A Theory of Efficient Short-termism

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Abstract

This paper develops a theory of efficient short-termism—the shareholders prefer short-termism in project choice. Unlike previous theories, a short-term bias in investment horizons maximizes firm value in the second-best case, whereas managers themselves prefer long-horizon projects. Short-termism benefits the firm because it limits managerial rent extraction by preventing investments in long-term bad projects that produce managerial private benefits but delay information revelation about project quality and managerial ability, thereby obstructing more efficient subsequent decisions. This result does not depend on stock mispricing, short-horizon investors, or a managerial desire to manipulate stock prices. The likelihood of short-termism is higher when corporate governance is stronger. Numerous testable predictions are discussed.

Keywords: Short-termism, Myopia, Internal Governance, Payback, Capital Budgeting, Project Choice

JEL Classification: C72, D82, G31, G32, M43

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“Critics need to acknowledge that short-term thinking often makes sense for U.S. businesses, the economy and long-term employment.” —Roe (2015)

1 Introduction

A widely-studied topic in corporate investment policy is “short-termism”, the practice of preferring lower-valued short-term projects over higher-valued long-term projects. It is sometimes undertaken for earnings management (e.g. Burgstahler and Dichev (1997) and Dichev, Graham, Harvey, and Rajgopal (2013)). Short-termism has been linked to numerous ills, including excessive risk-taking, underinvestment in R&D, and even the recent financial crisis.¹

The theoretical explanations for short-termism fall primarily into three groups. The first posits that the stock market puts pressure on firms to deliver higher short-term earnings at the expense of long-term value (see, for example, Stein (1989)).² The second explanation relies on managerial self-interest, that an agency problem between managers and shareholders leads managers to pursue short-term projects even though shareholders prefer long-term projects (e.g. Narayanan (1985a,b)). The third explanation is that short-termism is encountered in unsophisticated firms in which managers use a simple capital budgeting criterion like payback.³ Yet, short-termism continues to be widely practiced (e.g. Narayanan (1985a),

¹Bebchuk and Fried (2010) state: “...standard executive pay arrangements were leading executives to focus on the short term, motivating them to boost short-term results at the expense of long-term value. The crisis of 2008-09 has led to widespread recognition that pay arrangements that reward executives for short-term results can produce incentives to take excessive risks.” See also Polsky and Lund (2013) and Pozen (2014). Recently, evidence of the effects of short-termism has been provided for investments in R&D—see Budish, Roin, and Williams (2015) and Cremers, Pareek, and Sautner (2016). Additional empirical evidence in support of the idea that short-term incentives may influence R&D is provided by Chen, Cheng, Lo, and Wang (2015), who document that contractual protection in the form of employment and severance pay agreements for CEOs are less likely to cut R&D and engage in real earnings management. Also, see Rappaport and Bogle (2011) for a discussion of how short-termism may represent “a danger to capitalism.”

²As an example of this, in Dell’s recent decision to go private, one of the reasons provided by some observers was that Dell could pursue more long-term-oriented investment strategies if it did not face the pressure from the stock market to deliver short-term results.

³A project’s payback period is the length of time it takes for project cash flows to add up to the initial investment. Graham and Harvey (2001) found that 56.7% of the firms in their survey almost always used payback; they note: “This is surprising given that financial textbooks have lamented the shortcomings of the payback criterion for decades”. Pike’s (1996) evidence that, during 1975-1992, 4-14% of companies in the U.K. used payback as their only capital budgeting criterion suggests that payback is decision-relevant.
Lefley (1996), Pike (1996), exhibits little correlation with firm performance or negative outcomes (Kaplan (2017)), is used more in firms with stronger corporate governance (e.g. Gianetti and Yu (2016)), and does not appear to be used only by incompetent or unsophisticated managers (e.g. Graham and Harvey (2001)).

Why is short-termism so prevalent even in well-managed firms, and why does it not always lead to poor outcomes? In addressing this question, this paper challenges the notion that short-termism is inherently a misguided practice, and examines whether there are circumstances in which it is economically efficient. I derive three main results. First, the owners of the firm may prefer short-term projects in the (constrained) second-best case, even though long-term projects have higher first-best values. Moreover, this is independent of any stock market inefficiencies or pressures. This is in sharp contrast to earlier research in which short-termism emanates from investors’ short-term horizons (e.g. Bolton, Scheinkman, and Xiong (2006a,b)) or the risk that long-term projects may have their financing cut off (von Thadden (1995)).

Second, it is the managers with career concerns who dislike short-term projects, even when the firm’s owners prefer them. This is the opposite of previous papers such as Narayanan (1985a,b) and Stein (1989), where managers like short-term projects and the firm’s owners prefer long-term projects. In this paper, managerial career concerns inefficiently incline managers towards long-term horizons, and short-termism reduces this distortion. Third, firms with stronger corporate governance are more likely to practice short-termism.

These results are derived with a two-period model of internal governance and project

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Anecdotal evidence, in the form of examples of CEOs making statements that they have well-understood guidelines in their firms about the maximum permissible project payback periods, are also consistent with this.

Since shareholders prefer long-term investments even in the second-best case (with incentive constraints), investor monitoring is shown to overcome investment myopia. In my model, investors prefer the short-term project in the second best.

Darrough (1987) shows that Narayanan’s (1985a,b) equilibrium disappears if the firm uses an appropriate incentive scheme. Jeon (1991) shows that if stock prices reflect the manager’s strategic behavior, Stein’s (1989) effect can be at most transient.

Moreover, unlike in Holmstrom (1999), where career concerns reduce agency costs, in my model they increase agency costs. In this respect the model is similar to Holmstrom and Ricart i Costa (1986) where career concerns lead to investment distortions, albeit of a different sort.
choice, with career concerns and moral hazard distorting managerial project choices in firms. There is a top executive (called a “CEO”), who maximizes firm value in the base model.\footnote{The idea here is that executive compensation is designed to align the CEO’s interest with that of the shareholders. In a generalized version of this preference function, the CEO also cares about the utility of a manager who reports to her, which introduces an additional agency problem.}

Reporting to the CEO is a lower-level divisional manager (“manager” henceforth) who requests funding for (and manages) projects in two time periods. The manager receives ideas for projects in each period with variable quality—they can be good (positive NPV) or bad (negative NPV) projects. The manager knows project quality, but the CEO does not. Regardless of quality, the project can be (observably) chosen to be short-term or long-term, and a long-term project has higher intrinsic value.\footnote{One can think about the long-term and short-term projects concretely through examples. For an appliance manufacturer, investing in modifying some feature of an existing appliance, say the size of the freezer section in a refrigerator, would be a short-term project. By contrast, building a plant to make an entirely new product—say a high-technology blender that does not exist in the company’s existing product portfolio—would be a long-term project. The long-term project will have a longer gestation period, with not only a longer time to recover the initial investment through project cash flows, but also a longer time to resolve the uncertainty about whether the project has positive NPV in an \textit{ex post} sense. In a bank, loans can have either short or long maturities. There may also be industry differences that determine project duration. For example, long-distance telecom companies (e.g. AT&T) will typically have long-duration projects, whereas consumer electronics firms will have short-duration projects.}

The success probability for any good project depends on managerial ability, which is \textit{ex ante} unknown to everybody.

In the first best, the manager requests funding only for the long-term version of a good project. However, when the manager has private information about project quality, he may request funding for a bad project because he enjoys private benefits from investing.\footnote{These private benefits can be thought of as managerial quasi-rents in the perquisites-consumption framework of Jensen and Meckling (1976). There are many papers that assume managers enjoy private benefits, and analyze the resulting overinvestment, e.g. Aghion and Bolton (1992). Stein (2003) provides a review.}

Now consider the manager’s problem. In the second period, the manager can only propose a short-term project because there is only one period left. In the first period, the manager has a choice. But if he gets a bad project, he may nonetheless request funding, and do this for the long-term version of the project because of the private benefit from first-period investment. Moreover, because the first period reveals nothing about his ability, he also obtains funding and private benefits in the second period. So, the manager may invest in a
bad long-term project in the first-period.\textsuperscript{10} I call this the “incentive problem”.

The CEO recognizes the manager’s incentive, and may thus require that any first-period project must be a short-term project. This makes investing in a bad project in the first period more costly for the manager because adverse information is more likely to be revealed early about the project and hence about managerial ability, with a loss of his second-period private benefit. The manager may thus avoid a bad project in the first period. Such short-termism also speeds up the firm’s learning about the manager’s ability, so the second-period investment is conditioned on this learning. I call this the “learning problem”.

I show that there are circumstances in which, because of the benefit of short-termism in resolving the incentive and learning problems, the firm’s owners will wish to insist on projects whose cash flows reveal information early rather than late, and a CEO may stipulate that only short-term projects will be approved. I then examine various robustness issues.

First, I compare capital budgeting short-termism to contracting on managerial private benefits to solve the incentive problem. Wage contracting provides a costly resolution of the incentive problem, but without the learning benefit of short-termism. Since both the learning and incentive problems are resolved by short-termism, there are circumstances in which it can dominate wage contracting. Moreover, short-termism prevents lower-level managers from investing in bad projects, so its use should be greater for “routine” projects and less for strategic projects proposed by for top managers (like the CEO).\textsuperscript{11}

Second, I allow interim information about the payoff on the long-term project to be available before the payoff is realized. This could be either due to accrual accounting that provides performance signals before cash flows are realized or market research to obtain initial

\textsuperscript{10}Of course, a long-term bad project will convey unfavorable information about managerial ability at the end of the second period, but the manager does not care about that because it is the end of the game.

\textsuperscript{11}By “routine” projects, I mean projects that are less strategic and are on a smaller scale—essentially projects that would affect overall firm value less than strategic projects that influence the firm’s business portfolio mix. Some might argue that learning about managerial ability is not much of a concern for routine projects, so one should expect little need for short-termism. However, routine projects are typically analyzed by managers who subsequently get promoted and are replaced by managers with unknown abilities, and even routine projects may have payoff distributions that depend on managerial ability. Moreover, even if the learning benefit of short-termism was absent, the firm may still want to use a payback constraint to deal with the incentive problem.
customer feedback about the eventual success of a new product. However, such signals may be unreliable. For example, McDonald’s market research indicated that its low-fat McLean burger would be a hit, but it flopped when introduced. To examine this issue, I introduce costly CEO “attention” to acquire interim information about the long-term project, as in the recent Halac and Prat (2016) model. This analysis reveals conditions under which short-termism still emerges.

Third, I analyze the implications of switching from a structure with wages paid at the beginning of the period to one in which there is (ex post) payoff-contingent wage contracting and the manager is asked to report his private information to the firm before receiving funding. I show that short-termism may still arise. Finally, I discuss the implications of extending the model to more than two periods.

Overall, the most robust result from this analysis is that informational frictions bias the investment horizons of firms without any discounting-related time horizon effects (e.g. such as those in Laibson (1997)), and that short-termism may be value-maximizing. The result that both the incentive and learning problems are resolved by short-termism means that it may be used even when alternative mechanisms may resolve only one of the two problems. For example, interim signals of project quality may fail to resolve the incentive problem, whereas explicit wage contracting may not resolve the learning problem. This means that castigating short-termism as well as the rush to regulate CEO compensation to reduce its emphasis on the short term may be worth re-examining.\textsuperscript{12} Indeed, not engaging in short-termism may signal weak internal governance—an inability on the CEO’s part to resolve intrafirm agency problems—and thus adversely affect the stock price. This is not to suggest that short-termism is always a value-maximizing practice—the point of this paper is that some short-termism reduces agency costs and benefits the shareholders.

\textsuperscript{12}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...it makes no sense for brick-and-mortar retailers, say, to invest in long-term in new stores if their sector is likely to have no future because it will soon become a channel for Internet selling.”
related to models in which external financing is more costly than internal financing, so there is a preference for a faster generation of internal cash for investments. For example, in Whited (1992), the presence of external financing constraints enhances the shadow value of internal funds. In Thakor (1990), informational frictions open up a wedge between the costs of internal and external financing, which then creates a preference for short-payback projects. While this approach sheds light on payback use in certain kinds of firms, it cannot explain why payback use is not empirically observed to be greater among financially-distressed or capital-constrained firms (Graham and Harvey (2001)). By contrast, the theory in this paper predicts a preference for short-termism even in the absence of financial constraints.

