Short-termism, Managerial Talent, and Firm Value*

Richard T. Thakor†

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Abstract

This paper examines how the firm's choice of investment horizon interacts with rent-seeking by privately-informed, multi-tasking managers and the labor market. There are two main results. First, managers prefer longer-horizon projects that permit them to extract higher rents from firms, so short-termism involves lower agency costs and is value-maximizing for some firms. Second, when firms compete for managers, firms practicing short-termism attract better managerial talent when talent is unobservable, but larger firms that invest in long-horizon projects hire more talented managers when talent is revealed.

Keywords: Short-termism, Managerial Talent, Wage Contracting, Capital Budgeting, Project Choice, Labor Markets

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†University of Minnesota and MIT LFE. 321 19th Avenue South, 3-255, Minneapolis, MN 55455. E-mail: rthakor@umn.edu

1 Introduction

How do firms choose the investment horizons of their projects? This question has attracted considerable attention because this choice affects not only the values of the projects firms invest in (e.g. Barton and Weisman 2014), but also the nature of these projects (e.g. Barrot 2016), and the earnings firms report (e.g. Stein 1989). For example, many have argued that short-termism—the corporate practice of preferring short-term projects over higher-valued long-term projects—is myopic and ill-advised, leading to excessive risk-taking.[1]

This paper proposes a multi-tasking model of delegated project management that addresses the question above. The model has implications for how the firm's choice of investment horizon affects managerial *rents* and the *talent* of managers the firm attracts. The model has two time periods, and an agent (i.e. a manager) is hired in each period by the principal ("firm"), and asked to search for a good project. The firm sets the investment horizon (short or long) of the project, and the manager must expend costly search effort to find the project. Long-horizon projects, which span two periods, have higher innate values than short-horizon projects, which span one period. If search effort fails to find a good project, the manager can choose to not ask for funding or request funding for a bad project.

The firm cannot distinguish between good and bad projects. Moreover, the manager privately knows whether he is talented or untalented—the good project has a higher success probability with a talented manager than with an untalented manager. The short-horizon project outcome is revealed at the end of the period, whereas only a noisy (but informative) signal of the long-horizon project outcome is available.[2] Firms design optimal wage contracts in each period, and these contracts depend on project horizon as well as prior performance.

The model is first analyzed without interfirm competition for managerial talent. The

[1] See, for example, Barton, Bailey, and Zoffer (2017). For empirical evidence on the effect of short-termism on R&D investment, see Budish, Roin, and Williams (2015) and Cremers, Pareek, and Sautner (2016). Bebchuk and Fried (2010) attribute excessive risk taking during the financial crisis to the short-term incentives induced by executive compensation. Rappaport and Bogle (2011) assert that short-termism may represent "a danger to capitalism".

[2] The idea that short-term information is of higher quality than long-term information has been used before. See, for example, Gümbel (2005).

main result is that firms hire both talented and untalented managers, and the manager gets efficiency wages with both the long-horizon and short-horizon projects, but earns higher rents with the long-horizon project.[3] Thus, the *manager* strictly prefers long-term projects, but the firm imposes a short-termism requirement if the innate value difference between the long-horizon and short-horizon projects, which is increasing in firm size, is not too large.

At the heart of the model are two informational frictions: (i) dual incentive problems—motivating the manager to work hard to find a good project and also to not propose a bad project if a good project is not found; and (ii) asymmetric information about managerial talent and the greater speed with which information about this talent is revealed through the success or failure of a short-horizon project relative to that of a long-horizon project. Since managerial incentives to search for and propose funding for *good* projects are provided through wages that are paid before long-horizon project outcomes are unambiguously revealed, performance signals that matter for incentives are noisier for long-term projects than for short-term projects. The firm must thus steepen incentives for observed success versus failure for long-term projects in order to induce search effort. But this creates another incentive problem—the higher "performance wage" makes it more attractive for the manager to gamble by proposing a bad project when he does not find a good one. This necessitates a higher wage to the manager for *not* requesting funding, leading to efficiency wages and managerial rents that are higher with a long-term project than with a short-term project.[4] The only difference between the short-term and long-term projects driving this result is in the timing of the cash flow realizations of these projects. Managerial rents are an agency cost for the firm; short-termism reduces this agency cost via more efficient contracting.

While the model has a specific structure, the intuition behind it is very general. The

[3]See Katz (1986) for a review of the efficiency wage literature. See also Zhu (2018), which provides a microfoundation for the use of efficiency wage contracts.

[4]There are models in which managers make choices for "signal jamming" reasons in order to delay revelation of true quality. For example, in Goldman and Strobl (2013), the manager does this by increasing the complexity of investments. In Acharya, Pagano, and Volpin (2016), the manager does this by switching employers. The result here is completely different—while the untalented manager would benefit from the long-term project for signal-jamming, the talented manager benefits from the short-term project which reveals his type more efficiently. Yet I show that *both* types of manager prefer long-termism.

greater noise in performance assessment with the long-horizon project leads to higher agency costs and thus induces some firms to prefer short-termism. However, this is *not* for the usual reason in contracting models with agent risk aversion (e.g. Holmstrom 1979) where greater output noise makes the optimal contract less steep in output. Here the agent is risk neutral, so sacrificing risk sharing with steeper incentives is not a concern. Rather, as shown later, the key is that the greater performance assessment noise with the long-horizon project leads the firm to have to pay the manager more for achieving a favorable outcome (signal) in order to motivate him to expend search effort. Since this exacerbates the problem of the manager wanting to request funding for a bad project, he must also be paid more for *not* requesting funding, producing managerial rents that diminish firm value. Hence, agency costs are higher with the long-horizon project that the manager strictly prefers. This result is due to the multi-tasking activities of the manager. Viewed in the Holmstrom and Milgrom (1991) context, the firm prefers short-termism because long-termism involves greater noise in assessing one activity (whether the manager worked hard), which reduces the desirability of providing incentives for another activity (proposing a good project).[5]

The base model is then extended by allowing firms to compete for managers. Firms now design contracts to attract the highest-quality pool of managers, and short-termism affects the pool quality in equilibrium. Cross-sectional heterogeneity is introduced by allowing firms to be of different sizes. Now, the small firms choose to search for short-horizon projects in both periods, firms of intermediate size search for short-horizon projects in the first period and long horizon projects in the second period, and the largest firms search for long-horizon projects in both periods. Moreover, on average, firms that practice short-termism attract a *higher-quality* pool of managers. The intuition behind this result is also very general. With lesser performance-assessment noise, the short-horizon firms can design cream-skimming

[5]The multi-tasking here is with respect to a given short-term or long-term project, and *not* across projects. If the manager was multi-tasking in the sense of managing both the long-term and short-term projects in the same period, allocating effort across the two projects, then the Holmstrom and Milgrom (1991) analysis would imply that the noisier assessment of managerial effort in the long-term project will cause the firm to reduce the manager's pay-for-performance sensitivity in the *short-term* project.

contracts to attract only the talented managers more effectively than the long-horizon firms can. The analysis illuminates how this happens when all types of firms are competing for the best managers and the managers are rationally anticipating the probabilities of receiving offers, which are different across the short-horizon and long-horizon firms.

Overall, the marginal contribution of this analysis is threefold. First, it shows that informational frictions bias firms' investment horizons *without* any discounting-related time horizon effects (such as those in Laibson (1997)), *managers* prefer long-termism, and short-termism is value-maximizing for some firms due to lower agency costs.[6] Second, short-termism attracts better managerial talent when talent is unobservable. Third, when managers establish track records, large firms hire away those with the best track records.

This paper is related to the short-termism literature. There is survey evidence that short-termism is practiced widely (e.g. Graham and Harvey 2001).[7] The existing theoretical explanations for short-termism rely on stock market pressure to deliver short-term earnings (e.g. Bolton, Scheinkman, and Xiong 2006a) when blockholder monitoring is not there to prevent it (Edmans (2009)), and managerial career concerns that sacrifice firm value (e.g. Narayanan 1985a).[8] However, the empirical evidence raises doubt about the negative economic effects of short-termism (Kaplan 2017; Roe 2018; and Fried and Wang 2018). Moreover, it is used *more* in firms with stronger corporate governance (Gianetti and Yu 2016), and is not related to lack of managerial sophistication (Graham and Harvey 2001).[9]

This paper differs significantly from the previous literature. First, in sharp contrast to

[6] This is in line with Roe (2015), who states: "Critics need to acknowledge that short-term thinking often makes sense for U.S. businesses, the economy and long-term employment...[i]t makes no sense for brick-and-mortar retailers, say, to invest long-term in new stores if their sector is likely to have no future because it will soon become a channel for Internet selling."

[7] Graham and Harvey (2001) documented payback use by a majority of firms and noted, "This is surprising given that financial textbooks have lamented the shortcomings of the payback criterion for years." See also Lefley (1996) for evidence from U.K. firms.

[8] Edmans (2009) develops a model in which blockholders, by trading on their private information, cause prices to reflect fundamentals, thereby encouraging managers to abandon short-termism.

[9] Moreover, if stock market pressure results in value-decreasing short-termism, then removing that pressure should improve firm performance. However, the evidence is that going private does not appear to improve the performance of public firms (e.g. Cohn, Mills, and Towery (2014)). Evidence that governance affects corporate investment appears in Billett, Garfinkel, and Jiang (2011).

earlier research, the firm's short-termism preference is independent of stock market pressures (e.g. Bolton, Scheinkman, and Xiong 2006a,b and Stein 1989), the threat of financing being cut off (von Thadden (1995)), or unsophisticated managers. Second, it is the managers with career concerns who dislike short-term projects, which is the *opposite* of Narayanan (1985a,b) and Stein (1989), or where managers dislike long-term projects that shareholders prefer.[10] Third, in contrast to Narayanan (1985a,b), short-termism in my model persists despite optimal payoff-contingent contracting to align manager-shareholder preferences. Fourth, the shareholders' preference for short-termism here is unrelated to external financing costs (Thakor 1990; Whited 1992; and Milbradt and Oehmke 2015).[11] Finally, unlike the previous literature, I consider the interaction between short-termism and managerial talent allocation, and the impact of labor market competition.

Also relevant is the literature on dynamic models with managerial short-termism. Edmans, Gabaix, Sadzik, and Sannikov (2012) develop a multi-period model of optimal compensation in which time-dependent vesting is used to deter short-termism. Marinovic and Varas (2019) examine optimal CEO contracts when managers can manipulate their performance measures, and they characterize the dynamics of managerial short-termism under the optimal dynamic contract.[12] Varas (2018) develops a dynamic contracting model in which the manager can finish the project faster by reducing quality. Gryglewicz, Mayer, and Morellec (2019) develop a dynamic agency model in which an agent controls current earnings through short-term investment. There are two key differences between this literature and this paper. First, in these papers, the *manager* has a preference for short-termism, which shareholders attempt to deter via optimal contracting. In this paper, managers prefer *long-*

[10] Darrough (1987) shows that optimal incentive contracts can eliminate the equilibrium in Narayanan (1985a,b). Jeon (1991) shows that Stein's (1989) effect can at most be transient if stock prices reflect the manager's strategic behavior.

[11] Other related papers are Grenadier and Wang (2005) who use a real options framework to show that managers value the option-to-wait-to-invest more than owners, and Hackbarth, Rivera, and Wong (2017) who develop a model in which short-termism is ex post optimal for the shareholders in a levered firm due to a shareholder-bondholder conflict.

