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# Employee Ownership and Entrenchment Strategies

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**Abstract**

We study entrenchment in a signaling model of employee ownership. A manager, privately informed about their type, offers their employee a stake in the firm; the employee infers the manager's type from this offer and chooses their effort. A good manager finds it harder than a bad one to induce maximal effort, while both types rank contracts alike, which works against separation. When the dismissal threshold does not bind, the unique pure strategy equilibrium surviving a refinement of deviations is pooling. When it binds, a low-performing manager who keeps their position with positive probability grants more stock than under complete information only in equilibria in which the employee randomizes, and they are then exactly indifferent to doing so: over-granting appears, but it yields them nothing relative to the cheapest contract they offer, and it never reaches the level that entrenchment would require. In that regime, the cost of asymmetric information falls entirely on the low-performing manager, who may be expelled even when retaining them would make no party worse off and some strictly better off. With continuous effort, over-granting arises in every specification we compute, but it is unrelated to the threat of dismissal.

**Keywords:** employee ownership; entrenchment; signaling games; corporate governance

**JEL Classification:** L22; M12; C62; C72

## 1. Introduction

Modeling corporate governance relations as a signaling game has a long and prolific tradition starting with Fama (1980) and Chamley (1983).[1] Aubert et al. (2014) propose a model of this kind in which employee ownership plays a central role. A manager, privately informed about their ability, grants stock to an employee; the employee infers the manager's type from the grant before choosing their effort; and the shareholders dismiss the manager if their performance falls short of a threshold. Aubert et al. (2014) claim that inefficient managers may oversize employee stock ownership in order to avoid dismissal: since bad managers are more likely to underperform, they may want to grant more stock to give employees stronger incentives. Following Tirole (2010), they call this strategy "entrenchment".

This paper shows that employee ownership never functions as an entrenchment device in their model. Establishing this requires two preliminary steps. The first is to complete the game. Aubert et al. (2014) do not say what either party receives once the manager is dismissed, so that their game is not fully specified. We specify when the dismissal decision is taken and on what information, and we supply the missing payoffs in the way that makes the threshold operate as the constraint they treat it as: a dismissed manager forfeits their stake, while the employee keeps their shares. The second step is to state precisely what entrenchment means. A manager may grant more stock than they would if their type were

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known; we call this over-granting. Entrenchment, in the sense of Aubert et al. (2014), is a stronger property: the bad manager grants more than the contract that would motivate an employee who knows only the prior distribution of types, and this additional stock keeps them in place. The two notions are easily conflated, and in their model, the apparent support for the entrenchment hypothesis rests on that confusion.

A first difficulty requires no equilibrium analysis at all. Effort takes two values in the model, and at the equilibrium contract, the employee already exerts the higher of them. No further grant of stock can raise it, while every additional unit reduces the manager's wealth. Entrenchment is therefore counterproductive if the dismissal condition applies to that wealth, and empty if it applies to the rate of return on company stock. This effort ceiling concerns the effort channel only, which is the one Aubert et al. (2014) have in mind; it says nothing about channels, such as votes or takeover contests, that the model does not contain. Representing the mechanism they describe would require a continuous effort variable.

The equilibrium analysis of the completed game confirms this diagnosis. Since the manager's type is private information, the employee infers it from the grant they receive, and a good manager finds it hard to design a grant that a bad manager could not profitably imitate: an employee who expects a good manager already earns a high return without working, and must be granted more stock before they work, while both types rank grants in the same way. As a result, no separating equilibrium in pure strategies gives both types a strictly positive payoff; separation is possible only if the bad manager earns nothing or leaves the firm, which amounts to expelling them rather than protecting them. When the dismissal threshold does not bind, pooling equilibria in which both types keep their positions and grant more stock than necessary do exist, but they are sustained by beliefs that do not survive a standard requirement on the consistent interpretation of deviations; the equilibrium that survives pools at the contract that motivates an employee holding the prior, and involves no entrenchment. When the threshold binds, a bad manager who keeps their position grants more stock than under complete information only in equilibria in which the employee randomizes. They are then exactly indifferent across the contracts they offer: the additional stock is offset, to the last unit, by the increase in the probability that the employee works, which raises their probability of retention but not their payoff. Over-granting gives them nothing more than the cheapest contract they offer, leaves them worse off than under complete information, though better off than if they left the firm, and never reaches the level that entrenchment would require. In that regime, the payoff of the good manager is unaffected by the asymmetry of information.

The analysis also has a welfare consequence that runs against the concern that motivates Aubert et al. (2014). They worry that asymmetric information lets weak managers entrench themselves when they should not be retained. The opposite can occur: a low-performing manager who would clear the dismissal threshold may nevertheless be expelled, because the employee cannot distinguish them from a high-performing one and refuses to work, even though a planner who observed their type could retain them without making anyone worse off, and with a strict gain for them and for the employee. When the threshold binds, the cost of the informational friction thus falls entirely on the manager whom the entrenchment story casts as its beneficiary.

The effort ceiling suggests a natural extension: does over-granting reappear once effort can vary continuously, giving the manager the margin that the binary model denies them? We find, numerically, that it does. In a version of the model with continuous effort, which leaves the dismissal threshold aside in order to isolate the effort margin, separating equilibria exist in which a low-performing manager grants strictly more stock than under complete information, in each of the sixteen specifications we compute. This over-granting owes nothing to the threat of dismissal; it follows from the effort margin itself.

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Relative to Aubert et al. (2014), the contribution of the paper is therefore fourfold. It completes their game; it distinguishes entrenchment from over-granting; it characterizes the equilibria of the completed game, in pure and in mixed strategies, and shows that entrenchment either fails to exist or rests on beliefs that do not survive the refinement we use, while over-granting, where it exists, gives the manager who resorts to it nothing more than the cheapest contract they offer; and it shows that their mechanism requires a continuous effort variable, with which over-granting reappears for reasons unrelated to the threat of dismissal.

Beyond this specific model, the paper relates to two strands of literature. The first studies employee ownership as a governance device. Pagano and Volpin (2005) show how managers may ally with their employees, through generous labor contracts, to deter hostile takeovers; entrenchment then operates through the market for corporate control rather than through the employees' effort. Empirically, Hollandts (2018) finds that employee stock ownership strengthens the relation between poor performance and the dismissal of the chief executive officer, and Hollandts et al. (2018) document an inverted U-shaped relation between employee ownership and managerial entrenchment. Event studies of employee stock ownership plans point to several channels at once: Chaplinsky and Niehaus (1994) find evidence of takeover deterrence without a significantly negative average effect on shareholder wealth for defensive plans, and Beatty (1995) relates announcement effects to expected tax savings and to a reduced likelihood of takeover for firms under threat. Faleye et al. (2006) show that firms in which employees have a strong voice in governance differ in their policies and performance, consistent with employees weighing their contractual claims together with their residual ones. Aubert et al. (2018) extend the model of Aubert et al. (2014) to an ambiguity-averse employee; our analysis assumes expected utility and does not carry over automatically to that setting, although the effort ceiling, which rests only on the binary effort margin, does. Our model isolates a single channel, the effect of a grant on the employee's effort and beliefs, and its conclusions bear on that channel only.

The second strand concerns contracts used as signals. Formally, the model is an informed principal problem in which the principal's private information directly affects the agent's payoff, the common values case studied by Maskin and Tirole (1992). Two features call for an analysis of its own: the agent's effort is hidden, and the principal has a single instrument, a grant of stock whose value to the agent depends on the principal's type. Beaudry (1994) shows that a principal privately informed about the production technology may leave rents to the agent, the information being conveyed by the structure of base wages and bonuses; the single instrument of the present model rules out that channel. Leland and Pyle (1977) show that an entrepreneur can signal the quality of their project through the share of equity they retain, and Gallini and Wright (1990) and Macho-Stadler et al. (1996) study licensing contracts in which private information about the value of an innovation shapes the split between a fixed fee and a royalty. The informational structure is close to ours: in each case, a share of an uncertain value changes hands between an informed and an uninformed party, and the value of that share to each of them depends on the informed party's type. The comparison is instructive. A royalty ties the licensor's revenue to the true value of the innovation, and is therefore less costly for a licensor who knows that value to be high; this is what allows the royalty to sort types. The good manager of our model faces the opposite configuration. The employee requires more stock from them than from a bad manager, and the stake costs them more, since their retained wealth earns a higher return, while for a given effort, the two types rank grants identically. Both features run against separation through the contract, and their combination is the root of the results that follow.

The remainder of the paper is organized as follows. Section 2 presents the model, the timing of the dismissal decision and the solution concept. Section 3 introduces the

contracts on which the analysis rests and shows that the assumptions are consistent. Section 4 characterizes the complete information benchmark, defines over-granting and entrenchment, and sets out the effort ceiling. Section 5 studies the signaling equilibria of the binary-effort model, including the welfare result, and discusses the role of the maintained assumptions; it opens with a map of the results and of the assumptions under which each holds. Section 6 studies continuous effort. Section 7 concludes and discusses extensions. The mixed-strategy equilibria are analyzed in Appendix A, and all proofs are gathered in Appendix B.

## 2. The Model

As Aubert et al. (2014), we consider a signaling game between two players, a "manager" and an "employee". The manager privately observes their type and offers the employee a compensation scheme. The employee observes the scheme, updates their beliefs about the manager's type and chooses their level of effort. Returns are then realized, and the shareholders evaluate the manager's performance and dismiss them if it falls short of a threshold. Figure 1 summarizes the timing, and the rest of this section specifies each stage.

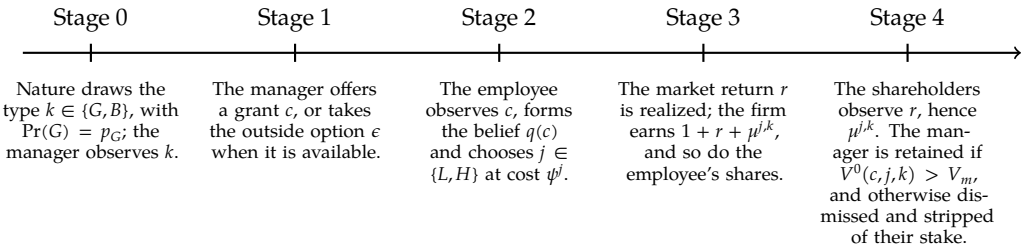



**Figure 1.** Timing of the game. Dismissal is decided after returns are realized, on the basis of the manager's performance net of the market return, and it does not affect the employee's shares.

The manager's type is denoted $k$ and can take the value $G$ (for a good manager) or the value $B$ (if they are a bad manager). The manager's probability of being of the type $G$ is denoted $p_G$. Hence, the probability of being of the other type is $1 - p_G$, denoted $p_B$, with $0 < p_G < 1$. These probabilities are common knowledge. Similarly, by $j$, we denote the employee's effort, which can be low $(L)$ or high $(H)$.

The rate of return of the company stock is $r + \mu^{j,k}$, where $r$ is a random variable with a continuous density $f(.)$ and a bounded support; the bounded support guarantees that all the expectations below are finite and can be differentiated under the integral sign. We assume throughout that the gross return on company stock is strictly positive in every state, that is,

$$1 + r + \mu^{L,B} > 0 \qquad \text{for every } r \text{ in the support of } f. \tag{1}$$

Since $\mu^{L,B}$ is the smallest of the four values $\mu^{j,k}$, condition (1) makes $1 + r + \mu^{j,k} > 0$ for every effort and every type. It plays two roles. It keeps the argument of the employee's utility function $u$, introduced in (6) below, strictly positive, so that the employee's expected utility is well defined under Inada's conditions, and it keeps the manager's gross payoff $(W_d - cW_s)(1 + r + \mu^{j,k})$ non-negative for every admissible contract. The integrals written below over $\mathbb{R}$ are therefore to be read as integrals over the support of $f$.

The variable $\mu^{j,k}$ is a deterministic quantity which can take four values. It is assumed that $\forall\, k \in \{B, G\}, \quad \mu^{H,k} > \mu^{L,k}$ and $\forall\, j \in \{H, L\}, \quad \mu^{j,G} > \mu^{j,B}$. It is also assumed that there is no cross-effect between effort and types:

$$\mu^{H,G} - \mu^{L,G} = \mu^{H,B} - \mu^{L,B}, \tag{2}$$

and

$$\mu^{H,G} - \mu^{H,B} = \mu^{L,G} - \mu^{L,B}. \tag{3}$$

Conditions (2) and (3) are two ways of writing the same restriction, $\mu^{H,G} - \mu^{L,G} - \mu^{H,B} + \mu^{L,B} = 0$; we record both because each is the convenient form in a different argument below. Equivalently, the return is additively separable in effort and type: there are numbers $\mu^H > \mu^L$ and $\mu^G > \mu^B$, unique up to a common additive constant, such that $\mu^{j,k} = \mu^j + \mu^k$ for every $j$ and $k$; one may take $\mu^L = 0$, $\mu^H = \mu^{H,B} - \mu^{L,B}$, $\mu^B = \mu^{L,B}$ and $\mu^G = \mu^{L,G}$, and condition (2) then gives $\mu^{H,G} = \mu^H + \mu^G$. We nevertheless keep the joint notation $\mu^{j,k}$ throughout the binary model. It makes visible which results rest on the restriction and which do not, a distinction that Section 5.3 exploits when discussing cross-effects, and it matches the notation of the continuous model of Section 6, where a general return $\mu(e,k)$ is specialized to the additive form $\mu(e) + \mu^k$.

The manager has an initial wealth denoted by $W_d$. All their wealth is invested in the project. The employee's net wealth is denoted $W_s$. Those quantities are strictly positive: $W_d > 0$, $W_s > 0$. The employee's compensation is a share of the total asset of the firm. After having observed their type, the manager proposes a quantity $cW_s$ of assets of the project, with $0 \leqslant c \leqslant \frac{W_d}{W_s}$. In the following, we will consider $c$ as a "contract". The fraction of the firm's assets transferred to the employee is $s(c) = cW_s/W_d$; contracts are reported in units of $c$, and statements about ownership in percentage points refer to $s(c)$.

After the grant, the manager's wealth $A(c) = W_d - cW_s$ remains invested in the firm. Write $\rho = 1 + \int_{\mathbb{R}} rf(r)dr$ for the expected gross return on the firm's assets. The manager's gross payoff is the expected value of their stake,

$$V^0(c,j,k) = \int_{\mathbb{R}} \big(1 + r + \mu^{j,k}\big)(W_d - cW_s)f(r)\,dr = A(c)\big(\rho + \mu^{j,k}\big), \tag{4}$$

where $j$ is the effort made by the employee and $k$ the type of the manager.

Following Aubert et al. (2014), the manager is subject to a minimum performance condition $V_m > 0$, set by the shareholders, who are not modeled as players: they are dismissed when their performance falls short of $V_m$. Aubert et al. (2014) leave three features of this rule unspecified, and any analysis of their model must supply them. We do so as follows.

The first concerns what is evaluated, and when. The shareholders act after the employee has chosen their effort and returns have been realized. They observe the market return $r$, a shock common to all firms, together with the firm's return $1 + r + \mu^{j,k}$, and therefore the firm-specific component $\mu^{j,k}$. They evaluate the manager's stake at the expected market return, that is, by $V^0(c,j,k)$, and dismiss them if $V^0(c,j,k) \leqslant V_m$. Filtering out a common shock that conveys no information about the contributions of the manager and the employee is the standard use of such information (Holmström, 1979), and the resulting condition is the one Aubert et al. (2014) state, a minimum on the manager's expected wealth given effort and type. Since the decision follows the employee's effort, the threshold applies effort level by effort level. When the employee randomizes, the manager may be retained after high effort and dismissed after low effort, so that their expected payoff can lie below $V_m$ even though they are retained with positive probability.

The second concerns what dismissal does to the manager. We assume that a dismissed manager forfeits their stake together with the benefits of control, and receives nothing. This is an assumption about payoffs, not a normalization: a residual stake would have a value $A(c)\big(\rho + \mu^{j,k}\big)$ that depends on the contract, so that removing it is not an additive constant common to all actions. We adopt it because it is the specification under which the threshold operates as the constraint that Aubert et al. (2014) treat it as: since $V^0(c,j,k) \geqslant 0$ for every admissible contract, a manager who falls below $V_m$ obtains the lowest payoff attainable in the model. It has an institutional counterpart in the "bad leaver" provisions of management equity plans, under which a manager dismissed for poor performance must sell their shares back at a price that may be as low as their nominal value, which we take to be zero. The

main alternative, in which a dismissed manager keeps their stake, whose value depends on the contract, and loses only the private benefits of control, defines a different game; the conclusion discusses which of our results it would preserve.

The third concerns what dismissal does to the firm and to the employee. Dismissal removes the manager; it does not close the firm, which continues under a replacement whom we do not model. Since the decision is taken after returns have been realized, the employee's shares have already earned $1 + r + \mu^{j,k}$, and their payoff does not depend on the dismissal decision.

The manager's payoff is therefore

$$V(c,j,k) = \begin{cases} V^0(c,j,k) & \text{if } V^0(c,j,k) > V_m, \\ 0 & \text{otherwise,} \end{cases}$$

since their retention depends on $\mu^{j,k}$ but not on $r$. The distinction matters only for the limit contracts introduced in Section 3 (Definition 2), the contracts beyond which a manager would rather grant nothing and let their employee shirk than grant stock and have them work; everywhere else, we work directly with $V$. Note that $V^0(\cdot,j,k)$ is strictly decreasing in $c$, whereas $V(\cdot,j,k)$ is only weakly so, since it is flat at zero below the threshold.

It will be convenient to name the contract at which a type $B$ manager whose employee works exactly reaches the threshold. Let

$$\hat{c}_B = \frac{1}{W_s}\left(W_d - \frac{V_m}{\rho + \mu^{H,B}}\right), \tag{5}$$

so that $V^0(\hat{c}_B, H, B) = V_m$. Since $V^0(\cdot, H, B)$ is strictly decreasing, $V^0(c, H, B) > V_m$ if and only if $c < \hat{c}_B$.

$P_M(c,k)$ denotes the manager's strategy, and $P_M(c,k) \in [0,1]$, $k \in \{B,G\}$ and $c \in \left[0, \frac{W_d}{W_s}\right]$. We define the strategy as a probability since we do not want to exclude mixed strategy equilibria. For the manager, a strategy is a probability of offering a certain contract depending on their type.

