Disclosure of Status in an Agency Setting

Anthony M. Marino and Oguzhan Ozbas*

Marshall School of Business
University of Southern California
Los Angeles, CA 90089-0804

E-Mail: amarino@usc.edu, ozbas@usc.edu

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Abstract

In this paper, we develop a hidden-action principal-agent model in which the principal and the agent share private information about the value of the agent for a multi-agent organization. The principal can disclose her private information and make public the relative standing or status of all agents in the organization. We study whether it is better in terms of profit and utility to disclose or to not disclose status to the group of agents. Conditions for the optimality of disclosure versus non-disclosure are characterized for the cases of exogenous and endogenous human capital.

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1. Introduction

In most multi-agent organizations, the principal and an individual agent share private information regarding the value of that agent for the organization. The information might arise in the course of day-to-day interaction between the principal and the agent or come from periodic performance review of the agent. The organization then has a choice in most situations to make the private information public, and thus disclose the relative standing or status of all members of the organization. In this paper, we study this novel organizational design question by building on recent theoretical and empirical works on status.

As hypothesized in much of the literature in economics and psychology, we assume that status and wages are complements in the agent’s utility. Given this assumption, we consider multiple identical agents in an organization where there is a hidden action agency problem for the principal with regard to each agent. The principal designs an optimal incentive contract for each agent and commits to a disclosure or a non-disclosure policy at the time of hiring the agents. Initially, we assume that each agent is endowed with a certain probability of having high human capital and study the effect of disclosing status to the group of agents after the agents’ human capital levels are realized. We find that disclosure is optimal for the principal if the firm faces a sufficiently favorable production situation – one in which the typical agent exhibits a high sensitivity of cash flow production to effort and/or a low sensitivity of effort cost to effort. In such situations, status concerns play a positive motivational role and increase the principal’s profit. Conversely, if the firm faces a sufficiently unfavorable production situation, then status concerns play a negative motivational role and non-disclosure is optimal for the principal. Interestingly, we find that agents always prefer disclosure to non-disclosure because more information about status allows them to better condition their effort choices. Thus, our model points to status concerns as a possible source of tension between agents and principals regarding the appropriate amount of organization-wide
transparency in principal-agent relationships.

In the basic model, we also ask how changes in human capital affect the principal’s profit. We find that under either disclosure rule, an increase in the typical agent’s probability of having high human capital can have a strong negative motivational effect through toughened competition for status and decrease the principal’s expected profit when there is rapidly rising or falling returns to status in utility. In all other cases, an increase in human capital increases expected profit as it normally does in standard models.

In a final section of the paper, we extend the model by allowing the agent to exert costly effort to increase the probability of having high human capital. If the firm faces a favorable production situation and there are increasing returns to status, then disclosure always results in greater human capital effort and expected profit as long as returns to status are not rising too rapidly. On the other hand, if the production situation is unfavorable and there are decreasing returns to status, then non-disclosure generates greater human capital effort and expected profit as long as returns to status are not falling too rapidly.

Our work is broadly related to a growing literature on social status. Departing from traditional preferences over absolute consumption, this literature considers social status as an additional argument in the utility function, which is similar to how psychologists and sociologists view preferences. Various experimental studies confirm the existence of preferences for status by inducing status in the lab (see Heffetz and Frank, 2011, for an excellent survey).

Specifically, we follow the same preference specification as in Auriol and Renault (2008), which is motivated by Maslow’s (1943) hierarchy of needs. The positive interaction between status and wealth in the preference specification implies that more wealthy agents care more about status and that they are more willing to exert effort to achieve it. This preference specification is consistent with Maslow’s theory that status and self-actualization motives are high-level psychological
needs that come only after basic physiological necessities are met. While advances from related fields continue to refine thinking in psychology in important ways, the broad outlines of Maslow’s hierarchical approach to understanding human motivation remain central (Kenrick, Griskevicius, Neuberg, and Schaller, 2010).

Our other modeling assumptions are intended to capture key features of status (Heffetz and Frank, 2011). First and foremost, status is positional with respect to a desirable trait. We take human capital to be that desirable trait. Status is also non-tradable and only acquired through actions. In our model, we assume that agents can engage in costly effort to accumulate human capital and thereby acquire status. Lastly, status is based on social perceptions and visibility. This is our main motivation for focusing on disclosure policies.

Our paper is related to recent works on behavioral agency theory that consider non-material incentives such as status and respect in optimal contracts. These works also explore implications for organizational design as we do (Auriol and Renault, 2008, and Ellingsen and Johannesson, 2007 and 2008). While our setting incorporates many of the standard features of status, our modeling approach is different in several important respects. In contrast to the usual modeling approach of endowing the principal with complete control over the allocation of a deterministic status budget, our approach instead endows the agent with a chance to achieve status through costly effort. Our emphasis on disclosure policies as an organizational design problem is also unique in endogenizing the source of status.

Finally, a related behavioral literature on other regarding preferences focuses on concerns for relative consumption and studies the effects of wage externalities across workers. These works represent a different but complementary approach to the study of interrelated preferences in organizations. See Itoh (2004) and his references.

The paper is organized as follows. Section 2 presents the model. Section 3 compares disclo-
sure and non-disclosure policies, and conducts comparative statics with respect to human capital. Section 4 endogenizes human capital accumulation and Section 5 concludes.

