Transparency, career concerns, and incentives for acquiring expertise*

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Abstract

Agents can exert effort to improve the information that guides actions, which, in turn, leads to observable outcomes. Incentives, both for effort and the choice of action, arise through career-concerns to demonstrate ability in gathering useful information. Principals anticipate that more-capable agents are relatively more likely to take certain "smart" actions. So, actions (when observed) might be distorted towards smart actions in spite of opposing information. When smart actions lead to sure outcomes, they conceal further signals of ability and so, allowing principals to observe actions dampens incentives for effort. Instead, when smart actions provide further information about the agent's ability, such transparency can boost effort.

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Consider the relationship between a firm's shareholders and its CEO, a relationship of perennial interest. A theme much discussed by interested parties and in the popular press is the degree of transparency in overseeing the CEO's activities. For example, Harvey Pitt, a former chairman of the Securities and Exchange Commission, has argued that "[t]ransparency is key" (Pitt, 2005). Transparency is also at the heart of numerous popular and academic discussions on politicians, managers, and countless other instances of principal-agent problems, where the incentives of agents arise through career concerns.[1]

This paper highlights that there are many different kinds of transparency and that assessing ability is complex. CEOs and other experts undertake different kinds of activities, including both operational decisions and information-gathering activities. Various forms of transparency can distort both the operational decisions and the effort to obtain the information used to guide such decisions.[2] As a result "transparency", or more accurately, different forms of transparency often have countervailing effects and ambiguous consequences.

To illustrate the central mechanism, consider the example of a CEO who can choose to maintain the status quo or restructure a particular business process. Suppose, further, that shareholders and other potential employers believe that a more capable CEO is relatively more likely to force a restructuring. This is likely to be the case if, for example, the firm is facing perceived difficulties. In this case, if the CEO's course of action is publicly observed, then he may be more likely to choose to restructure even if his information suggests that this is unwarranted. Anticipating this, he might, therefore, exert more effort in exploring different restructuring alternatives. This ex-ante boost to his incentives for information gathering could overcome any inefficiency in his ex-post decision on the course of action.

This paper introduces a model in which different types of agents differ in their ability to acquire informative signals. An agent first decides whether or not to exert effort in

[1] See, in particular, Prat (2005) and the discussion on related literature, below.

[2] Of course, there may be additional considerations inasmuch as a firm may wish to hide its market strategy or *modus operandi* from product-market rivals. We abstract from such considerations.

acquiring information. Then, on the basis of his information, he decides on a course of action. Potential employers always observe the outcome of the action; that is, there is always "outcome-transparency." However, we consider the role of different assumptions on the principals' information.

Potential employers might also directly observe the agent's choice of action or the agent's information. We term these different scenarios "action-transparency" and "signal-transparency" and contrast both with the case in which principals observe neither signals nor actions, which we term "opacity." Following the outcome, potential employers update their beliefs about the agent. The agent trades off the cost of information acquisition against the goal of maximizing the potential employers' posterior beliefs about his ability.

We show that action-transparency can lead to stronger incentives for information gathering than opacity can, as suggested in the example above. We explore circumstances in which this is the case. First, observe that action-transparency makes it more likely that an agent will take a "smart" action. Next, following the choice of action, the outcome may or may not reveal more information about the agent's ability. If a particular action always leads to the same outcome, then it reveals no further information; however, an action may be risky and its outcome realization may reveal much. Thus, an important distinction that arises is between cases in which smart actions reveal further information about the agent and cases in which smart actions conceal information.

Action-transparency induces the agent to take a smart action. If the smart action reveals further information, then the agent understands that potential employers will learn more about him. In this case, the agent is likely to exert more effort to learn the appropriate action and appear more capable than he would under action-opacity.[3] In contrast, if the smart action conceals further information, then under action-transparency, the agent can

[3] In effect, when the smart action is revealing, it forces the agent to act on the information that he has. In forcing the agent to take riskier, revealing actions, the mechanism through which decision-transparency can be beneficial is similar to one that has been highlighted in a contractual setting. In particular, Szalay (2005) demonstrates that (contractually) preventing an agent from taking certain ("safe") decisions might lead to stronger incentives for effort. Here, however, it is reputational concerns that lead agents to choose risky, revealing actions.

take the smart action regardless of his information, confident that there is no further updating; here, there is little reason to effort exert in acquiring information that he will not use.

In addition, action-transparency can lead to more information being revealed than signal-transparency can. The intuition here is that the same signal may have more information content when generated by a more able agent (for example both a good agent and a bad agent might generate signals that suggest undertaking a particular project, but a good agent's signal if known to be coming from a good agent is more reliable). In this case, observing the signal alone may reveal less about the type of the agent than observing the choice of a (revealing) action and the eventual outcome. Action-transparency might force such an action, and, therefore, lead to greater incentives for effort.

With regard to welfare, it is clear that if transparency leads to distorted decisions with no effect on incentives for effort, then it cannot be beneficial.[4] However, once incentives for effort are altered by transparency, this can generate sufficient efficiency gains so as to overcome the loss associated with any distorted choice of actions.[5] In general, effort incentives could either be too high or too low;[6] therefore, strengthening incentives can be either efficiency-enhancing or -diminishing depending on the circumstances. Typically, the literature has been concerned with strengthening rather than weakening incentives. In this case in particular, and following the logic outlined above, when smart actions are revealing and generate strong-enough incentives for effort, action-transparency might be optimal.

Returning to the example above, the status quo is an information-concealing choice of action; however, a restructuring is information-revealing, as there are many ways to restructure so that the outcome is likely to give shareholders and other interested parties further clues as to whether or not the CEO has made a good decision. In this context,

[4] This is the case discussed in Prat (2005) where there is no effort choice.

[5] Note, also, that this increased effort can also help to better sort agents—that is, distinguish between different types of agents and allocate them appropriately in future tasks.

[6] See, for example, Holmström (1999): An agent who puts considerable weight on the future might exert more than the efficient level of effort. This phenomenon is sometimes referred to as a "rat-race" effect.

a CEO, anticipating that he would undertake *some* form of restructuring (which is more likely to be the case when his choice of action is observed), would exert considerable effort to ensure that he found the best form of restructuring. If, in contrast, the smart decision were to stick with the (information-concealing) status quo, then under action-transparency, the CEO would anticipate taking the smart decision more often and, so, would have muted incentives to gather information.

Related Literature

This article is closely related to a literature on "career concerns for experts." In particular, the idea that agents distort their decisions towards smart actions, clearly elucidated in Prat (2005), is present in a number of articles, including Harrington (1993), Brandenburger and Polak (1996), Fingleton and Raith (2005), and Levy (2007). In these models, the focus is typically on the decision that the agent takes.

Milbourn, Shockley and Thakor (2001) instead suppose that the principal rather than the agent takes this decision but does so after observing the agent's information directly (analogous to what is termed "signal transpency"). They show that the agent's incentives to acquire information is higher than first best when he has career concerns on his ability to generate good projects.[7] Instead in this paper, agents career concerns are for their expertise—the quality of their information, or their ability to generate useful information—and in addition to making investments in the quality of their information, agents also make decisions about what projects to implement on the basis of that information. Indeed our focus is on the interaction of the effort-choice and the the decision of which project to implement. In particular we show that whether the smart action is information-revealing or -concealing changes results substantially.

