truthful reporting is costlier.

Extending the baseline model, another prediction is that boards might prefer a manager with better outside options. This occurs when managers are paid above their outside option, as then a higher outside option has the positive effect of reducing the need for severance pay. This could be true even if it comes at the expense of a better fit, explaining why boards tolerate investments in general human capital, increasing managers' outside options, even if they come at the expense of firm-specific human capital. Furthermore, it could explain why boards might appear to prefer managers from a "selected club" with good outside options and why they would avoid damaging departing managers' reputation (i.e., outside options). Indeed, the evidence is that replacing managers with a reputation for underperformance is more expensive (Goldman and Huang, 2015).

The paper's main contribution is to analyze a dynamic setting in which turnover is tied both to truthful reporting and to performance measures, which has novel implications for contract horizon, turnover, and compensation practices. A novel element is that the principal's lack of information is not due to reduced monitoring, but to not offering severance pay that would compensate the agent for not trying to avoid termination. This helps to cut through the agent's ability to extract rent, which is magnified in a dynamic setting. These features differentiate the paper from prior work advocating that there might be benefits of laxer control (Crémer, 1995; Aghion and Tirole, 1997); from papers in which managers are better informed about their fit, but in which that fit does not change over time (Hermalin and Weisbach, 1998; Taylor, 2010); as well as from prior static models rationalizing the use of severance pay (Levitt and Snyder, 1997; Inderst and Mueller, 2010; Almazan and Suarez, 2003; Van Wesep, 2010; Van Wesep and Wang, 2014). In particular, the paper has novel implications concerning contract horizons and the dynamic use and structure of severance agreements.

The paper's novel implications for contract horizon distinguish it also from Jenter and Lewellen (2017) and Garrett and Pavan (2012). Both papers consider dynamically changing types, but take the polar opposite approaches. In Jenter and Lewellen (2017), the board does not screen out managers and must, thus, rely on the firm's most recent performance to infer their productivity. By contrast, Garrett and Pavan (2012) analyze full-commitment contracts that always incentivize managers to report their private information. Their main insight is that the board becomes progressively more tolerant towards lower managerial quality. The decision how to evaluate the manager in the present paper can be seen as optimally relying on both approaches, while relaxing the assumption of full commitment. This closely relates the paper to the literature on relational contracts in which, given limited commitment, full revelation might also be suboptimal with persistent types (Halac, 2012; Malcomson, 2016). However, this literature is a better description of contracting "at will," as contract length and bonuses are not contractually specified, while in the present paper contract horizon and contractual incentives are the main focus.

Related are also Anderson et al. (2016) and Eisfeldt and Kuhnen (2013), in which a publicly observable shock that decreases industry returns prompts the firm to look for a manager who is better suited to the new environment. This offers one explanation to Jenter and Kanaan's (2015) findings that turnover is more likely in industry-wide bad times. Instead, in the present paper overall turnover is not more likely, but only its forced type, as boards rely more often on firm performance to judge the manager's fit. This could help explain why Fee et al. (2015) find no evidence for a lack of relative performance evaluation, once considering also supposedly "voluntary" turnover. Related, Eisfeldt and Rampini (2008) show that CEO turnover is procyclical. However, managers in their model only live for one period, which does not allow analyzing contract horizon.

Turnover features in the literature also as a threat to discipline managers (Stiglitz and Weiss, 1983), as well as when managers are risk averse and become too expensive to motivate or when they take a better outside option (Sannikov, 2008; Wang, 2011, 2015). Instead, the reason for turnover in the present paper is to appoint a better manager, which raises the question of whether severance pay should be offered to stimulate truthful reporting. The paper also contributes to prior work on human capital investments (Jovanovic, 1979 a,b; and Felli and Harris, 1996) by analyzing a setting in which the worker's fit is her private information that also changes over time.[6]

The paper continues as follows. Section 2 describes the model. Section 3 derives the optimal contract and discusses its implementation. Section 4 concludes. All derivations and proofs are in the Appendix. Implications 1–7 contain the main empirical implications.

2 Model

Consider an infinitely lived firm in which the board maximizes shareholder wealth and is in charge of hiring and replacing the firm's manager (she). The firm operates in an economy,

[6]Tenure limits reduce agents' ability to extract rent also in Lazear (1979), Prescott and Townsend (2006), and Hertzberg et al. (2010). The main difference to the political economy literature (Aghion and Jackson, 2016) is that turnover can occur at any time, and monetary incentives play a key role.

in which every period t consists of three dates. At the first date of every period, $\tau_t = 0$, an incumbent manager can invest in firm-specific human capital. Such investment carries a non-monetary cost c, but it increases the likelihood that her fit with the firm in the current period, $\theta_t \in \{\theta_G, \theta_N\}$, is good, $\theta_G > \theta_N$. At the interim date $\tau_t = 1$, the manager learns and can report her fit, and the board can decide whether or not to keep her on the job. Replacing the incumbent implies that a replacement manager will steer the firm as preferred by the board for the remainder of the period. All cash flows from the period are realized at the final date $\tau_t = 2$. If the board has not already replaced the manager at the interim date, it can choose again whether or not to keep her for the next period. Cash flows are verifiable and can take values $x_t \in \{x, x + \Delta x\}$. The manager's fit $0 \leq \theta_t \leq 1$ corresponds to the likelihood of achieving the higher cash flow $x + \Delta x$, where $x, \Delta x \geq 0$. At all times, the manager is protected by limited liability. All parties are risk neutral and the common discount factor between two neighboring periods is $\delta \in (0, 1)$.

Neither the board nor potential managers have private information when a new manager is hired. Furthermore, the pool of managers from which the board can choose have zero wealth and are identical in all respects except their age, i.e., managers are not infinitely lived and leave the labor market once they reach their retirement age. However, the key assumption is that, upon being hired, the manager privately learns the realization of θ_t at the interim date $\tau_t = 1$ of every period. This realization depends on whether the manager has invested in firm-specific human capital, which is also non-verifiable to outsiders. Without such investment at the beginning of a period, the manager's fit is not good, θ_N. If, instead, the manager invests in firm-specific human capital, there is a probability e_t that her fit is θ_G, and only probability $1 - e_t$ that it is θ_N.

The probability $e_t(\theta_{t-1})$ that a manager's investment in firm-specific human capital results in a good fit θ_G in period t depends on her fit θ_{t-1} from the previous period. Specifically, there is a positive correlation with $e_t(\theta_G) > e_1 > e_t(\theta_N)$, where e_1 is the likelihood of θ_G in the manager's first (complete) period after being hired. In this Markov environment, the t-subscripts in $e_t(\theta_G)$ and $e_t(\theta_N)$ are not necessary, but they are helpful to keep track of the intertemporal forces affecting contracting. Initially, $\{e_1, e_t(\theta_G), e_t(\theta_N)\}$ and the manager's outside option, which pays $\overline{U}$ per period, are fixed, but Section 3.3 relaxes these assumptions.

Contracting At the beginning of the employment relation, the board offers the manager a contract $\mathbf{w} = (w_t, \Delta w_t, w_{s,t},\ \psi_t^1, \psi_t^2)_{t=1}^T$. The contract components characterizing any given period t can depend on the current and past cash flow realizations $(x_i)_{i=1}^t$ as well as reports $(\widehat{\theta}_i)_{i=0}^t$ by the manager about her fit (if there are such reports). Unless this leads to confusion, the history dependence is not made explicit, but captured only by the subscript t. In this contract, w_t stands for the manager's wage in the low cash flow state and Δw_t stands for how much she receives in addition (i.e., her "bonus") in the case of a high cash flow realization; $w_{s,t}$ is the manager's severance pay if she is replaced at the interim date $\tau_t = 1$ *prior* to the cash flows realization $x_t \in \{x, x + \Delta x\}$ in that period, with ψ_t^1 being the probability of such interim replacement; ψ_t^2 stands for the probability of replacing the manager at the end of the period, i.e., in $\tau_t = 2$ *after* the cash flow realization x_t.[7] While the contract does not explicitly consider a payment to the manager for leaving the firm at the beginning of a period before she obtains private information or a payment at the interim date $\tau_t = 1$ for staying with the firm, we show that such payments will not arise.

The manager is penniless and protected by limited liability, which requires that $w_t, w_{s,t} \geq 0$.[8] The manager should further have no incentives to destroy cash flows, $\Delta w_t \geq 0$ (Innes, 1990). Contracts that satisfy these requirements are labeled as "feasible." Furthermore, it is assumed that the manager cannot be prevented from leaving the firm at any time during the employment relationship. Thus, the contract should at least compensate her for her outside employment opportunity, which would pay her $\overline{U}$ at the end of every period until retirement. We assume that if the manager leaves the firm at the interim date $\tau_t = 1$ of a period, she still obtains $\overline{U}$ from her outside employment opportunity for that period.[9] Figure 1 summarizes the timing of events in each period.

Replacement and Performance Evaluation If the board replaces the incumbent at the interim date, the new manager is paid $\overline{U}$ to complete the period with the board's preferred strategy, which has a success likelihood of $\overline{\theta}$, requires no firm-specific human capital investment and does not give rise to private information. Then, the board makes the manager an offer covering the whole potential relationship in the beginning of the following period. If a manager is replaced, she is not rehired. Furthermore, we define:

Definition 1. *An equilibrium with optimal termination is a perfect Bayesian equilibrium in pure strategies in which replacement and retention decisions are efficient from the board's perspective given its information at this point in time. In case of full revelation, these decisions should coincide with those of the subgame perfect equilibrium of the full information game at $\tau_t = 1$.*

[7] The payment to the manager at the end of the period could also be reinterpreted as the manager's severance pay if she is fired in the end of that period.

[8] We assume that the manager does not save. Though all parties are risk neutral, use the same discount factor, and cash flows are verifiable, the assumption is not innocuous. This is because a manager whose contract is terminated could otherwise offer the board a payment to be kept on the job.

[9] Assuming that the manager receives only a fraction of $\overline{U}$ leads to the same qualitative results.

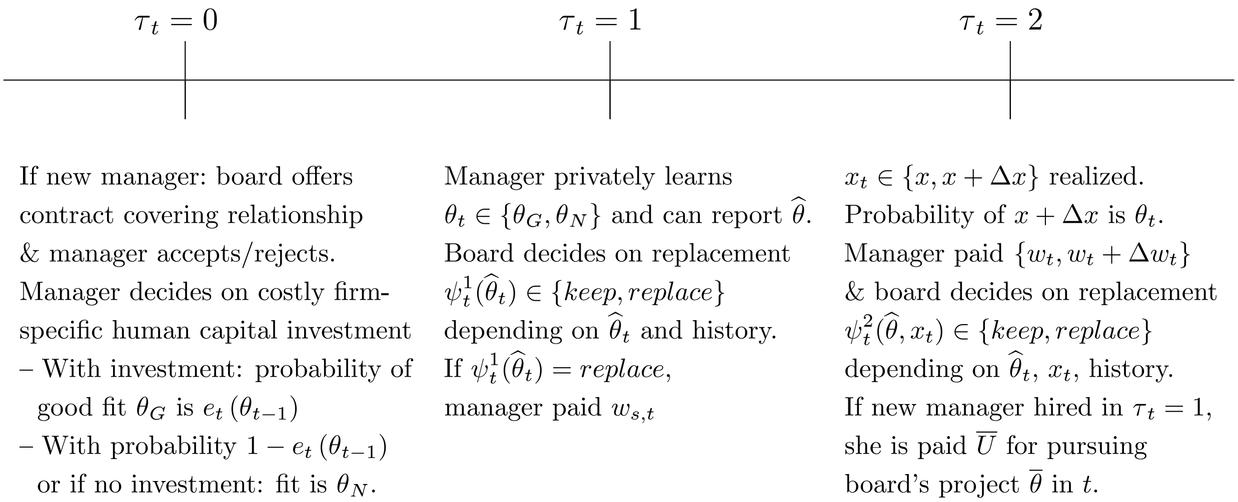

Figure 1: Timing of events in period t.

Following Malcomson (2016), Definition 1 restricts attention to pure strategies and rules out commitment not to renegotiate retention and replacement strategies that are suboptimal given the board's ex post information. In particular, it rules out a commitment to replace a manager whose fit is θ_G or to retain a manager whose fit is θ_N, as it is assumed that $\theta_N < \overline{\theta} < \theta_G$. As is standard, renegotiation-proofness is stipulated as part of the equilibrium concept rather than explicitly derived from a renegotiation game.

Because of its limited commitment, the board might find it optimal not to screen out the manager's private information at the interim date $\tau_t = 1$ and to remain uninformed about the manager's fit.[10] We follow Burkart et al. (1997) and assume that, when uninformed, the board abstains from "effective" control and retains the manager. A sufficient condition for this is

$$e_t(\theta_N)\,\theta_G + (1 - e_t(\theta_N))\,\theta_N > \overline{\theta} \Longleftrightarrow e_t(\theta_N) > \frac{\overline{\theta} - \theta_N}{\theta_G - \theta_N}. \tag{1}$$

In this case, if the firm produces high cash flows at the end of the period, the board expects that the incumbent's likelihood of being a good fit in the following period will be higher than that of a replacement manager; the board assumes the opposite if the firm has produced low cash flows

$$\mathbb{E}\left[e_{t+1}(\theta_t)\,|x\right] < e_1 < \mathbb{E}\left[e_{t+1}(\theta_t)\,|x + \Delta x\right], \tag{2}$$

where the expectation is about the realization of θ_t, conditional on the cash flow realization in t and the prior history. A sufficient condition for (2) to hold in terms of primitives is

[10] Remaining uninformed is often optimal in dynamic settings with limited commitment (Hart and Tirole, 1988; Bester and Strausz, 2001; Malcomson, 2016).

given in the Appendix (cf. expression (B.19)).

Together with Definition 1, condition (2) implies that the board will not show patience for managers that are (very likely) a bad fit. This helps to abstract from issues related to learning the manager's fit over an extended period of time, which have been studied extensively by the previous literature.[11] An immediate implication is that the replacement strategies are deterministic $\psi_t^\tau \in \{0,1\}$ and can be labeled for transparency as $\{keep, replace\}$. Further following Malcomson (2016), it should be noted that, Definition 1 does not impose full renegotiation-proofness when the manager's type has not been revealed, as it might be optimal to renegotiate to achieve such revelation. Section 3.2.5 discusses the implications of imposing this condition.

Alternative Interpretations of Fit The model can be extended to assume that the manager overestimates her fit. In a similar vein, one could interpret θ as the manager's vision—her way of doing things and steering the firm at a level that is difficult for the board to control or verify.[12] Such extensions lead to the same qualitative results.

Finally, though there is no truly voluntary turnover in this model, premature replacements (at the interim date $\tau_t = 1$) are labeled in what follows as "voluntary." The reason is that a smooth transition, eased by a severance package, might appear voluntary to outsiders, even if the board and the manager disagree behind the scenes whether a replacement could do a better job.

3 A Multi-Period Employment Relation

Let $\mathbf{w} = \left(w_t, \Delta w_t, w_{s,t}, \psi_t^1, \psi_t^2\right)_{t=1}^T$ be the contract that the board offers a manager in the first period of her employment relationship. Furthermore, recalling that compensation can depend on the history of reports and cash flow realizations, let $\omega_t \in \{w_t, w_t+\Delta w_t, w_{s,t}+\overline{U}\}$

[11] With continuous types and small changes to the manager's type, the board is more likely to be more patient (Garrett and Pavan, 2012). See also Taylor (2010) and He et al. (2017) for models with learning.

[12] One could assume that the board believes that $\overline{\theta} > \theta_N$, while the manager believes that the board's preferred way has a success probability of only $\overline{\theta}^m < \theta_N$. Such disagreement has been motivated with heterogeneous priors and overconfidence (Goel and Thakor, 2008; Gervais et al., 2011; Huang et al., 2016). Heterogeneous beliefs might not converge, as the board's alternative would pay off only if it is undertaken and then only at the end of the period. This alternative interpretation could be pertinent when the firm is doing things out of the ordinary and when the manager believes to understand the business better than an outside board. Indeed, 75% of CEOs are firm insiders (Gillan et al., 2009).

denote the firm's wage bill in period t.[13] The board's expected payoff in the first period is

$$V_1(\mathbf{w}) = \mathbb{E}\left[\sum_{i=1}^{T} \delta^{i-1}\left(q_i\left(x_i - \omega_i\right) + \widetilde{q}_i \delta V^*\right)\right], \tag{3}$$

where $\mathbb{E}$ is the expectation over the future θ_t and x_t realizations; and q_i and $\widetilde{q}_i$ are the (endogenous) probabilities that the incumbent manager is still with the firm in period i and, respectively, leaves the firm by the end of that period. V^* denotes the board's equilibrium expected payoff from hiring a new manager starting from the first complete period of that manager. Note that since managers are ex ante identical, their information evolves independently, and time is infinite, the board's contracting problem when making an offer to a replacement manager is identical to that faced with her predecessor. Thus, in equilibrium the board's expected payoff in (3) must be equal to V^*. Finally, T is the manager's retirement age and, thus, represents her upper tenure limit within the employment relation. For convenience, t is reset to one for every new manager, so that t could be interpreted as her tenure while at the firm. The board's promise keeping constraint implies that the manager's expected payoff at any given t during her tenure is

$$U_t\left(\theta_{t-1}, \mathbf{w}\right) = \mathbb{E}\left[\sum_{i=t}^{T} \delta^{i-t}\left(\overline{U} + q_i\left(\omega_i - c - \overline{U}\right)\right) | \theta_{t-1}\right]. \tag{4}$$

Expression (4) states that the manager can obtain $\overline{U}$ in every period until she leaves the labor market in T, but she might receive something different than $\overline{U}$ while she is employed by the firm. The board's belief that $\overline{\theta} > \theta_N$ implies that it will always provide incentives for firm-specific human capital investments, since the incumbent manager adds value only if she is a good fit. What will be crucial for the analysis is that the manager's fit persistence implies that her payoff in t, $U_t\left(\theta_{t-1}, \mathbf{w}\right)$, depends on her fit realization in $t-1$. There is no such prior realization when she is hired, so for period one we write $U_1(\mathbf{w})$.

