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Sunflower Management and Capital Budgeting*

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September 7, 2001

*Acknowledgements: We wish to thank Dan Bernhardt, Phil Dybvig, David Hirshleifer, Han Kim, Stephen Peters, Canice Prendergast, Bryan Routledge, Wilfried Zantman, participants at the 1998 WFA Meetings, and seminar participants at Boston College, INSEAD, Lancaster University, Stanford University, Stockholm School of Economics, UCLA, University of Chicago, University of California at Berkeley, University of Illinois, University of Maryland, University of Michigan and Washington University in St. Louis for many helpful comments. Boot and Milbourn are also grateful to the Studienzentrum Gerzensee for its hospitality.

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Sunflower Management and Capital Budgeting

Abstract

In organizations, it is often necessary to engage in costly delegation of ideas; such delegation seeks to efficiently aggregate multiple information signals. What this paper shows is that those who delegate often find it impossible to separate the evaluation of the ideas they delegate from the evaluation of the *abilities* of those who are delegated the task of assessing these ideas. This commingling of the assessment of the idea with that of the individual agent generates a tendency for the agent to ignore his own information and instead attempt to confirm the superior's prior belief. We refer to this as sunflower management. Our analysis also allows us to extract implications of sunflower management for the use of centralized versus decentralized capital budgeting systems, and other capital budgeting practices, such as the setting of project acceptance hurdle rate above the cost of capital and the continued reliance on the payback criterion.

1 Introduction

> Gentlemen, I take it we are all in complete agreement on the decision here... Then I propose we postpone further discussion of this matter until our next meeting to give ourselves time to develop disagreement and perhaps gain some understanding of what the decision is all about.
>
> Alfred P. Sloan, Jr.

A sunflower always turns toward the sun, seeking nourishment for its survival. Many managers in organizations behave similarly. They look up at their bosses, trying to figure out what they are thinking, so that their actions will match the expectations and beliefs of their bosses. We call such behavior "sunflower management". Why do people behave like this and what are the consequences of such behavior for how capital is allocated in organizations?

We argue that the answer to this question lies in the interaction of managerial career concerns and project delegation. In organizations, it is often necessary to engage in costly delegation of the assessment of ideas to take advantage of the specialized skills of those at lower levels or simply to aggregate multiple *independent* assessments of ideas. A classic example of this is a capital budgeting system in which senior executives ask junior financial analysts to evaluate projects. Such delegation may be viewed as empowerment, a way for a boss to free up time to pursue more strategic tasks while making the subordinate responsible and accountable for the delegated task. The study of delegation is thus an essential part of understanding the structure and economic function of organizational hierarchies.[1]

While delegation can have many benefits, it also has costs. These are of three types. First, there is the direct cost of delegation. By delegating a decision to a subordinate, there is an added cost of communication as well as motivating a possibly effort-averse subordinate (e.g., Mirrlees (1976) and Prendergast (1993)). Second, there is possibly a cost of less efficient decisionmaking if the subordinate is not as skilled as the boss. And third, the delegation to a subordinate induces an agency problem. In particular, the subordinate may engage in gaming behavior due to career concerns, which may distort decisions. In this paper, we focus on this third cost. The benefit of delegation in our model comes from aggregating multiple independent signals, while the cost is due to the distortions arising from the subordinate's career concerns. We show that these career concerns cause the subordinate to engage in sunflower management, tending to agree with his boss' prior assessment even when his analysis says otherwise.

[1] See Aghion and Tirole (1997) and Harris and Raviv (1998) for recent models of organizational hierarchies.

Although our analysis of this question has fairly wide organizational implications, our central focus is on capital budgeting. This focus motivates our model setup and allows us to address questions about various aspects of the design of capital budgeting systems, such as the optimal degree of decentralization and the criteria to use in evaluating projects.

To fix concepts, let us consider an example. Think of a typical organization in which a vice president (VP) generates an idea for a new project. Suppose the VP passes the project down for investigation by an analyst. Now, the analyst may recommend that the project be rejected for one of two reasons. One is that the project is truly bad upon further inspection. But the other is that the analyst is not very good at estimating the project's value, and hence his high estimation error has resulted in a type-I error in his recommendation. *A priori* the VP can't disentangle the first possibility from the second. However, the more confident the VP is about her positive assessment of the project's value, the more likely she is to believe that an analyst recommending project rejection is a poor analyst.

The astute analyst recognizes this commingling in the VP's potential inference. In particular, he sees that the VP's assessment of the project investigated by the analyst is inseparable from her assessment of the analyst himself. When the VP is seen as being favorable about the project, the analyst's privately-optimal response is to sometimes recommend acceptance of projects that his analysis reveals are bad bets. Similarly, when the VP is seen as being pessimistic, the analyst will tend to recommend rejection even though his analysis tells him the project is good. That is, the analyst strives to provide the VP with consensus rather than an independent assessment. We formally show that one possible resolution to this moral hazard problem is for the executive to set the hurdle rate for project acceptance above the cost of capital.

In addition to examining the broad issue of the interaction between project delegation, career concerns and project-acceptance hurdle rates, our analysis allows us to examine the following questions about capital budgeting in organizations:

1. What are the tradeoffs in determining the degree of decentralization of a capital budgeting system?

2. Can the use of the payback criterion in capital budgeting ever benefit shareholders?

3. Why would a company ever set the hurdle rate for project acceptance above its cost of capital?

4. Why is there a reluctance in organizations to give bad news in a timely manner? How does this affect the value of projects?

The answers to these organizational questions parallel the intuition of the model very closely. Consider the first two questions. The optimal degree of decentralization of a capital budgeting system depends on the tradeoff between the marginal value of information generated at lower levels in the organization and the career-concerns-induced cost of delegating project evaluation. On the issue of payback, the insight is that when the analyst does misrepresent the potential merits of a project, he is more likely to manipulate the more distant cash flows. These longer-term cash flow estimates are thereby less credible to the VP, implying that project payback matters. For the same reason, setting the project hurdle rate above the cost of capital – a common corporate practice according to Poterba and Summers (1995) – also makes sense in this context since it similarly discriminates against the more distant cash flows. Consider the fourth question. Our analysis suggests that people delay giving bad news because doing otherwise would convey potentially adverse information about their ability. While their action represents a judgement of a business situation, they realize that they are also being personally judged based on that action.

Our theory of sunflower management is related to four strands of the literature. The first is the literature on delegation and empowerment in hierarchies, in which Aghion and Tirole (1997) and Milgrom (1988) are major contributors.[2] While we also examine delegation, our focus on the sunflower management aspects of capital budgeting takes our analysis in a different direction.

The second strand is the modern capital budgeting literature. Harris and Raviv (1998) examine the managerial tradeoff between investigating projects, which provide private benefits of control if they are undertaken, and delegating them to a lower part of the hierarchy to save on (privately) costly project investigation. They find that project delegation is more prevalent when the effort costs of project investigations are severely high. Thakor (1990) shows how the wedge between the costs of external and internal financing affects the kinds of projects the firm chooses. Bernardo, Cai, and Luo (2000) jointly consider the capital allocation and compensation scheme in a decentralized firm where managers may misrepresent project quality as well as shirk on investigative efforts. Similar to our work, they find that firms underinvest relative to the NPV rule (i.e., in equilibrium firms (implicitly) set project hurdle rates above the cost of capital) when the optimal joint mechanism is employed. The primary difference between our model and these is that we consider the effects of career concerns and abstract from managerial effort aversion, private benefits of control, and external market frictions.

[2] Milgrom (1988) examines "influence costs" that arise when there are incentives for subordinates to influence the decisions of those in authority. Aghion and Tirole (1997) examine the delegation of formal and real authority and its effects on the subordinate's incentives to collect information and the superior's ultimate control. Harris and Raviv (1998) examine the problem of whether corporate headquarters should delegate control over the allocation of capital to the lower divisions.

The third strand is the literature on career concerns. Chevalier and Ellison (1999), Fama (1980), Gibbons and Murphy (1992), Hirshleifer and Thakor (1992), Holmstrom (1982, 1999), Holmstrom and Ricart i Costa (1986), Milbourn, Shockely and Thakor (2001), Narayanan (1985), Prendergast and Stole (1996), and others have shown how effort and investment incentives of agents are influenced by their career concerns. Holmstrom and Ricart i Costa (1986), in particular, show that when downward-rigid wage contracts are used for risk-averse agents, they may overinvest. We abstract from risk-sharing considerations and show that career concerns can lead to both overinvestment and underinvestment.

The fourth strand of the literature to which our work is most directly related is that on conformity, particularly Prendergast (1993).[3] Other examples are Banerjee and Besley (1990), Bernheim (1994), Bikhchandani, Hirshleifer, and Welch (1992), Brandenburger and Polak (1996), Morris (1999), Prendergast (1993), Scharfstein and Stein (1990) and Zwiebel (1995). The fundamental insight shared by these papers is that conformity is generated by a desire to distinguish oneself from the "type" that one wishes *not* to be identified with. This insight is an important aspect of sunflower management as well since the analyst agrees with the VP to avoid being identified as untalented in estimating project values. What distinguishes our work from this literature is our examination of the *interaction* between career concerns and conformity in the context of capital budgeting.