This paper is also related to the literature on managerial career concerns in capital budgeting, such as Holmstrom and Ricart i Costa (1986). In that paper, risk-averse managers with unknown abilities and career concerns never wish to invest, so they have to be given wage contracts with option-like features. This then causes over-investment, and capital rationing by headquarters. However, unlike in this paper, that paper does not focus on short-termism. Other related papers include Berkovitch and Israel (2004), which shows that the NPV criterion may not work well when managers have private benefits and are privately informed about investment projects, and Malenko (2012), who examines the optimal design of a capital allocation process in a dynamic setting with managerial private benefits. However, Malenko’s (2012) focus is on endogenizing a threshold division of authority for project approval. The allocation of control, which is taken as a given in my paper, is also endogenized in a different setting (involving disagreement) in Van den Steen (2010).

Finally, this paper is also related to how governance influences corporate behavior. For example, Levit and Malenko (2016) examine how the interaction between director reputation concerns and the labor market for directors affects corporate governance. Acharya, Myers, and Rajan (2010) develop a model of internal governance in which the self-serving behavior of

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13The reason why a risk-averse manager does not want to invest is that beliefs about the manager’s ability form a martingale (the expected posterior belief equals the prior belief), so, relative to not investing, the expected wage benefit from investing in a project whose future risky cash flows will noisily reveal ability is zero, which means its incremental expected utility impact is negative.
the CEO is limited by the possible reaction of the subordinate. While this paper also focuses on internal governance, the moral hazard problem here is inverted compared to Acharya, Myers, and Rajan (2010)—it is the subordinate’s self-interested behavior that the CEO is trying to limit through short-termism.\textsuperscript{14}

The remainder of the paper is organized as follows. Section 2 develops the model. Section 3 contains the analysis. Section 4 discusses the robustness of the results to various extensions. Section 5 concludes, and also discusses empirical implications. All proofs are in the Appendix.

2 The Model

This section first describes the agents and their preferences. It then describes the projects and the sequence of events, followed by a description of who knows and does what, and when. The section ends with a summary of assumptions and the time line.

2.1 Agents and Preferences

Consider a publicly-traded firm with a manager at the top, called the Chief Executive Officer (the “CEO”) and a lower-level divisional manager (the “manager”) reporting to him. There may be, say, \( n > 1 \) such managers who all report to the CEO, but the analysis will focus on a representative manager. For simplicity, the firm is financed entirely with equity, and starts out with $2 that it can invest or keep idle.

All agents are assumed to be risk neutral, and for simplicity the risk-free interest rate is zero. The CEO’s job is to design the capital budgeting system, which includes the rules by which capital is allocated for projects. The manager’s job is to search for project ideas and request capital from the CEO. The manager enjoys private benefits, represented as a

\textsuperscript{14}Another related paper is Grenadier and Wang (2005), which examines investment timing and agency conflicts related to contracting problems between managers and owners. Using a real options framework, they find that managers have an incentive to wait longer than owners to invest in projects, since they have a more valuable option to wait than owners. They then generalize their model to allow for greater impatience and “empire building” on the part of managers to explain their preferences for choosing projects with quicker paybacks, consistent with Narayanan (1985a).
utility gain $\beta \in (0, 1)$, from investing in projects, i.e., he likes “empire building”.\textsuperscript{15} This private benefit does not produce any shareholder benefit.\textsuperscript{16} The preferences of the CEO and the manager are described later. For now, note that the manager cares about his wages and private benefits, and the CEO cares about firm value and the manager’s welfare (utility). The manager is penniless, and cannot buy out the project from the shareholders.

The manager has some skill that is unknown to all at the beginning. However, because this skill can affect project cash flows (this is described later in this section), beliefs about the manager’s skill will be revised on the basis of observed cash flows. It is assumed that there are two types of managers: Talented ($T$) and Untalented ($U$). Let $\theta_t$ be the commonly-assigned probability at date $t$ that the manager is type $T$. Then, the prior probabilities attached to the manager’s skill (talent) at $t = 0$, which are common knowledge, and represented by:

$$\Pr(\text{type} = T) = \theta_0 \in (0, 1), \quad \text{and} \quad \Pr(\text{type} = U) = 1 - \theta_0.$$  

That is, it is assumed that the manager does not know his own type and there are common prior beliefs about this type.\textsuperscript{17}

### 2.2 Sequence of Events and Projects

There are three dates in the model ($t = 0$, $t = 1$, and $t = 2$) and thus two time periods, the first period ($t = 0$ to $t = 1$) and the second period ($t = 1$ to $t = 2$). Projects available to the manager differ in two dimensions: their value (NPV) and their cash-flow duration (or payback). This produces four types of projects that will be described below. A project in any period needs an initial $1$ investment that the manager must request from the CEO, so the firm will use $2$ if it invests in projects in both periods.

On the value dimension, a project can be good ($G$) or bad ($B$), with $G$ having positive

\textsuperscript{15}This is related to the “free cash flow” problem proposed by Jensen (1986), and it has been studied in various contexts in many papers, e.g. Aghion and Bolton (1992). One interpretation of this assumption is in the spirit of the perquisites-consumption assumption in Jensen and Meckling (1976). Being in control of a bigger asset base allows the manager to consume more perquisites. This is also similar to “managerial entrenchment”, as described by Shleifer and Vishny (1989).

\textsuperscript{16}In other words, the shareholders do not adjust the manager’s wage downward when he invests to account for the private benefit he enjoys from investing. While this is not formally justified within the analysis, there are many reasons why real-world wage contracts may not have such features. The main reason is that it can create strong incentives to not invest (e.g. Holmstrom and Ricart i Costa (1986)).

\textsuperscript{17}This is similar to Holmstrom and Ricart i Costa (1986) and it avoids signaling complications that can arise if the manager knows more about his own type than do others.
NPV, and $B$ having negative NPV. On the duration dimension, a project can be long-term ($L$) or short-term ($S$). An $L$ project requires an investment at $t = 0$ and delivers its cash flow at $t = 2$. An $S$ project requires an investment at $t = 0$ and delivers its cash flow at $t = 1$ (or if the investment is at $t = 1$, then the cash flow is at $t = 2$). Thus, in the first period the manager can choose either $L$ or $S$, but in the second period only $S$.

A good, long-term project (call it $L_G$) pays off $R_L > 1$ with probability 1 at $t = 2$ if the manager is of type $T$, but it pays off $R_L$ with probability $q \in (0, 1)$ and 0 with probability $1 - q$ at $t = 2$ if the manager is of type $U$. If investment occurs at $t = 0$, a good, short-term project (call it $S_G$) pays off $R_S > 1$ with probability 1 at $t = 1$ if the manager is of type $T$, but it pays off $R_S$ with probability $q$ and 0 with probability $1 - q$ at $t = 1$ if the manager is of type $U$. The short-term project has the same type-dependent payoff distribution at $t = 2$ if investment occurs at $t = 1$. A bad, long-term project (call it $L_B$) pays off 0 with probability 1, regardless of the manager’s type. Similarly, a bad, short-term project (call it $S_B$) pays off 0 with probability 1, irrespective of the manager’s type.

*Table 1* summarizes the type-dependent payoff distributions of projects:

[Insert Table 1 Here]

Regardless of project type, the manager enjoys a utility of $\beta$ if investment occurs in any period. Project availability is stochastic. It is assumed that, regardless of the manager’s type, the probability that the manager will receive a $G$ project idea in any period is $p \in (0, 1)$. The manager almost surely (with probability 1) has access to $B$ in any period. Moreover, once he receives a project idea, it can be structured as either $L$ or $S$.

Given below are the restrictions on the exogenous parameters that will be used:

$$R_L > 1.$$  \hspace{1cm} (1)

This means that $L_G$ is a positive-NPV (socially efficient) project when run by a talented ($T$)
manager. Further:

$$\beta + qR_L < 1. \quad (2)$$

This means that an $L_G$ project is both negative-NPV (since $qR_L < 1$) and socially inefficient (since $\beta + qR_L < 1$) when run by a type-$U$ manager. It also follows that:

$$1 < R_S < R_L. \quad (3)$$

This means that the $S_G$ project has positive NPV (and is socially efficient), but it has lower value than the $L_G$ project. Define $\Delta \equiv R_L - R_S$ as the difference in values of the $L_G$ and $S_G$ projects. The expected value of $\Delta$, evaluated at the prior beliefs about the manager’s type, is $\bar{\Delta}_0 \equiv \theta_0 [R_L - R_S] + [1 - \theta_0] q [R_L - R_S]$. From (2) and (3), it follows that:

$$\beta + qR_S < 1. \quad (4)$$

So, $S_G$ is socially inefficient and has negative NPV when run by a type-$U$ manager. $L_B$ gives a total payoff of $\beta$ (since the payoff of the $B$ project is 0 with probability 1, but the manager also receives a private benefit $\beta$) has negative NPV (the project payoff is 0) and is socially inefficient (since $\beta < 1$). It also directly follows that the $S_B$ project also has negative NPV and is socially inefficient. Finally, it is assumed that:

$$\theta_0 R_L + (1 - \theta_0) q R_L > 1, \quad (5)$$

$$\theta_0 R_S + (1 - \theta_0) q R_S > 1, \quad (6)$$

$$p \{\theta_0 R_S + (1 - \theta_0) q R_S\} > 1. \quad (7)$$

(5) and (6) represent sensible restrictions since, absent these, the CEO would never approve any project the manager proposed at the beginning (with prior beliefs about type). (7) is assumed since, without it, a CEO who puts enough weight on firm value would not
approve any project at $t = 1$ if an $L$ project was started at $t = 0$ (since with $L$ the posterior belief, $\theta_1$, at $t = 1$ that the manager is type $T$, equals the prior belief, $\theta_0$, at $t = 0$).

In the first period, the manager requests $1$ in funding if he wishes to invest. If funded, the project yields a (possibly random) payoff at $t = 1$ if it is $S$. Based on this, beliefs are revised from $\theta_0$ to $\theta_1$. If it was $L$, then nothing is observed at $t = 1$, so $\theta_0 = \theta_1$. The manager then requests second-period funding. The game ends at $t = 2$.

2.3 What the Agents Know and Do, and When

The manager knows the value of the project ($G$ or $B$) for which he is requesting funding, as well as whether it is short-term ($S$) or long-term ($L$). The CEO can observe whether the project is $S$ or $L$, but not the value ($G$ or $B$). As in Holmstrom and Ricart i Costa (1986) and Holmstrom (1999), it is assumed that the manager is paid his wage at the beginning of the period. So he is paid a first-period wage of $w_0$ at $t = 0$, and a second-period wage of $\tilde{w}_1$ (which is random) at $t = 1$. The second-period wage is random because the perception of the manager’s skill at $t = 1$ generally depends on the project cash flow at $t = 1$, and this cash flow is random. Let $w_1^+ \in \mathbb{R}$ (the real line) be the manager’s wage if the first-period project has a positive cash flow and the posterior belief that he is type $T$ is therefore higher than the prior belief, and let it be $w_1^- \in \mathbb{R}$ if the first-period cash flow is zero and this posterior belief is therefore lower than the prior belief. It is thus the case that $w_1^+ > w_1^-$. A wage is paid in any given period regardless of whether there is investment in a project in that period.

Now let $w^T$ be the wage of a manager of type $T$ and $w^U$ be the wage of a manager of type $U$; also set $w^U \equiv 0$ without loss of generality. Assume that wages are increasing in perceived managerial talent, and that wages are linear in perceived managerial talent (as in Holmstrom and Ricart i Costa (1986) and Holmstrom (1999)). Let $\theta_1^+ \equiv \Pr($manager’s type is $T \mid$ success at $t = 1$) and $\theta_1^- \equiv \Pr($manager’s type is $T \mid$ failure at $t = 1$). We then have that:

$$w_0 = \theta_0 w^T + (1 - \theta_0) w^U = \theta_0 w^T,$$  \hspace{1cm} (8)
\[ w^+_1 = \theta^+_1 w^T + (1 - \theta^+_1)w^U = \theta^+_1 w^T, \tag{9} \]
and
\[ w^-_1 = \theta^-_1 w^T + (1 - \theta^-_1)w^U = \theta^-_1 w^T. \tag{10} \]

Hence, the actual wage is a convex combination of the wages of the type-\( T \) and type-\( U \) managers, and is dependent on the prior and posterior beliefs of the respective types. \( w^T \) and \( w^U \) can be viewed as the reservation wages of talented and untalented managers, respectively, and similarly \( w_0, w^+_1, \) and \( w^-_1 \) can be viewed as the reservation wages conditional on the labor market’s beliefs about the manager’s type at \( t = 0 \) and \( t = 1 \). All wages, as well as whether the firm has adopted a short-termism restriction on project choice, are publicly observable at \( t = 0 \). Since wages are based on public information, the CEO has no control over the manager’s wage; it is market-determined in the base model.

