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Motivational investments and financial incentives

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ABSTRACT

If firms can invest in the motivation of workers to undertake costly effort, how does that affect the choice of explicit financial incentives? We develop a simple principal–agent model where the standard optimal contract is to offer a bonus that trades off incentive provision versus rent extraction. We allow the principal to undertake two types of motivational investments—one that increases the agent's disutility from deviating from a prescribed effort level, and another that reduces the cost of effort. We refer to these as guilt and inspiration, respectively. We characterize the conditions under which motivational investments and financial incentives are substitutes and complements, and find that it depends on the type of the investment as well as whether the worker's participation constraint is binding.

JEL CLASSIFICATIONS: D23, D86, D91, J33

1. INTRODUCTION

How can workers be motivated? In 1968, the *Harvard Business Review* carried an article titled "How Do You Motivate Employees?" that aimed to reshape how firms and managers approached this question (Herzberg 1968). Its author, Frederick Herzberg, argued that getting an employee to do things was not the same as motivating the employee and that the threat of punishment and the promise of rewards could get an employee to "move", but the only person "motivated" in this transaction was the one threatening or making promises. ["If I kick you in the rear (physically or psychologically), who is motivated? *I* am motivated; *you* move!"]. Herzberg emphasized, instead, a set of "motivator factors' that are intrinsic to the job for creating motivated workers (e.g., "achievement," "recognition for achievement," "responsibility," "psychological growth") as opposed to factors that are extrinsic to the job which are in the nature of reward or punishment, such as supervision, working conditions, salary, and status.

Herzberg's reasoning and terminology have since entered common parlance in management practice; implicit, for example, in a special issue in the same publication 35 years later giving advice to executives and managers on motivating those they lead (Nicholson 2003).

Understanding whether and to what extent financial incentives can motivate workers and raise their productivity is fundamental for firms and organizations to develop effective management practices. Around this central question, a growing body of academic work has explored how financial incentives interact with the intrinsic motivation of workers in different contexts, for example, when organizations are mission-oriented (Besley and Ghatak 2005, 2018), when workers desire to appear pro-social (Bénabou and Tirole 2006), seek praise from managers they approve (Ellingsen and Johannesson 2008), or have imperfect information about the work (Bénabou and Tirole 2003). Relatedly, there is growing evidence from lab and field experiments on how incentives impact workers' performance in situations where pro-social motivation is deemed to be important (Muralidharan and Sundararaman 2011; Rasul and Rogger 2018; Ashraf, Bandiera, and Jack 2014; Deserranno 2019; Berg et al. 2017; Ashraf et al. 2020).

Besides financial incentives, firms and organizations often spend considerable time and resources in activities aimed at raising the morale, team-spirit, and loyalty of the workforce. A broad range of activities may have such aims, including management and leadership training, team-based exercises, communication with workers about broader organizational goals. The financial incentives that firms and organizations provide may affect not only the intrinsic motivation of workers but also lead to (endogenous) adjustments in these types of motivational investments. A set of recent papers have theoretically investigated motivational investments in a principal–agent setting (Akerlof and Kranton 2005; Besley and Ghatak 2005, 2017; Kvaløy and Schottner 2015; Thakor and Quinn 2020).[1] Relatedly, a number of empirical studies have investigated how financial incentives interact with some forms of motivational investments (see, e.g., Kvaløy, Nieken and Schöttner 2015; Kosfeld, Neckermann, and Yang 2017).

In this article, we contribute to the theoretical literature on motivational investments. A key question that this literature has dealt with is whether organizations should use motivational investments as complements or substitutes of financial rewards in incentivizing workers. The existing literature shows that either case could hold true (Akerlof and Kranton 2005; Kvaløy and Schöttner 2015) and that the answer depends, in large part, on whether motivational investments raise or lower the marginal effect of financial incentives on workers' effort. We show that, for workers for whom both the participation constraint and the limited liability constraint bind, whether motivational investments substitute for or complement financial incentives is fully determined by how such investments affect the worker's *overall* welfare on the job. If motivational investments raise the worker's overall welfare, then, under a binding participation constraint, it substitutes for financial incentives. If motivational investments *lower* the worker's overall welfare—we discuss such an example below—then it complements financial incentives.

The intuition behind these results are as follows. A worker with a binding participation constraint will typically receive greater financial incentives than the second-best level obtained when the participation constraint is non-binding. If investing in the worker's level of motivation raises the worker's overall welfare, then this allows the employer to reduce financial incentives while ensuring that the participation constraint is still satisfied. Thus motivational investments and financial incentives move in opposite directions. But if investing in the worker's level of motivation *lowers* the worker's overall welfare, then this needs to be

[1] These papers deal with somewhat different but closely related concepts: Akerlof and Kranton (2005) consider an organization's investment in "motivational capital" to change a worker's identity; Besley and Ghatak (2005) consider an organization choosing a "compromise" mission, that reflects employee preferences, to motivate workers; in Kvaløy and Schottner (2015), a firm or an agent of the firm chooses motivational intensity/effort to motivate workers, whereas in Thakor and Quinn (2020) an organisation can choose, and commits resources to, a "higher purpose" to motivate workers.

accompanied by additional financial incentives to ensure that the participation constraint is still met. Thus, motivational investments and financial incentives move together.

To illustrate our arguments, we present and analyze two contrasting cases of our core model involving two different types of motivational investments that firms/organizations can make. The first type of investment, which we can think of as *guilt*, increases the agent's disutility from deviating from a benchmark effort level based, for example, on social norms, even though the actual choice of effort is unobservable. The second type of investment, which we can think of as *inspiration*, lowers the agent's cost of effort. We can think of the first type of motivational investment as an example of a negative reinforcement mechanism—something that raises the cost of falling short of expectations. In contrast, the second type of motivational investment is an example of a positive reinforcement mechanism—something that lowers the cost of undertaking effort. Crucially, while inspiration raises the worker's overall welfare on the job, guilt investments *lower* the worker's overall welfare on the job. The two types of motivational investments we model are not intended to capture all types of motivation relevant for real world situations (see Cassar and Meier 2018 for a recent review of the literature covering different types of non-monetary motivation). Rather, they have been chosen for expositional reasons to cover two contrasting scenarios.

For both types of motivational investments, a binding participation constraint changes the relationship between financial incentives and motivational investments. In a setting where motivational investments increase guilt, thereby reducing the overall expected payoff of workers, firms use motivational investments as a substitute of financial incentives if the worker's participation constraint is non-binding; but as a complement of financial rewards if the worker's participation constraint is binding. That is, motivational investments and financial incentives are substitutes or complements depending on the outside option of workers.

On the other hand, in a setting where motivational investments inspire workers and lower the cost of effort, thereby raising the overall expected payoff of the worker, firms choose financial incentives independently of the level of motivational investments if the participation constraint is non-binding; but financial incentives and motivational investments are used as substitutes if the participation constraint is binding. In Table 1, we summarize these results.

These results imply that how organizations incentivize workers—and specifically the combination of financial incentives and motivational investments they choose—should depend on the workers' outside options. For example, an improvement in the outside option would, other things equal, lead to an increase in financial incentives in settings with moral hazard and limited liability, given the standard trade-off between rent extraction and incentives. But the higher reward for success lowers the efficacy of guilt investments to induce effort and thus lowers guilt investment by the organization.

We draw on case studies of firm management practices to provide examples of motivational investments, including ones that *lower* the worker's job satisfaction. We also illustrate some empirical applications of our theoretical approach using surveys on firm management practices conducted using the methodology developed by Bloom and Van Reenen (2007). Using national unemployment rates as a measure of labor market tightness, and human capital of workers to proxy for their outside options, we show that the empirical relationship

Table 1. Relationship between motivational investments and financial incentives.

	Guilt	***Inspiration***
Participation Constraint Binding	Complements	Substitutes
Participation Constraint Not Binding	Substitutes	Independent

between management styles and worker outside options is broadly consistent with our theoretical predictions.

Kvaløy and Schöttner (2015) also investigates the relationship between motivational investments and financial incentives in a principal–agent model for a broad class of agent effort cost functions. However, in the Kvaløy–Schöttner model, when the agent has limited liability, the participation constraint does not bind. Akerlof and Kranton (2003, 2005, 2008) investigate similar models in which an organization has the possibility of making identity-related investments in a worker. They allow the agent's participation constraint to bind but do not explore the possibility that motivational investments could reduce the worker's overall welfare, as in our formulation of "guilt" investments. Therefore, our main theoretical insight is missing from this literature.[2]

The rest of the article is organized as follows. We make our core arguments first in a principal–agent model of motivational investments using fairly general functional forms for the agent's cost of effort and the cost of motivational investments. This is presented in Section 2. In the following sections, we present two more specific cases of motivational investment. In Section 3, motivational investments increase the agent's "guilt" in deviating from a benchmark effort level. We formalize the notion of "guilt" in Section 3.1 and provide an interpretation in Section 3.2. We derive the optimal contract in Sections 3.3–3.5. In Section 3.6, we investigate how the combination of financial incentives and motivational investments in the optimal contract changes with the agent's outside option. In Section 4, motivational investments lower the agent's cost of effort by "inspiring" the agent, and the analysis of the second model proceeds in the same manner as for the first. In Section 5, we discuss some anecdotal evidence as well as data from surveys on firm management to complement the theoretical analysis. Section 6 concludes.

2. A SIMPLE MODEL OF MOTIVATIONAL INVESTMENTS

2.1 Setup

Consider a simple principal–agent model where the agent provides effort $e \in [0,1]$. This produces output $A \in (0,1)$ with probability e and output zero otherwise. The principal observes output but not effort. Prior to production, the principal can make an investment $\psi \geq 0$ which reduces the agent's cost of effort. Specifically, the agent incurs a disutility $C(e,\psi)$ from effort e where $C(.)$ is a twice continuously differentiable function satisfying the conditions $C_e, C_{ee} > 0$ and $C_{e\psi} < 0$ for $e, \psi > 0$. In Sections 3 and 4, we will introduce additional structure to the function $C(.)$ and provide an interpretation of ψ as a form of "motivational investment" by the principal to induce the agent to exert more effort.

The cost of investment ψ is described by $\mu h(\psi)$ where the constant $\mu > 0$. The cost function $h(\psi)$ has the following properties: $h(0), h'(0) = 0$ and $h'(\psi), h''(\psi) > 0$ for $\psi > 0$. We assume that there is limited liability such that the principal cannot extract payments from the agent, for example, as penalties or fines.[3]

The agent receives a financial reward b only in the case of positive output (i.e., $A > 0$). We can represent a contract by (b,ψ) satisfying the conditions $b, \psi \geq 0$.[4] If the agent chooses not to accept the contract, he obtains a reservation utility of $\underline{u} \geq 0$.

[2] In a different setting, Dur, Kvaloy, and Schottner (2022) also find that the combination of financial and non-financial incentives may crucially depend on labor market conditions.

[3] In Appendix A, we discuss whether and how allowing the principal to extract payments from the agent affects our key results.

[4] Note that a contract of this form implies that the agent does not receive any financial payment if output equals 0. We take this approach because if the principal cannot extract payments from the agent, then any contract that involves a non-contingent payment can be improved upon by simultaneously increasing the bonus and lowering the non-contingent payment

Given a choice of effort e and contract (b, ψ), the agent's expected utility from the contract is given by

$$U(b, e, \psi) = be - C(e, \psi) \tag{1}$$

and the principal's expected profit is given by

$$\Pi(b, \psi) = \hat{e}(b, \psi)(A - b) - \mu h(\psi) \tag{2}$$

where $\hat{e}(b, \psi)$ is the agent's choice of effort given contract (b, ψ):

$$\hat{e}(b, \psi) = \arg\max_{e} U(b, e, \psi). \tag{3}$$

2.2 Equilibrium

Given our assumption that the principal cannot extract payments from the agent, the incentive compatibility and limited liability constraints will always bind in the contract that emerges in equilibrium. We show this formally in Lemma 5 in Appendix A.[5] By assumption, the agent's cost function is strictly convex in effort e. Therefore, if the agent's optimization problem has an interior solution, the level of effort is fully characterized by the following first-order condition:

$$b = C_e(\hat{e}(b, \psi), \psi). \tag{4}$$

Differentiating throughout equation (4) w.r.t. b and ψ, we obtain

$$\frac{\partial \hat{e}}{\partial b} = \frac{1}{C_{ee}} \text{ and } \frac{\partial \hat{e}}{\partial \psi} = -\frac{C_{e\psi}}{C_{ee}}. \tag{5}$$

Since, by assumption, $C_{ee} > 0$ and $C_{e\psi} < 0$, we have $\frac{\partial \hat{e}}{\partial b}, \frac{\partial \hat{e}}{\partial \psi} > 0$. Given the optimal choice of effort $\hat{e}(b, \psi)$, we can write the expected utility of the contract to the agent as follows:

$$V(b, \psi) = U(b, \hat{e}(b, \psi), \psi).$$

The principal's choice of contract is given by

$$(\hat{b}, \hat{\psi}) = \arg\max_{b,\psi} \hat{e}(b, \psi)(A - b) - \mu h(\psi) \tag{6}$$

subject to

$$V(b, \psi) \geq \underline{u} \tag{7}$$

such that the agent's expected utility is unchanged. This adjustment would lead to higher effort from the agent and higher expected profit for the principal (Banerjee, Gertler, and Ghatak 2002). We provide a formal version of this argument in Lemma 5 in Appendix A.