The rest of the paper is organized as follows. Section 2 describes the model. Section 3 contains the equilibrium analysis of the optimal project delegation policy and characterizes the distortions due to sunflower management. In Section 4, we focus on the capital budgeting implications of the analysis, and Section 5 concludes. All proofs are in the Appendix.

2 Model Setup

We model a firm in which there is one Vice President (VP) overseeing analysts of varying ability. All agents are assumed to be risk neutral. The VP generates project ideas and delegates some of these projects to the analyst for financial analysis. We want to examine the distortions that arise when projects are delegated to analysts for investigation. We let the analyst investigate

[3] Prendergast (1993) is perhaps the most closely related to our work. He develops a model with an effort-averse worker who must be motivated to work to produce a signal, with the motivation provided by an outcome-contingent wage. The problem is that there are no objective measures of output, so the worker's output can be judged only relative to his boss' own information about the signal. This makes the worker misreport his signal, telling his boss what he believes will coincide with the boss' information. The differences between Prendergast's model and ours are that we allow for objective measures of the analyst's output (the terminal payoff on a chosen project is observed ex post), model career concerns rather than effort aversion, and focus on capital budgeting applications.

the delegated project and make a "reject/accept" report to the VP based on his *private* signal. The VP then decides whether to invest capital. Following the investment decision, some information about the quality of the project is revealed regardless of whether the project was undertaken. If the project is accepted, its single cash flow is realized at $t = 2$. There is no additional information revealed on rejected projects. The sequence of events is summarized in *Table 1*.

Table 1 goes here

2.1 Projects and Delegation

The VP generates ideas for projects which can be either good or bad, $\{G, B\}$. The commonly-known quality of the project idea is the prior probability that the idea is good, defined as $\theta \in \Theta \equiv [0, 1]$. That is, for a given project idea,

$$\begin{aligned} \Pr(G) &= \theta \\ \Pr(B) &= 1 - \theta. \end{aligned} \tag{1}$$

Both types of projects require investment at date $t = 1$. Projects that are accepted pay off at $t = 2$.

We assume that the firm incurs a delegation cost $C > 0$ on all projects that are sent to the analyst for investigation. As a consequence, it may not be optimal for the VP to delegate all projects to the analyst. Intuitively, if the VP observes a θ very close to zero or very close to one for a project, she may choose not to send the project to the analyst for investigation. For such a project, the marginal value of the analyst's investigation (even it there was no misrepresentation) is outweighed by the delegation cost C.

We define θ_L and θ_H such that the marginal value of delegating a project with a prior quality assessment of θ_L or θ_H is equal to the delegation cost. This implies that projects with prior quality assessments of $\theta \in (0, \theta_L]$ are optimally rejected without investigation, and projects with prior quality assessments of $\theta \in [\theta_H, 1)$ are optimally accepted without investigation. Therefore, delegation only occurs for projects with prior quality assessments of $\theta \in (\theta_L, \theta_H)$, and we define this delegation region as Θ_D, where $\Theta_D \subset \Theta$.[4] For the remainder of the analysis, we focus on

[4] In general, the optimal project delegation set Θ_D would be a function of both the delegation cost C and the noise introduced by the analyst in his recommendation to the VP. Naturally, if delegation costs were prohibitively high, we could have a situation in which $\theta_L > \theta_H$. This would imply that Θ_D had zero measure and delegation would never occur. We will not consider this case in what follows. However, in Section 4, we do explore the project delegation problem in greater detail and provide a numerical analysis that illustrates how Θ_D is affected by both the costs of delgation and the analyst's distortionary behavior in equilibrium.

the equilibrium behavior of the analyst when the VP delegates project investigation of *all* project ideas for which her prior quality assessment $\theta \in \Theta_D$.

2.2 Analysts and their Signals

Analysts are *ex ante* observationally identical, but can be either Talented or Untalented $\{T, U\}$, where:

$$\Pr(T) = \beta \in (0, 1). \tag{2}$$

Analysts do not know their own type, but learn about it through time along with the VP.

If the analyst is delegated a project, the analyst observes a signal at $t = 1$ that is informative about the project's type. An untalented analyst *always* observes a noisy (but informative) signal. A talented analyst may observe a noisy signal as well, but sometimes observes a precise signal. Whether the analyst receives a precise signal depends on the underlying realization of a state variable Φ. Φ is a signal about project quality that is received by all after the VP has made the investment decision. Let $\Phi \in \{\Phi_G, \emptyset, \Phi_B\}$, with

$$\begin{aligned} \Pr(\Phi = \Phi_G | G) &= \Pr(\Phi = \Phi_B | B) = \alpha \\ \Pr(\Phi = \emptyset | G) &= \Pr(\Phi = \emptyset | B) = 1 - \alpha, \end{aligned}$$

where $\alpha \in (0, 1)$. Specifically, if $\Phi \in \{\Phi_G, \Phi_B\}$, then a talented analyst observes a *precise* signal with probability $P_T \in (0, 1)$ and a noisy signal with probability $1 - P_T$. By contrast, if $\Phi = \emptyset$, *all* analysts, including the talented ones, observe a noisy signal.

What we have in mind is a situation in which information about the project arrives after the firm decides to invest in it. For example, a company decides to invest \$100 million in a new plant to build appliances, after which it learns that a competitor has decided to build a similar plant. How much information this conveys to even a talented analyst is stochastic ex ante; in some instances, it could tell him all he needs to know, whereas in others it may convey more noisy information. Since an analyst knows whether his signal is precise or noisy, he can update his beliefs about *his* own quality upon observing his signal as:

$$\begin{aligned} \Pr(\text{T} \mid \text{precise signal}) &= 1 > \beta \\ \Pr(\text{T} \mid \text{noisy signal}) &= \frac{(1 - \alpha P_T)\beta}{1 - \beta\alpha P_T} \equiv \beta_0 < \beta. \end{aligned} \tag{3}$$

The noisy signal the analyst observes is a parameter $\eta \in (0, 1)$ and it is emitted by the project under review. That is, η can be drawn from probability density functions for either the good

project *or* the bad project, with these densities given by:

$$\begin{aligned} f\left(\eta|\text{ good project}\right) &= 2\eta \\ f\left(\eta|\text{ bad project}\right) &= 2(1-\eta), \end{aligned} \tag{4}$$

respectively. These densities have the property that the probabilities of higher values of η are higher for the good project than for the bad project.

Given an observation of η, the analyst revises his estimate that the project is good as

$$\Pr(G\,|\,\eta) = \frac{f(\eta|G)\Pr(G)}{f(\eta|G)\Pr(G) + f(\eta|B)\Pr(B)}.$$

Using (4) and (1), this posterior belief simplifies to

$$\Pr(G|\eta) = \frac{\eta\theta}{\eta\theta + (1-\eta)(1-\theta)}. \tag{5}$$

Note that (5) is increasing in η. Thus, for η sufficiently high (as we show later), the analyst will recommend project acceptance. Once the analyst has investigated the project delegated to him and updated his prior belief, he submits a recommendation of accept (A) or reject (R) to the VP.

2.3 Information Available to the VP

The VP initially knows only the observable quality, θ, of the project. Subsequently, she delegates the project evaluation and receives an accept/reject recommendation from the analyst. Based on this recommendation, the VP makes her investment decision at $t = 1$. Following the investment decision, the VP observes the signal Φ.

With this structure it is easy to see that more skilled analysts can improve their reputations more easily. Since only talented analysts can (with probability P_T) receive perfect signals, the probability of receiving a perfect signal is increasing in the probability that the analyst is talented. Thus, the higher the probability that the analyst is talented, the more likely it is that the project information Φ revealed at $t = 1$ (and therefore observed by the VP) will support the analyst's recommendation.[5]

2.4 Wages

Analysts are assumed to have utility functions that are strictly increasing in the VP's perception that they are talented. Thus, this could be interpreted as the analysts being paid reputation-

[5] We assume that Φ is revealed even if the project is not undertaken (owing to the analyst recommending rejection). This assumption is made only to preserve symmetry in the analysis. If Φ was revealed only for the projects that were actually undertaken, all of the results in the paper remain qualitatively unchanged (see *Theorem 2* and footnote 9).

contingent wages at dates $t = 1$ and $t = 2$. Without loss of generality, we assume that an analyst's wage at any date $t \in \{1, 2\}$ is

$$W_t = \Pr(T|\{\Omega_t\}), \tag{6}$$

where $\{\Omega_t\}$ represents the VP's information set at date t. Thus, the analyst's equilibrium behavior will be given by the strategy that maximizes the likelihood that the VP believes he is talented.

2.5 Definition of Equilibrium

In the following analysis, we focus on the Bayesian perfect Nash equilibrium for which:

1. The VP delegates project ideas to the analyst for investigation if her prior assessment of quality $\theta \in \Theta_D$, where Θ_D is the set of θ's for which the marginal value of the analyst investigating the project exceeds the delegation cost C, given the analyst's equilibrium behavior.

2. The analyst will make an investigation of the project and privately observes a signal. If the signal is precise, the analyst knows for sure that he is talented and provides a recommendation commensurate with the signal. if the signal is noisy, the analyst observes η. If $\eta \geq \overline{\overline{\eta}}$, he recommends acceptance, and if $\eta < \overline{\overline{\eta}}$, he recommends rejection, where $\overline{\overline{\eta}}$ is the analyst's privately-optimal, project-acceptance cutoff.