The employee's preferences are represented by the following expression:

$$\int_{\mathbb{R}} u\left[W_s(1+r_0) + cW_s\left(1 + r + \mu^{j,k}\right)\right] f(r)\, dr - \psi^j, \tag{6}$$

with the same conventions on $j$ and $k$. The function $u$ is a twice continuously differentiable, strictly increasing and strictly concave von Neumann–Morgenstern utility function satisfying Inada's conditions, and $r_0 > -1$ denotes the risk-free interest rate. The variable $\psi^j$ represents the disutility of effort. We assume that $\psi^L \geqslant 0$ and $\psi^H > \psi^L$, which is natural in a model of moral hazard. The employee chooses their level of effort after having observed the contract offered by the manager. We denote by $P_E(j,c)$ their strategy, with $j \in \{H,L\}$, $c \in \left[0, \frac{W_d}{W_s}\right]$ and $P_E(j,c) \in [0,1]$. The employee's strategy is a probability of choosing a level of effort, given the observed contract.

We need a restriction on the utility function $u(\cdot)$. Following Aubert et al. (2014), we assume that

$$\forall x > 0, -x\frac{u''(x)}{u'(x)} \leqslant 1. \tag{7}$$

This assumption guarantees that the employee's choice of effort is monotonic with respect to the contract: in short, a higher value of $c$ makes the choice of the high level of effort more likely. The first lemma in the next section makes this precise.

Moreover it is assumed that

$$u[W_s(1+r_0)] - \psi^L > 0, \tag{8}$$

and $\forall\, c \in \left[0, \frac{W_d}{W_s}\right]$, $\forall\, j \in \{H, L\}$,

$$\sum_{k\in\{G,B\}} \int_{\mathbb{R}} p_k u\big[W_s(1+r_0) + cW_s\big(1+r+\mu^{j,k}\big)\big] f(r)dr \geqslant u[W_s(1+r_0)]. \tag{9}$$

Since these assumptions do not affect our results, they could safely be dispensed with. We nevertheless retain them, as we want to derive our results within exactly the model proposed by Aubert et al. (2014).

*Solution Concept*

Throughout the paper, we use perfect Bayesian equilibrium. In the present game, each player moves once and only the employee is uninformed. An equilibrium therefore consists of a strategy $P_M(\cdot, k)$ for each type of manager, a strategy $P_E(\cdot, c)$ for the employee at every contract $c$, and a system of beliefs, $P_{kc}$ denoting the probability the employee assigns to type $k$ after observing $c$, such that the following conditions hold:[2]

- $P_M(c,k) > 0$ only if

$$c \in \underset{c'\in\left[0,\frac{W_d}{W_s}\right]}{\arg\max}\, U_k(c'), \qquad U_k(c') = \sum_{j\in\{H,L\}} P_E(j,c')V(c',j,k),$$

- $P_E(j,c) > 0$ only if

$$j \in \underset{e\in\{H,L\}}{\arg\max} \sum_{k\in\{G,B\}} P_{kc}\left(\int_{\mathbb{R}} u\big[W_s(1+r_0) + cW_s\big(1+r+\mu^{e,k}\big)\big] f(r)dr - \psi^e\right),$$

- $P_{kc} = \frac{P_M(c,k)p_k}{\sum_{l\in\{G,B\}} p_l P_M(c,l)}$ if $\sum_{l\in\{G,B\}} p_l P_M(c,l) > 0$, and $P_{kc}$ is an arbitrary real number between 0 and 1 otherwise.

We restrict attention to strategies of the manager with finite support, so that $P_M(\cdot, k)$ assigns probabilities to finitely many contracts; when the manager has an outside option, these probabilities sum to the probability that they run the firm. We call an equilibrium a pure-strategy equilibrium when all players, the employee included, use pure strategies; an equilibrium in which the manager uses a pure strategy while the employee randomizes is not a pure-strategy equilibrium.

The first two conditions require each player to maximize their expected payoff, the employee doing so at every contract, including those that are offered with probability zero. The function $U_k(c')$ is the expected payoff of a type $k$ manager who offers $c'$: it averages, over the employee's effort lottery, the truncated payoffs $V$ of the two effort branches, each evaluated under the dismissal rule of Section 2. When the manager has an outside option $\epsilon$, as in Section 5.1, the first condition also requires $U_k(c) \geqslant \epsilon$ at every contract they offer with positive probability, and they exit with positive probability only if $\epsilon \geqslant U_k(c')$ for every contract $c'$. We write $U_k$ for the equilibrium payoff of a type $k$ manager: it equals $U_k(c)$ at every contract they offer with positive probability, and $\epsilon$ when they exit. The third condition requires the employee's beliefs to be derived from the prior and the manager's strategy by Bayes' rule whenever possible; at contracts offered with probability zero, beliefs are unrestricted. We write $q(c) = P_{Gc}$ for the posterior probability of the good type, the notation used in Section 6 and in Appendices A and B. In a pure-strategy equilibrium in which the manager makes different offers according to their type, the third condition implies that the employee, having observed the contract, knows the manager's type. The complete information benchmark of Section 4 is the special case in which the employee's beliefs are degenerate at the true type.

Since beliefs off the equilibrium path are unrestricted, the game has many perfect Bayesian equilibria. Where this multiplicity matters, we select among them with the refinement stated formally in Definition 4 of Section 5.

It is useful to separate what the model inherits from Aubert et al. (2014) from what we add to it. The two types and their private observation by the manager, the binary effort of the employee, the stock grant as the only compensation instrument, the bound on the employee's relative risk aversion, the return technology with its absence of cross-effects between effort and type, and the dismissal threshold $V_m$ imposed by the shareholders on the manager's expected wealth are all taken from their model. Their account leaves open what happens once the threshold is applied; the timing of the dismissal decision, the information on which it rests, and the payoffs that follow it, under which a dismissed manager forfeits their stake while the employee keeps their shares, are specified here. Two extensions are our own: an outside option for the manager (Section 5.1) and a continuous effort variable (Section 6); we also discuss what changes when effort and type have cross-effects on the return (Section 5.3). Finally, Aubert et al. (2014) do not state an equilibrium concept explicitly; we use perfect Bayesian equilibrium, refined where necessary by the criterion of Definition 4.

## 3. Consistency and Preliminary Results

This section introduces the contracts on which the analysis rests and establishes their properties, before showing that the assumptions of the model are mutually consistent. For readability, all proofs are deferred to Appendix B.

**Lemma 1.** *If we define the function* $\omega_k(.)$ *as*

$$\begin{aligned} \forall c \geqslant 0,\ \omega_k(c) = \int_{\mathbb{R}} u\left[W_s(1+r_0) + cW_s\left(1+r+\mu^{H,k}\right)\right] f(r)dr \\ - \int_{\mathbb{R}} u\left[W_s(1+r_0) + cW_s\left(1+r+\mu^{L,k}\right)\right] f(r)dr \end{aligned} \tag{10}$$

*then* $\omega_k(0) = 0$ *and* $\forall\, c \in \left[0, \frac{W_d}{W_s}\right]$, $\omega_k'(c) > 0$.

We define a function $\omega(.)$ as $\omega(.) = \sum_k p_k \omega_k(.)$. The function $\omega$ has the same properties as the functions $\omega_k(.)$. The proof, given in Appendix B, relies on assumption (7), which bounds the employee's coefficient of relative risk aversion by one, together with $W_s > 0$, $r_0 > -1$ and (1); the bound is not a convenience, since the lemma fails for relative risk aversion above one once $c$ is large enough. The lemma implies that, for each type of manager and unambiguously so, the employee exerts low effort for "low" values of $c$ and maximal effort for "high" values of $c$. Between these two extreme cases, there is at most one contract making the employee indifferent between the two effort levels; condition (16) at the end of this section guarantees that it exists. These contracts play a central role in what follows, and we name them.

**Definition 1.** *We define* $c_k^*$ $(k \in \{G,B\})$ *as the contract for which an employee chooses indifferently to make the high or the low level of effort when they know for sure that the contract is offered by a manager having the type* $k$*. In formal terms:*

$$\begin{aligned} \int_{\mathbb{R}} u\left[W_s(1+r_0) + c_k^* W_s\left(1+r+\mu^{L,k}\right)\right] f(r)dr - \psi^L = \\ \int_{\mathbb{R}} u\left[W_s(1+r_0) + c_k^* W_s\left(1+r+\mu^{H,k}\right)\right] f(r)dr - \psi^H. \end{aligned} \tag{11}$$

*Similarly, we can define the contract* $c^*$ *that makes the employee indifferent between the two level of effort when they do not know the type of the manager.*

$$\begin{aligned} \sum_{k\in\{G,B\}} \int_{\mathbb{R}} p_k\, u\left[W_s(1+r_0) + c^* W_s\left(1+r+\mu^{L,k}\right)\right] f(r)dr - \psi^L = \\ \sum_{k\in\{G,B\}} \int_{\mathbb{R}} p_k\, u\left[W_s(1+r_0) + c^* W_s\left(1+r+\mu^{H,k}\right)\right] f(r)dr - \psi^H. \end{aligned} \tag{12}$$

In the remainder of the paper, we say that a contract $c$ is incentive-compatible with respect to a type $k$ manager if $c \geqslant c_k^*$. Similarly, if a contract $c$ is greater than or equal to $c^*$, we say that it is incentive-compatible with respect to the average type, meaning the type an employee holding the prior belief expects to face.

**Lemma 2.** *The threshold values $c_B^*$ and $c_G^*$ are unambiguously ranked: $c_G^* > c_B^*$.*

This result has a straightforward economic interpretation. A good manager has to grant more stock in order to induce a high level of effort: when the manager is of the good type, the employee earns a return on their shares even if they exert low effort. Since the employee therefore has weaker incentives to work under a "good" manager, such a manager must grant more stock to induce the highest effort. The formal argument, given in Appendix B, compares the employee's gain from effort across types directly.

The second family of contracts on which the analysis rests concerns the manager rather than the employee.

**Definition 2.** *We define $\bar{c}_k$ ($k \in \{G, B\}$) as the contract at which a type $k$ manager whose employee exerts high effort obtains the same gross payoff as when they grant nothing and the employee exerts low effort. In formal terms, $V^0(\bar{c}_k, H, k) = V^0(0, L, k)$, that is*

$$\int_{\mathbb{R}} W_d\big(1 + r + \mu^{L,k}\big) f(r)\, dr = \int_{\mathbb{R}} \big(W_d - \bar{c}_k W_s\big)\big(1 + r + \mu^{H,k}\big) f(r)\, dr, \tag{13}$$

*so that $\bar{c}_k = \frac{W_d}{W_s} \frac{\mu^{H,k} - \mu^{L,k}}{\rho + \mu^{H,k}}$.*

The definition must be read on the gross payoff $V^0$. Whenever $V^0(0, L, k) \leqslant V_m$, as is the case for the type $B$ manager when the dismissal threshold binds, both sides of (13) would be zero once truncated and the equation would admit a continuum of solutions.

**Lemma 3.** *The limit contracts $\bar{c}_B$ and $\bar{c}_G$ are unambiguously ranked: $\bar{c}_G < \bar{c}_B$.*

By (4), the expected gain from inducing effort is

$$V^0(c, H, k) - V^0(0, L, k) = W_d\big(\mu^{H,k} - \mu^{L,k}\big) - cW_s\big(\rho + \mu^{H,k}\big).$$

It starts from the same level for both types, since $\mu^{H,G} - \mu^{L,G} = \mu^{H,B} - \mu^{L,B}$ by (2), but each unit of stock costs the "good" manager more, since their retained wealth earns the higher return $\rho + \mu^{H,G}$. The cost of the grant therefore exhausts the gain after a smaller grant for the "good" manager, so that the inequality $\bar{c}_G < \bar{c}_B$ is intuitive. Appendix B shows that this property of the limit contracts is a direct consequence of the "no cross-effect" Assumptions (2) and (3).

Three families of contracts recur in the analysis, and the notation distinguishes them. Starred contracts, $c_k^*$, $c^*$ and, in Appendix A, $c^*(q)$, are incentive thresholds of the employee; barred contracts $\bar{c}_k$ are limit contracts of the manager; and the hatted contract $\hat{c}_B$, defined in (5), is the dismissal cutoff of a type $B$ manager whose employee works.

The contracts $\bar{c}_B$ and $\bar{c}_G$ are "limit contracts": beyond $\bar{c}_k$, employee ownership becomes more costly to a type $k$ manager than granting nothing at all. Their role is best understood by looking at the shape of the manager's induced payoff. Given a belief about their type, the employee exerts high effort if and only if the contract exceeds some threshold. The manager's payoff therefore decreases in $c$, jumps upwards at that threshold, and decreases again: it is not quasi-concave, and it admits two local maxima, $c = 0$ and the threshold itself. Which of the two dominates cannot be settled by the structure of the model alone, and we therefore assume the following.

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**Assumption 1.** $c_G^* < \bar{c}_G$.

By Lemma 3, $\bar{c}_G < \bar{c}_B$, so Assumption 1 also implies $c_G^* < \bar{c}_B$. In words: even at the most demanding incentive-compatible contract, either type of manager still prefers to have the employee work rather than grant nothing. Aubert et al. (2014) impose the same restriction type by type, in the form $c_k^* \leqslant \bar{c}_k$, and call it the manager's participation condition. We state it at $c_G^*$ rather than at $c_B^*$ for the type $B$ manager because in the equilibria studied below the latter is led to offer contracts as high as $c_G^*$, so that $c_B^* < \bar{c}_B$ would not be enough. Note that the extension to type $B$ rests on Lemma 3, hence on the "no cross-effect" conditions (2) and (3); were those relaxed, the ranking of the limit contracts could be reversed and a separate restriction on $\bar{c}_B$ would be needed. The discussion at the end of this section shows that Assumption 1 is consistent with the rest of the model, and Figure 2 depicts the configuration it describes.

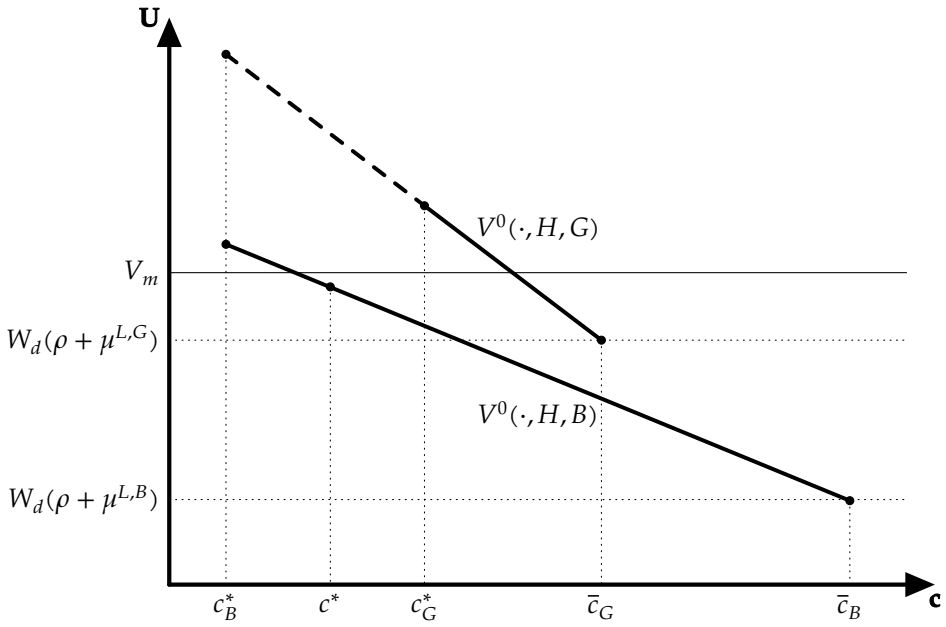



**Figure 2.** Gross payoffs $V^0(\cdot, H, k)$ of the two types of manager when the employee exerts high effort. The dashed part of $V^0(\cdot, H, G)$ lies below $c_G^*$, where an employee who knows they face a type $G$ manager does not work.

We may now record the consequence of Assumption 1 announced above.

**Lemma 4.** *Under Assumption 1, $V^0(c, H, k) > V^0(0, L, k)$ for every $c \leqslant c_G^*$ and every type $k \in \{G, B\}$. Moreover, at any contract $c > c_G^*$, high effort is the employee's unique optimal response whatever their belief about the manager's type, and at $c_G^*$, it is an optimal response whatever their belief.*

Taken together, the two statements mean that the manager's induced payoff can be treated as the single decreasing function $V(c, H, k)$ over the whole relevant range: neither the low-effort branch nor the corner $c = 0$ is ever chosen. This is what keeps the manager's objective simple in everything that follows.

At this point, one may ask whether all the conditions stated above are mutually consistent, i.e., whether the problem is not vacuous. Condition (8), namely, $u[W_s(1 + r_0)] - \psi^L > 0$, is a normalization of the level of utility: adding a constant to $u$ leaves every choice of the employee unchanged, and makes the condition hold. The value of $\psi^L$ admits an economic interpretation: with $\psi^L = 0$, low effort is costless and can be understood as "no work at all", which is consistent with the absence of a regular wage in the model.

Condition (9), namely, $\forall\, c \in \left[0, \frac{W_d}{W_s}\right]$, $\forall\, j \in \{H, L\}$,

$$\sum_{k\in\{G,B\}} \int_{\mathbb{R}} p_k u\big[W_s(1+r_0) + cW_s\big(1+r+\mu^{j,k}\big)\big] f(r)dr \geqslant u[W_s(1+r_0)], \tag{14}$$

follows from (1): since $1 + r + \mu^{j,k} > 0$ on the support of $f$ and $c \geqslant 0$, the argument of $u$ on the left-hand side is at least $W_s(1 + r_0)$ at every $r$, and $u$ is increasing.

Since we want to analyze the properties of the contracts $c_G^*$ and $c_B^*$, the equations (for $k \in \{G, B\}$)

$$\begin{aligned} \int_{\mathbb{R}} u\big[W_s(1+r_0) + c^* W_s\big(1+r+\mu^{L,k}\big)\big] f(r)dr - \psi^L = \\ \int_{\mathbb{R}} u\big[W_s(1+r_0) + c^* W_s\big(1+r+\mu^{H,k}\big)\big] f(r)dr - \psi^H, \end{aligned} \tag{15}$$

must have a solution. Lemma 1 guarantees that any solution is unique. Since $\omega_k(0) = 0 < \psi^H - \psi^L$ and $\omega_k$ is continuous and strictly increasing, the intermediate value theorem delivers a solution as soon as $\omega_k$ exceeds $\psi^H - \psi^L$ somewhere on the admissible range. Hence, we have to assume that

$$\min_{k\in\{B,G\}} \left\{\omega_k\left(\frac{W_d}{W_s}\right)\right\} > \psi^H - \psi^L. \tag{16}$$

This condition is fulfilled when $\mu^{H,k} - \mu^{L,k}$ is large enough, and, as shown below, it is implied by Assumption 1.