[5] If the principal can extract payments and the agent's liability is sufficiently large, an alternative type of contract can emerge in which the participation constraint binds, but the incentive compatibility and limited liability constraints are slack. In Appendix A, we show this formally and characterize the contract that emerges in this case.

We assume henceforth that the principal's optimization problem has an interior solution, that is, $\hat{b}, \hat{\psi} > 0$. Our key question of interest within this framework is whether the principal will treat financial rewards and motivational investments as substitutes or complements in incentivizing the worker. For the sake of clarity, we provide a formal definition of these terms in the context of our model before proceeding with the analysis:

Definition Financial rewards and motivational investments are complements if, in the constrained optimal contract defined in equations (6)–(7), they adjust in the same direction in response to a change in the cost of motivational investments. Financial rewards and motivational investments are substitutes if they adjust in opposite directions in response to a change in the cost of motivational investments.

Intuition suggests that whether the two instruments in the contract are complements or substitutes should depend on how financial rewards and motivation interact in the agent's choice of effort. If the agent's participation constraint is non-binding, this intuition holds in part, albeit with some ambiguity. This is shown by Kvaløy and Schöttner (2015), and we provide a formal statement specific to our setup below. (Further discussion and the proof of the proposition are provided in Appendix A.)

Proposition 1. *Suppose that the agent's cost function* $C(.)$ *is such that the principal's expected profit function* $\Pi(b, \psi)$ *is globally concave. If the agent's participation constraint is non-binding, then*

i) *if financial rewards reduce the marginal effect of motivational investments on the agent's choice of effort (and vice versa), then financial rewards and motivational investments are substitutes in the optimal contract;*

ii) *if financial rewards increase the marginal effect of motivational investments on the agent's choice of effort, then financial rewards and motivational investments may be either complements or substitutes in the optimal contract.*

A rather different result occurs if the participation constraint binds. This occurs if and only if $\underline{u}$, the agent's utility from the outside option, is sufficiently high. To analyze this case, we use results relating to monotone comparative statics in Topkis (1998). The key result is Theorem 2.8.1 in Topkis (1998) (henceforth called Topkis' theorem for brevity), but we cannot apply this result directly to the optimization problem in equations (6)–(7) as the constraint set is not "increasing" in the cost parameter μ as per the definition provided in Topkis (1998). Therefore, we proceed as follows. We define $\bar{b}(\psi, \underline{u})$ as the level of financial reward for which—given ψ—the agent obtains a reservation utility of $\underline{u}$, that is,

$$V(\bar{b}(\psi, \underline{u}), \psi) = \underline{u}$$
$$\Rightarrow \bar{b}(\psi, \underline{u})\hat{e}(\bar{b}(\psi, \underline{u}), \psi) - C(\hat{e}(\bar{b}(\psi, \underline{u}), \psi), \psi) = \underline{u}$$

Using $\bar{b}(\psi, \underline{u})$, we can rewrite the optimization problem in equations (6)–(7) as

$$\hat{\psi} = \arg \max_{\psi \in [0, \infty)} \hat{e}(\bar{b}(\psi, \underline{u}), \psi)(A - \bar{b}(\psi, \underline{u})) - \mu h(\psi) \tag{9}$$
$$\hat{b} = \bar{b}(\hat{\psi}, \underline{u}) \tag{10}$$

Let us denote the maximand in equation (9) by $\tilde{\Pi}(\psi, \mu)$. By definition,

$$\frac{\partial^2\tilde{\Pi}}{\partial\mu\partial\psi} = -h'(\psi) < 0 \tag{11}$$

The maximand in equation (9) is defined on a constraint set that is a sublattice of $\mathbb{R}$.[6] It follows that the constraint set is "increasing" in μ as per the induced set ordering defined in Topkis (1998).[7] Furthermore, the inequality in equation (11) implies that the maximand is supermodular in ψ and $-\mu$. Thus we can apply Topkis' theorem. It follows from the theorem that the level of motivational investment $\hat{\psi}$ is decreasing in the cost parameter μ.

To investigate how financial rewards change with the level of motivational investment, we differentiate throughout equation (8) w.r.t. μ:

$$\begin{aligned} &\frac{\partial\hat{\psi}}{\partial\mu}\left[\frac{\partial\bar{b}}{\partial\psi}\hat{e}(.) + \left\{\bar{b}(\psi,\underline{u}) - \frac{\partial C}{\partial e}\right\}\left(\frac{\partial\hat{e}}{\partial b}\frac{\partial\bar{b}}{\partial\psi} + \frac{\partial\hat{e}}{\partial\psi}\right) - \frac{\partial C}{\partial\psi}\right] = 0 \\ &\Rightarrow \frac{\partial\bar{b}}{\partial\psi}\hat{e}(.) + \left\{\bar{b}(\psi,\underline{u}) - \frac{\partial C}{\partial e}\right\}\left(\frac{\partial\hat{e}}{\partial b}\frac{\partial\bar{b}}{\partial\psi} + \frac{\partial\hat{e}}{\partial\psi}\right) = \frac{\partial C}{\partial\psi} \end{aligned} \tag{12}$$

Then, using the agent's first-order condition from equation (4) in equation (12), we obtain the following simplification:

$$\frac{\partial\bar{b}}{\partial\psi} = \frac{1}{\hat{e}(.)}\frac{\partial C}{\partial\psi}$$

Therefore, the level of financial reward $\bar{b}$ that exactly satisfies the agent's participation constraint increases (decreases) with motivational investment ψ if the agent's cost of effort $C(.)$ is increasing (decreasing) in ψ. We can summarize these results as follows:

Proposition 2. *Suppose the agent's participation constraint is binding. Then the principal will use financial rewards and motivational investments as complements (substitutes) if the level of the agent's cost of effort increases (decreases) with motivational investments.*

Proposition 2 highlights an interesting implication of a tight labor market (in which the worker's participant constraint binds) for the combination of financial rewards and motivational investments used by employers to incentivize workers. As noted above, if a worker's participation constraint is non-binding, then whether financial rewards and motivational investments will be used as substitutes or complements by the employer depends largely on whether their cross-partial derivative in the worker's effort choice function $(\hat{e}(b,\psi))$ is negative or positive. By contrast, if the worker's participation constraint binds, then whether financial rewards and motivational investments are used as complements or substitutes depends on whether motivational investments increases or decreases the worker's disutility from a given level of effort. If motivational investments decrease the disutility from work, the employer will use financial rewards and motivational investments as substitutes (regardless of the sign of their cross-partial derivative in the worker's choice of effort function).

However, if motivational investments *increase* the disutility from work, the employer will use financial rewards and motivational investments as complements. While it may seem

[6] See the definition of a sublattice in Section 2.2 of Topkis (1998).
[7] See the discussion on induced set ordering in Section 2.4 of Topkis (1998).

counterintuitive, motivational investments can lower the marginal cost of effort while at the same time *increasing* the overall disutility of work. In the next section, we present one such example which we call investing in "guilt."

3. MOTIVATING AGENT BY INCREASING GUILT

In this section, we present a particular case of the model in Section 2 in which motivational investments *increase* the disutility of work while lowering the marginal cost of effort. The purpose of this exercise is to provide a concrete example of such a scenario (that, to the best of our knowledge, has previously received little attention in the literature), provide an economic interpretation for it, and consider its implications for the optimal choice of financial rewards and motivational investments under different conditions.

3.1 Setup

We assume that all the model elements described in Section 2 continue to hold true, but we add structure to the agent's cost function and the principal's investment function. We assume $C(e,\psi)$ is made up of two components as follows. The agent experiences disutility in deviating from an exogenously given, benchmark effort level $e_c \in [0,1]$ at a cost $\frac{1}{2}\psi(e_c - e)^2$ which we call "guilt." We assume that the benchmark e_c is dictated by social norms and discuss the disutility from "guilt" in more detail in the next subsection. In addition to guilt, there is an effort cost equal to $\frac{1}{2}e^2$. Therefore, the agent's expected utility from the contract is given by

$$U(b, e_c, e, \psi) = be - \frac{1}{2}e^2 - \frac{1}{2}\psi(e_c - e)^2 \tag{13}$$

Turning to the principal's investment function, we assume that $h(\psi) = \frac{1}{2}\mu\psi^2$. It is straightforward to show that, given the assumed cost of effort, the first-best effort level is equal to A.[8] We assume henceforth that the benchmark e_c equals the first-best effort level.[9]

For our main results to follow, the key assumption we make is that motivational investments *tighten* the agent's participation constraint, given that the coefficient of ψ in equation (13) is negative. By contrast, in Akerlof and Kranton (2003, 2005, 2008), there is a gain in a worker's "identity utility" when a firm invests in "motivational capital"; and Kvaløy and Schöttner (2015) assume that motivational investments reduce the cost of any given level of effort. In both these models, motivational investments would *relax* the agent's participation constraint. Similarly, when an firm chooses a "compromise mission" in Besley and Ghatak (2005) or a "higher purpose" in Thakor and Quinn (2020), a worker finds employment with the firm more attractive for any given effort level, thus leading to a relaxation of the participation constraint.

To determine the optimal contract, we proceed with the analysis using backward induction. In Section 3.3, we determine the agent's choice of effort for a given contract (b,ψ) and investigate how the agent's effort level responds to changes in financial incentives and motivational investments. Then, we investigate how changes in the contract affects the agent's expected utility and, thus, her participation constraint. In Section 3.5, we solve the Principal's profit maximization problem to derive the optimal contract using the agent's effort function and her expected utility from a given contract.

[8] We obtain this result by solving $\max_{e,\psi} U(A, e_c, e, \psi)$. For any e_c, the optimal choice is given by $\psi = 0$ and $e = A$.
[9] It will become evident from the analysis that our results would not be qualitatively different if e_c is below the first-best effort level but higher than the second-best effort level under $\psi = 0$.

3.2 Interpretation

We interpret the effort level e_c as a reference point that is based on social norms and expectations about the appropriate level of effort (Kandel and Lazear 1992). Although the firm can explicitly refer to a different effort level in the employment contract, this would not affect the agent's utility or behavior as actual effort cannot be monitored; and the worker incurs disutility ('guilt') only when effort deviates from the social expectation e_c. As it is based on norms in the wider society, the firm cannot alter e_c. But the level of motivational investment can make the reference point more salient, that is, increase the disutility of deviating from the norm.

The notion of guilt in the model is loosely related to its formalization in the game-theoretic literature. For example, Battigalli and Dufwenberg (2007) defines "simple guilt" as disutility experienced by one player due to the payoff loss (vis-a-vis some expectation) that his strategy inflicts on another (to capture the notion that "a player cares about the extent to which he lets another player down"). If the effort level specified in the contract e_c affects the principal's beliefs about the agent's actual choice of effort e, then "simple guilt," as defined by Battigalli and Dufwenberg (2007), would be a function of $(e_c - e)$ as modeled here.[10] Charness and Dufwenberg (2006) show, in an experimental setting, that promises about actions made in pre-play communication in a principal–agent relationship indeed affect beliefs about behavior and the level of cooperation in the relationship, findings that they account for using the notion of "guilt aversion."

3.3 Agent's effort choice

The agent solves the following optimization problem:

$$\max_{e\in[0,1]} be - \frac{1}{2}e^2 - \frac{1}{2}\psi(e_c - e)^2 \tag{14}$$

It is clear upon inspection that the maximand in equation (14) is strictly concave in e. Therefore, the agent's optimization problem has a unique solution. Assuming an interior solution, we obtain e from the first-order condition:

$$e = e_c - \left(\frac{e_c - b}{1+\psi}\right) \tag{15}$$

We denote this solution by $\hat{e}(b,\psi)$. Using equation (15), it is straightforward to verify that the agent's effort is increasing in e_c. Furthermore, we have

$$\frac{\partial \hat{e}}{\partial \psi} = \frac{e_c - b}{(1+\psi)^2} \tag{16}$$

$$\frac{\partial \hat{e}}{\partial b} = \frac{1}{1+\psi} \tag{17}$$

From equation (16), we see that, for $e_c > b$, the agent's effort is increasing in ψ. Therefore, the principal will invest in guilt only if he sets $b < e_c$ at the same time. We can establish that

[10] Note that, disutility from 'simple guilt', as modelled by Battigalli and Dufwenberg (2007) would equal zero when the actual effort level exceeds expectations. In contrast, in our setup any deviation—positive or negative—from the benchmark effort level generates disutility. But this modelling choice, made for notational simplicity, does not affect the analysis as actual effort never exceeds the benchmark in equilibrium.

$\frac{\partial^2 \hat{e}}{\partial \psi^2} < 0$, that is, the efficacy of guilt in increasing the agent's effort level is decreasing in the existing level of guilt investments. Using equation (17), we can establish that $\frac{\partial^2 \hat{e}}{\partial \psi \partial b} < 0$; that is, the marginal effect of financial rewards on the agent's effort level is decreasing in the level of guilt investments. We summarize these results as follows.

Lemma 1. *The responsiveness of the agent's optimal choice of effort to guilt investments and financial rewards are decreasing in the level of guilt investment,* that is, $\frac{\partial^2 \hat{e}}{\partial \psi^2} < 0$ *and* $\frac{\partial^2 \hat{e}}{\partial \psi \partial b} < 0$.