3. The VP decides whether or not to undertake the project based on her prior belief and the analyst's recommendation.

4. The VP updates her prior belief that the analyst is talented using the information set $\{\Omega_1\}$ that includes the observed accept/reject decision of the analyst and the realization of Φ. This posterior belief is used to determine wage W_1 according to (6).

5. Following the output realization at $t = 2$ (occurring only for accepted projects), the information set becomes $\{\Omega_2\}$ and beliefs are again updated, resulting in the wage W_2.

3 Equilibrium analysis

In this section, we first examine the equilibrium strategy of the analyst and then explore the VP's first-best and second-best project delegation regions.

3.1 Equilibrium Strategy of the analyst

As described earlier, the analyst is given a project for review at $t = 1$ and has a prior on project type given by (1), where $\theta \in \Theta_D$. Since the equilibrium strategy of an analyst who observes a precise signal is straightforward, we focus on the case where he observes the noisy signal η, the density of which is given by (5). After observing this signal, the analyst comes up with a posterior belief about the value of the project, and must make a decision of whether to recommend "acceptance" or "rejection" to the VP. He will make the decision such that his expected wages for $t = 1$ and $t = 2$ are maximized.

Given η and the wage structure in (6), the sum of the analyst's expected wages for $t = 1$ and $t = 2$ from rejecting (R) the project is:

$$E_\eta[W_1|R] + E_\eta[W_2|R] \tag{7}$$

where $E_\eta[\cdot]$ is the expectations operator taken at $t = 0$, conditional on the observed η. The following result will be helpful in simplifying (7).

Lemma 1

The analyst's recommendation to reject a project implies that nothing can be learned about his type from output.

The intuition behind this result is straightforward. If the VP does not invest in the project, obviously nothing more can be learned from output. Given *Lemma 1*, we can rewrite (7) as

$$2\, E_\eta[W_1|R]. \tag{8}$$

In the case of project acceptance, we can write the analyst's total expected wages from accepting (A) the project as

$$E_\eta[W_1 \mid A] + E_\eta[W_2|A, \widetilde{x}], \tag{9}$$

where $\widetilde{x}$ is the project payoff at $t = 2$. Since we are focusing on the equilibrium strategies of analysts that have *not* received a precise signal, the following lemma helps simplify matters.

Lemma 2

Conditional on receiving a noisy signal, the expected reputation of the analyst is independent of the expected payoff on the project. Therefore, expected project payoff realizations have no impact on analysts' project-recommendation strategies as of $t = 1$.

Observe that payoff realizations only have reputational consequences for the analyst if the VP does not discover the project's type via Φ at $t = 1$. That is, project payoffs at $t = 2$ are only informative if the interim signal Φ is uninformative ($\Phi = \emptyset$). Obviously in the case where $\Phi \in \{\Phi_G, \Phi_B\}$, the VP doesn't learn any more about project quality by observing output. Moreover, in the case of the uninformative signal, talented analysts *cannot* receive precise signals. Talented and untalented analysts are therefore equally skilled in selecting projects, making the *expected* project payoff as of $t = 1$ inconsequential.

Given *Lemma 2*, we can rewrite (9), conditioned on the analyst having a noisy signal, as

$$2\, E_\eta[W_1|A]. \tag{10}$$

This allows us to concentrate on (8) and (10) when we consider the determination of an analyst's wages (given by (6)), and ultimately his equilibrium strategy.[6] In equilibrium, the analyst will choose whether to recommend project acceptance or rejection for a given noisy signal η by comparing

$$2\, E_\eta[\Pr(T|R)] \tag{11}$$

to

$$2\, E_\eta[\Pr(T|A)]. \tag{12}$$

We now solve for $E_\eta[\Pr(T|R)]$ and $E_\eta[\Pr(T|A)]$ as follows. Conditional on receiving a *noisy* signal, we can write the analyst's expectation that he will be perceived as talented if he recommends rejection of the project as

$$\begin{aligned} E_\eta[\Pr(T|R)] \;=\; & \Pr(G|\eta) \times \left[\begin{array}{c} \Pr(\Phi = \Phi_G|\eta, G) \times \Pr(T|R, \Phi = \Phi_G) \\ +\Pr(\Phi = \emptyset|\eta, G) \times \Pr(T|R, \Phi = \emptyset) \end{array} \right] \\ & + \Pr(B|\eta) \times \left[\begin{array}{c} \Pr(\Phi = \Phi_B|\eta, B) \times \Pr(T|R, \Phi = \Phi_B) \\ +\Pr(\Phi = \emptyset|\eta, B) \times \Pr(T|R, \Phi = \emptyset) \end{array} \right]. \end{aligned} \tag{13}$$

In words, the analyst first updates his probability assessment that the project is good (G), given his observation of the noisy signal η, as $\Pr(G|\eta)$ (see (5)). Then, conditional on the project being either good or bad, the analyst assesses the likelihood that the VP will see at $t = 1$ a given Φ for that *type* of project. For example, conditional on the project being good (first set of square brackets), the analyst assesses whether it is more likely that the VP will see $\Phi = \Phi_G$ or $\Phi = \emptyset$, given that

[6] Observe that both wages are determined following the realization of Φ. This formulation allows us to collapse the dynamic inference problem effectively into a single wage. Alternatively, we could have allowed the first wage to be determined just prior to the realization of Φ and the second wage following it. This alternative specification would not qualitatively affect our results.

he himself saw a noisy signal.[7] Lastly, for each of these possible realization of Φ, he attaches the appropriate reputational assessment assigned by the VP. An analogous argument applies to the case where the project may be bad (second set of square brackets), conditional on the noisy signal (i.e., $\Pr(B|\eta)$).

Similarly, the analyst's expectation that he will be perceived as talented if recommends project acceptance is given by

$$\begin{aligned} E_\eta[\Pr(T|A)] = \quad & \Pr(G|\eta) \times \left[\begin{array}{c} \Pr(\Phi = \Phi_G|\eta, G) \times \Pr(T|A, \Phi = \Phi_G) \\ + \Pr(\Phi = \emptyset|\eta, G) \times \Pr(T|A, \Phi = \emptyset) \end{array} \right] \\ & + \Pr(B|\eta) \times \left[\begin{array}{c} \Pr(\Phi = \Phi_B|\eta, B) \times \Pr(T|A, \Phi = \Phi_B) \\ + \Pr(\Phi = \emptyset|\eta, B) \times \Pr(T|A, \Phi = \emptyset) \end{array} \right]. \end{aligned} \tag{14}$$

Equations (13) and (14) allow us to fully characterize the equilibrium, and we now present the remainder of our results.

Lemma 3

Given the VP's delegation policy and the decision rule to only invest in those projects for which the manager recommends acceptance, unconditionally recommending acceptance of all projects is not an equilibrium strategy for the analyst. Moreover, unconditionally recommending rejection of all projects is not an equilibrium strategy either.

The intuition is as follows. Always accepting a project cannot be an equilibrium strategy for the analyst because he risks accepting a project for which the VP will observe $\Phi = \Phi_B$. This has negative reputational consequences for the analyst. Upon observing $\Phi = \Phi_B$, the VP would know for sure that the project was bad and that the analyst is more likely to be untalented. Similarly, an analyst who rejects unconditionally risks rejecting a project for which the VP will observe $\Phi = \Phi_G$; doing this has negative reputational consequences as well.

Given *Lemmas 1, 2,* and *3*, we can characterize the analyst's privately-optimal, project-acceptance decision rule. Observe that the analyst recommends acceptance if, for a given η,

$$\Psi \equiv \left\{ E_\eta[\Pr(T \mid A)] - E_\eta[\Pr(T \mid R)] \right\} > 0, \tag{15}$$

and optimally recommends rejection otherwise. In equilibrium, the analyst will choose a cutoff for his private signal of η, denoted by $\overline{\overline{\eta}}$, such that he is indifferent between accepting and rejecting

[7] Note that if the project is truly good, $\Phi \neq \{B\}$.

the project. That is, $\overline{\overline{\eta}}$ is the solution to

$$\Psi|_{\{\eta=\overline{\overline{\eta}}\}} = 0. \tag{16}$$

Theorem 1

There exists a unique interior solution $\overline{\overline{\eta}}$ to (16), such that the analyst recommends rejection of the project upon observing a signal $\eta < \overline{\overline{\eta}}$, and recommends acceptance upon observing a signal $\eta \geq \overline{\overline{\eta}}$.

In equilibrium, $\overline{\overline{\eta}}$ depends on the analyst's *perception of the VP's prior assessment of project quality*, given by θ. That is, the gaming behavior here takes the form of the analyst attempting to "please the VP" by accepting projects that he believes the VP "likes". This is a kind of signal jamming by the analyst and its severity ultimately depends on the analyst's perception of how much the VP likes the project (θ). This is formalized in the following corollary.

Corollary to Theorem 1

The analyst's privately-optimal choice of $\overline{\overline{\eta}}$ is decreasing in how much the VP likes the project (measured by θ). However, $\overline{\overline{\eta}}$ is independent of the distribution of the project's interim signal of quality, Φ, as captured by α.