[12] See also Zhu (2013) for a dynamic optimal contracting model with shirking. Manso (2011) also analyzes dynamic contracting issues, but in the context of innovation and shows that commitment to a long-term compensation plan is necessary to motivate innovation.

termism. Second, unlike this literature, this paper focuses on the impact of labor market competition on short-termism, and the impact of short-termism on talent attraction.

This paper is also connected to the literature on the ratchet effect (e.g. Carmichael and Maclead 2000 and Freixas, Guesnerie, and Tirole 1985) which examines principal-agent settings with learning, moral hazard, and no commitment in intertemporal settings, as this paper does. However, that literature focuses on agents restricting their output because they anticipate that firms will respond to the higher output by raising future targets or cutting pay. Such effects are not present here. Moreover, labor market competition does not feature significantly in those models. An exception is Charnes, Kuhn, and Villeval (2010) which shows that ratchet effects exist without competition but go away with competition.

This paper is also related to the literature on the effect of competition in the labor market when agents are multi-tasking. For example, Benabou and Tirole (2016) show that competition for the most talented workers leads to an increasing reliance on performance-pay and other high-powered incentives, shifting effort away from less-contractable tasks such as long-term investments. In this paper as well, labor market competition affects optimal compensation contracts, but it leads to a decrease in short-termism.

Finally, there is a related literature on competition and matching that examines talent cross-sectional talent allocation. Gabaix and Landier (2008) develop and calibrate a model in which CEOs with different talents are matched to firms competitively. In equilibrium, the best CEOs manage the largest firms, and earn more in firms with higher market values. Edmans, Gabaix, and Landier (2009) use this model to predict how incentives are related to firm size under optimal contracting. Axelson and Bond (2015) develop an optimal dynamic contracting model to show that finance jobs have high compensation and long work hours. This paper differs from this literature in that the matching of *a priori* unobservable managerial talent to firms is based on the project investment horizons chosen by firms.

The rest is organized as follows. Section 2 develops the base model. Section 3 contains the main results. Section 4 introduces firm size. Section 5 analyzes the effect of competition for managerial talent. Section 6 discusses the roles of the key model features, and the empirical implications of the analysis. Section 7 concludes. All proofs are in the Appendix, as well as a table that summarizes the notation in the model.

2 Model

In this section, I describe the basic model, in which firms do not compete for managers.

2.1 Preferences

All agents are risk neutral and the riskless interest rate is zero. There are three dates: $t = 1, 2, 3$. All firms are unlevered, and have funds to invest in projects. The firm (principal) hires a penniless manager. The firm maximizes its value and the manager maximizes expected utility over consumption at dates $t = 2$ and $t = 3$. The manager's utility is:

$$V(c_2, c_3) = c_2 + \delta c_3 \tag{1}$$

where $\delta \in (0, 1)$ is a consumption discount factor, and c_t is consumption at date t. All consumption is financed by wages. Unlike the manager, who values early consumption more than late consumption, the firm values all cash flows equally.[13]

2.2 Investment Opportunity

There are two time periods: the first starts at $t = 1$ and ends at $t = 2$, and the second at $t = 2$ and ends at $t = 3$. There are $N > 1$ firms, and each firm can invest in a project in each period requiring a \$1 investment. At $t = 1$, the firm chooses between a short-horizon project, S, that pays off at $t = 2$, and a long-horizon project, L, that pays off at some distant

[13]The manager's impatience to consume makes wage deferral costly, as shown later.

future date $t > 3$ beyond the model planning horizon.[14] A noisy but informative signal, ϕ, of the eventual payoff is available at $t = 2$. This captures the general idea that more distant project cash flows are measured with lower precision (Hodder and Riggs 1985; and Tarchys 2003). In the second period, the firm again chooses between S and L.

In each period, the firm must approve (or deny) funding for the project if the manager requests funding, and also decide whether to allow the manager to propose either L or S or to practice "short-termism" and limit the manager to S.

In each period, given the decision to search for L or S, the manager unobservably chooses effort $e \in \{0, 1\}$ to search for a good (G) project. The manager's private cost of effort is

$$\psi(e) = e\overline{\psi} \tag{2}$$

Regardless of whether the manager searches for L or S, the manager finds a good project with probability $p \in (0.5, 1)$ if $e = 1$, and with probability 0 if $e = 0$. If a good project is not found, the manager can always propose a bad (B) project that the CEO cannot distinguish from G. In each period, the manager decides whether or not to request project funding.

2.3 Managerial Ability and Project Payoff Distributions

There is a total of M ($> N$) managers.[15] The manager's ability affects the project payoff distributions. Let τ represent the manager's ability, with $\tau \in \{T, U\}$. If $\tau = T$, it means the manager is "talented", and if $\tau = U$, it means the manager is "untalented". Project payoffs depend on firm size, so if the project payoff is unit size, then it is Δz for a firm of size Δ.

[14] This can be interpreted as the project paying off at a time that is beyond the manager's tenure at the firm. The Bureau of Labor Statistics reports that the median number of years that wage and salary workers had been in their present jobs was 4.6 years, a time period much shorter than the duration of the typical long-term project in many industries. For example R&D investments by drug companies have payoff horizons typically exceeding 10 years. Similarly, companies (like AT&T) that build telecommunication networks have payoff horizons exceeding 15 years.

[15] The assumption that there are more managers than firms means that firms will design contracts to minimize the rents they provide managers, subject to managerial participation constraints. Nonetheless, managers will earn rents as firms compete for talented managers.

For a firm of unit size ($\Delta = 1$), the good L project pays off $R_L > 1$ at some $t > 3$ with probability $\tilde{q}(\tau)$ (that depends on τ) and pays off 0 with probability $1 - \tilde{q}(\tau)$, with

$$\tilde{q}(\tau) = \begin{cases} 1 & \text{if } \tau = T \\ q \in (0.5, 1) & \text{if } \tau = U \end{cases} \tag{3}$$

The good S project undertaken at date t by a unit-size firm pays off $R_S \in (1, R_L)$ at date $t+1$ with probability $\tilde{q}(\tau)$ and 0 with probability $1 - \tilde{q}(\tau)$, where $\tilde{q}(\tau)$ is described by (3). This means that L is higher-valued than S.

Each manager knows his type, but no one else does. Others share the common prior belief that $\Pr(\tau = T \text{ at date } t) = \theta_t \in (0, 1)$, so θ_1 is the manager's initial reputation. For $t \in \{2, 3\}$, θ_t^i denotes the posterior belief based on the observed outcome at t, with $i = n$ indicating no investment was made at $t - 1$, $i = l$ indicating project failure at t, and $i = h$ indicating project success at t. Define $\overline{q}_1 \equiv \theta_1 + [1 - \theta_1]\, q$. The bad S project pays off R_S with probability $b \in [0.5, q)$ and zero with probability $1 - b$ for a unit-size firm, regardless of managerial ability.[16] Similarly, the bad L project pays off R_L with probability b and 0 with probability $1 - b$. It is assumed that

$$qR_L - \frac{\overline{\psi}}{p} < 1 < \overline{q}_1 R_S - \frac{\overline{\psi}}{p} \tag{4}$$

This condition means that the expected net present value of S at the prior beliefs about managerial ability is positive in the first-best case, and the expected net present value of even the L project managed by the untalented manager is negative.[17]

Furthermore, it is assumed that $M_T \equiv \theta_1 M > N$, where M_T is the (expected) number of talented managers. This means there are enough talented managers to fully staff all firms.

[16]This means that the bad project is worse than the good project managed by the untalented manager, and thus, given (4) the bad project always has negative NPV.

[17]Condition (4) will later be replaced by a stronger condition (see (6)) to ensure positive NPV in the second best.

2.4 The Cross-Sectional Distribution of Firms

Each firm's size is drawn from $[\Delta_{\min}, \Delta_{\max}]$, and the distribution function η can be expressed as $\eta\left(\hat{\Delta}\right)$ = number of firms with $\Delta \leq \hat{\Delta}$. The subsequent analysis will focus on unit-size firms, and Δ will be introduced only when necessary. Moreover, it will also be assumed that if the firm does not fire the manager, it will continue with the same manager. That is, when firms will be allowed to compete for managers, this competition will occur ex ante at $t = 1$. I also examine the implications for second-period competition for managers.

2.5 Summary of Informational Assumptions

(Assumption.1) While the manager knows his own ability (T or U), others update their beliefs about it symmetrically at every date based on additional information.

(Assumption.2) If the manager requests funding, the firm can see whether the manager searches for an L or an S project, based on the firm's directive.

(Assumption.3) Only the manager observes his effort choices at all dates.

(Assumption.4) The manager privately observes whether he found a good project or not and whether the project for which funding is requested is good or bad.

(Assumption.5) The payoff on the first-period S project, $y_2 \in \{R_S, 0\}$ is observed by all at $t = 2$, and the payoff on the second-period S project, $y_3 \in \{R_S, 0\}$, is observed by all at $t = 3$. The payoff on L, also denoted as y_3 (the distinction between y_3 on S and L will be clear in context), is $y_3 \in \{R_L, 0\}$ and is realized at some $t > 3$ and not observed at any $t \in \{1, 2, 3\}$, but a signal, ϕ, of this payoff is observed at $t + 1$ for L chosen at $t \in \{1, 2\}$ (with no further information subsequently), with:

$$\Pr\left(\phi = h \mid y_3 = R_L\right) = \Pr\left(\phi = l \mid y_3 = 0\right) = \beta \in (0.5, 1) \tag{5}$$

Here $\phi = h$ means the signal says the outcome will be $y_3 = R_L$ and $\phi = l$ means the signal says the outcome will be $y_3 = 0$.

2.6 Wage Contracts

Projects are selected at dates $t = 1, 2$. Let $a_t \in \{L, S\}$ represent the project choice at date t. The second-period wage contract is $W_{a_2}(x_3, \theta_2)$, and it is a function of the outcome x_3 at $t = 3$ and beliefs about the manager's type, θ_2, at $t = 2$. In what follows, the superscript on θ_t indicating the dependence of θ_t on the project outcome at $t = 2$ will be used only when it is necessary to link θ_t to a specific outcome. In other cases, the superscript will be dropped, but it should be understood that θ_t always depends on the project outcome observed at t. The outcome $x_3 \in \{n, y_3\}$, where n stands for no investment at $t = 2$ and $y_3 \in \{R_S, 0, \phi\}$ observed at $t = 3$ depending on whether a_2 is S or L, $\phi \in \{h, l\}$ with L.

The first-period wage is $W_{a_1}(x_2, \theta_1, a_2)$, where a_2 is the (anticipated) second-period project choice, which potentially affects the first-period contract, $x_2 \in \{n, y_2\}$ is the outcome at $t = 2$, $y_2 \in \{R_S, 0, \phi\}$, depending on whether a_1 is S or L, with $\phi \in \{h, l\}$ with L.

All wages are constrained to be non-negative (limited liability for managers) and there is *no precommitment* by the firm to any future contract as part of a long-term arrangement. The firm asks the manager to report his type and then offers him a contract, with no precommitment to a report-contingent contract menu. That is, all wage contracts have to be optimal in the continuation game at the time that the contracts are offered (even within the continuation game following the manager's report).