Using (4) to plug in for the manager's compensation in (3), the board's objective when hiring a manager is to choose $\mathbf{w}$ to maximize

$$\max_{\mathbf{w}} \mathbb{E}\left[\sum_{i=1}^{T} \delta^{i-1}\left(q_i\left(x_i - c - \overline{U}\right) + \widetilde{q}_i \delta V^*\right)\right] - U_1(\mathbf{w}) + \sum_{i=1}^{T} \delta^{i-1}\overline{U}, \tag{5}$$

subject to the constraints that the contract $\mathbf{w}$ is feasible, incentive compatible, and indi-

[13] Recall that if the board replaces a manager at $\tau_t = 1$, it pays $w_{s,t}$ to the departing and $\overline{U}$ to the replacement manager to complete the period.

vidually rational for the manager in every period (stated below). Hence, the board acts as a residual claimant and trades off maximizing the surplus generated from employing a manager with minimizing the manager's rent $U_1(\mathbf{w}) - \sum_{i=1}^{T} \delta^{i-1}\overline{U}$.

Definition 1, together with (1) and (2) will imply that the board will follow one of two strategies in any given period—(i) either pursue truthful reporting and replace a manager if and only if she is a bad fit or (ii) abstain from offering incentives for truthful reporting and replace a manager if and only if she produces low cash flows. In what follows we specify the constraints characterizing each of these strategies. What is key is that in any given period t, the value of the manager's promised continuation payoffs $U_{t+1}(\theta_t, \mathbf{w})$ will take on two values, depending on her fit realization (θ_G or θ_N) in t, so both continuation payoffs will serve as state variables for characterizing the optimal contract.

Incentivizing Truthful Reporting Suppose, first, that the board offers incentives for truthful reporting in some period t. In this case, the only optimal replacement strategy consistent with the board's ex post information is to replace a manager if and only if her fit is θ_N. That is, $\psi_t^1(\theta_N) = \textit{replace}$, $\psi_t^1(\theta_G) = \textit{keep}$, and $\psi_t^2 = \textit{keep}$ regardless of x_t, unless the period coincides with the manager's retirement age. By replacing a manager whose fit is θ_N, the board can increase the likelihood of high cash flows both in the current and the subsequent period (as $\overline{\theta} > \theta_N$ and $e_1 > e_{t+1}(\theta_N)$). By contrast, it would be ex post suboptimal to replace an incumbent who is a good fit, as $\theta_G > \overline{\theta}$ and $e_{t+1}(\theta_G) > e_1$.

The incentive constraints that the manager reveals her fit truthfully and stays if her fit is θ_G or leaves with a severance package if her fit is θ_N are

$$w_t + \theta_G \Delta w_t + \delta U_{t+1}(\theta_G, \mathbf{w}) \geq w_{s,t} + \sum_{j=t}^{T} \delta^{j-t}\overline{U} \tag{6}$$

$$w_{s,t} + \sum_{j=t}^{T} \delta^{j-t}\overline{U} \geq w_t + \theta_N \Delta w_t + \delta U_{t+1}(\theta_N, \mathbf{w}). \tag{7}$$

In a Markov environment, if the manager is truthful on the equilibrium path in periods t and $t+1$, she would be truthful also off the equilibrium path in $t+1$ (i.e., after misreporting in t), as her true fit in t, θ_t, does not matter for her payoff in $t+1$ *after* her new fit θ_{t+1} is realized. However, for the manager's out-of-equilibrium continuation payoff $U_{t+1}(\theta_N, \mathbf{w})$ in expressions (7), we still need to keep in mind that investing in firm-specific human capital might not be optimal after misreporting θ_N.

To induce a manager to invest in firm-specific human capital in period t, the contract must further satisfy

$$U_t(\theta_{t-1}, \mathbf{w}) = \left(\begin{array}{c} e_t(\theta_{t-1})(w_t + \theta_G \Delta w_t + \delta U_{t+1}(\theta_G, \mathbf{w})) \\ +(1 - e_t(\theta_{t-1}))\left(w_{s,t} + \sum_{j=t}^{T} \delta^{j-t}\overline{U}\right) - c \end{array} \right) \geq w_{s,t} + \sum_{j=t}^{T} \delta^{j-t}\overline{U}, \quad (8)$$

where the right-hand-side of (8) captures that a manager who does not invest in firm-specific human capital does not have a good fit with certainty and is, thus, replaced at date $\tau_t = 1$ of the period. Note that if (8) is satisfied, the first incentive constraint (6) is lax.

Conditions (6)–(8) illustrate the effect of costly firm-specific human capital investments on the manager's compensation contract. Absent such investments, the board can pay the manager a fixed wage equal to her outside option, $w_t = \overline{U}$, and set her bonus and severance pay to zero, $w_{s,t} = \Delta w_t = 0$, in all periods. This would satisfy (6) and (7) with equality. Thus, it would not only ensure participation, but it would also eliminate the manager's incentives to hide that her fit has deteriorated, making her private information inconsequential. However, because firm-specific human capital investments are costly, the manager might be able to extract a strictly positive information rent

$$\nu_t(\theta_{t-1}, \mathbf{w}) := U_t(\theta_{t-1}, \mathbf{w}) - \sum_{j=t}^{T} \delta^{j-t}\overline{U}, \quad (9)$$

implying that she is paid an "efficiency wage" above her outside option. This makes the manager reluctant to report θ_N, which would lead to her dismissal, unless she is offered severance pay. The latter effect will play a key role for the design of the optimal contract.

Evaluating the Manager Based on Firm Performance Suppose, next, that the board does not offer incentives for truthful reporting at the interim date of some period t. Since in this case, the board does not believe she can do better by replacing the manager at $\tau_t = 1$, we have $\psi_t^1 = keep$. Upon the subsequent cash flow realization, the only *ex post* optimal replacement strategies in that period are $\psi_t^2(x) = replace$ and $\psi_t^2(x + \Delta x) = keep$.[14]

In a period in which the board follows such a replacement strategy, it still needs to make sure that investing in firm-specific human capital is better for the manager than not

[14] The Appendix shows that these strategies are also *ex ante* optimal, as they spur effort incentives.

investing and forgoing the chance of being a good fit or leaving the firm

$$\begin{aligned} U_t(\theta_{t-1}, \mathbf{w}) &= w_t + (\theta_N + e_t(\theta_{t-1})\Delta\theta)\Delta w_t + \delta\mathbb{E}_{\theta_{t-1}}\left[U^e_{t+1}(\theta_t, \mathbf{w})\right] - c \\ &\geq \max\left\{w_t + \theta_N \Delta w_t + \delta U^e_{t+1}(\theta_N, \mathbf{w}), \sum_{j=t}^{T} \delta^{j-t}\overline{U}\right\}, \end{aligned} \tag{10}$$

where $\Delta\theta \equiv \theta_G - \theta_B$ and the manager's continuation payoffs, depending on whether she already knows her fit θ_t in period t, are defined as

$$\begin{aligned} \mathbb{E}_{\theta_{t-1}}\left[U^e_{t+1}(\theta_t, \mathbf{w})\right] &\equiv e_t(\theta_{t-1}) U^e_{t+1}(\theta_G, \mathbf{w}) + (1 - e_t(\theta_{t-1})) U^e_{t+1}(\theta_N, \mathbf{w}) \\ U^e_{t+1}(\theta_t, \mathbf{w}) &\equiv \theta_t U_{t+1}(\theta_t, \mathbf{w}) + (1 - \theta_t) \sum_{j=t+1}^{T} \delta^{j-t-1}\overline{U}. \end{aligned}$$

Since in this case, the manager has no incentives to leave after learning that her fit in $\tau_t = 1$ is θ_N (i.e., (7) is violated), her interim participation constraint is[15]

$$w_t + \theta_N \Delta w_t + \delta U^e_{t+1}(\theta_N, \mathbf{w}) \geq \sum_{j=t}^{T} \delta^{j-t}\overline{U} + w_{s,t}. \tag{11}$$

Finally, note for completeness that if the board has not offered incentives for truthful reporting in period t, it will not offer incentives that the manager reports θ_t at the beginning of the next period $t+1$. This would require offering the manager the same information rent as when learning the manager's fit in period t, without allowing for the benefit of replacing the manager earlier (see Lemma B.1 in the Appendix).

3.1 Dynamics of the Manager's Contract

We can use now conditions (6)–(11) to derive the dynamics of the manager's contract for any given reporting strategy. The key state variables in any given period are the manager's continuation payoffs depending on her fit realizations, time, and the history of periods without truthful reporting.

Proposition 1 *The board pursues one of two replacement strategies in any given period t. (i) The first strategy is not to seek truthful reporting and replace the manager if and only if observing the low cash flow x at the end of the period ($\psi^1_t = keep$, $\psi^2_t(x) = replace$,*

[15] The reverse inequality together with (10) would imply that (6) and (7) are satisfied, and we would be in the truthful reporting case. Note that (11) implies that the manager stays also if her fit is θ_G and that the larger term in the max-term of (10) is the first one.

$\psi_t^2(x+\Delta x) = keep$). Implementing this strategy in period $t < T$, goes hand-in-hand with deferring bonus payments and offering

$$\Delta w_t = 0 \tag{12}$$
$$w_t = \max\left\{0, \sum_{j=t}^{T} \delta^{j-t}\overline{U}_j - \theta_N \Delta w_t - \delta U_{t+1}^e(\theta_N, \mathbf{w})\right\} \tag{13}$$
$$w_{s,t} = 0. \tag{14}$$

(ii) The second strategy is to provide incentives for truthful reporting, in which case the manager is replaced if and only if her fit is θ_N: $\psi_t^1(\theta_G) = keep$, $\psi_t^1(\theta_N) = replace$, $\psi_t^2 = keep$, regardless of x_t. Implementing this alternative requires

$$\Delta w_t = \begin{cases} \frac{c}{e_t(\theta_N)\Delta\theta} + \delta\frac{U_{t+1}(\theta_N,\mathbf{w}) - U_{t+1}(\theta_G,\mathbf{w})}{\Delta\theta} > 0 & \text{if truthful reporting in } t-1 \\ \max\left\{\begin{array}{c} \frac{c}{e_t(\theta_N)\Delta\theta} + \delta\frac{U_{t+1}(\theta_N,\mathbf{w}) - U_{t+1}(\theta_G,\mathbf{w})}{\Delta\theta}, \\ \Delta w_{t-n}^{-1}(0) \end{array}\right\} & \text{otherwise} \end{cases} \tag{15}$$
$$w_t = 0 \tag{16}$$
$$w_{s,t} = \max\left\{0, \theta_N \Delta w_t + \delta U_{t+1}(\theta_N, \mathbf{w}) - \sum_{j=t}^{T} \delta^{j-t}\overline{U}\right\}, \tag{17}$$

where $\Delta w_{t-n}^{-1}(0)$ is the minimum bonus in t after n periods without incentives for truthful reporting (and bonus deferrals), required to satisfy (10)-(11) for these n periods. The board always pursues truthful reporting in the final period T. In the first period, $e_t(\theta_N)$ needs to be replaced by e_1 in all (12)–(17).

Part (i) of Proposition 1 considers the case in which the manager is only offered incentives for investment in firm-specific human capital (but not for truthful reporting). This requires offering a reward for signals indicating investment in firm-specific human capital and a punishment for signals indicating the opposite. The signal in this case is the cash flow realization in t, and the punishment is termination if this realization is low. The reward is a bonus if the cash flow realization is high. However, analogous to Lazear's (1979) classical result, this bonus is optimally deferred to leverage the threat of termination as an incentive device. The deferral is until a period in which the manger truthfully reports her fit or until she reaches her retirement age.

The contract changes dramatically if the board additionally seeks truthful reporting (part (ii) of Proposition 1), as the signals about the manager's human capital investments are not the cash flows, but the manager's reports. As a result, the constraint that the manager invests in firm-specific human capital requires that her compensation is higher in case of a good fit. However, the incentive constraint for truthfully reporting a bad fit θ_N requires that the manager is paid severance for her dismissal ($w_{s,t} \geq 0$), which compensates her for the wage she would forgo by not lying about her fit. The key observation is that the need for severance limits the punishment for not investing in firm-specific human capital, as the manager receives a payment even for bad fit realizations. This makes it impossible to incentivize investment in firm-specific human capital by purely backloading compensation into future, and the manger must be promised a positive bonus. This can be easily seen in the special case in which the correlation between periods is weak (i.e., $e(\theta_G) \approx e(\theta_N)$). Then, the manger's incentive to lie about her fit is especially high, as her continuation payoff beyond period t is practically the same regardless of θ_t: $U_{t+1}(\theta_G, \mathbf{w}) \approx U_{t+1}(\theta_N, \mathbf{w})$. In this case, delaying all of the manager's bonus (i.e., having $\Delta w_t = 0$) makes it impossible to satisfy the constraint that she invests in firm-specific human capital (plug in (7) into (8)). Finally, recall that the source of the manager's rent is the need to incentivize investments in firm-specific human capital. Since the manager is no longer concerned with forgoing future rent in her final period T, incentivizing truthful reporting in that period brings no additional cost.[16]

3.2 The Board's Choice of Truthful Reporting, Contract Horizon, and Turnover

The objective of maximizing the board's payoff (5) can be stated now as determining the optimal reporting policy for every period, subject to (12)–(17). In this problem, the two continuation payoffs $U_{t+1}(\theta_G, \mathbf{w})$ and $U_{t+1}(\theta_N, \mathbf{w})$, time, and the history of periods with incentivizes for truthful reporting play the role of state descriptors completely characterizing the dynamics of the manager's contract. Since a manager's continuation payoffs in the final period T at which she must retire are zero ($U_{T+1}(\theta_T, \cdot) = 0$), her payoff can be derived recursively in every period for any truthful reporting policy the board can choose from. This can be used then to calculate the board's payoff for any such policy and to

[16] The reason we divide by $e_t(\theta_N)$, and not by $e_t(\theta_G)$, in (15) is the following: The board can improve the manager's effort incentives either by increasing her bonus Δw_t or the difference in her continuation payoffs $U_{t+1}(\theta_N, \mathbf{w})$ and $U_{t+1}(\theta_G, \mathbf{w})$. If the manager had no incentives to exert effort following an out-of equilibrium continuation in $t+1$ (but only stays on to collect $w_{s,t+1}$ in the following period), the difference between $U_{t+1}(\theta_N, \mathbf{w})$ and $U_{t+1}(\theta_G, \mathbf{w})$ could be increased by backloading more of the manager's bonus to future periods (this would affect only $U_{t+1}(\theta_G, \mathbf{w})$, but not the off-equilibrium payoff $U_{t+1}(\theta_N, \mathbf{w})$). It is optimal to stop backloading at the point in which the manager is just indifferent between exerting and not exerting effort off the equilibrium path. The reason is that backloading more would start increasing also $U_{t+1}(\theta_N, \mathbf{w})$, which would make truth-telling more difficult to achieve if the manager's fit is θ_N.

select the one that maximizes (5).

3.2.1 Illustration of Main Results With Two-Period Employment ($T = 2$)

Consider a labor market in which managers stay for at most two periods, i.e., $T = 2$, and assume, for illustration, that the primitives take the values from the description of Figure 2. Suppose, first, that the board seeks truthful reporting in both periods and offers $\{w_1, w_2\} = \{0, 0\}$; $\{\Delta w_1, \Delta w_2\} = \{4.7, 7.4\}$, and $\{w_{s,1}, w_{s,2}\} = \{2.8, 2\}$, which satisfy Proposition 1 for $\overline{U} = 1$. We can calculate the manager's payoff in $t = 1$ and $t = 2$ recursively from

$$U_t(\theta_{t-1}, \mathbf{w}) = \left(\begin{array}{c} e_t(\theta_{t-1})(w_t + \theta_G \Delta w_t + \delta U_{t+1}(\theta_G, \mathbf{w})) \\ +(1 - e_t(\theta_{t-1}))\left(w_{s,t} + \sum_{j=t}^{T} \delta^{j-t}\overline{U}\right) - c \end{array} \right) \text{ if truthful reporting in } t. \tag{18}$$

This gives us $U_2(\theta_G, \mathbf{w}) = 3.4, U_2(\theta_N, \mathbf{w}) = 3$, and $U_1(\mathbf{w}) = 4.7$ (where note that $e_t(\theta_{t-1}) = e_1$ in $t = 1$ and that $U_{T+1} = 0$). We can now verify that condition (6) is lax, while (7) and (8) are satisfied with equality. However if the manger's outside option is lower, $\overline{U} = 0$, the incentive constraint (7) to truthfully report θ_N would not be satisfied, as then the manager would be more reluctant to lose her job. To satisfy (7), we would then have to increase the manager's severance pay to $\{w_{s,1}, w_{s,2}\}_{\overline{U}=0} = \{4.7, 3\}$. Two insights follow immediately. First, severance pay is needed to compensate the manager for forgoing future rent when truthfully reporting θ_N. *Severance pay must be higher in $t = 1$ than in $t = 2$*, as the manager needs to be compensated for forgoing rent in two periods. Second, *a manager with a higher outside option requires less severance to be honest*, and might be preferable for the board.

Suppose now that the board does not seek truthful reporting in the first period and offers $\{w_1, w_2\} = \{0, 0\}$; $\{\Delta w_1, \Delta w_2\} = \{0, 12.6\}$ and $\{w_{s,1}, w_{s,2}\} = \{0, 4\}$. In particular, note that this contract offers no severance pay in $t = 1$ and that the first-period bonus is deferred and paid conditional on the firm performing well also in $t = 2$. By plugging in, we can now verify that conditions (6)–(11) are satisfied. Furthermore, the manager's payoff in $t = 2$ can be calculated again from (18) as $U_2(\theta_G, \mathbf{w}) = 6.5$ and $U_2(\theta_N, \mathbf{w}) = 5.7$. The payoff in $t = 1$ can be recursively calculated from

$$U_t(\theta_{t-1}, \mathbf{w}) = \left(\begin{array}{c} w_t + (\theta_N + e_t(\theta_{t-1})\Delta\theta)\Delta w_t \\ +\delta \mathbb{E}_{\theta_{t-1}}\left[U^e_{t+1}(\theta_t, \mathbf{w})\right] - c \end{array} \right) \text{ if no truthful reporting in } t. \tag{19}$$

If $\overline{U} = 1$, $U_1(\mathbf{w}) = 2.8$, which is 40% lower than with truthful reporting in both periods.