The first part of the corollary is straightforward. The higher is the VP's *a priori* quality assessment of the project, the better is the project likely to be, inducing the analyst to accept it more often. The precision of the VP's information at $t = 1$, as measured by α, does not affect the equilibrium choice of $\overline{\overline{\eta}}$ for the following reason. The analyst's privately optimal cutoff, $\overline{\overline{\eta}}$, is only relevant *conditional* on $\Phi \in \{\Phi_G, \Phi_B\}$. Therefore, the probabilities of $\Phi = \Phi_G$ or $\Phi = \Phi_B$, both given by α, are not relevant in determining $\overline{\overline{\eta}}$.

We now establish that the analyst's privately-optimal choice of $\overline{\overline{\eta}}$ can be higher *or* lower than the first-best η-cutoff.

Theorem 2

Let η_{FB} be the first-best cutoff for the value of the analyst's signal, such that the project is accepted if $\eta \geq \eta_{FB}$ and rejected if $\eta < \eta_{FB}$.[8] *We can now establish:*

1. *If $\eta_{FB} > \frac{1}{2}$ and $\theta > 1 - \eta_{FB}$, then $\overline{\overline{\eta}} < \eta_{FB}$.*
2. *If $\eta_{FB} < \frac{1}{2}$ and $\theta < 1 - \eta_{FB}$, then $\overline{\overline{\eta}} > \eta_{FB}$.*

Theorem 2 shows that an analyst accepts projects too often, relative to first best, when he believes the VP has a sufficiently high prior assessment of project quality. Similarly, the analyst accepts projects too infrequently, relative to first best, when he believes the VP has a relatively low prior assessment of project quality.[9] This theorem captures the intuition that since an analyst cares about his reputation, he will base his accept/reject decision partly on the probability that his recommendation "matches" the information of the VP. Thus, in the case of a VP delegating a high-θ project, the analyst is reluctant to recommend rejection, and in the case of a VP delegating a low-θ project, he is reluctant to recommend acceptance.

3.2 Further Analysis: Optimal Delegation Policy

The analysis thus far has focused on the behavior of analysts being delegated the evaluation of projects for which $\theta \in \Theta_D$. The (second-best) optimality of such a delegation region was taken as a given. We now consider more formally how Θ_D is derived in the presence of both delegation costs (C) and the analyst's gaming behavior. We begin by characterizing the optimal delegation policy of the VP in a first-best setting in which analysts do not distort their reports. We then examine how the analyst's gaming behavior in equilibrium affects the optimal delegation policy. To illustrate the change in the delegation set when we move from first-best to second-best, we include a numerical analysis.

First-Best Project Delegation

In a first-best setting, we need only consider the effect of the delegation cost (C) on the project delegation set. As discussed in Section 2.1, a positive C means that the VP will not delegate a

[8] Note that η_{FB} implies that $[\Pr(G|\eta_{FB}) \times NPV_G] + [(1 - \Pr(G|\eta_{FB})) \times NPV_B] = 0$. The precise numerical value of η_{FB} is inconsequential because a change in it only implies a re-scaling of NPV_G and NPV_B.

[9] If we alternatively assumed that the VP could only observe Φ for projects which were ultimately accepted, we still obtain the same result qualitatively. Under this assumption, the theorem would then be recast as: (1) if $\eta_{FB} > \frac{1}{\sqrt{2[1-\beta P_T]}}$ and $\theta > 1 - \eta_{FB}$, then $\overline{\overline{\eta}} < \eta_{FB}$; and (2) if $\eta_{FB} < \frac{1}{\sqrt{2[1-\beta P_T]}}$ and $\theta < 1 - \eta_{FB}$, then $\overline{\overline{\eta}} > \eta_{FB}$. Again, an analyst accepts too many projects if he believes the VP's prior assessment of project quality is sufficiently high, and rejects too often if the VP's prior belief is low.

project with a sufficiently low or sufficiently high prior belief θ because the expected incremental value of the analyst's information is exceeded by the delegation cost. This implies that there are three potential regions of prior beliefs to define. These regions are $\theta \in [0, \widehat{\theta}_L]$, where projects are rejected without being delegated; $\theta \in (\widehat{\theta}_L, \widehat{\theta}_H)$, where delegation always occurs and the investment decision depends on the results of the investigation; and $\theta \in [\widehat{\theta}_H, 1]$, where investment is always made immediately without any delegation. The first-best delegation boundaries, $\widehat{\theta}_L$ and $\widehat{\theta}_H$, are then given by the θ values that set the marginal value of the analyst's *unbiased* investigation equal to the delegation cost. We define the first-best delegation region as $\widehat{\Theta}_D \equiv (\widehat{\theta}_L, \widehat{\theta}_H)$.

The lower boundary, $\widehat{\theta}_L$, is calculated as the θ that sets the NPV of delegation equal to zero. Observe that the VP would only invest in a project after investigation at date $t = 1$ if the observed project signal $\eta > \eta_{FB}$. Thus, at of date $t = 0$, the NPV of delegating a project is given by:

$$NPV(delegation) = E[\Pr(G|\eta > \eta_{FB})]NPV_G + (1 - E[\Pr(G|\eta > \eta_{FB})])NPV_B - C, \tag{17}$$

where $E[\Pr(G|\eta > \eta_{FB})]$ can be interpreted as the average quality (likelihood of being good) of a project that is optimally financed after observing $\eta > \eta_{FB}$. Importantly, the expectations operator incorporates the likelihood that the observed signal η will exceed η_{FB}.

The NPV of not delegating a project and investing in it outright is simply $NPV(no\ delegation) = \theta NPV_G + (1 - \theta)NPV_B$. Therefore, the upper boundary of the first-best delegation region, $\widehat{\theta}_H$, is the θ at which the NPV of delegation equals the NPV of no delegation, that is

$$NPV(no\ delegation) = NPV(delegation). \tag{18}$$

Intuitively, if θ is sufficiently high, the cost of delegation C outweighs the incremental value of the additional information. The solutions to (17) and (18) of $\widehat{\theta}_L$ and $\widehat{\theta}_H$ then constitute the optimal project delegation region in the first-best case ($\widehat{\Theta}_D$).

Second-Best Project Delegation

We can now examine how the gaming behavior of the analyst affects the "delegation" and "no delegation" regions. While this gaming behavior adds noise to the report that the analyst submits to the VP, distortions will only occur if the noise that is added is not unbiased (i.e., white) noise. The reason is that the analyst recommends acceptance for all observations of the signal η above his own *privately-optimal* cutoff, $\overline{\overline{\eta}}$, given by the solution to (16), as opposed to those observations above η_{FB}. In equilibrium, the VP is aware of this and revises her estimate of the value of delegation in (17) now using $\overline{\overline{\eta}}$ in place of η_{FB}. Consequently, at the first-best boundaries of $\widehat{\theta}_L$

and $\widehat{\theta}_H$, delegation, which were previously breakeven decisions, now have a strictly negative NPV of delegation. The boundaries of the second-best delegation region are those that equate the marginal value of the analyst's (biased) investigation to the cost of delegation as θ_L and θ_H. Therefore, the set of projects investigated in equilibrium is given by $\Theta_D \equiv (\theta_L, \theta_H)$. We offer below a numerical example of how the second-best Θ_D differs from the first-best $\widehat{\Theta}_D$ and show that the second-best delegation region is nonempty in each of the cases we examine.

Table 2: Optimal Project Delegation

					First-Best		At $\theta = \widehat{\theta}_L$		At $\theta = \widehat{\theta}_H$	
Case	NPV_G	NPV_B	C	β	$\widehat{\theta}_L$	$\widehat{\theta}_H$	η_{FB}	$\overline{\overline{\eta}}$	η_{FB}	$\overline{\overline{\eta}}$
I	2	-2	$\frac{1}{4}$	$\frac{2}{5}$	0.3106	0.6894	0.6894	0.6344	0.3106	0.3656
II	2	-2	$\frac{1}{3}$	$\frac{2}{5}$	0.3683	0.6317	0.6317	0.5921	0.3683	0.4079
III	2	-2	$\frac{1}{3}$	$\frac{4}{5}$	0.3284	0.6716	0.6716	0.6382	0.3284	0.3618
IV	2	-3	$\frac{1}{4}$	$\frac{2}{5}$	0.3471	0.7843	0.7383	0.6074	0.2920	0.2903
V	2	-3	$\frac{1}{4}$	$\frac{4}{5}$	0.2936	0.8157	0.7830	0.6677	0.2531	0.2329

Note: We assume that $\alpha = \frac{1}{2}$ and $P_T = \frac{2}{3}$ for all cases.

In comparing Case I to Case II, we see immediately that the first-best delegation region is decreasing in the delegation cost C, which is intuitive. Moreover, Cases II and III highlight that the first-best delegation region is increasing in the prior probability that the analyst is talented (β). Comparing Cases I and IV, we see that as the disparity in value between the good and bad project increases, the first-best delegation region shifts to the right.

As we move to the second-best case where managers privately choose their own acceptance cutoff, the optimal delegation region *shrinks* in all cases. The reason is that the analyst's privately-optimal cutoff ($\overline{\overline{\eta}}$) is strictly different than the first-best cutoff (η_{FB}) in every case. Thus, the VP must estimate the NPV of delegating a project conditional on the analyst's privately-optimal cutoff and not the first-best cutoff. Across all the cases, if the VP were to delegate a project with a prior probability of being good at the lower boundary ($\theta = \widehat{\theta}_L$) of the first-best delegation region, the NPV of delegation is strictly negative in the second-best case whereas it was zero (by definition) in the first-best case. Thus, the VP is no longer indifferent to delegating such projects and instead shifts the lower boundary of the second-best delegation region to the right, delegating fewer projects in equilibrium.