### 2.4 The Utilities of the Agents

For the core results of the model, assume that the CEO maximizes firm value. A more general specification is one in which the CEO maximizes the following utility function:

\[ U_{CEO} = \alpha_1 \text{firm value} + \alpha_2 U_M, \tag{11} \]

where \( U_M \) is the utility of the manager, and \( \alpha_1 \) and \( \alpha_2 \) are positive exogenous weights. The value-maximizing preference is a special case with \( \alpha_2 = 0 \). The inclusion of the manager’s utility in (11) could reflect a variety of considerations, such as cronyism within the firm, internal politics, and alliances.\(^{18}\) The idea is that in general a CEO will not necessarily be indifferent to the welfare of subordinates.

\(^{18}\)It may also reflect a common emotional disposition called “avoidance of unfavorable occasions”; see Elster (1998) for a discussion. It says that human beings have a dislike for getting into situations that they anticipate will trigger negative emotions. Having to say no to a direct report who requests funding for a long-term project and thereby creating a confrontational situation is one example. A simple way to capture the effect of avoidance of unfavorable occasions is to put some weight on the manager’s welfare in the CEO’s utility. Of course, it is also possible that the reason the CEO puts weight on the manager’s utility is her own preferences is that the manager is a protege of the CEO and makes the CEO genuinely care about the well-being of the manager as a fellow employee.
Let $\omega \equiv \frac{\alpha_2}{\alpha_1}$. The parameter $\omega$ has numerous possible interpretations. It could be the CEO’s degree of firm ownership—the larger this ownership, the lower is $\omega$. Another interpretation is that the higher is $\omega$, the worse is the internal governance in the firm.

The manager maximizes the following utility function:

$$U_M = w_0 + \mathbb{E}(\tilde{w}_1) + \sum_{t=0}^{1} \beta_t \mathbf{1}_{\{x=1\},t}(x),$$

where $w_0$ is the manager’s wage at $t = 0$, $\mathbb{E}(\tilde{w}_1)$ is the expected value of the manager’s wage at $t = 1$, and $\mathbf{1}_{\{x=1\},t}(x)$ is the indicator function at date $t$, where $x = 1$ if the manager invests and $x = 0$ if the manager does not invest. $\beta_t$ is the manager’s private benefit at time $t = 0$ and $t = 1$, and $\beta_t = \beta \forall t$. Thus, the manager aims to maximize his expected wage at $t = 1$, given that he receives a private benefit for investing in a project. The internal governance mechanism comes from the CEO’s ability to approve projects. Given that the CEO knows moral hazard in project choice, she can enforce an internal governance mechanism that conditions project approval on project duration.

### 2.5 Summary of Assumptions and Timeline

The following is a summary of the key assumptions:

**A1.** (Private Benefits) The manager has a private benefit from investing in a project, but lacks the financial resources to buy out the project from the firm.

**A2.** (Observability) The project duration (its payback) is commonly observable, but project quality is only observable to the manager. Regardless of project quality, the long-term project has higher value than the short-term project.

**A3.** (Managerial Types) The manager’s type (Talented or Untalented) is not known by either the CEO or the manager, and is inferred from project outcomes. Later the manager is allowed to know more about his type than others.
A4. (Non-appropriability) All of the NPV from a project cannot be given to the manager. The firm always appropriates some of the project rents. In other words, the agency problem (due to the fact that the manager gets only a part of the rent) cannot be eliminated.

Assumption A2 that the long-term project has a higher (first-best) value than the short-term project may not be true in practice for all projects in the firm. If the short-term project has a higher first-best value, then short-termism arises trivially from the specified project technology. The interesting situation is when the long-term project has higher first-best value, so some efficiency is sacrificed in the practice of short-termism. The crucial defining attribute that separates a long-term project from a short-term project is that information about the value of the former is released more slowly over time. In the base model, the only signal of project value is its cash flow, so it is the timing of the cash flow that determines the speed of information revelation. This is often the case with real-world projects.

Figure 1 summarizes the main actions and events that are possible at each point in time:

[Insert Figure 1 Here]

3 Analysis of the Base Model

In this section, I analyze the base model and its implications. Section 3.1 analyzes the first-best. Section 3.2 describes the second-best. Section 3.3 examines whether imposing a short-termism constraint to force early revelation of information can improve firm value.

3.1 First-Best Case

In the first-best, shareholders and the CEO can observe project choice and the project’s payoff, so this choice maximizes the value of the firm. In this case, the manager will request
funding only if he receives a good project and the CEO will then fund the project.

Whether the first-best project at \( t = 0 \) is the \( L \) or the \( S \) version of the \( G \) project requires discussion. On the one hand, \( L \) has a higher value since \( R_L > R_S \). But on the other hand, by investing in \( S \), the firm can make a second-period investment decision at \( t = 1 \) that is conditional on what is learned in the first period about managerial ability. It will be shown that the posterior belief on managerial ability will be high enough conditional on success at \( t = 1 \) to guarantee second-period funding for the manager, and low enough conditional on failure at \( t = 1 \) to guarantee denial of second-period funding if the CEO puts sufficiently high weight on firm value (\( \omega \) is low). Since the prior probability of success for a \( G \) project is \( \theta_0 + (1 - \theta_0)q \) (where \( \theta_0 \) is the probability that the manager is \( T \) and succeeds almost surely, and \( 1 - \theta_0 \) is the probability that the manager is \( U \) and succeeds with probability \( q \)), a conditional investment policy results in second-period investment with probability \( \theta_0 + (1 - \theta_0)q \), whereas an unconditional policy (associated with investing in \( L \) at \( t = 0 \)) results in second-period investment with probability 1.

This means that, conditional on having \( G \) at \( t = 0 \), the condition for \( L \) to be the value-maximizing choice in the first-best case is:

\[
\tilde{\Delta}_0 + p(1 - \theta_0)[1 - q]qR_S \geq p[1 - \theta_0][1 - q],
\]

recalling that \( \tilde{\Delta}_0 \equiv \theta_0 [R_L - R_S] + [1 - \theta_0] q [R_L - R_S] \). In (13), the left-hand side represents the amount by which the expected value of \( L \) exceeds that of \( S \), plus the expected value of the second-period short (\( S \)) project, \( qR_S \), that is available with an untalented manager (probability \( 1 - \theta_0 \)) who receives a \( G \) project idea (probability \( p \)) but fails with a short-term project in the first period (probability \( 1 - q \)). This follows since investment in the second period is always available with a long-term first-period investment (because nothing is revealed about managerial ability), but not with a short-term investment in the first period that fails. The right-hand side is the expected saving in second-period investment due to the conditional (second-period) investment associated with choosing \( S \) in the first period rather
than the unconditional investment associated with choosing \( L \) in the first period, accounting for the probability of receiving a \( G \) project. Since only the incentive problem is eliminated in the first-best, the learning benefit of the short-payback project remains, so (13) says that the relative gain in intrinsic value from \( L \) exceeds the relative learning benefit of \( S \) (the right-hand side of (13)). The following condition (stronger than (13)) will be assumed to hold throughout and is sufficient for the first-best to be socially efficient:.

\[
\bar{\Delta}_0 + p(1 - \theta_0)[1 - q] (q R_S - 1) \geq 2 \beta,
\]

We now have:

**Lemma 1:** In the first-best case, at \( t = 0 \), the manager requests funding only if a \( G \) project arrives. In this case, the manager proposes only \( L_G \) and it is funded.

Now at \( t = 1 \), there is only one period left, so the manager can propose only an \( S \) project. He will thus only request funding in the first-best case if it is \( G \).

**Lemma 2:** In the first-best case, at \( t = 1 \) the manager requests funding only if he finds an \( S_G \) project.

### 3.2 Second-Best Case

The second best refers to the case in which the shareholders cannot directly control the internal project choice and approval process and delegate it to the CEO who can observe whether the manager is proposing an \( L \) or an \( S \) version of the project, but not whether it is \( G \) or \( B \). To analyze the second-best case, I use backward induction from the second period to the first. At \( t = 1 \), there are two scenarios:

1. The manager receives a \( G \) project. He proposes \( S_G \) and gains utility \( \bar{w}_1 + \beta \), where \( \bar{w}_1 \) is his wage at \( t = 1 \), which depends on the outcome at \( t = 1 \).

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\(^{19}\)The condition for \( L \) to be the socially efficient choice is \( \{\theta_0 + (1 - \theta_0)q\}(R_L - R_S) + p[(1 - \theta_0)(1 - q)q R_S + p\beta(1 - \theta_0 - (1 - \theta_0)q)] \geq p[1 - \theta_0 - (1 - \theta_0)q] \).
2. The manager does not receive a $G$ project. If he does not propose a project, his utility is $\tilde{w}_1$. If he proposes an $S_B$ project and it is accepted, his utility is $\tilde{w}_1 + \beta$.

Thus, the manager will propose $S_G$ if it is available, or $S_B$ if it is not (he has no incentive to propose $S_B$ if he has $S_G$). While the manager will always prefer to seek funding, whether he gets funding at $t = 1$ depends on $\theta_1$, the posterior belief about his type, and hence the expected project payoff as viewed by the CEO. We thus have:

**Lemma 3:** In the second period (at $t = 1$), the manager will always propose a project as an $S$ project regardless of its quality ($G$ or $B$). The funding policy that maximizes firm value is as follows. If the manager invests in $L$ at $t = 0$, he gets funding for sure at $t = 1$. Assuming that the manager’s equilibrium strategy is to invest in $S_G$ (but never $S_B$) at $t = 0$ if he chooses $S$, then the policy that maximizes firm value is to give a manager who invests in $S$ at $t = 0$ the requested additional funding at $t = 1$ if his first period project succeeds but to deny additional funding if his first period project fails (the project payoff is 0).\(^{20}\) A CEO who maximizes firm value (or with a sufficiently low $\omega$) will follow this policy. A CEO with a sufficiently high $\omega$ will provide the manager unconditional funding at $t = 0$ and $t = 1$.

The economic intuition is as follows. If the manager invests in $L$ at $t = 0$, there is no information revelation about his type at $t = 1$, so the belief about his type stays at its prior value and the manager receives additional funding at $t = 1$ (since he received funding at $t = 0$ with prior beliefs about his type).\(^{21}\) If he invests in $S$ at $t = 0$, then given the equilibrium strategy of choosing $S_G$, the CEO’s posterior probability that the manager is type $T$ is higher than the prior if there is success at $t = 1$, and lower than the prior if there is failure at $t = 1$. Thus, the value-maximizing policy is to give the manager additional funding at $t = 1$ following success, and deny it following failure. It is straightforward to see

\(^{20}\)The result that the manager who is constrained to choose $S$ will invest in $S_G$ but not $S_B$ at $t = 0$ is proved in Lemma 4.

\(^{21}\)The assumption that the manager receives project funding with prior beliefs about his type is necessary since the funding would never start at $t = 0$ without this assumption.
that a CEO with a low enough \( \omega \) will maximize firm value. However, the firm’s owners will face moral hazard in the form of a distorted investment policy if the CEO has a high \( \omega \).

I now analyze what happens at \( t = 0 \), deriving the conditions under which the manager chooses only \( G \) in the first period. First, suppose the CEO funds both \( L \) and \( S \) projects. Will the manager propose \( S \) or \( L \)?

**Proposition 1:** At \( t = 0 \), the manager always proposes an \( L \) project, regardless of whether the project is \( G \) or \( B \).

The intuition is that with a short-term project, there is a possibility of failure at \( t = 1 \) even if it is \( G \) (since the manager does not know his own type), in which case the manager will not get a second project if the CEO has a low \( \omega \). If \( \omega \) is high, the manager is guaranteed funding, so he will choose \( L \) at \( t = 0 \) because it has higher value with \( G \) and the same values as \( S \) with \( B \). Therefore, \( L \) is preferred at \( t = 0 \) in all circumstances.

The manager also prefers proposing a long-term project to proposing no project because of the private benefit of investing. Of course, if the project is \( B \), then proposing \( S_B \) is even worse since it would pay off zero with probability one in the next period, and his wage would be revised downward almost surely. This is avoided with the long-term project.

Thus, regardless of the project quality at \( t = 0 \), the manager will always want to invest and structure the project as a long-term project. Furthermore, from Lemma 3, at \( t = 1 \), the manager will always request funding for a short-term project regardless of its quality, and he will receive funding since he invested in a long-term project at \( t = 0 \).