3.4 Agent's participation constraint

We denote by $V(b, \psi)$ the agent's indirect utility from the contract (b, ψ), that is,

$$\begin{aligned} V(b,\psi) &= U(b, \hat{e}(b,\psi), \psi) \\ &= b\left(\frac{b+\psi e_c}{1+\psi}\right) - \frac{1}{2}\left(\frac{b+\psi e_c}{1+\psi}\right)^2 - \frac{1}{2}\psi\left(\frac{e_c - b}{1+\psi}\right)^2 \\ &= \frac{1}{2}\frac{(b^2 + 2\psi b e_c - \psi e_c^2)}{(1+\psi)} \end{aligned} \tag{18}$$

We define $\bar{b}(e_c, \psi, \underline{u})$ as the level of financial reward for which—given ψ—the principal obtains a reservation utility of $\underline{u}$, that is, $\bar{b}(e_c, \psi, \underline{u})$ is defined implicitly by the following equation.

$$\frac{1}{2}\frac{(\bar{b}^2 + 2\psi \bar{b} e_c - \psi e_c^2)}{(1+\psi)} = \underline{u} \tag{19}$$

This is the financial reward that the agent will receive for high output whenever the agent's participation constraint binds. Using equation (19), we can establish the following results:

Lemma 2. *When the agent's participation constraint binds, the financial reward for success* $\bar{b}(e_c, \psi, \underline{u})$ *is (i) increasing in* ψ *at a decreasing rate, that is,* $\frac{\partial \bar{b}}{\partial \psi} > 0$ *and* $\frac{\partial^2 \bar{b}}{\partial \psi^2} < 0$*; (ii) increasing in the agent's outside option* $\underline{u}$ *at a decreasing rate with respect to* ψ*, that is,* $\frac{\partial \bar{b}}{\partial \underline{u}} > 0$ *and* $\frac{\partial^2 \bar{b}}{\partial \psi \partial \underline{u}} < 0$.

The intuition behind the first part of Lemma 2 is that when the agent's participation constraint is binding, guilt is compensated through financial rewards, which translates into higher effort, which means that further increasing ψ has less effect on the agent's guilt and thus requires less financial compensation. The intuition behind the second part of the lemma is that if the agent has a strong outside option, then the financial rewards—and thus effort—are higher; therefore, increasing the guilt parameter has a smaller effect on the agent's disutility, which therefore requires less compensation.

3.5 Optimal contract

The principal's expected profits are given by

$$\Pi(b,\psi) = \hat{e}(b,\psi)(A-b) - \frac{1}{2}\mu\psi^2$$

To maximize profits, the principal solves

$$\max_{b,\psi} \hat{e}(b,\psi)(A-b) - \frac{1}{2}\mu\psi^2 \tag{20}$$

subject to

$$V(b,\psi) \geq \underline{u} \tag{21}$$

Non-binding participation constraint: First, we investigate the case in which the agent's participation constraint does not bind, a situation which arises for $\underline{u}$ sufficiently low. Then, using equation (15), the maximization problem in equations (20)–(21) can be written as

$$\max_{b,\psi} \left(\frac{b+\psi e_c}{1+\psi}\right)(A-b) - \frac{1}{2}\mu\psi^2 \tag{22}$$

For μ sufficiently small, we have an interior solution satisfying the following first-order conditions:

$$b : \frac{\partial \hat{e}}{\partial b}(A-b) - \hat{e}(b,\psi) = 0 \tag{23}$$

$$\psi : \frac{\partial \hat{e}}{\partial \psi}(A-b) - \mu\psi = 0 \tag{24}$$

It is difficult to obtain a closed-form solution using equations (23) and (24). But we can provide some comparative statics results by using the supermodularity properties of the maximand in equation (22). Differentiating the maximand w.r.t. b, we obtain

$$\frac{\partial \Pi(b,\psi)}{\partial b} = \frac{A(1-\psi) - 2b}{1+\psi} \tag{25}$$

It is clear that the expression in (25) is decreasing in ψ, that is, $\frac{\partial^2 \Pi}{\partial b \partial \psi} < 0$. Thus, $\Pi(b,\psi)$ is supermodular in b and $-\psi$. Furthermore, it is straightforward to show that $\frac{\partial^2 \Pi}{\partial \psi \partial \mu} < 0$ and $\frac{\partial^2 \Pi}{\partial b \partial \mu} = 0$. Then, using Topkis' theorem, we can show that the financial reward for success (b) is increasing, and investment in guilt (ψ) is decreasing, in the cost of motivation μ; in other words, guilt investments and financial rewards are substitutes. Formally, we state the result as follows.

Proposition 3. *If the agent's participation constraint is non-binding and the principal is making a positive level of guilt investment, then the principal will use guilt investments and financial rewards as* <u>*substitutes*</u>*.*

Proposition 3 echoes the result that the cross-partial derivative of the agent's effort level with respect to financial rewards and guilt investments is negative (see Lemma 1). However, we will see below that this parallel between the interactive effect of financial rewards and guilt investments on the agent's effort choice and on the principal's profits breaks down when the agent's participation constraint is binding.

Binding participation constraint: Next, we provide a partial characterization of the case in which the agent's participation constraint is binding. Using the function $\bar{b}(\psi, \underline{u})$ (defined implicitly by equation (19)), we can rewrite the optimization problem in equations (20)–(21) as

$$\max_{\psi} \hat{e}(\bar{b}, \psi)(A - \bar{b}) - \frac{1}{2}\mu\psi^2 \tag{26}$$

If the maximization problem has an interior solution, then ψ is given by the following first-order condition:

$$\psi : \left(\frac{\partial \hat{e}}{\partial \psi} + \frac{\partial \hat{e}}{\partial b}\frac{\partial \bar{b}}{\partial \psi}\right)(A - \bar{b}) - \hat{e}(b, \psi)\frac{\partial \bar{b}}{\partial \psi} - \mu\psi = 0 \tag{27}$$

Intuitively, increasing motivational investment ψ increases effort. Because the participation constraint is binding, the increase in guilt has to be compensated by higher financial rewards. This compensation is captured by the term $\frac{\partial \bar{b}}{\partial \psi} > 0$. The increase in financial rewards further increases effort (captured by the term $\frac{\partial \hat{e}}{\partial b}\frac{\partial \bar{b}}{\partial \psi}$), but it also means higher payment whenever the agent generates high output (captured by the term $\hat{e}(b, \psi)\frac{\partial \bar{b}}{\partial \psi}$). Rearranging equation (27), we obtain

$$\frac{\partial \hat{e}}{\partial \psi}(A - \bar{b}) + \frac{\partial \bar{b}}{\partial \psi}\left\{\frac{\partial \hat{e}}{\partial b}(A - \bar{b}) - \hat{e}(b, \psi)\right\} = \mu\psi \tag{28}$$

Note that the expression within the curly brackets in equation (28) is identical to the left-hand side of equation (23). Therefore, the expression is equal to the marginal effect of increasing the financial reward on the principal's expected profits. Therefore, if the participation constraint is binding, it must be zero or negative (because if it were positive, then the principal could increase expected profits by increasing b above $\bar{b}(\psi, \underline{u})$). As $\frac{\partial \bar{b}}{\partial \psi} > 0$, it follows that, at the optimum, we must have

$$\frac{\partial \hat{e}}{\partial \psi}(A - \bar{b}) \geq \mu\psi \tag{29}$$

Therefore, when the agent's participation constraint is binding, the marginal effect of motivational investments on the principal's expected profits is, in equilibrium, at least as large as the marginal cost of this type of investment. This property of the equilibrium is due to the fact that motivation investments tighten the agent's participation constraint. We will see in Section 4.4 that the opposite holds true when motivational investments take the form of "inspiration" rather than guilt.

We now address the question whether the principal will use guilt investments as a complement or a substitute of financial rewards in eliciting the agent's effort. For this purpose, we consider how a change in μ, the cost of guilt investments, affects the principal's decisions. As shown in Section 2, an increase in μ leads to a reduction in motivational investments. In the present model, this will decrease the agent's disutility from guilt and, thus, relax the participation constraint and reduce the need for financial rewards (for success) to induce the agent to take up the contract. Therefore, we obtain a decline in financial rewards. Thus, guilt investments and financial rewards move together in response to a change in the cost of guilt investments; in other words, they are complements. Lower financial rewards combined with reduced guilt investments will reduce the agent's level of effort. Formally, we have the following results.

Proposition 4. *If the participation constraint binds and the principal makes positive guilt investments, then (i) the principal will use guilt investments and financial rewards as complements, and (ii) the agent's level of effort is decreasing in the cost of motivational investments.*

Proposition 4 is the equivalent of Proposition 2 when motivational investments take the form of increasing the agent's "guilt" from deviating from a benchmark effort level. Proposition 2 implies that when motivational investments tighten the agent's participation constraint, the principal will use motivational investments and financial rewards as complements. Proposition 4 confirms this result in the case of "guilt" investments which, as formulated above, indeed increases a worker's disutility from taking up an employment contract and thus tightens her participation constraint. Note that the principal uses guilt investments and financial rewards as complements in spite of the fact that the corresponding cross-partial derivative in the agent's choice of effort function is negative.

3.6 Effects of changes in the agent's outside option

Next, we consider how the optimal contract is affected by the agent's outside option. Before presenting the formal results, we first provide some intuition about how changes in the agent's outside option would affect the optimal contract. An increase in $\underline{u}$ would, other things equal, lead to an increase in $\bar{b}$. A higher financial reward for success lowers the efficacy of guilt investments to induce effort (because $\frac{\partial^2 \hat{e}}{\partial \psi \partial \bar{b}} < 0$ by Lemma 1).[11] The increase in $\bar{b}$ also reduces the increase in net profits due to any increment in effort (i.e., a reduction in $(A - \bar{b})$), and the level of effort—and thus the cost of any additional financial compensation due to guilt investments $(\frac{\partial \bar{b}}{\partial \psi} \hat{e}(\bar{b}, e_c, \psi))$—is higher. Taking all these arguments together, we must have $\frac{\partial^2 \bar{\Pi}}{\partial \psi \partial \underline{u}} < 0$. Therefore, applying Topkis' theorem, guilt investments would decline as the agent's outside option improves.

The increase in $\bar{b}$ mentioned above is a *ceteris paribus* statement. But we can show that it also holds in equilibrium. Intuitively, as guilt investments decline, financial rewards are more effective in increasing effort. Moreover, as the agent exerts lower effort when there is less guilt investment, the marginal cost of financial reward is lower. Therefore, $\frac{\partial^2 \bar{\Pi}}{\partial b \partial \underline{u}} > 0$. Applying Topkis' theorem, financial rewards increase as the agent's outside option improves. Formally, we have the following result.

[11] An improvement in the outside option also means that less financial compensation is needed for any guilt investments (because $\frac{\partial^2 \bar{b}}{\partial \psi \partial \underline{u}} < 0$ by Lemma 2), that is, guilt investments are less costly, but we can show that the efficacy of guilt investments declines by even more.

Proposition 5. *If the participation constraint binds and the principal makes positive guilt investments, then an improvement in the agent's outside option (i) decreases guilt investments, and (ii) increases the financial rewards for success.*

As shown in Section 3.3, the agent's choice of effort is increasing in both the level of financial rewards and the level of motivational investments. As the former is increasing, and the latter is decreasing, in the agent's outside option, the overall effect of an improvement in the agent's outside option on the level of effort is ambiguous.

4. MOTIVATING AGENT BY INSPIRATION

In this section, we present another case of our general model in Section 2. In contrast to the model of guilt investments, in this case motivational investments will decrease the disutility of work as well as lower the marginal cost of effort. Although this formulation has previously been explored in the literature, the following exercise will allow a direct comparison of the optimal contract with the preceding case, particularly when the agent's participation constraint is binding.

4.1 Setup

As in our example on "guilt" investments (Section 3), we assume that all the model elements described in Section 2 continue to hold true. We add structure to the agent's cost function as follows: $C(e,\psi) = \frac{1}{2\psi}e^2$. Thus, the agent's expected utility from the contract is given by

$$U(b,e,\psi) = be - \frac{1}{2\psi}e^2 \tag{30}$$

The principal can make investments to raise the agent's "motivation," represented by $\psi \geq 0$. Drawing on Kvaløy and Schöttner (2015), we interpret the parameter ψ as investments by an organization in leaders or mentors who can inspire workers in a way that lowers the agent's disutility from effort. As in the preceding section, we assume that achieving a level of motivation ψ requires an investment equal to $\frac{1}{2}\mu\psi^2$ where $\mu \in (0,\infty)$.

We proceed with analyzing the model in the same manner as in Section 3. In Section 4.2, we determine the agent's choice of effort for a given contract (b,ψ) and investigate how the agent's effort level responds to changes in financial incentives and motivational investments. Then, we investigate how changes in the contract affects the agent's expected utility and, thus, her participation constraint. In Section 4.4, we solve the principal's profit maximization problem to derive the optimal contract using the agent's effort function and her expected utility from a given contract.