Consider now the delegation of a project with a prior probability of being good at the upper boundary ($\theta = \widehat{\theta}_H$) of the first-best region. Here, the NPV of delegation is strictly less than the NPV of investing in the project without delegation, whereas in the first-best case these NPVs were equal. Again, the VP is no longer indifferent between directly investing without delegation and delegating such projects. Rather, the VP shifts the upper boundary of the second-best delegation region to the left of the first-best upper boundary.

Importantly, the second-best project delegation region is of nonzero measure in all five cases above. However, the second-best delegation region is always strictly contained within the first-best delegation region. Therefore, attempts to cope with an analyst's tendency to practice sunflower management with changes in project delegation policy manifests itself in a greater number of projects being rejected without delegation (those projects for which $\theta \in (\widehat{\theta}_L, \theta_L)$) and a greater number of projects being accepted without delegation (those projects for which $\theta \in (\theta_H, \widehat{\theta}_H)$).

4 Capital Budgeting Implications of Sunflower Management

In practice, a VP must *prescreen* multiple projects to determine how many of them to delegate to the analyst. This determination must take into account the fact that organizational resources – especially the time people have available to evaluate projects – are constrained. This will cause the VP to favor projects with high θ's because the ex ante expected value of such projects is higher. Alternatively, a VP may be overly optimistic about project ideas she has generated herself, again raising her prior beliefs about project quality. We know from our analysis that when the analyst is faced with relatively high-θ projects, he tends to "overaccept" projects, resulting in overinvestment.

The question then is: how can the firm design the capital budgeting system to lessen the overinvestment distortion? In addition to setting higher project-acceptance hurdle rates, we consider two capital budgeting practices that can possibly help in this regard – centralization of capital budgeting and the use of the payback criterion. We end with a brief discussion of how sunflower management could create a reluctance to deliver bad news in organizations and how this could affect the values of projects.

4.1 Centralized versus Decentralized Capital Budgeting

In our model, when the VP delegates a project to the analyst, she always accepts his recommendation. An equivalent scheme would be one in which the VP simply delegates the project-selection decision to the analyst. This can be viewed as a decentralized capital budgeting system. For

projects that lie outside the delegation region, the VP decides on her own whether to invest. We can view this as centralized capital budgeting. Our analysis thus implies that the key factors that will affect whether one uses centralized or decentralized capital budgeting are: the VP's prior beliefs about project quality, the analyst's concern with his future reputation (which may depend on his expected job duration), and the prior belief about the analyst's talent in evaluating projects.

Centralized capital budgeting will be used for projects about which the VP has strong prior beliefs, i.e., projects that are *a priori* viewed as being of very high or low quality. It will also be used when analysts have relatively short job durations and hence a low concern with future reputation in this firm.[10] Finally, centralized capital budgeting will be used for projects that are difficult for the analyst to evaluate (such as new ventures) because the analyst's β (prior belief he is talented) will be low for such projects.

Decentralized capital budgeting will be used when the VP is relatively unsure of project quality, but believes that the analyst is sufficiently talented in assessing project quality and the analyst has a relatively long expected duration on the job. Thus, whenever a firm faces a variety of project opportunities, we should expect "mixed" capital budgeting systems, with centralized capital budgeting being used for some kinds of projects and decentralized capital budgeting for others.

4.2 The Payback Criterion

We showed earlier that reliance on output-based compensation may produce a force that can partially counter, but not overcome, sunflower management. In practice, the usefulness of this approach may be further limited because project cash flows typically occur over many time periods. In fact, the analyst may leave before all of a project's cash flows are realized, moving either to another position within the same organization or to take a job with another company. For example, in U.S. corporations, the average length of time an employee stays in a job appears to be somewhere between $1\frac{1}{2}$to 3 years. How could this affect the efficiency of wage-based solutions?

To examine this problem, consider an extension of the basic model in which there are two cash flows, one occurring early and one occurring late. Upon being delegated a project, the analyst is now asked to not only report the value of the project, but also the early and late cash flows leading to this value. We can then think of two distinct components of the analyst's utility being associated with the two cash flows.

Imagine now that there is a nonzero probability that the analyst will take a job with another

[10] This is not to say that the analyst is not career conscious. It simply reflects the fact that it is unlikely she will be in *this* firm and have the project payoff affect her reputation.

company after the early cash flow is realized but before the late cash flow is realized. Moreover, assume that the analyst still has some career concerns and would tend to misreport for some projects. It is then straightforward to show that the analyst perceives a lower personal cost associated with misrepresenting later cash flows than with misrepresenting the early cash flows. Because the selection of the project is still based on its *total* value, the analyst is better off inflating his report of the later cash flow to make the project look good when he thinks the VP's prior about the project is sufficiently favorable. The length of the "acceptable" payback period will be positively related to the average duration that the analysts in the firm stay on the job. The related empirical implication is that payback use is predicted to be greater in firms/industries with more rapid job rotation for employees.

This argument implies that using payback as a project selection criterion in addition to NPV makes sense *for the shareholders* in many instances. This is in sharp contrast to the standard textbook advice against payback. For example Ross, Westerfield and Jordan (1993) state (p. 226):

> "Put another way, there is no economic rationale for looking at payback in the first place, so we have no guide as to how to pick the cutoff. As a result, we end up using a number that is arbitrarily chosen."

Our analysis shows that the use of the payback criterion might be valuable in lessening the severity of misreporting incentives, thereby permitting the project delegation region to be expanded. Attempting to cope with sunflower management could thus make the firm look "myopic" by creating a (rational) aversion on the part of the VP to long-payback projects.

4.3 High Project-Acceptance Hurdle Rates

Poterba and Summers (1995) have documented that U.S. corporations set hurdle rates for project acceptance that are above their costs of capital. Our model provides a possible explanation for this practice.[11] The basic idea is that a hurdle rate above the cost of capital leads to a harsher project-acceptance criterion, helping to offset overinvestment.

One way to try and get rid of the problem is to punish the analyst whenever the VP has sufficient reason to believe ex post that the analyst invested in a project with a return below η_{FB}. The difficulty, of course, is that the VP can make these ex post inferences based only on the realized cash flows, which are merely noisy indicators of the project profitability signal observed ex ante by the analyst at the time he chose the project. In what follows, we illustrate through a simple

[11] One explanation is provided by Dixit (1992). He shows that when investment is irreversible and sufficient uncertainty exists about future project cash flows, the (real) option to invest at a later date is valuable. Thus, for such a project to be undertaken immediately, its expected return must be sufficiently above the cost of capital.

model that this noise in the VP's inference could negate the ability of a penalty to coax the analyst to make first-best project choices. However, using a penalty *in conjunction* with a hurdle rate set above the cost of capital (η_{FB}) could be potent enough to guarantee that the analyst does not take projects with returns below the cost of capital.

Consider a setting in which the analyst privately observes a signal η of project profitability and the VP and the analyst observe the project's (only) realized cash flow Y. Whenever $Y < \widehat{Y}$, the VP imposes a pecuniary penalty of $K > 0$ on the analyst. We interpret this penalty quite broadly. It could represent the present value of the loss in future wages because the analyst suffers a reputation decline due to a poor project outcome. Or it could be a proxy for the value of the perquisites the analyst may lose in the future because poor performance on this project results in more restricted access to capital for future projects.[12] Thus, we can write the analyst's expected penalty as:

$$E(\text{penalty}|\eta) = K \times \Pr(Y < \widehat{Y}|\eta). \tag{19}$$

We assume that the analyst's signal is an unbiased estimate of Y. For a given signal η, output is distributed over $(\underline{Y}(\eta), \overline{Y}(\eta))$. That is,

$$\eta = \int_{\underline{Y}(\eta)}^{\overline{Y}(\eta)} Y g(Y|\eta) dY \equiv E(Y|\eta).$$

The support $(\underline{Y}(\eta), \overline{Y}(\eta))$ moves with η, but $Q \equiv \overline{Y}(\eta) - \underline{Y}(\eta) > 0$ is independent of η. We can think of an increase in the risk of the project cash flow as an increase in Q, i.e., a mean-preserving increase in the spread of the distribution of Y.

For simplicity, assume $g(Y|\eta) = 2[Y - \underline{Y}]/Q^2$, and that K is bounded from above. It is natural to restrict K to be finite if for no other reason than the fact that the analyst's personal wealth – and hence his capacity to absorb K – is limited.

Now, in the absence of K, assume that the benefit to the analyst from deviating from η_{FB} is:

$$h(\varepsilon) \times C \tag{20}$$

where ε is the deviation from the first-best cutoff η_{FB} (i.e., η_{FB} minus the cutoff $\overline{\overline{\eta}}$ chosen by the analyst), $h(\varepsilon)$ is (according to our earlier analysis) an increasing and concave function of ε over the relevant range, $(0, \eta_{FB} - \overline{\overline{\eta}})$, and $C > 0$.