2. The Basic Model

Consider a firm with a principal and two agents. In stage 1, the two identical agents join the firm and each is endowed with a firm specific human capital level \( \theta \) which can be high, \( \theta_H \), or low, \( \theta_L \), \( \theta_H > \theta_L \). With probability \( p \) an agent’s capital is high, which is realized after the agent joins the firm. Only the agent and the principal observe the agent’s realized human capital. One can think of \( \theta \) as any measure of worth of an individual in the organization which is intrinsic to the individual. In our model, \( \theta \) is a critical component of the agent’s status, which we will initially assume is exogenous and later make endogenous. Importantly, \( \theta \) is not a symbol or award assigned by the principal as in Auriol and Renault (2008) nor is it bestowed by society, but instead it is a representation of the skill of the agent in doing her/his job within the organization. This measure could arise from third parties or from the observation of the principal. For a teacher, \( \theta \) might represent a score from teaching evaluations generated by students or it could be the average score of the teacher’s students in taking standardized tests. For a sales person, \( \theta \) could be a measure of that person’s interpersonal skills and this information might be communicated to the agent and the principal by customers. Most organizations have periodic performance reviews in which the agent submits to the principal information pertinent to job performance, and the principal generates an overall score, \( \theta \), for the agent. In many principal-agent settings, the principal learns such information about agents. The disclosure policy in this paper revolves around \( \theta \). The disclosure issue is whether to divulge to each agent the human capital levels of all agents (the other agent).

We will measure the relative standing or status \( s \) of an agent by the share of total human capital and assume that it enters an agent’s utility function in a positive way. Given the two outcomes for
There are three status outcomes \( s \in \{ s_H, s_L, s_M \} \) for each agent. The first is where the agent obtains high capital and the other agent attains low capital such that status is high and given by

\[
s_H \equiv \frac{\theta_H}{\theta_L + \theta_H}.
\]

The probability of this outcome for an agent is \( p(1 - p) \), from a stage 1 perspective. The second is the case where the agent attains a low capital and the other agent attains a high capital such that status is low and given by

\[
s_L \equiv \frac{\theta_L}{\theta_L + \theta_H}.
\]

From a stage 1 perspective, this state occurs with probability \( p(1 - p) \). The third is the case where an agent attains the same capital as the other agent and status is

\[
s_M \equiv \frac{\theta_H}{\theta_H + \theta_H} = \frac{\theta_L}{\theta_L + \theta_L} = \frac{1}{2}.
\]

The stage 1 probability of this state conditional on an agent attaining a high capital is \( p^2 \), while it is \( (1 - p)^2 \) conditional on an agent attaining a low capital.

Given a human capital parameter \( \theta \), in stage 2 an agent produces a cash flow for the principal which is given by

\[
\hat{x} \in \{ x, 0 \} \text{ with } \text{Prob}(\hat{x} = x) = \theta a^{\varepsilon}.
\]

where \( a \) is the agent effort in cash flow generation and \( \varepsilon \in (0, 1) \) is the effort elasticity parameter. We assume that \( a, \theta \in (0, 1) \). All agents have the same elasticity parameter \( \varepsilon \), but those with greater human capital or ability \( \theta \) generate more expected cash flow for a given amount of effort. Also, as discussed before, status is related to direct productivity and more than a token.

We further assume that compensation can only be based the agent’s cash flow, ruling out three
other potential conditioning variables: the agent’s human capital, and the other agent’s cash flow and human capital. In our model, it turns out that the principal would not condition compensation on the agent’s human capital even if there were no third party verifiability problems associated with measuring human capital.

Given the two states of cash flow, the principal’s compensation contract for the agent is given by

\[
w = \alpha + \beta \hat{x}. \]

The principal and the agent are risk neutral and the agent’s utility function is given by

\[
u = \sigma(s)w - \alpha^v.
\]

The function \(a^v, \ v > 1\), represents the agent’s personal cost of effort, and \(\sigma(s)\) represents a status function which is assumed to be complementary with the wage in the agent’s utility. We assume that \(\sigma\) is increasing in \(s\). Thus, the agent is risk neutral in the wage, given status, and utility is strongly monotonic in status and and the wage. Preferences are strictly convex in the wage and the status indicator \(\sigma\), so that there is diminishing marginal rate of substitution between \(\sigma\) and \(w\).

However, because the curvature of \(\sigma\) is general, there can be an increasing or decreasing marginal rate of substitution between the wage and status. If \(\sigma\) is concave, non-increasing marginal returns to status, then the marginal rate of substitution between status \(s\) and the wage is decreasing or constant. If \(\sigma\) is sufficiently strictly convex, increasing marginal returns to status, then the marginal rate of substitution between \(s\) and \(w\) can be increasing. Finally, under this formulation, the status function \(\sigma\) represents the marginal utility of another dollar. Because it is multiplicative with the wage in utility, there are increasing returns to scale in \(\sigma\) and \(w\) with respect to utility, gross of

\[\footnote{Given the two state cash flow process, this linear contract is fully general.} \]
effort cost.

The complementarity assumption has been utilized by others in examining status and utility. For example see Auriol and Renault (2008) and Hopkins and Kornienko (2004). The agent is assumed to be risk neutral in income, given status. The complementarity assumption asserts that the marginal utility of income is increasing in status such that richer agents enjoy extra status more than poorer agents and would be willing to exert more effort to increase status. As pointed out in Auriol and Renault (2008), this behavior is consistent with Maslow’s pyramid of needs (1943 and 1970) and his modern reinterpretation, Kenrick et al. (2010), from which it can be argued that individuals with lower income are concerned with material needs and do not pay as much attention to status, while those with greater income have met their material needs and are much more preoccupied with raising their status.⁵²

At this point it is useful to summarize the sequence of decisions from the perspective of an agent. (i) The principal hires the agent along with another agent while precommitting to a disclosure policy and informing the agent that he will be on a compensation contract with a fixed wage α and some positive fraction β of cash flow to be determined after the principal observes the agent’s θ; (ii) The agent is endowed with a θ; (iii) The principal sets α and β subject to the agent’s participation and limited liability constraints; (iv) The agent exerts effort α; (v) The returns to the principal and the agent accrue. The disclosure policy takes one of two forms. Full disclosure is defined as the case where the principal makes public the status levels of all agents, and non-disclosure is the situation where the principal does not reveal any information about status.