It remains to discuss Assumption 1, which has a simple economic content. Written for the type $G$ manager, it requires that granting $c_G^*$ and having the employee work be better than granting nothing and letting them shirk:

$$\int_{\mathbb{R}} \big(W_d - c_G^* W_s\big)\big(1+r+\mu^{H,G}\big) f(r)dr > \int_{\mathbb{R}} W_d\big(1+r+\mu^{L,G}\big) f(r)\, dr. \tag{17}$$

By the definition of $\bar{c}_G$, this is equivalent to

$$\int_{\mathbb{R}} \big(W_d - c_G^* W_s\big)\big(1+r+\mu^{H,G}\big) f(r)dr > \int_{\mathbb{R}} \big(W_d - \bar{c}_G W_s\big)\big(1+r+\mu^{H,G}\big) f(r)dr, \tag{18}$$

hence, $V^0(\cdot, H, G)$ being strictly decreasing, to $c_G^* < \bar{c}_G$. By Lemmas 2 and 3, we then have $c_B^* < c_G^* < \bar{c}_G < \bar{c}_B$, so that

$$c_k^* < \bar{c}_k, \qquad k \in \{G, B\}, \tag{19}$$

is a consequence of Assumption 1 and not an additional restriction.

The two thresholds delimit the contracts that both parties accept: the employee is willing to exert a high level of effort if and only if $c \geqslant c_G^*$, and the manager prefers granting stock to granting nothing if and only if $c \leqslant \bar{c}_G$. Assumption 1 says that the interval $\left[c_G^*, \bar{c}_G\right]$ is non-empty. It is therefore a gain from the trade condition rather than a technical convenience: when it fails, no contract both induces an employee who knows they face a type $G$ manager to work and is preferred by that manager to granting nothing. Employee ownership may then remain viable for a type $B$ manager, if $c_B^* < \bar{c}_B$, but the equilibria studied below, in which contracts as high as $c_G^*$ are offered, no longer exist in the form described.

Since $\omega_G$ is strictly increasing by Lemma 1 and $\omega_G(c_G^*) = \psi^H - \psi^L$ by definition of $c_G^*$, the assumption admits the equivalent form

$$\omega_G(\bar{c}_G) > \psi^H - \psi^L. \tag{20}$$

In this form, it restricts the disutility of effort alone, and states exactly how large that disutility may be. It also subsumes condition (16): $\bar{c}_G < \frac{W_d}{W_s}$, so $\omega_G\left(\frac{W_d}{W_s}\right) > \omega_G(\bar{c}_G)$, and $\omega_B > \omega_G$, whence $\min_k \omega_k\left(\frac{W_d}{W_s}\right) > \psi^H - \psi^L$.

In the limiting risk-neutral case $u(x) = x$, which lies outside the model since Lemma 2 requires strict concavity, one has $\omega_G(c) = cW_s\left(\mu^{H,G} - \mu^{L,G}\right)$ and (20) reduces to

$$\psi^H - \psi^L < \frac{W_d\left(\mu^{H,G} - \mu^{L,G}\right)^2}{\rho + \mu^{H,G}}. \tag{21}$$

The square arises because effort must be bought with stock, whose value to the employee is itself governed by $\mu^{H,G} - \mu^{L,G}$. Comparing (21) with the case of a concave $u$ requires fixing the scale of $u$ relative to the cost of effort. Under the normalization $u'(W_s(1 + r_0)) = 1$, which gives both utility functions the same marginal utility at the employee's baseline wealth, concavity lowers $\omega_G$, since every argument of $u$ in $\omega_G$ is at least $W_s(1 + r_0)$ by (1), and hence raises $c^*_G$: under that normalization, (21) is the most permissive case.

Condition (20) is sharper than the argument one might use instead. Since $\bar{c}_G$ does not depend on $\psi^H$ while $c^*_G$ tends to zero as $\psi^H$ approaches $\psi^L$, taking the disutility of effort small enough certainly delivers Assumption 1. That route is costly, however, since a smaller $\psi^H - \psi^L$ also narrows the range of dismissal thresholds $V_m$ the model can otherwise support. Condition (20) instead says how far $\psi^H - \psi^L$ may be pushed, and lets a sizeable difference in effort costs coexist with a wide range of admissible thresholds.

To summarize: condition (8) is a normalization, condition (9) follows from (1), and condition (16) follows from Assumption 1. If $\psi^H - \psi^L$ satisfies (20), all the assumptions of the model therefore hold simultaneously, for any distribution of $r$ with a continuous density, a bounded support and (1). They are thus consistent on an open set of parameters.

## 4. Moral Hazard Equilibrium

In this section, we treat the manager's type as common knowledge. Leaving every other feature of the model unchanged, the only remaining friction is moral hazard.

**Theorem 1.** *Suppose that the type of the manager is common knowledge, that this type is $k \in \{G, B\}$, and that $V^0\left(c^*_k, H, k\right) > V_m$. Then, in every equilibrium, the manager offers the contract $c^*_k$, and the employee exerts high effort at that contract. If the manager has an outside option $\epsilon$, the same conclusion holds provided $\epsilon < V^0\left(c^*_k, H, k\right)$.*

Two features of the statement deserve comment. The viability condition $V^0\left(c^*_k, H, k\right) > V_m$ cannot be dispensed with: if even the incentive-compatible contract leaves the manager below the threshold, every contract that induces high effort yields them zero, and the equilibrium contract is not determined. And at $c^*_k$, the employee is indifferent between the two effort levels, so that high effort is not imposed but follows from equilibrium: if the employee worked there with probability less than one, contracts slightly above $c^*_k$ would bring the manager arbitrarily close to $V^0\left(c^*_k, H, k\right)$ without ever reaching it, and the manager would have no best response.

The contracts $c^*_B$ and $c^*_G$ serve as benchmarks: in the next section, we refer to them in order to isolate the effect of incomplete information on the equilibrium contracts.

They also allow us to state precisely what entrenchment means, a notion on which the literature is not uniform. Aubert et al. (2014) start from a pooling equilibrium in which both types offer $c^*$, the contract that is incentive-compatible with respect to the average type (their Proposition 1). They call entrenchment the additional stock a type $B$ manager grants beyond $c^*$ when the threat of dismissal makes $c^*$ insufficient to keep them in place. A weaker notion compares the contract a manager offers with the one they would offer if their type were known. We retain both, under different names.

**Definition 3.** *Consider an equilibrium of the game with incomplete information, and a contract $c$ offered with strictly positive probability by a type $k$ manager.*

- *The type $k$ manager over-grants at $c$ if $c > c_k^*$, that is, if they grant more stock than they would if their type were common knowledge.*
- *The type $B$ manager entrenches themself at $c$ if $c > c^*$ and their expected payoff at $c$ is strictly positive, that is, if they grant more stock than the contract that is incentive-compatible with respect to the average type, and is retained with strictly positive probability.*

The second notion formalizes the gap identified by Aubert et al. (2014). The condition on the payoff restricts it to grants that actually keep the manager in place: a contract above $c^*$ at which the type $B$ manager is dismissed anyway protects nothing. Since $c_B^* < c^*$ (Lemma A1 in Appendix A), entrenchment implies over-granting, but not conversely, so any result ruling out over-granting also rules out entrenchment.

Three questions must be kept apart. Over-granting compares the stock a manager grants with a stated benchmark. Whether the additional stock raises their probability of retention, or their payoff, is a second question, which the equilibria of Section 5 answer separately. Whether their retention is socially undesirable is a third, and neither over-granting nor entrenchment, as defined here, addresses it: answering it would require the payoffs of a replacement manager or of closing the firm, which the model, like that of Aubert et al. (2014), does not specify. The only welfare comparison in the paper, Theorem 7, is accordingly made with a planner who observes the manager's type and faces the same dismissal threshold.

The distinction is not merely semantic. In a pooling equilibrium at $c^*$, the type $B$ manager over-grants, since $c^* > c_B^*$, while the type $G$ manager grants less than theywould under complete information. This is the ordinary cross-subsidy of pooling, which Aubert et al. (2014) take as their starting point and which does not involve the dismissal threshold at all. Entrenchment requires more. In the binary model, the reason it cannot arise is the effort ceiling to which we now turn; Section 5 shows how this plays out in each equilibrium, and Section 6, where the dismissal threshold plays no role, studies over-granting alone.

*The Effort Ceiling*

Theorem 1 deserves a comment before we turn to incomplete information, because it already settles the mechanism proposed by Aubert et al. (2014). Their Proposition 1 reaches the same conclusion as ours: at the equilibrium contract, the employee exerts the highest level of effort, whatever the manager's type.

Effort, however, takes only two values. Once the employee exerts $e^H$, no further grant of stock can raise it: the margin is exhausted. An additional unit of $c$ buys a return increment of $\mu^{H,k} - \mu^{H,k} = 0$ and costs the manager $W_s(\rho + \mu^{H,k})$ of wealth. Beyond the incentive-compatible contract, employee ownership is a pure transfer.

This is enough to dispose of entrenchment, under either reading of the dismissal condition. Suppose first, as we have assumed throughout, that $V_m$ applies to the manager's wealth. Then, $V^0(\cdot, H, k)$ is strictly decreasing, so granting more stock moves the manager towards dismissal rather than away from it; no threshold above which a larger grant protects them can exist. Suppose instead that $V_m$ applies to the rate of return on company stock, which is how Aubert et al. (2014) gloss the condition. That rate is $1 + r + \mu^{j,k}$, which does not involve $c$ at all, so the contract can matter only by determining whether the employee exerts $e^H$ or $e^L$. The threshold $c_m$ then coincides with $c_k^*$, and the prescription that a type $B$ manager offer $\max\{c_m, c^*\}$ yields no grant beyond the ordinary incentive contract of their own Proposition 2. Entrenchment is counterproductive on the first reading and empty on the second, and there is no third reading available. The argument concerns the effort

channel only, which is the one Aubert et al. (2014) have in mind. It says nothing about channels through which employee ownership may protect a manager outside this model, such as alliances between managers and workers against takeovers (Pagano & Volpin, 2005) or the role of employee stock ownership plans in takeover contests (Chaplinsky & Niehaus, 1994); the present game contains no takeover and no vote.

The difficulty is not a slip in the argument but a feature of the formalization: entrenchment requires slack in the employee's effort, and a binary effort whose equilibrium value is the higher of the two leaves none. A model capable of representing the mechanism would need a continuous effort $e \in [0, \bar{e}]$ with a return $\mu(e, k)$ increasing in $e$. The manager would then trade off, at the margin, the cost of a larger grant against the additional return it elicits, and the contract that just clears the dismissal threshold could exceed the one that maximizes their wealth. Entrenchment would become an interior phenomenon, and the comparative statics Aubert et al. (2014) seek (more employee ownership where managers are weaker) could be studied properly. We regard this as the modification their argument requires. Section 6 takes a first step by studying the effort margin alone, in a submodel without dismissal threshold; the model in which continuous effort and the threshold interact is left open.

The rest of the paper takes the model as it stands and asks what its equilibria look like. The reader may find it surprising that over-granting nevertheless reappears there, in the mixed-strategy equilibria of Section 5 and Appendix A. There is no contradiction: in those equilibria, the employee works with probability strictly less than one, so the effort margin is not exhausted and a larger grant does buy something. What we show is that it is sold at exactly its price: the manager obtains no more at a larger grant than at the cheapest contract they offer.

## 5. Signaling Equilibria

We now return to the game in which the manager's type is private information and characterize its perfect Bayesian equilibria, as defined in Section 2.

Table 1 maps the results of Sections 4–6 and of Appendix A: for each, it gives the regime of the dismissal threshold, the outside option and the participation conditions, the class of strategies, and the role of the refinement of Definition 4.

The first results of this section concern primarily the case in which the dismissal threshold does not bind at the pooling contract, $V^0(c^*, H, B) > V_m$. We begin, however, with a theorem that holds for any level of $V_m$.

**Theorem 2.** *The game has no fully separating equilibrium in which all players use pure strategies and both types make strictly positive profit.*

The intuition is simple. When the employee works at both contracts, the two types rank contracts in the same way, since each prefers to keep more of their wealth: whichever contract is cheaper is also preferred by the type who is supposed to offer the other one. Separation would require a contract that one type finds worth its cost and the other does not, and with a common ranking, no such contract exists.

This intuition can be derived from the manager's payoff, and it completes the employee's side given by Lemma 2. By Equation (4) and the additive form of the return, $V^0(c, j, k) = A(c)(\rho + \mu^j + \mu^k)$. For a given effort, the payoffs of the two types differ by $A(c)(\mu^G - \mu^B)$ and both decrease in $c$, so that no contract is ranked differently by the two types. Suppose now that the dismissal threshold is met at both effort levels and that the em-

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ployee works with probability $\pi$ at the contract $c$. The expected payoff of a type $k$ manager is then

$$A(c)\left(\rho + \mu^L + \mu^k + \pi\,\Delta\mu\right), \qquad \Delta\mu = \mu^H - \mu^L,$$

where $\Delta\mu$ is the same for both types by (2). A higher probability of effort is worth $A(c)\Delta\mu$ to both types, whereas one more unit of stock costs a type $k$ manager $W_s\left(\rho + \mu^L + \mu^k + \pi\,\Delta\mu\right)$, which is larger for the good type. The good manager is therefore less willing than the bad one to pay in stock for effort, while Lemma 2 says that they must pay more of it. The employee's incentive ranking alone does not determine the cost of signaling; the two sides together do, and they leave the good manager with no advantage that the bad manager cannot match.

**Table 1.** Map of the results: regime of the dismissal threshold, outside option and participation conditions, class of strategies, and role of the refinement of Definition 4.

| Result | Threshold Regime | Outside Option | Strategies | Refinement |
|---|---|---|---|---|
| Theorem 1 | Complete information, $V^0(c_k^*, H, k) > V_m$ | If available, $\epsilon < V^0(c_k^*, H, k)$ | Pure | Not needed |
| Theorem 2 | Any | Not used | Pure, all players | Not used |
| Theorem 3 | $V^0(c^*, H, B) > V_m$ | None | Pooling, pure | Only $\tilde{c} = c^*$ survives |
| Proposition 1 | $V^0(c^*, H, B) > V_m$ | None | Pure | Unique survivor |
| Corollary 1 | $V^0(c^*, H, B) > V_m$ | None | Pooling, employee mixes | None survives |
| Theorem 4 | Condition (22) | None | Pooling, pure | Survive |
| Theorem 5 | Condition (22) | None | Separating, pure | Survive (Proposition A3) |
| Theorem 6 | Condition (22) | $0 < \epsilon < V(c_G^*, H, G)$ | Pure, unique outcome | Survives (Proposition A3) |
| Theorem 7 | Conditions (22) and (23) | $0 < \epsilon < V(c_G^*, H, G)$ | Welfare comparison | Not used |
| Theorem 8 | Condition (22), $V^0(c_B^*, H, B) > V_m$ | $0 < \epsilon < \bar{\pi} V^0(c_B^*, H, B)$ | Employee mixes; type $G$ mixes | Survive (Proposition A3) |
| Proposition 2 | Condition (22) | $0 < \epsilon < V(c_G^*, H, G)$ | Type $G$ pure, type $B$ mixes | Holds for all equilibria |
| Proposition 3 | $V_m = 0$, continuous effort | None | Separating, pure | Not used |
| Theorem A1 | Condition (22) | $0 < \epsilon < V(c_G^*, H, G)$ | All equilibria | Not needed |
| Proposition A1 | Condition (22), $V^0(0, L, G) \leqslant V_m < V^0(c_B^*, H, B)$ | $\epsilon \leqslant A(c_G^*)(\rho + \mu^{H,B})$ | Both types mix | Survive (Proposition A3) |
| Proposition A2 | Condition (22) | $0 < \epsilon < V(c_G^*, H, G)$ | All equilibria | Not needed |
| Proposition A3 | Condition (22) | Any | Equilibria in which $U_G = V(c_G^*, H, G)$ | Definition 4 |

The restriction to pure strategies is indispensable. The equilibrium described after Corollary 1, and the first construction in the proof of Theorem 8, exhibit separating equilibria in which both types obtain strictly positive profits; separation is sustained there precisely because the employee randomizes over efforts, which breaks the monotonicity argument used in the proof. The restriction to strictly positive profits is indispensable as well: if $V_m$

exceeds every attainable payoff, all payoffs are zero, every player is indifferent, and any profile of strategies is an equilibrium.

This first theorem does not restrict the level of $V_m$ relative to the gross payoffs $V^0(c^*, H, G)$ and $V^0(c^*, H, B)$, and is therefore quite general. Recall the threshold $\hat{c}_B$ defined in (5). It locates the two cases that matter here: $\hat{c}_B > c^*$ exactly when the dismissal threshold does not bind in the sense above, and $\hat{c}_B > c^*_G$ exactly when it does not bind anywhere on $[c^*, c^*_G]$.

**Theorem 3.** *Assume $V^0(c^*, H, B) > V_m$. Then, the game has a continuum of pooling equilibria in which the manager offers the contract $\tilde{c}$ whatever their type is and the employee exerts high effort, one for every $\tilde{c}$ such that $c^* \leqslant \tilde{c} \leqslant c^*_G$ and $\tilde{c} < \hat{c}_B$.*

The binding party is the type $B$ manager: since $V^0(c, H, G) > V^0(c, H, B)$ for every $c$, a contract at which $B$ clears the dismissal threshold is one at which $G$ clears it too, so $\hat{c}_B$ alone determines where profits cease to be strictly positive. Two cases arise under the hypothesis of the theorem. When $\hat{c}_B > c^*_G$, one obtains the whole closed interval $[c^*, c^*_G]$. When $c^* < \hat{c}_B \leqslant c^*_G$, the continuum survives on $[c^*, \hat{c}_B[$, which is open at its upper end because a type $B$ manager offering exactly $\hat{c}_B$ earns a payoff of zero rather than a strictly positive one. When $\hat{c}_B \leqslant c^*$, the dismissal threshold binds, and Theorem 4 onwards treat that regime separately.

As is usual in signaling games, the game admits infinitely many equilibria: since out-of-equilibrium beliefs can be chosen arbitrarily, many credible threats can be constructed and many equilibria sustained.

On the interval of Theorem 3, the employee exerts a high level of effort throughout, so that the contract operates as a pure transfer: $V(\cdot, H, k)$ is strictly decreasing in $c$ for each type while the employee's expected utility is strictly increasing. No allocation on that interval can therefore be improved upon without harming one of the parties, and the equilibrium allocations are Pareto-efficient in that sense.