It is worth highlighting that equilibrium determines the actions that principals and the agent consider to be smart: Since the behavior of more and less capable agents is endoge-

[7] More carefully, Milborn, Shockley and Thakor (2001) show that incentives are too strong when only the outcome of the project undertaken is observed (the case considered in this paper). If the outcomes of all projects (that is including ones that are not undertaken) are observed then effort is first best.

nous, smart actions that are relatively more likely to display capability are also endogenous. In this paper, in presenting a relatively simple model with particular parameterizations, it is relatively simple to ensure that certain actions end up as smart. Specifically, the model allows for both information-revealing and -concealing actions to be smart, depending on the parameterization. In contrast, much of the literature is concerned with endogenizing which are the "smart" actions and the rewards to reputation, often in the context of competition among experts (for example, Scharfstein and Stein, 1994; Zwiebel, 1995; Prendergast and Stole, 1996; Ottaviani and Sørensen, 2006a,b,c, and Levy, 2004). We follow Prat (2005) most closely and adopt much of his terminology, such as the distinction between "outcome-transparency" and "action-transparency." However, in Prat's model, and in all of the literature on career concerns for experts, the ability of an actor is synonymous with the quality of the information he holds.[8] In particular, this literature takes the quality of the information as exogenous.

There are numerous contexts in which an agent's information when making a decision depends not only on his intrinsic ability, but also on the efforts that he has undertaken. It is plausible to believe that in these contexts, as in this article, "ability" might include some capacity to exert effort and thereby improve the information available. Indeed, it is hard to envisage instances in which the signal an actor receives or the information he has available is entirely exogenous.

While, here, we suppose that incentives arise through career concerns, an extant literature considers "delegated expertise" in a contractual environment, where outcome-contingent contracts aim to give incentives both for information-gathering and for decisions that use the information appropriately. The seminal paper in this literature is Demski and Sappington (1987); more recent work includes Aghion and Tirole (1997), Szalay (2005), Malcolmson (2009) and, in an interesting application, Inderst and Ottaviani (2008). In

[8] Another stream of the literature—for example, Benabou and Laroque (1992)—considers the case in which the quality of the signal is fixed, but the actors may differ in the extent to which their preferences are aligned with the principal or, equivalently, the extent to which they might misreport the signal.

particular, this literature highlights that decisions might be distorted in order to boost incentives for information-gathering. In this article, such distortions do not arise contractually, but career concerns that arise from the underlying economic environment distort decisions in a way that boosts or dampens incentives for information acquisition. Another strand of related literature considers incomplete contracting (and rather coarse rules) and information acquisition; however, that literature considers choices over disclosure of hard information, whereas this article, in effect, considers cheap talk. That coarse rules (such as mandatory or voluntary disclosure) interact with incentives for information acquisition has been explored in the context of legal rules (Allen et al., 1990, and Shavell, 1994), regulation of product markets (Matthews and Postlewaite, 1985) and competition policy (Lagerlöf and Heidues, 2005).

In addition to advancing the debate on transparency and career concerns for experts and providing a more nuanced perspective, the model also brings together two strands of the literature on reputation (See Bar-Isaac and Tadelis (2008) for a broad overview and taxonomy.) In traditional models of reputation (for example, the seminal work of Kreps and Wilson, 1982, and Milgrom and Roberts, 1982) or career concerns (such as the model presented in Section 2 of Holmström, 1999), principals have no doubts as to the appropriate action: The appropriate action is simply to exert more effort. But principals do not know whether the agent has taken such effort. A reputational concern, and the conflation of ability and effort in generating outcomes, leads the agent to undertake costly actions. In contrast, in the literature on career concerns for expertise, any of the actions could be optimal, and principals observe the chosen action; the reputational concern is for the appropriate use of judgement.[9] In the model presented below, an agent exerts effort that affects the quality of a signal, and principals have no doubt that more effort is better. The agent, then, has discretion over how he acts on this signal. The results highlight that such

[9]In the literature on career concerns for experts, different choices typically have no current costs associated with them (costs are purely future reputational costs). However, adding current costs, as in the reputation model of Ely and Välimäki (2003), does not change the argument.

discretion interacts with reputational incentives for effort. In particular, by considering the case of "signal-transparency," in which the principal can observe the agent's signal directly so that the agent has no discretion, it is shown that discretion may either dampen or boost these reputational incentives.

1 Model

An agent must make two strategic decisions: whether or not to exert effort in improving the quality of the signal he observes and, following observation of this signal, which action to take. The action, in turn, leads to some outcome.

There is a (commonly known) 'safe' action, and there is a continuum of 'risky' actions. The safe action always leads to an outcome 0. There are two types of risky action, good and bad. Of the continuum of risky actions, exactly one is good. The agent's signal can help the agent identify this good risky action.

A good risky action yields 0 with probability ρ and yields G with probability $1-\rho$, whereas a bad risky action yields 0 with probability ρ and -1 with probability $1-\rho$. Note that if $\rho = 0$, then, trivially, observers can tell whether the agent takes the safe action or a risky action, regardless of whether the action is observed directly; and if $\rho = 1$, then risky actions are identical to the safe one, so, for the problem to be substantive, assume that $\rho \in (0, 1)$.

The agent can be of two types: either high or low. The different types of agent generate different signals. As explained below, a good agent always generates a more informative signal than a bad agent, whether exerting effort or not. An agent does not know his type and shares the common belief with principals that he is the high type with probability λ.[10]

An agent's signal picks one of the risky actions as most likely to be the good one, but the signal might be weaker or stronger. In particular, the signal might be so weak that the right course of action is to maintain the status quo. Specifically, the agent observes either

[10] We, thus, consider a career-concerns model in which the agent does not know his own type, rather than a reputation model in which he does. This is in line with much of the literature on career concerns for experts; similar intuitions and effects can arise when an agent does know his own type.

a signal L or a signal H. Each picks out a single risky action as "best" among all risky actions; however, an H signal is always more likely to pick out a good risky action (and, thus, is relatively likely to suggest that this choice dominates the status quo) than is an L signal.

Timing, strategies, and payoffs The agent is risk-neutral and seeks to maximize his final reputation (the potential employers' or principals' belief that he is of the high type) minus the cost of any effort that he undertakes.

The timing is as follows.

1. The agent decides whether or not to exert effort at a cost c.

2. The agent observes L or H on some risky action.

3. The agent decides whether to choose the indicated risky action or, instead, the safe action.[11]

4. An outcome is realized.

5. The belief about the agent's type is updated.

The agent's strategy is a choice of whether or not to exert effort, as well as what action (safe or risky) to take after viewing a signal. In this model, the principal or audience is not strategic, but merely present to form opinions about the agent.[12]

In order to complete the description of the model, it remains to (i) outline the effects of an agent's ability and effort on the information that the he receives: that is, how these affect the informativeness of signals and the likelihood of obtaining an H rather than an L signal; and (ii) discuss the assumptions we make regarding what principals observe when updating their beliefs about the agent's type.

[11] In principle, we could allow the agent to randomly take a different risky action, but with a continuum of risky actions, the agent knows that a risky action that is not indicated by his signal is almost surely a bad one.

[12] Implicitly, we assume that the reason why the agent cares about the audience's beliefs is because they determine future wages, as would be the case, for example, if principals competed for the agent's services at the end of period 5 of the stage.

Informativeness of signals and effect of effort A high-type agent, when exerting no effort, receives the signal H with probability γ, and the signal indicates a good risky action with probability 1; otherwise, it yields a signal L that indicates a good risky action with probability $l \geq 0$ and with the complementary probability picks out a bad risky action. When the high-type agent exerts effort, at cost $c > 0$, he changes the probability of receiving H to $\eta \geq \gamma$ and improves the L signal, raising the probability that it indicates a good action to $h \geq l$. Assume that at least one of these inequalities is strict; otherwise, trivially, the agent exerts no effort.