To see the combined intuition for these results, note that the manager cares about both his wages and his private benefits. A manager who cared only about his wages would be indifferent between structuring a good project as either \( S \) or \( L \) because beliefs form a martingale and the expected value of his future wages would be the same with \( S \) or \( L \). But private benefits create an asymmetry. An upward revision in managerial ability at the

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22That is, the incentive problem arises because wages form a martingale but investment does not, and managerial private benefits are linked to whether investment occurs.
interim date due to project success assures the manager of a private benefit in the second period, but so does no revelation of ability at the interim date (which is achieved with L). By contrast, S may cause a downward revision of ability and loss of his private benefit. That is, investing in a short-term project is equivalent to the manager writing an option on his human capital and private benefit and giving it to the firm. This option is valuable to the firm because it can allow it to condition its second-period investment on revealed managerial ability at $t = 1$. But giving the firm this option is also costly to the manager because by exercising the option, the firm can deny him his second-period private benefit in one state. Investing in L denies the firm this option and guarantees second-period private benefit to the manager almost surely. Note that the option is worthless to the firm in the first-best case because the manager’s ability is known. With no learning benefit associated with S, the firm would prefer to invest in the higher-valued L project in the first period and then S in the second period. So the real value of the option to the firm and its cost to the manager both come from the same thing—interim learning about managerial ability.

3.3 Can the Shareholders Do Better by Imposing a Short-termism Constraint?

Given the self-interested managerial behavior described earlier, can firm value be improved by using capital budgeting to constrain the manager’s choice? Since the inefficiency is created by the manager always choosing L to defer detection of his choice of a bad project, a natural capital-budgeting restriction is to require that the project duration be no more than one period. This disciplines managers, as shown below.

**Lemma 4:** Suppose that L projects are banned, and the second-period funding policy maximizes firm value. Then, the manager will only propose an S project at $t = 0$ if he receives a G project.

This lemma states that a constraint that no long-term projects be proposed improves
project choice efficiency. The next proposition shows that this kind of constraint may be used by the firm. Before getting to that, the following expressions are useful.

If the firm approves a short-term project proposed by the manager and follows a policy that maximizes firm value, then its total expected (fundamental) value is given by:

\[
\bar{V}_S = p\{\theta_0 [R_S + pR_S] + [1 - \theta_0] q [R_S + pqR_S]\} + [1 - p]p[\theta_0 + q [1 - \theta_0]] R_S \\
+ \{p [1 - \theta_0] [1 - q] + [1 - p]\} \{1\} - 2w_0.
\] (15)

In (15), the first term, \(p\{\theta_0 [R_S + pR_S] + [1 - \theta_0] q [R_S + pqR_S]\}\), is the probability \(p\) that the manager will have \(G\) multiplied by the expected value of the first-period and second-period investments, with the expectation taken over managerial type.\(^{23}\)

The second term in (15), \([1 - p]p[\theta_0 + q [1 - \theta_0]] R_S\), is the probability \((1 - p)\) that \(G\) does not arrive in the first period, so the manager will not request project funding (Lemma 4), multiplied by the probability \(p\) that \(G\) arrives in the second period, times the expected payoff, which is \(R_S\) if the manager is type \(T\) (probability \(\theta_0\)) and \(qR_S\) if the manager is type \(U\) (probability \(1 - \theta_0\)). The second-last term in (15) is merely the probability that $1 will remain idle due to no investment in either the first or the second period (note that with \(S\) an investment occurs in the first period only if \(G\) arrives).\(^{24}\) The last term in (15) is the total expected wage paid to the manager over two periods. The manager’s first-period wage is clearly \(w_0\), and since wages are paid regardless of whether investment occurs, we need to calculate his expected second-period wage, which is also \(w_0\) because beliefs form a martingale.

\(^{23}\)If the manager is type \(T\) (probability \(\theta_0\)), the first-period project pays off \(R_S\) with probability 1, and \(G\) arrives with probability \(p\) in the second period and pays off \(R_S\) with probability 1. This yields \(\theta_0 [R_S + pR_S]\). If the manager is type \(U\) (probability \(1 - \theta_0\)), then the first-period project pays off \(R_S\) with probability \(q\), and second-period funding is available only if the first-period project succeeds (Lemma 3). The second-period investment in \(G\) occurs only if \(G\) arrives (probability \(p\)). This explains \([1 - \theta_0] q [R_S + pqR_S]\).

\(^{24}\)With probability \(p\), \(G\) arrives in the first period and investment occurs, but the manager is type \(U\) (probability \(1 - \theta_0\)) and his first-period project fails (probability \(1 - q\)), so there is no second-period funding, resulting in $1 being idle in the second period; with probability \(1 - p\), \(G\) did not arrive in the first period, so $1 stayed idle in the first period, but then second-period funding occurred with probability 1. This probability is multiplied with $1, the amount that stays idle. Note that the probability that the entire $2 available at \(t = 0\) will remain idle is zero, since the second-period project is funded with probability one if there is no first-period investment.
Now, if the firm approves a long-term project in the first period and follows a value-maximizing policy, then its total fundamental value is given by:

\[
\bar{V}_L = p \{ \theta_0 R_L + [1 - \theta_0] q R_L \} + p \{ \theta_0 R_S + [1 - \theta_0] q R_S \} - 2w_0
\]

Since with \( L \), the manager obtains funding in both periods with probability 1, (16) is straightforward to interpret—observe that \( p \{ \theta_0 R_L + [1 - \theta_0] q R_L \} \) and \( p \{ \theta_0 R_S + [1 - \theta_0] q R_S \} \) are the expected payoffs on the first-period and second-period projects, respectively.

It will be assumed that \( p \) and \( \bar{\Delta}_0 \) are small enough for the following condition to hold:

\[
2[1 - p]p^{-1} > \bar{\Delta}_0 + [1 - \theta_0] pq[1 - q] R_S.
\]

This leads to the following result:

**Proposition 2 (Short-termism):** *Given that the CEO aims to maximize firm value, it may be in the best interests of the CEO to ban L projects and insist on S projects when (17) holds. If (17) does not hold, the value-maximizing policy may permit L to be funded at \( t = 0 \). Only a CEO with a sufficiently low \( \omega \) will ban L projects.*

Thus, provided that the values of the long-term good project and the short-term good project do not diverge significantly (\( \bar{\Delta}_0 \) is small), firm value is maximized by short-term projects. When \( \bar{\Delta}_0 \) is high, however, the long-term project is too valuable to ban. Thus, Proposition 2 identifies circumstances in which CEOs will embrace short-termism—when corporate governance is strong (the CEO is maximizing firm value) and the value loss from choosing the short-term project is not too large.

**Corollary 1:** *If the project is being proposed by the CEO rather than the manager, shareholders will have no interest in a constraint that only an S project can be submitted for approval, as long as \( \omega \) is low.*
The intuition is that a low-ω CEO’s interests are aligned with the shareholders, so she will never propose $B$. Moreover, since a long-term good project is worth more than a short-term good project, the CEO should be free to invest in $L$. The shareholders thus have no reason to insist on $S$ for proposals being made directly by a low-ω CEO. One interesting implication of this result is that firms are less likely to practice short-termism or impose a payback constraint for “strategically important” projects that are created by the CEO. Projects may be constrained to be of short duration if they are initiated by lower-level managers.

This result also has an implication for the firm’s decision with respect to the size of its internal capital market. When the board of directors is unsure of whether the CEO will effectively handle the agency problem with respect to the manager (i.e. $\omega$ is high), and monitoring the payback periods of projects the CEO approves is too costly for the board, then the board may wish to watch over the firm’s cash level, and insist on special repurchases or dividends when that level exceeds what is needed for operating purposes. The reason is that not having enough internal cash forces the CEO to seek board approval for external financing, which gives the board an opportunity to ask for information about the projects being funded with that financing, and stop long-term projects. Thus, having a policy of not having excess cash lying around permits the board to engage in selective capital rationing.$^{25}$

4 Model Robustness and Extensions

In this section, the role of the key assumptions and model robustness are discussed.

4.1 Key Assumptions and Robustness

There are six key assumptions that drive the main results. The first is that the manager’s type is unknown at the beginning. This leads to managerial career concerns that generate inefficiencies in capital budgeting, which then rationalizes value-maximizing short-termism. An alternative assumption is that the manager knows more about his type than the CEO. In

$^{25}$See Malenko (2012) for an analysis of how firms can optimally design internal capital markets.
this case, more talented managers will have an incentive to separate themselves via the early revelation associated with short-term projects, whereas less talented managers prefer delayed revelation. Thus, asymmetric information will strengthen the short-termism result.\footnote{These details are not provided here, but are available upon request.}

The second key assumption is that when the manager proposes a project, the CEO knows whether it is a short-duration or long-duration project, but is unaware of its NPV. Asymmetric information about project quality generates moral hazard involving the manager misrepresenting project quality. Symmetry about project-duration information is necessary to enable short-termism to be implemented in capital budgeting. This is realistic in that the firm should be able to determine whether the manager is proposing a short-term or a long-term project, even though project quality is unknown.

The third key assumption is that the manager enjoys private benefits from investing. This assumption should be viewed quite broadly. It could mean that the manager has a preference for “empire building”. It could also be because increasing investment allows the manager to enjoy greater perquisites consumption.\footnote{For example, investment in a project may mean more purchases from suppliers who may shower the manager with more gifts to get the business.} Without this assumption, there is no agency problem, so the issues studied in this paper disappear. In the next section, I first analyze the implications of contracting explicitly on private benefits and then discuss how the analysis would be affected if managerial private benefits were replaced by risk aversion.

A fourth assumption is that it is assumed that no interim information is available about the long-term project at \( t = 1 \). In Section 4.4, I introduce an informative interim signal about the payoff on the long-term project and examine its effect on short-termism.

A fifth assumption is that the manager’s wage is paid at the start of the period, so there is no payoff-contingent contracting. Section 4.5 analyzes the implications of such contracting.

The final key assumption has to do with the two-period structure of the model. In Section 4.6, I discuss whether short-termism would survive in a richer time-structure.
Using Explicit Wage Contracting Instead of a Short-termism Constraint

In this model, wages are optimal in the sense that they are the unique outcomes of binding participation constraints at different dates. However, wages have not been explicitly made dependent on private benefits and have not been used to solve the incentive problem of inducing the manager to not invest in $B$ at $t = 1$. I now do this to compare the short-termism solution analyzed earlier to a wage contracting solution, focusing on the policy that maximizes firm value. The maintained assumption from the base model is that the manager’s wage is paid at the beginning of the period.

The wage contracting solution must satisfy the manager’s participation constraints at dates $t = 0$ and $t = 1$. That is, $w_0 \geq \theta_0 w_T$ at $t = 0$ and $\tilde{w}_1 \geq \tilde{\theta}_1 w_T$ at $t = 1$. Moreover, the wage contract should satisfy the incentive compatibility constraint that the manager will choose $G$ at $t = 0$. That is, a manager who is allowed to choose $L$ must be dissuaded from $B$ at $t = 0$. This requires that his expected utility is the same whether he proposes $B$ or rejects it. This can be achieved with a wage contract that pays him $w_0$ at $t = 0$ if he invests in a project and $w_0 + \beta$ if he does not invest. This makes the manager’s participation constraint on the wage at $t = 0$ slack.

The second-period wage structure is the same as before: the manager gets a wage conditional on the first-period outcome. Given the earlier analysis, it follows that the manager will invest in $L$ (rather than $S$) if he has a type-$G$ project at $t = 0$. If he has a type-$B$ project, there is no reason for him to invest in $L$ since his first-period payoff, $w_0 + \beta$, is the

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28 The reason why the dynamic individual rationality constraint (IR) becomes a sequence of one-period participation constraints is that in each period, the manager’s wage is paid at the start of the period. To see this, note that the dynamic IR constraint at the beginning of the first period is $w_0 + \mathbb{E}[\tilde{w}_1] \geq \theta_0 w_T + \mathbb{E}[\tilde{\theta}_1] w_T$, where $w^T$ is the reservation wage of a type-$T$ manager (see Section 2.3). But since beliefs follow a martingale, $\mathbb{E}[\tilde{\theta}_1] = \theta_0$. Moreover, in the second period, the ability of the agent to switch jobs (“quitting constraint”) means that $\tilde{w}_1 \geq \tilde{\theta}_1 w_T$ must be honored. This implies $\mathbb{E}[\tilde{w}_1] \geq w_T \theta_0$. The dynamic constraint thus reduces to $2w_0 \geq 2\theta_0 w_T$.