The statement should not be given more weight than it carries. It holds because the contract is a one-dimensional transfer along which the two parties' interests are exactly opposed, and because the manager is risk-neutral while the residual uncertainty is independent of effort, so that neither incomplete information nor moral hazard bites along the equilibrium path. It is also efficiency within the contract space the model allows. Since $r$ is independent of effort, a share of company stock exposes a risk-averse employee to a variance $c^2 W_s^2 \int_{\mathbb{R}} (r - \mathbb{E}r)^2 f(r) dr$ that conveys no information about htheir effort. Whether another compensation scheme would do better depends on what is verifiable. If the market return $r$ were verifiable, a payment indexed to the firm's return net of $r$ would filter that risk, in line with the informativeness principle of Holmström (1979); if neither the employee's effort nor $r$ is verifiable, the comparison requires an analysis of incentive compatibility that lies outside the model, whose only instrument is the stock grant. In a richer contract space, Beaudry (1994) shows how the split between a base wage and a bonus can convey a principal's private information about the production technology; whether pooling and over-granting would survive such instruments is a question the present model, by construction, cannot answer. Efficiency here is thus constrained efficiency, and the constraint is the instrument itself. The welfare question that bears on Aubert et al. (2014) is a different one, and we turn to it in Section 5.2.

Can these equilibria, and in particular those with $\tilde{c} > c^*$, be interpreted as "entrenchment" equilibria? In them, managers do grant more stock than is technically necessary to induce high effort. But this apparent entrenchment is entirely driven by the manager's beliefs: whatever their type, they expect the employee to read any other contract as an offer

made by a "good" manager, which would render that offer not incentive-compatible. Such an equilibrium is economically unconvincing.

Among the continuum of equilibria just characterized, not all are equally credible. To select the most robust equilibria, signaling models often rely on the intuitive criterion of Cho and Kreps (1987). Applied to an equilibrium in which type $k$ obtains $U_k$, it removes a type from the support of the employee's belief after a deviation $c'$ whenever even the most favorable optimal response of the employee to some belief leaves that type below its equilibrium payoff at $c'$; the equilibrium fails if, with beliefs so restricted, some type obtains more than its equilibrium payoff whatever the employee's optimal response. In the pooling equilibria of Theorem 3, a deviation $c'$ with $c^* < c' < \tilde{c}$ is profitable for both types when the employee works, so that no type is removed and the criterion has no bite. The divinity criterion of Banks and Sobel (1987), which shifts beliefs toward the types who gain from a deviation for the larger set of responses, is not used here, and we make no claim about its implications. We use instead a consistency requirement that goes back to Farrell (1993), who formulated it for cheap talk, where messages are costless. Grossman and Perry (1986) build a related credible updating requirement into perfect sequential equilibrium, for signaling games in which messages are costly, and Gertner et al. (1988) apply the requirement to costly signals of the kind studied here. In our game, the signal is costly, since the contract directly affects the manager's payoff. We use only the test of Definition 4 below, and make no claim about perfect sequential equilibrium. The test asks whether a deviation can be interpreted consistently: if the employee, upon observing it, believed that it came from exactly those types who gain from it, would exactly those types gain? For a non-empty set of types $K \subseteq \{G, B\}$ and a type $k \in \{G, B\}$, write

$$p_{k|K} = \begin{cases} \dfrac{p_k}{\sum_{l \in K} p_l} & \text{if } k \in K, \\ 0 & \text{otherwise,} \end{cases}$$

for the probability of type $k$ obtained by conditioning the prior on the event that the manager's type belongs to $K$. In particular, $p_{G|\{G,B\}} = p_G$, $p_{G|\{G\}} = 1$ and $p_{G|\{B\}} = 0$.

**Definition 4.** *Consider an equilibrium, and let $U_G$ and $U_B$ denote the equilibrium payoffs of the two types of manager defined in Section 2, including the outside option when it is taken. A contract $c'$ that neither type offers in that equilibrium is a credible deviation if there exists a non-empty set of types $K \subseteq \{G, B\}$ such that, for every optimal response of the employee at $c'$, pure or mixed, to the belief that assigns probability $p_{G|K}$ to type $G$, the set of types whose payoff at $c'$ strictly exceeds their equilibrium payoff is exactly $K$. An equilibrium survives the criterion if it admits no credible deviation.*

The definition makes the unraveling argument precise. Take a pooling equilibrium of Theorem 3 with $\tilde{c} > c^*$ and a contract $c'$ with $c^* < c' < \tilde{c}$. Under the belief $p_{G|\{G,B\}}$, which is the prior, the employee works at $c'$ because $c' > c^*$, and both types gain because they keep more of their wealth. The set of types who gain is $\{G, B\} = K$: the deviation is credible, and the equilibrium is discarded. At $\tilde{c} = c^*$, by contrast, no downward deviation is credible. Under the prior, the employee shirks at any $c' < c^*$, so that no type gains; under the belief that the deviation comes from a good manager, they shirk as well, since $c' < c^*_G$; and under the belief that it comes from a bad manager, either working is their only optimal response, in which case, both types gain, or $c' = c^*_B$, where shirking is an optimal response under which no type gains. In neither case is the set of types who gain exactly $\{B\}$ for every optimal response. Criteria of this family are compared by Mailath et al. (1993), whose undefeated equilibrium points in the same direction here: the pooling equilibrium at $c^*$ is strictly preferred by both types to every other pooling equilibrium of Theorem 3.

**Proposition 1.** *Assume $V^0(c^*, H, B) > V_m$. Then, the game has a unique pure-strategy equilibrium surviving the criterion, and it is characterized by*

- *the manager offers the contract $c^*$ whatever their type is, and the employee exerts the highest effort,*
- *if they observe a contract $c < c^*$, the employee believes, with probability $p_k$, that the contract is offered by a manager having the type $k$, thus they make no effort.*

The hypothesis is exactly the condition $\hat{c}_B > c^*$ under which the interval of Theorem 3 is non-empty. The contract $c^*$ is its lower endpoint, and it is the only one that survives: unlike a deviation from $\tilde{c} > c^*$, a downward deviation from $c^*$ leaves the employee unwilling to work under their prior, so it is profitable for neither type and is not a credible deviation in the sense of Definition 4.

The employee may also randomize between the two effort levels. The next result shows that, in a pooling equilibrium, this possibility does not enlarge the set of contracts that can be offered, and that it does not survive the criterion either. Equilibria in which the employee randomizes may also separate the two types, even in this regime, as shown after the corollary; the corollary concerns pooling equilibria only.

**Corollary 1.** *Assume $V^0(c^*, H, B) > V_m$. In any pooling equilibrium in which the employee randomizes over effort levels, the manager offers the contract $c^*$ whatever their type is. No such equilibrium survives the criterion.*

The restriction to pooling equilibria cannot be dropped. Suppose that the dismissal threshold does not bind at $c^*$ but binds at $c^*_G$, that is, $c^* < \hat{c}_B \leqslant c^*_G$, and that $V^0\big(c^*_G, H, G\big) > V_m \geqslant V^0(0, L, G)$. Then, the following profile is an equilibrium: the type $G$ manager offers $c^*_G$, the type $B$ manager offers $c^*_B$, the employee works with probability one at $c^*_G$ and with probability $\pi = A\big(c^*_G\big)/A(c^*_B)$ at $c^*_B$, and they attribute every other contract to a type $G$ manager. Each offer reveals the manager's type, so that the employee is indifferent between the two effort levels at both. All low-effort payoffs are zero, so that the type $G$ manager obtains $\pi A(c^*_B)\big(\rho + \mu^{H,G}\big) = V\big(c^*_G, H, G\big)$ at either contract, while a type $B$ manager who mimics $c^*_G$, or makes any other offer that induces effort, falls below the threshold, since $V^0(c, H, B) \leqslant V^0\big(c^*_G, H, B\big) \leqslant V_m$ for $c \geqslant c^*_G$. The offers separate, the employee randomizes, and neither type offers $c^*$. With $u(x) = \sqrt{x}$, the parameters of the example of Appendix A.4, $V_m = 13.61$, and the triangular density $f(r) = (a - |r|)/a^2$ on $[-a, a]$, $a = 0.01$, one obtains $c^*_B \approx 0.86982$, $c^* \approx 0.90506$, $c^*_G \approx 0.94459$, $\hat{c}_B \approx 0.92667$ and $\pi \approx 0.99181$; Script S2 in the Supplementary Materials reproduces these values. Such equilibria do not survive the refinement of Definition 4: a deviation to a contract between $c^*$ and $\hat{c}_B$ induces effort under the prior and is profitable for both types, since it lies below $c^*_G$ and keeps the type $B$ manager above the threshold.

Once out-of-equilibrium beliefs are restricted to consistently interpretable ones, the equilibria exhibiting "entrenchment" vanish. Entrenchment here was a protection against employees' beliefs rather than a response to the constraint $V_m$; eliminating equilibria supported by implausible beliefs eliminates it. We therefore regard entrenchment as a non-robust feature of the game. In the terms of Definition 3, the pooling equilibria of Theorem 3 with $\tilde{c} > c^*$ display entrenchment, and none of them survives the criterion. The surviving equilibrium at $c^*$ displays over-granting by the type $B$ manager, since $c^* > c^*_B$, but no entrenchment: it is the pooling benchmark of Aubert et al. (2014) itself, and the dismissal threshold, which does not bind, plays no part in it.

We now turn to the case in which the dismissal threshold binds. From now on we assume

$$V^0\big(c^*_G, H, G\big) > V_m \geqslant V^0(c^*, H, B). \tag{22}$$

The second inequality says that a "bad" manager cannot keep their position when both types offer the contract that is incentive-compatible with respect to the average type. The first says that a "good" manager clears the threshold at every contract up to $c_G^*$; since they offer contracts as high as $c_G^*$ in the equilibria that follow, a condition stated at $c^*$ alone would not guarantee their survival. Condition (22) is the configuration depicted in Figure 2. Since $V^0(\tilde{c}, H, B) \leqslant V^0(c^*, H, B) \leqslant V_m$ for every $\tilde{c} \geqslant c^*$, no pooling equilibrium in which the employee works can deliver a strictly positive payoff to the type $B$ manager, and by Theorem 2, no pure-strategy equilibrium can separate the types while giving both of them strictly positive payoffs. The equilibria arising here may therefore be qualitatively different from those studied above. To analyze them, one must specify the manager's options precisely.

### *5.1. When the Dismissal Threshold Binds*

First, we may follow Aubert et al. (2014) and assume that the manager's only choice is the level of the contract $c$. The two theorems below describe the equilibria sustained under this assumption. Second, and more realistically, one may allow the manager to refuse to run the project and secure a strictly positive payoff independent of their type. It seems reasonable, for instance, that after observing their type, the manager may abandon the project and invest their capital on the financial market, obtaining $W_d(1 + r_0)$.

If the manager has no outside option, we obtain the following results.

**Theorem 4.** *Under condition (22), the contracts $\tilde{c}$ with $c^* \leqslant \tilde{c} \leqslant c_G^*$ are still offered by both types in equilibrium, the type B manager now earning a payoff of zero.*

Unlike the pooling equilibria of Theorem 3, these equilibria survive the refinement of Definition 4. A deviation to a contract below $c^*$ induces effort only if the employee attributes it to a "bad" manager, and the "good" manager then gains from it as well, since such a contract lies below $\tilde{c}$; a deviation above $c^*$ cannot benefit the "bad" manager, who is dismissed there. In these equilibria, however, the type $B$ manager earns zero: the stock they grant does not keep them in place, and they display no entrenchment in the sense of Definition 3. We therefore turn to equilibria in which the two types offer different contracts.

**Theorem 5.** *Under condition (22), there exists a continuum of equilibria, indexed by a contract $c_B \in [0, c_B^*[$, characterized by the following rules:*

- *if the manager has the type G, they offer the contract $c_G^*$,*
- *if the manager has the type B, they offer the contract $c_B$,*
- *the employee believes that $c_B$ is offered by a type B manager and that any other contract is offered by a type G manager,*
- *the employee exerts high effort if and only if the contract they observe is at least $c_G^*$; in particular, they work at $c_G^*$ and shirk at $c_B$.*

The logic rests on the inverted response of the employee in Lemma 2. An employee who believes they face a good manager demands the most stock before they work, so that any contract below $c_G^*$ attributed to a good manager fails to induce effort. A type $B$ manager therefore cannot buy effort more cheaply than at $c_G^*$, and at that contract they fall below the dismissal threshold, since $c_G^* > c^*$ and $V^0(c^*, H, B) \leqslant V_m$. Every contract earns them zero, they are indifferent between them, and this indifference is the source of the continuum. The type $B$ manager grants less than they would under complete information: there is no over-granting, let alone entrenchment.

Assume now that the manager can abandon the project and obtain a payoff of $\epsilon > 0$. If $\epsilon$ is taken to be "small", this modification can be read as a robustness check on the preceding model. We do not, however, restrict $\epsilon$ to be small; it admits several interpretations, the most natural being the return on an investment alternative to the current project. We only assume $\epsilon < V(c_G^*, H, G)$, so that a type $G$ manager whose employee works prefers running the firm to the outside option. When the manager takes the outside option, no project runs: the employee keeps their wealth invested at the risk-free rate and exerts low effort, the activity whose cost $\psi^L$ they bear in every case, so that their payoff is $u[W_s(1 + r_0)] - \psi^L$.

**Theorem 6.** *Under condition (22), if the manager has an outside option $\epsilon$ with $0 < \epsilon < V(c_G^*, H, G)$, then there exists a unique pure-strategy equilibrium outcome, characterized by the following rules:*

- *if the manager has the type G, they offer the contract $c_G^*$,*
- *if the manager has the type B, they take the outside option,*
- *the employee works at $c_G^*$.*

*This outcome is supported, for instance, by the following strategy and beliefs of the employee: they believe that any contract they observe is offered by a type G manager, and they exert high effort if and only if that contract is at least $c_G^*$. Other out-of-equilibrium beliefs can support the same outcome.*

With an outside option, the indifference that sustains the continuum of Theorem 5 disappears. Every contract still earns the type $B$ manager zero, while the outside option earns them $\epsilon > 0$, so they leave. Only the contract of the type $G$ manager is observed, and it reveals their type without distorting their offer. Uniqueness among pure-strategy outcomes rests on an argument that recurs below: any contract at which a type $B$ manager, once identified, would be made to work is cheaper than $c_G^*$, and would therefore attract the type $G$ manager.

### *5.2. Who Is Expelled, and Whether It Should Be*

The equilibrium of Theorem 6 drives the type $B$ manager out of the market. Whether this is desirable is the welfare question that bears directly on the concern of Aubert et al. (2014), and it requires the efficiency notion to be stated precisely.

**Definition 5.** *An allocation is interim Pareto-efficient if there is no other allocation, feasible for a planner who observes the manager's type and is bound by the dismissal threshold $V_m$, that gives at least the same expected payoff to the employee and to the manager of each type, with a strict improvement for at least one of these three parties. Payoffs are evaluated after the manager has learnt their type and before the return r is realized.*

Two features of the definition deserve emphasis. The manager is treated type-by-type rather than in expectation over types, which is the demanding convention: an allocation is disqualified only if it harms neither type. And the planner is held to the same threshold $V_m$ as the market, so that what follows is not an artifact of relaxing a constraint the market must respect.

**Theorem 7.** *Under condition (22), if the manager has an outside option $\epsilon$ with $0 < \epsilon < V(c_G^*, H, G)$, and if*

$$V^0(c_B^*, H, B) > \max\{V_m, \epsilon\}, \tag{23}$$

*then the equilibrium of Theorem 6 is not interim Pareto-efficient in the sense of Definition 5: a planner who observes the manager's type can make the type B manager and the employee strictly better off without making the type G manager worse off.*

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The comparison is with a planner who observes the manager's type. It is a complete information benchmark; it does not show that a mechanism respecting the employee's information constraints could do better, and it involves no claim about shareholders or aggregate welfare, whose payoffs the model does not define. In the terms of the informed principal literature (Maskin & Tirole, 1992), what the manager could achieve with a mechanism that respects the employee's information constraints remains open here, and the characterization of that literature cannot be imported unchanged: the model adds hidden effort, restricts the manager to a single stock grant, and gives them a discontinuous payoff at the dismissal threshold. The employee's payoff, in turn, is their expected utility, which combines their residual claim on the firm with the cost of their effort; it is not shareholder value, and Faleye et al. (2006) show that the distinction matters when employees weigh their contractual claims together with their residual ones. Condition (23) is not a technicality: it says that a type $B$ manager whose employee works would clear the dismissal threshold and would rather run the firm than take their outside option. Such a manager is viable. They are nevertheless expelled, because the employee cannot tell them apart from a type $G$ manager offering the same contract and therefore refuses to work.

This reverses the concern that motivates Aubert et al. (2014). They fear that weak managers entrench themselves and are retained when they should not be; in their own model, once the missing payoffs are supplied, the failure runs the other way. Weak managers are driven out even when retaining them would leave no party worse off and make both them and their employees strictly better off, and the cause is not any protective device available to them but the very absence of one. Asymmetric information here is a blunt instrument against the low-performing manager, not a shield for them. Together with Theorem A1, which shows that in this regime, the good manager's payoff is untouched, this locates the entire cost of the informational friction on the type the entrenchment story casts as its beneficiary.

With an outside option, there is therefore no entrenchment in the sense of Definition 3. In pure strategies, the market's punishment is so blunt that a type $B$ manager cannot secure their position by proposing a favorable compensation scheme to the employee; the mixed-strategy equilibria studied below let them keep it with some probability, but at no gain in payoff.

Having criticized the beliefs supporting the other equilibria, we must ask whether the equilibrium of Theorem 6 is the only credible one. It is unique among pure-strategy outcomes. The next theorem shows that mixed-strategy equilibria exist as well, and the discussion that follows shows that they leave the conclusions unchanged.

**Theorem 8.** *Assume condition (22) and* $V^0(c_B^*, H, B) > V_m$*, and let*

$$\bar{\pi} = \frac{V(c_G^*, H, G) - V(c_B^*, L, G)}{V(c_B^*, H, G) - V(c_B^*, L, G)}. \tag{24}$$

*If the manager has an outside option* $\epsilon$ *with* $0 < \epsilon < \bar{\pi}\, V^0(c_B^*, H, B)$*, then there exists an equilibrium with the following properties:*

- *the type B manager offers a contract* $c$ *with* $c_B^* < c < \hat{c}_B$*,*
- *the type G manager randomizes between* $c_G^*$ *and* $c$*,*
- *the employee works with probability one at* $c_G^*$*, randomizes at* $c$*, and believes that any other contract is offered by a type G manager.*

These mixed-strategy equilibria exhibit over-granting in the sense of Definition 3: a type $B$ manager may grant more than $c_B^*$.[3] They exhibit no entrenchment, however, since Proposition A2 in Appendix A confines the contracts offered by a type $B$ manager to $[c_B^*, \hat{c}_B[$,

an interval strictly below $c^*$; and the larger the outside option, the less likely such equilibria are to exist. These equilibria therefore confirm the non-existence of entrenchment strategies rather than contradict it.