⁵²For some indirect empirical evidence that there is complementarity between s and w, see Auriol and Renault (2008), pp. 309-310.
2.1. Full disclosure

In this case, an agent knows his status level $s$ in addition to his human capital level $\theta$ before exerting effort. The agent solves

$$\max_{\{a\}} \sigma(s)(\alpha + \beta x \theta a^x) - a^v.$$

The solution is given by

$$a(\theta, s) = \left[\frac{\varepsilon}{\nu} \beta x \theta \sigma(s)\right]^{\frac{1}{1 - \varepsilon}}, \quad \text{(IC}^d\text{)}$$

and the second order condition for this problem is met under our assumptions.$^3$ Condition (IC$^d$) is a constraint in the principal’s problem. In addition, the principal faces participation and limited liability constraints as follows:

$$\sigma(s)(\alpha + \beta x \theta a^x) - a^v - \bar{u} \geq 0, \quad \text{(P}^d\text{)}$$

$$\alpha, \beta \geq 0. \quad \text{(LL)}$$

We will employ the following assumption in what follows.

(A.1) The participation constraint is non-binding at a solution.

Under (A.1), the principal’s optimal $\alpha = 0$ and the principal’s choice of compensation, given the agent’s human capital $\theta$ and status $s$, is described by

$$\max_{\{\beta\}} x \theta \left[\frac{\varepsilon}{\nu} \beta x \theta \sigma(s)\right]^{\frac{\varepsilon}{1 - \varepsilon}}(1 - \beta).$$

$^3$The second order condition for this problem is met if the second derivative of $a^x - a^v$ is negative. Under our assumption that $\varepsilon \in (0, 1)$ and $\nu > 1$, this derivative is negative.
The first order condition is

\[ \beta = \frac{\varepsilon}{v}. \]  

(1)

At a point where the first order condition is met, the second order condition is satisfied. To see this note that if we define

\[ \tau \equiv \frac{\varepsilon}{v - \varepsilon}, \]

then the principal’s problem is equivalent to maximizing \( \beta^\tau - \beta^{\tau+1} \). The first order condition yields \( \beta = \tau/(\tau + 1) \) and the second order condition is that \( \tau(\tau - 1)\beta^{\tau-2} - \tau(\tau + 1)\beta^\tau < 0 \). If \( \tau \leq 1 \), then this condition is met. Assume that \( \tau > 1 \) and rewrite the second order condition as \( 1/\beta^2 < (\tau + 1)/(\tau - 1) \). Substitute \( \beta = \tau/(\tau + 1) \) and the second order condition becomes \(-1 < 0\), which is true.

Note that the agent’s effort \( a \) depends on \( \theta \) and \( s \) while the incentive pay \( \beta \) does not. Thus, our modelling choices help isolate a pure effort channel in principal-agent relationships with status concerns.

The principal’s reduced form profit under full disclosure from an agent who knows his human capital \( \theta \) and status \( s \) is written as

\[ \pi^d (\theta, s) = x^{\tau+1}[(\frac{\varepsilon}{v})^{2\tau} - (\frac{\varepsilon}{v})^{2\tau+1}]\theta[\theta\sigma(s)]^\tau. \]

(2)

Further, the agent’s reduced form utility can be written as

\[ u^d (\theta, s) = x^{\tau+1}[(\frac{\varepsilon}{v})^{2\tau+1} - (\frac{\varepsilon}{v})^{2(\tau+1)}][\theta\sigma(s)]^{\tau+1}. \]

(3)

This completes optimization in stage 2, under full disclosure.
2.2. Non-disclosure

With non-disclosure, the principal does not reveal an agent’s human capital level to any other agent. The agent maximizes expected utility conditional on knowing only his own human capital \( \theta \).

\[
\max_{\{\omega\}} \ E[\sigma(s)|\theta] (\alpha + \beta x \theta a^z_i) - a^v_i,
\]

where

\[
E[\sigma(s)|\theta_L] = p\sigma(s_L) - (1-p)\sigma(s_M),
\]

\[
E[\sigma(s)|\theta_H] = p\sigma(s_M) - (1-p)\sigma(s_H).
\]

Solving this problem, we have that\(^4\)

\[
a(\theta) = \left(\frac{\bar{\varepsilon}}{\bar{v}} \beta x \theta E(\sigma(s)|\theta)\right)^{\frac{1}{\bar{v} - \bar{\varepsilon}}}. \tag{IC^a}
\]

The principal takes (IC\(^a\)) as a constraint in his problem and, in addition, faces participation and limited liability constraints. The participation constraint is

\[
E[\sigma(s)|\theta] (\alpha + \beta x \theta a^z_i) - a^v - \bar{u} \geq 0. \tag{P^n}
\]

and the limited liability constraint is (LL) above.

We assume again that (A.1) is met with respect to (P\(^n\)). The principal’s problem is analogous to (1) with (IC\(^a\)) replacing (IC\(^d\)) and the solution for the optimal share is again \( \beta = \frac{\varepsilon}{v} \).\(^5\) The

\(^4\)Using the same reasoning as in the case of disclosure, we can show that our assumptions guarantee that the second order condition for the agent’s problem is met.

\(^5\)Using the same reasoning as in the case of disclosure, it can be shown that the second order condition to the principal’s problem is met at a point where the first order condition is satisfied.
principal’s reduced form profit from employing an agent who knows only his own human capital \( \theta \) is

\[
\pi^n (\theta) = x^{\tau+1} \left[ (\frac{\xi}{y})^{2\tau} - (\frac{\xi}{y})^{2(\tau+1)} \right] [\theta E \sigma(s) | \theta]^{\tau}.
\]

(4)

The reduced form utility of the agent is

\[
u^n (\theta) = x^{\tau+1} \left[ (\frac{\xi}{y})^{2\tau+1} - (\frac{\xi}{y})^{2(\tau+1)} \right] [\theta E \sigma(s) | \theta]^{\tau+1}.
\]

(5)

3. Comparisons and Comparative Statics

3.1. Comparisons

In this sub-section, we are interested in examining two questions. If the principal were to precommit to a disclosure policy and contract with the agent, then which disclosure policy would result in greater ex ante expected profit for the principal and which policy would result in greater ex ante expected utility for the agent?