29 Operationally, this may be achieved by basing the manager’s compensation on the free cash flow of his division. By avoiding investment, the manager increases free cash flow and collects a larger bonus for himself, which would be the analog of being paid $\beta$ to not invest.
same whether he invests or not, and he invests in the second-period project at the same wage regardless of whether he invests in the first period. It is also clear that he will not invest in an $S$ project of type $B$ at $t = 0$ since this yields a first-period utility of $w_0 + \beta$ but a lower second-period utility, i.e., a lower total utility than that from not investing.

The value of the firm with this wage contract, net of the wage and the investment, is:

$$p \{\theta_0 R_L + (1 - \theta_0)qR_L - 1\} - w_0 + (1 - p)(-\beta) + p \{\theta_0 R_S + (1 - \theta_0)qR_S\} - w_0 - 1, \quad (18)$$

The first term in (18) is $p \{\theta_0 R_L + (1 - \theta_0)qR_L - 1\}$, which is the expected NPV of the $L$ project of type $G$ (with the expectation taken over managerial type) multiplied by the probability, $p$, of having $G$. The second term is the subtraction of the wage $w_0$ paid to the manager regardless of whether he invests, and the third term is the subtraction of the extra wage $\beta$ paid to him if he does not invest. Now consider the next three terms, $p \{\theta_0 R_S + (1 - \theta_0)qR_S\} - w_0 - 1$, which represent the expected value of the second-period project (which is $\theta_0 R_S + (1 - \theta_0)qR_S$ if it is $G$, and zero if it is $B$) minus wage $w_0$ and the investment of 1.

The expected value of the firm, net of wages and investments, with short-termism is:

$$p \{\theta_0 R_S + (1 - \theta_0)qR_S - 1\} - w_0 + p \{\theta_0 R_S + (1 - \theta_0)q^2R_S\} - [\theta_0 + (1 - \theta_0)q] \{w_0 + 1\}. \quad (19)$$

In (19), $p \{\theta_0 R_S + (1 - \theta_0)qR_S - 1\} - w_0$ represents the expected value of the first-period project net of the managerial wage and investment. The term $p \{\theta_0 R_S + (1 - \theta_0)q^2R_S\}$ represents the expected value of the second period project, recognizing that the manager will be able to invest only if he experiences first-period success, and the term $[\theta_0 + (1 - \theta_0)q] \{w_0 + 1\}$ represents the expected wage and investment in the second period (the probability of second-period investment is $\theta_0 + (1 - \theta_0)q$).

Comparing (18) and (19) leads to the following result:
Proposition 3: Assume that both the incentive and learning problems matter in the sense that $p$ and $\theta_0$ are both in the interior of $(0,1)$ and are not too high or too low. Then, if the initial project investment ($S_1$), the manager’s date-0 wage ($w_0$), and his private benefits ($\beta$) are large relative to the difference between the payoffs in the success states of the long and short $G$ projects, $\Delta$, then short-termism leads to a higher firm value than using wages to induce the manager to avoid investing in the bad project at $t = 0$. In addition:

1. If the incentive problem is eliminated ($p = 1$), then, assuming that $q$ is low enough, the short-termism restriction is preferred for a sufficiently low value of the prior probability, $\theta_0$, that the manager is type $T$, and the wage contracting solution is preferred by the shareholders for a sufficiently high value of $\theta_0$.

2. If the value of learning is eliminated ($\theta_0 = 1$), then the short-termism restriction is preferred by the shareholders if the probability of getting a $G$ project, $p$, is sufficiently low, and the wage contracting solution is preferred if $p$ is sufficiently high.

The intuition is as follows. The benefit of short-termism relative to the wage contracting resolution is that it allows the firm to learn about the manager’s ability by observing the first-period project outcome, and conditioning second-period wage and investment on that. When the required investment and wage are high, this benefit is also high. Moreover, short-termism enables the firm to avoid paying the manager $\beta$ in the first period to compensate him for his lost private benefit in the no-investment state. Again, the larger the $\beta$, the greater is the relative advantage of short-termism.\(^{30}\)

This proposition also clearly highlights the intuition related to the two economic functions served by short-termism: resolving the incentive problem, and the learning made possible by observing the outcome of a short project at $t = 1$ before deciding whether to invest in another.

\(^{30}\)Note that the incentive benefit of short-termism, namely the elimination of the manager’s investment in the bad project in the first period, is symmetrically available with the wage contracting resolution as well, so it does not show up in a comparison of the two approaches.
When the incentive problem is absent \((p = 1)\), the only value of short-termism is learning. This value decreases as \(\theta_0\) increases, and in the limit as \(\theta_0\) approaches 1 (the manager is almost surely talented), short-termism has no value. Thus, the wage contracting resolution dominates for \(\theta_0\) high enough. By contrast, when learning is eliminated entirely \((\theta_0 = 1)\) but the incentive problem is resurrected \((p \in (0, 1))\), short-termism is preferred if the incentive problem is severe enough \((p\) is low enough) because in this case the expected cost of compensating the manager in the no-investment state is high. Thus, short-termism is preferred to the wage contracting resolution either when the value of learning is sufficiently high and/or the incentive problem is sufficiently severe.\(^{31}\)

All of this presumes that wage contracts can be written on private benefits. This is a strong assumption. In practice, private benefits may be difficult to estimate for contracting. Moreover, paying managers to not invest may be inefficient if they also have to be motivated to expend effort to generate project ideas. Thus, there are numerous reasons why wage contracting as a substitute for short-termism may be infeasible or inefficient.

### 4.3 Managerial Private Benefits versus Risk Aversion

Since the manager’s preference for a long-term project arises from his desire to delay revelation of information about his ability, can managerial risk aversion replace private benefits to generate the same managerial preferences? The answer is yes. To see this, suppose the divisional manager was risk averse, but there are no private benefits. In that case, if the manager chooses the short-payback project, his second-period wage is stochastic, either \(w_1^+\) or \(w_1^-\), depending on whether the first-period project outcome. If he chooses the long-term project, his second-period wage is the expected value of \(w_1^+\) and \(w_1^-\). A risk-averse manager will always strictly prefer the expected value of \(w_1^+\) and \(w_1^-\) to a stochastic wage, and hence

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\(^{31}\)Recall that short-termism is predicted to be more likely for routine projects. To interpret Proposition 3, it should be noted that both the value of learning and the severity of the incentive problem can vary in the cross-section. The value of learning can vary cross-sectionally for routine projects due to differences in managerial turnover, and the severity of the incentive problem can vary cross-sectionally due to differences across firms in managerial private benefits.
$L$ will be preferred to $S$.$^{32}$

However, even though the risk-aversion can explain managerial concern with project duration, investment inefficiencies cannot be explained with risk aversion. The manager would not prefer to invest in a (long-term) *bad* project in the first period over not investing at all in that period. This is because he receives the expected value of \( w_1^+ \) \& \( w_1^- \) as his second-period wage in both cases, so he is indifferent between the two choices, and standard convention would choose the no-investment outcome. And if there was any ex-post compensation adjustment associated with ability revelation at \( t = 2 \), the manager would have a strict preference to not invest (see also Holmstrom and Ricart i Costa (1986)). Absent any investment distortion associated with the manager’s preference for a long-term project, the firm would have no reason to adopt a short-termism constraint.$^{33}$

### 4.4 Interim Signal of Cash Flow of Long-term Project

It has been assumed thus far that all information about the long-term project is available only at \( t = 2 \). But often there may be interim signals of final cash flows. Suppose that at \( t = 1 \) the CEO could observe an informative but noisy signal \( \phi \in \{0, R_L\} \) of the cash flow of the long-term project at \( t = 2 \). The probability distribution of \( \phi \) is:

\[
\Pr(\phi = i \mid x = i) = \lambda \in [0.5, \bar{\lambda}] \subset [0.5, 1), \ i \in \{0, R_L\},
\]

where \( x \) is the cash flow at \( t = 2 \) and \( \bar{\lambda} \in (0.5, 1) \). The cost to the CEO of generating a signal with precision \( \lambda \) is \( \varphi(\lambda) \), with \( \varphi(0.5) = 0, \varphi' > 0, \varphi'' > 0 \), and the Inada conditions \( \varphi'(0.5) = 0 \) and \( \varphi'(\bar{\lambda}) = \infty \). This is similar to the idea in Halac and Prat (2016) that the boss may have to make a costly investment in “attention technology” to recognize good worker performance. The analysis below does not examine the dynamic aspects of their

$^{32}$One advantage of the risk aversion assumption is that the manager would prefer the long-term project even if investments were a martingale.

$^{33}$Recall the specification that, despite the learning afforded by the short-payback project, the long-payback project is first-best. This is the only specification that makes sense if “short-termism” is viewed as a distortionary practice, or a deviation from first-best that needs to be explained.
model, but focuses on the static implications.

Now, based on the previous analysis, it is clear that at $\lambda = 1$ the manager would never choose $B$ at $t = 0$, even if it were a long-term project. In this case, imposing short-termism is unnecessary. On the other hand, at $\lambda = 0.5$ the interim signal is uninformative, so the manager will behave as in the base model and short-termism enhances firm value. By continuity, this means that there exists $\lambda^* \in (0.5, 1)$ such that the manager will avoid the $L_B$ project if the chosen $\lambda \geq \lambda^*$. The following result is now evident:

**Lemma 5**: Suppose $\bar{\lambda} < \lambda^*$. Then for $p$ low enough, short-termism is value maximizing in the second-best case.

The intuition is that if the interim signal is not informative enough to resolve the incentive problem, the firm prefers short-termism. Note that the condition that $p$ is not too high is similar to (17) in the base model; a lower $p$ means a more severe incentive problem, given the equilibrium behavior of the manager.

### 4.5 Information-Eliciting Payoff-Contingent Compensation and Short-termism

The model analyzed here has relied on the kind of career concerns model developed by Holmstrom and Ricart i Costa (1986) in which wages are paid at the beginning of each period. However, it is worth exploring the implications of relaxing this assumption. So, suppose we design a revelation game (e.g. Myerson (1979)) in which the manager is asked to directly and truthfully report at each date $t \in \{0, 1\}$ to the firm (CEO) his private information about the project and then, conditional on the report $r_t$ at date $t$, receives an up-front wage $w_t(r_t)$ plus a bonus $c_t(\tilde{R}, r_t)$ that is a function of the random project payoff $\tilde{R}$. That is, the reporting game is a function $\psi_t : \{G, B\} \rightarrow \mathbb{R}^2$, where $\mathbb{R}$ is the real line. The

---

34The analysis that follows is along the lines of Osband and Reichelstein’s (1985) analysis of information-eliciting compensation schemes.
focus of the analysis is on a linear \(c_t(\tilde{R})\) function:

\[
c_t(\tilde{R}, r_t) = \begin{cases} 
\gamma_t \left[ \tilde{R} - \mu_G(\mathbb{E}(T_t)) \right] & \text{if } r_t = G \\
0 & \text{if } r_t = B
\end{cases}
\]  

(21)

where \(\gamma_t > 0\) is a parameter whose value is endogenously determined, \(\tilde{R}\) is the actual random payoff on the project, and \(\mu_G(\mathbb{E}(T_t))\) is the expected payoff on the \(G\) project given the manager’s expected talent at date \(t\). Also set

\[
w_t(r_t) = w_1 \in \{w_1^{-}, w_1^{+}\} \quad \forall r_t.
\]  

(22)

Now, working backwards, consider the last period. At \(t = 1\), only an \(S\) project can be chosen. Given a posterior belief of \(\theta_1\) about the manager’s type, we can write:

\[
\mu_G(\mathbb{E}(T_1)) = \theta_1 R_S + [1 - \theta_1] qR_S.
\]  

(23)

Consider a manager who has received a \(G\) project at \(t = 1\). His expected utility from truthful reporting is:

\[
U(G \mid G) = w_1 + \beta + \gamma \left[ \mathbb{E}(\tilde{R} \mid G, \mathbb{E}(T_1)) - \mu_G(\mathbb{E}(T_1)) \right]
\]

\[
= w_1 + \beta.
\]  

(24)

A manager who has a \(G\) project at \(t = 1\) but reports \(r_1 = B\) would get a utility of

\[
U(B \mid G) = w_1,
\]  

(25)

since no funding would be provided for a \(B\) project, but the manager would still receive a
wage of \( w_1 = w_1^+ \) or \( w_1^- \), depending on the first-period project outcome. Now clearly,

\[
U(G \mid G) > U(B \mid G),
\]  

so a manager with \( G \) will always report truthfully.