Moreover, even under specifications in which the contract $c$ offered by the type $B$ manager is substantially larger than $c_B^*$, over-granting is not the most striking property of these equilibria. A "good" manager offers, with positive probability, a contract that is very convenient for them, granting a relatively low share of the stock to the employee. The cost is that the employee then exerts high effort only with some probability, so the "good" manager cannot fully exploit their uncompetitive offer. Symmetrically, even when they offer a contract above $c_B^*$, a "bad" manager cannot induce high effort with certainty. Since they are dismissed whenever the employee shirks, the probability that the employee works is also their probability of retention: a larger grant raises that probability, but not their payoff, which is the same at every contract they offer. These equilibria therefore cannot be read as equilibria with a genuine entrenchment strategy, since the strategy only partially succeeds.

One structural feature of these equilibria deserves to be recorded, because it delimits how far the randomization of a "bad" manager can go. In the second equilibrium constructed in the proof of Theorem 8, and in the equilibria of Proposition A1 in Appendix A, the type $G$ manager randomizes whenever the type $B$ manager does. This is not an accident of the constructions.

**Proposition 2.** *Under the assumptions maintained in Appendix A, there is no equilibrium in which the type G manager plays a pure strategy while the type B manager randomizes over two or more contracts.*

The economic content of Proposition 2 is the mirror image of Lemma A2. If the type $G$ manager offers a single contract, every contract a type $B$ manager offers is fully revealing, and a fully revealing contract is one at which the employee works while the manager retains more wealth than they would at $c_G^*$. Such a contract is worth more to a type $G$ manager than their own equilibrium offer, and they take it. Randomization by a "bad" manager can be sustained only when a "good" manager randomizes over the same contracts, which is precisely what keeps the posterior belief there strictly positive and the contract expensive enough to deter them. Over-granting through randomization is thus not a strategy a low-performing manager can adopt on their own: it requires the cooperation, in equilibrium, of the manager it is supposed to protect them from.

Both assumptions maintained in Appendix A matter for Proposition 2. Without an outside option, a type $B$ manager who earns zero at every contract is indifferent between all of them and may randomize freely, as in the equilibria of Theorem 5. When the dismissal threshold does not bind, the type $B$ manager can afford contracts above $c^*$, and equilibria of the kind excluded by Proposition 2 can be constructed: the type $G$ manager offers a single contract $c_G$ with $c^* < c_G < \min\{c_G^*, \hat{c}_B\}$, the type $B$ manager randomizes between $c_G$ and a fully revealing contract $c'$ with $c_G < c' < \min\{c_G^*, \hat{c}_B\}$, and the employee randomizes at $c_G$, with probabilities chosen so that the posterior belief at $c_G$ makes them indifferent and the type $B$ manager is indifferent between their two contracts. None of these equilibria survives the refinement of Definition 4: a deviation to a contract slightly above $c^*$ induces effort under the prior and is profitable for both types, in line with Proposition 1.

To complete the analysis, note that when the dismissal threshold binds, a type $G$ manager offers $c_G^*$ with positive probability and obtains their complete information payoff in every equilibrium (Theorem A1 in Appendix A): their payoff is unaffected by incomplete information. This may be read as a particular instance of the celebrated "no distortion at the top" property.[4] In that regime, the manager suffers from incomplete information

only when they are of the "bad" type, and such a manager may even be driven out of the market. The property is specific to the binding regime. When the threshold does not bind, the pooling equilibrium at $c^*$ selected by Proposition 1 gives the type $G$ manager $V(c^*, H, G) > V(c_G^*, H, G)$: they gain from incomplete information, since they pay the stock that motivates an employee holding the prior rather than the larger stock that motivates an employee who knows the manager is good.

### *5.3. The Role of the Maintained Assumptions*

Three assumptions carry most of the weight in the analysis: effort is binary, the manager is subject to a dismissal threshold whose consequences we had to specify, and effort and type have no cross-effect on the return. The first is the subject of Section 4 and is relaxed in Section 6. The second calls for a word of intuition. The threshold $V_m$ is a performance floor imposed by the shareholders, as in Aubert et al. (2014). What matters for our results is not its level but whether it binds at the pooling contract $c^*$, which is why the analysis is organized around the two regimes $V^0(c^*, H, B) > V_m$ and condition (22). Within each regime, the qualitative results do not depend on the value of $V_m$, and the alternative specifications of the payoffs that follow dismissal are discussed in Section 7. The remainder of this subsection is devoted to the third assumption, whose role is less visible.

The no cross-effect conditions (2) and (3) enter the analysis at two points only: in the ranking $c_G^* > c_B^*$ of Lemma 2, through the stronger property $\omega_G < \omega_B$ established in Lemma A1, and in the ranking of the limit contracts in Lemma 3, which serves only to extend Assumption 1 to the type $B$ manager. Several results do not depend on them at all. Lemma 1 and Theorem 1 hold type-by-type. The effort ceiling of Section 4 holds whatever the return function, since it uses only the fact that effort cannot exceed its higher value. The argument behind Theorem 2 uses the conditions only through Lemma 4, which can be restated with $\max\{c_G^*, c_B^*\}$ in place of $c_G^*$ provided Assumption 1 is imposed at that contract for both types. Its core, the fact that both types rank contracts in the same way when the employee's effort is given, holds because $V^0(c, j, k)$ is proportional to $W_d - cW_s$ for every $j$ and $k$. The same is true of the unraveling argument behind Proposition 1.

Where the conditions matter is in the direction of the employee's response. The employee's gain from effort under a type $k$ manager combines two forces: the return increment $\mu^{H,k} - \mu^{L,k}$ that effort produces, and a wealth effect, by which a higher level of return lowers, $u$ being concave, the marginal utility of that increment. Under (2), the increment is the same for both types and only the wealth effect is at work; this is why a good manager must grant more stock. The limiting risk-neutral case, which lies outside the model, makes the point starkly. With $u(x) = x$, one has $\omega_k(c) = cW_s(\mu^{H,k} - \mu^{L,k})$, so that $c_k^* = (\psi^H - \psi^L)/(W_s(\mu^{H,k} - \mu^{L,k}))$ and $c_G^* = c_B^*$ under (2): the strict ranking of Lemma 2 is due entirely to the concavity of $u$.

The rest of this subsection is a robustness discussion: unlike the results stated as lemmas, theorems and propositions, the observations that follow are not proved in the paper, and they indicate how the arguments would have to be adapted. Let $\kappa = \mu^{H,G} - \mu^{L,G} - \mu^{H,B} + \mu^{L,B}$ measure the cross-effect, so that (2) reads $\kappa = 0$. Substitutability between effort and type, $\kappa < 0$, reinforces the wealth effect and leaves every result unchanged. Complementarity, $\kappa > 0$, works against it. As long as it is weak enough for $\omega_G < \omega_B$ to hold on the relevant range of contracts, we expect the arguments to carry over, provided Assumption 1 is imposed for both types directly, since this inequality, rather than (2) itself, is what they use. When complementarity is strong enough to reverse the inequality, which in the risk-neutral case happens as soon as $\kappa > 0$, the employee requires less stock from a good manager than from a bad one, the threshold $c^*(q)$ of Lemma A1 becomes decreasing in the belief $q$, and being taken for a good manager becomes valuable to both types. The

model then has the familiar orientation of a signaling game, but the good manager is no better able to distinguish themself, since both types still rank contracts in the same way. In the regime in which the dismissal threshold does not bind, we expect the argument of Proposition 1 to apply with minor changes and to select the pooling contract $c^*$, which now lies between $c_G^*$ and $c_B^*$. The distortion then falls on the good manager, who grants $c^* > c_G^*$, while the bad manager grants less than they would under complete information. Over-granting changes sides, and entrenchment, which requires a contract above $c^*$, does not appear. The binding regime is more involved, because the dismissal threshold and the reversed response of the employee then interact, and we leave its characterization for future work. What the discussion shows is that the no cross-effect conditions determine who bears the cost of the informational friction, not whether employee ownership can protect a weak manager; establishing these observations formally is left for future work.

## 6. Continuous Effort

Section 4 traced the failure of the entrenchment mechanism to the binary effort variable: at the equilibrium contract, the employee already exerts the higher of the two values, so no further grant can buy anything. The natural repair is to let effort vary continuously, and this section carries it out. The conclusion is qualified. Continuous effort does open room for over-granting: in every specification we examine, there are separating equilibria in which the bad manager grants more stock than they would under complete information. These equilibria form a continuum, and we do not attempt to select among them. Over-granting reappears in every specification we examine, as a possibility rather than a unique prediction.

### *6.1. The Extended Model*

Effort is now a variable $e \in [0, \infty)$ and the return on company stock is $1 + r + \mu(e, k)$. We maintain the counterpart of the no cross-effect conditions (2) and (3) and take the return to be additively separable, $\mu(e, k) = \mu(e) + \mu^k$, where $\mu$ is increasing, strictly concave and satisfies Inada's conditions, and $\mu^G > \mu^B$. The cost of effort $\psi(e)$ is increasing, strictly convex, and satisfies $\psi'(0) = 0$ and $\psi'(\infty) = \infty$. Everything else is as in Section 2, except that we abstract from the dismissal threshold and from the outside option: we set $V_m = 0$, so that the payoff of a type $k$ manager who offers $c$ while the employee exerts $e$ is their gross payoff

$$V_k(c, e) = (W_d - cW_s)\big(\rho + \mu(e) + \mu^k\big). \tag{25}$$

The continuous model is therefore an explicitly nonbinding submodel: it isolates the effort margin, and the threat of dismissal plays no part in it. We write $\delta = \mu^G - \mu^B$.

The additive form $\mu(e) + \mu^k$ is the continuous counterpart of the "no cross-effect" conditions (2) and (3): effort and type contribute separately to the return, so that the increment obtained from additional effort does not depend on the manager's type. The binary model is recovered by restricting $e$ to two values $e^L < e^H$, with $\mu^{j,k} = \mu\big(e^j\big) + \mu^k$, which is the additive form of Section 2.

Facing a contract $c$ and assigning probability $q$ to the manager being of type $G$, the employee solves

$$\max_{e \geqslant 0} \sum_{k \in \{G,B\}} q_k \int_{\mathbb{R}} u\big[W_s(1 + r_0) + cW_s\big(1 + r + \mu(e) + \mu^k\big)\big] f(r)dr - \psi(e), \tag{26}$$

with $q_G = q$ and $q_B = 1 - q$. For $c > 0$, the objective is strictly concave in $e$, and Inada's conditions make its maximizer $e^*(c, q)$ interior and unique. At $c = 0$, the employee's wealth does not depend on their effort, so that $e^*(0, q) = 0$. The function $e^*$ is continuous on $[0, W_d/W_s] \times [0, 1]$, by the maximum theorem for $c > 0$ and because $e^*(c, q)$ tends to zero as $c$ tends to zero; the payoff functions used below are therefore continuous on the compact

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set of contracts, and their maxima exist. We retain assumption (7), which bounds relative risk aversion by one, for comparability with the binary model; none of the results below uses the monotonicity of $e^*(\cdot, q)$ in $c$, which we do not establish here.

**Lemma 5.** *$e^*(c, q)$ is strictly decreasing in $q$.*

Lemma 5 is the counterpart of Lemma 2 and carries the same economic content, in a form that is perhaps more striking: an employee who becomes more confident that their manager is good works less, because their shares already pay well. Both types of manager therefore prefer to be taken for the bad one, since the payoff $V_k(c, e)$ of either type increases with the employee's effort: this explains why the belief $q = 1$ is the natural punishment. Like Lemma 2, the result rests on the additive form of the return: with a return $\mu(e, k)$ whose marginal product of effort increases with the type strongly enough, the direct effect would dominate and the conclusion would be reversed, as discussed for the binary model in Section 5.3.

### *6.2. Punishment Functions*

An equilibrium specifies beliefs $q(c)$ at every contract. Define the associated punishment function

$$\Pi(c) = e^*(c, q(c)), \tag{27}$$

the effort the employee exerts at $c$ under those beliefs, and the deviation payoff of a type $k$ manager,

$$D_k(c) = (W_d - cW_s)\big(\rho + \mu(\Pi(c)) + \mu^k\big), \tag{28}$$

recalling $\rho = 1 + \int_{\mathbb{R}} rf(r)dr$ from Section 2. By Lemma 5 the harshest punishment function is $\underline{\Pi}(c) = e^*(c, 1)$, obtained when every deviation is attributed to a good manager. We use it throughout; milder ones only shrink the set of equilibria.

Two features of the binary model survive intact. First, for any contract and any effort, the gross payoffs (25) satisfy

$$V_G(c, e) - V_B(c, e) = (W_d - cW_s)\delta, \tag{29}$$

so that the difference between the types is proportional to the wealth the manager retains. Second, adding the two incentive constraints of a separating equilibrium and using (29) yields $W_d - c_G W_s \geqslant W_d - c_B W_s$, that is $c_G \leqslant c_B$: the good manager never grants more than the bad one. The ordering of the two types' contracts is thus preserved by the continuous specification.

### *6.3. Separating Equilibria*

A separating equilibrium is a pair $(c_G, c_B)$ with $c_G \neq c_B$ such that each type prefers its own contract to the other's and to every deviation punished by $\underline{\Pi}$. Writing $f_B(c) = V_B(c, e^*(c, 0))$ for the payoff of a type $B$ manager who is correctly identified, and $g_G(c) = V_G(c, e^*(c, 0))$ for the payoff a type $G$ manager would obtain at $c$ if they were taken for a bad one, the conditions reduce to the following.

**Proposition 3.** *In any separating equilibrium punished by $\underline{\Pi}$, the type $G$ manager offers a contract that maximizes $V_G(c, e^*(c, 1))$, that is, a complete information optimum, and obtains the payoff $U_G \equiv \max_c V_G(c, e^*(c, 1))$. The contracts $c_B$ that can be sustained are exactly those satisfying*

$$f_B(c_B) \geqslant M_B \equiv \max_c V_B(c, e^*(c, 1)) \qquad \text{and} \qquad g_G(c_B) \leqslant U_G. \tag{30}$$

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The first part of Proposition 3 is the "no distortion at the top" property of Theorem A1, and it now requires no argument at all: it follows from the fact that the good manager faces the same beliefs on and off the equilibrium path. The second part characterizes the multiplicity. Both conditions in (30) involve a single variable, so the admissible set can be computed without any search over pairs of contracts. We do not claim that it is an interval in general, nor that the maximizer of $V_G(c, e^*(c, 1))$ is unique: both properties depend on the shape of the reduced payoff functions. In every specification reported below, the maximizer is unique and the admissible set is a single interval, which we verify numerically.

That interval is typically non-degenerate, and it lies strictly above the complete information benchmark $c_B^{FI}$: the bad manager grants more stock than they would if their type were known. Table 2 reports the outcome for a family of specifications with $u(x) = x^{1-\gamma}/(1-\gamma)$ for $\gamma \neq 1$ and $u(x) = \ln x$ for $\gamma = 1$, $\mu(e) = \alpha\sqrt{e}$ and $\psi(e) = \beta e^2/2$. The return $r$ is degenerate at 0, which makes these computations a limiting illustration, since a degenerate return has no density; recomputing the four rows of Table 2 with the triangular density $f(r) = (a - |r|)/a^2$ on $[-a, a]$, $a = 0.01$, changes no entry at the reported precision. The computations solve the employee's first-order condition by root finding on the logarithm of effort, with a tolerance of $10^{-13}$; they locate the managers' optima on a grid of 2001 contracts on $[0, W_d/W_s]$, refined by local optimization with a tolerance of $10^{-12}$; and they compute the admissible set on a grid of 5001 contracts, whose endpoints are refined by root finding with a tolerance of $10^{-12}$. Expectations under the triangular density are computed with a composite Simpson rule. The R scripts that produce these results, together with the residual and margin checks they perform, are provided as Supplementary Materials.

Across the sixteen specifications obtained by crossing these parameters, each of $\alpha$, $\beta$, $\delta$ and $\gamma$ taking the two values shown in Table 2, every one admits such equilibria; the admissible set is always a single interval, and it always lies strictly above $c_B^{FI}$. The prior $p_G$ plays no role in these computations: beliefs are degenerate on the equilibrium path, and the punishment attributes every deviation to a good manager. Table 2 reports four representative cases drawn from this sweep.

**Table 2.** Separating equilibria with over-granting, $W_d = 10$, $W_s = 1$, $r_0 = 0.02$, $r$ degenerate at 0 and $\mu^B = 0$. The type $G$ manager offers a single contract, a complete information optimum, whereas the type $B$ manager can offer any contract in an interval. Over-granting ranges from +0.003 to +0.318 across the sixteen specifications examined.

| $\alpha$ | $\beta$ | $\delta$ | $\gamma$ | $c_G$ | $c_B^{FI}$ | Admissible $c_B$ |
|---|---|---|---|---|---|---|
| 0.4 | 0.5 | 0.4 | 0.5 | 0.316 | 0.451 | [0.454, 0.632] |
| 0.6 | 0.3 | 0.4 | 0.5 | 0.552 | 0.723 | [0.820, 1.040] |
| 0.6 | 0.5 | 0.4 | 1.0 | 0.353 | 0.475 | [0.597, 0.756] |
| 0.6 | 0.3 | 0.2 | 1.0 | 0.442 | 0.511 | [0.649, 0.725] |

### *6.4. What This Establishes*

Continuous effort does what Section 4 said was missing: it gives the manager a margin, so that a larger grant elicits more effort and can be worth its cost. Over-granting equilibria exist, and they are numerous: in every specification we examine, a whole interval of contracts can be sustained.

Table 2 gives the economic content of this multiplicity. Relative to the complete information benchmark $c_B^{FI}$, informational asymmetry does produce over-granting once effort is continuous: every admissible contract lies strictly above $c_B^{FI}$, so a low-performing manager grants more stock than they would if their type were known. Over-granting is not a single number but an interval, ranging up to +0.318 in the specifications examined, that is, 3.18

percentage points of the firm's assets, since $s(c) = c/10$ here, and its width is itself a measure of how much latitude the bad manager retains.

We draw a deliberately narrow conclusion. Making effort continuous does not rescue the mechanism of Aubert et al. (2014) in the sense of pinning down a unique prediction: the good manager's contract is pinned down as a complete information optimum, unique in every specification we examined, but the bad manager's is genuinely indeterminate, and every value in the admissible interval represents over-granting relative to complete information. What continuous effort does show is that, once the manager has a real margin to trade off against the cost of the stock they grant, over-granting no longer rests on the exact indifference it requires in the binary model (Proposition A2): it arises in pure strategies, in every specification we have examined, though we have not proved this in general. It is not, however, entrenchment in the sense of Definition 3. The dismissal threshold plays no role in the continuous model, so the over-granting identified here cannot be a response to the threat of dismissal: it is driven by the effort margin itself.

## 7. Conclusions

We have shown that employee ownership cannot operate as an entrenchment device in the signaling model proposed by Aubert et al. (2014), in any equilibrium that survives the refinement of Definition 4. This may seem surprising: if managers differ in quality, it is natural to expect a "bad" manager to do whatever they can to make their employees work and thereby generate good results. Four observations stand in the way.