4.2 Agent's effort choice

The agent solves the following optimization problem:

$$\max_{e\in[0,1]} be - \frac{1}{2\psi}e^2 \tag{31}$$

The coefficient of e^2 in the maximand in equation (31) is negative. Therefore, the agent's optimization problem has a unique solution. Assuming an interior solution, we obtain e from the first-order condition:

$$e = \psi b \tag{32}$$

We denote this solution by $\hat{e}(b, \psi)$. Using equation (32), it is straightforward to establish the following results:

Lemma 3. *The responsiveness of the agent's optimal choice of effort to financial rewards is increasing in the level of motivational investments, that is,* $\frac{\partial^2 \hat{e}}{\partial b \partial \psi} > 0$*; the responsiveness of the agent's optimal choice of effort to motivational investments is constant in the level of motivational investments, that is,* $\frac{\partial^2 \hat{e}}{\partial \psi^2} = 0$

4.3 Agent's participation constraint

The agent's indirect utility from a contract (b, ψ) is given by

$$\begin{aligned} V(b, \psi) &= U(b, \hat{e}(b, \psi), \psi) \\ &= b(\psi b) - \frac{1}{2\psi}(b\psi)^2 = \frac{1}{2}b^2\psi \end{aligned}$$

We define $\bar{b}(\psi, \underline{u})$ as the level of bonus for which—given ψ—the agent obtains a reservation utility of $\underline{u}$, that is,

$$\frac{1}{2}b^2\psi = \underline{u} \tag{33}$$

Rearranging terms in equation (33) and differentiating throughout with respect to ψ and $\underline{u}$, we obtain

$$\frac{\partial \bar{b}}{\partial \psi} = -\frac{\underline{u}}{\bar{b}\psi^2} < 0 \tag{34}$$

$$\frac{\partial \bar{b}}{\partial \underline{u}} = \frac{1}{\bar{b}\psi} > 0 \tag{35}$$

Thus, as expected, a stronger outside option increases the financial rewards required to satisfy the participation constraint. Using equation (34), we can also establish the following results.

Lemma 4. *When the agent's participant constraint binds, the financial reward for success* $\bar{b}(\psi, \underline{u})$ *is (i) decreasing in motivational investment* ψ *at a decreasing rate, that is,* $\frac{\partial \bar{b}}{\partial \psi} < 0$ *and* $\frac{\partial^2 \bar{b}}{\partial \psi^2} > 0$*; (ii) increasing in the agent's outside option* $\underline{u}$ *at a decreasing rate, that is,* $\frac{\partial \bar{b}}{\partial \underline{u}} > 0$ *and* $\frac{\partial^2 \bar{b}}{\partial \psi \partial \underline{u}} < 0$.

Thus, when the agent has a binding participation constraint, a better outside option increases the amount by which financial rewards can be reduced when there are additional motivational investments; additionally, at higher levels of motivational investments, the smaller is the amount by which financial rewards can be reduced following an increment in motivational investments.

4.4 Optimal contract

The principal's expected profits are given by

$$\Pi(b,\psi) = \hat{e}(b,\psi)(A-b) - \frac{1}{2}\mu\psi^2$$

To maximize profits, the principal solves

$$\max_{b,\psi} \hat{e}(b,\psi)(A-b) - \frac{1}{2}\mu\psi^2 \tag{36}$$

subject to

$$V(b,\psi) \geq \underline{u} \tag{37}$$

Non-binding participation constraint: First, we analyze the case in which the agent's participation constraint is non-binding. For $\underline{u}$ sufficiently low, the participation constraint does not bind. Then, the maximization problem in equations (36)–(37) becomes

$$\max_{b,\psi} \Pi(b,\psi)$$

We obtain the following first-order conditions:

$$\frac{\partial \Pi(b,\psi)}{\partial b} = \frac{\partial \hat{e}}{\partial b}(A-b) - \hat{e}(b,\psi) = 0 \tag{38}$$

$$\frac{\partial \Pi(b,\psi)}{\partial \psi} = \frac{\partial \hat{e}}{\partial \psi}(A-b) - \mu\psi \tag{39}$$

Substituting for $\frac{\partial \hat{e}}{\partial b}$ and $\hat{e}(b,\psi)$ in equation (38), we obtain

$$\begin{aligned} \frac{\partial \Pi(b,\psi)}{\partial b} &= \psi(A-b) - b\psi = 0 \\ &= \psi(A-2b) = 0 \\ &\Rightarrow b = \frac{A}{2} \end{aligned} \tag{40}$$

Substituting for $\frac{\partial \hat{e}}{\partial \psi}$ and $\hat{e}(b,\psi)$ in equation (39), we obtain

$$\begin{aligned} \frac{\partial \Pi(b,\psi)}{\partial \psi} &= b(A-b) - \mu\psi = 0 \\ \Rightarrow \psi &= \frac{b(A-b)}{\mu} = \frac{A^2}{4\mu} \end{aligned} \tag{41}$$

Therefore, motivational investments are decreasing in μ (as we would expect) while financial rewards are independent of μ. Thus, motivational investments and financial rewards are neither complements, nor substitutes. It follows from equation (32) that the agent's effort level is also decreasing in μ. Formally, we state these results as follows.

Proposition 6. *If the agent's participation constraint is non-binding, then financial rewards are neither a substitute nor a complement of motivational investments: an increase in the cost of motivation (μ) has <u>no effect</u> on the financial reward for success although it <u>reduces</u> motivational investments and effort goes down.*

It is evident from the equation for the optimal choice of effort (32) that financial rewards and motivational investments are complements in eliciting the agent's effort. Therefore, this case is covered by Proposition 1(ii) describing the case of a slack participation constraint in Section 2. But while we obtain an ambiguous result for the general model, the additional structure we introduce in this section enables an explicit statement about how access to motivational investments affects the use of financial rewards by the principal in eliciting agent effort. For this particular model, it does not but, more significantly, we will see in the next section that this relationship changes when the agent's participation constraint binds.

Binding participation constraint: Next, we provide a partial characterization of the case in which the agent's participation constraint is binding. Using the function $\bar{b}(\psi, \underline{u})$—defined implicitly by equation (33)—we can rewrite the optimization problem in equations (36)–(37) as

$$\max_{\psi} \hat{e}(\bar{b}, \psi)(A - \bar{b}) - \mu\psi^2 \tag{42}$$

If the maximization problem has an interior solution, then ψ is given by the following first-order condition:

$$\psi : \left(\frac{\partial \hat{e}}{\partial \psi} + \frac{\partial \hat{e}}{\partial b}\frac{\partial \bar{b}}{\partial \psi}\right)(A - \bar{b}) - \hat{e}(\bar{b}, \psi)\frac{\partial \bar{b}}{\partial \psi} - \mu\psi = 0 \tag{43}$$

Intuitively, increasing motivational investment ψ increases effort. Because the participation constraint is binding, the increase in motivation means that the participation constraint can be satisfied for a lower level of financial reward. This reduction in financial rewards is captured by the term $\frac{\partial \bar{b}}{\partial \psi} < 0$. The decrease in financial rewards decreases effort (captured by the term $\frac{\partial \hat{e}}{\partial b}\frac{\partial \bar{b}}{\partial \psi}$), but it also means lower payment whenever the agent generates high output (captured by the term $\hat{e}(b, \psi)\frac{\partial \bar{b}}{\partial \psi}$). Rearranging equation (43), we obtain

$$\frac{\partial \hat{e}}{\partial \psi}(A - \bar{b}) + \frac{\partial \bar{b}}{\partial \psi}\left\{\frac{\partial \hat{e}}{\partial b}(A - \bar{b}) - \hat{e}(\bar{b}, \psi)\right\} = \mu\psi \tag{44}$$

Note that the expression within the curly brackets in equation (44) is identical to the right-hand side of equation (38). Therefore, the expression is equal to the marginal effect of increasing the financial reward on the principal's expected profits. Therefore, if the participation constraint is binding, it must be zero or negative (because if it were positive, then the principal could increase expected profits by increasing b above $\bar{b}(\psi, \underline{u})$). As $\frac{\partial \bar{b}}{\partial \psi} < 0$, it follows that, at the optimum, we must have

$$\frac{\partial \hat{e}}{\partial \psi}(A - \bar{b}) < \mu\psi \tag{45}$$

Therefore, when the agent's participation constraint is binding, the marginal effect of motivational investments on the principal's expected profits is, in equilibrium, smaller than the marginal cost of this type of investment. This is the opposite of the case shown in Section 3.5 where motivational investments take the form of guilt.

Next, we address the question whether the principal will use motivational investments as a complement or a substitute of financial rewards in eliciting the agent's effort. As shown in Section 2, when there is an increase in the marginal cost of motivational investments, the level of motivational investments will go down. This increases the agent's disutility from effort and thus tightens the participation constraint. Then the principal would increase financial rewards to ensure that the agent's participation constraint is still satisfied. Therefore, financial rewards and motivational investments will go in opposite directions, that is, they are substitutes. Although financial rewards and motivational investments go in opposite directions, we can show that the agent's effort level will go down, that is, the effect of motivational investments will dominate. Formally, we have the following result.

Proposition 7. *If the participation constraint binds and the principal makes positive motivational investments, then (i) the principal will use motivational investments and financial rewards as substitutes, (ii) the agent's level of effort is <u>decreasing</u> in the cost of motivational investments.*

Proposition 7 is the equivalent of Proposition 2 when motivational investments involve "inspiring" workers, thus lowering their cost of effort. Proposition 2 implies that when motivational investments relax the agent's participation constraint, the principal will use motivational investments and financial rewards as substitutes. Proposition 7 confirms this result in the case of motivation through "inspiration" which, as formulated above, indeed decreases a worker's disutility from taking up an employment contract and thus relaxes her participation constraint.

4.5 Effect of changes in the agent's outside option

Parallel to our analysis in Section 3.6, here we look at how the optimal contract is affected by the agent's outside option in the case of investment in inspiration. We start by providing some intuition for how an improvement in the agent's outside option affects the optimal contract. An increase in $\underline{u}$ would, other things equal, lead to an increase in $\bar{b}$. A higher financial reward for success increases the efficacy of motivational investments to induce effort (since $\frac{\partial^2 \hat{e}}{\partial \psi \partial b} > 0$ by Lemma 3). In addition, an improvement in the outside option means that financial rewards can be reduced by even more when there is an increase in motivational investments (since $\frac{\partial^2 \bar{b}}{\partial \psi \partial \underline{u}} < 0$ by Lemma 4). Taking these arguments together, we must have $\frac{\partial^2 \bar{\Pi}}{\partial \psi \partial \underline{u}} > 0$. Therefore, applying Topkis' theorem, motivational investments are increasing in the agent's outside option. An increase in the outside option will also mean that the agent is provided higher financial rewards for success to induce her to take up the contract. Higher motivational investments and financial rewards will increase the agent's effort level. Formally, we have the following result.

Proposition 8. *If the participation constraint binds and the principal makes positive motivational investments, then an improvement in the agent's outside option (i) <u>increases</u> motivational investments, (ii) <u>increases</u> the financial reward for success, and (iii) <u>increases</u> the agent's level of effort.*

5. EMPIRICAL APPLICATIONS

Next, we consider a number of management practices in the empirical literature, and discuss how well they map onto the different types of motivational investments explored theoretically in the preceding sections. The case studies and empirical analysis in this section demonstrate some possible empirical applications of the theoretical concepts and results developed in this article. In particular, the case studies illustrate how some investments undertaken by firms to motivate workers in practice *lower* their job satisfaction, while the empirical analysis illustrates how the theoretical predictions of the model can be taken to existing quantitative data on firm management practices. The empirical patterns we uncover are also consistent with our comparative statics results relating to the agent's outside option.

5.1 The "good jobs strategy"

Ton (2014) introduces the idea of a "good jobs strategy," arguing that jobs that are secure, well-paid, and rewarding lead to motivated workers who take pride in their work and internalize the organizational goals. In contrast, firms that focus on cutting labor costs and display a lack of trust in employees by excessive supervision and micromanagement are likely to have the opposite result by creating a sense of limited autonomy and of being constantly monitored. Ton supports her arguments through a range of examples of management practices in the retail sector, including four supermarket chains—Costco, QuickTrip, and Trader Joe's in the United States, and Mercadona in Spain—that embrace the "good jobs strategy." Besides providing job security and opportunities for career development, these retailers provide their employees with a high level of autonomy in their day-to-day jobs, a practice that encourages continuous improvements in working methods and processes. Ton argues that although these types of management practices are costly, they are an investment in the organization's human capital that, at least under certain conditions, have returns in the form of increased efficiency in the workplace that far outweigh the investment costs.

To the extent that the "good jobs strategy" can motivate workers to increase effort on their jobs, it is akin to motivational investment in the workforce. Job security, career development opportunities, and autonomy also make these jobs attractive from the workers' point of view and, thus, within the framework of the model in Section 2, relax their participation constraint. However, Ton also argues that good retailers increase efficiency by standardizing certain tasks, developing very precise instructions for how a task should be done and how long it should take.[12] Standardization can create pressure on workers to exert effort to meet the firm's expectations on work standards even if close monitoring by management is not possible.

As we have argued in Section 3, this type of pressure can make the job less attractive from the workers' point of view and tighten their participation constraint. In particular, the standardization of tasks can increase the salience of any gap between the worker's effort or efficiency in tasks and the employer's expectations. While firms may also engage in other activities to increase the salience of shortcomings in worker performance, explicit benchmarks of the kind created by standardization are likely to be part of the overall motivational strategy. If these benchmarks also align with social norms, then it can potentially induce a sense of "guilt" in the worker as modeled in Section 3.

[12] Ton gives an example of how standardization and monitoring works in practice at the car company Toyota: "Worksheets detailing an employee's standardized work are posted outward, away from the operator. The operator is well trained in the standardized procedures he has to follow, so he doesn't need to keep looking at the written instructions. The only reason the worksheet is posted at all is so that team leaders and group leaders can check to see if it is being followed by the operator" (Ton 2014, p. 123–124).