Suppose the manager has only \( B \) at \( t = 1 \). If he reports truthfully, his utility is

\[
U(B \mid B) = w_1,
\]  

and if he reports \( r_1 = G \), his expected utility is

\[
U(G \mid B) = w_1 + \gamma_1 [0 - \mu_G (\mathbb{E}[T])] + \beta.
\]  

We need

\[
U(B \mid B) \geq U(G \mid B),
\]  

for incentive compatibility (IC). That is, the IC constraint will be satisfied if:

\[
\gamma_1 \geq \frac{\beta}{\theta_1 R_S + [1 - \theta_1] q R_S}.
\]  

It is straightforward to show that the firm’s payoff will be maximized by setting

\[
\gamma_1 = \frac{\beta}{\theta_1 R_S + [1 - \theta_1] q R_S}.
\]  

The following result follows immediately from the above.

**Lemma 6:** If the firm can use a reporting game like the one described above in the second period, it will produce a strictly higher second-period firm value than if the firm simply chooses to pay the manager only an up-front wage at the start of the second period.

The intuition is that, in equilibrium, the manager always reports truthfully, so the ex-
pected bonus paid to the manager is zero. Thus, the only wage the firm pays to each manager is the same as that with the policy of only paying the manager an up-front wage that was considered earlier. However, in the previous analysis (see Lemma 3), we saw that the policy of only paying an up-front wage leads to the manager seeking second-period funding even for a $B$ project. This leads to a lower second-period firm value than with the reporting mechanism in which the manager never seeks funding for a $B$ project.

Now consider the firm’s choice at $t = 0$. The following lemma can be proved:

**Lemma 7:** Taking as given the second-period reporting game, at $t = 0$, the firm can adopt the policy of asking the manager to invest in either the $L$ or the $S$ version of the project the manager has and truthfully report the type ($G$ or $B$) of the project to the firm. The reporting game involves the manager being paid an up-front wage of $w_0$ at $t = 0$ regardless of his report. He is denied funding if he reports $B$. If he reports $G$, he receives funding and a bonus $c_0$ that is conditional on the first-period project outcome:

$$c_0^L = \frac{\beta}{\theta_0 R_L + [1 - \theta_0] q R_L} \text{ if the manager proposes an } L \text{ project}, \quad (32)$$

$$c_0^S = \frac{\beta [1 - p]}{\theta_0 R_S + [1 - \theta_0] q R_S} \text{ if the manager proposes an } S \text{ project.} \quad (33)$$

This lemma essentially verifies that the direct reporting mechanism can also be used in the first period. The next question is: should short-termism be expected in an environment in which output-contingent wage contracting in a reporting game framework is feasible?

**Proposition 4:** Suppose

$$p \Delta_0 + p [1 - \theta_0] [p - q] q R_S < p [1 - \theta_0] [1 - q] - [1 - p] [4p - 1]. \quad (34)$$

Then the firm always prefers short-termism. If the inequality in (34) is reversed, then the
The intuition is as follows. Because output-contingent contracting ensures that the manager avoids proposing $B$ even with the $L$ version of the project, one of the relative benefits of short-termism—the resolution of the incentive problem—is lost since this problem is resolved with wage contracting. Of course, the learning benefit of short-termism still remains. (34) says that the learning benefit is large compared to the intrinsic-value gain from investing in the $L$ version of $G$ compared to investing in the $S$ version, so short-termism survives. This will be true when $\bar{\Delta}_0$, the intrinsic-value gain from investing in the $L$ rather than the $S$ version of $G$, is small and $\theta_0$ and $q$ are small as well. This is intuitive since a sufficient reduction in $\bar{\Delta}_0$ makes the learning benefit of short-termism exceed the loss in value from eschewing the $L$ version of $G$. When (34) is reversed, the learning benefit of short-termism is exceeded by the value loss from short-termism.

### 4.6 A Richer Time Structure

The intuition emerging from the two-period analysis carries over to a structure that has more than two periods, as long as the manager cares about how his ability is perceived at dates prior to all the project payoffs being realized. That is, the analysis captures the idea that the tenure of the typical manager in a given job is often shorter than the payoff horizons of long-term projects. 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.\(^\text{35}\) As an example of this, it is not uncommon for a manager to enter a job with the intention or expectation of finding a new job within a few years. The analysis then suggests that the manager would rather not jeopardize future employment opportunities by allowing uncertain

\(^{35}\)For example, the project horizon for a beer brewery is typically 15-20 years. Similarly, R&D investments by drug companies have payoff horizons typically exceeding 10 years. Term loans by banks may have maturities of 5-7 years.
project outcomes to be revealed in the short-term.

5 Conclusion

Corporate short-termism has been the subject of much research and public debate. The thrust of the research has been that short-termism sacrifices long-term value and is an undesirable consequence of managerial self-interest or stock market pressure to engage in earnings management or cater to short-horizon investors.

This paper has challenged this idea and argued that short-termism may be good for firm value. Were firms not to insist on short-term results that lead to early revelation of information about project quality and managerial ability, managers would be tempted to choose projects that benefit them personally at the expense of firm value, and firms would learn less efficiently about managerial abilities. Pushing the revelation of information about such activities further into the future is an effective way for managers to protect themselves against the outcome of their rent-seeking being misinterpreted as evidence of low ability, which enables rent extraction to last longer. This makes short-termism a valuable tool of internal governance. Thus, it is the guardians of firm value, like investors, who want short-termism, and it is self-interested managers who like long-term projects.

This approach produces a number of empirical predictions. For example, firms with stronger corporate governance will emphasize short-termism more (see Gianetti and Yu (2016)). Finally, short-termism is more likely to be encountered in industries in which the loss in value from insisting on short-term projects is not excessive (e.g. traditional manufacturing rather than R&D-intensive firms).

\footnote{The idea that the quality of governance affects corporate investments is also consistent with the evidence in Billett, Garfinkel, and Jiang (2011) that poor governance is associated with overinvestment.}
Appendix

Proof of Lemma 1: In the first-best case, project choice can be observed by the shareholders, so it maximizes firm value. It will first be shown that the funding will occur only if he has a $G$ project. With a $G$ project, since $1 - \theta_0$ is the probability that the manager is type $U$ and thus receives a project payoff of 0 with probability $1 - \theta_0$, the net expected project payoff across the two types of managers will be $\theta_0 R_T + (1 - \theta_0) q R_T - 1$ where $T \in \{L, S\}$ if the manager does not know his type, and the expected social value will be $\theta_0 R_T + (1 - \theta_0) R_T + \beta - 1$. Now, if the manager does not invest, net social surplus and the net expected project payoff are both 0, so the CEO accepts the project in the first-best case. Now if the manager does not receive a $G$ project, then he has a $B$ project which pays off 0 regardless of his type. In the first-best case, there is no investment in the project since the NPV < 0 and also the sum of his private benefit and project NPV is $\beta - 1 < 0$. Next, it will be established that (13) is a necessary and sufficient condition for $L_G$ to have higher value for the firm than $S_G$. Suppose the firm invests in $L_G$ in the first period. Its expected net payoff after the first period is $\theta_0 R_L + (1 - \theta_0) q R_L - 1$. At the beginning of the second period, no information is revealed about the manager’s type since an $L$ project was undertaken at $t = 0$, so $\theta_1 = \theta_0$. The manager receives a $G$ project with probability $p$, which then gives an expected net payoff of $\theta_0 R_S + (1 - \theta_0) q R_S - 1 > 0$. If the manager proposes a $B$ project, the expected net payoff is $-1$, and if the manager does not invest, the payoff is 0. Thus, the manager will only propose a $G$ project, and its expected net payoff across the two periods is:

$$\{\theta_0 R_L + (1 - \theta_0) q R_L - 1\} + p\{\theta_0 R_S + (1 - \theta_0) q R_S - 1\} \quad (A.1)$$

Now, suppose that the firm invests in $S_G$ in the first period. Its expected net payoff after the first period is $\theta_0 R_S + (1 - \theta_0) q R_S - 1$. At the beginning of the second period, posterior beliefs about the manager’s type are updated from $\theta_0$ to $\theta_1$ via Bayes’ Rule, based on the outcome of the first-period project. In the case where the first-period project fails, then beliefs are revised to:

$$\theta_1 = \Pr(\text{manager’s type} = T \mid \text{failure at} \ t = 1)$$
$$= \frac{\Pr(\text{failure} \mid \text{type} = T) \Pr(\text{type} = T)}{\Pr(\text{failure} \mid \text{type} = T) \Pr(\text{type} = T) + \Pr(\text{failure} \mid \text{type} = U) \Pr(\text{type} = U)} \quad (A.2)$$

where “failure” means that the first period project payoff is 0, and “success” means that the payoff is $R_S$. In this case, the expected net payoff of proposing a $G$ project at $t = 1$ is $\theta_1 R_S + (1 - \theta_1) q R_S - 1 = q R_S - 1 < 0$ from (4). The net payoff of proposing a $B$ project is $-1$, and the payoff of not investing is 0. Thus, given failure at $t = 1$, the manager will choose to not invest in the second period in the first-best. In the case where the first-period project succeeds, beliefs are revised to:
\[ \theta_1 = \Pr(\text{manager’s type} = T \mid \text{success at } t = 1) = \frac{\theta_0}{\theta_0 + q(1 - \theta_0)} \equiv \theta_1^+, \quad (A.3) \]

\[ 1 - \theta_1 = \Pr(\text{manager’s type} = U \mid \text{success at } t = 1) = \frac{q(1 - \theta_0)}{\theta_0 + q(1 - \theta_0)} \equiv 1 - \theta_1^+. \quad (A.4) \]

In this case, the expected payoff of proposing \( G \) at \( t = 1 \) is \( \theta_1^+ R_S + (1 - \theta_1^+) q R_S - 1 \). Since the first-period project succeeds with probability \( \theta_0 + (1 - \theta_0) q \), the manager receives second-period funding only if he receives a second-period \( G \) project and succeeds in the first period. The expected net payoff across the two periods when the firm invests in \( S_G \) is:

\[
\{\theta_0 R_S + (1 - \theta_0) q R_S - 1\} + p \{\theta_0 + (1 - \theta_0) q\} \left\{ \left[\frac{\theta_0}{\theta_0 + q(1 - \theta_0)}\right] R_S + \left[\frac{q(1 - \theta_0)}{\theta_0 + q(1 - \theta_0)}\right] q R_S - 1 \right\} \\
= \{\theta_0 R_S + (1 - \theta_0) q R_S - 1\} + p \left\{\theta_0 R_S + (1 - \theta_0) q^2 R_S - \theta_0 - (1 - \theta_0) q\right\}.
\]

(A.5)

Now, for \( L_G \) to be value maximizing, (A.1) should exceed (A.5). This yields (13).

**Proof of Lemma 2:** At \( t = 1 \), only \( S \) is available. From Lemma 1, the manager at \( t = 0 \) only requests funding for an \( L_G \) project. Then no information is revealed about the manager’s type at \( t = 1 \), so \( \theta_1 = \theta_0 \) (this will also be the case if no project was proposed at \( t = 0 \)). Since we know that \( R_S > 1 > \beta \), the expected project payoff for \( G \) project is \( \theta_0 R_S + (1 - \theta_0) q R_S > 1 \). If the manager requests funding, then the net social surplus is \( \theta_0 R_S + (1 - \theta_0) q R_S > 1 \). The expected project payoff for \( B \) is 0, so the net social surplus will be \( \beta - 1 < 0 \) (and the value to the firm will be -1). If the manager does not invest, net social surplus will be 0. Therefore, in the first best at \( t = 1 \), the manager will only propose \( S_G \), and he will receive funding for it. ■