Now, returning to (19), we define $\widehat{Y}$ as *the maximum* Y for which

$$K \Pr(Y < \widehat{Y}|\overline{\overline{\eta}} \geq \eta_{FB}) = 0. \tag{21}$$

[12] The idea here is that operating a larger base of assets leads to higher perquisites (and possibly higher compensation as well) for managers.

That is, $\widehat{Y}$ is such that the probability of "falsely" penalizing the analyst is zero. This should be interpreted as the VP setting η_{FB} as the hurdle rate and then setting $\widehat{Y}$ to ensure that it is never possible for the analyst to be punished when he selects a project with a return at least as great as that hurdle rate. We can now prove the following result.

Theorem 3

For any finite K and a stated hurdle rate η_{FB} set by the VP, the analyst's privately-optimal hurdle rate in project selection ($\overline{\overline{\eta}}$) is always less than η_{FB}, so that there is overinvestment.[13] *However, given a K, there does exist a hurdle rate $\eta^* > \eta_{FB}$ that the VP could set such that the analyst optimally chooses $\overline{\overline{\eta}} = \eta_{FB}$.*

This theorem says that, with a bounded penalty, it is impossible to set the hurdle rate at η_{FB} and expect the analyst to turn down all projects with $\eta < \eta_{FB}$. The *expected* future penalty is never enough to overcome the sunflower-management-induced benefit to the analyst of accepting the project. The intuition is that when ε is very small, the analyst's private benefit from accepting the project (with return below η_{FB}) is substantial at the margin (note ($h(\varepsilon)$ is concave) relative to the expected penalty. In particular, as $\varepsilon > 0$ tends to zero, the expected penalty *asymptotically* approaches zero, but not the benefit. One way to eliminate this problem is to set $K = \infty$, which is ruled out. The only resolution is to set $\eta^* > \eta_{FB}$ and $\widehat{Y}$ according to $K \Pr(Y < \widehat{Y} | \overline{\overline{\eta}} \geq \eta^*) = 0$ (see (21)), such that the analyst chooses $\overline{\overline{\eta}} = \eta_{FB}$. This rationalizes the corporate practice of setting the hurdle rate for project acceptance above the cost of capital. How this practice varies with the underlying variability of project payoffs is delineated below.

Corollary to Theorem 3

Holding K fixed, as the risk in the project cash flow increases (higher Q), the difference, $\eta^* - \eta_{FB}$, increases.

The intuition for why the distance between the corporate hurdle rate (η^*) and the cost of capital (η_{FB}) goes up with an increase in the riskiness of the project cash flow distribution is as follows. As this riskiness rises, the expected penalty, for a fixed K, declines, which diminishes its effectiveness. It thus becomes more difficult to incent the analyst to decline projects with $\eta < \eta_{FB}$. This requires raising η^* to restore the appropriate project choice incentives (or, if feasible, K could be increased).

[13] As stated before, we focus on the case where $\eta_{FB} > 1/2$ and $\theta > 1 - \eta_{FB}$ (see Theorem 2).

An important aspect of our explanation is that there is noise in the VP's assessment of the analyst's private signal about the project. But this is very different from the popular "errors in project-value estimation" story that we dismissed earlier. In that story, there is *no bias* in the analyst's project selection, so that raising the corporate hurdle rate above the cost of capital can be even more damaging than setting the hurdle rate below the cost of capital. In our theory, the analyst exhibits an overinvestment bias due to sunflower management. That is what makes it optimal to set the hurdle rate above the cost of capital.[14]

What explains the *co-existence* of payback and hurdle rates as capital budgeting tools? It is true that both are, to some extent, substitutes. At first blush, using hurdle rates seems to dominate payback. Hurdle rates can accomplish the desired discrimination against late, less-credible cash flows in a much more fine-tuned manner than that possible with payback. Payback seems to be a rather blunt instrument. So, why use payback?

One reason is that setting high hurdle rates not only punishes late cash flows, it also punishes early cash flows. Payback doesn't do this. Payback's (blunt) punishment occurs only for cash flows *outside* the payback period. So when the early periods are important, as when the analyst has a short expected tenure on the job, payback is superior in that it does not punish cash flows in the early periods during the analyst's tenure.

Other dimensions may be important as well. In research-intensive industries, for example, project payoffs are observed only in the long run. In that case, hurdle rates are clearly superior to payback. So in our view, whether a firm uses payback or high hurdle rates to cope with the overinvestment due to sunflower management depends on the relative importance of early cash flows. If these play a dominant role, payback may be superior; otherwise, high hurdle rates dominate. Since the importance of early cash flows can vary by project within a firm, payback and high hurdle rates may both be part of the firm's capital budgeting system.

[14] A question that needs to be answered is why one would not opt for a positive threshold ratio of NPV-to-investment that projects must clear for acceptance rather than the high hurdle rate. So the puzzle is why firms prefer high hurdle rates to such NPV thresholds. Our analysis suggests that one reason for this is that an NPV ratio threshold does *not* discriminate against projects with high cash flows late relative to high cash flows early, whereas a high hurdle rate does. Since the analyst's career concerns create a stronger propensity to misstate later cash flows, a high hurdle rate is more effective in improving the delegation region than an NPV ratio threshold. This makes it similar to using payback.

4.4 The Reluctance to be the Bearer of Ill Tidings

A common lament in organizations is that employees don't deliver bad news in a timely manner.[15] It has been claimed that this is because of a flawed management style that "kills the bearer of ill tidings". Our model suggests that this may have less to do with "... the tyranny of the prevailing style of management" described by Deming (1990), and more to do with how people are judged in normal human interaction.

To see this, consider a three-date world, with $t \in \{0, 1, 2\}$. Suppose that θ is the VP's probabilistic assessment at $t = 0$ of the business environment; the higher the θ the greater is the probability that the business environment is good. The interim state of the business – that is observed at $t = 1$ – depends on the business environment as well as the analyst's ability. The analyst monitors the business on an ongoing basis. This allows him to observe the state of the business at $t = 1$, and he is supposed to report to the VP when the business is not doing well, so that corrective action can be taken by the VP at $t = 1$.[16] Assume that corrective action is impossible without the VP's intervention. Moreover, the actual outcome is realized at $t = 2$ and it is stochastic, conditional on the interim information observed at $t = 1$. That is, the analyst's observation of the state of the business at $t = 1$ provides him with only a noisy signal of the outcome at $t = 2$.

When the analyst observes an unfavorable state at $t = 1$, he has two choices. One is to report it to the VP so that corrective action can be taken at $t = 1$. This will lead to a reduction in losses at $t = 2$ if the outcome then is unfavorable as suggested by the interim signal. However, if the VP had observed a favorable θ at $t = 0$, then she will revise downward her assessment of the analyst's ability. The other choice for the analyst is to report *no* bad news at $t = 1$ and thus avoid the downward revision in the assessment of his ability. The cost of doing this is that the losses at $t = 2$ will be greater if the outcome is unfavorable. But there is, of course, some probability of a favorable outcome, just by luck. There will be circumstances in which the analyst will choose the second option, thereby producing a report that agrees with the VP's initial assessment of the business. Recognizing this, the VP will attach lesser importance to the analyst's interim business reports; this is the analog of a shrinking of the delegation region in our model.

If we interpret the business as a project that the analyst recommended and whose performances he must now monitor, then we see that sunflower management will lead to inefficiencies in the

[15] Indeed, the problem transcends intrafirm behavior. Boot and Thakor (1993) develop a model that explains why reputation-conscious bank regulators may delay closing troubled banks in the hope that these banks will resurrect themselves and their problems, including the regulator's failure to take action earlier, will go undetected.

[16] This is similar to the VP asking the analyst to evaluate the project in our model.

post-auditing of projects, causing post-investment interventions to be suboptimally delayed. This will reduce the *ex ante* values of projects and lead to a further shrinking of the delegation region in a decentralized capital budgeting system.

5 Conclusion

We have developed a model in which the interaction between project delegation and career concerns produces a phenomenon we call "sunflower management". Simply put, sunflower management is the inclination for employees to act in a manner that produces consensus between their own views and the views they ascribe to their superiors. This diminishes the value of delegation and is value-dissipating because the organization explicitly dedicates resources to generate *multiple* signals about business situations. Thus, when employees disregard the information conveyed by their signals to produce recommendations that agree with the prior beliefs of the people they report to, the damage done to the organization exceeds not just the cost associated with the loss of information aggregation. In particular, bad projects may be chosen, good projects may be discarded and problems ignored until they impose catastrophic losses. We have used this analysis to explain, among other things, the tradeoffs inherent in the choice between centralized and decentralized capital budgeting, why corporations continue to use the payback criterion for project selection, and set project hurdle rates above the cost of capital.

Our analysis also generates empirically-testable predictions, which are summarized below.

- The cutoff period chosen with the payback criterion will be positively related to the expected duration of the analyst in his present job. Thus, payback use is predicted to be greater in firms/industries with more rapid job rotation for employees.

- The difference between project-acceptance hurdle rates and the cost of capital will be increasing in the volatility of project payoffs and decreasing in the expected duration of the analyst in his present job.