Let \( I \equiv x^{\tau+1} \left[ (\frac{\xi}{y})^{2\tau} - (\frac{\xi}{y})^{2(\tau+1)} \right] > 0 \). Consider

\[
E \left[ \pi^d(\theta, s) \right] = I \left\{ p \theta_H [p(\theta_H \sigma(s_M))^{\tau} + (1-p)(\theta_H \sigma(s_H))^{\tau}] + (1-p)\theta_L [p(\theta_L \sigma(s_L))^{\tau} + (1-p)(\theta_L \sigma(s_M))^{\tau}] \right\}
\]

(7)

and

\[
E \left[ \pi^n (\theta) \right] = I \left\{ p \theta_H [p(\theta_H \sigma(s_M)) + (1-p)(\theta_H \sigma(s_H))]^{\tau} + (1-p)\theta_L [p(\theta_L \sigma(s_L)) + (1-p)(\theta_L \sigma(s_M))]^{\tau} \right\}.
\]

(8)

**Proposition 1.** The following comparisons can be made.
(i) If $0 < \tau < 1$, then $E[\pi^n (\theta)] > E[\pi^d (\theta, s)]$.

(ii) If $\tau > 1$, then $E[\pi^d (\theta, s)] > E[\pi^n (\theta)]$.

(iii) $E[u^d (\theta, s)] > E[u^n (\theta)]$.

(All proofs are provided in the Appendix.)

In order to better interpret the comparisons of ex ante expected profit, define the relative elasticity ratio

$$r \equiv \frac{\varepsilon}{v} \in (0, 1).$$

If $r$ is low, then the firm’s expected cash flow technology is not very responsive to the agent’s effort and/or the disutility of effort is very responsive to increases in effort exertion. If the opposite is true, then increases in the agent’s effort produce large increases in expected cash flow and/or very small increases in effort cost. The situation where $r$ is high is then a situation with a combination of a favorable technology of cash flow production and/or the retention of an employee whose effort cost is favorable to the firm in the sense that it is not very responsive to effort exertion. If the firm has high $r$, we can think of it as facing a “favorable” production situation. The parameter $	au = r/(1 - r)$ is monotonically increasing in $r$ and satisfies $\tau \geq 1$ if and only if $r \geq 0.5$. If $\tau > 1$ or, equivalently, if $r > 0.5$, then the firm is said to face a favorable production situation and unfavorable otherwise.

Proposition 1 shows that if the firm faces an unfavorable production situation, then it is better for the principal to not disclose status in the organization. If the opposite is true and a favorable production situation is present, then the principal should disclose status. In the unfavorable situation, the function $(\theta \sigma)^\tau$, $\tau = \frac{\varepsilon}{v-\varepsilon} < 1$, is concave in the product $(\theta \sigma)$, and the sign of $E(\pi^d) - E(\pi^n)$ is that of the difference between a convex combination of the images of this concave function and the concave image of the same convex combination of $(\theta \sigma)$ values. It then follows that by concavity of $(\theta \sigma)^\tau$, this difference is negative and non-disclosure dominates for the principal. A type of risk
aversion is created for the principal, with respect to the status variable \( \theta \sigma \), which induces him to shy away from disclosing status to the agent. This is because disclosure creates more variability in the principal’s profit with respect to \( \theta \sigma \). In the favorable production situation, the opposite is true in that the function \((\theta \sigma)^{\tau}\) is convex in \((\theta \sigma)\) as opposed to concave. The the sign of \( E(\pi^{d}) - E(\pi^{n}) \) is that of the difference between a convex combination of the images of this convex function and the convex image of the same convex combination of \((\theta \sigma)\) values. By convexity of \((\theta \sigma)^{\tau}\), this difference is positive and disclosure dominates for the principal. A risk seeking attitude is created and the principal favors more variability in the status variable, \( \theta \sigma \).

One can think about Proposition 1 (i) and (ii) through the motivational effects of disclosure for agents with status concerns. If \( \tau > 1 \), the principal’s optimal contract \( \beta \left( = \frac{\theta}{\gamma} \right) \) induces greater expected probability of high cash flow when status levels of all agents are made public. If \( \tau < 1 \), the opposite result holds when the principal does not disclose any information about status. Let \( \eta_{ij} = \theta_{i}\sigma(s_{j}) \). The sign of the difference in expected probability of high cash flow is given by

\[
sign \{ E_{d}[\theta a^{e}] - E_{n}[\theta a^{e}] \}
= \text{sign} \{ p[p(\eta_{HM})^{\tau} + (1 - p)(\eta_{HH})^{\tau} - (p\eta_{HM} + (1 - p)\eta_{HH})^{\tau}] \\
+ (1 - p)[p(\eta_{LL})^{\tau} + (1 - p)(\eta_{LM})^{\tau} - (p\eta_{LL} + (1 - p)\eta_{LM})^{\tau}] \},
\]

which is positive when \( \tau > 1 \) and negative when \( \tau < 1 \). And, because the optimal contract pays the same \( \beta \left( = \frac{\theta}{\gamma} \right) \) fraction of high cash flow under both status disclosure policies, the comparisons for expected probability of high cash flow carry over to expected profits that the principal retains after paying the agent.

Proposition 1 also shows that while non-disclosure may be better for the principal with an unfavorable situation, it is never better than disclosure for the agent. For an agent, \( E(u^{d}) \) and
\( E(u^n) \) are based on a convex function of the product \((\theta \sigma), (\theta \sigma)^{\tau+1}, (\tau + 1) > 1 \). In \( E(u^n) \) we take the convex image of a convex combination of \((\theta \sigma)\) values and in \( E(u^d) \) we take the same convex combination of image values of \((\theta \sigma)^{\tau+1}\), with all other terms equal. It then follows that by convexity of \((\theta \sigma)^{\tau+1}\), the latter expectation dominates and disclosure is better.