**Proof of Lemma 3:** First, I show that the manager will always seek funding at \( t = 1 \). Suppose the manager did not propose a project a \( t = 1 \). Then his utility at \( t = 1 \) is \( U_{M,t=1}(\emptyset) = \tilde{w}_1 \). Now, if the manager does propose a project at \( t = 1 \), and he gets funding for it, then his utility is \( U_{M,t=1}(S_G) = U_{M,t=1}(S_B) = \tilde{w}_1 + \beta \), which does not depend on \( G \) or \( B \). Clearly \( U_{M,t=1}(S_G) = U_{M,t=1}(S_B) > U_{M,t=1}(\emptyset) \), so the manager will propose a project at \( t = 1 \). Now, suppose that a policy of maximizing firm value is in place. Then, at \( t = 1 \), the manager will get funding if the expected payoff of the project as viewed by the CEO (given that the CEO cannot see whether he received a \( G \) project or not) exceeds 1. Thus, the manager gets funding at
The interpretation of this is that at \( t = 1 \) if \( p \{ \theta_1 R_S + (1 - \theta_1)q R_S \} + [1 - p]0 = p \{ \theta_1 R_S + (1 - \theta_1)q R_S \} > 1 \). The funding decision thus depends on \( \theta_1 \), the posterior belief at \( t = 1 \). Now, if the manager invested in an \( L \) project at \( t = 0 \), then \( \theta_1 = \theta_0 \) (so there is no information revealed about the manager’s type at \( t = 1 \)). Since we have that \( \theta_0 R_S + (1 - \theta_0)q R_S > 1 \) from (6), it follows that the manager will get funding at \( t = 1 \) if he invests in an \( L \) project at \( t \). Now suppose that the manager invested in \( S \) at \( t = 0 \). Then there are two possibilities: \( S \) fails at \( t = 1 \) or \( S \) succeeds at \( t = 1 \). Belief revision now depends on what equilibrium choices were made at \( t = 0 \). Given the equilibrium in which the manager only invests in \( S_G \) (not \( S_B \)) at \( t = 0 \), posterior beliefs are obtained using Bayes’ Rule as in the proof of Lemma 1. That is, Pr(manager’s type = \( T \) | failure at \( t = 1 \)) = \( \theta_1^- = 0 \), and Pr(manager’s type = \( T \) | success at \( t = 1 \)) = \( \theta_1^+ = \theta_0 [\theta_0 + q(1 - \theta_0)]^{-1} \), where “failure” means that the first period project payoff is 0, and “success” means that the payoff is \( R_S \). Thus, when the manager only invests in \( S_G \) at \( t = 0 \), then \( \theta_1 = \theta_1^+ \) if there is success in the first period (given by (A.3)), and \( \theta_1 = \theta_1^- = 0 \) if there is failure in the first period (given by (A.2)). Therefore, for the manager to get funding at \( t = 1 \) conditional upon first-period project success, we need:

\[
p \{ \theta_1^+ R_S + (1 - \theta_1^+)q R_S \} > 1. \tag{A.6}
\]

Note that, (A.6) directly follows from (7) and the fact that \( \theta_1^+ > \theta_0 \) (which follows from (A.3)). The interpretation of this is that at \( t = 1 \) we know that the manager will invest in \( S_G \) in the second period if he has \( G \), and in \( S_B \) if he does not have \( G \). We know that Pr(\( G \)) = \( p \) and Pr(\( B \)) = \( 1 - p \), and also that the payoff the manager gets with \( B \) is 0. Therefore, in (A.6), \( p \) is multiplied with the expected payoff of a \( G \) project with managerial type uncertainty (the expectation is taken over the manager being \( T \) or \( U \)).

It is also clear that if there is failure at \( t = 1 \) that the manager will never get funding at \( t = 1 \), since \( \theta_1^- = 0 \) and thus that the expected payoff is \( pq R_S < 1 \) (as a result of (4)).

**Proof of Proposition 1:** Suppose first that the manager has a \( G \) project. If he proposes \( S_G \) (the good short project), his expected utility will be:

\[
U_{M,t=0}(S_G) = w_0 + \beta + \theta_0 (w_1^+ + \beta) + [1 - \theta_0] \left\{ q (w_1^+ + \beta) + [1 - q] w_1^- \right\}
= w_0 + \beta + [\theta_0 + (1 - \theta_0)q] (w_1^+ + \beta), \tag{A.7}
\]

where \( w_1^+ \) is the upward-revised wage given that the manager succeeds (see (9)), and \( w_1^- \) is the downward-revised wage given that the manager fails in the first period (see (10)). Since \( \theta_1^- = 0 \), we see that \( w_1^- = 0 \). Thus, the manager’s expected utility at \( t = 0 \) from an \( S_G \) project is a function of his initial wage, his private benefit from taking on the project, and the probability weighting of his type (and how likely he is to succeed given that he is untalented). Similarly, if the manager proposes \( L_G \), his expected utility will be:
\[ U_{M,t=0}(L_G) = w_0 + \beta + (w_0 + \beta), \quad (A.8) \]

where in (A.8) \( w_1 = w_0 \) since there is no new information about the manager’s type at \( t = 1 \), so his wage is unchanged. We want to verify whether \( U_{M,t=0}(L_G) > U_{M,t=0}(S_G) \), ie whether:

\[ w_0 + \beta > [\theta_0 + (1 - \theta_0)q] (w_1^+ + \beta). \quad (A.9) \]

Comparing term by term, since \([\theta_0 + (1 - \theta_0)q] < 1\) we have \( \beta > [\theta_0 + (1 - \theta_0)q] \beta \). It thus only remains to compare the terms \( w_0 \) and \([\theta_0 + (1 - \theta_0)q] w_1^+ \). Now, using (8) and (9) we have:

\[ \theta_0 w_1^+ = \theta_0 \theta_1^+ w^T = \left[ \frac{\theta_0}{\theta_0 + q(1 - \theta_0)} \right] \theta_0 w^T = \left[ \frac{\theta_0}{\theta_0 + q(1 - \theta_0)} \right] w_0 \quad \text{(A.10)} \]

Thus,

\[ w_0 = [\theta_0 + (1 - \theta_0)q] w_1^+. \quad \text{(A.11)} \]

From (A.11), it follows that (A.6) holds, and that \( U_{M,t=0}(L_G) > U_{M,t=0}(S_G) \). Thus, the manager will always propose \( L \) when he has \( G \). Finally, we need to show that the manager will prefer to propose \( L \) over the option to propose nothing at all. To see this, note that the utility from proposing \( L \) is \( U_{M,t=0}(L_G) = w_0 + \beta + (w_0 + \beta) \) and the utility from proposing nothing is \( U_{M,t=0}(\emptyset) = w_0 + (w_0 + \beta) \). Thus \( U_{M,t=0}(L_G) > U_{M,t=0}(\emptyset) \), so the manager will prefer to propose \( L \).

Now suppose that the manager has \( B \). His expected utility at \( t = 0 \) from \( S_B \) is:

\[ U_{M,t=0}(S_B) = w_0 + \beta. \quad \text{(A.12)} \]

And the expected utility from an \( L_B \) project is:

\[ U_{M,t=0}(L_B) = w_0 + \beta + (w_0 + \beta). \quad \text{(A.13)} \]

It is clear that \( U_{M,t=0}(L_B) > U_{M,t=0}(S_B) \), so \( L \) is better for the manager, given that he has only \( B \). In addition, suppose that the manager proposes nothing at \( t = 0 \) with \( B \). This gives him utility \( U_{M,t=0}(\emptyset) = w_0 + (w_0 + \beta) \) versus proposing \( L_B \), which gives utility \( U_{M,t=0}(L_B) = w_0 + \beta + (w_0 + \beta) \). Clearly, \( U_{M,t=0}(L_B) > U_{M,t=0}(\emptyset) \), so the manager proposes \( L \) when he only has \( B \).

**Proof of Lemma 4:** If the manager has a \( B \) project that has a short payback, then his expected utility is \( U_{M,t=0}(S_B) = w_0 + \beta \) from (A.12). If the manager proposes nothing at \( t = 0 \), then his utility is \( U_{M,t=0}(\emptyset) = w_0 + (w_0 + \beta) \), since he will retain access to second-period funding. We see now that \( U_{M,t=0}(\emptyset) > U_{M,t=0}(S_B) \), so the manager would rather not propose anything than propose a short-term \( B \) project. But if the manager has a short-term \( G \) project, then proposing it at \( t = 0 \) leads to \( U_{M,t=0} = w_0 + \beta + [\theta_0 + (1 - \theta_0)q] (w_1^+ + \beta) \) from (A.7). From (A.9) we had that
\( w_0 + \beta > [\theta_0 + (1 - \theta_0)q] (w_1^* + \beta) \). To show that \( U_{M,t=0}(S_G) > U_{M,t=0}(\emptyset) \), we need to show:

\[
    w_0 + \beta + [\theta_0 + (1 - \theta_0)q] (w_1^* + \beta) > w_0 + (w_0 + \beta).
\] (A.14)

Now, from (A.11) we know that \([\theta_0 + (1 - \theta_0)q] w_1^* = w_0\). We thus see that (A.14) is satisfied as long as \( \beta > 0 \), which holds by assumption. ■

**Proof of Proposition 2:** The proof requires comparing the NPV from choosing \( S \) with the NPV from choosing \( L \). Note that this can be done independently of calculating the dilution in ownership, \( y \), for current shareholders, since a strategy that maximizes fundamental value will also minimize \( y \). The NPV from choosing \( S \) (denoted by \( \tilde{V}_S^{NPV} \)) is given by \( \tilde{V}_S \) minus the unconditional expected investment costs (since the manager may not invest in a short-term project in each period), which are given by \( p \{1 + \theta_0 + q[1 - \theta_0]\} - [1 - p]\{1\} \). We can write this as:

\[
    \tilde{V}_S^{NPV} \equiv \tilde{V}_S - p \{1 + \theta_0 + q[1 - \theta_0]\} - [1 - p]\{1\} \\
    = p \{\theta_0 [R_S + pR_S] + [1 - \theta_0] q [R_S + pqR_S]\} + [1 - p]p[\theta_0 + q[1 - \theta_0]] R_S \\
    + [p [1 - \theta_0] [1 - q] + [1 - p]] \{1\} - 2w_0 - p \{1 + \theta_0 + q[1 - \theta_0]\} - [1 - p]\{1\} \\
    = -2w_0 + p \{\theta_0 [R_S + pR_S + [1 - p]R_S] + [1 - \theta_0] qR_S[1 + pq + 1 - p]\} \\
    - p [1 + \theta_0 + [1 - \theta_0] [2q - 1]].
\] (A.15)

The NPV from choosing \( L \) (denoted by \( \tilde{V}_L^{NPV} \)) is given by \( \tilde{V}_L - 2 \), since the manager will invest in a project in both periods for sure. Thus, \( \tilde{V}_L^{NPV} \) is given by:

\[
    \tilde{V}_L^{NPV} \equiv \tilde{V}_L - 2 \\
    = p \{\theta_0 [R_L + R_S] + [1 - \theta_0] [qR_L + qR_S]\} - 2w_0 - 2.
\] (A.16)

We want \( \tilde{V}_S^{NPV} > \tilde{V}_L^{NPV} \), so we want (A.15) to exceed (A.16). That is, we want:

\[
    2 - p [[1 - \theta_0][2q - 1] + 1 + \theta_0] > p \{\theta_0 \left[ [R_L + R_S] - [R_S + R_S]\right] +\} + p \theta_0 \left[ 1 - \theta_0 \right] q \left[[R_L + R_S] - (R_S + R_S[pq + 1 - p])\right] \\
\] (A.17)

Now, note that the left-hand side in (A.17) is:

\[
    1 - p + 1 - p \left[\theta_0 + (1 - \theta_0)(2q - 1)\right] > 1 - p + 1 - p \\
    = 2(1 - p).
\] (A.18)
where the inequality follows since $\theta_0 + (1 - \theta_0)(2q - 1) < 1$. Now (A.17) holds if:

$$2[1 - p] > p \{\theta_0 (RL - RS) + (1 - \theta_0) q [R_L - R_S[pq + 1 - p]]\}, \quad (A.19)$$

which is guaranteed by (17). The proof of the rest of the proposition follows trivially. ■

**Proof of Corollary 1:** Given that the CEO attempts to maximize firm value (as she will with a low $\omega$), the asymmetric information problem disappears, taking us back to the first-best case. Following from Lemmas 1 and 2, the CEO (who is now proposing the project instead of the manager) will only propose a project if it is $G$. At $t = 0$, if he receives a $G$ project, he will structure it as an $L$ project. Therefore, a constraint that the project must have a short payback is suboptimal. ■

**Proof of Proposition 3:** For the short-termism constraint to be preferred to the wage contracting solution, we need the expression in (19) to exceed that in (18). This comparison yields:

$$(1 - p)\beta + (w_0 + 1)(1 - \theta_0 - (1 - \theta_0)q) > p \{\theta_0 + (1 - \theta_0)q\} [R_L - R_S] + (1 - q)(1 - \theta_0)pqR_S. \quad (A.20)$$

Clearly, the left-hand side ($LHS$) of (A.20) is increasing in $\beta$, $w_0$, and the initial investment, whereas the right-hand side ($RHS$) is increasing in $[R_L - R_S]$. Moreover, if $p = 1$, then:

$$LHS = (w_0 + 1)[1 - \theta_0 - (1 - \theta_0)q], \quad (A.21)$$

$$RHS = \{\theta_0 + (1 - \theta_0)q\} [R_L - R_S] + (1 - \theta_0)(1 - q)qR_S, \quad (A.22)$$

and $\frac{\partial LHS}{\partial \theta_0} < 0$. Moreover, $\frac{\partial RHS}{\partial \theta_0} > 0$ at $q = 0$ and hence by continuity $\frac{\partial RHS}{\partial \theta_0} > 0$ for $q$ small enough. Moreover, comparing (A.21) and (A.22), we see that at $\theta_0 = 1$, the $RHS = R_L - R_S > 0 = LHS$. Thus, short-termism is dominated at $\theta_0 = 1$. At $\theta_0 = 0$, $LHS = (w_0 + 1)(1 - q)$ and $RHS = q[R_L - qR_S]$. Thus, $LHS > RHS$ for $q = 0$ and hence inequality (A.20) holds for $q$ small enough by continuity, so short-termism dominates at $\theta_0 = 0$. Since $\frac{\partial LHS}{\partial \theta_0} < 0$, $\frac{\partial RHS}{\partial \theta_0} > 0$, short-termism dominates at $\theta_0 = 0$, and wage contracting dominates for $\theta_0 = 1$, it has been proven that short-termism dominates for $\theta_0$ low enough and wage contracting dominates for $\theta_0$ high enough.