A low-type agent always receives the same signal, regardless of effort, and this signal is always assumed to be pure noise.[13] Since there are a continuum of risky actions and the signal is pure noise, the signal always indicates a bad risky action. We consider separately two scenarios:

- the low-type agent always observes L; and
- the low-type agent always observes H.

These turn out to correspond, respectively, to a case in which the (endogenously determined) smart action reveals additional information about the agent's ability beyond the choice of action, and a case in which the smart action conceals information. The intuition here is that if the low type always observes L, then it is only the high type who observes H. As a result, intuitively, the high type is more likely to take the risky action; thus, taking the risky action is smart and suggestive of a high-type agent. The outcome of the risky action then gives further clues as to the agent's ability, and it is in this sense that the smart action is information-revealing. In contrast, if the low type always observes H, then observing L (and so being more inclined to the safe action) is an indication that the

[13] Allowing more informative signals for the low agent and allowing his effort to affect the informativeness of his signal would complicate the analysis and, in particular, would make it more difficult to establish circumstances in which the smart action is information-concealing or -revealing, but would not affect the mechanisms at play and the qualitative conclusions.

agent is high type. Since the safe action leads to a sure outcome, here, the smart action is information-concealing.

What do principals observe? We contrast different assumptions on what principals observe. It is assumed throughout that outcomes are observed and that efforts (and agents' types) are not. We consider three cases in both scenarios for the low-type's signal:

- Principals also observe the agent's choice of actions (that is, principals observe stage 3); we term this action-transparency.
- Principals do not observe this information; we term this action-opacity.
- Principals observe the agent's signal directly (that is, principals observe stage 2). We term this signal-transparency and, further, suppose that, in this case, the current principal always forces the agent to take the myopically efficient action.[14]

Note that, as in Prat (2005), in the absence of incentives for effort (for example, when c is prohibitively high), action-opacity always yields more-efficient decisions than action-transparency does.

Further assumption and notation Finally, we make one further assumption and introduce some additional notation. Specifically, we assume that on observing an H signal, the agent assigns higher likelihood to the indicated action being a good one than if he had observed an L signal. That is:

$$\Pr(\text{indicated project is good}|H) > \Pr(\text{indicated project is bad}|L). \tag{1}$$

We make this assumption to interpret the signal H as better news about the risky action.

In the case in which the low-type agent always observes L, (1) holds trivially. However, in the case in which the low-type agent always observes H, this requires additional

[14]It is easy to justify the myopically efficient action being taken. In particular, this will be the case if the current principal may not be the principal in the future—as is implicit in the career-concerns literature.

parametric restrictions, specifically:

$$\lambda\gamma > l \text{ and } \lambda\eta > h. \qquad \text{(Assumption 1)}$$

It is convenient to introduce notation, widely used in the appendix, for principals' posteriors conditional on the actions and outcomes they observe. We denote these posteriors by $\lambda(a, o)$ where the action $a \in \{\emptyset, R, S\}$ and the outcome $o \in \{0, G, -1\}$. Here, $\emptyset$ denotes that the action is unobserved; in this case of action-opacity, we will frequently suppress this argument and write $\lambda(o)$). In the case in which principals observe that the agent has chosen the action S, the only possible outcome is 0, and so, we suppress the argument o and simply write $\lambda(S)$. In general, $\lambda(a, o)$ is derived using Bayes' rule, but depends on principals' equilibrium expectations regarding the agent's effort choice and project-selection rule (that is, how likely the agent is to choose the risky action after he observes L or H).

2 Low-type agent always observes L

Action-transparency

We explore the extent to which transparency boosts or dampens incentives for effort. A natural way to do so in this model with a discrete effort choice is to consider whether or not the agent exerts effort. We characterize the circumstances in which an equilibrium with no effort exists and see how these circumstances vary with the extent of transparency. Therefore, to verify the possibility of such an equilibrium, assume that the agent exerts no effort.

Consider the decision that an agent makes following the observation of a given signal. In general, since there are two signals (H and L) and two actions (the safe action or the risky action), this allows for four possible pure strategies. There is no equilibrium in which the agent would choose the safe action when observing H and the risky action when observing L. We show that the only possibility is that the agent always chooses the risky action. Intuitively, an agent who chooses the risky action demonstrates some confidence in the quality of his signal and indicates that he is a high-type agent. That is, the risky action is a "smart" action. This consideration forces even those who received an L signal to pool.

This intuition is borne out in the following Lemma. The proof appears in the appendix, as do all subsequent proofs.

Lemma 1 *When the low-type agent always observes L and actions are transparent, in an equilibrium with no effort, it cannot be that the agent chooses the safe action regardless of his signal, or that he chooses the safe action if and only if observing L; in contrast, it is always an equilibrium for the agent to always choose the risky action regardless of the signal he observes.*

Turning to the effort decision, when the agent always chooses the risky action, then it is intuitive that the agent prefers to exert no effort when effort is too costly. Writing down explicitly the expected payoff when exerting effort and comparing it to the case in which the agent does not exert effort determines the threshold for the cost of effort.

Lemma 2 *When the low-type agent always observes L and actions are transparent, there is an equilibrium with no effort when*

$$c > \lambda(1-\lambda)(1-\rho)\frac{(h-l)(1-\eta)+(\eta-\gamma)(1-l)}{\lambda(1-\gamma)(1-l)+1-\lambda}. \tag{2}$$

Opacity

Again, we begin by examining the action that an agent chooses following the observation of a given signal. Here, the principals' beliefs do not depend on actions, but only on outcomes (G, 0 or -1) since actions are unobserved. In contrast to the case of action-transparency, choosing the risky action conveys no information in itself (since the choice of action is unobserved), and, instead, the agent takes the action that is likely to yield the best observed outcome.

Lemma 3 *When the low-type agent always observes L and actions are opaque, in an equilibrium with no effort, the agent chooses the risky action when observing the H signal and the safe action when observing the L signal.*

Next, as in the transparency case, we can consider a lower bound on the cost of effort, which ensures that a no-effort equilibrium exists. The analysis, here is a little more involved and depends on the following, somewhat cumbersome condition, whose derivation appears in the appendix.

$$0 \leq \lambda (1-\lambda) \frac{-h + l + h\eta - l\gamma + \gamma\rho + h\lambda\gamma - l\lambda\eta - h\lambda\gamma\eta - h\lambda\gamma\rho + l\lambda\gamma\eta - \lambda\gamma\eta\rho + h\lambda\gamma\eta\rho}{(1-\lambda\eta)(1-\lambda\gamma+\lambda\gamma\rho)(1-l\lambda-\lambda\gamma+l\lambda\gamma)}. \tag{SM}$$

Lemma 3 suggests that when exerting no effort and observing L, the agent prefers to choose the safe action; however, this does not guarantee that this is still the case when then the agent does exert effort. When the agent exerts effort, he may prefer to choose the risky action following an observation of L since, if he turns out to be the high type, the L signal is more likely to be indicating a good action. Condition (SM) guarantees that this effect is not too large, so that even when deviating to exert effort, an agent prefers the safe action when observing L; and when Condition (SM) fails, the agent prefers taking the risky action in such circumstances.