The absence of precommitment precludes the use of the Revelation Principle (e.g. Myerson (1979)) to sort out the type-U managers at the outset. Regardless of what the firm might say about what it will give the manager upon reporting his type as U, the firm will renege and not hire him. So the reporting game involves both types claiming to be type T and this pooling—which is also encountered in other models with learning like those on the rachet effect—preserves unobservable talent heterogeneity which matters for the analysis.

Of course, once the firm does offer a contract, it is obligated to honor its terms.

2.7 The Choices at $t = 1$ and $t = 2$ and Timeline

At the start of the first period ($t = 1$), the firm asks the manager to report his type and then makes a take-it-or-leave-it (TIOLI) offer of a possibly type-dependent wage contract, $W_{a_1}(x_2, \theta_1, a_2 \mid \tau)$.[18] The contract stipulates how the manager will be paid based on the observed outcome, x_2, at $t = 2$. The firm then either allows the manager to propose searching for either L or S, or limit him to S. If the manager searches for an $a_t \in \{L, S\}$ project, there is no chance of "accidentally" discovering an $\hat{a}_t \neq a_t$ project. Moreover, a manager asked to search for $a_t \in \{L, S\}$ cannot search for $\hat{a}_t \neq a_t$ since payoffs in the success states across L and S are distinguishable, so "forcing contracts" deter deviation from a_t.

At $t = 2$, the firm decides whether to retain or fire the incumbent manager. If retained, the manager receives a TIOLI of a second-period wage contract, $W_{a_2}(x_3, \theta_2)$, which stipulates payment terms based on beliefs, θ_2, at $t = 2$ and payment terms based on beliefs, θ_2, at $t = 2$ and the outcome x_3 at $t = 3$. If the incumbent manager is fired, a new manager is asked to report his type and then given a TIOLI offer of a possibly type-dependent contract similar to that offered a retained incumbent. *Figure 1* summarizes the timeline.

2.8 Manager's Reservation Utility and Firm's Firing Cost

The manager's reservation utility in each period is 0. In each period, the manager accepts the firm's take-it-or-leave-it offer if it satisfies his participation constraint.

It costs the firm $\zeta > 0$ to fire and replace the manager.[19] This reflects the transactions costs of searching for and hiring a new manager. To ensure that it makes sense for the firm

[18] Since the equilibrium is pooling in τ, henceforth the dependence of W_{a_1} on τ will be dropped.

[19] The firm makes its firing decision based solely on the cash flow observed at the end of the first period. This is different from Edmans (2011), who allows shareholders to determine the cause of the first-period project performance through monitoring and fire the manager only if he is believed to be untalented. Debt leads to equity concentration and encourages shareholder monitoring, which leads to skilled managers not being deterred from investing in long-term projects with low short-term cash flows.

to both replace a failed manager ($y_2 = 0$) with a new manager at $t = 2$, and to continue at $t = 2$ with a manager who proposes no project at $t = 1$, the following condition is sufficient:

$$\theta_2^n \left[R_S - 1\right] - \overline{\psi} \left[A_1 + b\right] \left[A_1 \delta\right]^{-1} - \zeta > 0 \tag{6}$$

where θ_2^n is the posterior belief the manager is type T with no investment at $t = 1$, and it is defined as:

$$\theta_2^n \equiv \frac{[1-p]\theta_1}{[1-p]\theta_1 + 1 - \theta_1} \tag{7}$$

Further, define:

$$A_1 \equiv p\left[1 - b\right] \tag{8}$$

We will see later that the expected cost of compensating the manager under the optimal contract is bounded from above by $\overline{\psi} \left[A_1 + b\right] \left[A_1 \delta\right]^{-1}$. In the base model, it is assumed that ζ is small enough to ensure that ζ is not a deterrent to firing the manager, or if firing is optimal, then to ensure that it is not large enough to induce the firm to avoid S.

2.9 Equilibrium

In the game between the firm and the manager in the absence of interfirm competition for managerial talent, I focus on Bayesian perfect equilibria, i.e., in each period the firm asks the manager to report his type and then makes a take-it-or-leave-it wage contract offer, where contracts are designed to maximize firm value over the remaining time horizon. The firm takes the choice of a_1 in the first period as well as the anticipated choice of a_2 at $t = 2$ and solves for optimal wage contract for the first and second periods that will be offered to the manager. In each case, the firm rationally anticipates the manager's choices of search effort and decisions about when to request funding, as well as the firm's own decision about when the manager will be replaced for the second period. The firm then compares the values of the firm (net of managerial wages) in the two cases and decides whether to impose a short-termism constraint.

3 Base Model Analysis: No Talent Competition

3.1 First Best

In the first best, the manager's search effort, his ability and project quality are all observable. Thus, the firm will hire only a type T manager in each period to search for a good L project, instruct him to choose $e = 1$, and pay him a fixed wage of $\overline{\psi}$. If a good project is found, it is funded; otherwise, no investment is made.[20]

3.2 Second Best Contracts

Now the manager's search effort, talent (T or U), and project quality are not observable. Before solving the model with backward induction, some preliminary results are established.

3.2.1 Firm's Preference for Talent

While the firm would prefer to hire only a talented manager, the following lemma shows that it is impossible to have separating contracts to do this in the second best.

Lemma 1: *Suppose the contract designed for the type T has a rent for the manager even if no funding is requested. Then no manager will ever report himself to be type U.*

The managerial rent this lemma refers to is the manager earning more than his reservation utility. The reason why separating contracts are infeasible is the lack of precommitment by the firm. The project has negative NPV with an untalented a manager. So the firm will not hire any manager who reports his type as U. Anticipating this, the type-U manager will

[20] As long as effort is observable, the manager is always paid a fixed wage $\overline{\psi}$—since effort disutility is not ability-dependent—and asked to choose L.

choose the type-T manager's contract, and earn a rent by choosing $e = 0$, and not request funding.[21] Thus, the firm will design wage contracts at $t = 1$, knowing that these will be taken by both types of managers reporting themselves as type T. Next we have:

Lemma 2: *A firm that wants its manager to search for either the S project or the L project at $t = 1$ will design wage contracts to induce type T managers to choose search effort $e = 1$ and propose only good projects for funding in both periods. The contracts will also induce type U managers to choose $e = 0$ in both periods and not request any funding.*

The intuition is that even a good project chosen by type U has negative NPV, so the firm designs its wage contract to elicit search effort and funding requests only from type T. This is possible since searching for a good project is less profitable for type U.

3.2.2 Second-period Contracts

Beliefs at $t = 2$: At $t = 2$, the posterior belief that the manager is T is given by θ_2. If there was no investment at $t = 1$, then given Lemma 2, $\theta_2^n = \{[1-p]\theta_1\}\{[1-p]\theta_1 + 1 - \theta_1\}^{-1}$. If there was investment in S in the first period and the project failed, then the posterior belief is:

$$\theta_2^l = \Pr(\tau = T \mid y_2 = 0) = 0 \tag{9}$$

Given (4), we see that (9) implies that the manager will be fired and replaced with a new manager if $y_2 = 0$. If $y_2 = R_S$, then the posterior belief is

$$\theta_2^h = \Pr(\tau = T \mid y_2 = R_S) = \frac{\theta_0}{\theta_0 + [1-\theta_0]\, q} \tag{10}$$

To solve for the optimal second-period contracts, we first must define the necessary incentive compatibility and participation constraints for the manager. Before doing this, we

[21] It will be shown later that equilibrium wage contracts generate rents for managers.

write down the expected wage of type $\tau \in \{T, U\}$ given (a_2, θ) and the G project as:

$$\mathbb{E}\left[W_{a_2}\left(y_3, \theta_2\right) \mid \tau, G\right] = \begin{cases} q(\tau) W_S\left(h, \theta_2\right) + \left[1 - q(\tau)\right] W_S\left(l, \theta_2\right) & \text{if } a_2 = S \\ \overline{q}(\tau, \beta) W_L\left(h, \theta_2\right) + \left[1 - \overline{q}(\tau, \beta)\right] W_L\left(l, \theta_2\right) & \text{if } a_2 = L \end{cases} \tag{11}$$

where

$$\overline{q}(\tau, \beta) \equiv q(\tau)\beta + \left[1 - q(\tau)\right]\left[1 - \beta\right] \tag{12}$$

Note that h indicates both $\phi = h$ and $y_3 = R_S$ and l indicates both $\phi = l$ and $y_3 = 0$. The expected wage with the B project is:

$$\mathbb{E}\left[W_{a_2}\left(y_3, \theta_2\right) \mid \tau, B\right] = \begin{cases} b W_S\left(h, \theta_2\right) + \left[1 - b\right] W_S\left(l, \theta_2\right) & \text{if } a_2 = S \\ \overline{b}\left(\beta\right) W_L\left(h, \theta_2\right) + \left[1 - \overline{b}\left(\beta\right)\right] W_L\left(l, \theta_2\right) & \text{if } a_2 = L \end{cases} \tag{13}$$

where

$$\overline{b}\left(\beta\right) \equiv b\beta + [1 - b][1 - \beta] \tag{14}$$

The first IC constraint is that the type T manager prefers $e = 1$ to $e = 0$ with G:

$$\delta\left\{p\mathbb{E}\left[W_{a_2}\left(y_3, \theta_2\right) \mid T, G\right] + [1 - p] W_{a_2}\left(n, \theta_2\right)\right\} - \overline{\psi} \geq \delta W_{a_2}\left(n, \theta_2\right) \tag{15}$$

The second IC constraint is that the type U manager prefers to choose $e = 0$:

$$\delta\left\{p\mathbb{E}\left[W_{a_2}\left(y_3, \theta_2\right) \mid U, G\right] + [1 - p] W_{a_2}\left(n, \theta_2\right)\right\} - \overline{\psi} \geq \delta W_{a_2}\left(n, \theta_2\right) \tag{16}$$

The third IC constraint is that a manager without a good project will not request funding:

$$\delta\mathbb{E}\left[W_{a_2}\left(y_3, \theta_2\right) \mid \tau, B\right] \leq \delta W_{a_2}\left(n, \theta_2\right) \; \forall \tau \tag{17}$$

The type T manager's participation constraint is:

$$\delta \left\{ p\mathbb{E}\left[W_{a_2}\left(y_3, \theta_2\right) \mid T, G\right] + [1-p] W_{a_2}\left(n, \theta_2\right)\right\} - \overline{\psi} \geq 0 \tag{18}$$

A property of the optimal wage contract in the second period is given below.

Lemma 3: *Second-period contracts have a 0-1 property. The manager is either fired at $t = 1$ or retained, and if retained, he receives the same second-period contract regardless of the first-period project duration choice (S or L) and the first-period project outcome.*

When the manager is retained in the second period, he receives the same contract regardless of whether he requested funding and experienced $y_2 = R_S$ or $\phi = h$ or he did not request funding. This is despite the fact that the firm's posterior belief about the manager's talent is different in these cases—$\Pr\left(\tau = T \mid y_2 = R_S\right) = \theta_2^h > \theta^0$ as given by (10), and $\Pr\left(\tau = T \mid \text{no funding}\right) \equiv \theta_2^n = \frac{[1-p]\theta_1}{[1-p]\theta_1 + 1 - \theta_1} < \theta_1$. The reason is that contracts are designed to induce appropriate investment only by the type T manager, so the firm uses the contracts that would be offered if only the type T manager was in the labor pool. Given this, the second-period wage contract notation can be simplified to $W_{a_2}\left(x_3\right)$.