We should, however, note that standardization and monitoring, as described by Ton (2014), can affect the contract in ways not captured by the model. For example, they would allow the employer to measure and monitor performance more precisely and reward the worker accordingly. These procedures may also enable the employer to identify low-skilled workers and retrain or reassign them accordingly.

5.2 Employee surveillance at Amazon

Recent reports and media stories on Amazon's employment practices provide a case where standardization and monitoring of tasks was taken to a point where, arguably, workers were placed at risk of physical and mental harm. Amazon is the leading online retailer, and the largest employer of warehouse workers, globally. In early 2024, Amazon was fined in France for "excessive" employee surveillance using data from workers' handheld scanners (Gruet 2024). The metrics used by the company for monitoring purposes include number of tasks completed per hour, average time between scans, and idle time (Palmer 2023). Recent reports indicate Amazon's guidelines for warehouse managers includes the use of tracking tools to identify workers with high levels of "time off task," and disciplinary procedures including written warnings and firing of workers unable to provide a satisfactory explanation for gaps in working activity (Foxglove 2022; Gurley 2022). These disciplinary procedures could, arguably, increase the salience of any gap between the worker's effort or efficiency in tasks and the benchmarks set by Amazon. In a recent national survey of Amazon's warehouse workers in the United States, 53% said they "feel a sense of being watched or monitored in their work," and 41% felt pressured to work faster, most or all of the time (Gutelius and Pinto 2023). Amazon's investment in its worker surveillance technology combined with the disciplinary procedures related to unaccounted time off tasks could be thought of as motivating agents through "guilt" as in the model in Section 3. It is important to recognize, however, that surveillance and disciplinary procedures—in particular the threat of being laid off—would affect the contract in ways not captured by the model.

The same survey found that 69% had taken unpaid time off due to pain or exhaustion from working in the company during the previous month. These findings raise the question how a competitive labor market would lead to employment contracts that workers clearly felt were harmful for their physical and mental health. Amazon's dominant position in the warehousing industry combined with the economic slowdown during the Covid-19 pandemic could have resulted in a decline in the value of the workers' outside option, that is, potential employment opportunities outside of the company. Our model predicts that "guilt" investments should increase when the value of the workers' outside option goes down (Proposition 5). Consistent with this prediction, Amazon's surveillance practices increasingly came under fire during the early months of the pandemic when Amazon managed to hire at record levels, adding 175,000 employees to its workforce in just two months (Yohn 2020). Amazon's workers reported that the rate at which Amazon expected them to stow items—tracked via their handheld scanners—fluctuated over time according to the availability of workers. A Washington Post report in December 2021 quoted Amazon workers as saying "Right now, with a tight labor market and Amazon scrambling to fill jobs … the company has dialed back reprimands of workers not meeting targets" (Greene 2021).

5.3 Monitoring versus rewards

Next, we carry out some simple empirical analysis using data from surveys on firm management practices conducted using the methodology developed by Bloom and Van Reenen (2007) and examine whether the evidence supports the theoretical predictions regarding how motivational investments vary according to the outside option of workers. Propositions

5 and 8 together imply that, under tight labor market conditions (when workers' participation constraints are more likely to bind), motivational investments that increase (decrease) job satisfaction should be higher (lower) for workers with better outside options. We use data from the 2004–2010 combined survey of over 10,000 organizations across 20 countries reported in Bloom et al. (2012). The data includes coded responses to 18 open-ended questions regarding a firm's management practices answered by plant managers.

We identify five of the survey measures—presented in Table 2—as capturing, at least in part, some element of the two types of motivational investments modeled in Sections 3 and 4. In particular, we argue that management practices related to the tracking and review of worker performance, and communication of performance measures, would put pressure on workers to meet the firm's set performance standards akin to the "guilt" investments modeled in Section 3. It is important to recognize, however, that these measures could also improve observability of the worker's effort and thus affect the contract in ways not captured by the model. Rewards for high performance and promoting high performers may include a combination of financial rewards and other (non-pecuniary) forms of worker recognition. The latter could induce workers to exert more effort akin to the motivational investments in Section 4. The survey questions do not distinguish between these two types of incentives. Nevertheless, these measures provide a useful basis for taking the theoretical predictions to the data as the model predicts that, under a binding participation constraint, *both* types of incentives should increase with the agent's outside option (Proposition 8).

For our empirical analysis, we use the log transformation of the proportion of firm employee's with higher education as a proxy for the outside option of workers. Our rationale for this proxy measure is that workers with higher levels of human capital should, at any given point in time, have more opportunities in the labor market. We use the unemployment rate in a given country and year, from the World Development Indicators database, to construct a measure of labor market tightness. To investigate how the use of specific management practices varies with the level of human capital of workers and labor market tightness, we estimate the following equation:

$$y^m_{ict} = \alpha + \beta_1 LT_{ct} + \beta_2 HC_{ict} + \beta_3 LT_{ct} \times HC_{ict} + \beta_4 MP_{ict} + \delta_c + \gamma_t + \varepsilon_{ict} \tag{46}$$

where y^m_{ict} is the normalized score for management practice m in firm i in country c surveyed in year t; LT_{ct} is an indicator for whether the unemployment rate in country c in year t is 1

Table 2. Management practice categories on performance monitoring and rewarding.

Category	**Score from 1 to 5 based on**
Performance Tracking	Tracking ad hoc and incomplete, or performance continually tracked?
Performance Review	Performance reviewed continually with expectation of continuous improvement?
Performance Clarity	Performance measures well-defined, clearly communicated and made public
Rewarding High Performance	Rewards related to performance and effort?
Promoting High Performers	Firm actively identifies, develops and promotes its top performers?

Notes: The table above is adapted from Table 1 in Bloom and Van Reenen (2010). It includes only the relevant survey questions in abbreviated form. Further details on the management practice categories and the open-ended questions asked can be found in Bloom and Van Reenen (2010).

standard deviation or more below the average between 1991 and 2022, δ_c is a country fixed-effect, γ_t is a survey year fixed-effect, ε_{ict} is an error term, and $\alpha, \beta_1, \beta_2, \beta_3$, and β_4 are parameters to be estimated.[13] We allow ε_{ict} to be correlated within industries (three-digit SIC) in the same country. The variable MP_{ict} is a measure of the firm's overall management quality, equal to the first principal component of the firm's score across all 18 categories in the survey.

The sum of the coefficients β_2 and β_3 captures how management practices vary with the outside options of firm employees (as measured by their human capital) under tight labor market conditions (when their participation constraints are more likely to bind). Our theoretical results in Sections 3 and 4 suggest that the sum should be negative for the performance monitoring measures and positive for the performance rewarding measures.

We control for overall management quality because, as noted in Bloom et al. (2012), there is a large variation in management quality across firms included in the survey. Introducing this control ensures that any association we find between our management practices of interest and labor market tightness or outside options is not due to variations in overall management quality. It is important to note that our empirical approach does not allow a causal interpretation of the estimate of $(\beta_2 + \beta_3)$ because the right-hand side variables may be correlated with other unobserved firm characteristics. Nevertheless, the regressions provide a general indication as to whether variations in firm management practices are broadly consistent with the theoretical predictions.

Estimates of equation (46) are reported in Table 3. The point estimates for the level of human capital within the firm are negative for the performance tracking variables and positive in the case of the performance rewarding variables but statistically significant only in the case of rewards for high performance. The associations are typically larger in magnitude under tight labor market conditions as captured by the sum of the estimates $(\beta_2 + \beta_3)$ (with the exception of performance clarity). The last row of the table reports the p-value from an F-test of the relationship $(\beta_2 + \beta_3) = 0$. The test does not reject the null hypothesis except in the case of performance tracking.

In Table 4, we provide estimates based on an alternative measure of labor market tightness, defined as an unemployment rate 2 standard deviations or more below the long-term average. The estimates are similar to those obtained with the previous measure: the estimate of $(\beta_2 + \beta_3)$ is negative in the case of the performance monitoring measures and positive in the case of performance rewarding measures. Under this alternative definition of a "tight" labor market, the F-test for joint significance rejects the null in all cases except in the case of performance tracking. Thus, these patterns are consistent with the theoretical results stated in Propositions 5 and 8.

6. CONCLUSION

In this article, we use the term "motivational investments" to describe a broad range of activities that firms and other types of organizations can undertake to incentivize workers, including management and leadership training, team-based exercises, and communication with workers about broader organizational goals aimed at raising the morale, team-spirit, and loyalty of the workforce. It is well known from the existing literature that organizations may use

[13] Note that each firm in the dataset was surveyed once only. Therefore, it is not possible to include firm fixed-effects in the specification.

Table 3. Management quality versus human capital and labor market tightness.

	Perf. Tracking	Perf. Review	Perf. Clarity	Reward High Perf.	Promote High Perf.
% Degrees	−0.0185	−0.0153	-0.0300^{+}	0.0481^{**}	0.00611
	(0.012)	(0.012)	(0.016)	(0.013)	(0.020)
Tight Labor	0.0631^{+}	−0.0500	0.0422	0.0324	−0.149
	(0.036)	(0.068)	(0.102)	(0.060)	(0.095)
% Degrees × Tight Labor	−0.0182	−0.00796	0.0104	0.00330	0.0573
	(0.022)	(0.042)	(0.048)	(0.046)	(0.043)
Management Quality	0.719^{**}	0.753^{**}	0.618^{**}	0.576^{**}	0.634^{**}
	(0.019)	(0.012)	(0.018)	(0.018)	(0.024)
Constant	0.0497	0.0477^{+}	0.192^{**}	−0.0430	−0.0240
	(0.046)	(0.026)	(0.063)	(0.055)	(0.064)
Observations	6222	6222	6222	6222	6222
R^2	0.546	0.589	0.414	0.409	0.449
F-test (p-value)	0.08	0.59	0.67	0.29	0.18

Notes: The dependent variables are normalized scores at the firm-level using the Management Survey Data from Bloom et al. (2012). A "tight" labor market is defined as a national unemployment rate 1 standard deviation or more below the long-term average for 1991–2022. The specification includes country fixed-effects and survey year fixed-effects. Standard errors (in parenthesis) are clustered at the country-industry level.
$^{+}$ $p < 0.10$, $^{*}p < 0.05$, ** $p < 0.01$.

Table 4. Management quality versus human capital and labor market tightness (alternative measure).

	Perf. Tracking	Perf. Review	Perf. Clarity	Reward High Perf.	Promote High Perf.
% Degrees	−0.0205	−0.0146	−0.0283	0.0476^{**}	0.0104
	(0.012)	(0.012)	(0.016)	(0.014)	(0.024)
Tight Labor	0.0120	0.206^{**}	0.236^{**}	−0.0483	-0.518^{**}
	(0.055)	(0.050)	(0.049)	(0.043)	(0.064)
% Degrees × Tight Labor	0.0101	-0.136^{**}	-0.138^{**}	0.0766^{**}	0.199^{**}
	(0.016)	(0.019)	(0.019)	(0.012)	(0.029)
Management Quality	0.719^{**}	0.753^{**}	0.618^{**}	0.576^{**}	0.634^{**}
	(0.020)	(0.012)	(0.019)	(0.018)	(0.024)
Constant	0.0529	0.0489	0.184^{**}	−0.0429	−0.0322
	(0.045)	(0.029)	(0.061)	(0.053)	(0.065)
Observations	6222	6222	6222	6222	6222
R^2	0.546	0.589	0.414	0.410	0.449
F-test (p-value)	0.41	0.00	0.00	0.00	0.00

Notes: The dependent variables are normalized scores at the firm-level using the Management Survey Data from Bloom et al. (2012). A "tight" labor market is defined as a national unemployment rate 2 standard deviation or more below the long-term average for 1991–2022. The specification includes country fixed-effects and survey year fixed-effects. Standard errors (in parenthesis) are clustered at the country-industry level.
$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$.

motivational investments either as a substitute or a complement of financial incentives to induce workers to exert more effort. Our focus in the paper has been on how the worker's outside opportunities affect an organization's choice of motivational investments and financial incentives.

We model two types of motivational investments to explore this question. In the first model, motivational investments increase the agent's disutility from deviating from a level of effort specified in the labor contract (which we call "investing in guilt"). In the second model, motivational investments lower the agent's cost of effort (which we call "investing in inspiration").

The key insight to emerge from our analysis is that the worker's outside option is a key determinant of whether motivational investments and financial incentives are used as complements or substitutes in the optimal employment contract. The reason is that motivational investments affect not only the worker's effort level but also overall job satisfaction. Some forms of motivational investments can make the work seem more enjoyable and thus increase job satisfaction. Other forms may elicit effort by exerting "pressure" on the worker and thus lower job satisfaction. We are agnostic about the type of motivational investment that an employer would choose: this choice ultimately depends on the availability and cost of different technologies for motivational investments. But, in both cases, the fact that motivational investments affect job satisfaction means that financial incentives play a dual role: to elicit the agent's effort and to ensure that the agent's participation constraint is satisfied. If the worker's outside option is sufficiently strong such that her participation constraint is binding, an increase in guilt investments (due, for example, to a decrease in the cost of such investments) is accompanied by a compensatory increase in financial incentives, while motivational investments that lower the agent's cost of effort are accompanied by a reduction in financial incentives. Our theoretical results imply that the tightness of the labor market is an important factor in determining whether organizations use motivational investments as a substitute or complement of financial incentives.