Lemma 4 *When the low-type agent always observes L and actions are opaque, then*

(a) if Condition (SM) holds, there is an equilibrium with no effort when

$$c > \lambda(1-\rho)(\eta-\gamma)\frac{1-\lambda}{\rho\lambda\gamma+\lambda(1-\gamma)+1-\lambda}; \text{ and,} \tag{3}$$

(b) if Condition (SM) fails, there is an equilibrium with no effort when

$$c > \lambda (1-\lambda)(1-\rho) \frac{\eta - \gamma + l\gamma - l\eta - \gamma\rho + \lambda\gamma^2 - \lambda\gamma\eta - l\lambda\gamma^2 + l\lambda\gamma\eta + l\lambda\gamma\rho + \lambda\gamma\eta\rho - l\lambda\gamma\eta\rho}{(1-\lambda\gamma+\lambda\gamma\rho)(1-l\lambda-\lambda\gamma+l\lambda\gamma)}. \tag{4}$$

Recall that effort increases the likelihood that a high type receives an H signal from γ to η, and it also increases the likelihood that the high type's L signal indicates a good risky action from l to h.

First, consider case (a), and note that the no-effort equilibrium can be sustained when (3) holds and that it is easier to satisfy the smaller is $\eta - \gamma$. In particular, (3) must hold if $\eta = \gamma$ (that is, if effort does not affect the likelihood of an H signal, but only the informativeness of an L signal). In contrast, in the case where actions are transparent, the sustainability of a no-effort equilibrium rests on (2) which can fail when $\eta = \gamma$ as long as $h > l$. Similarly, consider the case $h = l$ (in which effort does not change the informativeness of the L signal). Again, it may be that some effort must be exerted in equilibrium under action-transparency but not under action-opacity.[15]

The intuition, here is that discussed in the introduction: Since transparency leads the agent to take a risky action more often, the agent has greater incentives to exert effort to make sure that he picks the right risky action.

Similarly, in case (b), when $\eta = \gamma$, then (4) can be rewritten as

$$c > -\lambda (1-\lambda)(1-\rho) \frac{\gamma\rho (1-\lambda(l+\gamma(1-l)))}{(1-\lambda\gamma(1-\rho))(1-\lambda(l+\gamma(1-l)))}, \tag{5}$$

which is necessarily true; however, (2) need not hold when $\eta = \gamma$.

Note, however, that action-transparency can also lead the agent to act against his information and pick a risky action, even though he believes that the status quo is the better action. This inefficient use of information might dampen the incentive to acquire information and provide an opposite result. That is, there are parameters where there is equilibrium effort under action-opacity but not under action-transparency.[16]

These observations prove the following proposition whether or not Condition (SM) holds.

[15] For example, this is the case at $l = h = 0$, $\lambda = \rho = \gamma = 0.5$, $\eta = 0.95$ and $c = 0.07$.

[16] For example, this is the case at $l = h = 0.1$, $\lambda = \gamma = 0.5$, $\rho = 0.1$, $\eta = 0.95$ and $c = 0.13$. Note, however, that this cannot be the case when $h = l = 0$.

Proposition 1 *When the low-type agent always observes L, there are parameter values where no effort is an equilibrium when actions are opaque but cannot be an equilibrium where actions are transparent.*

In this sense, transparency can lead to greater effort than opacity can.

Signal-transparency

If the project is always conducted, then there cannot be less effort with signal-transparency than with either action-transparency or action-opacity. This results from the observation that if the project is always conducted, then maximal information about the content of the signals is generated, in addition to all signals being directly observed. However, it may be that the project is not always conducted under signal-transparency: The project may be conducted more often under action-transparency and, in this case, more information about the content of the signals might lead the agent to exert more effort.

Proposition 2 *When the low-type agent always observes L and the value of a successful project (G) is low enough, under signal-transparency, the project is conducted only if the H signal is observed. In this case, effort can be no lower under signal-transparency than under action-opacity; however, effort may be higher under action-transparency than under signal-transparency.*

In particular, as demonstrated in the proof, when condition (SM) holds, for effort to be higher under action-transparency than under signal-transparency requires that $h > l$ (that is, that effort affects the informativeness of the L signal). The intuition here is that when effort leads to a more revealing L signal, which gets used under action-transparency but not under signal-transparency, action-transparency can induce greater effort.

3 Low-type agent always observes H

Now, suppose that the low-type agent always observes the signal H, which for the low type agent is simply noise. Here, an agent who observes L is both more capable and more inclined to choose the safe action. This, then, is likely to cause the safe action to be viewed as smart. However, when the safe action is taken, there is no further opportunity to learn about the agent's ability. In this case, the smart action conceals information. Action-transparency, which encourages the agent to take the safe action is, therefore, likely to dampen incentives for information gathering.

This section follows the same order as in Section 2 and characterizes equilibria under different assumptions on the principals' information.

Action-transparency

Recall Assumption 1, which states that, even though an agent does not know his ability, the H signal is more likely than the L signal to identify a good risky action. Here, however, since the L signal indicates a high-type agent, an agent will be prone to taking the safe action to suggest that he has received such a signal. As a result, in equilibrium, the agent always takes the safe action.

Lemma 5 *When the low-type agent always observes H and actions are transparent, in an equilibrium with no effort, the agent always chooses the safe action regardless of the signal he observes.*

Next, turning to effort, the following results.

Lemma 6 *When the low-type agent always observes H and actions are transparent, then no effort is an equilibrium when either of the following conditions holds:*

$$\lambda - \left(\rho \frac{\lambda\gamma}{\lambda\gamma + 1 - \lambda} + (1-\rho)h\right) > 0, \text{ or} \tag{6}$$

$$c > \lambda(1-\gamma)\left(\rho \frac{\lambda\gamma}{\lambda\gamma + 1 - \lambda} + (1-\rho)h - \lambda\right). \tag{7}$$

The first of these conditions ensures that even when exerting effort, the agent will prefer to choose the safe action regardless of the observed signal. Clearly, under such circumstances, there is no reason to exert effort. The second condition characterizes the case in which the signal would change the agent's choice of action. Here, no effort is undertaken if it is too costly.

Opacity

Again, the L signal, which is relatively likely to lead to a safe action and an outcome of 0, can be observed only by a high-type agent. The agent will still be prone to taking the safe action—although this choice is not observed directly. The agent, by taking the safe action, can guarantee the outcome of 0. This outcome is suggestive of the safe action and suggests that the agent is relatively more likely to be the high type. As a result, again, the agent will always take the safe action.

Lemma 7 *When the low-type agent always observes H and actions are opaque, in an equilibrium with no effort, the agent always chooses the safe action regardless of the signal he observes.*

Turning to effort in this case, we obtain the following.

Lemma 8 *When the low-type agent always observes H and actions are opaque, no effort is an equilibrium when either of the following conditions holds:*

$$\lambda > h, \text{ or} \tag{8}$$

$$c > \lambda(1-\gamma)(h-\lambda). \tag{9}$$

Similar to the case of action-transparency, the first condition ensures that, regardless of the signal, the agent prefers the safe action when exerting effort. When this condition fails, the agent, when exerting effort, will change his action depending on the observed signal. In this case, the agent would exert no effort if effort is too costly.

Using Lemma 7 and Lemma 6, we obtain the following.

Proposition 3 *When the low-type agent always observes H, if no effort is an equilibrium when actions are opaque, then no effort is also an equilibrium when actions are transparent.*

In this way, there is more effort with opacity. The intuition here is that taking a risky action is rewarded through higher beliefs by principals only when it results in a good outcome, but a good outcome can be observed equally well under action-opacity or -transparency. Instead a risky action with a 0 outcome is perceived as a worse signal of ability when it is observed (through transparency) than under opacity (when this event is pooled with the safe action). Thus, taking a risky action is relatively more attractive under opacity, and so the incentives for effort are higher under opacity than under action-transparency.