The intuition here is that the agent can make better effort decisions under disclosure versus non-disclosure because effort is based on actual status as opposed to the expectation of status as would be the case if there were non-disclosure. Given the same \( \beta \) across solutions, ex-ante expected utility is greater under disclosure regardless of the favorability versus unfavorability of production. However, if there is an unfavorable production situation, the principal would prefer non-disclosure and prefer the agent to make the wrong effort choice by basing effort on expected status. This yields greater ex-ante expected profit, given that the agent retains some surplus through the non-binding participation constraint and that the principal is maximizing his share of total surplus rather than total surplus. The opposite is true with a favorable situation.

In sum, for firms with favorable production situations, disclosure raises both profit and utility so that total surplus is greater than it is non-disclosure. In the case of firms facing unfavorable production situations, non-disclosure raises profit, but lowers utility, so that the effect on total surplus is ambiguous. It is easy to show that, depending on the parameters, total surplus can be greater or less under non-disclosure with an unfavorable production situation. If the production situation is sufficiently unfavorable, then total surplus is always greater under non-disclosure. Let the state total surplus under disclosure be given by \( TS^d (\theta, s) \) and let the same under non-disclosure be denoted \( TS^n (\theta) \). Using the results of Proposition 1 we can summarize the results on total surplus in the following.

**Corollary 1.** If \( \tau > 1 \), \( E [TS^d (\theta, s)] > E [TS^n (\theta)] \). If \( \tau < 1 \) is sufficiently small, then \( E [TS^d (\theta, s)] < E [TS^n (\theta)] \).
3.2. Comparative Statics of $p$

In standard principal-agent models, an increase in the agent’s talent ($p$ in our model) would lead to an increase in the principal’s expected profit in equilibrium as long as the marginal cost of talent is sufficiently low for the principal. As we show below, this standard result may not hold when agents have status concerns. Specifically, the principal may be worse off with more talented agents, even when the principal faces no marginal cost of hiring talent in the traditional sense – recall our assumption that the participation constraint is non-binding at a solution. The reason is that status concerns affect the principal’s ability to induce effort.

In one set of results, we show that if agents have a sufficiently risk-seeking preference for status (convex $\sigma$), the negative motivational effect of decreasing status variability while increasing $p$ in the interval $[1/2, 1]$ can be larger than the positive talent effect, leading the principal to locally prefer less talent over more talent and globally prefer an interior $p$, under either disclosure rule. In a parallel set of results, a similar local effect arises if agents have a sufficiently risk-averse preference for status (concave $\sigma$). This time the negative motivational effect of increasing status variability while increasing $p$ in the interval $[0, 1/2]$ can be larger than the positive talent effect. Proposition 2, Cases 1 and 2, contains these results for the case of disclosure, and Propositions 3 and 4 present analogous results for the case of non-disclosure.

At an intuitive level, an increase in $p$ would seem to result in an increase in the principal’s expected profit in equilibrium for either disclosure rule. However, this intuition is not correct if there are status concerns. The reason is that, for either disclosure rule, an increase in $p$ increases the probability of achieving the “high branch” convex combination of status levels, from (7) and (8),

$$\theta_H[p(\theta_H\sigma(s_M)) + (1 - p)(\theta_H\sigma(s_H))]$$

or

$$\theta_H[p(\theta_H\sigma(s_M)) + (1 - p)(\theta_H\sigma(s_H))].$$
and it decreases the probability of achieving the “low branch” convex combination of status states

\[ \theta_L[p(\theta_L \sigma(s_L))^\tau + (1-p)(\theta_L \sigma(s_M))^\tau], \text{ or } \theta_L[p(\theta_L \sigma(s_L)) + (1-p)(\theta_L \sigma(s_M))]^\tau. \]

Clearly, the sum of these two marginal effects is positive. However, an increase in \( p \) also has negative marginal effects that can swamp these positive effects. First, an increase in \( p \) makes more probable that the medium status state in the high branch, \((\theta_H \sigma(s_M))\) (both agents have high human capital), is obtained and lowers the probability that the high status state, \((\theta_H \sigma(s_H))\), is obtained in that branch. Second, an increase in \( p \) raises the probability that the low status state in the low branch, \((\theta_L \sigma(s_L))\), will occur and it lowers the probability that the medium status state, \((\theta_L \sigma(s_M))\), in the low branch is obtained. Depending on parameters and under either disclosure rule, we will show that it is possible for increases in \( p \) to produce decreases in equilibrium expected profit for the principal. That is, despite the fact that an increase in \( p \) means that the agent has greater total factor productivity through greater expected human capital, status concerns can cause a decrease in expected profit under either disclosure rule. We investigate this interesting issue next.

### 3.2.1. Comparative Statics of \( p \): Disclosure

Consider the case of disclosure and define the following augmented share term

\[ \gamma(\tau) \equiv \frac{\theta_H^{\tau+1}}{\theta_H^{\tau+1} + \theta_L^{\tau+1}}, \]

where it can be verified that \( \gamma(\tau) \in (0.5, 1), \gamma(0) = s_H, \) and \( \gamma'(\tau) > 0, \) by \( \theta_i \in (0, 1) \) and \( \theta_H > \theta_L. \)

Also let \( \sigma_i \) denote \( \sigma(s_i) \) for \( i \in \{H, L, M\}. \) Differentiation of \( E(\pi^d(\theta, s)) \) with respect to \( p \) yields

\[ \partial E[\pi^d(\theta, s)] / \partial p \gtrless 0 \text{ iff } (1 - 2p)(\gamma \sigma_H^\tau + (1 - \gamma)\sigma_L^\tau) \gtrless 2(1 - \gamma - p)\sigma_M^\tau. \] (9)
Proposition 2. For a given $\tau$, we have the following two cases.