The first requires no equilibrium analysis. Effort is binary and the employee already exerts its higher value at the equilibrium contract, so the margin through which employee ownership could protect a manager is exhausted before entrenchment begins. Granting more stock is then either counterproductive or irrelevant, depending on whether the dismissal condition is read as applying to the manager's wealth or to the rate of return on company stock. Section 6 develops a model with continuous effort, in which this margin exists; there, over-granting does become possible, and seems, on the basis of our numerical exploration, to be a feature of a whole family of equilibria in every specification we examined, although it owes nothing to the threat of dismissal. These equilibria are not subjected to any refinement.

Second, no separating equilibrium in pure strategies gives both types a strictly positive payoff (Theorem 2). When the employee works at both contracts, the two types rank contracts in the same way, so that the type supposed to offer the more expensive contract would offer the cheaper one instead. Separation in pure strategies is possible only when the "bad" manager earns nothing, as in Theorem 5, or leaves the firm, as in Theorem 6.

Third, when the dismissal threshold does not bind, entrenchment does arise in the pooling equilibria where managers offer the same compensation scheme regardless of type and grant more stock than is technically necessary. But there, it stems from the fear, shared by both types, that the employee will interpret any deviation as an offer from a "good" manager. These equilibria rest on counter-intuitive beliefs and do not survive the refinement of Definition 4.

There is also a welfare finding that runs against the entrenchment narrative. By Theorem 7, a low-performing manager who would clear the dismissal threshold and prefer running the firm to their outside option is nevertheless expelled, because the employee cannot distinguish them from a high-performing one and refuses to work. Retaining them would have left no party worse off and made both them and the employee strictly better off. The concern that weak managers are improperly protected is thus inverted: in this model, they are improperly discarded.

Fourth, over-granting does survive in mixed-strategy equilibria, and these survive the refinement of Definition 4 (Proposition A3). Yet it gives the "bad" manager nothing more

than the cheapest contract they offer. A "bad" manager is exactly indifferent across every contract they offer, because the extra stock they grant is offset precisely by the increase in the probability that the employee works, which raises their probability of retention but not their payoff; in the equilibria we construct, the employee never works with certainty at the contracts they offer; and the manager remains strictly worse off than under complete information, though strictly better off than if they left the firm. Meanwhile, by Theorem A1, a "good" manager obtains their complete-information payoff in every equilibrium of the binding regime. In that regime, the whole cost of the asymmetry of information falls on the very manager whom entrenchment was supposed to protect.

One limitation should be stated plainly. Aubert et al. (2014) do not specify what either party receives once the manager is dismissed, and the convention we adopt in Section 2, under which a dismissed manager forfeits their stake while the employee keeps their shares, is one of several defensible ones. Two alternatives stand out. A dismissed manager may keep their stake and lose only the private benefits of control; or the threshold may be read as a viability constraint, so that a failed project also destroys the employee's shares. Each defines a different game. The effort ceiling of Section 4 survives in both, since it does not involve the payoffs that follow dismissal. The equilibrium analysis of the binding regime would have to be redone: under the first alternative, a dismissed "bad" manager no longer earns zero, and under the second, the employee's incentive to work depends on the manager's survival, so that the ranking of Lemma 2 would have to be re-established. Our results should therefore be read as establishing what follows from the model of Aubert et al. (2014) once its missing payoffs are supplied as specified in Section 2, and as identifying that omission as a question their framework leaves open. Nor do our results extend automatically beyond expected utility: Aubert et al. (2018) study an ambiguity-averse employee, and of our conclusions only the effort ceiling of Section 4, which rests on the binary effort margin alone, carries over to that setting without further analysis. The absence of cross-effects between effort and type, which we inherit from their model, is less restrictive than it may seem: as Section 5.3 argues, the effort ceiling does not depend on it, and relaxing it shifts the cost of the informational friction from one type of manager to the other without restoring entrenchment when the dismissal threshold does not bind.

A natural extension adds a second source of moral hazard. Suppose that, after choosing $c$, the manager also exerts an unobservable effort which, together with the employee's, determines the return on the firm's assets. The manager then has two instruments to raise performance: their own effort and the stock they grant. We conjecture that this extension would reinforce rather than overturn our conclusions, for three reasons. First, the effort ceiling of Section 4 does not depend on how the return is generated: once the employee's effort is at its higher value, further stock remains a pure transfer. Second, the stock they grant dilutes the manager's own claim, $W_d - cW_s$, and hence their incentive to exert effort, so that over-granting would depress performance through a second channel and bring the manager closer to the dismissal threshold. Third, under an additive specification, managerial effort acts on the employee as a better type does in Lemma 2: by raising the return on their shares, it weakens rather than strengthens their incentive to work, so that the two instruments are not substitutes. Whether these forces leave any room for entrenchment when both efforts are continuous is a question we leave for future research.

We continue to see signaling as an interesting line of research on corporate governance and entrepreneurship. As far as entrenchment strategies are concerned, however, the approach appears unfruitful when a good manager has no means of differentiating their offer from that of a bad manager.

**Supplementary Materials:** The following supporting information can be downloaded at https://github.com/gpiaser/Employee (accessed on 26 October 2026): Script S1, S6_continuous_effort.R, which computes the separating equilibria of Section 6 and Table 2; Script S2, A4_mixed_equilibrium_example.R, which computes the example of Appendix A.4 and the separating equilibrium with a randomizing employee discussed after Corollary 1; Script S3, A5_overgranting_range.R, which computes the magnitudes reported in Appendix A; the driver file run_all.R, which runs the three scripts; and the files S6_results.csv, A4_example_output.csv, Corollary1_counterexample.csv and A5_grid_results.csv, which contain their outputs together with residual and margin checks.

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## Appendix A. Mixed-Strategy Equilibria

This appendix characterizes the mixed-strategy equilibria of the game when the dismissal threshold binds. We first introduce some notation and record a monotonicity property of the employee's incentives (Appendix A.1). We then show that the posterior beliefs prevailing on the support of a "bad" manager are severely constrained (Appendix A.2), and exploit the martingale property of Bayesian beliefs to pin down the "good" manager's equilibrium payoff in every equilibrium of the binding regime, pure or mixed (Appendix A.3). Appendix A.4 shows, by means of an explicit example, that mixing by a "bad" manager cannot be ruled out, so that this characterization cannot be sharpened into a bound on the number of contracts offered in equilibrium.

Throughout the appendix, we maintain the assumptions of the binding regime of Section 5.1: condition (22) holds, and the manager has an outside option $\epsilon$ with $0 < \epsilon < V(c_G^*, H, G)$. These assumptions imply

$$V^0(0, L, B) < V_m, \tag{A1}$$

since $V^0(0, L, B) < V^0(c^*, H, B) \leqslant V_m$ by Lemma 4 and (22). Condition (A1) guarantees that a "bad" manager never reaches the threshold $V_m$ when the employee shirks. Throughout, $a_k$ denotes the probability that a type $k$ manager runs the firm, that is, offers some contract rather than taking the outside option, so that $\sum_c P_M(c, k) = a_k$. As stated in Section 2, the manager's strategies have finite support: they assign positive probability to finitely many contracts, so that all the expectations below are finite sums. The results of this appendix, including the expressions "every equilibrium" and "any equilibrium", concern equilibria in such strategies; extending them to nonatomic strategies would require writing these expectations as integrals with respect to probability measures over contracts, which we do not do.

### *Appendix A.1. Notation and Preliminaries*

We write $A(c) = W_d - cW_s$ for the wealth retained by the manager, $q(c)$ for the employee's posterior probability that the manager is of type $G$ after observing the contract $c$, and $\pi(c) = P_E(H, c)$ for the probability with which they then exert high effort. Define

$$\Omega(c, q) = q\,\omega_G(c) + (1 - q)\omega_B(c) - \left(\psi^H - \psi^L\right), \tag{A2}$$

the employee's expected net gain from exerting high rather than low effort. Their optimality conditions can be written compactly as

$$\pi(c) > 0 \implies \Omega(c, q(c)) \geqslant 0, \qquad \pi(c) < 1 \implies \Omega(c, q(c)) \leqslant 0. \tag{A3}$$

**Lemma A1.** *For every $c > 0$, we have $\omega_G(c) < \omega_B(c)$. Consequently, $\Omega$ is strictly increasing in $c$ and strictly decreasing in $q$, the equation $\Omega(c, q) = 0$ has a unique solution $c^*(q)$ for each $q \in [0, 1]$, the map $q \mapsto c^*(q)$ is strictly increasing, and*

$$c^*(0) = c_B^*, \qquad c^*(p_G) = c^*, \qquad c^*(1) = c_G^*. \tag{A4}$$

**Proof.** By the "no cross-effect" condition (3), we may write $\mu^{H,G} = \mu^{H,B} + \delta$ and $\mu^{L,G} = \mu^{L,B} + \delta$ with $\delta = \mu^{L,G} - \mu^{L,B} > 0$. Hence, writing $y = W_s(1 + r_0)$,

$$\omega_G(c) = \int_{\mathbb{R}} \Big\{ u\big[y + cW_s\big(1 + r + \mu^{H,B}\big) + cW_s\delta\big] - u\big[y + cW_s\big(1 + r + \mu^{L,B}\big) + cW_s\delta\big] \Big\} f(r)dr. \tag{A5}$$

For $a > b$, the map $s \mapsto u(a + s) - u(b + s)$ is strictly decreasing whenever $u$ is strictly concave. Applying this pointwise in $r$ with $s = cW_s\delta > 0$ gives $\omega_G(c) < \omega_B(c)$, which also re-proves Lemma 2.

Strict monotonicity of $\Omega$ in $c$ is Lemma 1, and strict monotonicity in $q$ follows from $\omega_G(c) < \omega_B(c)$. Since $\Omega(0, q) = -\big(\psi^H - \psi^L\big) < 0$ and $\Omega(\cdot, q)$ is continuous and strictly increasing, $c^*(q)$ is well defined and unique; the implicit function theorem and the sign of $\partial\Omega/\partial q$ give strict monotonicity of $c^*(\cdot)$. The three values in (A4) are exactly the definitions of $c_B^*$, $c^*$ and $c_G^*$. □

Lemma A1 is the key comparative statics of the model: the more confident the employee is that they face a "good" manager, the larger the share of stock they must be granted before they are willing to work. Equivalently, observing a low contract is good news about the manager's type.

*Appendix A.2. The Support of a "Bad" Manager*

**Lemma A2.** *Let $c$ belong to the support of $P_M(\cdot, B)$. Then, $c < \hat{c}_B \leqslant c^*$, where $\hat{c}_B$ is the threshold defined in (5), and consequently $q(c) < p_G$.*

**Proof.** The outside option guarantees that a type $B$ manager obtains at least $\epsilon > 0$ in equilibrium, so every contract in the support of $P_M(\cdot, B)$ yields them a strictly positive payoff. By the maintained assumption (A1) and the monotonicity of $V(\cdot, L, B)$, we have $V(c, L, B) = 0$ for every $c$; a strictly positive payoff at $c$ therefore requires both $\pi(c) > 0$ and $V^0(c, H, B) > V_m$, that is, $c < \hat{c}_B$. Since $V^0(\cdot, H, B)$ is strictly decreasing and $V^0(c^*, H, B) \leqslant V_m$ by (22), we obtain $\hat{c}_B \leqslant c^*$.

Because $\pi(c) > 0$, the first implication in (A3) gives $\Omega(c, q(c)) \geqslant 0$, i.e., $c \geqslant c^*(q(c))$. Hence, $c^*(q(c)) \leqslant c < c^* = c^*(p_G)$, and the strict monotonicity of $c^*(\cdot)$ established in Lemma A1 yields $q(c) < p_G$. □

The economic content of Lemma A2 is worth stating plainly. A "bad" manager can only survive on contracts that are cheap enough for them to clear the threshold $V_m$; but cheap contracts induce effort only if the employee is sufficiently pessimistic about the manager's type. Every contract a "bad" manager can afford to offer therefore carries unfavorable news about the manager. This is precisely the mechanism that defeats entrenchment.

*Appendix A.3. The Equilibrium Payoff of a "Good" Manager*

**Lemma A3.** *In any equilibrium in which $p_G a_G + p_B a_B > 0$, the expected posterior belief conditional on a contract being offered is*

$$\mathbb{E}[q(c) \mid \text{a contract is offered}] = \frac{p_G a_G}{p_G a_G + p_B a_B}. \tag{A6}$$

**Proof.** Let $P(c) = p_G P_M(c, G) + p_B P_M(c, B)$ denote the probability of observing $c$. Whenever $P(c) > 0$, Bayes' rule gives $q(c)P(c) = p_G P_M(c, G)$. Summing over the finitely many contracts offered with positive probability and using $\sum_c P_M(c, k) = a_k$ yields $\sum_c q(c)P(c) = p_G a_G$ and $\sum_c P(c) = p_G a_G + p_B a_B$, whose ratio is (A6). □

**Theorem A1.** *Under the assumptions maintained in this appendix, in every equilibrium, in pure strategies or in mixed strategies with finite support, the type G manager runs the firm, obtains the payoff*

$$U_G = V(c_G^*, H, G), \tag{A7}$$

*and offers the contract $c_G^*$ with strictly positive probability, at which the employee works with probability one.*

**Proof.** Step 1: $U_G \geqslant V(c_G^*, H, G)$, and the type $G$ manager runs the firm. Let $\eta > 0$. By Lemmas 1 and A1, $\Omega(c_G^* + \eta, q) \geqslant \Omega(c_G^* + \eta, 1) > \Omega(c_G^*, 1) = 0$ for every $q \in [0, 1]$, so that high effort is the employee's unique optimal response at $c_G^* + \eta$, whatever their belief. A type $G$ manager who offers $c_G^* + \eta$ therefore obtains $V(c_G^* + \eta, H, G)$, which equals $V^0(c_G^* + \eta, H, G)$ for $\eta$ small enough, since $V^0(c_G^*, H, G) > V_m$ by (22). Hence, $U_G \geqslant V^0(c_G^* + \eta, H, G)$ for every small $\eta > 0$, and letting $\eta$ tend to zero gives $U_G \geqslant V^0(c_G^*, H, G) = V(c_G^*, H, G)$. Since $\epsilon < V(c_G^*, H, G)$, the outside option is strictly worse than running the firm, and $a_G = 1$. This step requires no restriction on out-of-equilibrium beliefs and no assumption on how the employee breaks ties.

Step 2: the type $G$ manager offers a contract outside the support of $P_M(\cdot, B)$. Suppose not. Then, every contract offered with positive probability lies in the support of $P_M(\cdot, B)$, so that $q(c) < p_G$ for all such contracts by Lemma A2, and the conditional expectation in (A6) is strictly smaller than $p_G$. But $a_G = 1$ by Step 1, so that Lemma A3 gives $p_G/(p_G + p_B a_B) \geqslant p_G$, a contradiction.

Step 3: conclusion. Let $\tilde{c}$ be a contract offered with positive probability by the type $G$ manager and outside the support of $P_M(\cdot, B)$. Bayes' rule gives $q(\tilde{c}) = 1$. Every contract in the support of the type $G$ manager's strategy yields them $U_G$. If $\tilde{c} < c_G^*$, the employee shirks, and the type $G$ manager obtains $V(\tilde{c}, L, G) \leqslant V^0(0, L, G) < V^0(c_G^*, H, G) \leqslant U_G$ by Lemma 4, a contradiction. If $\tilde{c} > c_G^*$, they obtain at most $V^0(\tilde{c}, H, G) < V^0(c_G^*, H, G) \leqslant U_G$, again a contradiction. Hence, $\tilde{c} = c_G^*$, where they obtain

$$\pi(c_G^*) V^0(c_G^*, H, G) + (1 - \pi(c_G^*)) V(c_G^*, L, G).$$

Since $V(c_G^*, L, G) < V^0(c_G^*, H, G)$ and this payoff is at least $V^0(c_G^*, H, G)$ by Step 1, we must have $\pi(c_G^*) = 1$ and $U_G = V(c_G^*, H, G)$. □

Theorem A1 establishes the "no distortion at the top" property announced in Section 5 for the whole class of equilibria of the binding regime at once, without invoking a refinement of out-of-equilibrium beliefs. In that regime, incomplete information leaves the "good" manager's payoff untouched, and only the "bad" manager bears its cost. The property does not extend to the regime in which the threshold does not bind: in the pooling equilibrium at $c^*$ selected by Proposition 1, a "good" manager grants $c^* < c_G^*$ and obtains $V(c^*, H, G) > V(c_G^*, H, G)$, so that they gain from incomplete information.

*Appendix A.4. Mixing by a "Bad" Manager Cannot Be Excluded*

One might hope to sharpen Theorem A1 into a statement bounding the number of contracts offered in equilibrium. We now show that this is not possible: for an open set of parameters, the game admits equilibria in which the type $B$ manager randomizes over an arbitrary finite number of contracts.

The reason is an exact alignment of the two types' preferences. Suppose that, in addition to (A1), the parameters satisfy $V^0(0, L, G) \leqslant V_m$ (the configuration drawn in Figure 2). Then, $V(c, L, k) = 0$ for both types and every $c$, so that the manager's expected payoff at a contract $c$ is

$$\sum_{j \in \{H,L\}} V(c, j, k) P_E(j, c) = \Phi(c)\big(\rho + \mu^{H,k}\big), \qquad \Phi(c) \equiv \pi(c) A(c), \tag{A8}$$

for $k \in \{G, B\}$, as long as $V^0(c, H, k) > V_m$. Both types thus rank contracts according to the same index $\Phi$, up to a positive multiplicative constant. Any collection of contracts leaving the type $B$ manager indifferent leaves the type $G$ manager indifferent as well, and no argument based on the type $B$ manager's indifference alone can rule such a collection out.