Signal-transparency

If the action were never implemented, the agent would not exert effort, since this merely decreases the probability of the revealing L signal that, in these circumstances, is the only indication of capability. If the action is implemented following the high signal, which requires $\lambda\gamma G - 1 + \lambda > 0$, then the agent's type is perfectly revealed (any instance of the L signal is fully revealing, and the outcome following implementation of the risky action is also revealing). As a result, there is no incentive to exert effort. Finally, due to the assumption that $\lambda G > l$, it cannot be that the action is implemented following the L signal but not otherwise. Thus, there is never any effort under signal-transparency, and so effort can only be higher under either action-opacity or action-transparency.[17]

4 Conclusions

This article has aimed to provide a nuanced view of action-transparency and highlight . In particular, it has considered the distinction between smart actions that reveal and conceal

[17] Note that the result here is in contrast to Milbourn, Shockley and Thakor (2001) where there is over-investment in effort with signal-transparency. However, here career concerns are to demonstrate ability in information-gathering or "expertise", whereas in Milbourn, Shockley and Thakor (2001) all agents have the same ability in information-gathering and career concerns are to demonstrate ability to "create" rather than identify good risky projects.

information. When the smart action conceals information (here, where the low type always observes H), transparency on actions reduces incentives for effort. Conversely, when the smart action reveals information (where the low type always observes L), transparency on actions can increase incentives for effort (in the sense that no effort can be sustained as an equilibrium when the choice of action is not observed, but cannot be sustained as an equilibrium when the action is observed).

In many applications, it is more plausible that a smart action is revealing than concealing. For example, an agent who pursues the status quo might be perceived as devoid of ideas. Transparency on actions, which might encourage new initiatives, can be beneficial inasmuch as it might encourage efficient effort from an agent in determining which new initiative is best.

In addition to contrasting action-transparency with the case in which actions are unobserved, the article has considered the case win which the agent's information is directly observed (a case that one might consider as an active principal who does not delegate, but insists on reviewing all reports). In both cases when the smart action is revealing and concealing, there can be greater effort when signals are unobserved (perhaps corresponding to delegation) than when they are observed.

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A Omitted Proofs

Proof of Lemma 1

First, suppose that the agent always chooses the safe action. Then, any observation of the risky action is clearly an off-equilibrium observation; however, it must be that the (off-equilibrium) belief following an observation of a choice of the risky action and an outcome of G is that the agent must be good. Forward-induction arguments would, therefore, also suggest that the belief following an observation of the risky action and an outcome of 0 would be that the agent must be good, or, with passive beliefs, that the audience's beliefs do not change. Trivially, therefore, if the agent receives an H signal, he would decide on the risky action, contradicting the assumption that it is an equilibrium to always take the safe action.

Next, suppose that the agent chooses the risky action when observing H and the safe action when observing L. Then, the belief following an observation of the risky action and an outcome of G would be $\lambda(R, G) = 1$; the belief following a choice of the risky action and an outcome of 0 would be $\lambda(R, 0) = 1$; the belief following the choice of the safe action would be $\lambda(S) = \frac{\lambda(1-\gamma)}{\lambda(1-\gamma)+1-\lambda}$; and the (off-equilibrium) belief following the observation $\lambda(R, -1) = \frac{\lambda(1-\gamma)(1-l)}{\lambda(1-\gamma)(1-l)+1-\lambda}$. For this to be an equilibrium, it must be that the agent prefers the safe action when observing the signal L. Choosing the safe action yields a payoff of $\frac{\lambda(1-\gamma)}{\lambda(1-\gamma)+1-\lambda}$, whereas choosing the risky action would yield

$$\begin{aligned}
&\rho\lambda(R,0) + (1-\rho)\left[\frac{\lambda(1-\gamma)}{\lambda(1-\gamma)+1-\lambda} l\lambda(R,G) + \left(1 - \frac{\lambda(1-\gamma)}{\lambda(1-\gamma)+1-\lambda} l\right)\lambda(R,-1)\right] \\
&= \rho + (1-\rho)\left[\frac{\lambda(1-\gamma)}{\lambda(1-\gamma)+1-\lambda} l + \left(1 - \frac{\lambda(1-\gamma)}{\lambda(1-\gamma)+1-\lambda} l\right)\frac{\lambda(1-\gamma)(1-l)}{\lambda(1-\gamma)(1-l)+1-\lambda}\right] \\
&= \frac{\lambda(1-\gamma)+\rho(1-\lambda)}{1-\lambda\gamma}. \qquad (10)
\end{aligned}$$

So, this is indeed an equilibrium if

$$\frac{\lambda(1-\gamma)}{\lambda(1-\gamma)+1-\lambda} - \frac{\lambda(1-\gamma)+\rho(1-\lambda)}{1-\lambda\gamma} = -\rho\frac{1-\lambda}{1-\lambda\gamma} > 0. \qquad (11)$$

This is clearly false, and the contradiction completes the proof of the first half of the lemma.

It remains to verify that the remaining pure strategy—that the agent always takes the risky action—is an equilibrium. In this case, one can write the belief following the risky action and an outcome of G as $\lambda(R, G) = 1$; the belief following the risky action and an outcome of -1 as $\lambda(R, -1) = \frac{\lambda(1-\gamma)(1-l)}{\lambda(1-\gamma)(1-l)+1-\lambda}$, the belief following the risky action and an outcome of 0 as $\lambda(R, 0) = \lambda$; and the off-equilibrium belief $\lambda(S) = \frac{\lambda(1-\gamma)}{\lambda(1-\gamma)+1-\lambda}$ (where we plausibly assume that the off-equilibrium safe action is more likely to arise from an agent observing the L signal). Then, after receiving a signal L, the agent prefers the risky action when

$$\rho\lambda(R,0) + (1-\rho)\left[\frac{\lambda(1-\gamma)}{\lambda(1-\gamma)+1-\lambda} l\lambda(R,G) + \left(1 - \frac{\lambda(1-\gamma)}{\lambda(1-\gamma)+1-\lambda} l\right)\lambda(R,-1)\right] > \lambda(S), \quad (12)$$

iff

$$\rho\lambda + (1-\rho)\left[\frac{\lambda(1-\gamma)}{\lambda(1-\gamma)+1-\lambda} l + \left(1 - \frac{\lambda(1-\gamma)}{\lambda(1-\gamma)+1-\lambda} l\right)\frac{\lambda(1-\gamma)(1-l)}{\lambda(1-\gamma)(1-l)+1-\lambda}\right] - \frac{\lambda(1-\gamma)}{\lambda(1-\gamma)+1-\lambda} = \lambda\gamma\rho\frac{1-\lambda}{1-\lambda\gamma} > 0,$$

which is always true.

Proof of Lemma 2

When the agent exerts no effort, he anticipates earning

$$\rho\lambda(R,0)+(1-\rho)\lambda(\gamma+(1-\gamma)l)\lambda(R,G)+(1-\rho)(\lambda(1-\gamma)(1-l)+1-\lambda)\lambda(R,-1), \tag{13}$$

and when exerting effort, he anticipates earning

$$\rho\lambda(R,0)+(1-\rho)\lambda(\eta+(1-\eta)h)\lambda(R,G)+(1-\rho)(\lambda(1-\eta)(1-h)+1-\lambda)\lambda(R,-1)-c. \tag{14}$$

It follows that he prefers to exert no effort when

$$\begin{aligned} c &> \lambda(1-\rho)(h-l+\eta-\gamma-h\eta+l\gamma)(\lambda(R,G)-\lambda(R,-1)) \\ &= \lambda(1-\lambda)(1-\rho)\frac{(h-l)(1-\eta)+(\eta-\gamma)(1-l)}{\lambda(1-\gamma)(1-l)+1-\lambda}. \end{aligned} \tag{15}$$

Proof of Lemma 3

First, suppose that the agent always chooses the safe action. Then, the belief following an outcome of 0 is $\lambda(0)=\lambda$, and the belief following the off-equilibrium observation G must be $\lambda(G)=1$. So the agent prefers the risky action when observing the H signal, and always choosing the safe action cannot be an equilibrium.