6 Appendix

6.1 Proof of Theorem 1

We first characterize the components of $E_\eta[\Pr(T|R)]$ and $E_\eta[\Pr(T|A)]$ of Ψ given by (13) and (14). Using Bayes rule, we can solve for the analyst's perception of what the VP will observe at $t = 1$ as follows:

$$\begin{aligned}
\Pr(\Phi = \Phi_G|\eta, G) &= \frac{\Pr(\eta, G|\Phi = \Phi_G)\Pr(\Phi = \Phi_G)}{\sum_{i\in\{\Phi_G,\emptyset\}} \Pr(\eta, G|\Phi = \{i\})\Pr(\Phi = \{i\})} \\
&= \frac{(1-\beta P_T)\theta\alpha}{(1-\beta P_T)\theta\alpha + \theta(1-\alpha)} \\
&= \frac{(1-\beta P_T)\alpha}{1-\beta P_T\alpha} \\
&\equiv \Phi_{\{G\}}. \qquad (22)
\end{aligned}$$

Similarly, we have

$$\begin{aligned}
\Pr(\Phi = \Phi_B|\eta, B) &= \frac{(1-\beta P_T)\alpha}{1-\beta P_T\alpha} \\
&\equiv \Phi_{\{B\}} = \Phi_{\{G\}}. \qquad (23)
\end{aligned}$$

Given the equivalence of (22) and (23),

$$\Pr(\Phi = \emptyset|\eta, G) = \Pr(\Phi = \emptyset|\eta, B) = 1 - \Phi_{\{G\}}.$$

Now, the reputation assigned to the analyst when he recommends rejection varies, depending on the VP's observed Φ. Solving for each possible Φ yields the following:

$$\begin{aligned}
\Pr(T|R, \Phi = \Phi_G) &= \frac{\beta(1-P_T)}{1-\beta P_T} \equiv \beta_{LOW} < \beta \\
\Pr(T|R, \Phi = \emptyset) &= \beta \\
\Pr(T|R, \Phi = \Phi_B) &= \frac{\beta P_T + \beta(1-P_T)(2\overline{\eta} - \overline{\eta}^2)}{\beta P_T + (1-\beta P_T)(2\overline{\eta} - \overline{\eta}^2)} \equiv \beta_{HI,R} > \beta. \qquad (24)
\end{aligned}$$

Substituting (22), (23) and (24) into (13) yields

$$\begin{aligned}
E_\eta[\Pr(T|R)] &= \Pr(G|\eta)\Big\{\Phi_{\{G\}} \times \beta_{LOW} + (1-\Phi_{\{G\}}) \times \beta\Big\} \\
&\quad + [1-\Pr(G|\eta)]\Big\{\Phi_{\{G\}} \times \beta_{HI,R} + (1-\Phi_{\{G\}}) \times \beta\Big\}. \qquad (25)
\end{aligned}$$

In terms of simplifying (14), equations (22) and (23) obtain here as well and thus all we need are the various reputations assigned when the analyst recommends acceptance. These are

$$\Pr(T|A, \Phi = \Phi_G) = \frac{\beta P_T + \beta(1-P_T)(1-\overline{\eta}^2)}{\beta P_T + (1-\beta P_T)(1-\overline{\eta}^2)} \equiv \beta_{HI,A} > \beta$$

$$\begin{aligned}\Pr(T|A,\Phi=\emptyset) &= \beta \\ \Pr(T|A,\Phi=\Phi_B) &= \beta_{LOW},\end{aligned} \tag{26}$$

where β_{LOW} is given by (24). Collecting terms, we obtain

$$\begin{aligned}E_\eta[\Pr(T|A)] &= \Pr(G|\eta)\Big\{\Phi_{\{G\}}\times\beta_{HI,A}+(1-\Phi_{\{G\}})\times\beta\Big\} \\ &\quad +[1-\Pr(G|\eta)]\Big\{\Phi_{\{G\}}\times\beta_{LOW}+(1-\Phi_{\{G\}})\times\beta\Big\}.\end{aligned} \tag{27}$$

With (25) and (27) in hand, we now prove that there exists an unique interior solution $\overline{\overline{\eta}}$ to the equilibrium condition given by (16). We proceed in two steps. First, we prove that Ψ (given generally by (15)) is continuous and monotonically nondecreasing in a prospective cutoff η_0, $\forall\eta_0\in[0,1]$. Second, we will show that Ψ is negative as $\eta_0\to 0$ and positive as $\eta_0\to 1$.

Using (25) and (27), we can express (15) as

$$\begin{aligned}\Psi &= \Pr(G|\eta)\times\left\{\Phi_{\{G\}}(\beta_{HI,A}-\beta_{LOW})\right\} \\ &\quad +(1-\Pr(G|\eta))\times\left\{\Phi_{\{G\}}(\beta_{LOW}-\beta_{HI,R})\right\}.\end{aligned} \tag{28}$$

Inspection of (28) reveals that only $\Pr(G|\eta),\beta_{HI,A}$ and $\beta_{HI,R}$ are functions of η. Therefore, we can differentiate (28) with respect to η as

$$\begin{aligned}\frac{\partial\Psi}{\partial\eta} &= \Phi_{\{G\}}(\beta_{HI,A}-\beta_{LOW})\times\frac{\partial\Pr(G|\eta)}{\partial\eta} \\ &\quad +\Pr(G|\eta)\cdot\Phi_{\{G\}}\times\frac{\partial\beta_{HI,A}}{\partial\eta} \\ &\quad +\Phi_{\{G\}}(\beta_{LOW}-\beta_{HI,R})\times\left(-\frac{\partial\Pr(G|\eta)}{\partial\eta}\right) \\ &\quad +(1-\Pr(G|\eta))\Phi_{\{G\}}\times\left(-\frac{\partial\beta_{HI,R}}{\partial\eta}\right).\end{aligned} \tag{29}$$

We can establish that Ψ is monotonically nondecreasing in η by showing that (29) is nonnegative $\forall\eta\in[0,1]$. Continuity follows if (29) is finite $\forall\eta$ as well.

Using (22), we know that $\Phi_{\{G\}}>0$. Moreover, from (24) and (26), we know that $(\beta_{LOW}-\beta_{HI,R})<0$ and $(\beta_{HI,A}-\beta_{LOW})>0$. Thus, we simply have to determine the signs of the three partial derivatives in (29). We tackle these in order of appearance.

Using (5), we obtain

$$\frac{\partial\Pr(G|\eta)}{\partial\eta}=\frac{\theta(1-\theta)}{[\eta\theta+(1-\eta)(1-\theta)]^2}>0. \tag{30}$$

From (26), we obtain

$$\frac{\partial\beta_{HI,A}}{\partial\eta}=\frac{2\eta P_T\beta(1-\beta)}{[\beta P_T+(1-\beta P_T)(1-\eta^2)]^2}>0. \tag{31}$$

Lastly, using (24), we obtain

$$\frac{\partial \beta_{HI,R}}{\partial \eta} = \frac{(2-2\eta)P_T\beta(\beta-1)}{[\beta P_T + (1-\beta P_T)(2\eta-\eta^2)]^2} < 0 \tag{32}$$

since $\beta < 1$.

Hence, by substituting (30), (31) and (32) into (29), we see that $\frac{\partial \Psi}{\partial \eta}$ is nondecreasing in η, $\forall \eta \in [0,1]$, and is strictly increasing in η for $\eta > 0$. Moreover, (29) is finite $\forall \eta \in [0,1]$ and therefore, Ψ is a continuous and nondecreasing function of η, $\forall \eta \in [0,1]$.

To establish that there exists an η_0, $\overline{\overline{\eta}}$, such that $\Psi = 0$ for $\eta_0 = \overline{\overline{\eta}}$, we show that the analyst strictly prefers to *reject* the project for low values of η_0 (i.e., negative Ψ) and strictly prefers to *accept* the project for high values of η_0 (i.e., positive Ψ). We show this by taking the limit of Ψ as $\eta_0 \to 0$ and $\eta_0 \to 1$, respectively. This yields

$$\lim_{\eta_0 \to 0} \Psi = 0 + 1 \cdot \Phi_{\{B\}} \cdot (\beta_{LOW} - 1) < 0 \tag{33}$$

and

$$\lim_{\eta_0 \to 1} \Psi = 1 \cdot \Phi_{\{G\}} \cdot (1 - \beta_{LOW}) + 0 > 0. \tag{34}$$

Therefore, by the continuity and monotonicity of Ψ, and using (33) and (34), there exists an η_0, denoted $\overline{\overline{\eta}}$, such that $\Psi(\overline{\overline{\eta}}) = 0$. Moreover, $\Psi < 0$ for $\eta_0 < \overline{\overline{\eta}}$ and $\Psi > 0$ for $\eta_0 > \overline{\overline{\eta}}$. ■

6.2 Proof of Corollary to Theorem 1

To prove that $\overline{\overline{\eta}}$ is decreasing in θ, we show that Ψ (as simplified in (28)) is increasing in θ. This is sufficient to prove the theorem since it implies that increases in θ shifts $\Psi(\eta)$ upwards in $\{\Psi, \eta_0\}$ space. Therefore, the η_0 that sets $\Psi = 0$ in the case of higher θ is less than the $\overline{\overline{\eta}}$ of *Theorem 1*. Thus, we must show that $\frac{\partial \Psi}{\partial \theta} > 0$ for any η_0.