$\{x, \Delta x\}$	$\overline{U}$	$V_{n,r}^*$	$V_{r,r}^*$
$\{100, 50\}$	0	2,536	2,527
	1	2,531	2,534
$\{1000, 500\}$	0	25,759	26,004
	1	25,754	26,011

Table 1: Board's expected payoff. The table compares the board's expected payoff $V_{r,r}^*$ from offering incentives for truthful reporting in both periods and from abstaining from offering such incentives in the first period, $V_{n,r}^*$, for different values of $x, \Delta x$ and $\overline{U}$.

Thus, there is a *trade-off between lowering the manager's rent and risking an inefficient replacement* decision by evaluating the manager based on the firm's cash flows.

Table 1 compares the board's residual claim (5) when sticking to each of the two strategies described above for every new hire. It illustrates two of the paper's main results. *If the manager's outside option* $\overline{U}$ *decreases* from 1 to 0 (i) the *manager becomes more expensive to hire and the board's payoff decreases* if it seeks truthful reporting in both periods (last column); and (ii) *relying on performance evaluation (rather than incentives for truthful reporting) becomes more attractive*, especially if the firm is small ($V_{n,r}^* > V_{r,r}^*$ if $x = 100$, $\Delta x = 50$).[17] The rest of the paper generalizes and discusses the intuition for these insights. It further shows that, with longer time horizons ($T > 2$), even large firms will regularly abstain from offering incentives for truthful reporting (Figure 2). Readers mainly interested in the implications of the analysis can skip to Implications 1–7.

3.2.2 The Cost-Benefit Mismatch of Incentivizing Truthful Reporting

The first question that should be clarified is why the board might choose not to offer incentives for truthful reporting in all periods. The first-best replacement policy would require seeking truthful reporting in every period and hiring the manager with the longest time to retirement T, as the positive correlation of fit between periods ($e(\theta_G) > e_1$) implies that a manager who stays a good fit should be kept as long as possible. However, this policy might require giving up too much information rent to the manager. Using that the effort constraint (8) is binding (for $\theta_{t-1} = \theta_C$, see Proposition 1), the manager's expected payoff in period t when there is truthful reporting in $t-1$ and t is

$$U_t(\theta_{t-1}, \mathbf{w}^r) = \left(\frac{e_t(\theta_{t-1})}{e_t(\theta_N)} - 1\right) c + w_{s,t}^r + \sum_{j=t}^{T} \delta^{j-t} \overline{U}, \tag{20}$$

[17] The derivations are in the Appendix. If $\overline{U} = 0$, we need to change $\Delta w_2 = 11$ and $w_{s,2} = 4.4$ and we have $U_1(w) = 1.9$.

where the superscript r stands for truthful reporting. Thus, offering the manager severance pay as an incentive to retire voluntarily if her fit is not good leads to information rent of proportionate size.

Suppose now that the board seeks truthful reporting in every period. Plugging in for the severance pay $w^r_{s,t}$, the manager's expected rent (9) when she is hired in period one is[18]

$$\begin{aligned} \nu_1 &= \frac{\theta_N c}{e_1 \Delta\theta} + \delta \frac{\theta_G U_2(\theta_N, \mathbf{w}^r) - \theta_N U_2(\theta_G, \mathbf{w}^r)}{\Delta\theta} - \sum_{j=1}^{T} \delta^{j-1} \overline{U} \\ &= \frac{\theta_N c}{e_1 \Delta\theta} - \overline{U} - \delta \frac{\theta_N}{\Delta\theta} \left(\frac{\Delta e_2}{e_2(\theta_N)} \right) c + \delta w^r_{s,2} \\ &= \frac{\theta_N c}{e_1 \Delta\theta} - \overline{U} + \sum_{j=2}^{T} \delta^{j-1} \left(\frac{\theta_N}{\Delta\theta} \left(\frac{1 - \Delta e_j}{e_j(\theta_N)} \right) c - \overline{U} \right), \end{aligned} \tag{21}$$

where $\Delta e_t = e_t(\theta_G) - e_t(\theta_N)$ captures the persistence of fit between two periods. This persistence implies that a bad fit today is likely to be a bad fit tomorrow, which decreases the manager's incentives to lie and reduces the rent that needs to be promised to her. Thus, if $\frac{\theta_N}{\Delta\theta}\left(\frac{1-\Delta e_t}{e_t(\theta_N)}\right) c < \overline{U}$, the manager's rent decreases as T increases.

Proposition 2 *The board follows the first-best policy of hiring the manager with the longest time to retirement and incentivizing truthful reporting in all periods if*

$$\frac{\theta_N}{\Delta\theta} \left(\frac{1 - \Delta e_t}{e_t(\theta_N)} \right) c < \overline{U} \text{ in all } t. \tag{22}$$

If the reverse inequality holds, the board might find it optimal to set a limit on maximal tenure (i.e., choose lower T) or abstain from seeking truthful reporting in some periods. This case features both voluntary and performance-induced turnover.

If condition (22) does not hold, the manager can expect an "efficiency" wage above her outside option in all periods until she is replaced. This makes her reluctant to truthfully report θ_N, especially in light of the fact that, by lying, she could stay on the job even following low cash flow realizations. Thus, the severance package needed to incentivize truthful reporting must be higher, the more periods she can potentially stay on the job (dashed line in Figure 2). This results in a mismatch between the costs and benefits of offering incentives for truthful reporting until T. With such a policy, severance pay compensates the manager as if she would stay until the contract's end in T. However, the

[18]Note that in the first period, e_t is just the constant e_1, and the first term in (20) is zero.

board does not realize the benefit of truthful reporting in some period t if the manager has been replaced by that point. Since the likelihood that the manager remains a good fit until the contract's end in T dwindles in T, it is optimal not to seek truthful reporting at least in some periods (risking an inefficiently retention or replacement decision) or to hire an older manager.

3.2.3 Relying on Performance Measures Instead of Truthful Reporting

Suppose in all that follows that the first-best condition (22) is not satisfied. Not offering incentives for truthful reporting comes with the compelling advantage of reducing the rent that needs to be promised to the manager. This was already illustrated in Section 3.2.1, and holds quite generally.

Proposition 3 *Introducing a period without truthful reporting in a sequence of periods with truthful reporting, decreases the manager's rent not only in that period, but also in all preceding periods.*

A period in which the manager is judged only based on performance cuts through her ability to stay with the firm by lying about her fit in all periods. The prospect of lower future rent, in turn, implies that the manager is truthful about her fit even when offered lower severance pay in all preceding periods. Thus, by choosing whether to seek truthful reporting, the board faces a trade-off between making an efficient replacement decision and minimizing the manager's rent.

This trade-off is in the heart of Figure 2, which plots the optimal contract offered to the manager when the board determines the optimal sequence of truthful reporting periods that maximizes its expected payoff as well as a contract that always offers incentives for truthful reporting. Solving for the optimal truthful reporting policy for $T > 2$ is not tractable. Numerically, this can be easily done by recursively deriving the manager's payoff from (18)–(19) in every period for any truthful reporting policy the board can choose from, and then selecting the policy that maximizes (5).

INSERT FIGURES 2 AND 3

Figure 2 illustrates that the manager's severance pay (and, thus, rent) is higher, the more periods with truthful reporting (and, thus, rent extraction) she has ahead of herself (Proposition 2). However, by introducing a period without incentives for truthful reporting, the board not only saves on the cost of offering severance pay in that period, but can also afford to offer lower severance pay in all preceding periods (Proposition 3). Figure 2 illustrates that it is optimal to rely only on performance measures to infer the manager's fit in periods six and 11 even though her wage is only a very small fraction of the firm's value. This is because such policy halves the manager's expected rent, while exposing the board to the relatively mild risk of making a wrong replacement decision in periods six and 11, which the incumbent manager reaches with only eight and one percent probability, respectively. Finally, note that the manager obtains a non-trivial bonus conditional on achieving high cash flows in periods with truthful reporting, with bonus increases following periods without reporting to account for deferrals in such periods (Proposition 1).

In what follows, the question is what determines how often the board will evaluate the manager's fit based on the firm's performance rather than relying on severance agreements to stimulate voluntary turnover.

Lemma 1 *Take any two contracts seeking a different level of truthful reporting from the manager over some maximal tenure length T. (i) The contract for which the manager's rent decreases more strongly in $\overline{U}$ becomes more attractive as $\overline{U}$ increases. (ii) The contract for which the firm's expected cash flows increase more strongly in Δx becomes more attractive as Δx increases.*

Focusing for now on the first part of Lemma 1, Figure 3 implies that the manager's rent decreases more strongly in $\overline{U}$ when there is more truthful reporting. This is only natural, since a higher outside option makes the manager less reluctant to report that her fit is θ_N and seek alternative employment. Hence, the rent that the board needs to promise her to reveal such fit is lower, making this policy more attractive.

This intuition can be derived analytically for two special cases. The first is when a short-term shock affects the manager's outside option only in the first period of the employment relation. The second is when managers can be employed for at most two periods (i.e., $T \leq 2$). In this case, it can also be derived that incentivizing truthful reporting becomes more attractive as Δx increases, which parallels the second part of Lemma 1. This is because for larger firms and firms with higher growth prospects, there is more at stake from having the right manager in charge.

Proposition 4 ***Factors affecting truthful reporting and performance evaluation:*** *(i) Consider a short-term shock that increases the manager's outside option only in the first period. Such a shock makes seeking truthful reporting in the first period more attractive.*
(ii) Suppose that the manager can be employed for at most two periods $T \leq 2$. Incentivizing truthful reporting becomes more attractive for the board as $\overline{U}$ and Δx increase.

To the extent that managers' outside options are lower in industry downturns—e.g., because more firms are going bankrupt, fewer firms are being started, and there is more competition among the labor force for available positions—an immediate corollary is that:

Implication 1 ***Turnover in downturns****: (i) There is less truthful reporting in industry downturns. This implies less voluntary and more forced turnover in downturns, which might appear to an outsider as a lack of relative performance evaluation.*[19] *(ii) Despite being ex post more likely to replace managers in downturns, the board is ex ante more likely to retain managers who are not a good fit because it is offering less adequate incentives for voluntary departures. This might exacerbate downturns.*

3.2.4 Implementation with Renewable Fixed-Term Contracts

How does the contract illustrated in Figure 2 map into contracts in practice, given that such contracts either contain ex ante severance agreements or they don't? A simple way to implement policies that alternate between offering and not offering incentives for truthful reporting (and, thus, severance pay) in regular intervals is with renewable fixed-term contracts (i) that stipulate severance pay for premature terminations as a multiple of the manager's bonus and remaining tenure;[20] (ii) for which severance is not paid when not renewing the manager's contract at renewal dates; (iii) for which, absent termination, the contract continues as originally agreed upon.

This implementation is suitable, as the board can choose the end of the contract to coincide with a period in which it would be optimal not to seek truthful reporting. Specifically, the manager would have no incentives to report truthfully a deteriorating fit close to a renewal date, at which point the board can replace her without severance pay. In such cases, the board would have to judge the manager's fit solely based on her performance, and would renew the CEO's contract (according to the initial agreement) only if it is happy with that performance. Thus, both the board's and the manager's strategies would mimic those in a period without incentives for truthful reporting.

About 45% of CEO contracts in practice are fixed-term contracts that renew automatically, unless one of the parties objects (Gillan et al., 2009). The majority of such contracts contain ex ante severance agreements (Rau and Xu, 2013; Brown, 2015). In line with Proposition 1, these severance agreements are usually a multiple of managers' salary and

[19]Somewhat losely speaking, one could think of this model as one in which abnormal and relative performance have already been filtered out.

[20]Voluntary" turnover coupled with a severance pay needs to be initiated by the board, as severance pay cannot be claimed without a "good reason," such as a change of duty, diminution of pay, or relocation (Rau and Xu, 2013). This is not in conflict with the model, as reporting a bad fit triggers such termination.

bonus and can depend on their remaining tenure. Moreover, boards pay more attention to performance and the relation between turnover and performance is stronger close to renewal dates (Liu and Xuan, 2016; Cziraki and Groen-Xu, 201). This is in line with the prediction that the board relies on the firm's performance rather than truthful reporting in renewal periods. Thus, the above results provide a simple intuition for the wide-spread use of such renewable fixed-term contracts. Based on Proposition 4, we predict:

Implication 2 ***Determinants of contract horizon***: *The length of renewable fixed-term contracts will be shorter in downturns. (ii) Larger firms and firms with better growth options will offer contracts with longer horizons. This will go hand-in-hand with higher (average) severance pay.*

3.2.5 Renegotiations and Hiring Older Managers

The preceding results show that it might be optimal for the board to abstain from offering incentives for truthful reporting in some periods in order to limit the manager's rent. However, once reaching such a period, the board could offer to renegotiate the existing contract and restructure it in a way that offers incentives for truthful reporting, as this would increase the firm's cash flows. There are several reasons why pursuing this strategy can become optimal ex post, even if it is not optimal ex ante. First, one benefit of not seeking truthful reporting in t is that it decreases the manager's rent not only in t, but also in all preceding periods. However, the latter benefit ceases to exist once both parties arrive in t. Second, there is scope for renegotiations after the manager has invested in firm-specific human capital and the cost c in period t is sunk, as at this point incentivizing firm-specific human capital investment is no longer an objective. As is usual, though such renegotiations might be beneficial ex post, they reduce the board's expected payoff ex ante.

Committing to avoid such renegotiations is relatively easy in the present context. In particular, if the board engages in renegotiations once, all future managers would expect the same and demand only renegotiation-proof contracts from then on. Since the firm is infinitely-lived, this "trigger strategy" would prevent the board from deviating from its commitment to avoid renegotiations if δ is sufficiently high.

Still, discussing the other extreme in which the potential for renegotiations forces the board to offer a contract that incentivizes truthful reporting in all periods is also interesting, as it has clear implications for the manager's maximal tenure length T.[21,22] In this

[21] There are no clear predictions regarding T from the previous section except that larger firms (in the sense of higher Δx) tend to offer longer contracts.

[22] Indeed, renegotiations leading to increases in managers' severance pay are common in practice. Among

case, the board's problem is equivalent to that discussed in Proposition 2. Then, if the first-best condition (22) is not satisfied, the board might have to offer a shorter contract, as the manager's rent might otherwise become too high. A commitment to such tenure limits is credible, as T is chosen to coincide with the manager's retirement age.

To gain some intuition about the factors affecting the manager's maximal tenure limit, it is helpful to consider again condition (22). It suggests that a higher per-period outside option $\overline{U}$ decreases the manager's rent. A more attractive outside opportunity makes the manager less reluctant to leave the firm, which reduces the severance pay she needs to be promised to truthfully report her fit. Thus, given that the cost of employing the manager longer is lower, while the benefit is unchanged, the board finds it optimal to offer contracts with longer horizons. Also similar to before, longer contracts are optimal if Δx is higher, as there is more at stake from holding on longer to a manager who is a good fit.

Proposition 5 *Suppose that the first-best condition (22) is not satisfied and that the board incentivizes truthful reporting in all periods. Then, the upper limit T on the manager's tenure is higher if her per-period outside option $\overline{U}$ and cash flow upside Δx are higher.*

Recalling that upper tenure limits are implemented by choosing T to coincide with the manager's retirement age, Proposition 5 implies:

Implication 3 ***CEO age****: Suppose that the first-best condition (22) is not satisfied and that the board incentivizes truthful reporting in all periods. (i) Then, the board needs to offer younger managers higher severance pay. (ii) Furthermore, the board prefers hiring an older manager (i.e., T is lower) if $\overline{U}$ and Δx are lower. This implies that older managers are preferred in industry downturns and by firms with low growth potential.*

While the second part of Implication 3 has not been tested, the first part finds empirical support in Rau and Xu (2013).

3.3 Discussion and Extensions

3.3.1 Hiring Managers with Better Outside Options

Suppose now that the pool of potential managers differs according to their success likelihood e_t and their outside options $\overline{U}$. Furthermore, assume that condition (22) is not satisfied for any $\overline{U}$ and e_t. All remaining parameters of the model remain the same.

the cases in which there was a clear conflict with the board, in 42% of the time the original contracts were renegotiated and the departing manager received substantial severance pay (Goldman and Huang, 2015). For similar evidence from firms entering bankruptcy, see Eckbo et al. (2016). Both papers acknowledge the difficulty of distinguishing between forced and voluntary turnover and follow different classifications.

Clearly, if all information was common knowledge, the board would prefer hiring the manager with the highest likelihood e_t of being a good fit and with the lowest outside option $\overline{U}$. However, when the manager's fit is her private information, and the board must offer incentives for truthful reporting, it pays the manager an "efficiency wage," which is above her outside option. In this case, hiring a manager with a higher outside option could be beneficial, since it reduces the need for generous severance pay $w_{s,t}$. This can be seen especially clearly in the extreme case in which the board stimulates truthful reporting in all periods (as in Section 3.2.5). Then, the board strictly prefers hiring a manager with a higher outside option. Thus, if the board is faced with the choice of selecting between a manager that has a higher likelihood e_t of being a good fit or one with a higher outside option $\overline{U}$, it might prefer the manager with the higher outside option.

Proposition 6 *(i) Take any given truthful reporting policy the board is seeking to implement over a given maximal tenure length of T. If $\left(p(T) - \delta^T\right) > (1-\delta)\frac{\partial}{\partial \overline{U}} U_1(T)$, the board's payoff increases in $\overline{U}$ for that policy.*[23] *Under truthful reporting in all periods, the board always prefers hiring a manager with a higher outside option. (ii) Furthermore, the board might prefer a manager with a higher outside option $\overline{U}$ to one who is more likely to be a good fit (higher e_t).*

Investments in general human capital, such as taking board seats at different firms, increase CEOs' outside options. Thus, it might seem surprising that boards tolerate such behavior given that it might distract managers, and CEOs could use it as a bargaining chip to get a higher salary. However, CEOs rarely leave the firm to become CEOs elsewhere (Fee and Hadlock, 2004) and their labor income declines on average by 40% following termination (Nielsen, 2017). Thus, if CEOs are paid anyway above their outside options, the more pertinent effect might be:

Implication 4 ***Investments in general human capital****: Investments in general human capital, increasing the manager's outside options, make it cheaper to offer incentives that she is truthful about her fit. Thus, boards might tolerate such investments even if they come at the expense of investments in firm-specific human capital (lower e_t).*

3.3.2 Outside Options and Experience

Up to now, outside options were assumed to stay fixed over time. However, one could imagine that, as managers stay longer with the firm, their reputation in the labor market

[23] $p(T)$ is defined in the Appendix. Note, however, that a higher $\overline{U}$ might lead the board to choose a different reporting policy.

improves and, as a result, their outside options increase. One of the main points of the present paper is that such increases do not necessarily make the manager more expensive to the firm. In fact, the exact opposite might be the case. If the manager is paid an efficiency wage above her outside option, increases in that outside option imply that it becomes easier to keep the manager honest. Thus, one could expect that the board relies more often on truthful revelation and less often on performance measures to judge the manager's fit. Further relating to the implementation of the optimal contract, we have:

Implication 5 ***Experience****: If a manager's outside options increase with her tenure: (i) The relation between managerial turnover and firm performance will weaken with the manager's tenure. (ii) The length of renewable contacts would increase with the manager's tenure.*

Another implication of the analysis is that boards will avoid damaging departing CEOs' outside options, as this would necessitate higher severance pay. Indeed, there is evidence that severance pay is higher when firms replace CEOs with a reputation for firm mismanagement (Goldman and Huang, 2015).