Further, the decision to fire the manager when $y_2 = 0$ is observed at $t = 1$ is the firm's best response to the observed project outcome, and is thus time consistent. It is not just a precommitment for incentive reasons, as in Stiglitz and Weiss (1983), who rationalize credit rationing by showing that the threat of denying a second-period loan to a borrower who defaults on its first-period loan can be used as a device to improve borrower incentives. In the Stiglitz and Weiss (1983) model, this threat is ex ante efficient but not time consistent. The next result describes the second period contracts when the manager is retained.

Lemma 4: *If the manager searched for S in the first period that was funded and had $y_2 = 0$, he is fired. If it had $y_2 = R_S$ at $t = 2$, or no funding was requested for it at $t = 1$, then the* *optimal second-period wage contract for searching for S in the second period is:*

$$W_S(h) = \frac{\overline{\psi}}{p[1-b]\delta}, \quad W_S(l) = 0, \quad W_S(n) = \frac{b\overline{\psi}}{p[1-b]\delta} \tag{19}$$

The optimal second-period wage contract for searching for L in the second period is:

$$W_L(h) = \frac{\overline{\psi}}{p\delta[1-b][2\beta-1]}, \quad W_{L2}^l(l) = 0, \quad W_L(n) = \frac{\overline{\psi}b(\beta)}{p\delta[1-b][2\beta-1]} \tag{20}$$

If L was chosen in the first period, the contract for choosing L in the second period is the same as (20), but the manager is retained for the second period regardless of the realized ϕ.[22] *Given these contracts, the type T manager chooses $e = 1$ and the type U manager always $e = 0$. For each type of manager, the participation constraint is slack. In the second period, the type T manager earns a rent equal to $W_S(n)$ with (utility) value of $\delta W_S(n)$ with S and $W_L(n)$ with utility $\delta W_L(n)$ with L.*

Three points are worth noting. First, it is clear that the higher $W_{a_2}(l)$ is, the more costly it is for the firm to ensure satisfaction of the IC constraint (15). So, given the non-negativity constraint on wages, it is efficient to set $W_{a_2}(l) = 0$. Second, to satisfy the IC constraint (17), the manager must be paid a wage even when he does not request project funding. Absent this wage, the manager will request funding even for a bad project. This multitasking—investing effort to find a good project and then deciding whether to propose a bad project—generates a rent for the manager. That is, the combination of the manager's private information about his own effort *and* about project quality generates an efficiency wage that gives him an informational rent. Third, because second-period contracts, conditional on managerial retention, are the same for all $x_2 \in \{n, R_S\}$, the notational dependence of these contracts on the first-period outcome, x_2, is unnecessary.

[22]It is shown later that if L is chosen in the first period, it is never optimal to choose S in the second period (see Lemma 5).

3.2.3 Second-period Profitability and Project Choice

Let the firm's second-period profit from implementing project $a_2 \in \{L, S\}$ at $t = 2$ given a_1 at $t = 1$ be $\Pi_2 (a_2, \theta_2 \mid a_1)$. Then let

$$a_2^* (a_1) \in \arg\max_{a_2} \Pi_2 (a_2, \theta_2 \mid a_1) \tag{21}$$

This leads to:

Lemma 5:

$$a_2^* (a_1) \in \{S, L\} \textit{ if } a_1 = S, \quad a_2^* (a_1) = L \textit{ if } a_1 = L \tag{22}$$

This lemma says that it is never optimal for the firm to choose S in the second period after choosing L in the first period. The reason is that L is higher valued in the first best but also has a higher agency cost in the second best. So S is undertaken because of the lower agency cost. However, S lowers agency costs more in the first period than in the second, so if S is selected in only one period, it is optimal to do it in the first period.

3.2.4 First-period Contracts

The first-period contract is $W_{a_1} (x_2, \theta_1, a_2)$,where $a_1 \in \{L, S\}$, $x_2 \in \{n, y_2\}$, and $y_2 \in \{R_S, 0, \phi\}$, with $\phi \in \{h, l\}$. A manager choosing G has an expected first-period wage:

$$\mathbb{E} [W_{a_1} (y_2, \theta_1, a_2) \mid \tau, G] = \begin{cases} q(\tau) W_S (h, \theta_1, a_2) + [1 - q(\tau)] W_S (l, \theta_1, a_2) & \text{if } a_1 = S \\ \overline{q}(\tau, \beta) W_L (h, \theta_1, a_2) + [1 - \overline{q}(\tau, \beta)] W_L (l, \theta_1, a_2) & \text{if } a_1 = L \end{cases} \tag{23}$$

The first IC constraint is that T prefers $e = 1$ to $e = 0$:

$$p \left\{ \mathbb{E} \left[W_{a_1} \left(y_2, \theta_1, a_2 \right) \mid \tau, G \right] + \delta W_{a_2}(n) \right\} + [1 - p] \left\{ W_{a_1} \left(n, \theta, a_2 \right) + \delta W_{a_2}(n) \right\} - \overline{\psi}$$
$$\geq W_{a_1} \left(n, \theta_1, a_2 \right) + \delta W_{a_2}(n) \qquad (24)$$

The second IC constraint is that the manager will not ask for funding for a B project:

$$\mathbb{E} \left[W_{a_1} \left(y_2, \theta_1, a_2 \right) \mid \tau, B \right] + b\delta W_{a_2}(n) \leq W_{a_1} \left(n, \theta_1, a_2 \right) + \delta W_{a_2}(n) \qquad (25)$$

And the participation constraint of T is:

$$p \left\{ \mathbb{E} \left[W_{a_1} \left(y_2, \theta_1, a_2 \right) \mid \tau, G \right] + \delta W_{a_2}(n) \right\} + [1 - p] \left\{ W_{a_1} \left(n, \theta_1, a_2 \right) + \delta W_{a_2}(n) \right\} - \overline{\psi} \geq 0 \quad (26)$$

This leads us to the following result:

Proposition 1: *The optimal first-period wage contract for S is as follows:*

$$W_S \left(h, \theta_1, S \right) = \frac{\overline{\psi}}{p \left[1 - b \right]} - \delta W_S(n);\ W_S \left(n, \theta_1, S \right) = \frac{b\overline{\psi}}{p \left[1 - b \right]} - \delta W_S(n) = 0 \qquad (27)$$

$$W_S \left(l, \theta_1, S \right) = 0 \qquad (28)$$

$$W_S \left(h, \theta_1, L \right) = \overline{\psi}/p;\ W_S \left(n, \theta_1, L \right) = \max \left\{ \frac{b\overline{\psi}}{p[1 - b]} - \delta W_L(n), 0 \right\} = 0 \qquad (29)$$

With this wage contract, the type T manager chooses $e = 1$ to search for S in the first period, the type U manager chooses $e = 0$, both managers request first-period funding only for a good project, and each is retained in the second period if S was funded in the first period and experienced $y_2 = R_S$ or if first-period funding was not requested. If retained, the manager receives the second-period wage contract described in Lemma 4.

This result shows that the first-period contracts anticipate the manager's second-period rent and adjust accordingly. Combining Lemma 4 and Proposition 1, we see that when the firm is searching for S in both periods, wages are higher in the second period than in the first period in equilibrium. The general result is that wages are downward rigid, conditional on a project of the same investment horizon being searched for. It should be noted that this result does *not* rely on agent risk aversion, as in Harris and Holmstrom (1982).

Proposition 2: *Regardless of what the manager searches for in the second period, the optimal first-period wage contract for L is as follows:*

$$W_L(h, \theta_1, a_2) = \frac{\overline{\psi}}{p[1-b][2\beta-1]}, \quad W_L(l, \theta_1, a_2) = 0, \quad W_L(n, \theta_1, a_2) = \frac{\overline{\psi}\overline{b}(\beta)}{p[1-b][2\beta-1]} \tag{30}$$

The type T manager chooses $e=1$ to search for L in the first period, and requests first-period funding only if he finds a good project. The type U manager chooses $e=0$ and does not request funding, and the manager is retained in the second period regardless of the signal ϕ.

3.3 Managerial Preferences for L vs. S

The next result describes the manager's preference for L versus S at $t=1$.

Proposition 3: *Given the optimal contracts in Propositions 1 and 2, the manager's expected utility is higher with the contract that induces him to search for L in the first period than with the contract that induces him to search for S.*

This proposition says that, given a choice, the manager would strictly prefer to search for L than to search for S. The intuition is that L gives the manager rents that exceed his rents from searching for S at $t=1$. The reason for this is that the signal of project performance at $t=2$ is more noisy with L. Thus, a bad L project is less likely to be detected at $t=2$ than a bad S project. Moreover, with S, the manager can get fired at $t=2$ if the project fails, which denies him his second-period rent. This does not happen with L. Consequently, the manager's incentive to work hard at $t = 1$ to find a good project is weaker with L than with S, all else equal, i.e. agency costs are higher with L. So the firm must make the wage schedule steeper with L by paying more for a good performance signal at $t = 2$. But this creates another incentive problem—it induces the manager to gamble and propose a *bad* project, to get the performance bonus with a positive probability. To counter this, the firm must increase the efficiency wage, which gives the manager a rent. Note also that firing never occurs along the path of play since the type U managers never invest and the type T managers never fail when they invest only in good projects. Thus, firing occurs only off the equilibrium path.

This result is important in part because it sharply distinguishes this paper from the earlier work of Narayanan (1985a,b) and Stein (1989). In those papers there is no optimal contracting and the manager strictly prefers short-termism even when such myopia is not good for the shareholders.[23] In contrast, in this paper the manager strictly prefers long-termism under optimal contracting, so the shareholders instruct the manager to go for short-termism. The reason for the manager's preference for long-termism is that he earns higher rents with L than with S, and these rents arise from the manager's multi-tasking—searching for a good project and then proposing only a good project

4 Firm Size and Project Choice

4.1 Firm's Choice

Firm size Δ is now introduced. The payoff on S is thus ΔR_S and that on L is ΔR_L.

Proposition 4: *There exist* $\Delta_1, \Delta_2 \in (\Delta_{\min}, \Delta_{\max}]$ *such that firms with* $\Delta \leq \Delta_1$ *choose S in both periods, firms with* $\Delta \in (\Delta_1, \Delta_2]$ *choose S in the first period and L in the second, and*

[23] In Stein (1989) this myopia arises because the manager's utility depends on current earnings which short-termism can boost. In footnote 6 of his paper, Stein (1989) notes that such an objective function can be formalized by assuming that the manager is given stock to incentivize effort and a positive takeover probability is allowed to capture synergy gains. Nonetheless, this results in the *manager* strictly preferring short-termism (S) under the optimal contract.

firms with $\Delta > \Delta_2$ *choose* L *in both periods. When the manager chooses* S *in the first period, the out-of-equilibrium belief when project failure is observed at* $t = 2$ *is that the manager is type* U.[24]

The intuition is that agency costs are higher for the firm with L than with S (Proposition 3). Thus, when the value difference between L and S is small, the firm prefers S in both periods, when it is intermediate the firm chooses S in the first period and L in the second, and when it is large it prefers L in both periods. The result follows from the fact that $\Delta [R_L - R_S]$ is increasing in Δ.[25]

4.2 Inefficiency of Wage Deferral

Until now, it has been assumed that deferring the manager's wage that is payable at $t = 2$ until $t = 3$ is not allowed. It will be shown now that such a deferral is inefficient.