Inspection of (28) reveals that only $\Pr(G|\eta)$ is a function of θ. Therefore, the derivative of Ψ with respect to θ is

$$\begin{aligned} \frac{\partial \Psi}{\partial \theta} &= \Phi_{\{G\}}(\beta_{HI,A} - \beta_{LOW}) \times \frac{\partial \Pr(G|\eta)}{\partial \theta} \\ &\quad + \Phi_{\{G\}}(\beta_{LOW} - \beta_{HI,R}) \times \left(-\frac{\partial \Pr(G|\eta)}{\partial \theta}\right). \end{aligned} \tag{35}$$

We wish to show that (35) is positive.

From (5), we obtain

$$\frac{\partial \Pr(G|\eta)}{\partial \theta} = \frac{\eta(1-\eta)}{[\eta\theta + (1-\eta)(1-\theta)]^2} > 0. \tag{36}$$

Substituting (36) into (35), we see that $\frac{\partial \Psi}{\partial \theta} > 0$. Therefore, by the continuity and monotonicity of Ψ in η_0, established in the proof of *Theorem 1*, higher θ results in a lower privately chosen value of $\overline{\overline{\eta}}$.

To prove that $\overline{\overline{\eta}}$ is independent of α, note that since $\Phi_{\{G\}} = \Phi_{\{B\}}$, $\Phi_{\{G\}}$ drops out of the equilibrium condition of $\Psi = 0$ (see (28)). Note that the remaining terms in (28) do not involve α. Therefore, the equilibrium value $\overline{\overline{\eta}}$ solving $\Psi = 0$ does not depend on α. ■

6.3 Proof of Theorem 2

As above, noting that $\Phi_{\{G\}} = \Phi_{\{B\}}$, we can evaluate Ψ (see (28)) at $\eta_0 = \eta_{FB}$ as

$$\begin{aligned} \Psi|_{\eta_0=\eta_{FB}} \quad = \quad & \Phi_{\{G\}} \times \big\{ \Pr(G|\eta_{FB}) \times [\beta_{HI,A} - \beta_{LOW}] \\ & +[1 - \Pr(G|\eta)] \times [\beta_{LOW} - \beta_{HI,R}] \ \big\}. \end{aligned} \tag{37}$$

Now whether the analyst's equilibrium cutoff $\overline{\overline{\eta}} \lesseqgtr \eta_{FB}$ depends on whether $\Psi|_{\eta_0=\eta_{FB}} \gtreqless 0$. Moreover, from the proof of *Theorem 1*, we know that Ψ is continuous and monotonically nondecreasing in η. Thus, if $\Psi|_{\eta_0=\eta_{FB}} < 0$, then $\overline{\overline{\eta}} > \eta_{FB}$. And if $\Psi|_{\eta_0=\eta_{FB}} > 0$, then $\overline{\overline{\eta}} < \eta_{FB}$. Therefore, the proof of this theorem obtains simply from deriving the two sufficient conditions for $\Psi|_{\eta_0=\eta_{FB}}$ to be positive or negative.

As a starting point, let $\eta_{FB} = \frac{1}{2}$. Then, from (24) and (26) we know that

$$\beta_{HI,A}|_{\eta_0=\eta_{FB}} = \beta_{HI,R}|_{\eta_0=\eta_{FB}}.$$

Moreover, if $\eta_{FB} > \frac{1}{2}$, then

$$\beta_{HI,A}|_{\eta_0=\eta_{FB}} > \beta_{HI,R}|_{\eta_0=\eta_{FB}}$$

and if $\eta_{FB} < \frac{1}{2}$, then

$$\beta_{HI,R}|_{\eta_0=\eta_{FB}} > \beta_{HI,A}|_{\eta_0=\eta_{FB}}.$$

Given the result above, let us focus first on $\eta_{FB} > \frac{1}{2}$. In this case,

$$[\beta_{HI,A} - \beta_{LOW}] > |[\beta_{LOW} - \beta_{HI,R}]|.$$

Thus, a sufficient (but not necessary) condition for $\Psi|_{\eta_0=\eta_{FB}>\frac{1}{2}} > 0$ is that

$$\Pr(G|\eta_{FB}) > 1 - \Pr(G|\eta_{FB}).$$

Or equivalently, if

$$\eta_{FB}\theta > (1 - \eta_{FB})(1 - \theta). \tag{38}$$

Equation (38) is true if $\theta > 1-\eta_{FB}$. Therefore, if $\eta_{FB} > \frac{1}{2}$ and $\theta > 1-\eta_{FB}$, then $\Psi|_{\eta_0=\eta_{FB}} > 0$. This implies that $\overline{\overline{\eta}} < \eta_{FB}$, which completes the proof of part 1.

The proof of part 2 is analogous. If $\eta_{FB} < \frac{1}{2}$, then

$$[\beta_{HI,A} - \beta_{LOW}] < |[\beta_{LOW} - \beta_{HI,R}]|.$$

Thus, a sufficient condition for $\Psi|_{\eta_0=\eta_{FB}<\frac{1}{2}} < 0$ is that

$$2\eta_{FB}\theta < 2(1-\eta_{FB})(1-\theta). \tag{39}$$

Equation (39) is true if $\theta < 1-\eta_{FB}$. Thus, if $\eta_{FB} < \frac{1}{2}$ and $\theta < 1-\eta_{FB}$, then $\Psi|_{\eta_0=\eta_{FB}} < 0$. This implies that $\overline{\overline{\eta}} > \eta_{FB}$, thereby completing the proof of part 2. ■

6.4 Proof of Theorem 3

We first prove that a hurdle rate η_{FB} induces an analyst to choose $\overline{\overline{\eta}}$ strictly less than η_{FB} for any finite K. Assume that the analyst chooses $\overline{\overline{\eta}} = \eta_{FB} - \varepsilon$, for $\varepsilon > 0$. We can now compute the expected penalty as

$$\begin{aligned} E(\text{penalty}|\overline{\overline{\eta}}) &= \int_{\underline{Y}}^{\underline{Y}+\varepsilon} K\left\{\frac{2[Y-\underline{Y}]}{Q^2}\right\} dY \\ &= [\varepsilon^2/Q^2]K. \end{aligned} \tag{40}$$

In constructing (40), observe that a choice of $\overline{\overline{\eta}} = \eta_{FB} - \varepsilon$ shifts the support of Y to the left by the quantity ε.

The "net benefit" of the analyst choosing $\overline{\overline{\eta}}$ instead of η_{FB} is given by

$$h(\varepsilon)C - [\varepsilon^2/Q^2]K. \tag{41}$$

The first order condition of (41) is

$$h'C - [2\varepsilon^*/Q^2]K = 0,$$

implying that

$$\varepsilon^* = \{[Q^2 h'C]/2K\}. \tag{42}$$

From (42), we immediately see that $\varepsilon^* = 0$ (and hence $\overline{\overline{\eta}} = \eta_{FB}$) *cannot* be an equilibrium choice for any finite K.

We now turn to the second part of the Theorem. Let $\eta^* \equiv \eta_{FB} + a$, where a is a strictly positive scalar. Penalties are now imposed (see (21)) in the region up to $\widehat{Y}$, where $\widehat{Y}$ is the maximum Y for which

$$K \Pr(Y < \widehat{Y} | \overline{\overline{\eta}} \geq \eta^*) = 0. \tag{43}$$

As before, $\overline{\overline{\eta}} = \eta_{FB} - \varepsilon$. The expected penalty is now given by

$$\begin{aligned} E(\text{penalty}|\overline{\overline{\eta}}) &= \int_{\underline{Y}}^{\underline{Y}+a+\varepsilon} K \left\{ \frac{2[Y - \underline{Y}]}{Q^2} \right\} dY \\ &= \left[(a+\varepsilon)^2 / Q^2 \right] K. \end{aligned} \tag{44}$$

The "net benefit" of the analyst choosing $\overline{\overline{\eta}}$ instead of η_{FB} is given by

$$h(\varepsilon)C - \left\{ [(\varepsilon + a)^2 - a^2]/Q^2 \right\} K. \tag{45}$$

The first order condition of (45) is

$$h'C - \left[2(\varepsilon^* + a)/Q^2 \right] K = 0,$$

implying that

$$\varepsilon^* = \left\{ [Q^2 h' C]/2K \right\} - a. \tag{46}$$

From (46), we immediately see that the VP can induce the analyst to choose $\varepsilon^* = 0$ (thus $\overline{\overline{\eta}} = \eta_{FB}$) by choosing a (and thus η^*) appropriately. ■

6.5 Proof of Corollary to Theorem 3

Observe from (46) that a higher Q will increase ε^*. Thus, in order to preserve $\varepsilon^* = 0$, we need to increase a (and hence η^*). ■

Table 1: Sequence of Events

t = 0	**t = 1**	**t = 2**
- VP gets a project idea.	- Analyst invests in a (possibly) noisy signal and privately observes its realization.	- Project payoff realized on all accepted projects.
- VP delegates project analysis to analyst on all projects for which $\theta \in \Theta_D$.	- Analyst *reports* a "Reject/Accept" decision to VP based on outcome of his signal.	- Analyst receives an additional reputation - contingent wage.
	- VP makes project investment decision based on analyst's report.	- The world ends.
	- Once investment decision is made, the information Φ is observed.	
	- Analyst receives a reputation-contingent wage based on his project report.	

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