Now set $\theta_0 = 1$. Then,

$$LHS = (1 - p)\beta \quad (A.23)$$

$$RHS = p[R_L - R_S]. \quad (A.24)$$

At $p = 1$, $LHS = 0$ and $RHS = R_L - R_S$, so short-termism is dominated. At $p = 0$, $LHS = \beta$.
Similarly, $E$ term is the second-period private benefit. Since the manager never proposes a $B$ project is funded (which only happens if the first-period project succeeds), and $\beta$ is subgame perfect for the CEO to fund the second-period project after observing where $\phi$ is type $T$. It follows that $\hat{\varphi}(\lambda)$, which is true $\forall \lambda$. By continuity, therefore, it holds for $p$ small enough. \hfill \blacksquare

**Proof of Lemma 5:** Let the analog of (16) with a signal of precision $\lambda$ be:

$$
\hat{V}_L(\lambda) = p \{ \theta_0 R_L + [1 - \theta_0] q R_L \} + p \{ \theta_1^+(\lambda) R_S + [1 - \theta_1^+(\lambda)] q R_S \} - 2 w_0 - \varphi(\lambda).
$$

(A.25)

where $\theta_1^+(\lambda)$ is the posterior belief the manager is type $T$ after observing $\phi = R_L$. Note that it is subgame perfect for the CEO to fund the second-period project after observing $\phi = R_L$ since $\theta_1^+(\lambda) > \theta_0$. Comparing (A.25) to (15), we see that $\hat{V}_S > \hat{V}_L(\lambda)$ at $p = 0$ since the condition collapses to $1 > -\varphi(\lambda)$, which is true $\forall \lambda$. By continuity, therefore, it holds for $p$ small enough. \hfill \blacksquare

**Proof of Lemma 6:** Given the payoff-contingent wage contract with the $\gamma_1$ given in (31) the manager never proposes a $B$ project. Thus, the value of the second-period project is $\mu_G(\mathbb{E}(T_1))$ (see (23)). With just an up-front wage, the value is $p \mu_G(\mathbb{E}(T_1))$ since the manager will propose $B$ if he does not have $G$. It follows that $\mu_G(\mathbb{E}(T_1)) > p \mu_G(\mathbb{E}(T_1))$ since $p \in (0, 1)$. \hfill \blacksquare

**Proof of Lemma 7:** Let $U^i(j | k)$ be the expected utility of the manager at $t = 0$ if he proposes the $i$ version of the project with $i \in \{L, S\}$, has a type $k$ project with $k \in \{G, B\}$, and reports $j \in \{G, B\}$. Suppose first that the manager is proposing an $S$ project. Then

$$
U^S(G | G) = w_0 + c^S_0 \left\{ \mathbb{E} \left( \hat{R} \right) - \mu_G(\mathbb{E}(T_0)) \right\} + \beta,
+ \{ \theta_0 + q [1 - \theta_0] \} \cdot p \{ w_1^+ + \beta \}.
$$

(A.26)

where $w_0$ is the up-front wage at $t = 0$, $c^S_0$ is the payoff-contingent bonus term, $\beta$ is the first-period private benefit, $\theta_0 + q [1 - \theta_0]$ is the probability of success of the $G$ project given the prior belief $\theta_0$, $p$ is the probability of having $G$ in the second period, $w_1^+$ is the wage if the manager’s second-period project is funded (which only happens if the first-period project succeeds), and $\beta$ in the $\{ w_1^+ + \beta \}$ term is the second-period private benefit. Since $\mathbb{E} \left( \hat{R} \right) = \mu_G(\mathbb{E}(T_0))$, (A.26) simplifies to:

$$
U^S(G | G) = w_0 + \beta + \{ \theta_0 + q [1 - \theta_0] \} \cdot p \{ w_1^+ + \beta \}.
$$

(A.27)

Similarly,

$$
U^S(G | B) = w_0 - c^S_0 \mu_G(\mathbb{E}(T_0)) + \beta + w_0,
$$

(A.28)

since $\mathbb{E} \left( \hat{R} \right) = 0$ on $B$. Further,

$$
U^S(B | B) = w_0 + p \beta + w_0,
$$

(A.29)
since the manager receives no first-period funding when he reports $B$ at $t = 0$, so there is no first-period bonus or private benefit (only the up-front wage $w_0$). If he receives $G$ in the second-period (probability $p$), he requests funding and hence a private benefit $\beta$. Given that we are taking the second-period reporting game as given, the incentive compatibility is assured and the manager does not ask for funding with $B$. Since $E(\tilde{R}) = \mu_G(E(T_1))$ in the second period, the bonus term drops out as in (A.27). The second-period up-front wage $w_0$ is paid unconditionally at $t = 1$.

Incentive compatibility requires that $U^S(B|B) \geq U^S(G|B)$, so we need

$$p\beta \geq -c^S_0 \{\theta_0 R_S + [1 - \theta_0] q R_S\} + \beta,$$

(A.30)

where $\mu_G(E(T_0)) = \theta_0 R_S + [1 - \theta_0] q R_S$ has been substituted. Recognizing that the IC constraint is binding and solving (A.29) as an equation yields (32). It is easy to verify that with this $c^S_0$, $U^S(G|G) \geq U^S(G|B)$. The analysis of the $L$ version of the project is exactly the same as the analysis in the text preceding Lemma 5. This is because no information is revealed at $t = 1$, so regardless of what the manager reports at $t = 0$, the outcome is the same at $t = 1$, which means the events at $t = 1$ have no effect on the analysis. This is why $c^L_0$ in (31) is the same as $\gamma_1$ in (31).

**Proof of Proposition 4:** We can use (15) to write the value of the firm with $S$. The only difference is that, with payoff contingent contracting, the manager will never propose a $B$ project, which means cash will idle in more states of the world relative to (15). Using $V^*_i$ to designate the value of the firm with $i \in \{S, L\}$, we can write a modified version of (15):

$$V^*_S = \bar{A} + p \{\theta_0[1 + p] R_S + [1 - \theta_0] q[1 + pq] R_S\}$$

$$+ [1 - p]p \{\theta_0 + q[1 - \theta_0]\} R_S$$

$$+ \{p[1 - \theta_0][1 - q] + 1 - p\} + 2[1 - p]^2 - 2w_0.$$

(A.31)

In comparing this to (15), note that there is an additional term, $2[1 - p]^2$, which represents the state in which $\$2$ idles (no funding in either period), the probability of which is $[1 - p]^2$. Similarly, adapting (16), we can write:

$$V^*_L = \bar{A} + p \{\theta_0 [R_L + R_S] + [1 - \theta_0] q R_L + q R_S\}$$

$$+ \{(1 - p)p + p[1 - p]\} \{1\} + [1 - p]^2 \{2\},$$

(A.32)

where the last two terms represent the idle cash states. The probability that the manager will have $G$ in only one period is $[1 - p]p + p[1 - p]$, and in this state $\$1$ idles. The probability that the manager will have $G$ in neither period is $[1 - p]^2$, and in this state $\$2$ idles. Simplifying (A.32)
yields:

\[ V_L^* = \bar{A} + p \{ \theta_0 [R_L + R_S] + [1 - \theta_0] q R_L + q R_S \} + 2 [1 - p^2]. \]  

(A.33)

By comparing (A.31) and (A.33) and recalling that \( \bar{\Delta}_0 = \theta_0 [R_L - R_S] + [1 - \theta_0] q [R_L - R_S] \), it can be shown that \( V_L^* < V_S^* \) if (34) holds. Note further that for the right-hand side of (34) to be positive, we need

\[ p [1 - \theta_0] [1 - q] > [1 - p] [4p - 1]. \]  

(A.34)

Now, we ask if \( p > [1 - p][4p - 1] \) is true? This simplifies to verifying whether \( 0 > -[2p - 1]^2 \), which clearly is true. Thus, by continuity, (A.34) will hold for \( \theta_0 \) and \( q \) small enough. That is, with \( \theta_0 \) and \( q \) small enough, the right-hand side of (34) will be positive. Consequently, if \( \bar{\Delta}_0, \theta_0, \) and \( q \) are small enough, (34) will hold (note that (34) holds for \( \bar{\Delta}_0 = \theta_0 = q = 0 \), and hence holds by continuity for \( \bar{\Delta}_0, \theta_0, \) and \( q \) small enough). \( \blacksquare \)
References


### Table 1: Project Payoff Distributions

<table>
<thead>
<tr>
<th>Project Type</th>
<th>Manager Type</th>
<th>Project Payoff</th>
</tr>
</thead>
<tbody>
<tr>
<td>$L_G$</td>
<td>$T$</td>
<td>$R_L &gt; 1$ with probability 1 at $t = 2$, with investment at $t = 0$.</td>
</tr>
<tr>
<td>$L_G$</td>
<td>$U$</td>
<td>$R_L &gt; 1$ with probability $q$ and 0 with probability $1 - q$ at $t = 2$, with investment at $t = 0$.</td>
</tr>
<tr>
<td>$S_G$</td>
<td>$T$</td>
<td>• $R_S &gt; 1$ with probability 1 at $t = 1$, with investment at $t = 0$.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• $R_S &gt; 1$ with probability 1 at $t = 2$, with investment at $t = 1$.</td>
</tr>
<tr>
<td>$S_G$</td>
<td>$U$</td>
<td>• $R_S &gt; 1$ with probability $q$ and 0 with probability $1 - q$ at $t = 1$, with investment at $t = 0$.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• $R_S &gt; 1$ with probability $q$ and 0 with probability $1 - q$ at $t = 2$, with investment at $t = 1$.</td>
</tr>
<tr>
<td>$L_B$ or $S_B$</td>
<td>$T$ or $U$</td>
<td>0 with probability 1</td>
</tr>
</tbody>
</table>
Figure 1: Timeline of Actions and Events

<table>
<thead>
<tr>
<th>t = 0</th>
<th>t = 1</th>
<th>t = 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>• A $G$ project arrives with probability $p$. Manager has access to a $B$ project regardless.</td>
<td>• If an $S$ project was proposed, it pays off 0 if it was $B$. If it was $G$, it pays off $R_S$ with probability 1 if the manager is $T$, but with probability $q$ (and 0 with probability $1 - q$) if the manager is $U$.</td>
<td>• If an $L$ project was proposed at $t = 0$, it pays off 0 if it was $B$. If it was $G$, it pays off $R_L$ with probability 1 if the manager is $T$, but with probability $q$ (and 0 with probability $1 - q$) if he is $U$.</td>
</tr>
<tr>
<td>• The common prior belief is that the probability is $\theta_0$ that the manager is type $T$.</td>
<td>• Beliefs about the manager’s type being $T$ are revised to $\theta_1$.</td>
<td>• If an $S$ project was proposed at $t = 1$, it pays off 0 if it was $B$. If it was $G$, it pays off $R_S$ with probability 1 if the manager is $T$, but with probability $q$ if the manager is $U$.</td>
</tr>
<tr>
<td>• Manager may propose an $S$ or $L$ project for the first period.</td>
<td>• CEO either accepts or rejects proposed project.</td>
<td>• The game ends.</td>
</tr>
<tr>
<td>• CEO either accepts or rejects proposed project.</td>
<td>• Manager is paid a wage of $w_0$.</td>
<td>• Manager is paid a second-period wage of $w_1^+$ if $\theta_1 &gt; \theta_0$, $w_1^-$ if $\theta_1 &lt; \theta_0$, or $w_0 = w_1$ if $\theta_1 = \theta_0$.</td>
</tr>
</tbody>
</table>