Lemma 6: *Deferring the manager's compensation at* $t = 2$ *until* $t = 3$ *is inefficient.*

The intuition is as follows. Suppose the manager searched for L at $t = 1$. If the manager is paid at $t = 3$ instead of $t = 2$, then there are two possibilities. One is that the deferred wage is simply added to the manager's second-period wage in each state, in which case it has no impact on the manager's incentives on either the first-period project or the second-period project. In this case, the deferral is inefficient because the manager prefers consumption at $t = 2$ over consumption at $t = 3$. Further, the wage deferral cannot improve on the incentives provided by the optimal contract derived for L previously, since that is the least-cost contract

[24] It can be shown that this equilibrium is sequential and satisfies the Intuitive Criterion refinement of Cho and Kreps (1987). The sequential equilibrium proof is available upon request. To see why the equilibrium satisfies the Intuitive Criterion, note that the probability of failure on an S project chosen by a type T manager is zero. Thus, applying Step 1 of the Intuitive Criterion, the type T manager can be eliminated in the setting of posterior beliefs, and the posterior probability is 1 that the manager is type U.

[25] The analysis assumes that the manager is not fired at $t = 2$ with L, regardless of the signal ϕ. However, it can be shown that the main result of higher agency costs with L holds even if the manager is fired at $t = 2$ for some ϕ. It turns out that the possibility of firing with L reduces the manager's rent with L, but it is nonetheless the case that L has higher agency costs than S. The reason is that the greater noise in assessing the manager's performance at $t = 1$ with L is a source of managerial rent.

to incentivize the manager to work hard and propose only the good project; this contract cannot be improved upon by predicating the manager's payoff on a future project.

So deferral can only improve second-period incentives. But any optimal contract requires a zero payment for a failed project. Thus, the entire wage deferral must be spread out over the manager's second-period wage for success on the second-period project or his wage for not proposing a second-period project. However, this cannot improve incentives on the second-period project since we solved for the optimal contract with a zero payoff for project failure. Therefore, wage deferral fails to improve incentives and leads to a higher wage cost.

While the lack of commitment can also rule out deferred compensation, Lemma 6 does not rely on it. The key to this result is twofold—the inability of deferred compensation to improve incentives and the manager's preference for early consumption. In dynamic wage contracting models (e.g. Edmans et al. (2012)), wage deferral is an optimal response to the agent's sacrificing future output to inflate current performance. This does not happen here.

5 Competition for Managerial Talent

The preceding analysis examines what happens when a single firm contracts with a single manager who is privately informed about his type. It turns out that the firm offers the contract it would if it knew that the manager was type T. This contract is taken by both types of managers, but the type U manager taking this contract chooses $e = 0$ in both periods. Thus, the firm's lack of knowledge of the manager's type forces it to give a rent to a type U manager who does nothing in both periods. However, this is better than trying to induce such a manager to choose $e = 1$.

5.1 Matching Managers to Firms

We now introduce interfirm competition for managers. This leads to issues related to how managers are matched with firms. For now, competition occurs only at $t = 1$; second-period competition is considered later. Project choices of firms and the matching of managers and firms proceed as follows. Each firm decides on whether it wants its manager to search for S or L at $t = 1$, and announces this; given Proposition 4, managers also know the type of project the firm will search for in the second period. Managers then decide which firms they wish to apply to and report their types, based on which firms decide whether they want to hire them and what wage contracts they want to include in take-it-or-leave it offers. All decisions made by firms maximize their own values. Thus, this is the same process as in the previous section, except that managers can choose between S-project and L-project firms.

The core intuition underlying the analysis in this section is as follows. Because managers earn higher rents with the L-project firms, they will all flock to these firms, leaving the S-project firms possibly unstaffed. By designing contracts to offer *only* the type T managers higher rents than they get with the wages offered by these firms when they are not competing with the L-project firms, the S-project firms can poach some of the talent away from the L-project firms. I show that this is not possible in equilibrium for the L-project firms. Consequently, the S-project firms end up with a richer mix of talented managers than the L-project firms, and as a consequence they also invest more.

Recalling that there are N firms and M managers, the next result shows that the solution characterized in Proposition 4 does not work when firms are competing for managers.

Lemma 7: *When firms are competing for managers, given the contracts in Proposition 4, with $N/M \in (0, 1)$ sufficiently large, all managers will strictly prefer to apply only to firms that want their managers to search for L projects.*

Since working for an L-project firm gives both types of managers a higher rent (see Proposition 3), they all flock to those firms as long as the *expected* rent from applying to such a firm is higher than from applying to an S-project firm. The difference between the rents offered by the L-project and S-project firms is increasing in the effort cost $\overline{\psi}$. Moreover, N/M is the probability of being employed by a firm if all N firms are L-project firms and all M managers apply to those firms. Of course, if firms expect managers to only apply to L-project firms, all firms will choose to be L-project firms. It will be assumed henceforth that the conditions in Lemma 6 hold. The following result can be shown:

Proposition 5: *Suppose some firms that declare that they will search for S in the first period, and some firms declare that they will ask their managers to search for L in the first period. Then:*

(a) If the type T managers strictly prefer to apply to the L-project firms, both the type T and type U managers will apply only to the L-project firms.

(b) If the type T managers strictly prefer to apply to the S-project firms, it is possible for the type U managers to strictly prefer the L-project firms, but this can never be an equilibrium; and

(c) If the type T managers are indifferent between the contracts offered by the two types of firms, type U managers strictly prefer the L-project firms.

(d) Given any first-period project choice, under the optimal contracts in Lemma 4 and Propositions 1 and 2, all managers strictly prefer the firms searching for L.

The intuition is as follows. A manager's preference for a particular firm comes from the rent he earns, and this rent in any period is exactly equal to the efficiency wage. Thus, (a) follows from the fact that both managers enjoy the same rent from the L-project firms. As for (b), given Lemma 7, the only way an S-project firm can create a strict preference for it is by offering higher wages than in Proposition 4. Since it is possible to provide part of the higher wage for success on the first-period project, the firm can generate a rent for the type T manager that is unavailable to the type U manager who does not invest in equilibrium. Consequently, the type T manager can strictly prefer the S-project firm, whereas the type U manager prefers the L-project firm. But this cannot be an equilibrium because the L-project firms would never hire just managers who report themselves to be type U. The logic for (c) is similar, but this can be an equilibrium due to the randomization by the type T managers that can provide the L-project firms with a pool of both types of managers.

From Lemma 6 and Proposition 5, we see why designing its wage contract to induce the type T managers to be indifferent between the S-project and L-project firms may be value-maximizing for the S-project firms. If all managers prefer the L-project firms, then the S-project firms are unstaffed and have a value of zero. Then it may pay for some (smaller) firms to pursue the S project and raise wages to attract (only some of) the type T managers, with all type T managers being indifferent between the S-project and L-project firms. This leads to the next result.

Proposition 6: *Suppose there exist $\Delta_1, \Delta_2 \in (\Delta_{\min}, \Delta_{\max}]$ such that firms with $\Delta \leq \Delta_1$ choose S in both periods (SS firms), firms with $\Delta \in (\Delta_1, \Delta_2]$ choose S in the first period and L in the second period (SL firms), and firms with $\Delta > \Delta_2$ choose L in both periods (LL firms). Then the equilibrium must be such that each type T manager asks to join an SS firm with probability $\xi_{SS} \in (0,1)$, an SL firm with probability ξ_{SL}, and an LL firm with probability $1 - \xi_{SS} - \xi_{SL} \in (0,1)$. There is an equilibrium in which the probability of the manager being hired is $e_{SS} = 1$ if applying to an SS firm, $e_{SL} \in (0,1)$ if applying to an SL firm, and $e_{LL} \in (0, e_{SL})$ if applying to an LL firm. The talent pool at the SS and SL firms is better than at the LL firms.*

This proposition states that in equilibrium the firms that want their managers to search for S projects in both periods have to provide them with the most rents above the rents in the no-competition case when they are competing with SL and LL firms. The next highest rent difference above the non-competition case must be provided by the SL firms, and the LL firms can offer the contracts they offered in the no-competition case. The reason is that in the no-competition case, all managers prefer LL over SL, and SL over SS. So the additional rents make the type T managers indifferent between the three types of firms. However, any rent that makes the talented managers indifferent between the three types of firms will make the untalented managers strictly prefer the LL firms (Proposition 5). The

SL and SS firms are therefore able to attract a talent pool of managers that is better on average than that of the LL firms. This increases each SS and SL firm's value, so the outcome in which all managers strictly prefer the LL firm cannot be an equilibrium. The SL and SS firms therefore are chosen by talented managers, but not by any untalented managers. Consequently, the probability of investment in S-project firms is also higher since the type U managers never request funding.

The LL firms cannot improve their talent pool by raising wages because a higher wage only makes them more attractive to the untalented managers. And these firms cannot make the talented managers strictly prefer them because that would only induce the other firms to raise their wages until the talented managers were indifferent. So the equilibrium must involve the offered wage contracts being such that the talented managers are indifferent between the three types of firms, and the untalented managers strictly prefer the LL firms.

Moreover, given the equilibrium wage schedules, no firm will deviate by offering a lower wage, because this would cause its probability of hiring a manager to drop to zero.

The bottom line of Lemma 6 and Propositions 5 and 6 taken together is the following. If contracts that do not involve inter-firm competition for managers are used with competition, all managers will prefer firms that choose L in the first period. Recognizing this, the firms choosing S will modify their contracts to offer higher rents to managers than without competition, and in equilibrium its contracts will make the type T managers indifferent between joining the firms pursuing S and those pursuing L. Given these contracts, the type U managers will strictly prefer the firms pursuing L. Consequently, the firms pursuing S projects will have better managerial talent in equilibrium than those pursuing L projects.

5.2 Competition for Managers in the Second Period

I now examine the implications of allowing firms to compete for managers in the second period. Firms have more information about managers at $t = 2$. Specifically, the managers who invest in the first period are revealed at $t = 2$ to be type T with probability 1 since their (good) projects succeed. All firms will want to hire these managers since by doing so they raise the probability of investing in a good second-period project from $p\theta_1$ (at $t = 1$) to p (at $t = 2$). Let N_{SS} be the number of firms searching for S in both periods, N_{SL} the number of firms pursuing S in the first period and L in the second, and N_{LL} the number of firms searching for L in both periods. This leads to our final result:

Proposition 7: *There exists a critical firm size, Δ^0, such that all the managers who invested in S projects in the first period and are revealed to be talented at $t = 2$ will get hired by firms with size $\Delta > \Delta^0$ that themselves do not have managers revealed as type T, with smaller firms retaining their first-period managers.*

The intuition is that the value of a talented manager is bigger for larger firms since they have higher-valued good projects and therefore benefit from a higher probability of investing in these projects. If such a firm does not itself have a manager that it knows is type T, it will offer a manager revealed to be type T at $t = 2$ enough rents to make the firm of size Δ^0 indifferent between retaining its incumbent manager and hiring a type-T manager.

Second-period competition for managerial talent has an interesting consequence. Because the type-T managers stand to get bigger rents from having firms compete for them in the second period, they will now have a stronger preference for firms that invest in S in the first period. This means that the SS and SL firms will be able to lower the rents they must offer these managers when they are designing their first-period contracts. Consequently, the appeal of short-termism to firms will grow stronger.