Implication 6 ***Reputation****: (i) When replacing CEOs, boards will avoid damaging their reputation, as replacing CEOs with a reputation for mismanagement requires offering higher severance pay.*

3.3.3 Persistence of Fit and Contract Horizon

One of the assumptions in the analysis so far was that if a manager is a good fit in a given period, she is more likely to be a good fit also in the following period. What would be different about a model with zero correlation (i.e., with $e_t(\theta_G) = e_t(\theta_N) = e_1$) is that there would be no benefit from retaining a manager with a good fit, as her likelihood of being a good fit also in the following period would be the same as that of a new manager. Thus, if the board seeks truthful revelation in all periods, it would hire managers for one period only. Hiring, say, for two periods would be suboptimal, as it would imply that the manager is compensated as if she would always stay with the firm in both periods (Proposition 2). The remaining insights are unchanged. In particular, hiring for more than one period might be optimal if the board abstains from offering incentives for truthful revelation in some periods, as then it might be possible to provide cheaper incentives for investment in firm specific human capital (Proposition 1). By contrast, a model with perfect correlation ($e_t(\theta_G) = 1$ and $e_N(\theta_N) = 0$) gives a stark implication: The board chooses the longest time to retirement T, stimulates truthful reporting in the first period and retains the manager until T if and only if she is a good fit. Finally, though the comparative statics regarding the effect of an increase in correlation are not analytically tractable, numerically a weaker correlation leads to more periods with performance evaluation. This is because it becomes both more expensive and less valuable to incentivize truthful reporting, when a good fit today does not guarantee good fit tomorrow. Overall, the prediction for cases in which the manager's fit is more likely to change over time is:

Implication 7 ***Fit persistence****: Contract horizon is likely to be shorter and turnover will be more strongly tied to performance if firms are in dynamically changing environments, such as firms in the hightech or biotech industries, or if firms are in the process of undergoing change, selling major assets, or seeking diversification.*

Implication 7 is consistent with the empirical evidence of Wagner and Peters (2014) that CEOs of companies experiencing more volatile industry conditions are more likely to be forced out. It further highlights that CEO compensation and the likelihood of forced turnover are jointly determined by industry characteristics.

3.3.4 Relying on Both Truthful Reporting and Performance Measures

Relying on both truthful reporting and performance measures could be optimal if cash flow realizations bring additional information regarding the manager's fit relative to her signal at the interim date of a period. With more than two cash flow states, this could lead to turnover following low cash flow realizations even when the manager truthfully reports θ_G. However, it would remain true that the more periods with truthful reporting a manager can look forward to, and the lower her outside option, the stronger her incentives to lie are going to be. Thus, the properties of the solution are likely to be similar to those in Figures 2 and 3.

Reliance on both reporting and performance measures could also arise when allowing for mixed strategies. Specifically, it is conceivable that there is an equilibrium in which the manager randomizes between reporting θ_N or θ_G if her fit is θ_N and the board subsequently randomizes between replacing and keeping the manager depending on the cash flow realization. Such stochastic replacement reduces the manager's on and off-equilibrium continuation payoffs and, thus, the need for severance pay. However, it still remains true that having a low outside option and having the ability to stay with the firm for more periods even following low cash flow realizations increases the incentives to lie. Dealing with the additional complexity of mixed strategies would be an interesting, but a challenging extension, as issues related to learning (potentially over multiple periods) become central for the analysis.[24]

4 Conclusion

The paper develops a model of contract horizon and turnover in which the agents' fit with the firm evolves over time, and agents are better informed about such changes. The principal can minimize the likelihood that an agent who has become a bad fit stays with the firm, but this is not always in its best interest, as it would require paying generous incentive and severance packages. Thus, the principal will sometimes judge an agent's fit based on the firm's performance instead of relying on truthful reporting in the form of generous severance pay. Though potentially inefficient, as it does not preempt bad performance and would lead to inefficient replacement and retention decisions, this policy could keep the agent's compensation from growing too large. While pervasive in various settings, a key application for which there is rich evidence is in the context of boards hiring managers.

The main predictions from the analysis framed in the context of this application are as follows. First, most of the time, boards will offer adequate severance agreements that lead to what might appear as voluntary turnover of managers with deteriorating fit. However, they will abstain from such incentives in regular intervals and will judge the manager's fit based on the firm's underperformance. The resulting optimal contract can be implemented with renewable fixed-term contracts, stipulating ex ante severance pay as a multiple of the manager's wage, but allowing to costlessly replace the manager when her term expires—contracts which are widely used in practice (Gillan et al., 2009; Rau and Xu, 2013). Thus, seemingly voluntary turnover, accompanied with severance pay, is likely to be common, if not the more common, form of turnover, as boards will seek to preempt bad performance from occurring by having a manager with a good fit in charge. This suggests that selection might be of concern in empirical studies of the effectiveness of CEO contracts, neglecting that both voluntary and forced turnover can be the result of a deteriorating fit.

Second, when managers' outside options are low, they will be offered less often incentives for truthful reporting, and the board will have to judge more often their fit based on the firm's cash flow performance. This is because in such cases managers will be espe-

[24] In the presence of limited commitment, randomization generates interesting dynamics even with constant types (Hart and Tirole, 1988; Laffont and Tirole, 1990). Another level of randomization is between incentivizing and not incentivizing truthful reporting in a given period. However, this would require committing to a randomization device, as an ex ante optimal randomization is in general not optimal ex post and vice versa (Proposition 3).

cially reluctant to lose their job. One implication of this result is that managers will have less adequate incentives to reveal a bad fit in industry downturns, which would result in less voluntary and more performance-induced turnover. There is, indeed, evidence for this result, but it has hitherto been interpreted as a lack of relative performance evaluation (Jenter and Kanaan, 2015). Furthermore, the stronger reliance on performance-, rather than "voluntary" turnover in downturns is more likely to leave firms with managers who are not a good fit, even if the board subsequently seems overly active to replace the manager in case of underperformance. This might exacerbate downturns. Another implication of a more frequent reliance on performance measures (at renewal dates) implies that renewable contracts will be of shorter length in downturns. The paper further shows that contract length will be longer and, thus, severance pay will be larger for larger firms and firms with better growth prospects. However, contract length will be shorter and performance evaluation more frequent in more volatile industries.

Third, in some cases the board will not be able to commit not to renegotiate the manager's contract in times that the manager is not offered incentives for truthful reporting. In such cases, it is optimal to set upper tenure limits, which can be implemented by hiring older managers whose retirement age coincides with such limits. Such strategy helps to keep the manager's pay from growing too large, as younger managers would need to be offered larger severance packages. An important factor that affects tenure limits is again the manager's outside option, suggesting that boards would be more likely to hire older CEOs in industry downturns. Fourth, the paper outlines that there can be a trade-off between hiring a manager with a higher outside option and one who is likely to be a better fit. While such a trade-off would not exist in a world in which information is common knowledge, hiring a manager with a higher outside option could lower the incentive and severance pay firms need to offer to their managers. However, this insight—that a higher outside option helps to keep the manager honest—implies that firms might prefer hiring a manager with high outside options even if it is unlikely that she will be a better fit. The same idea could also shed some light on why boards might tolerate investments in general human capital even if they come at the expense of firm-specific human capital investments.

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Appendix A Omitted Proofs

Proof of Proposition 1. The main technical step in the proof is to determine which constraints shape the manager's compensation contract. For periods without truthful reporting, the binding constraints are the feasibility condition that $\Delta w_t \geq 0$ (i.e., bonuses are deferred) together with the interim participation constraint (11), which pins down w_t (to zero, unless the manager is paid her outside option); severance is clearly suboptimal in such periods (i.e., $w_{s,t} = 0$). In a period with truthful reporting, the manager's severance pay $w_{s,t}$ is determined by the binding incentive constraint (7). If there is truthful reporting also in the preceding period, Δw_t is determined from the effort constraint (8) (for $\theta_{t-1} = \theta_N$, see footnote 16); otherwise, it is set high enough that it compensates the manager for not receiving a bonus in the preceding periods without truthful reporting; w_t is set to zero to minimize the cost of incentivizing effort. The technical details bring little further insights and are, thus, relegated to Lemma B.2 in Appendix B.

It remains to argue that the board will always seek truthful reporting in period T. Observe, first, that if the board seeks truthful reporting in the final period, we have

$$\begin{aligned}
\Delta w_t &= \max\left\{\Delta w_{T-n}^{-1}(0), \frac{c}{e_T(\theta_N)\Delta\theta}\right\} \\
w_{s,T} &= \max\left\{0, \theta_N \Delta w_T - \overline{U}\right\},
\end{aligned}$$

where $\Delta w_{T-n}^{-1}(0)$ is the cumulative deferred bonus in case there is no truthful reporting in the preceding n periods. Instead, if the board seeks no truthful reporting in the final period, it can no longer delay payments, and it must offer a payment that satisfies (B.5)–(B.6), while also making it optimal to set $\Delta w_t = 0$ in the immediately preceding periods without truthful reporting (in case there are such periods). Thus,

$$\begin{aligned}
\Delta w_t &= \max\left\{\Delta w_{T-n}^{-1}(0), \frac{c}{e_T(\theta_N)\Delta\theta}\right\} \\
w_t &= \max\left\{0, \overline{U} - \theta_N \Delta w_T\right\}.
\end{aligned}$$

Plugging into the manager's payoff U_T, we obtain that this payoff is identical in both cases. However, the board's payoff is higher with truthful reporting, implying that it will seek, indeed, truthful reporting in the final period. **Q.E.D.**

Proof of Proposition 2. We, first, introduce some notation and then argue to a contradiction.

Step 1. *Notation.* Let the likelihood that the manager retains her job depending on whether there is truthful reporting and depending on the manager's fit from the previous period be defined as

$$\mathbf{e}_t = \begin{cases} \text{if } t=1 & \text{if } 1 < t \leq T & \\ \begin{pmatrix} e_1 & 0 \end{pmatrix} & \begin{pmatrix} e_t(\theta_G) & 0 \\ e_t(\theta_N) & 0 \end{pmatrix} & \text{truthful reporting} \\ \begin{pmatrix} e_1\theta_G & (1-e_1)\theta_N \end{pmatrix} & \begin{pmatrix} e_t(\theta_G)\theta_G & (1-e_t(\theta_G))\theta_N \\ e_t(\theta_N)\theta_G & (1-e_t(\theta_N))\theta_N \end{pmatrix} & \text{otherwise} \end{cases}.$$

The vector/matrix representation will be useful to minimize notation. Analogously, let the probability of replacement in any given period be defined as

$$\mathbf{p}_t = \begin{cases} \begin{array}{ccc} \text{if } t=1 & \text{if } 1<t\leq T & \\ 1-e_1 & \begin{pmatrix} 1-e_t(\theta_G) \\ 1-e_t(\theta_N) \end{pmatrix} & \text{truthful reporting} \\ \begin{array}{c} e_1(1-\theta_G) \\ +(1-e_1)(1-\theta_N) \end{array} & \begin{pmatrix} e_t(\theta_G)(1-\theta_G)+(1-e_t(\theta_G))(1-\theta_N) \\ e_t(\theta_N)(1-\theta_G)+(1-e_t(\theta_N))(1-\theta_N) \end{pmatrix} & \text{otherwise} \end{array} \end{cases}.$$

We can define now the discounted likelihood of replacement (and, thus, of obtaining V^* from hiring a new manager) over the course of the entire potential employment relation as

$$p(T) := \delta \mathbf{p}_1 + \sum_{i=2}^{T-1} \delta^i \Pi_{k=1}^{i-1} \mathbf{e}_k \mathbf{p}_i + \delta^T \Pi_{k=1}^{T-1} \mathbf{e}_k \mathbf{1}, \tag{A.1}$$

which corresponds to $\mathbb{E}\left[\sum_{i=1}^{T} \delta^{i-1}\widetilde{q}_i\right]\delta$ in expression (5). Note that the replacement probability in the final period T is $\mathbf{1}=(1;1)$. Similarly, we can define the expected amount that the outgoing manager would be paid by the outside labor market upon her dismissal as[25]

$$h\left(\overline{U},T\right) := \delta \mathbf{p}_1 \sum_{j=2}^{T} \delta^{j-2}\overline{U}_j + \sum_{i=2}^{T-1}\left(\delta^i \Pi_{k=1}^{i-1}\mathbf{e}_k\mathbf{p}_i \sum_{j=k+1}^{T}\delta^{j-k-1}\overline{U}_j\right), \tag{A.2}$$

which corresponds to $\sum_{i=1}^{T}\delta^{i-1}\overline{U} - \mathbb{E}\left[\sum_{i=1}^{T}\delta^{i-1}q_i\overline{U}\right]$ in expression (5). Since $\overline{U}$ is the same in all periods, we obtain

$$\begin{aligned} h\left(\overline{U},T\right) \quad : \quad &= \frac{\overline{U}}{1-\delta}\left(\delta\mathbf{p}_1\left(1-\delta^{T-1}\right) + \sum_{i=2}^{T-1}\delta^i\Pi_{k=1}^{i-1}\mathbf{e}_k\mathbf{p}_i\left(1-\delta^{T-i}\right)\right) \\ &= \frac{\overline{U}}{1-\delta}\left(-\mathbf{p}_1\delta^T + \underbrace{\delta\mathbf{p}_1 + \sum_{i=2}^{T-1}\delta^i\Pi_{k=1}^{i-1}\mathbf{e}_k\mathbf{p}_i}_{p(T)-\delta^T\Pi_{k=1}^{T-1}\mathbf{e}_k\mathbf{1}} - \delta^T\sum_{i=2}^{T-1}\Pi_{k=1}^{j-1}\mathbf{e}_k\mathbf{p}_i\right) \\ &= \frac{\overline{U}}{1-\delta}\left(-\mathbf{p}_1\delta^T + p(T) - \delta^T\Pi_{k=1}^{T-1}\mathbf{e}_k\mathbf{1} - \delta^T\left(\mathbf{e}_1 - \Pi_{k=1}^{T-1}\mathbf{e}_k\right)\mathbf{1}\right) \\ &= \frac{\overline{U}}{1-\delta}\left(-\delta^T + p(T)\right). \end{aligned} \tag{A.3}$$

[25] To be precise, in case the manager reveals that she is a bad fit, she receives $\overline{U}$ from the outside labour market in the period in which she is fired, but the firm hires a new manager for $\overline{U}$ for the remainder of the period, and the two terms cancel out in board's expected payoff.

Denoting further $s_1(T) = \mathbb{E}\left[\sum_{i=1}^{T} \delta^{i-1} q_i (x_i - c)\right]$ and expressing $U_1(\mathbf{w})$ as $\nu_1(\mathbf{w}, T) + \sum_{j=1}^{T} \delta^{j-1} \overline{U}_j$ using (9), the board's equilibrium expected payoff in period one (5) can be stated as

$$V^* = -\nu_1(\mathbf{w}, T) - \sum_{j=1}^{T} \delta^{j-1} \overline{U}_j + s_1(T) + h\left(\overline{U}, T\right) + p(T) V^*, \tag{A.4}$$

The functional dependence on T makes explicit that the maximal tenure length is T. Using (A.3), we can simplify (A.4) to

$$V^*(T) = \frac{s_1(T) - v_1(\mathbf{w}, T)}{1 - p(T)} - \frac{\overline{U}}{1 - \delta}. \tag{A.5}$$

Step 2. *Optimality of Upper Tenure Limits and/or Abstaining from Incentives for Truthful Reporting.* We argue to a contradiction. Suppose that the board incentivizes truthful reporting in all periods. We have

$$\begin{aligned} s_1(T) \quad : \quad &= x + \left(\overline{\theta} + e_1\left(\theta_G - \overline{\theta}\right)\right)\Delta x - c \\ &+ \left(\delta e_1 + \sum_{j=2}^{T-1} \delta^j e_1 \Pi_{i=2}^{j} e_i(\theta_G)\right)\left(x + \left(\overline{\theta} + e(\theta_G)\left(\theta_G - \overline{\theta}\right)\right)\Delta x - c\right) \\ = \quad & x + \left(\overline{\theta} + e_1\left(\theta_G - \overline{\theta}\right)\right)\Delta x - c \\ &+ \left(\delta e_1 \frac{\left(1 - e(\theta_G)^{T-1}\delta^{T-1}\right)}{1 - e(\theta_G)\delta}\right)\left(x + \left(\overline{\theta} + e(\theta_G)\left(\theta_G - \overline{\theta}\right)\right)\Delta x - c\right). \end{aligned} \tag{A.6}$$

where, given the Markov structure, it is without loss to omit the subscripts of $e(\theta_G)$. Furthermore

$$\begin{aligned} 1 - p(T) &= 1 - \left(\delta(1 - e_1) + \sum_{j=2}^{T-1} \delta^j e_1 e(\theta_G)^{j-2}(1 - e(\theta_G)) + \delta^T e_1 e(\theta_G)^{T-2}\right) \\ &= (1 - \delta)\left(1 + \frac{\delta e_1\left(1 - e(\theta_G)^{T-1}\delta^{T-1}\right)}{1 - e(\theta_G)\delta}\right) \end{aligned} \tag{A.7}$$