**Case 1.** Let
\[
\frac{(\gamma(\tau)\sigma_H^T + (1 - \gamma(\tau))\sigma_L^T)}{\sigma_M^T} > 1,
\]
(*)

then

(i) $\partial E \left[ \pi^d(\theta, s) \right] / \partial p > 0$, for $p \in (0, 0.5)$,

(ii) If $2\gamma(\tau) \geq \frac{(\gamma(\tau)\sigma_H^T + (1 - \gamma(\tau))\sigma_L^T)}{\sigma_M^T}$, \( \partial E \left[ \pi^d(\theta, s) \right] / \partial p > 0 \), for $p \in (0.5, 1]$,

(iii) If $2\gamma(\tau) < \frac{(\gamma(\tau)\sigma_H^T + (1 - \gamma(\tau))\sigma_L^T)}{\sigma_M^T}$, then there is a \( \hat{p}(\tau) \in (0.5, 1) \) such that $\partial E \left[ \pi^d(\theta, s) \right] / \partial p > 0$, for $p \in (\hat{p}, 1)$, and $\partial E \left[ \pi^d(\theta, s) \right] / \partial p = 0$, for $p = \hat{p}$.

**Case 2.** Let
\[
\frac{(\gamma(\tau)\sigma_H^T + (1 - \gamma(\tau))\sigma_L^T)}{\sigma_M^T} \leq 1,
\]
\(\sim(*)\)

then

(iv) If $\frac{(\gamma(\tau)\sigma_H^T + (1 - \gamma(\tau))\sigma_L^T)}{\sigma_M^T} \geq 2(1 - \gamma(\tau))$, \( \partial E \left[ \pi^d(\theta, s) \right] / \partial p > 0 \), for $p \in (0, (1 - \gamma(\tau)))$,

(v) If $\frac{(\gamma(\tau)\sigma_H^T + (1 - \gamma(\tau))\sigma_L^T)}{\sigma_M^T} < 2(1 - \gamma(\tau))$, then there is a \( \hat{p}(\tau) \in (0, (1 - \gamma(\tau))) \) such that $\partial E \left[ \pi^d(\theta, s) \right] / \partial p < 0$, for $p \in (0, \hat{p})$, $\partial E \left[ \pi^d(\theta, s) \right] / \partial p > 0$, for $p \in (\hat{p}, (1 - \gamma(\tau)))$, and $\partial E \left[ \pi^d(\theta, s) \right] / \partial p = 0$, for $p = \hat{p}$,

(vi) $\partial E \left[ \pi^d(\theta, s) \right] / \partial p > 0$, for $p \in [(1 - \gamma(\tau)), 1]$.

Condition (*) can be interpreted by thinking of the parameters $\theta_i$ as being fixed and then defining the agent’s preferences for status through the image values of the function $\sigma$. That is, think in terms of a family of $\sigma$ functions. Conditions (*) and $\sim(*)$ can be rewritten as

\[
\frac{\theta_H^T}{\theta_L^T + \theta_H^T} \left( \frac{\sigma_H}{\sigma_M} \right)^T + \frac{\theta_L^T}{\theta_L^T + \theta_H^T} \left( \frac{\sigma_L}{\sigma_M} \right)^T \leq 1.
\]

(10)
Condition (*) is met when, given $\theta_i$ and $\tau$, both $\frac{\sigma_H}{\sigma_M} > 1$ and $\frac{\sigma_L}{\sigma_M} < 1$ are large. This would be true when the three points $\sigma_i$, $i = L, M, H$, define a convex first order spline function. Such a function would take on the form $\hat{\sigma} : [s_L, s_H] \rightarrow [\sigma(s_L), \sigma(s_H)]$, where

$$\hat{\sigma}(s) = \begin{cases} 
\lambda \sigma(s_L) + (1 - \lambda)\sigma(s_M) & \text{for } s = \lambda s_L + (1 - \lambda)s_M, \lambda \in [0, 1], \\
\lambda \sigma(s_M) + (1 - \lambda)\sigma(s_H) & \text{for } s = \lambda s_M + (1 - \lambda)s_H, \lambda \in [0, 1]. 
\end{cases}$$

The convex spline function $\hat{\sigma}$ would satisfy the condition

$$\frac{\sigma_H - \sigma_M}{s_H - s_M} > \frac{\sigma_M - \sigma_L}{s_M - s_L} \Leftrightarrow \sigma_M(\frac{\sigma_H/\sigma_M - 1}{s_H - s_M}) > \sigma_M(\frac{1 - \sigma_L/\sigma_M}{s_M - s_L}) \Leftrightarrow \sigma_H/\sigma_M - 1 > 1 - \sigma_L/\sigma_M, \quad (11)$$

so that each ratio $\sigma_i/\sigma_M$ is large. If the three points $\sigma_i$ form a concave first order spline function, then $\frac{\sigma_H}{\sigma_M}$ and $\frac{\sigma_L}{\sigma_M}$ are small and Condition $\sim(*)$ would be met. The convex case will be termed rising marginal returns to status and the concave case will be called falling marginal returns to status.

Second order differentiation of the expected profit function in $p$ reveals that $E[\pi^d(\theta, s)]$ is strictly concave in $p$ if (*) holds and it is convex in $p$ under $\sim(*)$. We have

$$\frac{\partial^2 E[\pi^d(\theta, s)]}{\partial p^2} \equiv 0 \text{ as } 1 - \frac{\gamma \sigma_H^2 + (1 - \gamma)\sigma_M^2}{\sigma_M^2} \equiv 0.$$  

Thus, rising marginal returns to status lead to a concave profit function in $p$ and falling marginal returns to status lead to a convex profit function in $p$.

Proposition 2 tells us that when (*) holds, as would be the case with rising marginal returns to status, then, under disclosure, increases in the likelihood of high human capital will lead to increases in the principal’s expected equilibrium profit except in the case where $p$ is relatively large and rising marginal returns are sufficiently great to generate the condition $1 < 2\gamma(\tau) < \frac{(\gamma(\tau)\sigma_H^2 + (1 - \gamma(\tau))\sigma_M^2)}{\sigma_M^2}$. In

\[ \text{In (11), we use the fact that } (s_H - s_M) = (s_M - s_L), \text{ given our assumptions.} \]
In this case, expected profit actually decreases in \( p \). Under (*) the profit function is concave in \( p \). If 
\[
2\gamma(\tau) \geq \frac{(\gamma(\tau)\sigma_H + (1 - \gamma(\tau))\sigma_L)}{\sigma_M}
\] and rising returns to status are not too great, expected profit strictly increases in \( p \) and reaches a maximum at \( p = 1 \). If 
\[
2\gamma(\tau) < \frac{(\gamma(\tau)\sigma_H + (1 - \gamma(\tau))\sigma_L)}{\sigma_M}
\] and rising marginal returns to status are great, expected profit reaches a unique maximum at an interior \( \hat{p} \) which is greater than one half. This completes the case of rising marginal returns to status.