This proposition also suggests a life-cycle effect. Specifically, young managers without a track record will tend to start with small firms, and then, conditional upon success, will be hired away by larger firms willing to pay more. Proposition 4 says that small firms invest in S in both periods. So Proposition 7 suggests that a manager who runs an S project at a small firm and succeeds at $t = 2$ will be revealed to be T and thus be hired away by a large firm. We know by Proposition 4 that large firms choose L in both periods. So together

Propositions 4 and 7 imply that young managers without a track record will work on short-horizon projects at small firms and then will switch to long-horizon projects at large firms after establishing a record of success.[26]

5.3 Managerial Turnover

As explained earlier, managerial firing at the end of the first period occurs only off the equilibrium path. However, a small tweak of the model can make firing an equilibrium phenomenon without qualitatively changing other results.

Suppose that managers privately know their types but only probabilistically. Then the type T manager is type T with probability $\gamma \in (0, 1)$ and type U with probability $1 - \gamma$, where $1 - \gamma = \varepsilon > 0$ is arbitrarily small. Similarly, a type U manager is type U with probability γ and type T with probability $1 - \gamma$. The existence of these two types and each type's probability distribution over T and U are common knowledge, but only the manager knows his own probability distribution. Then the type T manager will invest and the type U manager will not. A type T who invests in an S project will experience first-period failure with a small probability at $t = 2$. It will be optimal for the firm to fire such a manager, so there will be a higher incidence of firing in equilibrium with the S project than with the L project. Moreover, the managers who invest in S and are successful at $t = 2$ will still be hired away by bigger firms in the second period.

[26]This assumes that firms cannot discover the young manager's talent before it is revealed through a track record. To the extent that screening processes (including interviews, tests, etc.) can reveal something useful about the talent of young managers, Proposition 7 would imply that large firms would also hire young managers they screen and find to be talented.

6 Discussion of Model Features and Empirical Implications

In this section, I first discuss the key features of the model and the roles they play in the analysis. Then I discuss the empirical implications of the analysis.

6.1 Model Features

The analysis relies on four key features of the model that combine to generate the main results. In this subsection, I discuss the specific roles played by these features, with an indication of the results that would be lost without these features. The four features are: (i) managerial multi-tasking wherein the manager is first searching for a good project and then deciding whether to request funding; (ii) the manager's choice between a good (G) and bad (B) version of either the L or the S project; (iii) project choices in the first and second periods; (iv) two types of managers who are privately informed about their different abilities but are *a priori* observationally identical to firms.

To see the specific roles of these features, it is useful to begin with a simple, stripped-down version of the model in which these features are mostly absent and see what this model can and cannot deliver.

Simplified Model: As in the preceding analysis, there are three dates: $t = 1, 2, 3$. There is no discounting. At $t = 1$, the firm can choose between S and L. S pays off R_S or 0 at $t = 2$, and L pays off $R_L > R_S$ or 0 at $t > 3$. If the manager chooses effort $e = 1$, each project succeeds with probability 1. If the manager chooses $e = 0$, the project $i \in \{S, L\}$ succeeds with probability q_i, with $1 > q_L > q_S > 0$. The manager's effort disutility is $e\psi$, with $\psi > 0$. The payoff on L cannot be observed within the planning horizon of agents in the model, but a signal $\phi \in \{h, l\}$ with precision $\beta \in (0.5, 1)$ can be observed at $t = 2$. The payoff on S can be observed at $t = 2$. The first-period manager works only for a period and is replaced by a new manager at $t = 2$ who runs the firm for another period but produces nothing and is paid nothing.

Is is straightforward to see that the IC constraints here lead immediately to wage contracts that pay the manager:

$$\begin{cases} \frac{\psi}{[1-q_S]} & \text{with } S\text{, if the payoff at } t=2 \text{ is } R_S\text{, and 0 otherwise} \\ \frac{\psi}{[1-q_L]} & \text{with } L\text{, if the payoff at } t=2 \text{ is } R_L\text{, and 0 otherwise} \end{cases} \tag{31}$$

Since $q_L > q_S$, it is clear that $\frac{\psi}{[1-q_L]} > \frac{\psi}{[1-q_S]}$, implying a higher equilibrium wage cost to the firm with L than with S.

Discussion: This model has one result of the main model—the manager earns a higher rent with L than with S and thus prefers long-termism. It is consistent with the broader message of the paper that managers will prefer projects that have higher contracting frictions, and thus give them higher rents, but firms will have the same project preference only if the projects with higher agency costs also have sufficiently higher first-best values.

Additional Insights Provided by the Richer Model with all Four Features: While the stripped-down model delivers the result that the manager prefers L to S, this result is based entirely on the assumption that $q_L > q_S$, i.e., the consequence of shirking is less severe for the manager with L, so it is more costly to provide him with incentives *not* to shirk. If we assumed instead that $q_L < q_S$, agency costs would be higher with S, and there is no innate difference between L and S that pins down the relationship between q_L and q_S. The central focus of this paper is on exploiting the key difference between short-horizon and long-horizon projects that short-term cash flows can be measured with greater precision than long-term cash flows (see Section 1 and Section 2.2), especially when wages are paid on the basis of realized cash flows with the former and *estimated* cash flows with the latter. Thus, the main analysis relies crucially on *horizon differences* in generating a difference in agency costs between S and L.

This means that even when the benefit of shirking—proposing a B project—is the *same* across S and L in the sense that B has the same payoff distribution for S and L, agency costs are higher with L than with S. In such a setting, multi-tasking (feature (i)) is necessary to produce managerial rents (agency costs for firm) that are positive for both S and L but differ solely based on the timing of payoff realizations. Moreover, since multi-tasking is both searching for a good project and then deciding whether to request funding (even when a good project is not found), feature (ii) is needed as well in generating managerial rents.

Features (iii) and (iv) also play a role in creating a difference in the agency costs of L and S. Since the manager earns a rent in the second period only if he is retained, he is averse to being fired, and this threat is greater with S than with L when the manager shirks. This makes shirking *endogenously* less costly for the manager with L, requiring the firm to pay higher wages both for success and for not proposing a project with L than with S. The second-period project choice (feature (iii)) thus contributes to creating a wedge in the agency costs of S and L in the first period. Finally, feature (iv) plays the role of making the firing threat optimal for the firm. Absent unobservable heterogeneity in managerial talent, there would be *no* reason for the firm to fire the manager at the end of the first period.

Features (iii) and (iv) play an essential role in the analysis of competition for managerial talent in Section 5.[27] Competition for managerial talent would not exist without managerial talent heterogeneity. Moreover, it would not be possible to analyze the difference in initial competition for young managers with unknown talent and subsequent competition for managers with track records among firms of different sizes (Propositions 6 and 7) without project choices in both periods.

[27] Features (i) and (ii) are also necessary in this analysis because it relies heavily on the earlier results about higher agency costs for L than for S based on payoff timing differences.

6.2 Empirical Implications

The preceding analysis has numerous empirical implications. First, unlike the previous short-termism literature (e.g. Narayanan 1985a,b and Stein 1989), it is the *manager* who dislikes short-termism and the *shareholders* who prefer short-termism. This implies short-termism is practiced by the firm in the interest of shareholders, and we should expect it even in well-managed firms with good corporate governance. This belies the notion that short-termism is practiced only by unsophisticated firms, or that it is pursued only by self-interested managers who are sacrificing firm value to do it. However, it is consistent with the empirical evidence in Giannetti and Yu (2016).

Second, wages are downward rigid, and with short-horizon projects they strictly increase over time, even without managerial risk aversion. The standard explanation for downward-rigid wages is worker risk aversion (e.g. Harris and Holmstrom 1982). The analysis here shows that risk aversion is not necessary.

Third, when managerial talent is unknown, smaller firms will have more talented managers. Moreover, firms that practice short-termism will hire more talented managers. The analysis also implies that smaller firms are more likely to practice short-termism, so the testable prediction here is a segmentation of firms by size in terms of both the hiring of unobservably talented managers and the practice of short-termism. To my knowledge, this is a novel prediction that has not been previously tested.

Fourth, when managerial talent is revealed over time, so that managers develop track records and firms can compete at this stage for managerial talent, the larger firms will hire the more talented managers. This is consistent with the evidence in Gabaix and Landier (2008).[28]

Fifth, firms that start out being short-term oriented in project choices may switch to long-horizon projects, and this is more likely with larger firms. This is suggestive of large

[28] This also holds for young managers that large firms can screen and discover as being more talented. Examples may be large firms like Goldman Sachs and McKinsey that have extensive screening processes to identify talented graduates at universities.

firms conducting "experiments" with new ideas, wherein they invest in short-horizon, lower-valued versions of the idea initially when they are unsure of the talent of the managers they are working with, and then switch to higher-valued, long-horizon projects when they are more certain that managers have high talent. Note that this is because of the value of learning about managerial talent, rather than learning about project quality as in the innovation literature, but it complements the idea in that literature that firms may wish to initially explore ideas and then exploit a well-known technology.

Sixth, with unknown managerial talent, it is never the case that the firm first assigns the manager the high-agency-cost project (L) before assigning the low-agency-cost project—see Proposition 6. This is in contrast to Axelson and Bond (2015).

Finally, a modified version of the model implies that firms adopting short-term projects will experience greater turnover in equilibrium. This is an implication that appears to be amenable to empirical testing.

7 Conclusion

This paper has developed a theory of the choice of investment horizon by firms that relies on the interaction between investment horizon, innate project value, managerial rent extraction, and managerial talent selection. The analysis shows that optimal wage contracts generate efficiency wages, leading to informational rents for privately informed managers that are higher when they invest in intrinsically higher-valued long-horizon projects. The manager's rent is an agency cost for the firm. To limit this agency cost, the firm chooses to limit the manager's choice to short-horizon projects in the interest of its shareholders. Short-termism is eschewed by bigger firms for which the long-horizon project is intrinsically much more highly valued than the short-horizon project. When firms compete for managerial talent, short-termism enables firms to attract better talent.[29] The model thus generates numerous

[29]To the extent that short-termism boosts current reported earnings, the analysis implies that it may be in the best interest of shareholders.

testable predictions.

These predictions are generated by the interaction of two key informational frictions in the model—moral hazard and the manager's private information about his type. Moral hazard with multi-tasking generates managerial rents, whereas the manager's private information affects both his career path as well as the nature of interfirm competition for managerial talent. This labor market competition makes short-termism even more attractive for firms.

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Figure 1: Timeline

$t = 1$	$t = 2$	$t = 3$	$t > 3$
• Firm asks the manager to report his type and then makes a TIOLI offer of a wage contract. • The firm either restricts the manager to S project, or allows L or S. • The manager decides whether to propose L or S, and chooses his effort to search for a G project. The manager unobservably chooses to structure the project either as G (if available) or B.	• Payoffs of S are realized, if chosen in first period. A noisy but informative signal, ϕ, of the eventual payoff of L is available if it was chosen. • The firm decides whether to retain or fire the manager. If retained, the manager gets a TIOLI offer of a wage contract. If fired, firm asks a new manager to report his type and then makes a TIOLI offer of a wage contract. • If S was chosen in first period, the manager decides whether to propose L or S, and chooses his effort to search for a G project. The manager unobservably chooses to structure the project either as G (if available) or B.	• If L was chosen in the first period, payoffs are realized. If S was chosen in both periods, payoffs of second-period S project realized. • A noisy but informative signal, ϕ, of the eventual payoff of L is available if it was chosen in the second period.	• The payoffs of L are realized if it was chosen in the second period.