We illustrate some empirical applications of our theoretical approach using surveys on firm management practices. We show that, under tight labor markets (low unemployment rates) the empirical relationship between management styles and worker outside options are broadly consistent with our theoretical predictions.

APPENDIX A: GENERAL MODEL

In this section of the Appendix, we present results relating to the general model presented in Section 2.

First, we prove that, if the equilibrium effort level is below the first-best level, the optimal contract cannot involve a positive payment in case of low (i.e., zero) output.

Lemma 5. *If the principal cannot extract payments from the agent, the incentive compatibility and limited liability constraints will bind in the constrained optimal contract.*

Proof. We represent contracts by the three-tuple (w, b, ψ) representing a wage w paid independently of the realized output, a bonus b in case output equals A, and motivational investment ψ. Let us denote by $\hat{e}(w, b, \psi)$ the agent's optimal choice of effort given this contract. For a given ψ, the (unconstrained) optimal effort level is given by

$$e^*(\psi) = \arg\max_e eA - C(e, \psi) \tag{A1}$$

We can rule out $\hat{e}(w, b, \psi) > e^*(\psi)$ as, in such a scenario, lowering the financial reward for success so that effort equals $e^*(\psi)$ would increase the surplus generated by the contract. From equation (A1), it is evident that effort level $e^*(\psi)$ requires $b = A$. Since the agent retains the full output, for such a contract to be beneficial to the principal, it must involve a rental payment from the agent to the principal. By assumption, the principal cannot extract payments from the agent. Therefore, a contract that generates the effort level $e^*(\psi)$ is not feasible. Therefore, we must have $\hat{e}(w,b,\psi) < e^*(\psi)$. Thus, the incentive compatibility constraint will bind in the constrained optimal contract.

The principal's expected profit from the contract (w,b,ψ) is given by

$$\Pi(w,b,\psi) = \hat{e}(w,b,\psi)(A-b) - w - \mu h(\psi) \tag{A2}$$

We prove by contradiction that we must have $w=0$. Suppose that $w>0$. Then, the expected utility of the agent from the contract equals

$$w + b\hat{e}(w,b,\psi) - C\Big(\hat{e}(w,b,\psi),\psi\Big)$$

We define b' implicitly using the following equation:

$$b'\hat{e}(0,b',\psi) - C\Big(\hat{e}(0,b',\psi),\psi\Big) = w + b\hat{e}(w,b,\psi) - C\Big(\hat{e}(w,b,\psi),\psi\Big) \tag{A3}$$

By construction, the alternative contract $(0,b',\psi)$ allows the agent to achieve the same expected utility as obtained from (w,b,ψ). Since $w>0$, equation (A3) implies that $b'>b$. Then, using equation (3), we obtain $\hat{e}(0,b',\psi) > \hat{e}(w,b,\psi)$. Since $\hat{e}(w,b,\psi) < e^*(\psi)$, the effort level $\hat{e}(0,b',\psi)$ is closer to the unconstrained optimal level than $\hat{e}(w,b,\psi)$. Thus, the contract $(0,b',\psi)$ generates a higher expected surplus than (w,b,ψ). Therefore, since the contract $(0,b',\psi)$ provides the agent the same payoff as (w,b,ψ), it must yield a higher payoff for the principal than (w,b,ψ). Therefore, (w,b,ψ), where $w>0$, cannot be an optimal contract. ■

Next, we present comparative statics results with respect to μ for the case where the agent's participation constraint is non-binding. If the function $\Pi(b,\psi)$ is concave in (b,ψ)[14] and there is an interior solution to the optimization problem, the contract is fully characterized by the first-order conditions:

$$\frac{\partial\hat{e}}{\partial b}(A-b) - \hat{e}(b,\psi) = 0 \tag{A4}$$

$$\frac{\partial\hat{e}}{\partial\psi}(A-b) - \mu h'(\psi) = 0. \tag{A5}$$

We are interested in whether financial rewards and motivational investments are used as substitutes or complements by the principal (alternatively, whether the level of financial rewards go up or down when the cost of motivational investments increase). Proposition 1, stated in Section 2, describes this property. The proof of the proposition is provided below.

Proof of Proposition 1. Using the Implicit Function Theorem,[15] we obtain

[14] The condition we need to ensure strict concavity is that the Hessian of the function $\Pi(b,\psi)$ is negative definite. The precise condition in terms of the model primitives are provided in the proof of Proposition 1.
[15] See Mas-Colell, Whinston and Green (1995), Theorem M.E.1 .

$$\begin{bmatrix} \frac{\partial \hat{b}}{\partial \mu} \\ \frac{\partial \hat{\psi}}{\partial \mu} \end{bmatrix} = -\begin{bmatrix} \left(\frac{\partial^2 \hat{e}}{\partial b^2}\right)(A-b) - 2\frac{\partial \hat{e}}{\partial b} & \left(\frac{\partial^2 \hat{e}}{\partial b \partial \psi}\right)(A-b) - \frac{\partial \hat{e}}{\partial \psi} \\ \left(\frac{\partial^2 \hat{e}}{\partial \psi \partial b}\right)(A-b) - \frac{\partial \hat{e}}{\partial \psi} & \left(\frac{\partial^2 \hat{e}}{\partial \psi^2}\right)(A-b) - \mu h''(\psi) \end{bmatrix}^{-1} \begin{bmatrix} 0 \\ -h'(\psi) \end{bmatrix}$$

$$= -\frac{1}{K}\begin{bmatrix} \left(\frac{\partial^2 \hat{e}}{\partial \psi^2}\right)(A-b) - \mu h''(\psi) & -\left(\frac{\partial^2 \hat{e}}{\partial b \partial \psi}\right)(A-b) + \frac{\partial \hat{e}}{\partial \psi} \\ -\left(\frac{\partial^2 \hat{e}}{\partial \psi \partial b}\right)(A-b) + \frac{\partial \hat{e}}{\partial \psi} & \left(\frac{\partial^2 \hat{e}}{\partial b^2}\right)(A-b) - 2\frac{\partial \hat{e}}{\partial b} \end{bmatrix} \begin{bmatrix} 0 \\ -h'(\psi) \end{bmatrix}$$

Therefore, we have

$$\frac{\partial \hat{b}}{\partial \mu} = \frac{1}{K} h'(\psi)\left\{-\left(\frac{\partial^2 \hat{e}}{\partial b \partial \psi}\right)(A-b) + \frac{\partial \hat{e}}{\partial \psi}\right\} \tag{A6}$$

$$\frac{\partial \hat{\psi}}{\partial \mu} = \frac{1}{K} h'(\psi)\left\{\left(\frac{\partial^2 \hat{e}}{\partial b^2}\right)(A-b) - 2\frac{\partial \hat{e}}{\partial b}\right\} \tag{A7}$$

By assumption, the function $\Pi(b,\psi)$ is strictly concave. Therefore, as shown above, we must have $K > 0$ and $\frac{\partial^2 \Pi}{\partial b^2} < 0$.

Therefore, the expression on the right-hand side of equation (A7) is negative. Thus $\hat{\psi}$ is decreasing in μ. If $\frac{\partial^2 \hat{e}}{\partial b \partial \psi} \le 0$, then $\hat{b}$ is increasing in μ; but if $\frac{\partial^2 \hat{e}}{\partial b \partial \psi} > 0$, then $\hat{b}$ is potentially decreasing in μ. ■

So far, we have assumed that the principal cannot extract any payments from the agent. Here, we consider the case where the agent has some positive initial wealth $\underline{w}$ that can be extracted by the principal. Then, if the limited liability constraint binds (i.e., the principal extracts the agent's initial wealth in full when output is low), then the constrained optimal contract changes by the amount of the agent's liability. The next proposition is a formal statement of this result.

Proposition 9. *If a contract $(-\underline{w}, b^*, \psi^*)$ is constrained optimal for an agent with outside option $\underline{u}$ and liability limited to $\underline{w}$, then the contract $(0, b^*, \psi^*)$ is constrained optimal for an agent with outside option $\underline{u} - \underline{w}$ and liability limited to 0.*

Proof. Suppose

$$(\underline{w}, b^*, \psi^*) = \arg\max_{w,b,\psi} \hat{e}(\underline{w}, b, \psi)(A-b) - w - \mu h(\psi)$$

subject to

$$w + b\hat{e}(w,b,\psi) - C(\hat{e}(w,b,\psi),\psi) \ge \underline{u} \tag{A8}$$

$$w \ge \underline{w} \tag{A9}$$

$$\hat{e}(w,b,\psi) = \arg\max_{e} w + be - C(e,\psi) \tag{A10}$$

The solution of the optimization problem in (A10) is independent of w. Therefore, $\hat{e}(0, b^*, \psi^*) = \hat{e}(-\underline{w}, b^*, \psi^*)$. Therefore, the contract $(0, b^*, \psi^*)$ satisfies the incentive compatibility constraint and generates the same expected output as the contract $(-\underline{w}, b^*, \psi^*)$. By construction, it also satisfies the participation constraint and the limited liability constraint for an agent with outside option $\underline{u} - \underline{w}$ and liability limited to 0. Suppose $(0, b^*, \psi^*)$ were not constrained optimal. Then, there must be an alternative contract (w', b', ψ') that generates higher output and also satisfies the participation constraint and the limited liability constraint. Then, we can design a contract $(w' - \underline{w}, b', \psi')$ that generates higher output than $(-\underline{w}, b^*, \psi^*)$ and also satisfies the participation constraint and the limited liability constraint for an agent with outside option $\underline{u}$ and liability limited to $\underline{w}$. Therefore, $(-\underline{w}, b^*, \psi^*)$ cannot be constrained optimal, which contradicts our initial premise. ■

Given Proposition 9, the reasoning and comparative statics results in Propositions 1 and 2 still hold when the principal can extract payments up to $\underline{w}$ from the agent. If the limited liability constraint does not bind, then the contract will take a particular form in which the financial reward for success is independent of the level of motivational investment. This is characterized by Proposition 10.

Proposition 10. *Suppose that the agent has initial wealth $\underline{w} > 0$ that may be extracted by the principal. A contract (w, b, ψ) (i.e., an unconditional payment w to the agent) such that $w > -\underline{w}$ is constrained optimal if and only if the participation constraint is binding, $b = A$, $\psi = \psi^*(\mu)$ and*

$$\underline{w} \geq S\Big(\psi^*(\mu)\Big) - \underline{u} \tag{A12}$$

where

$$\psi^*(\mu) = \max_{\psi \geq 0} S(\psi) - \mu\psi \tag{A13}$$

The contract generates equilibrium effort level $e^*(\psi)$ given by equation (A1).

Proof. Since $w > -\underline{w}$, we must have a binding participation constraint; otherwise, the principal could lower w and increase profits without affecting the effort level or violating the participation constraint. Furthermore, the equilibrium effort level implied by the contract, $e(w, b, \psi)$, must equal $e^*(\psi)$; otherwise, the principal could lower w, increase b and thus bring the effort level closer to the first-best without violating the participation constraint. Then, equation (A1) implies that $b = A$. So, we have a rental contract in which the agent pays rent $S(\psi) - \underline{u}$. We must have $\psi = \psi^*(\mu)$. If not, it would be possible to adjust the level of motivation, increase the surplus generated by the contract and thus achieve a Pareto improvement. Then, the required rental payment satisfies the limited liability constraint if and only if equation (A12) is satisfied. ■

APPENDIX B: MODEL OF MOTIVATION THROUGH GUILT

In this section of the Appendix, we present proofs of results stated in Section 3.

Proof of Lemma 2. (i) Rearranging equation (19), we obtain

$$\bar{b}^2 + \psi e_c(2\bar{b} - e_c) = 2\underline{u}(1+\psi) \tag{B1}$$

Differentiating throughout equation (B1) w.r.t. ψ, we obtain

$$2\bar{b}\frac{\partial \bar{b}}{\partial \psi} + e_c(2\bar{b} - e_c) + 2\psi e_c\frac{\partial \bar{b}}{\partial \psi} = 2\underline{u} \tag{B2}$$

$$\Rightarrow \frac{\partial \bar{b}}{\partial \psi} = \frac{2\underline{u} + e_c(e_c - 2\bar{b})}{2(\bar{b} + \psi e_c)} \tag{B3}$$

Then, substituting for $\underline{u}$ in equation (B3) using equation (19), we obtain[16]

$$\frac{\partial \bar{b}}{\partial \psi} = \frac{(\bar{b} - e_c)^2}{2(\bar{b} + \psi e_c)(1+\psi)} \tag{B4}$$

If $\psi > 0$, we must have $\bar{b} < e_c$ (otherwise, guilt either lowers the agent's effort or has no effect on effort; and so the principal is better-off setting $\psi = 0$). Hence, we have $\frac{\partial \bar{b}}{\partial \psi} > 0$. Note that the right-hand side of equation (B4) is decreasing in ψ. Therefore, $\frac{\partial \bar{b}}{\partial \psi}$ is decreasing in ψ, that is, $\frac{\partial^2 \bar{b}}{\partial \psi^2} < 0$.