Plugging in for $s_1(T)$, $p(T)$, as well as for $h(T)$ from (A.3) and $v_1(T)$ from (21), (A.5) becomes

$$V^* = \frac{\left(\begin{array}{c} x + \left(\overline{\theta} + e_1\left(\theta_G - \overline{\theta}\right)\right)\Delta x - c + \left(\delta e_1 \frac{\left(1-e(\theta_G)^{T-1}\delta^{T-1}\right)}{1-e(\theta_G)\delta}\right)\left(x + \left(\overline{\theta} + e\left(\theta_G\right)\left(\theta_G - \overline{\theta}\right)\right)\Delta x - c\right) \\ -\left(\frac{\theta_N c}{e_1 \Delta\theta} - \overline{U} + \frac{\delta\left(1-\delta^T\right)}{1-\delta}\left(\frac{\theta_N}{\Delta\theta}\left(\frac{1-\Delta e_t}{e_t(\theta_N)}\right)c - \overline{U}\right)\right) \end{array}\right)}{(1-\delta)\left(1 + \frac{\delta e_1\left(1-e(\theta_G)^{T-1}\delta^{T-1}\right)}{1-e(\theta_G)\delta}\right)}$$

$$-\frac{\overline{U}}{1-\delta}.$$

It is now sufficient to show that increasing tenure $T \to \infty$, can make the board's expected payoff V^* negative. This is the case if

$$\left(\frac{\theta_N}{\Delta\theta}\left(\frac{1-\Delta e_t}{e_t\left(\theta_N\right)}\right)c - \overline{U}\right) > \frac{1-\delta}{\delta}\left(\begin{array}{c} \left(x + \left(\overline{\theta} + e_1\left(\theta_G - \overline{\theta}\right)\right)\Delta x - c\right) - \frac{\theta_N c}{e_1\Delta\theta} \\ + \frac{\delta e_1}{1-e(\theta_G)\delta}\left(x + \left(\overline{\theta} + e\left(\theta_G\right)\left(\theta_G - \overline{\theta}\right)\right)\Delta x - c - \overline{U}\right) \end{array}\right) \tag{A.8}$$

The key observation now is that the RHS of (A.8) decreases towards zero as δ increases towards one (in particular, note that $\frac{1-\delta}{\delta}$ and $\frac{\delta e_1}{1-e(\theta_G)\delta}$ do not cancel out). This reflects that the manager's rent increases almost linearly in T (but for discounting) even though the likelihood that the manager stays one period longer (and, thus, that the board enjoys the benefit of offering longer employment) is only $e\left(\theta_G\right)$. By contrast, the LHS of (A.8) is independent of δ and positive if (22) is not satisfied. Thus, for any parameter constellation, there is a threshold $\widehat{\delta}$ such that for $\delta > \widehat{\delta}$, this condition is satisfied. Hence, in these cases the board will always deviate from a policy of pursuing truthful reporting in all periods without a maximum tenure limit. **Q.E.D.**

Proof of Lemma 1. Consider an equilibrium candidate featuring n periods with truthful reporting. Let $V_n^*\left(T\right)$ and $V_{n+k}^*\left(T\right)$ be of equal maximal tenure T with V_{n+k}^* featuring k more periods with truthful reporting. In what follows, it is sufficient to argue that

$$\frac{\partial}{\partial\overline{U}}\left(V_{n+k}^*\left(T\right) - V_n^*\left(T\right)\right) > 0 \tag{A.9}$$

$$\frac{\partial}{\partial\Delta x}\left(V_{n+k}^*\left(T\right) - V_n^*\left(T\right)\right) > 0. \tag{A.10}$$

The increasing differences will imply that the $V_{n+k}^*\left(T\right)$ offer becomes increasingly more attractive for the board as $\overline{U}$ and Δx increase. Plugging in from (A.5), (A.9) and (A.10) can be rewritten as

$$\begin{aligned}
\frac{\partial}{\partial \overline{U}}\left(V_{n+k}^{*}(T)-V_{n}^{*}(T)\right) &= \frac{\partial}{\partial \overline{U}}\left(\frac{-v_1(\mathbf{w}_{n+k},T)}{1-p_{n+k}(T)}-\frac{-v_1(\mathbf{w}_n,T)}{1-p_n(T)}\right)\\
\frac{\partial}{\partial \Delta x}\left(V_{n+k}^{*}(T)-V_{n}^{*}(T)\right) &= \frac{\partial}{\partial \Delta x}\left(\frac{s_{1,n+k}(T)}{1-p_{n+k}(T)}-\frac{s_{1,n}(T)}{1-p_n(T)}\right)
\end{aligned}$$

proving the claim. **Q.E.D.**

Proof of Proposition 3. Take as a starting point the case in which the board always pursues truthful reporting, described in Proposition 2, and suppose that the board considers abstaining from offering truth reporting incentives in period t.[26] Plugging in for $\Delta w_t = \frac{c}{e_t(\theta_N)\Delta\theta}+\delta\frac{U_{t+1}^{e}(\theta_N,\mathbf{w})-U_{t+1}^{e}(\theta_G,\mathbf{w})}{\Delta\theta}=0$ from Proposition 1, the manager's expected payoff in period t can be stated as

$$\begin{aligned}
U_t(\theta_{t-1},\mathbf{w}^{nr}) &= w_t^{nr}+(\theta_N+e_t(\theta_{t-1})\Delta\theta)\left(\frac{c}{e_t(\theta_N)\Delta\theta}+\delta\frac{U_{t+1}^{e}(\theta_N,\mathbf{w})-U_{t+1}^{e}(\theta_G,\mathbf{w})}{\Delta\theta}\right)\\
&\quad+\delta e(\theta_{t-1})U_{t+1}^{e}(\theta_G,\mathbf{w}^{nr})+\delta(1-e(\theta_{t-1}))U_{t+1}^{e}(\theta_N,\mathbf{w}^{nr})-c\\
&= \frac{\theta_G\delta\left(U_{t+1}^{e}(\theta_N,\mathbf{w}^{nr})-\theta_N U_{t+1}^{e}(\theta_G,\mathbf{w}^{nr})\right)}{\Delta\theta}+\left(\frac{\frac{\theta_N}{\Delta\theta}+e_t(\theta_{t-1})}{e_t(\theta_N)}-1\right)c\\
&= \delta\frac{\theta_G\theta_N\left(U_{t+1}(\theta_N,\mathbf{w}^{nr})-U_{t+1}(\theta_G,\mathbf{w}^{nr})\right)}{\Delta\theta}+\sum_{j=t+1}^{T}\delta^{j-t}\overline{U}_j\\
&\quad+\left(\frac{\frac{\theta_N}{\Delta\theta}+e_t(\theta_{t-1})}{e_t(\theta_N)}-1\right)c. \qquad \text{(A.11)}
\end{aligned}$$

where the superscript nr highlights that there is no truthful reporting in period t. Subtracting (A.11) from (20), we obtain

$$\begin{aligned}
&\delta\frac{\theta_G U_{t+1}(\theta_N,\mathbf{w}^{r})-\theta_N U_{t+1}(\theta_G,\mathbf{w}^{r})}{\Delta\theta}\\
&-\left(\delta\frac{\theta_G\theta_N\left(U_{t+1}(\theta_N,\mathbf{w}^{nr})-U_{t+1}(\theta_G,\mathbf{w}^{nr})\right)}{\Delta\theta}+\sum_{j=t+1}^{T}\delta^{j-t}\overline{U}_j\right)\\
=\ &\delta\left(\frac{\theta_G\nu_{t+1}(\theta_N,\mathbf{w}^{r})-\theta_N\nu_{t+1}(\theta_G,\mathbf{w}^{r})}{\Delta\theta}-\frac{\theta_G\theta_N\left(\nu_{t+1}(\theta_N,\mathbf{w}^{nr})-\nu_{t+1}(\theta_G,\mathbf{w}^{nr})\right)}{\Delta\theta}\right)\\
\geq\ &\frac{\delta}{\Delta\theta}\left(\theta_G(1-\theta_N)\nu_{t+1}(\theta_N,\mathbf{w}^{r})-\theta_N(1-\theta_G)\nu_{t+1}(\theta_G,\mathbf{w}^{r})\right)\\
>\ &\frac{\delta}{\Delta\theta}(1-\theta_N)\left(\theta_G\nu_{t+1}(\theta_N,\mathbf{w}^{r})-\theta_N\nu_{t+1}(\theta_G,\mathbf{w}^{r})\right)>0 \qquad \text{(A.12)}
\end{aligned}$$

[26] We look at the case in which $w_t=0$. If $w_t>0$, the manager's rent is zero, and the result is immediate.

where the first inequality follows from the fact that when there is truthful reporting in t, $\mathbf{w}^{nr}$ minimizes $\nu_{t+1}^{nr}(\theta_N, \mathbf{w}) - \nu_{t+1}^{nr}(\theta_G, \mathbf{w})$ (in expression A.11), and the last inequality follows from the assumption that (22) is not satisfied.

To complete the proof, it is sufficient to show that, for any given reporting strategy in $t-1$, $U_{t-1}(\theta_{t-2}, \mathbf{w})$ is higher when there is truthful reporting in t. The result is immediate if the board does not seek truthful reporting in $t-1$, as then $w_t = \Delta w_t = 0$. With incentives for truthful reporting in $t-1$ and $t-2$, it is sufficient to show that $U_{t-1}(\theta_{t-2}, \mathbf{w})$ decreases in $w_{s,t-1}$. Using (17) and (20)), if the manager extracts rent in $t-1$,

$$w_{s,t-1} = \left(\frac{\theta_N c}{e_{t-1}(\theta_N)\,\Delta\theta} + \frac{\delta}{\Delta\theta} \frac{\Delta e_t}{e_t(\theta_N)} \right) + \delta U_t(\theta_N, \mathbf{w}) - \sum_{j=t}^{T} \delta^{j-t} \overline{U},$$

which is minimized when $U_t(\theta_N, \mathbf{w})$ is minimized. Finally, without truthful reporting in $t-2$, Δw_{t-1} might not depend on $U_t(\theta_{t-1}, \mathbf{w})$ (see 15). However, $w_{s,t-1}$ continues to be minimized when $U_t(\theta_N, \mathbf{w})$ is minimized. Hence, a period without incentives for truthful reporting reduces the manager's rent in all preceding periods. **Q.E.D.**

Proof of Proposition 4. (i) Consider a shock that only increases the manager's outside option in period one. Clearly, the board's preference for truthful reporting when hiring a new manager after this period is unchanged by this shock. Let the board's expected payoff when hiring a new manager after period one be V^*. For period one, the board's payoff is

$$V = s_1(T) + p(T)\,V^* + h\left(\overline{U}, T\right) - U_1(\mathbf{w}, T).$$

Since the manager's outside option in period one, $\overline{U}_1$, does not enter $h\left(\overline{U}, T\right)$, it only affects $U_1(\mathbf{w}, T)$ in this expression. From (20) and (A.11), this payoff depends on $\overline{U}_1$ only if the manager extracts no rent in period one (i.e., if $w_{s,1} = 0$ in case of truthful reporting, and $w_1 > 0$ in case of no truthful reporting). In this case, a unit increase in $\overline{U}_1$ leads to a unit increase in $U_1(\mathbf{w}, T)$ regardless of whether there is truthful reporting in that period. If the manager extracts no rent, there is no effect.

In (A.12), we have shown that the manager's rent is lower if she is not incentivized to report truthfully. Thus, there is a range of parameters for which the manager extracts rent when offered incentives for truthful reporting, but not without such incentives, in period one. For this range, an increase in $\overline{U}_1$ makes offering incentives for truthful reporting in period one more attractive (otherwise, there is no effect).

(ii) Suppose that the manager lives for at most two periods and that the first-best condition (22) is not satisfied. If employing a manager for one period only, the board always seeks truthful reporting by Proposition 1. Thus, the proposition is based on the case with $T = 2$. We start by deriving the separate components of (A.5) and then plug into (A.9) and (A.10).

In the final period, the board always seeks truthful reporting by Proposition 1, implying that

$$\begin{aligned} U_2(\theta_1, \mathbf{w}_2) &= e_2(\theta_1)(w_2 + \theta_G \Delta w_2) + (1 - e_2(\theta_1))\left(w_{s,2} + \overline{U}\right) - c \\ &= (\theta_N + e_2(\theta_1)\Delta\theta)\Delta w_2 - c. \end{aligned}$$

were we use that $w_{s,2} = \theta_N \Delta w_2 - \overline{U}$ and $w_2 = 0$. If the board does not seek truthful reporting in the first period, the manager's bonus in the second period must be such that her bonus in period one can be set to zero. Thus, Δw_2 must be such that

$$\begin{aligned} 0 = \Delta w_1 &= \frac{c}{e_1 \Delta\theta} + \delta \frac{U_{t+1}^e(\theta_N, \mathbf{w}) - U_{t+1}^e(\theta_G, \mathbf{w})}{\Delta\theta} \\ &= \frac{c}{e_1 \Delta\theta} + \delta \frac{\begin{array}{c}\theta_N((\theta_N + e_2(\theta_N)\Delta\theta)\Delta w_2 - c) + (1-\theta_N)\overline{U} \\ -\theta_G((\theta_N + e_2(\theta_G)\Delta\theta)\Delta w_2 - c) - (1-\theta_G)\overline{U}\end{array}}{\Delta\theta}, \end{aligned}$$

implying that $\Delta w_2 = \max\left\{\frac{\frac{c}{e_1\Delta\theta} + c + \overline{U}}{\delta(\theta_G e_2(\theta_G) + \theta_N(1 - e_2(\theta_N)))}, \frac{c}{e_2(\theta_N)\Delta\theta}\right\}$. If the second term is larger, $U_1(\mathbf{w}^{nr})$ is independent of $\overline{U}$. If the first term is larger, we have

$$\begin{aligned} \nu_1(\mathbf{w}^{nr}, 2) &= \delta \mathbb{E}_{\theta_0}\left[U_2^e(\theta_t, \mathbf{w})\right] - c - \overline{U}(1+\delta) \\ &= \delta\left(\theta_N\left((e_N\theta_G + (1-e_N)\theta_N)\frac{\left(\frac{c}{e_1\Delta\theta} + c + \overline{U}\right)}{\delta(\theta_G e_G + (1-e_N)\theta_N)} - c\right) + (1-\theta_N)\overline{U}\right) - \overline{U}(1+\delta) \\ &= \theta_N\left(\frac{(e_N\theta_G + (1-e_N)\theta_N)}{\delta(\theta_G e_G + (1-e_N)\theta_N)}\left(\frac{1}{e_1\Delta\theta} + 1\right) - \delta\right)c \\ &\quad + \left(\frac{\theta_N(e_N\theta_G + (1-e_N)\theta_N)}{\delta(\theta_G e_G + (1-e_N)\theta_N)} - 1 - \delta\theta_N\right)\overline{U}. \end{aligned}$$

If the board does not seek truthful reporting in the first period, then by (21) the manager's rent is simply

$$\nu_1(\mathbf{w}^r, 2) = \frac{\theta_N}{\Delta\theta}\left(\frac{1}{e_1} + \delta\left(\frac{1 - \Delta e_j}{e_N}\right)\right)c - \overline{U}(1+\delta).$$

By plugging $\nu_1(\mathbf{w}^r, 2)$ and $\nu_1(\mathbf{w}^{nr}, 2)$ into (A.9), we obtain that

$$\begin{aligned}
& \frac{\partial}{\partial \overline{U}}\left(\frac{-\nu_1(\mathbf{w}^r, 2)}{1-p^r(2)} - \frac{-\nu_1(\mathbf{w}^{nr}2)}{1-p^{nr}(2)}\right) \\
= \quad & \frac{1+\delta}{1-\delta(1-e_1)-\delta^2 e_1} - \frac{-\delta\left(\frac{\theta_N(e_N\theta_G+(1-e_N)\theta_N)}{\delta(\theta_G e_G+(1-e_N)\theta_N)} + (1-\theta_N)\right) + (1+\delta)}{1-\delta(1-e_1\theta_G-(1-e_1)\theta_N) - \delta^2(e_1\theta_G+(1-e_1)\theta_N)} \\
= \quad & \frac{(1+\delta)\delta(\mathbb{E}\theta - e_1) + \left(\theta_N\frac{(e_N\theta_G+(1-e_N)\theta_N)}{(\theta_G e_G+(1-e_N)\theta_N)} + \delta(1-\theta_N)\right)(1+\delta e_1)}{(1-\delta)(1+\delta e_1)(1+\delta\mathbb{E}\theta)} \\
> \quad & \delta\frac{(1+\delta)(\mathbb{E}\theta - e_1) + (1-\theta_N)(1+\delta e_1)}{(1-\delta)(1+\delta e_1)(1+\delta\mathbb{E}\theta)}
\end{aligned}$$

where $\mathbb{E}\theta := e_1\theta_G + (1-e_1)\theta_N$. After some transformations, the last expression becomes

$$\frac{\delta(\theta_N + \theta_G e_1 - 2\theta_N e_1) + (\theta_G - \theta_N)e_1 + 1 - e_1}{(1-\delta)(1+\delta e_1)(1+\delta\mathbb{E}\theta)} > 0.$$

Hence, (A.9) is positive, proving the claim.

Approaching (A.10) similarly, we have

$$\begin{aligned}
& \frac{s_1^r(2)}{1-p^r(2)} - \frac{s_1^{nr}(2)}{1-p^{nr}(2)} \\
= \quad & \frac{x + \left(e_1\theta_G + (1-e_1)\overline{\theta}\right)\Delta x - c + \delta e_1\left(x + \left(e_G\theta_G + (1-e_G)\overline{\theta}\right)\Delta x - c\right)}{(1-\delta)(1+\delta e_1)} \\
& - \frac{x + (e_1\theta_G + (1-e_1)\theta_N)\Delta x - c + \delta\begin{pmatrix} e_1\theta_G\left(x + \left(e_G\theta_G + (1-e_G)\overline{\theta}\right)\Delta x - c\right) \\ +(1-e_1)\theta_N\left(x + \left(e_N\theta_G + (1-e_N)\overline{\theta}\right)\Delta x - c\right)\end{pmatrix}}{(1-\delta)(1+\delta\mathbb{E}\theta)}.
\end{aligned}$$

After some transformations, the terms dependent on Δx become

$$\frac{\Delta x}{(1-\delta)(1+e_1\delta)(1+\delta\mathbb{E}\theta)}\begin{pmatrix} \delta\left(\theta_G - \overline{\theta}\right)\left((e_G - e_1)(e_1 - \mathbb{E}\theta) + \theta_N\Delta e(1-e_1)(1+\delta e_1)\right) \\ +\left(\overline{\theta} - \theta_N\right)(1-e_1)(1+\delta e_1)\end{pmatrix}$$

which is strictly positive even if $e_1 < \mathbb{E}\theta$, as then

$$\begin{aligned}
& (e_G - e_1)(e_1 - \mathbb{E}\theta) + \theta_N\Delta e(1-e_1)(1+\delta e_1) \\
> \quad & \Delta e\left(\theta_N(1-e_1)(1+\delta e_1) - (\mathbb{E}\theta - e_1)\right) \\
> \quad & \Delta e\left(\theta_N(1-e_1) + e_1 - e_1\theta_G - (1-e_1)\theta_N\right) = \Delta e(e_1 - e_1\theta_G) > 0
\end{aligned}$$

Hence, expression (A.10) is positive, proving also the second statement. **Q.E.D.**

Proof of Proposition 5. Using (A.4) to express V^*, we have to show that

$$\frac{\partial}{\partial \overline{U}}\left(V^*\left(T'\right)-V^*\left(T\right)\right)=\frac{\frac{\partial}{\partial \overline{U}}h\left(T'\right)\left(1-p\left(T\right)\right)-\frac{\partial}{\partial \overline{U}}h\left(T\right)\left(1-p\left(T'\right)\right)}{\left(1-p\left(T\right)\right)\left(1-p\left(T'\right)\right)}>0 \tag{A.13}$$

where $T' = T+1$. To obtain the equality in (A.13), we use that when condition (22) does not hold, the manager's expected payoff $U_1(\mathbf{w}, T)$ is independent of $\overline{U}$ (cf. (20)). The increasing difference in (A.13) will imply that the T' offer becomes increasingly more attractive as $\overline{U}$ increases.