Appendix

Table A1: Summary of Notation in the Model

Notation	Definition
N	Number of firms
M	Number of managers
δ	Manager's consumption discount factor
c_t	Manager's consumption at date t
S	Short-horizon project
L	Long-horizon project
$a_t \in \{L, S\}$	Project choice at date t
$\phi \in \{h, l\}$	Signal of eventual project payoff on L
β	Precision of signal ϕ
e	Manager's effort choice
$\psi(e) = e\overline{\psi}$	Manager's cost of effort
p	Probability manager finds a good project
$\tau \in \{T, U\}$	Manager's ability: talented (T) or untalented (U)
Δ	Firm size
η	Distribution function of Δ
R_L	Payoff of good long-term project
R_S	Payoff of good short-term project
y_t	Realized payoff of project at date t
$\tilde{q}(\tau) = \begin{cases} 1 & \text{if } \tau = T \\ q \in (0.5, 1) & \text{if } \tau = U \end{cases}$	Probability good project succeeds
θ_t	Prior belief about manager's type at date t
θ_t^i	Posterior belief about manager's type, based on observed outcome i at date t
b	Probability bad project pays off positive amount
$W_{a_t}(x_{t+1})$	Wage contract as a function of outcome x and project choice at date t
ζ	Cost to firm of firing manager

Proof of Lemma 1: Suppose, counterfactually, that the type U manager reports himself as type U. Then the firm will not wish to hire him, so no contract will be offered. This gives the manager a utility of zero. Thus, the type U manager would be strictly better off reporting himself to be a type T manager and collecting the rent the type T earns for *not* requesting funding. This holds even if a manager not requesting funding in the first period is fired at $t = 1$, since in that case the manager's second-period utility is zero, but the manager earns a rent on the first-period contract. ■

Proof of Lemma 2: The proof follows from the fact that incentivizing the type-U manager to expend search effort (choose $e = 1$) is inefficient, given (4), i.e., it reduces firm value and cannot occur in equilibrium. Thus, in case the firm does end up with a type-U manager, it is efficient to not have the manager choose $e = 1$ and also to not propose a bad project. However, it is efficient to incentivize the type-T manager to choose $e = 1$ (see (4)) and propose only a good project, in that this increases firm value. Thus, it is part of the equilibrium. The feasibility of the offered contracts is assured by Assumptions 1 through 5. ■

Proof of Lemma 3: Suppose S was chosen in the first period. We know that if $y_2 = 0$, then $\Pr(\tau = T \mid y_2 = 0) = 0$, so the firm knows that the manager is type U with probability 1 and fires him. If the manager is retained, then by Lemma 2 we know that second-period contracts will be designed to induce the type T manager to choose $e = 1$ and the type U manager to choose $e = 0$. Given this, the second-period contracts do not depend on the firm's belief about the manager's type. If L was chosen in the first period and the manager was fired, then clearly the new manager's second-period contract is independent of what happened in the first period. If the manager is retained after the first-period, then again by Lemma 2, the second-period contract does not depend on beliefs about the manager's type. Hence, second-period contracts, conditional on retention, are unaffected by the first-period. ■

Proof of Lemma 4: Suppose the manager is searching for S in the first period. As argued in the text, it is optimal to set $W_S(l) = 0$. Next, note that (15) and (17) will be binding in equilibrium. Solving these simultaneously yield (19). With this solution, (18) is clearly satisfied. From Lemma

3, we also know that the manager will be fired if $y_2 = 0$. What remains to be shown is that the manager will be retained if he did not request funding at $t = 1$ or if $y_2 = R_S$ at $t = 2$. Suppose the manager did not request funding at $t = 1$. Then

$$\Pr(\tau = T \mid x_2 = n) = \theta_2^n \tag{A.1}$$

where

$$\theta_2^n = \frac{[1-b]\theta_1}{[1-p]\theta_1 + 1 - \theta_1} \tag{A.2}$$

is also defined in (7). Thus, the expected firm value from retaining the manager in the second period is

$$\theta_2^n \{R_S - \mathbb{E}[\text{compensation cost} \mid \tau = T] - 1\} - [1-\theta_2^n] W_{S2}^n \tag{A.3}$$

where we use the fact that a type U manager (the probability of the manager being type T is $1-\theta_2^n$) chooses $e = 0$ and does not invest. The proof that the type U manager will prefer to choose $e = 0$ over $e = 1$ follows from the fact that (15) is binding in equilibrium, so (16) clearly holds because $qW_S(h, \theta_2) + [1-q]W(l, \theta_2) = \mathbb{E}[W_{a_2}(y_3, \theta_2) \mid U, G] < \mathbb{E}[W_{a_2}(y_3, \theta_2) \mid T, G] = W_S(h, \theta_2)$. Here

$$\mathbb{E}[\text{compensation cost} \mid \tau = T] = pW_S(h) + [1-p]W_S(n) \tag{A.4}$$

Substituting (A.4) into (A.3) yields:

$$\begin{aligned}
&\theta_2^n R_S - \theta_2^n p W_S(h) - \{\theta_2^n[1-p] + 1 - \theta_2^n\} W_S(n) - \theta_2^n \\
=&\theta_2^n R_S - \theta_2^n p W_S(h) - \{1 - \theta_2^n p\} W_S(n) - \theta_2^n \\
=&\theta_2^n R_S - \theta_2^n p \frac{\overline{\psi}}{p[1-b]\delta} - \frac{[1-\theta_2^n p]\, b\overline{\psi}}{p[1-b]\delta} - \theta_2^n \\
=&\theta_2^n [R_S - 1] - \frac{\overline{\psi}\,[\theta_2^n p + b - \theta_2^n p b]}{p[1-b]\delta} - \theta_2^n \\
=&\theta_2^n [R_S - 1] - \overline{\psi}\,[b + \theta_2^n A_1]\,[A_1\delta]^{-1}
\end{aligned} \tag{A.5}$$

recalling that $A_1 \equiv p[1-b]$. Given (6), we know that the expression in (A.5) is strictly positive.

Now suppose $y_1 = R_S$. Then the expected firm value is

$$\theta_1^h \left[R_S - 1\right] - \overline{\psi}\left[b + \theta_1^h A_1\right]\left[A_1\delta\right]^{-1} \tag{A.6}$$

which is also strictly positive given (6). Thus, the manager will be retained if no funding was requested at $t = 1$ or $y_1 = R_S$. The result that $W_{S2}^h = W_{S2}^h(n) = W_{S2}^h(h)$, $W_{S2}^l = W_{S2}^l(n) = W_{S2}^l(h)$ and $W_{S2}^n = W_{S2}^n(n) = W_{S2}^n(h)$ follows from Lemma 3.

Next, it will be proven that the firm will hire a replacement manager when it fires the first-period manager following $y_1 = 0$. The expected firm value in the second period from firing the first-period manager and hiring a new manager is:

$$\begin{aligned}&\theta_1\left\{R_S - \mathbb{E}\left[\text{compensation cost} \mid \tau = T\right] - 1\right\} - \left[1 - \theta_1\right] W_S(n) - \zeta \\ =&\theta_1\left[R_S - 1\right] - \overline{\psi}\left[b + \theta_1 A_1\right]\left[A_1\delta\right]^{-1} - \zeta \end{aligned} \tag{A.7}$$

which is strictly positive given (6) since $\theta_1 > \theta_2^n$.

Now consider the manager searching for L in the first period. The proof that (20) represents optimal second-period contracts uses (15) and (17) and is similar to the steps followed above. Along the path of play, the type U manager never chooses $e = 1$ and never requests funding, which means the firm knows that it is the type T manager in charge of the project about which the signal ϕ is observed. As long as $\beta < 1$, any observed value of ϕ is consistent with the project choice having been made by a type T manager, and hence that value of ϕ is an equilibrium outcome. Given this, the firm does not fire the manager for any $\phi \in \{h, n, l\}$. ■

Proof of Lemma 5: Follows readily from the discussion of the intuition in the text. ■

Proof of Proposition 1: Consider first the choice of S in both periods. $W_S\left(l, \theta_1, S\right) = 0$ follows from earlier arguments. (27) and (29) are obtained by solving (24) and (25) as simultaneous equations because both constraints are binding at the optimum.

Next consider L in the second period after S in the first. The solution procedure for first-period contracts is essentially the same as above, except that the rent on the second-period project is now

$W_L(n)$ instead of $W_S(n)$, and hats are used to distinguish the first-period contracts in this case. Proceeding to solve for contracts this way leads to

$$W_S(n, \theta_1, L) = \frac{b\overline{\psi}}{p[1-b]} - W_L(n) \tag{A.8}$$

where $W_L(n)$ is given by (20). It is straightforward to show that $\delta W_L(n) > \frac{b\overline{\psi}}{p[1-b]}$. Since negative wages are precluded, we have $W_S(n, \theta_1, L) = 0$, which means that (25) becomes slack (since $W_S(n, \theta_1, L) = 0 > \frac{b\overline{\psi}}{p[1-b]} - \delta W_L(n)$) and we cannot use it as an equality to solve for $W_S(n, \theta_1, L)$. Since (24) is binding and reduces to:

$$W_S(h, \theta_1, L) - W_S(n, \theta_1, L) = \frac{\overline{\psi}}{p} \tag{A.9}$$

plugging in $W_S(n, \theta_1, L) = 0$ into (A.9) yields the $W_S(h, \theta_1, L)$ in (27). ■

Proof of Proposition 2: $W_L(l, \theta_1, a_2) = 0$ is clear from earlier arguments. Moreover, since (24) and (25) are binding in equilibrium, we can treat them as simultaneous equations and recognize that to obtain (30). Clearly, (26) holds with (30). The rest of the proof follows in a straightforward manner. ■

Proof of Proposition 3: Since second-period contracts are identical for a first-period project choice of either L or S, the manager's preference will depend solely on a comparison of his utility with L to his utility with S in the first period. Moreover, since the manager chooses $e = 1$ in both cases and experiences the same effort disutility cost $\overline{\psi}$, we can simply compare the manager's expected first-period compensation with L to that with S. With S, the type T manager's expected compensation is

$$\mathbb{E}[c_S] = pW_S(h, \theta_1, S) + [1-p]W_S(n, \theta_1, S) \tag{A.10}$$

and substituting for $W_S(h, \theta_1, S)$ and $W_S(n, \theta_1, S)$ from Proposition 1 and for $W_S(n)$ from Lemma 4 gives us:

$$\mathbb{E}[c_S] = \frac{p\overline{\psi}[1-b]}{p[1-b]} \tag{A.11}$$

Using Proposition 2 for a similar exercise with L, we have:

$$\mathbb{E}\left[c_L\right] = pW_L\left(h, \theta_1, a_2\right) + [1-p]W_L\left(n, \theta_1, a_2\right) \tag{A.12}$$

and substituting from Proposition 2 for $W_L\left(h, \theta_1, a_2\right)$ and $W_L\left(n, \theta_1, a_2\right)$ yields:

$$\begin{aligned} \mathbb{E}\left[c_L\right] = & \frac{p\overline{\psi}}{p[1-b][2\beta-1]} + \frac{[1-p]\overline{b}(\beta)\overline{\psi}}{p[1-b][2\beta-1]} \\ = & \frac{\overline{\psi}\left[p + [1-p]\overline{b}(\beta)\right]}{p[1-b][2\beta-1]} \end{aligned} \tag{A.13}$$