**Proposition A1.** *Assume $V^0(0, L, G) \leqslant V_m < V^0(c_B^*, H, B)$, so that $c_B^* < \hat{c}_B \leqslant c^*$, and $\epsilon \leqslant A(c_G^*)(\rho + \mu^{H,B})$. Let $n \geqslant 1$ and let $c_1 < \cdots < c_n$ be any contracts in $[c_B^*, \hat{c}_B[$. Set $\Phi^* = A(c_G^*)$ and*

$$\pi(c_i) = \frac{\Phi^*}{A(c_i)}, \qquad q_i = (c^*)^{-1}(c_i), \qquad \lambda_i = \frac{p_B}{p_G} \frac{q_i}{1 - q_i}. \tag{A9}$$

*Then, for any $b_1, \ldots, b_n > 0$ summing to one, the following is an equilibrium: the type B manager offers $c_i$ with probability $b_i$; the type G manager offers $c_i$ with probability $\lambda_i b_i$ and $c_G^*$ with the remaining probability $1 - \sum_i \lambda_i b_i > 0$; the employee exerts high effort with probability $\pi(c_i)$ at $c_i$, with probability one at $c_G^*$, and believes that any other contract is offered by a type G manager.*

**Proof.** Bayes' rule at $c_i$ delivers exactly $q_i$ by construction of $\lambda_i$; since $c_i < \hat{c}_B \leqslant c^*$, Lemma A1 gives $q_i < p_G$, whence $\lambda_i < 1$ and $\sum_i \lambda_i b_i < \sum_i b_i = 1$, so that the residual probability is strictly positive. Since $c_i = c^*(q_i)$, the employee is exactly indifferent at $c_i$ and any $\pi(c_i)$ is optimal; at $c_G^*$, they are indifferent as well and high effort is optimal. By (A8) and $\pi(c_i) A(c_i) = \Phi^* = A(c_G^*)$, both types obtain the same payoff at every contract in their support, namely, $\Phi^*(\rho + \mu^{H,B})$ and $\Phi^*(\rho + \mu^{H,G}) = V(c_G^*, H, G)$ respectively. Finally, any deviation is met with the belief $q = 1$, so that the employee works only if the deviation is at least $c_G^*$; such a contract yields the type $G$ manager at most $V(c_G^*, H, G)$ and yields the type $B$ manager zero, since $V^0(c, H, B) \leqslant V^0(c_G^*, H, B) < V^0(c^*, H, B) \leqslant V_m$ by (22). Neither type gains by taking the outside option either: the type $G$ manager obtains $V(c_G^*, H, G) > \epsilon$ in equilibrium, and the type $B$ manager obtains $\Phi^*(\rho + \mu^{H,B}) \geqslant \epsilon$ by assumption. No deviation is profitable. The weak inequality is all that an equilibrium requires: at equality, the type $B$ manager is indifferent between running the firm and exiting, and the strategy described, under which they run the firm, remains optimal. A strict preference for running the firm requires $\epsilon < \Phi^*(\rho + \mu^{H,B})$, which holds in the numerical example below. □

The following numerical example, with $n = 3$, shows that the parameter restrictions of Proposition A1 are compatible with all the assumptions of the model. Let $u(x) = \sqrt{x}$, let $r$ be degenerate at 0, and take $W_d = 10$, $W_s = 1$, $r_0 = 0.02$, $\mu^{L,B} = 0$, $\mu^{H,B} = 0.5$, $\mu^{L,G} = 0.3$, $\mu^{H,G} = 0.8$, $\psi^L = 0$, $\psi^H = 0.15$, $p_G = 0.5$, $\epsilon = 0.01$ and $V_m \approx 13.66884$, the midpoint of the interval $\big]V^0(c^*, H, B), V^0(c_B^*, H, B)\big[$. One computes $c_B^* = 0.8698$, $c^* = 0.9051$, $c_G^* = 0.9446$, $\hat{c}_B = 0.8874$ and $\Phi^* = 9.0554$. The equilibrium of Proposition A1 with $b_i = 1/3$ is reported in Table A1.

**Table A1.** Equilibrium of Proposition A1 in the numerical example, with $n = 3$ and $b_i = 1/3$: contract $c$, probability $\pi(c)$ of high effort, posterior belief $q(c)$, and probabilities $P_M(c, B)$ and $P_M(c, G)$ with which each type offers $c$. Values are rounded to four decimals.

| | $c$ | $\pi(c)$ | $q(c)$ | $P_M(c, B)$ | $P_M(c, G)$ |
|---|---|---|---|---|---|
| $c_1$ | 0.8725 | 0.9921 | 0.0395 | 0.3333 | 0.0137 |
| $c_2$ | 0.8786 | 0.9928 | 0.1303 | 0.3333 | 0.0499 |
| $c_3$ | 0.8848 | 0.9934 | 0.2193 | 0.3333 | 0.0936 |
| $c_G^*$ | 0.9446 | 1 | 1 | 0 | 0.8427 |

The two types obtain $U_B = 13.5831$ and $U_G = 16.2997 = V(c_G^*, H, G)$, in accordance with Theorem A1; both types run the firm, and the average posterior belief is $0.5 = p_G$, as required by Lemma A3 with $a_G = a_B = 1$. All values are rounded to four decimals; Script S2 in the Supplementary Materials reports them at full precision, together with the residual of the employee's indifference condition at each contract. Since a degenerate return has no density, the example is a limiting illustration: with the triangular density $f(r) = (a - |r|)/a^2$ on $[-a, a]$, $a = 0.01$, every value changes by less than $3 \cdot 10^{-6}$. The thresholds and beliefs are obtained by root finding with a tolerance of $10^{-14}$, and expectations under the triangular density by a composite Simpson rule with 801 nodes. The same construction goes through verbatim with any finite number of atoms. No bound on the size of the support of $P_M(\cdot, B)$ can therefore be established.

*Appendix A.5. Equilibrium Properties*

Two features of these equilibria deserve emphasis, and together they dispose of the entrenchment interpretation.

**Proposition A2.** *In any equilibrium, every contract in the support of $P_M(\cdot, B)$ satisfies $c < c^*$. Moreover, if the type B manager randomizes over at least two contracts, then $\pi(c) < 1$ at the lowest of them.*

**Proof.** The first claim is Lemma A2. For the second, let $c_1 < c_2$ belong to the support of $P_M(\cdot, B)$. Indifference of the type $B$ manager and $V(\cdot, L, B) = 0$ give $\pi(c_1)A(c_1) = \pi(c_2)A(c_2) > 0$. Since $A$ is strictly decreasing, $A(c_1) > A(c_2)$ and therefore $\pi(c_1) < \pi(c_2) \leqslant 1$. □

A "bad" manager may thus grant strictly more stock than the full-information benchmark $c_B^*$ requires, and to that extent, the equilibria of Proposition A1 do display over-granting in the sense of Definition 3. They display no entrenchment, and the strategy never delivers what entrenchment is supposed to deliver. In the equilibria of Proposition A1, the employee works with probability strictly less than one at every contract offered by the type $B$ manager, and Proposition A2 shows that in any equilibrium in which that manager randomizes, this is the case at least at the lowest contract they offer; the over-granting therefore fails to secure high effort. And by Proposition A2, the contracts offered remain below $c^*$, so they never reach the level at which an uninformed employee would work for sure.

The magnitude of the effect is also small. We have computed it on a grid of seventy-five parameter points around the example of Appendix A.4, varying the gap between the types, the cost of effort and the prior; forty-eight of them admit the equilibria of Proposition A1. With $V_m$ at the midpoint of the interval on which these equilibria exist, as in the example, the largest contract a "bad" manager can offer, $\hat{c}_B$, exceeds the benchmark $c_B^*$ by between 0.15% and 2.9% of $c_B^*$; even with $V_m$ at the bottom of that interval, the excess remains below 6%. The grid and the computations are given in Script S3 in the Supplementary Materials.

The largest values arise when the prior probability of a good manager is high, which brings $c^*$ closer to $c_G^*$. Over-granting survives as a formal possibility on an open set of parameters, but not as an economically significant phenomenon.

Finally, the refinement of Definition 4, which selects a unique equilibrium when the threshold does not bind, has no bite when it binds.

**Proposition A3.** *Assume condition (22). Every equilibrium in which the type G manager obtains $V(c_G^*, H, G)$ survives the criterion of Definition 4. Under the assumptions maintained in this appendix, this is the case of every equilibrium, by Theorem A1; without an outside option, it is the case of the equilibria of Theorem 5.*

**Proof.** Consider such an equilibrium, so that $U_G = V(c_G^*, H, G)$ and $U_B \geqslant 0$, a contract $c'$ that neither type offers, and a non-empty set of types $K$. To show that $c'$ is not a credible deviation, it suffices to exhibit one optimal response of the employee to the belief $p_{G|K}$ under which the set of types who gain is not $K$.

If shirking is an optimal response, no type gains under it. The type $B$ manager obtains $V(c', L, B) = 0 \leqslant U_B$ by (A1), and the type $G$ manager obtains $V(c', L, G) \leqslant V^0(0, L, G) < V^0(c_G^*, H, G) = U_G$ by Lemma 4. The set of types who gain is then empty. It remains to consider the cases in which working is the employee's unique optimal response, that is, $c' > c^*(p_{G|K})$.

If $K = \{B\}$, the employee works if $c' > c_B^*$. When $c' < \hat{c}_B$, the type $G$ manager gains, since $c' < \hat{c}_B \leqslant c^* < c_G^*$ gives $V(c', H, G) > V^0(c_G^*, H, G) = U_G$, so that the set of types who gain contains $G$. When $c' \geqslant \hat{c}_B$, the type $B$ manager is dismissed and does not gain. In neither case is the set $\{B\}$. If $K = \{G\}$, the employee works if $c' > c_G^*$; the type $G$ manager then obtains less than $V^0(c_G^*, H, G) = U_G$, and the type $B$ manager, being dismissed since $c' > c_G^* > \hat{c}_B$, obtains zero, so that no type gains. If $K = \{G, B\}$, the employee works if $c' > c^*$; the type $B$ manager is then dismissed, since $c' > c^* \geqslant \hat{c}_B$, and does not gain, so that the set of types who gain is not $\{G, B\}$. No contract is therefore a credible deviation. □

Proposition A3 is the counterpart, in the binding regime, of Proposition 1. When the threshold does not bind, a deviation slightly above $c^*$ is profitable for both types, and the criterion selects the pooling equilibrium at $c^*$. When it binds, the "bad" manager is dismissed at every contract above $c^*$, and any contract at which they could gain is also profitable for the "good" manager: no deviation can be interpreted consistently, and the criterion neither selects among the equilibria of Theorems 5, 6 and 8 and Proposition A1 nor removes the over-granting of the latter.

## Appendix B. Proofs of the Main Text

This appendix collects the proofs of the results stated in Sections 3–6, in the order in which they appear.

### *Appendix B.1. Proofs for Section 3*

**Proof of Lemma 1.** Fix a type $k$ and write $y = W_s(1 + r_0)$ and $a_j = W_s(1 + r + \mu^{j,k})$ for $j \in \{H, L\}$, so that $a_H > a_L$ since $\mu^{H,k} > \mu^{L,k}$. Then,

$$\omega_k(c) = \int_{\mathbb{R}} [u(y + ca_H) - u(y + ca_L)] f(r) dr = \int_{\mathbb{R}} \left[ c \int_{a_L}^{a_H} u'(y + cs) ds \right] f(r) dr,$$

where the substitution is valid since condition (1) guarantees $y + cs > 0$ throughout the range of integration. Differentiating under the integral sign,

$$\frac{\partial}{\partial c} \left[ c \int_{a_L}^{a_H} u'(y + cs) ds \right] = \int_{a_L}^{a_H} [u'(y + cs) + cs\, u''(y + cs)] ds.$$

Substituting $x = y + cs$, so that $cs = x - y$, the integrand becomes

$$u'(x) + (x-y)u''(x) = u'(x)\left[1 + x\,\frac{u''(x)}{u'(x)} - y\,\frac{u''(x)}{u'(x)}\right].$$

By assumption (7), the first term inside the brackets is non-negative. Since $u$ is strictly concave, $-u''(x)/u'(x) > 0$, and since $W_s > 0$ and $r_0 > -1$, we have $y > 0$, so the second term is strictly positive. The bracket is therefore strictly positive, and since $u'(x) > 0$, the integrand is strictly positive for every $s \in [a_L, a_H]$. As $a_H > a_L$, the inner integral is strictly positive for every $r$, and integrating over $r$ preserves the strict inequality. Hence, $\omega_k'(c) > 0$ for every $c \in [0, W_d/W_s]$. □

**Proof of Lemma 2.** By Lemma A1 in Appendix A, whose proof relies only on the "no cross-effect" condition (3) and the strict concavity of $u$, $\omega_G(c) < \omega_B(c)$ for every $c > 0$. By Lemma 1, $\omega_k$ is strictly increasing, and by definition (Equation (11)), $c_k^*$ is the unique solution of $\omega_k(c_k^*) = \psi^H - \psi^L$. Since $\omega_G$ lies strictly below $\omega_B$ everywhere, reaching the common value $\psi^H - \psi^L$ requires a strictly larger argument for $\omega_G$ than for $\omega_B$; hence, $c_G^* > c_B^*$. □

**Proof of Lemma 3.** By Definition 2, $\bar{c}_k = \dfrac{W_d}{W_s}\dfrac{\mu^{H,k} - \mu^{L,k}}{\rho + \mu^{H,k}}$. By the "no cross-effect" condition (2), $\mu^{H,G} - \mu^{L,G} = \mu^{H,B} - \mu^{L,B} =: \Delta$, so that

$$\bar{c}_k = \frac{W_d}{W_s} \cdot \frac{\Delta}{\rho + \mu^{H,k}},$$

which is strictly decreasing in $\mu^{H,k}$, since $\rho + \mu^{H,k} > 0$ by (1). Since $\mu^{H,G} > \mu^{H,B}$, it follows that $\bar{c}_G < \bar{c}_B$. □

**Proof of Lemma 4.** Since $V^0(\cdot, H, k)$ is strictly decreasing and $V^0(\bar{c}_k, H, k) = V^0(0, L, k)$ by (13), the first inequality holds if and only if $c < \bar{c}_k$. Assumption 1 gives $c \leqslant c_G^* < \bar{c}_G$, and $\bar{c}_G < \bar{c}_B$ by Lemma 3, so the inequality holds for both types. For the second claim, let $q$ denote the probability the employee assigns to the manager being of type $G$; their gain from exerting effort is $q\,\omega_G(c) + (1-q)\omega_B(c)$, which is decreasing in $q$ since $\omega_G < \omega_B$ (Lemma A1 in Appendix A). The threshold above which they work is therefore highest at $q = 1$, where it equals $c_G^*$: by Lemma 1, their gain from effort is strictly positive at every $c > c_G^*$ under every belief, and non-negative at $c_G^*$. □

*Appendix B.2. Proofs for Section 4*

**Proof of Theorem 1.** Under complete information, the employee's belief is degenerate at $k$. By Lemma 1, they work at every $c > c_k^*$, shirk at every $c < c_k^*$, and are indifferent at $c_k^*$, where they work with some probability $\pi$. A contract at which the employee shirks yields the manager $V(c, L, k) \leqslant V^0(0, L, k) < V^0(c_k^*, H, k)$, by Lemma 4 and $c_k^* \leqslant c_G^*$. A contract $c > c_k^*$ yields $V(c, H, k) \leqslant V^0(c, H, k) < V^0(c_k^*, H, k)$, and $V(c, H, k) = V^0(c, H, k)$ for $c$ close enough to $c_k^*$, since $V^0(c_k^*, H, k) > V_m$. If $\pi < 1$, the payoff at $c_k^*$ is $\pi V^0(c_k^*, H, k) + (1-\pi)V(c_k^*, L, k) < V^0(c_k^*, H, k)$. The manager's payoff is then bounded above by $V^0(c_k^*, H, k)$, approaches it as $c$ decreases to $c_k^*$, and never attains it, so that the manager has no best response and there is no equilibrium. Hence, $\pi = 1$, the contract $c_k^*$ yields $V^0(c_k^*, H, k)$, and it is the unique best response. With an outside option, running the firm at $c_k^*$ is strictly better than exit if and only if $\epsilon < V^0(c_k^*, H, k)$. □

*Appendix B.3. Proofs for Section 5*

**Proof of Theorem 2.** Suppose, by way of contradiction, that such an equilibrium exists. A type $G$ manager offers the contract $\tilde{c}_G$ and a type $B$ manager offers $\tilde{c}_B$, with $\tilde{c}_G \neq \tilde{c}_B$ since

the equilibrium is separating. Along the equilibrium path, an employee who observes $\tilde{c}_G$ believes with probability one that the manager is of type $G$ and chooses their effort accordingly; the same holds for $\tilde{c}_B$ and type $B$. Since the equilibrium is in pure strategies, the employee's effort is deterministic at each of the two contracts.

We first show that the employee exerts a high level of effort at both contracts. Suppose they exert a low level of effort at $\tilde{c}_k$ for some type $k$. That manager's payoff is $V(\tilde{c}_k, L, k)$, which is strictly positive by assumption, so that $V^0(\tilde{c}_k, L, k) > V_m$. Consider the deviation to $c^*_G + \eta$ with $\eta > 0$. By Lemma 4, high effort is the employee's unique optimal response there whatever they believe, and

$$V^0\left(c^*_G, H, k\right) > V^0(0, L, k) \geqslant V^0(\tilde{c}_k, L, k) > V_m,$$

where the first inequality is the first part of Lemma 4 and the second follows from the monotonicity of $V^0(\cdot, L, k)$. By continuity, $V^0\left(c^*_G + \eta, H, k\right) > V^0(\tilde{c}_k, L, k)$ for $\eta$ small enough, so that the deviation is strictly profitable, a contradiction. Both contracts consequently induce a high level of effort, and both types earn strictly positive profits, so that $V(\cdot, H, k)$ is strictly decreasing over the relevant range.

The ranking of $\tilde{c}_G$ and $\tilde{c}_B$ is then the same under both types. Suppose first that $V(\tilde{c}_G, H, G) > V(\tilde{c}_B, H, G)$, which is equivalent to $\tilde{c}_G < \tilde{c}_B$ and hence implies $V(\tilde{c}_G, H, B) > V(\tilde{c}_B, H, B)$. The type $B$ manager then has a profitable deviation: offering $\tilde{c}_G$ rather than $\tilde{c}_B$. Given the employee's strategy and beliefs, this deviation yields them $V(\tilde{c}_G, H, B)$ instead of $V(\tilde{c}_B, H, B)$, a strict improvement. If instead $V(\tilde{c}_B, H, B) > V(\tilde{c}_G, H, B)$, a symmetric argument applies to the type $G$ manager. Finally, if $V(\tilde{c}_G, H, G) = V(\tilde{c}_B, H, G)$ or $V(\tilde{c}_G, H, B) = V(\tilde{c}_B, H, B)$, the strict monotonicity of $V$ in $c$ implies $\tilde{c}_B = \tilde{c}_G$, contradicting separation. □

**Proof of Theorem 3.** Let $\tilde{c}$ satisfy $c^* \leqslant \tilde{c} \leqslant c^*_G$ and $\tilde{c} < \hat{c}_B$. Since $\tilde{c} \geqslant c^*$, the contract is incentive-compatible with respect to the average type, so that the employee exerts a high level of effort along the equilibrium path. Since $\tilde{c} < \hat{c}_B$, definition (5) gives $V^0(\tilde{c}, H, B) > V_m$, and as $V^0(\tilde{c}, H, G) > V^0(\tilde{c}, H, B)$ both types earn strictly positive profits.