Next, suppose that the agent always chooses the risky action. Then, the belief following an observation of 0 is $\lambda(0)=\lambda$; the belief following an outcome of G is $\lambda(G)=1$; and the belief following an outcome of -1 is $\lambda(-1)=\frac{\lambda(1-g)(1-l)}{\lambda(1-g)(1-l)+1-\lambda}$. The agent, therefore, prefers taking the risky action after receiving the signal L if

$$\rho\lambda(0)+(1-\rho)\left[\frac{\lambda(1-\gamma)}{\lambda(1-\gamma)+1-\lambda}l\lambda(G)+\left(1-\frac{\lambda(1-\gamma)}{\lambda(1-\gamma)+1-\lambda}l\right)\lambda(-1)\right]>\lambda(0), \tag{16}$$

which requires

$$\begin{aligned} \frac{\lambda(1-\gamma)}{\lambda(1-\gamma)+1-\lambda}l+\left(1-\frac{\lambda(1-\gamma)}{\lambda(1-\gamma)+1-\lambda}l\right)\frac{\lambda(1-g)(1-l)}{\lambda(1-g)(1-l)+1-\lambda}-\lambda= \\ -\lambda\left(1-\lambda\right)\frac{\gamma l(1-\lambda)+g\left(1-\lambda\gamma\right)\left(1-l\right)}{\left(1-\lambda\gamma\right)\left(1-\lambda(g+l-gl)\right)}>0, \end{aligned} \tag{17}$$

which cannot be true, and so provides the contradiction that completes the proof.

Consider the case in which the agent chooses the risky action when observing the signal H and the safe action otherwise. Then, $\lambda(G)=1$ and $\lambda(0)=\frac{\rho\lambda\gamma+\lambda(1-\gamma)}{\rho\lambda\gamma+\lambda(1-\gamma)+1-\lambda}$. In the (off-equilibrium) event that the outcome -1 is observed, the posterior belief is $\lambda(-1)=\frac{\lambda(1-\gamma)(1-l)}{\lambda(1-\gamma)(1-l)+1-\lambda}$. It is easy to verify that this is equilibrium behavior. This is equilibrium behavior so long as the agent prefers the safe action when he gets the L signal. This requires

$$\rho\lambda(0)+(1-\rho)\left[\frac{\lambda(1-\gamma)l}{\lambda(1-\gamma)+1-\lambda}\lambda(1)+\left(1-\frac{\lambda(1-\gamma)l}{\lambda(1-\gamma)+1-\lambda}\right)\lambda(-1)\right]<\lambda(0)$$

or

$$\lambda(0) - \left[\frac{\lambda(1-\gamma)l}{\lambda(1-\gamma)+1-\lambda}\lambda(1) + \left(1 - \frac{\lambda(1-\gamma)l}{\lambda(1-\gamma)+1-\lambda}\right)\lambda(-1)\right] > 0,$$

$$\frac{\rho\lambda\gamma+\lambda(1-\gamma)}{\rho\lambda\gamma+\lambda(1-\gamma)+1-\lambda} - \frac{\lambda(1-\gamma)l}{\lambda(1-\gamma)+1-\lambda} - \left(1 - \frac{\lambda(1-\gamma)l}{\lambda(1-\gamma)+1-\lambda}\right)\frac{\lambda(1-\gamma)(1-l)}{\lambda(1-\gamma)(1-l)+1-\lambda} \geq 0$$

$$\lambda\gamma\rho\frac{1-\lambda}{(1-\lambda\gamma)(1-\lambda\gamma+\lambda\gamma\rho)} \geq 0,$$

which is always true.

Proof of Lemma 4

Here, if the agent exerts no effort, then he obtains

$$\lambda\gamma(1-\rho)\lambda(1) + (1-\lambda\gamma(1-\rho))\lambda(0). \tag{18}$$

If the agent exerts effort, then he may prefer to choose the risky action following an observation of L since, if he turns out to be the high type, the L signal is more likely to be indicating a good action; however, contingent on receiving the L signal, the agent is less likely to be of the high type, which would dampen the desire to take the risky action. Suppose that the first effect is not too large, so that the agent prefers taking the safe action following an observation of L when exerting effort. This requires that

$$\begin{aligned}\lambda(0) &> \rho\lambda(0) + (1-\rho)\left[\frac{\lambda(1-\eta)}{\lambda(1-\eta)+1-\lambda}h\lambda(G) + \left(1 - \frac{\lambda(1-\eta)}{\lambda(1-\eta)+1-\lambda}h\right)\lambda(-1)\right] \\ &= \rho\frac{\rho\lambda\gamma+\lambda(1-\gamma)}{\rho\lambda\gamma+\lambda(1-\gamma)+1-\lambda} + (1-\rho)\left[\frac{\lambda(1-\eta)}{\lambda(1-\eta)+1-\lambda}h + \frac{1-\lambda}{\lambda(1-\eta)+1-\lambda}h\frac{\lambda(1-\gamma)(1-l)}{\lambda(1-\gamma)(1-l)+1-\lambda}\right],\end{aligned}$$

which is true if and only if

$$\begin{aligned}0 &\leq \lambda(0) - \frac{\lambda(1-\eta)}{\lambda(1-\eta)+1-\lambda}h\lambda(G) - \left(1 - \frac{\lambda(1-\eta)}{\lambda(1-\eta)+1-\lambda}h\right)\lambda(-1) \qquad \text{(SM)} \\ &= \lambda(1-\lambda)\frac{-h+l+h\eta-l\gamma+\gamma\rho+h\lambda\gamma-l\lambda\eta-h\lambda\gamma\eta-h\lambda\gamma\rho+l\lambda\gamma\eta-\lambda\gamma\eta\rho+h\lambda\gamma\eta\rho}{(1-\lambda\eta)(1-\lambda\gamma+\lambda\gamma\rho)(1-l\lambda-\lambda\gamma+l\lambda\gamma)}.\end{aligned}$$

There are parameter values for which this is the case (for example, when $h = l$, since $\frac{\lambda(1-\eta)}{\lambda(1-\eta)+1-\lambda} < \frac{\lambda(1-\gamma)}{\lambda(1-\gamma)+1-\lambda}$, the condition always must hold). We first consider this parametric assumption (SM) here and then turn to consider outcomes when it fails. When (SM) holds, the agent, when exerting effort, expects to earn

$$\lambda\eta(1-\rho)\lambda(1) + (1-\lambda\eta(1-\rho))\lambda(0) - c. \tag{19}$$

In this case, no effort is an equilibrium as long as

$$\begin{aligned}c &> \lambda(1-\rho)(\eta-\gamma)(\lambda(1)-\lambda(0)) \\ &= \lambda(1-\rho)(\eta-\gamma)\frac{1-\lambda}{\rho\lambda\gamma+\lambda(1-\gamma)+1-\lambda}. \qquad (20)\end{aligned}$$

Next, consider the case in which (SM) fails.