So comparing (A.11) and (A.13), we see that the manager's expected compensation is higher with L than with S if (A.13) exceeds (A.11), i.e., if

$$p + [1-p]\overline{b}(\beta) > p[1-b][2\beta-1] \tag{A.14}$$

which is true since $b < 1$ and $2\beta - 1 < 1$. Thus, the manager strictly prefers L. ■

Proof of Proposition 4: The firm's preference depends on its expected profit over two periods. Denote a_1a_2 as choosing project $a_1 \in \{S, L\}$ in the first period and a_2 in the second. Since SL strictly dominates LS for any firm that wishes to invest in S in one period and L in the other, we can make a comparison of the firm's profits from SS, SL, and LL. The firm's expected profit with SS is:

$$\pi_{SS} = 2\Delta\theta_1 p\left[R_S - 1\right] - \theta_1 p\left\{W_S\left(h, \theta_1, S\right) + W_S(h)\right\} - \left\{\theta_1[1-p] + 1 - \theta_1\right\}\left\{W_S\left(n, \theta_1, S\right) + W_S(n)\right\} \tag{A.15}$$

where it is recognized that the type-T manager always invests (and succeeds) when he finds a good project (the probability of which is p). The prior probability of the manager being type T is θ_1. π_{SS} consists of the expected net two-period payoff, which is $\theta_1 p\left[R_S - 1\right]$ in each period there is investment. Similarly,

$$\pi_{SL} = \Delta\theta_1 p \{[R_S - 1] + [R_L - 1]\} - \theta_1 p \{W_S(h, \theta_1, S) + W_L(h)\} - \{\theta_1[1-p] + 1 - \theta_1\} \{W_S(n, \theta_1, S) + W_L(n)\} \tag{A.16}$$

$$\pi_{LL} = 2\Delta\theta_1 p \{R_L - 1\} - \theta_1 p \{W_L(h, \theta_1, L) + W_L(h)\} - [\theta_1[1-p] + 1 - \theta_1] [W_L(n, \theta_1, L) + W_L(n)] \tag{A.17}$$

Comparing π_{SS}, π_{SL}, and π_{LL}, we see that expected contracting costs are highest in π_{LL}, followed by π_{SL}, and the lowest in π_{SS}. However, the expected project payoff over two periods is also the highest in π_{LL}, followed by π_{SL} and then π_{SS}, and the differences between the expected payoffs, $2\Delta\theta_1 p \{R_L - 1\} - \Delta\theta_1 p \{[R_S - 1] + [R_L - 1]\}$ and $\Delta\theta_1 p \{[R_S - 1] + [R_L - 1]\} - 2\Delta\theta_1 p \{R_S - 1\}$, are both strictly increasing in Δ. The proposition now follows. ■

Proof of Lemma 6: Suppose $\delta = 1$, and assume that the manager is paid based on the contracts described in Proposition 2 at $t = 3$ instead of $t = 2$. Given that $W_L(l, \theta_1, a_2) = 0$, one possibility for the firm is to implement the deferral scheme by paying the manager $W_S(h) + W_L(x_2, \theta_1, S)$ if the second-period project succeeds, $W_S(l) + W_L(x_2, \theta_1, S)$ if the second-period project fails, and $W_S(n) + W_L(x_2, \theta_1, S)$ if the manager did not request funding for the second-period project. It is clear that doing this will have no effect on the manager's incentives with respect to either the first-period or the second-period project. Of course, to maximize the effectiveness of incentives, we know that the manager should be paid 0 at $t = 3$ if the second-period project fails. However, we derived the cheapest way to incentivize the manager to choose $e = 1$ and propose only the good project in the second period when we solved for the optimal contract in the continuation game in the second period. So we cannot improve on second-period incentives by paying the manager more. Further, the manager's incentives on the first-period contract also cannot be improved by this deferral since beliefs follow a martingale and the manager's choices on L at $t = 0$ do not affect the success probability of S chosen at $t = 2$.

Thus, with $\delta = 1$, wage deferral cannot improve on the outcome with the wage paid at $t = 1$. This means that with $\delta < 1$, wage deferral leads to a strictly higher expected wage cost (with no improvement in incentives). ■

Proof of Lemma 7: Now suppose all firms are L-project firms and all managers apply to L-project firms. Then the probability a manager will be hired is N/M. The claim that both types of managers will strictly prefer to apply to the firms with the L projects is true if $(N/M)\mathbb{E}[c_L] > \mathbb{E}[c_S]$, where $\mathbb{E}[c_S]$ and $\mathbb{E}[c_L]$ are defined in (A.11) and (A.13), respectively. Since $\mathbb{E}[c_L] > \mathbb{E}[c_S]$, this inequality will hold for N/M large enough. Thus, it is a Nash equilibrium for all managers to flock to type-L firms and for all firms to be type-L firms. ■

Proof of Proposition 5: The proof is similar to the arguments outlined in the text. Part (a) follows from Lemma 1, which implies that the type U manager will always choose to mimic the type T manager, and Proposition 3 which indicates that the type T manager earns a rent with his equilibrium contract. As for (b), Lemma 1 has established that a separating equilibrium is not possible. As for (c), the only way for a type T manager to strictly prefer the S project firm is if it offers a higher wage than needed to incentive compatibility, i.e.,

$$\hat{W}_S(h, \theta_1, S) = W_S(h, \theta_1, S) + \alpha \tag{A.18}$$

where $\alpha > 0$, and from (19) and (27), we have $W_S(h, \theta_1, S) = \overline{\psi}/p$. Since in equilibrium the type-U manager does not propose a project, the additional rent α is not available to such a manager, so it is possible that the type-T manager strictly prefers the S-project firm or is indifferent between S-project and L-project firms, and the type-U manager strictly prefers the L-project firm. Part (d) follows from Proposition 3. ■

Proof of Proposition 6: It is clear that if all firms offer the contracts in Lemma 4 and Propositions 1 and 2, all managers prefer the LL firms to the SL firms, and the SL firms to the SS firms. From Proposition 5, we know that the offered contracts cannot be such that the type-T managers still strictly prefer the LL firms (part (a) in Proposition 5), because in this case the other firms would be unstaffed, contradicting the premise that these firms are in the market. From (b) in Proposition 5, it can also not be the case that the type-T managers strictly prefer the SS or SL firms. Thus, part (c) is the only possibility in that the type-T managers must be indifferent across all three types of firms, so each will randomize applying across the three types of firms, with the probability of applying to an ij firm indicated as ξ_{ij}, $i, j \in \{S, L\}$. From Proposition 5, we know that in this case the type-U managers strictly prefer the LL firms.

Let N_{SS}, N_{SL}, and N_{LL} represent the number of SS, SL, and LL firms competing for managers. Let e_{ij} be the probability with which a manager applying to an ij firm will be hired. It is clear that, given managerial preferences under the optimal wage contracts indicated in Propositions 1 and 2 and Lemma 4, the SS and SL firms will have to offer higher rents to the type-T managers than under those contracts to make them indifferent across the three types of firms. Now, the SS firm can set its type-T managerial rent, Ω_{SS}, such that $e_{SS} = 1$ and $N_{SS} = \xi_{SS}\theta_1 M$, where N_{SS} is the expected number of managers applying to the SS firms under the type-T manager's randomization policy.

The SL firm can take ξ_{SL} and offer a type T managerial rent, Ω_{SL}, such that $N_{SL} \leq \xi_{SL}\theta_1 M$, yielding $e_{SL} \leq 1$. The LL firm can set its type T managerial rent, Ω_{LL}, such that $N_{LL} \leq \xi_{LL}\theta_1 M$. For the type T manager to be indifferent across all three types of firms, we need

$$\Omega_{SS} = e_{SL}\Omega_{SL} = e_{LL}\Omega_{LL} \tag{A.19}$$

The equilibrium is a vector $\{\Delta_1, \Delta_2, \Omega_{SS}, \Omega_{SL}, \Omega_{LL}, e_{SS}, e_{LL}, N_{SS}, N_{SL}, N_{LL}\}$that, taking $e_{SS} = 1$ without loss of generality and taking the manager's randomization probabilities, is a solution to (A.19) and:

$$\pi_{SS}^{\Delta_1}(\Omega_{SS}) = \pi_{SL}^{\Delta_1}(\Omega_{SL}) \tag{A.20}$$

$$\pi_{SL}^{\Delta_2}(\Omega_{SL}) = \pi_{LL}^{\Delta_2}(\Omega_{LL}) \tag{A.21}$$

$$\eta(\Delta_1) = N_{SS} \tag{A.22}$$

$$\eta(\Delta_2) = N_{SL} \tag{A.23}$$

$$1 - \eta(\Delta_2) = N_{LL} \tag{A.24}$$

where $\pi_{ij}^{\Delta}(\Omega_{ij})$ is the net profit of a firm of size Δ searching for $i \in \{S, L\}$ in the first period and $j \in \{S, L\}$ in the second period and which provides its manager a rent of Ω_{SS}.

Note from (A.20) that because the expected project payoff with SL exceeds that with , it must be true that $\Omega_{SL} > \Omega_{SS}$, since π is decreasing in Ω for all firms. Similarly, $\Omega_{LL} > \Omega_{SL}$. Thus, from (A.19) it follows that

$$e_{LL} < e_{SL} < e_{SS} = 1 \tag{A.25}$$

The solution to (A.19)-(A.24) yields the equilibrium number of firms that choose SS, SL, annd LL. Based on earlier arguments, $\Delta_1 \in (\Delta_1, \Delta_{\max}]$.

Finally, since the type T managers apply to all three types of firms but the type U manager apply only to the LL firms, the average quality of the talent pool is higher at the SS and SL firms than at the LL firms. ■

Proof of Proposition 7: The value of a talented manager to a firm of size Δ is:

$$\Delta p \left[R_i - 1\right] \tag{A.26}$$

where $i \in \{S, L\}$. Thus, the maximum expected wage, $W^{\Delta}_{\max}$, a firm of size Δ can offer is $\Delta p \left[R_i - 1\right]$, which is strictly increasing in Δ. A firm that does not have a first-period manager who experienced success at $t = 2$ will want to hire a new manager for the second period if:

$$\Delta p \left[R_i - 1\right] - \zeta - W^{\Delta}_{\max} > \theta_2 p \Delta \left[R_i - 1\right] - \mathbb{E}\left[W\right] \tag{A.27}$$

where $\mathbb{E}\left[W\right]$ is the expected wage with the incumbent manager. Rearranging (A.27) yields

$$\Delta p \left[R_i - 1\right] \left[1 - \theta_2\right] > W^{\Delta}_{\max} + \zeta - \mathbb{E}\left[W\right] \tag{A.28}$$

The left-hand size of (A.28) is strictly increasing in $\Delta \ \forall \, \theta_2 < 1$, whereas the right-hand side is independent of Δ. Thus, $\exists \ \Delta^0$ such that (A.28) holds for $\Delta > \Delta^0$, and is reversed for $\Delta < \Delta^0$. ■