Recalling from (A.3) that $h(T) = \frac{\overline{U}}{1-\delta}\left(-\delta^T + p(T)\right) = \frac{\overline{U}}{1-\delta}\left(1-\delta^T+p(T)-1\right)$ and plugging in from (A.7), we can express the numerator in the LHS of (A.13) as

$$\begin{aligned}
& \frac{1}{1-\delta}\left(\left(1-\delta^{T+1}+p\left(T'\right)-1\right)\left(1-p\left(T\right)\right)-\left(1-\delta^{T}+p\left(T\right)-1\right)\left(1-p\left(T'\right)\right)\right)\\
= & \frac{1}{1-\delta}\left(\left(1-\delta^{T+1}\right)\left(1-p\left(T\right)\right)-\left(1-\delta^{T}\right)\left(1-p\left(T'\right)\right)\right)\\
= & \left(1-\delta^{T+1}\right)\left(1+\frac{\delta e_1\left(1-\left(\delta e_G\right)^{T-1}\right)}{1-\delta e_G}\right)-\left(1-\delta^{T}\right)\left(1+\frac{\delta e_1\left(1-\left(\delta e_G\right)^{T}\right)}{1-\delta e_G}\right)
\end{aligned}$$

which after some transformations becomes

$$\begin{aligned}
& \frac{\delta^T}{1-\delta e_G}\left(\left(1-\delta\right)\left(1-\delta e_G\right)+e_1\left(\delta\left(1-\delta\right)+\left(e_G\right)^{T-1}\left(\delta^{T+1}\left(1-e_G\right)-\left(1-\delta e_G\right)\right)\right)\right) \qquad \text{(A.14)}\\
\geq & \ 0.
\end{aligned}$$

To see the last inequality, observe that expression (A.14) is positive if the term in brackets following e_1 is positive. If it is negative, expression (A.14) would decrease in e_1, so it would obtain its minimum value for $e_1 = e_G$

$$\delta^T\left(\frac{\left(1-\delta+\left(e_G\right)^T\delta^{T+1}\left(1-e_G\right)\right)}{1-\delta e_G}-\left(e_G\right)^T\right).$$

The sign of this expression is the same as the sign of the term in brackets. The minimum of that term is zero, which is obtained for $\delta = 1$.[27] Hence, for any T, $\delta \in [0,1]$, $e_G \in [0,1]$,

[27] We have

$$\frac{\partial}{\partial \delta}\left(\frac{\left(1-\delta+\left(\delta e_G\right)^T\delta\left(1-e_G\right)\right)}{1-\delta e_G}-\left(e_G\right)^T\right)=\left(1-e_G\right)\frac{T\left(\delta e_G\right)^T\left(1-\delta e_G\right)+\left(\delta e_G\right)^T-1}{\left(1-\delta e_G\right)^2}$$

This term is nonpositive, as the maximum value (of zero) of the numerator is obtained for $\delta e_G = 1$.

$e_1 \in [0, e_G]$, (A.14) is (weakly) positive, and it is strictly positive for $e_G < 1$ and $\delta < 1$, implying that we have strictly increasing differences in (A.13).

Next, we argue that

$$\frac{\partial}{\partial \Delta x}\left(V^*(T') - V^*(T)\right) = \frac{\frac{\partial}{\partial \Delta x} s_1(T')(1-p(T)) - \frac{\partial}{\partial \Delta x} s_1(T)(1-p(T'))}{(1-p(T))(1-p(T'))} > 0. \quad \text{(A.15)}$$

Observe first that from (A.6), we have

$$\frac{\partial}{\partial \Delta x} s_1(T) = \left(\overline{\theta} + e_1\left(\theta_G - \overline{\theta}\right)\right) + \delta e_1 \frac{\left(1 - e(\theta_G)^{T-1}\delta^{T-1}\right)}{1 - e(\theta_G)\delta}\left(\overline{\theta} + e(\theta_G)\left(\theta_G - \overline{\theta}\right)\right).$$

Plugging in for $p(T)$, (A.15) becomes

$$\begin{aligned}
&\left(\left(\overline{\theta} + e_1\left(\theta_G - \overline{\theta}\right)\right) + \delta e_1 \frac{\left(1 - e_G^T\delta^T\right)}{1 - e_G\delta}\left(\overline{\theta} + e_G\left(\theta_G - \overline{\theta}\right)\right)\right)(1-\delta)\left(1 + \frac{\delta e_1\left(1 - e_G^{T-1}\delta^{T-1}\right)}{1 - e_G\delta}\right) \\
&- \left(\left(\overline{\theta} + e_1\left(\theta_G - \overline{\theta}\right)\right) + \delta e_1 \frac{\left(1 - e_G^{T-1}\delta^{T-1}\right)}{1 - e_G\delta}\left(\overline{\theta} + e_G\left(\theta_G - \overline{\theta}\right)\right)\right)(1-\delta)\left(1 + \frac{\delta e_1\left(1 - e_G^T\delta^T\right)}{1 - e_G\delta}\right) \\
= \; & \delta^T e_1 (e_G - e_1) e^{T-1}(1-\delta)\left(\theta_G - \overline{\theta}\right) > 0
\end{aligned}$$

proving the claim. **Q.E.D.**

Proof of Proposition 6. Recall from Lemma 1 that we can express

$$V^*(T) = \frac{s_1(T) + \frac{\overline{U}}{1-\delta}\left(p(T) - \delta^T\right) - U_1(T)}{1 - p(T)}.$$

Hence, $\frac{\partial}{\partial \overline{U}} V^*(T) > 0$ as long as $\left(p(T) - \delta^T\right) > (1-\delta)\frac{\partial}{\partial \overline{U}} U_1(T)$. This is trivially satisfied if there is always truthful reporting and the first-best condition (22) is not satisfied, as then $U_1(T)$ is independent of $\overline{U}$. **Q.E.D.**

Appendix B Supplementary Material

Lemma B.1 *If it is not optimal to learn the manger's fit in period $t-1$, it would also not be optimal to learn that fit in the beginning of the following period t.*

Proof of Lemma B.1. Suppose that $\mathbf{w}$ is an optimal contract that does not induce truthful reporting in period $t-1$, but induces truthful reporting in the beginning of period t. Let $\widetilde{w}_{s,t}$ be the severance pay paid to the manager in the beginning of period t for disclosing that her fit realization in $t-1$ is θ_N. Truthful reporting at the beginning of period t after no truthful reporting in period $t-1$ requires that

$$U_t(\theta_G, \mathbf{w}) \geq \sum_{j=t}^{T} \delta^{j-t} \overline{U}_j + \widetilde{w}_{s,t} = U_t(\theta_N, \mathbf{w}). \tag{B.1}$$

Multiplying all sides of (B.1) with δ and adding $w_{t-1} + \theta_G \Delta w_{t-1}$ on both sides of the inequality, we obtain

$$\begin{aligned} & w_{t-1} + \theta_G \Delta w_{t-1} + \delta U_t(\theta_G, \mathbf{w}) \qquad\qquad (B.2) \\ \geq\ & w_{t-1} + \theta_G \Delta w_{t-1} + \delta \left(\sum_{j=t}^{T} \delta^{j-t} \overline{U}_j + \widetilde{w}_{s,t} \right) \\ =\ & w_{t-1} + \theta_N \Delta w_{t-1} + \delta \left(\sum_{j=t}^{T} \delta^{j-t} \overline{U}_j + \widetilde{w}_{s,t} \right) + \Delta\theta \Delta w_{t-1} \\ =\ & \sum_{j=t-1}^{T} \delta^{j-t+1} \overline{U}_j + w_{s,t-1} + \widetilde{\omega}_{t-1} + \Delta\theta \Delta w_{t-1} \end{aligned}$$

where the last inequality follows from the period $t-1$ analogue of (11); where we use that $U_t(\theta_N, \mathbf{w}) = \sum_{j=t}^{T} \delta^{j-t} \overline{U}_j + \widetilde{w}_{s,t}$ (cf. (B.1)); and where we define $\widetilde{\omega}_{t-1}$ as the difference between the left- and the right-hand-side of the period $t-1$ analogue of (11).[28] Consider now the requirements for truth-telling in an equilibrium in which the manager reports truthfully already in period $t-1$

$$w_{t-1} + \theta_G \Delta w_{t-1} + \delta U_t(\theta_G, \mathbf{w}) \geq w_{s,t-1} + \sum_{j=t-1}^{T} \delta^{j-t+1} \overline{U}_j \geq w_{t-1} + \theta_N \Delta w_{t-1} + \delta U_t(\theta_N, \mathbf{w}).$$

[28] Note, that all subscripts are with respect to $t-1$ rather than t as in (11).

From the first and the last line of (B.2), we see that a manager with fit θ_G would would not have mimicked a manager with fit θ_N if she were asked to report that fit in period $t-1$ (cf. (6)) given a severance pay offer of $\widehat{w}_{s,t-1} := w_{s,t-1} + \widetilde{\omega}_{t-1}$. Furthermore, from the third and the fourth line of (B.2), we obtain that a manager with fit θ_N would have been indifferent to disclosing her fit also in period $t-1$ (cf. (7)) if she was compensated for doing so with $\widehat{w}_{s,t-1} = w_{s,t-1} + \widetilde{\omega}_{t-1}$. Thus, the manager's expected rent is the same regardless of whether she reports in period $t-1$ or in the beginning of period t. However, learning the manager's fit in period $t-1$ increases the board's payoff, contradicting that $\mathbf{w}$ is optimal and proving the claim. **Q.E.D.**

Binding constraints in Proposition 1. For the proofs below, it is helpful to reformulate conditions (6)–(11) as follows:

(i) Observe, first that if the constraint that the manager invests in firm-specific human capital (8) is satisfied, so is the incentive constraint to reveal type θ_G (6). Thus, the relevant constraints are (7), (8), together with the feasibility constraint $\Delta w_t \geq 0$. These constraints can be restated as

$$\begin{aligned} & \frac{w_{s,t} - w_t + \sum_{j=t}^{T} \delta^{j-t}\overline{U}_j - \delta U_{t+1}(\theta_N, \mathbf{w})}{\theta_N} \\ \geq \quad & \Delta w_t \geq \max\left\{0, \frac{\frac{c}{e_t(\theta_{t-1})} + w_{s,t} - w_t - \delta U_{t+1}(\theta_G, \mathbf{w}) + \sum_{j=t}^{T} \delta^{j-t}\overline{U}_j}{\theta_G}\right\}. \end{aligned} \tag{B.3}$$

The first inequality together with the feasibility constraint on $w_{s.t}$ can be stated as

$$w_{s,t} \geq \max\left\{0, w_t - \sum_{j=t}^{T} \delta^{j-t}\overline{U}_j + \theta_N \Delta w_t + \delta U_{t+1}(\theta_N, \mathbf{w})\right\}. \tag{B.4}$$

(ii) From (10), (11), and feasibility, we have:

$$\Delta w_t \;\geq\; \max\left\{0, \frac{\frac{c}{e_t(\theta_{t-1})} + \delta U^e_{t+1}(\theta_N, \mathbf{w}) - \delta U^e_{t+1}(\theta_G, \mathbf{w})}{\Delta\theta}\right\} \tag{B.5}$$

$$w_t \;\geq\; \max\left\{0, \sum_{j=t}^{T} \delta^{j-t}\overline{U}_j + w_{s,t} - \delta U^e_{t+1}(\theta_N, \mathbf{w}) - \theta_N \Delta w_t\right\}. \tag{B.6}$$

In what follows, we take the board's truthful reporting policy as given and derive the structure of the compensation contract that minimizes $U_1(\mathbf{w})$, while satisfying conditions (B.3)–(B.6). The proof initially assumes that the board seeks to minimize the manager's expected payoff U_t in any given period t for any given reporting strategy the board seeks to implement. At the end of the proof, it is shown that minimizing U_t helps to minimize U_{t-1} and, thus, preceding recursively, one minimizes the manager's expected payoff all the way to period one. This achieves the objective of maximizing the board's expected payoff in (5) for the chosen reporting policy. The proof boils down to showing the following claim:

Lemma B.2 *(i) If the board seeks truthful reporting in period t, condition (B.4) is binding. Condition (B.3) is also binding (for $e_t(\theta_{t-1}) = e_t(\theta_N)$) if the board seeks truthful reporting in the preceding period. (ii) Conditions (B.5)–(B.6) are binding in a period without truthful reporting (for $e_t(\theta_{t-1}) = e_t(\theta_N)$).*

We consider four main cases depending on whether there is truthful reporting in period t, and $t+1$. For these proofs, it is assumed that there is truthful reporting in period $t-1$, but towards the end we show that the cases in which there is no truthful reporting in period $t-1$ lead to the same results.

Truthful reporting in period t. We show the claim by induction by arguing first that it is always satisfied in period 1. We argue to a contradiction. Suppose that the claim is not true and that the board seeks to implement truthful reporting in period 1. Recall that $e_1(\theta_G) = e_1(\theta_N) = e_1$ in period $t = 1$. Setting $\{w_1, \Delta w_1, w_{s,1}\}$ to their minimal values maximizes the board's expected payoff, as it minimizes the manager's payoff, without affecting her incentives in the following periods. Thus, in period one (B.3), (B.4), and $w_1 \geq 0$ are satisfied with equality.

We now argue that if the claim is satisfied for all periods up to period t, then it must also be satisfied in period $t+1$. Recall that for any given reporting policy, the board seeks to minimize the manager's payoff U_{t+1}, U_t, etc. The problem with minimizing $\{w_{t+1}, \Delta w_{t+1}, w_{s,t+1}\}$ by satisfying (B.3) and (B.4) in period $t+1$ with equality (as dictated by Proposition 1) is that we need to take into account how these contract terms affect the manager's payoff (over her continuation payoffs) also in the preceding periods.

Case 1: Truthful reporting in periods t and $t+1$. The manager's expected payoff in period t is

$$U_t(\theta_{t-1}, \mathbf{w}) = e_t(\theta_{t-1})(w_t + \theta_G \Delta w_t + \delta U_{t+1}(\theta_G, \mathbf{w})) + (1 - e(\theta_{t-1}))\left(w_{s,t} + \sum_{j=t}^{T} \delta^{j-t} \overline{U}_j\right) - c.$$

Using the induction hypothesis (15)–(17) to plug into w_t, Δw_t, and $w_{s,t}$, this payoff becomes

$$
\begin{aligned}
& e_t\left(\theta_{t-1}\right)\left(w_t+\frac{\theta_G c}{e_t\left(\theta_N\right) \Delta \theta}+\frac{\theta_G \delta U_{t+1}\left(\theta_N, \mathbf{w}\right)-\theta_N \delta U_{t+1}\left(\theta_G, \mathbf{w}\right)}{\Delta \theta}\right) \\
& +\left(1-e\left(\theta_{t-1}\right)\right) \max \left\{\sum_{j=t}^T \delta^{j-t} \overline{U}_j, \frac{\theta_N c}{e_t\left(\theta_N\right) \Delta \theta}+\delta \frac{\theta_G U_{t+1}\left(\theta_N, \mathbf{w}\right)-\theta_N U_{t+1}\left(\theta_G, \mathbf{w}\right)}{\Delta \theta}-c\right\} .
\end{aligned}
$$

In what follows, it is shown that choosing $\{w_{s,t+1}, w_{t+1}, \Delta w_{t+1}\}$ as dictated in Proposition 1 minimizes

$$
A_{t+1}(\mathbf{w}) := \theta_G U_{t+1}\left(\theta_N, \mathbf{w}\right)-\theta_N U_{t+1}\left(\theta_G, \mathbf{w}\right), \tag{B.7}
$$

and, thus, minimizes $U_t\left(\theta_{t-1}, \mathbf{w}\right)$.

Observe that $U_{t+1}\left(\theta_N, \mathbf{w}\right)$ is type θ_N's off-equilibrium continuation payoff if she mimics θ_G and stays also in $t+1$. We now argue that the manager would exert effort also in this case. If she would not do so, her fit would be θ_N in $t+1$, which would give her a payoff of $U_{t+1}\left(\theta_N, \mathbf{w}\right) = w_{s,t+1}+\sum_{j=t+1}^T \delta^{j-t-1} \overline{U}_j$. But then, it would be optimal for the board to increase w_{t+1} or Δw_{t+1}, since it would only affect $U_{t+1}\left(\theta_G, \mathbf{w}\right)$ and would, thus, decrease (B.7). But sufficiently increasing Δw_{t+1} would make investing in firm-specific human capital attractive also for θ_C, proving the claim. Hence, we must have $U_{t+1}\left(\theta_N, \mathbf{w}\right) \geq w_{s,t+1}+\sum_{j=t+1}^T \delta^{j-t-1} \overline{U}_j$, which is equivalent to

$$
\Delta w_{t+1} \geq \frac{\frac{c}{e_{t+1}\left(\theta_N\right)}-w_{t+1}+w_{s,t+1}+\sum_{j=t+1}^T \delta^{j-t-1} \overline{U}_j-\delta U_{t+2}\left(\theta_G, \mathbf{w}\right)}{\theta_G}. \tag{B.8}
$$

Expression (B.8) is the $t+1$ analogue of (B.3). Thus, (B.8) guarantees truthful reporting of θ_G as well as incentives for investing in firm-specific human capital in $t+1$ regardless of the manager's fit θ_t in the preceding period. Recall that truthful reporting in period $t+1$ would further require (analogous to the first inequality in (B.3)) that

$$
\frac{w_{s,t+1}-w_{t+1}+\sum_{j=t+1}^T \delta^{j-t-1} \overline{U}_j-\delta U_{t+2}\left(\theta_N, \mathbf{w}\right)}{\theta_N} \geq \Delta w_{t+1}. \tag{B.9}
$$

In what follows, we show that (B.8), (B.9), and $w_{t+1} \geq 0$ will be binding.