When \( \sim(*) \) holds, as would be the case with falling marginal returns to status, then increases in \( p \) lead to increases in expected equilibrium profit except in the case where \( p \) is relatively small and falling marginal returns are sufficient to induce the condition 
\[
\frac{(\gamma(\tau)\sigma_H + (1 - \gamma(\tau))\sigma_L)}{\sigma_M} < 2(1 - \gamma(\tau)) < 1.
\] Here expected profit decreases in \( p \). The profit function is convex in this case. If 
\[
\frac{(\gamma(\tau)\sigma_H + (1 - \gamma(\tau))\sigma_L)}{\sigma_M} \geq 2(1 - \gamma(\tau)),
\] then falling marginal returns to status are not too great and expected profit strictly increases in \( p \) with a maximum at \( p = 1 \). If 
\[
\frac{(\gamma(\tau)\sigma_H + (1 - \gamma(\tau))\sigma_L)}{\sigma_M} < 2(1 - \gamma(\tau))
\] and falling marginal returns to status are great, then there is an interior \( p \), less than one half, at which expected profit reaches a minimum. In this case, expected profit reaches a maximum in the boundary at \( p = 1 \), since 
\[
E[\pi^d(\theta, s)]_{p=0} < E[\pi^d(\theta, s)]_{p=1}.
\]

The counter intuitive case, where expected profit decreases in status, appears whenever returns to status are strongly rising or strongly falling. In the former case it can happen at high \( p \) and in latter it can happen at low \( p \). If there are constant returns to status, expected profit is linear in and strictly increases in \( p \). The intuition for these results can be explained by noting that, given \( p \), the probability of having heterogeneous agents is \( p(1 - p) \) which is maximized at \( \frac{1}{2} \) in \( p \). If there are IRS (increasing returns to status), profit is concave in \( p \) and there can be greater profit when there is greater probability of being different due to greater effort being supplied by the relatively high status agent. When \( p \) increases, the direct effect is that profit goes up because you expect to get a better person, but, at the same time, there is an indirect positive effect of being different. If there are IRS and \( p \) is small, both effects increase profit. As \( p \) gets closer to \( \frac{1}{2} \) there is a greater
probability of being different and you expect a higher value person so that profit goes up. When $p$ gets above $\frac{1}{2}$, the indirect effect is less if IRS is strong and profit goes down because everyone is expected to be good. With DRS the opposite is true in that there is negative marginal value to being different and profit is convex in $p$. With small $p$, everyone is expected to be low quality and there is not much heterogeneity. As $p$ goes up heterogeneity increases with the indirect effect pushing profit down and the direct effect pushing it up. If DRS are sufficiently strong the former effect dominates and profit goes down. As $p$ gets greater profit eventually rises as the probability of heterogeneity goes down.

Proposition 2 can also be interpreted as saying that if the principal could choose the ex ante probability $p$ that an agent would have high human capital, he would choose $p = 1$ except in one case. This case occurs when there are strong increasing returns to status $(\ast)$ and $2\gamma(\tau) < \frac{(\gamma(\tau)\sigma_H^2 + (1 - \gamma(\tau))\sigma_L^2)}{\sigma_M^2}$ and the principal’s profit function is strictly concave with an interior maximum $\hat{p} \in (0.5, 1)$. This is an interesting and counter intuitive result.

### 3.2.2. Comparative Statics of $p$: Non-disclosure

The case of non-disclosure has similar comparative static effects of $p$ as the case of disclosure. The analysis is complicated by the fact that the agent does not know status perfectly and must take conditional expectations, but the conclusions are analogous.

For the case of non-disclosure, we have that

$$\partial E[\pi^n(\theta)]/\partial p \geq 0 \quad \text{iff} \quad \frac{1 - \tau[\frac{1}{(1-p)+p}\frac{\sigma_M^2}{\sigma_H^2} - 1]}{1 + \tau[1 - \frac{1}{p+(1-p)\frac{\sigma_M^2}{\sigma_H^2}}]} \leq \frac{\theta_L^2[p\frac{\sigma_L^2}{\sigma_M^2} + (1-p)\frac{\sigma_M^2}{\sigma_H^2}]}{\theta_H^2[(1-p)\frac{\sigma_M^2}{\sigma_H^2} + p]}.$$  

(12)

The right side of (12) is a positive fraction and is decreasing in $\tau$. On the left side we have $\frac{1}{(1-p)+p\frac{\sigma_M^2}{\sigma_H^2}} - 1 \geq 0$ and $[1 - \frac{1}{p+(1-p)\frac{\sigma_M^2}{\sigma_H^2}}] \in [0, 1)$. Condition (12) is generally difficult to evaluate, but both positive and negative signs are again possible.
Let us consider two cases. First assume that

\[ \tau > \frac{\sigma_M}{\sigma_H - \sigma_M}. \]

This condition is most likely to be met when \( \frac{\sigma_i}{\sigma_M} \) are large and we have rising marginal returns to status. We can prove

**Lemma 1.** If \( \tau > \frac{\sigma_M}{\sigma_H - \sigma_M} \), then there exists a \( \hat{p} \) such that \( 1 - \tau \left[ \frac{1}{(1-p)p + \frac{\sigma_M}{\sigma_H}} - 1 \right] = 0 \) and, for all \( p \in (\hat{p}, 1] \), \( 1 - \tau \left[ \frac{1}{(1-p)p + \frac{\sigma_M}{\sigma_H}} - 1 \right] < 0 \) and \( \partial E(\pi^n_j) / \partial p < 0 \).