(ii) Differentiating throughout equation (B1) w.r.t. $\underline{u}$, we obtain

$$\begin{aligned} 2\bar{b}\frac{\partial \bar{b}}{\partial \underline{u}} + 2\psi e_c\frac{\partial \bar{b}}{\partial \underline{u}} &= 2(1+\psi) \\ \Rightarrow \frac{\partial \bar{b}}{\partial \underline{u}} &= \frac{1+\psi}{\bar{b} + \psi e_c} > 0 \end{aligned} \tag{B5}$$

[16] The intermediary steps are as follow. Substituting for $\underline{u}$ in (B3), we obtain

$$\begin{aligned} \frac{\partial \bar{b}}{\partial \psi} &= \frac{1}{2(\bar{b} + \psi e_c)}\left\{\frac{(\bar{b}^2 + 2\psi\bar{b}e_c - \psi e_c^2)}{(1+\psi)} + e_c(e_c - 2\bar{b})\right\} \\ &= \frac{1}{2(\bar{b} + \psi e_c)(1+\psi)}\left\{(\bar{b}^2 + 2\psi\bar{b}e_c - \psi e_c^2) + e_c(e_c - 2\bar{b})(1+\psi)\right\} \\ &= \frac{1}{2(\bar{b} + \psi e_c)(1+\psi)}\left\{(\bar{b}^2 + 2\psi\bar{b}e_c - \psi e_c^2) + e_c(e_c + e_c\psi - 2\bar{b} - 2\bar{b}\psi)\right\} \\ &= \frac{1}{2(\bar{b} + \psi e_c)(1+\psi)}\left\{(\bar{b}^2 + 2\psi\bar{b}e_c - \psi e_c^2) + e_c^2 + e_c^2\psi - 2\bar{b}e_c - 2\bar{b}\psi e_c\right\} \\ &= \frac{(\bar{b}^2 + e_c^2 - 2\bar{b}e_c)}{2(\bar{b} + \psi e_c)(1+\psi)} = \frac{(\bar{b} - e_c)^2}{2(\bar{b} + \psi e_c)(1+\psi)} \end{aligned}$$

Differentiating throughout equation (B4) w.r.t. $\underline{u}$, we obtain

$$\begin{aligned}\frac{\partial^2 \bar{b}}{\partial\psi\partial\underline{u}} &= \frac{\partial \bar{b}}{\partial\underline{u}}\frac{d}{db}\left\{\frac{(\bar{b}-e_c)^2}{2(\bar{b}+\psi e_c)(1+\psi)}\right\}\\ &= \frac{\partial \bar{b}}{\partial\underline{u}}\left[\frac{2(\bar{b}-e_c)}{2(\bar{b}+\psi e_c)(1+\psi)} - \frac{(\bar{b}-e_c)^2}{2(1+\psi)(\bar{b}+\psi e_c)^2}\right]\end{aligned} \tag{B6}$$

Simplifying the expression within the square brackets in equation (B6) and substituting for $\frac{\partial \bar{b}}{\partial \underline{u}}$ using equation (B5), we obtain[17]

$$\frac{\partial^2 \bar{b}}{\partial\psi\partial\underline{u}} = \frac{1}{2}\frac{(\bar{b}-e_c)(\bar{b}+2\psi e_c+e_c)}{(\bar{b}+\psi e_c)^3}$$

Therefore, if $e_c > \bar{b}$ (as reasoned in the proof of part (i)), then $\frac{\partial^2 \bar{b}}{\partial\psi\partial\underline{u}} < 0$. ∎

Proof of Proposition 4. Applying the Envelope Theorem to the optimization problem to equation (14) shows that the agent's expected utility from a contract (b, ψ) is decreasing in ψ. Therefore, Proposition 2 implies that the principal uses financial rewards and motivational investments as complements. We show in Section 2 that the optimal motivational investment $\hat{\psi}$ is decreasing in μ. Therefore, $\bar{b}$ is also decreasing in μ. Using equation (15), $\hat{e}(b, \psi)$ is increasing in b and ψ. It follows that effort is decreasing in μ. ∎

Proof of Proposition 5. Let us denote by $\bar{\Pi}(\psi, \underline{u}, \mu)$ the maximand in equation (26). Then, we have

$$\frac{\partial\bar{\Pi}}{\partial\psi} = \frac{\partial\hat{e}}{\partial\psi}(A-\bar{b}) + \frac{\partial\bar{b}}{\partial\psi}\left\{\frac{\partial\hat{e}}{\partial b}(A-\bar{b}) - \hat{e}(\bar{b}, e_c, \psi)\right\} - \mu\psi \tag{B7}$$

[17] We can simplify the expression in equation (B6) as follows:

$$\begin{aligned}\frac{\partial^2 \bar{b}}{\partial\psi\partial\underline{u}} &= \frac{\partial \bar{b}}{\partial\underline{u}}\left\{\frac{(\bar{b}-e_c)}{(\bar{b}+\psi e_c)(1+\psi)}\right\}\left\{1-\frac{(\bar{b}-e_c)}{2(\bar{b}+\psi e_c)}\right\}\\ &= \frac{\partial \bar{b}}{\partial\underline{u}}\left\{\frac{(\bar{b}-e_c)}{(\bar{b}+\psi e_c)(1+\psi)}\right\}\left\{\frac{2(\bar{b}+\psi e_c)-(\bar{b}-e_c)}{2(\bar{b}+\psi e_c)}\right\}\\ &= \frac{\partial \bar{b}}{\partial\underline{u}}\left\{\frac{(\bar{b}-e_c)}{(\bar{b}+\psi e_c)(1+\psi)}\right\}\left\{\frac{\bar{b}+2\psi e_c+e_c}{2(\bar{b}+\psi e_c)}\right\}\\ &= \frac{1}{2}\frac{(\bar{b}-e_c)\{\bar{b}+2\psi e_c+e_c\}}{(\bar{b}+\psi e_c)^3}\end{aligned}$$

i) Substituting for $\frac{\partial \hat{e}}{\partial \psi}$ using equation (16), for $\frac{\partial \bar{b}}{\partial \psi}$ using equation (B4), for $\frac{\partial \hat{e}}{\partial b}$ using equation (17), and for $\hat{e}(\bar{b}, e_c, \psi)$ using equation (15) in equation (B7), we obtain

$$\frac{\partial \bar{\Pi}}{\partial \psi} = \frac{(A-\bar{b})(e_c-\bar{b})}{(1+\psi)^2} + \frac{(A-\bar{b})}{(\bar{b}+\psi e_c)}\left\{\frac{(\bar{b}-e_c)^2}{2(1+\psi)^2}\right\} - \mu\psi - \frac{(\bar{b}-e_c)^2}{2(1+\psi)^2} \tag{B8}$$

Then, using $e_c = A$ in the expression above and simplifying and rearranging terms, we obtain

$$\begin{aligned}\frac{\partial \bar{\Pi}}{\partial \psi} &= \frac{(e_c-\bar{b})^3}{2(1+\psi)^2(\bar{b}+\psi e_c)} + \frac{(e_c-\bar{b})^2}{2(1+\psi)^2} - \mu\psi \\ &= \frac{(e_c-\bar{b})^2}{2(1+\psi)^2}\left\{\frac{(e_c-\bar{b})}{(\bar{b}+\psi e_c)} + 1\right\} - \mu\psi\end{aligned} \tag{B9}$$

It is clear that, if $e_c > \bar{b}$, then this last expression is decreasing in $\bar{b}$. Therefore, $\frac{\partial^2 \bar{\Pi}}{\partial \psi \partial \underline{u}} < 0$. Since $\frac{\partial^2 \bar{\Pi}}{\partial \psi \partial \underline{u}} < 0$, we can apply Topkis' theorem to show that ψ is decreasing in $\underline{u}$.

ii) To investigate the effect of increasing $\underline{u}$ on b, we define $\bar{\psi}(b, \underline{u})$ as the level of motivational investment that—given $b, \underline{u}$—causes the participation constraint to hold with equality. Using equation (18), we can write

$$\frac{1}{2}\frac{(b^2 + 2\bar{\psi} bA - \bar{\psi} A^2)}{(1+\bar{\psi})} = \underline{u}$$

Rearranging terms, we obtain

$$\bar{\psi} = \frac{b^2 - 2\underline{u}}{A^2 + 2\underline{u} - 2bA} \tag{B10}$$

By assumption, $\bar{\psi} \geq 0$. Therefore,

$$\frac{b^2 - 2\underline{u}}{A^2 + 2\underline{u} - 2bA} \geq 0 \tag{B11}$$

Then, we can show that $b^2 - 2\underline{u} \geq 0$ and $A^2 + 2\underline{u} - 2bA > 0$.[18] Differentiating throughout equation (B10) with respect to b and rearranging terms, we obtain

[18] A proof-by-contradiction for this last statement is as follows. The only other way in which (B11) can be satisfied is if $b^2 - 2\underline{u} \leq 0$ and $A^2 + 2\underline{u} - 2bA < 0$. Combining these two inequalities, we obtain

$$\begin{aligned}&A^2 + b^2 - 2bA < 0 \\ &\Rightarrow (A-b)^2 < 0\end{aligned}$$

But $A - b \geq 0$ under profit maximisation. This contradicts the last inequality above.

$$\frac{\partial \bar{\psi}}{\partial b} = \frac{4b\underline{u}}{(A^2 + 2\underline{u} - 2bA)^2} \tag{B12}$$

Differentiating throughout equation (B12) with respect to $\underline{u}$ and rearranging terms, we obtain

$$\frac{\partial^2 \bar{\psi}}{\partial b \partial \underline{u}} = \frac{4b(A^2 + 6\underline{u} - 2bA)}{(A^2 + 2\underline{u} - 2bA)^3} \tag{B13}$$

Since $A^2 + 2\underline{u} - 2bA > 0$, it follows that $\frac{\partial \bar{\psi}}{\partial b} > 0$ and $\frac{\partial^2 \bar{\psi}}{\partial b \partial \underline{u}} > 0$. Differentiating equation (B12) w.r.t. b, we obtain

$$\begin{aligned}\frac{\partial^2 \bar{\psi}}{\partial b^2} &= \frac{4\underline{u}}{(A^2 + 2\underline{u} - 2bA)^2} + \frac{(-2)4b\underline{u}(-2A)}{(A^2 + 2\underline{u} - 2bA)^3} \\ &= \frac{4\underline{u}(A^2 + 2\underline{u} + 2bA)}{(A^2 + 2\underline{u} - 2bA)^3} > 0\end{aligned}$$

Using $\bar{\psi}(b, \underline{u})$, we can rewrite the principal's optimization problem as follows:

$$\max \; \hat{e}(b, \bar{\psi})(A - b) - \frac{1}{2}\mu\bar{\psi}^2 \tag{B14}$$

We denote the maximand in equation (B14) as $\tilde{\Pi}(b, \underline{u})$. The first-order condition to equation (B14) can be written as

$$\frac{\partial \tilde{\Pi}}{\partial b} = \left(\frac{\partial \hat{e}}{\partial b} + \frac{\partial \hat{e}}{\partial \psi}\frac{\partial \bar{\psi}}{\partial b}\right)(A - b) - \hat{e}(b, \bar{\psi}) - \mu\bar{\psi}\frac{\partial \bar{\psi}}{\partial b} = 0 \tag{B15}$$

Let us denote by $b^*(\underline{u})$ the solution to equation (B15) when the agent's outside option is $\underline{u}$. Then, using the Implicit Function Theorem, we obtain

$$\frac{\partial b^*(\underline{u})}{\partial \underline{u}} = -\frac{\partial^2 \tilde{\Pi}(b, \underline{u})}{\partial b \partial \underline{u}} \Big/ \frac{\partial^2 \tilde{\Pi}(b, \underline{u})}{\partial b^2} \tag{B16}$$

Differentiating throughout equation (B15) with respect to $\underline{u}$, we obtain

$$\begin{aligned}\frac{\partial^2 \tilde{\Pi}(b, \underline{u})}{\partial b \partial \underline{u}} &= \left(\frac{\partial^2 \hat{e}}{\partial b \partial \psi}\frac{\partial \bar{\psi}}{\partial \underline{u}} + \frac{\partial^2 \hat{e}}{\partial \psi^2}\frac{\partial \bar{\psi}}{\partial \underline{u}}\frac{\partial \bar{\psi}}{\partial b} + \frac{\partial \hat{e}}{\partial \psi}\frac{\partial^2 \bar{\psi}}{\partial b \partial \underline{u}}\right)(A - b) - \frac{\partial \hat{e}}{\partial \psi}\frac{\partial \bar{\psi}}{\partial \underline{u}} - \mu\left(\frac{\partial \bar{\psi}}{\partial \underline{u}}\frac{\partial \bar{\psi}}{\partial b} + \bar{\psi}\frac{\partial^2 \bar{\psi}}{\partial b \partial \underline{u}}\right) \\ &= \left(\frac{\partial^2 \hat{e}}{\partial b \partial \psi}\frac{\partial \bar{\psi}}{\partial \underline{u}} + \frac{\partial^2 \hat{e}}{\partial \psi^2}\frac{\partial \bar{\psi}}{\partial \underline{u}}\frac{\partial \bar{\psi}}{\partial b}\right)(A - b) - \frac{\partial \hat{e}}{\partial \psi}\frac{\partial \bar{\psi}}{\partial \underline{u}} - \mu\frac{\partial \bar{\psi}}{\partial \underline{u}}\frac{\partial \bar{\psi}}{\partial b} + \left\{\frac{\partial \hat{e}}{\partial \psi}(A - b) - \mu\bar{\psi}\right\}\frac{\partial^2 \bar{\psi}}{\partial b \partial \underline{u}}\end{aligned}$$