To find the contract parameters $\{w_{s,t+1}, w_{t+1}, \Delta w_{t+1}\}$ that minimize (B.7), subject to (B.8), (B.9), and $w_{s,t+1}, w_{t+1}, \Delta w_{t+1} \geq 0$, we apply Kuhn Tucker's Theorem. Define the function

$$
\begin{aligned}
& \mathcal{L}(\mathbf{w}, \Lambda) \\
= \; & -\left(\theta_G e_{t+1}(\theta_N) - \theta_N e_{t+1}(\theta_G)\right)\left(w_{t+1} + \theta_G \Delta w_{t+1} + \delta U_{t+2}(\theta_G, \mathbf{w})\right) \\
& -\left(\theta_G\left(1 - e_{t+1}(\theta_N)\right) - \theta_N\left(1 - e_{t+1}(\theta_G)\right)\right)\left(w_{s,t+1} + \sum_{j=t+1}^{T} \delta^{j-t-1} \overline{U}_j\right) + \Delta\theta c \\
& +\lambda\left(\Delta w_{t+1} - \frac{\frac{c}{e_{t+1}(\theta_N)} - w_{t+1} + w_{s,t+1} + \sum_{j=t+1}^{T} \delta^{j-t-1}\overline{U}_j - \delta U_{t+2}\left(e_{t+2}(\theta_G), \mathbf{w}\right)}{\theta_G}\right) \\
& +\mu\left(\frac{w_{s,t+1} - w_{t+1} + \sum_{j=t+1}^{T} \delta^{j-t-1}\overline{U}_j - \delta U_{t+2}(\theta_N, \mathbf{w})}{\theta_N} - \Delta w_{t+1}\right) \\
& +\kappa w_{s,t+1} + \rho w_{t+1} + \chi \Delta w_{t+1}
\end{aligned}
$$

where the first two lines correspond to the negative of (B.7) (as the objective is to minimize (B.7)), and $\Lambda = \{\lambda, \mu, \kappa, \rho, \chi\}$ is the set of weakly positive Kuhn Tucker multipliers. Taking the first order conditions

$$
\begin{aligned}
\frac{\partial \mathcal{L}(\mathbf{w}, \Lambda)}{\partial w_{s,t+1}} &= 0 = -\left(\theta_G\left(1 - e_{t+1}(\theta_N)\right) - \theta_N\left(1 - e_{t+1}(\theta_G)\right)\right) - \lambda\frac{1}{\theta_G} + \mu\frac{1}{\theta_N} + \kappa \\
\frac{\partial \mathcal{L}(\mathbf{w}, \Lambda)}{\partial \Delta w_{t+1}} &= 0 = -\left(\theta_G e_{t+1}(\theta_N) - \theta_N e_{t+1}(\theta_G)\right)\theta_G + \lambda - \mu + \chi \\
\frac{\partial \mathcal{L}(\mathbf{w}, \Lambda)}{\partial w_{t+1}} &= 0 = -\left(\theta_G e_{t+1}(\theta_N) - \theta_N e_{t+1}(\theta_G)\right) + \lambda\frac{1}{\theta_G} - \mu\frac{1}{\theta_N} + \rho,
\end{aligned}
$$

we obtain from the second and third conditions that $\theta_G \rho = \mu \frac{\Delta\theta}{\theta_N} + \chi$. From the first and third conditions, we further have $\kappa + \rho = \Delta\theta$. Finally, from the second condition, we have

$$
\lambda = \left(\theta_G e_{t+1}(\theta_N) - \theta_N e_{t+1}(\theta_G)\right)\theta_G + \mu - \chi.
$$

Assuming now that $\Delta w_{t+1} \geq 0$ and $w_{s,t+1} \geq 0$ are not binding—i.e., $\chi = 0$ and $\kappa = 0$—we have: $\rho = \Delta\theta$, $\mu = \theta_G \theta_N$, and $\lambda = \left(\left(\theta_G e_{t+1}(\theta_N) - \theta_N e_{t+1}(\theta_G)\right) + \theta_N\right)\theta_G > 0$. Thus, $\rho, \mu, \lambda > 0$, implying that (B.8), (B.9), $w_{t+1} \geq 0$ must be binding. It is now straightforward to verify that this implies

$$
\begin{aligned}
\Delta w_{t+1} &= \frac{c}{e_{t+1}(\theta_N)\Delta\theta} + \frac{\delta U_{t+2}(\theta_N, \mathbf{w}) - \delta U_{t+2}(\theta_G, \mathbf{w})}{\Delta\theta} \\
w_{s,t+1} &= \theta_N \Delta w_{t+1} + \delta U_{t+2}(\theta_N, \mathbf{w}) - \sum_{j=t+1}^{T} \delta^{j-t-1} \overline{U}_j,
\end{aligned}
$$

which is the $t+1$ analogue of (15)–(17), as was to be shown.

If, instead $w_{s,t+1} \geq 0$ is binding, the manager extracts no rent in period $t+1$. For this case we argue in the main text that this would also imply that she extracts no rent in period t and the board will incentivize truthful reporting in all preceding periods following Proposition 1, making the proposed contract optimal. The same arguments will apply to Case 3 below. We verify below that $\Delta w_{t+1} > 0$.

Case 2: Truthful reporting in period t and no truthful reporting in period $t+1$. Similar to case 1, we can show that the board would like to minimize (B.7), subject to $U_{t+1}(\theta_N, \mathbf{w}) \geq w_{s,t+1} + \sum_{j=t+1}^{T} \delta^{j-t-1}\overline{U}_j$. The difference is that, absent truthful reporting in $t+1$, the manager's payoff in that period is

$$\begin{aligned} U_{t+1}(\theta_t, \mathbf{w}) &= w_{t+1} + (\theta_N + e_{t+1}(\theta_t)\Delta\theta)\Delta w_{t+1} - c \\ &\quad + e_{t+1}(\theta_t)\delta U^e_{t+2}(\theta_G, \mathbf{w}) + (1 - e_{t+1}(\theta_t))\delta U^e_{t+2}(\theta_N, \mathbf{w}). \end{aligned} \tag{B.10}$$

We now argue that it would be optimal that the manager invests in firm specific human capital also out-of equilibrium (i.e., if she misreports θ_N in t). Suppose not, then $U_{t+1}(\theta_N, \mathbf{w}) = w_{t+1} + \theta_N \Delta w_{t+1} + \delta U^e_{t+2}(\theta_N, \mathbf{w})$. But then to minimize (B.7), it would be optimal to increase Δw_{t+1}.[29] Just as in Case 1, this would make investing in firm-specific capital more attractive, so that eventually, $U_{t+1}(\theta_N, \mathbf{w})$ must be

$$w_{t+1} + (\theta_N + e_{t+1}(\theta_N)\Delta\theta)\Delta w_{t+1} + \mathbb{E}_{\theta_t}\left[U^e_{t+2}(\theta_{t+1}, \mathbf{w})\right] - c \geq w_{s,t+1} + \sum_{j=t+1}^{T} \delta^{j-t-1}\overline{U}_j. \tag{B.11}$$

There are now no confounding effects between minimizing (B.7) and minimizing $\{w_{t+1}, \Delta w_{t+1}\}$, as plugging (B.10) into (B.7), we obtain

$$\begin{aligned} \frac{\partial A_{t+1}(\mathbf{w})}{\partial w_{t+1}} &= \Delta\theta \\ \frac{\partial A_{t+1}(\mathbf{w})}{\partial \Delta w_{t+1}} &= (\theta_G(\theta_N + e_{t+1}(\theta_N)\Delta\theta) - \theta_N(\theta_N + e_{t+1}(\theta_G)\Delta\theta)) \\ &= \theta_N\Delta\theta - e_{t+1}(\theta_G)\theta_N\Delta\theta + e_{t+1}(\theta_N)\theta_G\Delta\theta > 0. \end{aligned}$$

Thus, $A_{t+1}(\mathbf{w})$ increases in w_{t+1} and Δw_{t+1}, and to minimize (B.7), we have to minimize w_{t+1} and Δw_{t+1} subject to (B.11) and the analogue of (B.5)–(B.6) for period $t+1$ (for θ_N), as was to be shown. It is now also clear that it is optimal to set $w_{s,t+1} = 0$, as this relaxes

[29] We would have then $\frac{\partial A_{t+1}(\mathbf{w})}{\partial \Delta w_{t+1}} = (\theta_G\theta_N - \theta_N(\theta_N + e_{t+1}(\theta_N)\Delta\theta)) < 0$.

(B.11). We verify at the end that for these conditions, we will have that $\Delta w_{t+1} = 0$.

Finally, using some of the derivations in Section 3.2, it can be verified that for the contract specified in the Lemma, we would always have $\Delta w_t > 0$ (and so $\chi = 0$ in case 1 above) when there is truthful reporting in period t. To see this plug into Δw_t from (20) in case of truthful reporting in $t+1$ to obtain

$$\Delta w_t = \left(\frac{1}{e_t(\theta_N)\,\Delta\theta} - \delta \frac{\Delta e_{t+1}}{e_{t+1}(\theta_N)\,\Delta\theta} \right) c > 0.$$

In case of no truthful reporting in $t+1$, we obtain the same expression by plugging in from (A.11). **Q.E.D.**

No truthful reporting in period t. We continue in the steps laid out above. Suppose we have no truthful reporting in t. The aim is to minimize the manager's payoff

$$\begin{aligned} U_t(\theta_{t-1}, \mathbf{w}) \;&=\; w_t + (\theta_N + e_t(\theta_{t-1})\,\Delta\theta)\,\Delta w_t - c \\ &\quad + e_t(\theta_{t-1})\,\delta U^e_{t+1}(\theta_G, \mathbf{w}) + (1 - e_t(\theta_{t-1}))\,\delta U^e_{t+1}(\theta_N, \mathbf{w}). \end{aligned} \tag{B.12}$$

subject to (B.5) and (B.6). Clearly, in $t = 1$, the choice of w_1, Δw_1, and $w_{s,1}$ has no effect on the payoffs in neither previous (as there are none) nor following periods. Thus, the aim is to minimize both Δw_1 and w_1, implying that conditions (B.5) and (B.6) will hold with equality. This proves the first induction step.

Case 3: No truthful reporting in period t and truthful reporting in period $t+1$. Observe that if choosing the compensation contract both in period t and $t+1$ as dictated in Proposition 1, would imply that $w_t > 0$, the manager's participation constraint in period t is binding—i.e., $U_t(\theta_{t-1}, \mathbf{w}) = \sum_{j=t}^{T} \delta^{j-t}\overline{U}_j$. Thus, the $t+1$ choice must indeed have been optimal. Suppose, instead, that the zero lower bound on w_t is binding, i.e., $w_t = 0$. Using the induction hypothesis that (B.5) is binding to plug into the manager's payoff (B.12) in period t, we have

$$\begin{aligned} &(\theta_N + e_t(\theta_{t-1})\,\Delta\theta) \max\left\{ 0, \frac{\frac{c}{e_t(\theta_N)} + \delta\left(U^e_{t+1}(\theta_N, \mathbf{w}) - U^e_{t+1}(\theta_G, \mathbf{w})\right)}{\Delta\theta} - c \right\} \\ &+ e_t(\theta_{t-1})\,\delta U^e_{t+1}(\theta_G, \mathbf{w}) + (1 - e_t(\theta_{t-1}))\,\delta U^e_{t+1}(\theta_N, \mathbf{w}) \\ = &\begin{cases} \frac{\theta_G \delta U^e_{t+1}(\theta_N, \mathbf{w}) - \theta_N U^e_{t+1}(\theta_G, \mathbf{w})}{\Delta\theta} + \left(\frac{e_t(\theta_{t-1})}{e(\theta_N)} - 1 + \frac{\theta_N}{e_t(\theta_N)\Delta\theta} \right) c & \text{if } \Delta w_t \geq 0 \\ e_t(\theta_{t-1})\,\delta U^e_{t+1}(\theta_G, \mathbf{w}) + (1 - e_t(\theta_{t-1}))\,\delta U^e_{t+1}(\theta_N, \mathbf{w}) - c & \text{if } \Delta w_t = 0 \end{cases} \end{aligned} \tag{B.13}$$

Clearly if $\Delta w_t = 0$, the objective would be to minimize all of $\{w_{s,t+1} w_{t+1}, \Delta w_{t+1}\}$ subject to (B.8), (B.9), and $w_{t+1} \geq 0$, which would prove the claim. Thus, it remains to consider the case in which $\Delta w_t \geq 0$. From (B.5) and the requirement that it should apply to both θ_N and θ_G, $\Delta w_t \geq 0$ would require that

$$\begin{aligned} 0 &\leq \frac{\frac{c}{e_t(\theta_N)} + \delta\left(U^e_{t+1}(\theta_N, \mathbf{w}) - U^e_{t+1}(\theta_G, \mathbf{w})\right)}{\Delta\theta} \\ &= \frac{\frac{c}{e_t(\theta_N)} + \delta\left(\theta_N U_{t+1}(\theta_N, \mathbf{w}) - \theta_G U_{t+1}(\theta_G, \mathbf{w}) + \Delta\theta \sum_{j=t+1}^{T} \delta^{j-t-1} \overline{U}_j\right)}{\Delta\theta}. \end{aligned} \tag{B.14}$$

To minimize the first line of (B.13), we need to minimize

$$\begin{aligned} & \theta_G U^e_{t+1}(\theta_N, \mathbf{w}) - \theta_N U^e_{t+1}(\theta_G, \mathbf{w}) \\ = \;& \theta_G \theta_N \left(U_{t+1}(\theta_N, \mathbf{w}) - U_{t+1}(\theta_G, \mathbf{w})\right) + \Delta\theta \sum_{j=t+1}^{T} \delta^{j-t-1} \overline{U}_j \end{aligned} \tag{B.15}$$

or, thus, equivalently to minimize

$$U_{t+1}(\theta_N, \mathbf{w}) - U_{t+1}(\theta_G, \mathbf{w}) \tag{B.16}$$

subject to (B.8), (B.9), (B.14), and $w_{s,t+1}, w_{t+1}, \Delta w_{t+1} \geq 0$. Hence, define

$$\begin{aligned} & \mathcal{L}(\mathbf{w}, \Lambda) \\ = \;& -\left(e_{t+1}(\theta_N) - e_{t+1}(\theta_G)\right)\left(w_{t+1} + \theta_G \Delta w_{t+1} + \delta U_{t+2}(\theta_G, \mathbf{w})\right) \\ & -\left(\left(1 - e_{t+1}(\theta_N)\right) - \left(1 - e_{t+1}(\theta_G)\right)\right)\left(w_{s,t+1} + \sum_{j=t+1}^{T} \delta^{j-t-1} \overline{U}_j\right) \\ & +\lambda\left(\Delta w_{t+1} - \frac{\frac{c}{e_{t+1}(\theta_N)} - w_{t+1} + w_{s,t+1} + \sum_{j=t+1}^{T} \delta^{j-t-1} \overline{U}_j - \delta U_{t+2}(\theta_G, \mathbf{w})}{\theta_G}\right) \\ & +\mu\left(\frac{w_{s,t+1} - w_{t+1} + \sum_{j=t+1}^{T} \delta^{j-t-1} \overline{U}_j - \delta U_{t+2}(\theta_N, \mathbf{w})}{\theta_N} - \Delta w_{t+1}\right) \\ & +\kappa w_{s,t+1} + \rho w_{t+1} + \chi \Delta w_{t+1} \\ & +\sigma\left(\theta_N U_{t+1}(\theta_G, \mathbf{w}) - \theta_G U_{t+1}(\theta_G, \mathbf{w}) + \Delta\theta \sum_{j=t+1}^{T} \delta^{j-t-1} \overline{U}_j + \frac{c}{\delta e(\theta_G)}\right), \end{aligned}$$

where $\Lambda = \{\lambda, \mu, \kappa, \rho, \chi, \sigma\}$ is the set of weakly positive Kuhn Tucker multipliers. Taking the first order conditions

$$\frac{\partial \mathcal{L}(\mathbf{w},\Lambda)}{\partial w_{s,t+1}} = 0 = \quad -\left(\left(1-e_{t+1}(\theta_N)\right)-\left(1-e_{t+1}(\theta_G)\right)\right)$$
$$+\sigma\left(\theta_N\left(1-e_{t+1}(\theta_N)\right)-\theta_G\left(1-e_{t+1}(\theta_G)\right)\right)-\lambda\frac{1}{\theta_G}+\mu\frac{1}{\theta_N}+\kappa$$
$$\frac{\partial \mathcal{L}(\mathbf{w},\Lambda)}{\partial \Delta w_{t+1}} = 0 = \quad -\left(e_{t+1}(\theta_N)-e_{t+1}(\theta_G)\right)\theta_G$$
$$+\sigma\left(\theta_N e_{t+1}(\theta_N)-\theta_G e_{t+1}(\theta_G)\right)\theta_G+\lambda-\mu+\chi$$
$$\frac{\partial \mathcal{L}(\mathbf{w},\Lambda)}{\partial w_{t+1}} = 0 = \quad -\left(e_{t+1}(\theta_N)-e_{t+1}(\theta_G)\right)$$
$$+\sigma\left(\theta_N e_{t+1}(\theta_N)-\theta_G e_{t+1}(\theta_G)\right)+\lambda\frac{1}{\theta_G}-\mu\frac{1}{\theta_N}+\rho$$

we obtain from the second and third condition that $\mu\frac{\Delta\theta}{\theta_N}=\theta_G\rho-\chi$. From the first and third condition, we have $\sigma=\frac{\kappa+\rho}{\Delta\theta}$. Hence, if $\rho>0$ then $\sigma>0$, implying that (B.14) is binding and $\Delta w_t=0$. Otherwise, if $\Delta w_t>0$, (B.14) must be lax and we must have $\sigma=0$. However, this would imply that $\kappa=\rho=0$, and further that $\mu=\chi=0$. But then the RHS of the second first order condition would be strictly positive, leading to a contradiction. Hence, we must have $\sigma>0$, implying that it is optimal to increase Δw_{t+1} until (B.14) binds and we have $\Delta w_t=0$. Suppose now that $\kappa=0$. In this case, $\sigma=\frac{\kappa+\rho}{\Delta\theta}$ implies that $\rho>0$, which then implies that $\mu>0$. If, instead, $\kappa>0$ (i.e., $w_{s,t+1}=0$), the proposed contract is still optimal, as in this case the manager's payoff is equal to her outside option and she extracts no rent.