Under action-opacity with no effort, again, the agent chooses the risky action when observing the signal H and the safe action otherwise. Here, $\lambda(G)=1$ and $\lambda(0)=\frac{\rho\lambda\gamma+\lambda(1-\gamma)}{\rho\lambda\gamma+\lambda(1-\gamma)+1-\lambda}$. In the (off-equilibrium) event that the outcome -1 is observed, the posterior belief is $\lambda(-1)=\frac{\lambda(1-\gamma)(1-l)}{\lambda(1-\gamma)(1-l)+1-\lambda}$.

Here, if the agent chooses, if the agent exerts no effort, then he obtains

$$\lambda\gamma(1-\rho)\lambda(G)+(1-\lambda\gamma(1-\rho))\lambda(0)=\lambda. \tag{21}$$

Suppose that (SM) fails, so that

$$\begin{aligned}0 &> \lambda(0)-\frac{\lambda(1-\eta)}{\lambda(1-\eta)+1-\lambda}h\lambda(G)-(1-\frac{\lambda(1-\eta)}{\lambda(1-\eta)+1-\lambda}h)\lambda(-1) \\ &= \lambda\left(1-\lambda\right)\frac{-h+l+h\eta-l\gamma+\gamma\rho+h\lambda\gamma-l\lambda\eta-h\lambda\gamma\eta-h\lambda\gamma\rho+l\lambda\gamma\eta-\lambda\gamma\eta\rho+h\lambda\gamma\eta\rho}{\left(1-\lambda\eta\right)\left(1-\lambda\gamma+\lambda\gamma\rho\right)\left(1-l\lambda-\lambda\gamma+l\lambda\gamma\right)}.\end{aligned} \tag{22}$$

If the agent exerts effort, he prefers to choose the risky action following an observation of L, and then, when exerting effort, he expects to earn

$$\begin{aligned}&\lambda\eta(\rho\lambda(0)+(1-\rho)\lambda(G))+\lambda(1-\eta)(\rho\lambda(0)+(1-\rho)h\lambda(G)+\\ &(1-\rho)(1-h)\lambda(-1))+(1-\lambda)(\rho\lambda(0)+(1-\rho)\lambda(-1))-c\\ =&\ \lambda\eta(1-\rho)+\lambda\eta\rho\frac{\rho\lambda\gamma+\lambda(1-\gamma)}{\rho\lambda\gamma+\lambda(1-\gamma)+1-\lambda}\\ &+\lambda(1-\eta)\left[\rho\frac{\rho\lambda\gamma+\lambda(1-\gamma)}{\rho\lambda\gamma+\lambda(1-\gamma)+1-\lambda}+(1-\rho)h+(1-\rho)(1-h)\frac{\lambda(1-\gamma)(1-l)}{\lambda(1-\gamma)(1-l)+1-\lambda}\right]+\\ &(1-\lambda)\left[\rho\frac{\rho\lambda\gamma+\lambda(1-\gamma)}{\rho\lambda\gamma+\lambda(1-\gamma)+1-\lambda}+(1-\rho)\frac{\lambda(1-\gamma)(1-l)}{\lambda(1-\gamma)(1-l)+1-\lambda}\right]-c.\end{aligned} \tag{23}$$

So, no effort is an equilibrium when this is less than λ, or, equivalently,

$$c>\lambda\left(1-\lambda\right)\left(1-\rho\right)\frac{\eta-\gamma+l\gamma-l\eta-\gamma\rho+\lambda\gamma^2-\lambda\gamma\eta-l\lambda\gamma^2+l\lambda\gamma\eta+l\lambda\gamma\rho+\lambda\gamma\eta\rho-l\lambda\gamma\eta\rho}{\left(1-\lambda\gamma+\lambda\gamma\rho\right)\left(1-l\lambda-\lambda\gamma+l\lambda\gamma\right)}. \tag{24}$$

Proof of Proposition 2

First note that under signal-transparency, the project is conducted whenever the H signal is observed, and a principal prefers the safe action to the risky action when the L signal is observed as long as

$$0>\frac{\lambda(1-\gamma)}{\lambda(1-\gamma)+1-\lambda}lG-(1-\frac{\lambda(1-\gamma)}{\lambda(1-\gamma)+1-\lambda}l)=\frac{\lambda(1-\gamma)(lG-1+l)-1+\lambda}{\lambda(1-\gamma)+1-\lambda}, \tag{25}$$

which is necessarily true for G small enough.

Again, trivially, effort can be no lower under signal-transparency than under action-opacity.

In this case (when (25) holds), the belief following the observation that the agent has received the signal L is $\lambda(L)=\frac{\lambda(1-\gamma)}{\lambda(1-\gamma)+1-\lambda}$, and so no effort is an equilibrium under signal-transparency when

$$c>\lambda(\eta-\gamma)(\lambda(H)-\lambda(L))=\lambda(\eta-\gamma)\frac{1-\lambda}{\lambda(1-\gamma)+1-\lambda}. \tag{26}$$

Note that (SM) is independent of G, and so it is easy to find instances where both (SM) and (25) hold. Consider, such cases and compare signal-transparency with action-transparency. There is more effort under action-transparency and, in particular, condition (2) when

$$\lambda(1-\rho)((h-l)(1-\eta)+(\eta-\gamma)(1-l))\frac{1-\lambda}{\lambda(1-\gamma)(1-l)+1-\lambda} > c > \lambda(\eta-\gamma)\frac{1-\lambda}{\lambda(1-\gamma)+1-\lambda}. \quad (27)$$

Suppose that $h = l$. Then, this reduces to

$$(1-\rho)(1-l)\frac{\lambda(\eta-\gamma)(1-\lambda)}{\lambda(1-\gamma)(1-l)+1-\lambda} > c > \frac{\lambda(\eta-\gamma)(1-\lambda)}{\lambda(1-\gamma)+1-\lambda}, \quad (28)$$

and since the denominator of the fraction on the left-hand side is larger, the fraction must be smaller. Thus, the expression on the left-hand side must also be smaller than the one on the right-hand side so that condition (27) cannot hold.

Suppose, instead, that $h > l$, but that $\eta = \gamma$. Then, condition (27) reduces to

$$\lambda(1-\rho)(h-l)(1-\gamma)\frac{1-\lambda}{\lambda(1-\gamma)(1-l)+1-\lambda} > c > 0, \quad (29)$$

which can always be sustained for a suitable c.

Proof of Lemma 5

First, suppose that the agent always takes the risky action. Then, the off-equilibrium belief that survives forward-induction arguments following an observation of the safe action is that the agent should be the good type $\lambda(S) = 1$, but then this cannot be an equilibrium. Similarly, it cannot be an equilibrium for the agent to take the safe action if and only if observing the L signal.

Suppose that the agent always takes the safe action. Then, $\lambda(S) = \lambda$, regardless of the observed signal. Reasonable off-equilibrium beliefs are $\lambda(R, G) = 1$, since only a high-type agent can find a good project, and one would anticipate that the deviation is to take the risky action when it is more likely to point to a good project—given assumption 1: that is, when H is observed—and so we take $\lambda(R, -1) = 0$ and $\lambda(R, 0) = \frac{\lambda\gamma}{\lambda\gamma+1-\lambda}$. It follows that always choosing the safe action is an equilibrium as long as

$$\lambda(S) \geq \rho\lambda(R,0) + (1-\rho)\frac{\lambda\gamma}{\lambda\gamma+1-\lambda}\lambda(R,G) + (1-\rho)(1-\frac{\lambda\gamma}{\lambda\gamma+1-\lambda})\lambda(R,-1), \quad (30)$$

or, equivalently,

$$\lambda - \rho\frac{\lambda\gamma}{\lambda\gamma+1-\lambda} - (1-\rho)\frac{\lambda\gamma}{\lambda\gamma+1-\lambda} = \lambda\left(1-\gamma\right)\frac{1-\lambda}{1-\lambda+\lambda\gamma} > 0, \quad (31)$$

which is always true.