Since $\frac{\partial \bar{\psi}}{\partial \underline{u}} < 0$, $\frac{\partial^2 \hat{e}}{\partial b \partial \psi} < 0$ and $\frac{\partial^2 \hat{e}}{\partial \psi^2} < 0$ (Lemma 1), $\frac{\partial \hat{e}}{\partial \psi} > 0$ and $\frac{\partial \bar{\psi}}{\partial b} > 0$ (see Section 3.3), all the terms within the first parentheses, and the terms $-\frac{\partial \hat{e}}{\partial \psi}\frac{\partial \bar{\psi}}{\partial \underline{u}}$ and $-\mu\frac{\partial \bar{\psi}}{\partial \underline{u}}\frac{\partial \bar{\psi}}{\partial b}$ are positive. Furthermore, $\frac{\partial^2 \bar{\psi}}{\partial b \partial \underline{u}} > 0$ (shown above). The only remaining term is that within the curly brackets. Suppose it is negative, that is,

$$\frac{\partial \hat{e}}{\partial \psi}(A-b)-\mu\bar{\psi}<0$$

Then the principal can increase expected profits by lowering guilt investments. Doing so would relax the participation constraint. This contradicts the original premise that the participation constraint is binding. Therefore, we must have

$$\left.\frac{\partial^2 \tilde{\Pi}(b,\underline{u})}{\partial b \partial \underline{u}}\right|_{b=b^*(\underline{u})}>0$$

Next, considering the denominator of equation (B16), we must have local concavity at the optimum. If not, the principal can increase profits by increasing the financial reward, which would imply that the choice of financial reward $b=b^*(\underline{u})$ is not optimal.[19] Therefore,

$$\left.\frac{\partial^2 \tilde{\Pi}(b,\underline{u})}{\partial b^2}\right|_{b=b^*(\underline{u})}<0$$

Then, it follows from equation (B16) that $\frac{\partial b^*(\underline{u})}{\partial \underline{u}}>0$, that is, the level of financial reward is increasing in the agent's outside option. ■

APPENDIX C: MODEL OF MOTIVATION THROUGH INSPIRATION

In this section of the Appendix, we present proofs of results stated in Section 4.

Proof of Lemma 4.

i) Differentiating throughout equation (34) w.r.t. $\underline{u}$, we obtain

$$\begin{aligned}
&2\frac{\partial \bar{b}}{\partial \underline{u}}\frac{\partial \bar{b}}{\partial \psi}+2\bar{b}\frac{\partial^2 \bar{b}}{\partial \psi \partial \underline{u}}=-\frac{2}{\psi^2}\\
&\Rightarrow \bar{b}\frac{\partial^2 \bar{b}}{\partial \psi \partial \underline{u}}=-\left(\frac{1}{\psi^2}+\frac{\partial \bar{b}}{\partial \underline{u}}\frac{\partial \bar{b}}{\partial \psi}\right)\\
&\Rightarrow \frac{\partial^2 \bar{b}}{\partial \psi \partial \underline{u}}=-\left(\frac{1}{\psi^2}+\frac{\partial \bar{b}}{\partial \underline{u}}\frac{\partial \bar{b}}{\partial \psi}\right)/\bar{b}\\
&=-\left(\frac{1}{\psi^2}-\frac{1}{\bar{b}\psi}\frac{\underline{u}}{\bar{b}\psi^2}\right)/\bar{b}=-\left\{\frac{1}{\psi^2}-\frac{\underline{u}}{(\bar{b})^2\psi^3}\right\}/\bar{b}\\
&=-\left\{\frac{1}{\psi^2}-\frac{\underline{u}}{\left(\frac{2\underline{u}}{\psi}\right)\psi^3}\right\}/\bar{b}=-\left(\frac{1}{\psi^2}-\frac{1}{2\psi^2}\right)/\bar{b}\\
&=-\frac{1}{2\psi^2\bar{b}}<0
\end{aligned}$$

ii) Differentiating throughout equation (34) w.r.t. ψ, we obtain

[19] Additionally, if $b^*(\underline{u})>0$, we must have an interior solution because the principal makes zero or negative profits for $b \geq A$.

$$
\begin{aligned}
&\frac{\partial \bar{b}}{\partial \psi}\frac{\partial \bar{b}}{\partial \psi}+\bar{b}\frac{\partial^2 \bar{b}}{\partial \psi^2}=\frac{2\underline{u}}{\psi^3}\\
&\Rightarrow \frac{\partial^2 \bar{b}}{\partial \psi^2}=\frac{1}{\bar{b}}\left\{\frac{2\underline{u}}{\psi^3}-\left(\frac{\partial \bar{b}}{\partial \psi}\right)^2\right\}\\
&=\frac{1}{\bar{b}}\left\{\frac{2\underline{u}}{\psi^3}-\left(\frac{\underline{u}}{\bar{b}\psi^2}\right)^2\right\}=\frac{1}{\bar{b}}\left\{\frac{2\underline{u}}{\psi^3}-\frac{\underline{u}^2}{\left(\frac{2\underline{u}}{\psi}\right)\psi^4}\right\}\\
&=\frac{1}{\bar{b}}\left\{\frac{2\underline{u}}{\psi^3}-\frac{\underline{u}}{2\psi^3}\right\}=\frac{\underline{u}}{\bar{b}\psi^3}\left(2-\frac{1}{2}\right)>0
\end{aligned}
$$

Proof of Proposition 8. We denote by $\bar{\Pi}(b,\psi)$ the maximand in equation (42). Using equation (43), when the agent's participation constraint is binding, the marginal effect of increasing motivational investments can be written as

$$
\frac{\partial \bar{\Pi}}{\partial \psi}=\frac{\partial \hat{e}}{\partial \psi}(A-\bar{b})+\frac{\partial \bar{b}}{\partial \psi}\left\{\frac{\partial \hat{e}}{\partial b}(A-\bar{b})-\hat{e}(\bar{b},\psi)\right\}-\mu\psi \tag{C1}
$$

i) We can write equation (C1) as

$$
\begin{aligned}
\frac{\partial \bar{\Pi}}{\partial \psi}&=\bar{b}(A-\bar{b})+\left(-\frac{\underline{u}}{\bar{b}\psi^2}\right)\{\psi(A-\bar{b})-\bar{b}\psi\}-\mu\psi\\
&=\bar{b}(A-\bar{b})-\left(\frac{\underline{u}}{\bar{b}\psi}\right)(A-2\bar{b})-\mu\psi
\end{aligned}
$$

Therefore,

$$
\begin{aligned}
\frac{\partial^2 \bar{\Pi}}{\partial \psi \partial \underline{u}}&=\frac{\partial \bar{b}}{\partial \underline{u}}(A-2\bar{b})-\frac{1}{\psi}\left[\left\{\frac{1}{\bar{b}}-\frac{\underline{u}}{(\bar{b})^2}\frac{\partial \bar{b}}{\partial \underline{u}}\right\}(A-2\bar{b})+\left(\frac{\underline{u}}{\bar{b}}\right)\left(-2\frac{1}{\bar{b}\psi}\right)\right]\\
&=\frac{\partial \bar{b}}{\partial \underline{u}}(A-2\bar{b})-\frac{1}{\psi}\left[\frac{1}{\bar{b}}\left(1-\frac{\underline{u}}{\bar{b}^2\psi}\right)(A-2\bar{b})-2\left(\frac{\underline{u}}{\bar{b}^2\psi}\right)\right]\\
&=\frac{1}{\bar{b}\psi}(A-2\bar{b})-\frac{1}{\psi}\left[\frac{1}{2\bar{b}}(A-2\bar{b})-1\right]=\frac{1}{\psi}\left[\frac{1}{\bar{b}}(A-2\bar{b})-\frac{1}{2\bar{b}}(A-2\bar{b})+1\right]\\
&=\frac{1}{\psi}\left[\frac{1}{2\bar{b}}(A-2\bar{b})+1\right]=\frac{1}{\psi}\left(\frac{A}{2\bar{b}}-1+1\right)\\
&=\frac{A}{2\bar{b}\psi}>0
\end{aligned}
$$

Since $\frac{\partial^2 \bar{\Pi}}{\partial \psi \partial \underline{u}}>0$, we can apply Topkis' theorem to show that ψ is increasing in $\underline{u}$.

ii) To investigate the effect of increasing $\underline{u}$ on b, we define $\bar{\psi}(b, \underline{u})$ as the level of motivational investment that—given $b, \underline{u}$—causes the participation constraint to hold with equality. Using equation (33), we can write

$$\bar{\psi}(b, \underline{u}) = \frac{2\underline{u}}{b^2} \tag{C2}$$

Using $\bar{\psi}(b, \underline{u})$, we can rewrite the principal's optimization problem as follows:

$$\max \hat{e}(b, \bar{\psi})(A - b) - \frac{1}{2}\mu\bar{\psi}^2 \tag{C3}$$

We denote the maximand in equation (C3) as $\tilde{\Pi}(b, \underline{u})$. Therefore, we have

$$\begin{aligned} \frac{\partial\tilde{\Pi}}{\partial b} &= \left(\frac{\partial\hat{e}}{\partial b} + \frac{\partial\hat{e}}{\partial\psi}\frac{\partial\bar{\psi}}{\partial b}\right)(A - b) - \hat{e}(b, \bar{\psi}) - \mu\bar{\psi}\left(-\frac{4\underline{u}}{b^3}\right) \\ &= \left(\frac{\partial\hat{e}}{\partial b} + \frac{\partial\hat{e}}{\partial\psi}\frac{\partial\bar{\psi}}{\partial b}\right)(A - b) - \hat{e}(b, \bar{\psi}) + 4\frac{\mu\bar{\psi}\underline{u}}{b^3} \end{aligned} \tag{C4}$$

Recall from equation (32) that $\hat{e}(b, \bar{\psi}) = b\psi \Rightarrow \frac{\partial\hat{e}}{\partial b} = \psi, \frac{\partial\hat{e}}{\partial\psi} = b$. Also, from equation (C2), $\frac{\partial\bar{\psi}(b,\underline{u})}{\partial b} = -\frac{4\underline{u}}{b^3}$. Substituting using these expressions in equation (C4), we have

$$\begin{aligned} \frac{\partial\tilde{\Pi}}{\partial b} &= \left(\bar{\psi} - \frac{4\underline{u}}{b^2}\right)(A - b) - b\bar{\psi} + 8\frac{\mu\underline{u}^2}{b^5} \\ &= \left(\frac{2\underline{u}}{b^2} - \frac{4\underline{u}}{b^2}\right)(A - b) - b\frac{2\underline{u}}{b^2} + 8\frac{\mu\underline{u}^2}{b^5} \\ &= -\frac{2\underline{u}}{b^2}(A - b) - b\frac{2\underline{u}}{b^2} + 8\frac{\mu\underline{u}^2}{b^5} \\ &= -\frac{2\underline{u}A}{b^2} + \frac{8\mu\underline{u}^2}{b^5} \end{aligned} \tag{C5}$$

Therefore, the first-order condition for the optimization problem in equation (C3) can be written as

$$\begin{aligned} &-\frac{2\underline{u}A}{b^2} + \frac{8\mu\underline{u}^2}{b^5} = 0 \\ &\Rightarrow \frac{1}{b^2}\left(-2\underline{u}A + \frac{8\mu\underline{u}^2}{b^3}\right) = 0 \\ &\Rightarrow \frac{8\mu\underline{u}^2}{b^3} = 2\underline{u}A \Rightarrow b = \left(\frac{4\mu\underline{u}}{A}\right)^{\frac{1}{3}} \end{aligned} \tag{C6}$$

Therefore, b is increasing in the outside option $\underline{u}$.

iii) Since ψ and b are both increasing in $\underline{u}$ and the agent's optimal level of effort is increasing in ψ and b, it follows that the level of effort is also increasing in the outside option. ■

Proof of Proposition 7. Applying the Envelope theorem to the optimization problem in equation (31) shows that the agent's expected utility from a contract (b, ψ) is increasing in ψ. Therefore, Proposition 2 implies that the principal uses financial rewards and motivational investments as substitutes. We show in Section 2 that the optimal motivational investment $\hat{\psi}$ is decreasing in μ. Therefore, $\bar{b}$ is increasing in μ; that is, as μ increases, the principal substitutes away from motivational investments toward financial rewards to ensure that the agent's participation constraint is satisfied.

The overall effect of an increase in ψ on the agent's effort is given by

$$\begin{aligned}
&\frac{d}{d\psi}\hat{e}(\bar{b}, \psi) \\
&= \frac{\partial \hat{e}}{\partial b}\frac{\partial \bar{b}}{\partial \psi} + \frac{\partial \hat{e}}{\partial \psi} \\
&= \psi\left(-\frac{\underline{u}}{\bar{b}\psi^2}\right) + \bar{b} \\
&= -\frac{\underline{u}}{\bar{b}\psi} + \bar{b} = \frac{-\underline{u} + (\bar{b})^2\psi}{\bar{b}\psi} \\
&= \frac{-\underline{u} + \frac{2\underline{u}}{\psi}\psi}{\bar{b}\psi} = \frac{-\underline{u} + 2\underline{u}}{\bar{b}\psi} \\
&= \frac{\underline{u}}{\bar{b}\psi} > 0
\end{aligned}$$

Therefore, the decrease in motivational investments will lead to decreased effort by the agent. ■

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