Case 4: No truthful reporting in periods t **and** $t+1$**.** Observe that, if setting $\{w_{s,t+1}w_{t+1},\Delta w_{t+1}\}$ as dictated by Proposition 1 would imply that $w_t>0$, the manager extracts no rent. Hence, this is strategy is (weakly) optimal. Suppose now that the zero-lower bound $w_t\geq 0$ is binding, i.e., $w_t=0$. In this case, (B.13) implies that the board's objective is to minimize

$$\begin{array}{ll} U_{t+1}(\theta_N,\mathbf{w})-U_{t+1}(\theta_G,\mathbf{w}) & \text{if } \Delta w_t\geq 0 \\ e_t(\theta_{t-1})\,\delta U^e_{t+1}(\theta_G,\mathbf{w})+(1-e_t(\theta_{t-1}))\,\delta U^e_{t+1}(\theta_N,\mathbf{w}) & \text{if } \Delta w_t=0 \end{array}, \tag{B.17}$$

subject to the $t+1$ equivalent of (B.5) and (B.6) and the feasibility restrictions. In the latter case ($\Delta w_t=0$), it is clearly optimal to minimize w_{t+1} and Δw_{t+1}, proving the claim for this case. To show the former case ($\Delta w_t \geq 0$), we now argue similar to case 3. Since

$$\begin{aligned} U_{t+1}(\theta_t, \mathbf{w}) &= w_{t+1} + (\theta_N + e_{t+1}(\theta_t)\Delta\theta)\Delta w_{t+1} - c \\ &\quad + e_t(\theta_t)\theta_G \delta U_{t+2}(\theta_G, \mathbf{w}) + (1 - e_{t+1}(\theta_t))\theta_N \delta U_{t+2}(\theta_N, \mathbf{w}) \\ &\quad + (e_t(\theta_t)(1-\theta_G) + (1 - e_{t+1}(\theta_t))(1-\theta_N)) \left(\sum_{j=t+2}^{T} \delta^{j-t-2} \overline{U}_j \right), \end{aligned}$$

neglecting all terms that do not depend on $\{w_{s,t+1} w_{t+1}, \Delta w_{t+1}\}$ from this payoff, to minimize the first line in (B.17), we can define

$$\begin{aligned} &\mathcal{L}(\mathbf{w}, \Lambda) \\ = &- (e_{t+1}(\theta_N) - e_{t+1}(\theta_G))\Delta\theta\Delta w_{t+1} \\ &+ \lambda \left(\Delta\theta\Delta w_{t+1} + \delta(e_t(\theta_t) U^e_{t+2}(\theta_G, \mathbf{w}) - U^e_{t+2}(\theta_N, \mathbf{w})) - \frac{c}{e_t(\theta_t)} \right) \\ &+ \mu \left(w_{t+1} + \theta_N \Delta w_{t+1} + \delta U^e_{t+2}(\theta_N, \mathbf{w}) - \sum_{j=t+1}^{T} \delta^{j-t-1} \overline{U}_j - w_{s,t+1} \right) \\ &+ \kappa w_{s,t+1} + \rho w_{t+1} + \chi \Delta w_{t+1} \\ &+ \sigma \left(\theta_N U_{t+1}(\theta_G, \mathbf{w}) - \theta_G U_{t+1}(\theta_N, \mathbf{w}) + \Delta\theta \sum_{j=t+1}^{T} \delta^{j-t-1} \overline{U}_j + \frac{c}{\delta e(\theta_N)} \right). \end{aligned}$$

Taking the first order condition with respect to Δw_{t+1}, we have

$$\begin{aligned} \frac{\partial \mathcal{L}(\mathbf{w}, \Lambda)}{\partial \Delta w_{t+1}} = 0 = \quad & - (e_{t+1}(\theta_N) - e_{t+1}(\theta_G))\Delta\theta + \lambda\Delta\theta + \mu\theta_N + \chi \\ & + \sigma(\theta_N(\theta_N + e_{t+1}(\theta_G)\Delta\theta) - \theta_G(\theta_N + e_{t+1}(\theta_N)\Delta\theta)). \end{aligned} \tag{B.18}$$

Since the first line in (B.18) is positive, it must be that $\sigma > 0$ as the term following σ can be rewritten as $-\theta_N(1 - e_{t+1}(\theta_G)) - e_{t+1}(\theta_N)\theta_G\Delta\theta$, which is strictly negative. Hence, both in Case 3 and 4, we have that $\sigma > 0$, implying that $\Delta w_t = 0$ as claimed in the second part of Lemma B.2. For completeness, note that from (B.13), we know that it is optimal to minimize w_{t+1} and $w_{s,t+1}$, as this minimizes the manager's payoff, while relaxing the $t+1$ analogue of (B.6). This proves (12)–(14) of Proposition 1.

Finally, we show that minimizing U_t minimizes U_{t-1}, and thus, proceeding recursively, minimizes the manager's payoff all the way to period one. From (B.13), this is clearly the case if period $t-1$ does not offer incentives for truthful reporting, as then $\Delta w_{t-1} = 0$. To see that this is true also if there is truthful reporting in period $t-1$, plug in for w_t, Δw_t

and $w_{s,t}$ into the period $t-1$ analogue to (B.7)

$$\begin{aligned}
& \theta_G U_t(\theta_N, \mathbf{w}) - \theta_N U_t(\theta_G, \mathbf{w}) \\
= \; & (\theta_G e_t(\theta_N) - \theta_N e_t(\theta_G))(w_t + \theta_G \Delta w_t + \delta U_{t+1}(\theta_G, \mathbf{w})) \\
& + (\theta_G(1 - e_t(\theta_N)) - \theta_N(1 - e_t(\theta_G)))\left(w_{,st} + \sum_{j=t}^{T} \delta^{j-t}\overline{U}_j\right) - \Delta\theta c \\
= \; & \varrho + \Delta\theta\delta \frac{\theta_G U_{t+1}(\theta_N, \mathbf{w}) - \theta_N U_{t+1}(\theta_G, \mathbf{w})}{\Delta\theta}
\end{aligned}$$

where ϱ stands for terms that are not related to contract provisions. We can see now that minimizing (B.7) minimizes the last expression, proving the claim.

Cases 5–8. No truthful reporting in period $t-1$**.** Finally, suppose that there is no truthful reporting in period $t-1$. To see that the proof for the remaining four cases is identical to those above, it is sufficient to show that choosing $\{w_{t+1}, \Delta w_{t+1}, w_{s,t+1}\}$ to minimize the manager's payoff in t again boils down to minimizing (B.7) in the case of truthful reporting in period t and (B.13) in the case of no truthful reporting in period $t-1$ respectively. This can be easily verified by using the induction hypothesis to plug in for the manager's payoff in period t.

Finally, it is straightforward to modify Cases 2 and 4 to show that replacing the manager following a low cash flow realization is optimal also from an ex ante perspective. We omit the details, as the derivations are straightforward. **Q.E.D.**

Omitted Derivations in Main Text

Lemma B.3 *A sufficient condition for (2) to hold is*

$$\begin{aligned}
& \frac{e_N\theta_G}{e_N\theta_G + (1-e_N)\theta_N} e_G + \frac{(1-e_N)\theta_N}{e_N\theta_G + (1-e_N)\theta_N} e_N \\
> \; & e_1 > \frac{e_G(1-\theta_G)}{e_G(1-\theta_G) + (1-e_G)(1-\theta_N)} e_G + \frac{(1-e_G)(1-\theta_N)}{e_G(1-\theta_G) + (1-e_G)(1-\theta_N)} e_N.
\end{aligned} \tag{B.19}$$

Proof of Lemma B.3 The second inequality in (2) is most difficult to satisfy if underperformance in period t should (ex post) make it optimal to replace a manager even if her fit in $t-1$ was θ_G. The first inequality is most difficult to satisfy if it should be ex post optimal to keep the manager after realizing the high cash flow in t even if her fit in $t-1$ was θ_N. These conditions are captured by (B.19). Intuitively, they require that the board is willing to change her belief about the manager completely based on the firm's cash flows in period t. Note that for this sufficient condition to hold, the correlation between t and $t-1$ (which is captured by $\Delta e = e_G - e_N$) cannot be too large. **Q.E.D.**

Calculating the Board's Expected Payoff in Section 3.2.1 In equilibrium, the board's expected payoff is V^*. Hence, we can rewrite (5) as

$$V^* = \frac{\sum_{i=1}^{2} \delta^{i-1}\overline{U} - U_1(\mathbf{w}) + \mathbb{E}\left[\sum_{i=1}^{2} \delta^{i-1} q_i \left(x_i - c - \overline{U}\right)\right]}{1 - \mathbb{E}\left[\sum_{i=1}^{2} \delta^{i-1} \widetilde{q}_i\right] \delta}.$$

If the board seeks truthful reporting in both periods, this expression becomes

$$V^* = \frac{-U_1(\mathbf{w}) + \begin{pmatrix} x + \left(\overline{\theta} + e_1\left(\theta_G - \overline{\theta}\right)\right)\Delta x - c \\ +\delta e_1 \left(x + \left(\overline{\theta} + e_2(\theta_G)\left(\theta_G - \overline{\theta}\right)\right)\Delta x - c\right) \end{pmatrix} + \delta(1-e_1)\overline{U}}{1 - \delta(1-e_1) - \delta^2 e_1}.$$

If instead, the board seeks truthful reporting only in the second period, we have

$$V^* = \frac{-U_1(\mathbf{w}) + \begin{pmatrix} (x + (\theta_N + e_1(\theta_G - \theta_N))\Delta x - c) \\ +\delta e_1 \theta_G \left(x + \left(\overline{\theta} + e_2(\theta_G)\left(\theta_G - \overline{\theta}\right)\right)\Delta x - c\right) \\ +\delta(1-e_1)\theta_N \left(x + \left(\overline{\theta} + e_2(\theta_N)\left(\theta_G - \overline{\theta}\right)\right)\Delta x - c\right) \end{pmatrix} + \delta \begin{pmatrix} e_1(1-\theta_G) \\ +(1-e_1)(1-\theta_N) \end{pmatrix} \overline{U}}{1 - \left(\delta\left(e_1(1-\theta_G) + (1-e_1)(1-\theta_N)\right) + \delta^2\left(e_1\theta_G + (1-e_1)\theta_N\right)\right)}.$$

By plugging in for $\{x, \Delta x\}$, $\overline{U}$, and $U_1(\mathbf{w})$, we obtain the values in Table 1.

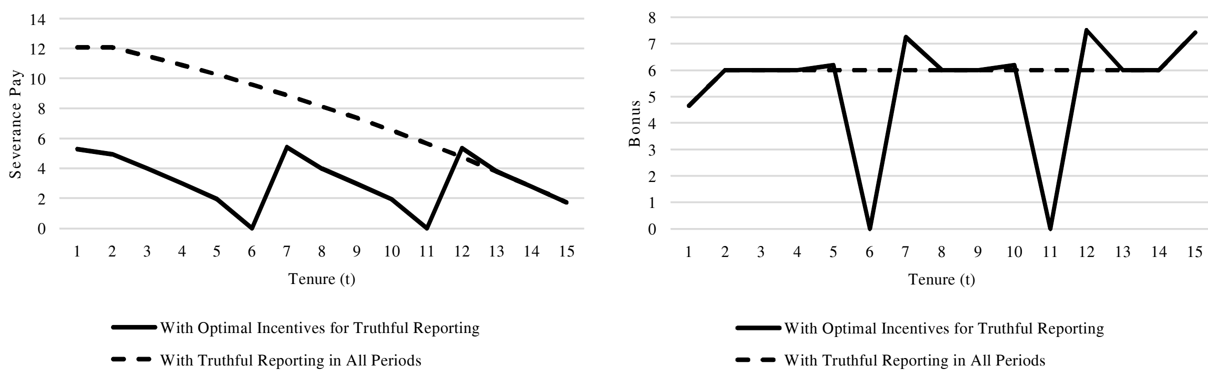

Figure 2: Optimal Incentives for Truthful Reporting vs. Truthful Reporting in All Periods. The figure compares the board's optimal contract choice with one that always offers incentives for truthful reporting over a maximal tenure length of fifteen periods. The dips in bonus and severance pay correspond to periods in which the board does not offer incentives for truthful reporting, but relies on firm performance. In terms of implementation, the dips would correspond to the term-ends of renewable fixed-term contracts. The simulations are performed with $e_1 = 0.55$, $e(\theta_G) = 0.65$, $e(\theta_N) = 0.45$, $c = 1$, $\theta_G = 0.7$, $\theta_N = 0.4$, $\overline{\theta} = 0.48$, $\delta = 0.95$, $x = 1000$ and $\Delta x = 500$, $\overline{U} = 1.25$. The figure illustrates that, even though the manager's pay is small relative to the firm's size, the decision to elicit the manager's private information is not trivial, as the likelihood that the manager is still with the firm in periods six and 11 is small.

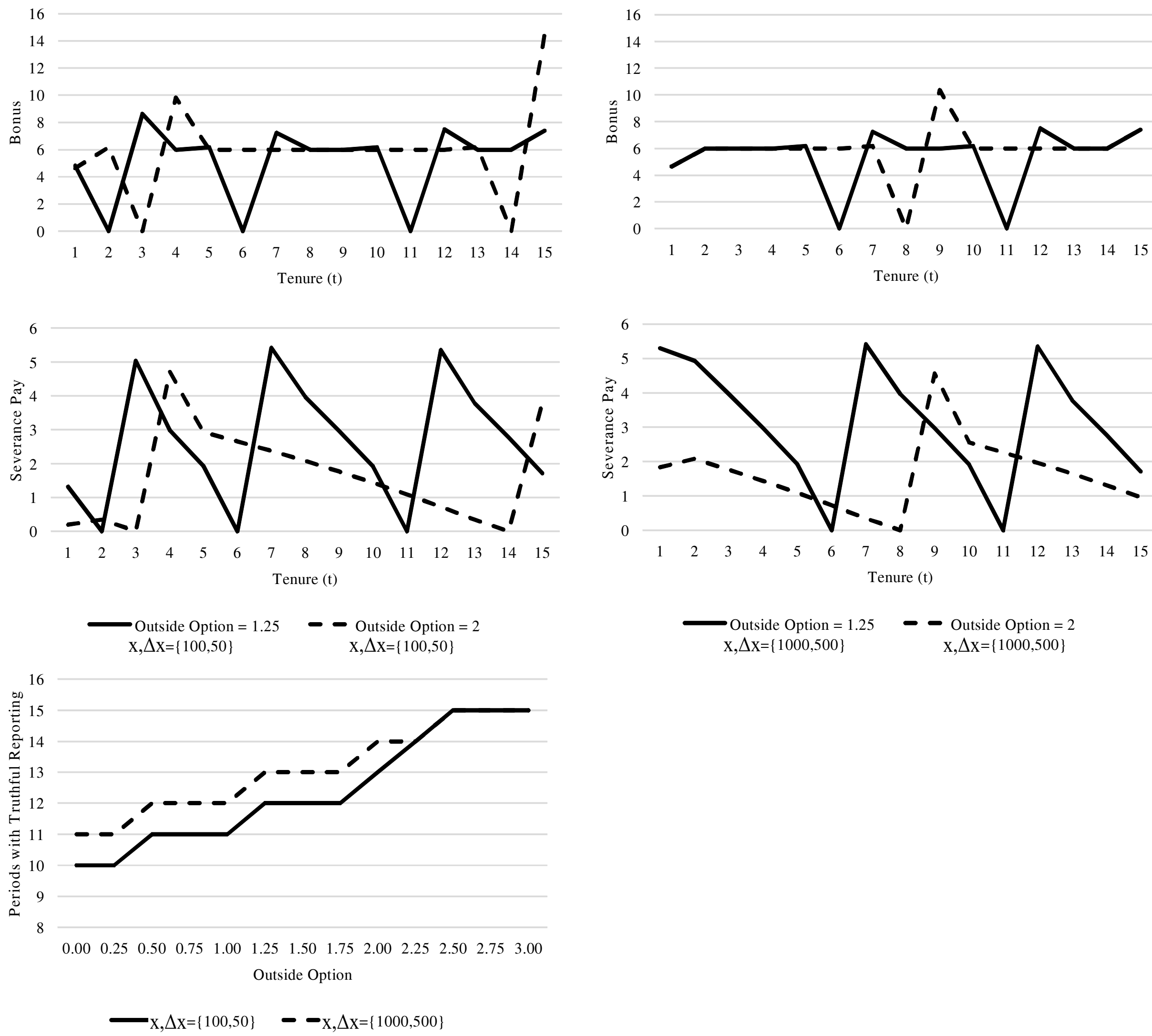

Figure 3: Comparative Statics. The figure presents the board's optimal contract choice over a maximal tenure length of fifteen periods depending on the manager's outside option and the firm's size. The dips in bonus and severance pay correspond to periods in which the board does not offer incentives for truthful reporting, but relies on firm performance. In terms of implementation, the dips would correspond to the term-ends of renewable fixed-term contracts. The simulations are performed with $e_1 = 0.55$, $e(\theta_G) = 0.65$, $e(\theta_N) = 0.45$, $c = 1$, $\theta_G = 0.7$, $\theta_N = 0.4$, $\overline{\theta} = 0.48$, $\delta = 0.95$, $\{x, \Delta x\} = \{100, 50\}$ and $\{1000, 500\}$, respectively. The figure illustrates that the board seeks more truthful reporting when the manager's outside option is higher and when the firm is larger.