It remains to specify beliefs off the equilibrium path. Since these beliefs cannot be derived from Bayes' rule, they are arbitrary. We assume that an employee who observes a contract $c < \tilde{c}$ believes that the manager is of type $G$ and therefore exerts low effort, since $c < \tilde{c} \leqslant c^*_G$. Any downward deviation then yields $V(c, L, k) \leqslant V^0(0, L, k) < V^0(\tilde{c}, H, k)$ by Lemma 4, and is unprofitable; any upward deviation is unprofitable because it lowers the manager's share without changing the employee's effort. □

**Proof of Proposition 1.** Since $V^0(c^*, H, B) > V_m$, we have $\hat{c}_B > c^*$ by (5), so $c^*$ belongs to the interval of Theorem 3 and the profile described is an equilibrium, the employee exerting the highest effort because $c^*$ is incentive-compatible with respect to the average type.

We show that it is the only pure strategy equilibrium surviving the criterion. By Theorem 2, the game has no pure-strategy fully separating equilibrium in which both types earn strictly positive profits; and a separating equilibrium in which one type earns zero does not survive either, since that type gains by deviating to a contract slightly above $c^*$, where the employee works under their prior, while the other type gains as well because such a contract lies below $c^*_G$ and therefore leaves them more wealth than their own equilibrium contract. Every surviving equilibrium is therefore pooling, hence of the form described in Theorem 3, with $\tilde{c} \in \left[c^*, \min\left\{c^*_G, \hat{c}_B\right\}\right[$.

Let $\tilde{c} > c^*$ be such a contract and consider a deviation to $c$ with $c^* < c < \tilde{c}$. Under the prior, the employee exerts the highest effort, since $c > c^*$, and each type obtains $V(c, H, k) > V(\tilde{c}, H, k)$ because $V(\cdot, H, k)$ is strictly decreasing. Both types gain, so $c$ is a credible deviation with $K = \{G, B\}$ in the sense of Definition 4, and the equilibrium is discarded.

For $\tilde{c} = c^*$, we check that no contract is a credible deviation. In this equilibrium, $U_k = V^0(c^*, H, k)$ for both types. Two inequalities are used repeatedly. If the employee works at a contract $c' > c^*$, a type $k$ manager obtains at most $V^0(c', H, k) < U_k$. If the employee shirks at any contract $c'$, a type $k$ manager obtains $V(c', L, k) \leqslant V^0(0, L, k) < V^0(c^*, H, k) = U_k$, by Lemma 4 and $c^* \leqslant c^*_G$. Consider first a contract $c' > c^*$. Whatever the belief and the employee's response, no type gains, by the two inequalities. Consider next a contract $c' < c^*$. Under the belief $p_{G|\{G,B\}}$, which is the prior, the employee shirks since $c' < c^*$, and no type gains. Under the belief $p_{G|\{G\}}$, they shirk as well, since $c' < c^* < c^*_G$, and again, no type gains. Under the belief $p_{G|\{B\}}$, three cases arise. If $c' < c^*_B$, shirking is their only optimal response, and no type gains. If $c^*_B < c' < c^*$, working is their only optimal response, and both types gain, since $V^0(c', H, k) > V^0(c^*, H, k) = U_k$ for $k \in \{G, B\}$; the set of types who gain is $\{G, B\} \neq \{B\}$. If $c' = c^*_B$, they are indifferent between the two effort levels, and shirking is an optimal response under which no type gains, so that the set of types who gain is not $\{B\}$ for every optimal response. No contract is therefore a credible deviation, and the equilibrium survives the criterion. □

**Proof of Corollary 1.** Suppose the employee randomizes at the contract $\tilde{c}$ offered in equilibrium. Randomizing requires indifference between the two effort levels at $\tilde{c}$. Since the equilibrium is pooling, the employee's belief at $\tilde{c}$ is their prior, and indifference reads $\sum_k p_k \omega_k(\tilde{c}) = \psi^H - \psi^L$. By Lemma 1, the left-hand side is strictly increasing, so this equation has at most one solution, which is $c^*$ by definition. Hence, $\tilde{c} = c^*$.

Let $\pi < 1$ be the probability of high effort at $c^*$ and consider a deviation to $c^* + \varepsilon$ with $\varepsilon > 0$ small. Under the prior, the employee exerts the highest effort, so a type $k$ manager obtains $V(c^* + \varepsilon, H, k)$, which tends to $V(c^*, H, k)$ as $\varepsilon$ tends to zero. Their equilibrium payoff is $\pi V(c^*, H, k) + (1 - \pi) V(c^*, L, k)$, which is strictly smaller than $V(c^*, H, k)$ because $\pi < 1$ and $V(c^*, L, k) < V(c^*, H, k)$. For $\varepsilon$ small enough, both types therefore gain, the deviation is credible with $K = \{G, B\}$ in the sense of Definition 4, and the equilibrium is discarded. □

**Proof of Theorem 4.** In this regime, $\hat{c}_B \leqslant c^*$, so the construction of Theorem 3 does not apply and the argument must be redone. We keep the employee's system of beliefs unchanged. Nothing changes for a type $G$ manager, whose payoff at $\tilde{c}$ remains strictly positive, since $V^0(\tilde{c}, H, G) \geqslant V^0(c^*_G, H, G) > V_m$ by (22). A type $B$ manager obtains a payoff of 0, since $V^0(\tilde{c}, H, B) \leqslant V^0(c^*, H, B) \leqslant V_m$. If they deviate to a contract $c < \tilde{c}$, the employee interprets the offer as coming from a type $G$ manager and exerts the lowest effort, so the deviation yields $V(c, L, B) = 0$ as well and is not profitable. They are therefore indifferent, and the profile remains an equilibrium. □

**Proof of Theorem 5.** We first check the employee's behavior. At every contract $c \geqslant c^*_G$, high effort is optimal whatever their belief, by Lemma 4, and the strategy prescribes it; at $c^*_G$, in particular, where they are indifferent under the belief that the manager is of type $G$, working is the optimal response that the equilibrium selects. At any other contract $c \neq c_B$, they believe they face a type $G$ manager, and $c < c^*_G = c^*(1)$ makes shirking optimal. At $c_B$, they know the manager is of type $B$, and $c_B < c^*_B$ makes shirking optimal. Beliefs are derived by Bayes' rule at $c^*_G$ and $c_B$, the only contracts offered in equilibrium.

A type $G$ manager has no profitable deviation: increasing the equilibrium contract would reduce their wealth, while decreasing it would destroy the employee's incentive to work and, by Lemma 4, lower their payoff. A type $B$ manager earns zero at every contract. At a contract $c < c^*_G$, the employee shirks, and $V^0(c, L, B) \leqslant V^0(0, L, B) < V^0(c^*, H, B) \leqslant V_m$ by Lemma 4, so that the threshold is not met. At a contract $c \geqslant c^*_G$, the employee works, but $V^0(c, H, B) \leqslant V^0(c^*_G, H, B) < V^0(c^*, H, B) \leqslant V_m$. Being indifferent across all contracts, the type $B$ manager has no profitable deviation from $c_B$. □

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**Proof of Theorem 6.** Existence follows the argument used in the proof of Theorem 5: the employee's behavior is optimal given their beliefs, a type $G$ manager has no profitable deviation, and a type $B$ manager earns zero at every contract, strictly less than the outside option $\epsilon > 0$.

For uniqueness, consider a pure-strategy equilibrium in which the type $B$ manager runs the firm. It cannot be pooling: at a common contract, the employee holds their prior, and the argument of the proof of Theorem 5 shows that the type $B$ manager then earns zero, so that the outside option would be strictly better. It cannot be separating either. The type $B$ manager's contract $c_B$ must then yield them at least $\epsilon > 0$, which requires the employee, who knows their type, to work, so that $c_B \geqslant c_B^*$, and requires $V^0(c_B, H, B) > V_m$, so that $c_B < \hat{c}_B \leqslant c^* < c_G^*$. In equilibrium, the type $G$ manager obtains either the outside option $\epsilon$ or, at their own contract, at most $V(c_G^*, H, G)$, by Lemma 4. By offering $c_B$, they would be taken for a type $B$ manager, the employee would work, and they would obtain $V^0(c_B, H, G)$. This exceeds $V^0(c_G^*, H, G) \geqslant V_m$, by (22) and $c_B < c_G^*$, and it exceeds $V^0(c_B, H, B) \geqslant \epsilon$. They would deviate, a contradiction. □

**Proof of Theorem 7.** Consider a planner who observes the manager's type and imposes the following rules:

- If the manager has the type $B$, they must propose the contract $c_B^*$, the employee must accept it and make the highest effort,
- if the manager has the type $G$, they must propose the contract $c_G^*$, the employee must accept it and make the highest effort.

When the manager is of type $G$, utilities are unchanged. Suppose they are of type $B$. Condition (23) guarantees that the manager clears the threshold $V_m$ and that they obtain $V(c_B^*, H, B) > \epsilon$, that is, strictly more than the outside option they take in equilibrium. As for the employee, the definition of $c_B^*$ makes them indifferent between the two effort levels at that contract, so that their payoff under the planner equals

$$\int_{\mathbb{R}} u\big[W_s(1 + r_0) + c_B^* W_s\big(1 + r + \mu^{L,B}\big)\big] f(r)dr - \psi^L,$$

which strictly exceeds $\int_{\mathbb{R}} u[W_s(1 + r_0)]f(r)dr - \psi^L$, their payoff when no project is run, since $c_B^* > 0$ and $u$ is strictly increasing. The type $B$ manager and the employee are therefore strictly better off, and the type $G$ manager is unaffected: the planner's allocation is an interim Pareto improvement on the equilibrium allocation in the sense of Definition 5. □

**Proof of Theorem 8.** We use a continuity argument. Suppose first that the manager plays $c_B^*$ with probability 1 when their type is $B$, and $c_G^*$ with probability 1 when their type is $G$.

- if they observe neither $c_B^*$ nor $c_G^*$, the employee believes that the contract is offered by a type $G$ manager and acts accordingly;
- if they observe $c_G^*$, they exert the highest level of effort;
- if they observe $c_B^*$, they mix over the two effort levels, choosing high effort with probability $\pi$ and low effort with probability $1 - \pi$.

We choose $\pi = \bar{\pi}$, defined in (24), so as to make a type $G$ manager indifferent between the contracts $c_G^*$ and $c_B^*$:

$$\pi V(c_B^*, H, G) + (1 - \pi)V(c_B^*, L, G) = V(c_G^*, H, G), \tag{A10}$$

or

$$\pi = \frac{V(c_G^*, H, G) - V(c_B^*, L, G)}{V(c_B^*, H, G) - V(c_B^*, L, G)}. \tag{A11}$$

From the relations

$$V(c_B^*, H, G) > V(c_B^*, L, G) \text{ and } V\big(c_G^*, H, G\big) < V(c_B^*, H, G), \tag{A12}$$

we have $\pi < 1$. Moreover,

$$c_G^* < \overline{c}_G \quad \Rightarrow \quad V\big(c_G^*, H, G\big) > V(c_B^*, L, G), \tag{A13}$$

hence $\pi > 0$.

The players have no strictly profitable deviations:

- when the manager is of type $G$, they are indifferent between $c_G^*$ and $c_B^*$, given the employee's mixed strategy, and any other contract yields them a lower payoff given the employee's beliefs;
- when they are of type $B$, they obtain $\bar{\pi}\, V^0(c_B^*, H, B) > \epsilon$, since $V^0(c_B^*, H, B) > V_m$ and $V(c_B^*, L, B) = 0$; any other contract yields them zero, since either the employee shirks or $V^0(c, H, B) \leqslant V^0\big(c_G^*, H, B\big) < V^0(c^*, H, B) \leqslant V_m$, so that their strategy is optimal;
- the employee's behavior is always optimal and their beliefs are derived by Bayes' rule whenever possible.

We have thus characterized an equilibrium in which the employee plays a mixed strategy. We now characterize a second equilibrium in which the following apply:

- the manager plays $c_B^e = c_B^* + e$, with $e > 0$ arbitrarily "small", when their type is $B$;
- the manager mixes over $c_B^e$ and $c_G^*$ when their type is $G$;
- the employee exerts the highest effort when they observe $c_G^*$ and mix over efforts when they observe $c_B^e$. If they observe any contract other than $c_G^*$ and $c_B^e$, they believe that the manager is of type $G$ and choose the effort that is optimal given this belief.

To complete the proof, we characterize the equilibrium probabilities $\pi^e$, the probability that the employee exerts the highest effort upon observing $c_B^e$, and $\pi^m$, the probability that a type $G$ manager offers $c_B^e$. Following the argument above, we must have $\pi^e = \frac{V(c_G^*, H, G) - V(c_B^e, L, G)}{V(c_B^e, H, G) - V(c_B^e, L, G)}$. The probability $\pi^m$ must in turn make the employee indifferent between the two effort levels upon observing $c_B^e$:

$$\begin{aligned} &\textstyle\sum_{k \in \{G,B\}} \frac{p'_k}{p'_B + p'_G} \Big( \int_{\mathbb{R}} u\big[W_s(1 + r_0) + c_B^e W_s\big(1 + r + \mu^{L,k}\big)\big] f(r)\, dr - \psi^L \Big) = \\ &\textstyle\sum_{k \in \{G,B\}} \frac{p'_k}{p'_B + p'_G} \Big( \int_{\mathbb{R}} u\big[W_s(1 + r_0) + c_B^e W_s\big(1 + r + \mu^{H,k}\big)\big] f(r)\, dr - \psi^H \Big), \end{aligned} \tag{A14}$$

where $p'_B = p_B$ and $p'_G = p_G \times \pi^m$. Expression (A14) is a simple linear equation with a unique solution in $\pi^m$. By the continuity argument, as $e$ tends to 0, the new equilibrium converges to the previous one, so that $\pi^m$ belongs to $]0, 1[$ for $e$ small enough. For $e$ small enough, we also have $c_B^e < \hat{c}_B$, since $V^0(c_B^*, H, B) > V_m$, and the type $B$ manager's payoff $\pi^e V^0\big(c_B^e, H, B\big)$, which converges to $\bar{\pi}\, V^0(c_B^*, H, B) > \epsilon$, still exceeds their outside option. The type $G$ manager obtains $V\big(c_G^*, H, G\big) > \epsilon$. The first construction has separating offers and a randomizing employee; the second has overlapping supports and is semi-separating. Neither is a pure-strategy equilibrium. □

**Proof of Proposition 2.** By Theorem A1, the type $G$ manager offers $c_G^*$ with strictly positive probability in every equilibrium; if they play a pure strategy, they offer it with probability one.

Let $S_B$ denote the support of $P_M(\cdot, B)$ and suppose that it contains at least two contracts. By Lemma A2, every $c \in S_B$ satisfies $c < \hat{c}_B \leqslant c^* < c_G^*$, so that $c_G^* \notin S_B$. Every contract in $S_B$ is therefore offered by the type $B$ manager alone, and Bayes' rule gives $q(c) = 0$ for every $c \in S_B$.

Fix $c \in S_B$. By Lemma A1, the employee's net gain from exerting high rather than low effort at that contract is $\Omega(c, 0)$, which is strictly negative for $c < c_B^*$ and strictly positive for $c > c_B^*$, since $c^*(0) = c_B^*$. Two consequences follow.

First, no contract below $c_B^*$ belongs to $S_B$. At such a contract $\pi(c) = 0$, so the type $B$ manager obtains $V(c, L, B)$, which is zero by the maintained assumption (A1), hence strictly less than the outside option $\epsilon > 0$ they can secure. Therefore, $S_B \subseteq [c_B^*, \hat{c}_B[$.

Second, $S_B$ contains at most one contract strictly above $c_B^*$. At any such contract, $\pi(c) = 1$ and the type $B$ manager obtains $V^0(c, H, B)$, which is strictly decreasing in $c$; two distinct contracts of this kind would yield them different payoffs, and both cannot be optimal. Since $S_B$ has at least two elements, it is exactly $S_B = \{c_B^*, c'\}$ for some $c'$ with $c_B^* < c' < \hat{c}_B$.

Consider now the type $G$ manager and the deviation to $c'$. That contract is offered with strictly positive probability in equilibrium, so the employee's belief there is $q(c') = 0$ and, by the argument above, they exert high effort with probability one. The deviation therefore yields $V^0(c', H, G)$. Since $c' < c^* < c_G^*$ and $V^0(\cdot, H, G)$ is strictly decreasing, condition (22) gives

$$V^0(c', H, G) > V^0\big(c_G^*, H, G\big) \geqslant V_m,$$

so that the deviation payoff equals $V^0(c', H, G)$ and strictly exceeds $V\big(c_G^*, H, G\big)$, the payoff the type $G$ manager obtains in equilibrium by Theorem A1. The deviation is strictly profitable, a contradiction. □

*Appendix B.4. Proofs for Section 6*

**Proof of Lemma 5.** The marginal benefit of effort in (26) is

$$cW_s\mu'(e)\sum_k q_k \int_{\mathbb{R}} u'\big[W_s(1 + r_0) + cW_s\big(1 + r + \mu(e) + \mu^k\big)\big]f(r)dr.$$

Raising $q$ shifts weight from $\mu^B$ to $\mu^G > \mu^B$, which raises the argument of $u'$ and therefore lowers $u'$, $u$ being strictly concave. The marginal benefit falls while the marginal cost $\psi'$ is unchanged, so the optimal effort falls. □

**Proof of Proposition 3.** Beliefs equal $q = 1$ both at $c_G$, by Bayes' rule, and at every contract other than $c_B$, by the choice of punishment function. The type $G$ manager therefore faces the single objective $V_G(c, e^*(c, 1))$ on that set, and $c_G$ must maximize it there. Since the objective is continuous and the set excludes a single contract, its supremum on the set equals its maximum over all contracts, so that $c_G$ is a maximizer of $V_G(c, e^*(c, 1))$ over all contracts; since $q = 1$ is also the belief under complete information, $c_G$ is a complete information optimum. The first condition in (30) states that a type $B$ manager prefers $c_B$ to their best punished deviation, which includes mimicking $c_G$; the second states that a type $G$ manager does not wish to be taken for a bad one at $c_B$. □

## Notes

1 A comprehensive survey of the literature on signaling theory can be found in Connelly et al. (2011).

2 For a formal introduction to perfect Bayesian equilibrium, the reader may refer to Fudenberg and Tirole (1991), Myerson (1991) or Osborne and Rubinstein (1994). Sobel (2009) studies extensively the class of signaling games.

3 Appendix A characterizes the mixed-strategy equilibria of the binding regime. It shows that the "good" manager's payoff is the same in every equilibrium of that regime (Theorem A1), but also that the type $B$ manager may randomize over arbitrarily many contracts, so that no bound on the size of their support can be obtained (Proposition A1).

4 This property is discussed extensively in Laffont and Martimort (2009).

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