Proof of Lemma 6

Suppose that the agent exerts effort. Then, if he still prefers the safe action, then clearly there is no benefit from exerting effort. Effort is beneficial only if it changes the agent's decision and induces him to take the risky action in some circumstances (following either the L or the H signal).

By taking the risky action following an observation of the H signal (and maintaining the presumption that the agent exerts effort), the agent obtains

$$\rho\lambda(R,0) + (1-\rho)\frac{\lambda\eta}{\lambda\eta+1-\lambda}\lambda(R,G) + (1-\rho)(1-\frac{\lambda\eta}{\lambda\eta+1-\lambda})\lambda(R,-1) = \frac{\lambda\eta}{\lambda\eta+1-\lambda}, \quad (32)$$

which is always dominated by taking the safe action and obtaining λ. By taking the risky action with the L signal and effort, the agent obtains

$$\rho\lambda(R,0) + (1-\rho)(h\lambda(R,G) + (1-h)\lambda(R,-1)) = \rho\frac{\lambda\gamma}{\lambda\gamma+1-\lambda} + (1-\rho)h, \quad (33)$$

which is dominated by the safe action when

$$\lambda - (\rho\frac{\lambda\gamma}{\lambda\gamma+1-\lambda} + (1-\rho)h) > 0. \tag{34}$$

When (34) holds, clearly no effort is an equilibrium; when it fails, no effort continues to be an equilibrium as long as

$$c > \lambda(1-\gamma)(\rho\frac{\lambda\gamma}{\lambda\gamma+1-\lambda} + (1-\rho)h - \lambda). \tag{35}$$

Proof of Lemma 7

First, suppose that the agent always takes the risky action. Then, $\lambda(0) = 0$, $\lambda(G) = 1$ and $\lambda(-1) = \frac{\lambda(1-\gamma)(1-l)}{\lambda(1-\gamma)(1-l)+1-\lambda}$. When observing the H signal, the agent prefers the risky to the safe action if $\frac{\lambda\gamma}{\lambda\gamma+1-\lambda}\lambda(G) + (1 - \frac{\lambda\gamma}{\lambda\gamma+1-\lambda})\lambda(-1) > \lambda(0)$, or, equivalently,

$$\begin{gathered}\frac{\lambda\gamma}{\lambda\gamma+1-\lambda} + (1-\frac{\lambda\gamma}{\lambda\gamma+1-\lambda})\frac{\lambda(1-\gamma)(1-l)}{\lambda(1-\gamma)(1-l)+1-\lambda} - \lambda = \\ \lambda\left(1-\gamma\right)\left(1-\lambda\right)\frac{\lambda\gamma(1-l)-l(1-\lambda)}{\left(1-\lambda+\lambda\gamma\right)\left(1-l\lambda-\lambda\gamma+l\lambda\gamma\right)} > 0.\end{gathered} \tag{36}$$

When observing the L signal, the agent prefers the risky over the safe action when $l\lambda(G) + (1-l)\lambda(-1) > \lambda(0)$, or, equivalently,

$$l + (1-l)\frac{\lambda(1-\gamma)(1-l)}{\lambda(1-\gamma)(1-l)+1-\lambda} - \lambda = (1-\lambda)\frac{l(1-\lambda)-\lambda\gamma(1-l)}{1-l\lambda-\lambda\gamma+l\lambda\gamma} > 0. \tag{37}$$

Clearly, (36) and (37) cannot both be true.

Second, suppose that the agent takes the safe action when observing L and the risky action otherwise. Then, $\lambda(G) = 1$, $\lambda(-1) = 0$ and $\lambda(0) = \frac{\lambda(1-\gamma)+\lambda\gamma\rho}{\lambda(1-\gamma)+\lambda\gamma\rho+(1-\lambda)\rho}$. The agent prefers the risky action when observing the H signal whenever $\frac{\lambda\gamma}{\lambda\gamma+1-\lambda}\lambda(G) + (1 - \frac{\lambda\gamma}{\lambda\gamma+1-\lambda})\lambda(-1) > \lambda(0)$, or, equivalently,

$$\begin{gathered}\frac{\lambda\gamma}{\lambda\gamma+1-\lambda} - \frac{\lambda(1-\gamma)+\lambda\gamma\rho}{\lambda(1-\gamma)+\lambda\gamma\rho+(1-\lambda)\rho} = \\ -\lambda\left(1-\gamma\right)\frac{1-\lambda}{\left(1-\lambda+\lambda\gamma\right)\left(\lambda(1-\gamma)+\lambda\gamma\rho+(1-\lambda)\rho\right)} > 0,\end{gathered} \tag{38}$$

which can never be true.

Next, consider the case in which the agent takes the safe action when observing H and the risky action otherwise. This trivially cannot be an equilibrium since $\lambda(G) = \lambda(-1) = 1$, and so an agent always prefers to take the risky action.

Finally, consider the case in which the agent always takes the safe action regardless of the signal observed. Then, $\lambda(0) = \lambda$, and the off-equilibrium beliefs are $\lambda(G) = 1$ and $\lambda(-1) = 0$. It is easy to verify that, if there is no effort in equilibrium, these are equilibrium actions.

Proof of Lemma 8

With no effort, the agent anticipates earning λ. If the agent still prefers to take the safe action after exerting effort, clearly there is no benefit from exerting effort, and the agent will not exert any effort.

Suppose that the agent exerts effort. Then, he prefers taking the risky action after observing the H signal whenever $\frac{\lambda\eta}{\lambda\eta+1-\lambda}\lambda(G) + (1 - \frac{\lambda\eta}{\lambda\eta+1-\lambda})\lambda(-1) > \lambda(0)$ or, equivalently, $\frac{\lambda\eta}{\lambda\eta+1-\lambda} - \lambda > 0$, which can never be true. He prefers the risky action when observing the L signal whenever $h\lambda(G) + (1-h)\lambda(-1) > \lambda(0)$, which is true when

$$h > \lambda. \tag{39}$$

In this latter case, no effort remains an equilibrium as long as $c > \lambda(1-\gamma)(h\lambda(G) + (1-h)\lambda(-1) - \lambda(0))$ or, equivalently,

$$c > \lambda(1-\gamma)(h-\lambda). \tag{40}$$

Proof of Proposition 3

First, note that if $\lambda > h$, then $\lambda - \rho\frac{\lambda\gamma}{\lambda\gamma+1-\lambda} > (1-\rho)h$, and so if no effort under action-opacity is an equilibrium for this reason, no effort is also an equilibrium under action-transparency. Suppose that $h > \lambda$, but $c > \lambda(1-\gamma)(h-\lambda)$and $c < \lambda(1-\gamma)(\rho\frac{\lambda\gamma}{\lambda\gamma+1-\lambda} + (1-\rho)h - \lambda)$. Then, $\frac{\lambda\gamma}{\lambda\gamma+1-\lambda} > h$, but this is incompatible with $h > \lambda$. Thus, whenever no effort is an equilibrium under action-opacity, it is also an equilibrium under action-transparency.