Next, we can show

**Proposition 3.** If \( \tau > \frac{\sigma_M}{\sigma_H - \sigma_M} \) and \( \frac{\sigma_i}{\sigma_M}, i = L, H, \) are sufficiently large, then \( E[\pi^n(\theta)] \) has an interior maximum in \( p \) over \( (0, 1) \). \( \partial E[\pi^n(\theta)] / \partial p \) is positive for small \( p \) and negative for large \( p \).

The second case is where

\[ \tau \leq \frac{\sigma_M}{\sigma_H - \sigma_M}. \]

In this case, \( 1 - \tau \left[ \frac{1}{(1-p)p + \frac{\sigma_M}{\sigma_H}} - 1 \right] > 0 \), for all \( p \in [0, 1] \). This case corresponds to situations where \( \frac{\sigma_i}{\sigma_M} \) are small and we have falling marginal returns to status. First consider the limit of (12) as \( p \) tends to zero and we have that (12) holds if

\[ \left( \frac{\theta_H}{\theta_L} \right)^{2\tau} \left( \frac{\sigma_H}{\sigma_M} \right)^{\tau} \triangleq 1 + \tau \left( 1 - \frac{\sigma_L}{\sigma_M} \right). \]

(13)

Fix \( \theta_H/\theta_L \) and let both \( \sigma_H/\sigma_M \) and \( \sigma_L/\sigma_M \) be small. This case is implied by falling marginal returns to status and it would lead to negativity of (13) with the inverse relationship between \( p \) and profit for small \( p \). Next, consider the limit of (12) as \( p \) tends to unity. Here, (12) holds if

\[ \left( \frac{\theta_H}{\theta_L} \right)^{2\tau} \left( \frac{\sigma_M}{\sigma_L} \right)^{\tau} \triangleq \frac{1}{1 - \tau \left( \frac{\sigma_H}{\sigma_M} - 1 \right)}. \]

(14)
If both $\sigma_H/\sigma_M$ and $\sigma_L/\sigma_M$ are small (falling marginal returns to status), then we have a positive relationship between $p$ and profit as in the case of disclosure above, for large $p$. With falling marginal returns to status we have

**Proposition 4.** If $\tau \leq \frac{\sigma_H}{\sigma_H - \sigma_M}$ and $\frac{\partial}{\partial M}$, $i = L, H$, are sufficiently small, then $E[\pi^n(\theta)]$ has a boundary maximum at $p = 1$. $\partial E[\pi^n(\theta)]/\partial p$ is negative for small $p$ and positive for large $p$.

Our results for non-disclosure mirror those for disclosure. Propositions 3 and 4 point out that it is possible for expected profit to be decreasing in $p$ if marginal returns to status are strongly rising or falling. Further, with rising marginal returns to status, the diminishing profit case can occur at high $p$, while with falling marginal returns it can occur at low $p$. Finally, the counter intuitive case, where the principal would not want to set $p = 1$ if he could control it, can occur if there are sufficient rising marginal returns to status. In this case, $E(\pi^n(\theta))$ has an interior maximum in $p$ and strong rising marginal returns to status can cause the negative effects of increasing $p$ on profit to dominate. The intuition is the same as in the case of disclosure.

### 4. Endogenous Human Capital Acquisition

In this section, we extend the model to consider the case where the agent can exert effort in stage 1 of the game to build human capital. In stage 2, the cash flow production process takes place as before.

Formally, when the two identical agents join the firm in stage 1, each exerts effort $\epsilon$ to increase the probability of having high human capital within the firm. With probability $p(\epsilon)$ the agent achieves high capital $\theta_H$ and with probability $1 - p(\epsilon)$ the agent achieves low capital, $\theta_L$. The function $p$ is strictly concave with $p' > 0$, $p'' < 0$. Only the agent and the principal observe the agent’s realized productivity. While an agent can deduce the other agent’s effort for productivity, because agents are identical, an agent does not know the other agent’s realized human capital.
To compute endogenous probabilities for status shares in the extended model, let \( e_1 \) and \( e_2 \) denote the respective effort levels of the first and second agents. The probability of a high status share for the first agent is \( p(e_1)(1 - p(e_2)) \), the probability of a medium status share is \( p(e_1)p(e_2) \), conditional on the agent attaining a high productivity, while it is \( (1 - p(e_1))(1 - p(e_2)) \), conditional on the agent attaining a low productivity, and, finally, the probability of a low status share is \( p(e_1)(1 - p(e_2)) \). Endogenous probabilities for status shares for the second agent are defined analogously.

In the extended model, the sequence of decisions from the perspective of an agent is as follows:

(i) The principal hires the agent along with another agent while precommitting to a disclosure policy and informing the agent that he will be on a compensation contract with a fixed wage \( \alpha \) and some positive fraction \( \beta \) of cash flow to be determined after the principal observes the agent’s \( \theta \);

(ii) The agent rationally expecting such payments exerts effort \( \epsilon \); (iii) The agent’s \( \theta \) is realized; (iv) The principal sets \( \alpha \) and \( \beta \) subject to the agent’s participation and limited liability constraints; (v) The agent exerts effort \( \alpha \); (v) Returns to the principal and the agent accrue.

4.1. Full disclosure

Utilizing reduced form (3), the stage 1 problem for the agent is to solve

\[
\max_{\{e_i\}} p(e_i)[u(\theta_H, s_H)(1 - p(e_j)) + u(\theta_H, s_M)p(e_j)] \\
+(1 - p(e_i))[u(\theta_L, s_M)(1 - p(e_j)) + u(\theta_L, s_L)p(e_j)] - e_i^v,
\]

where the cost of human capital effort takes the same form as cash flow effort. It is assumed that the solution to this problem satisfies the agent’s ex ante participation constraint. After simplification
this problem can be rewritten as

\[
\max_{\{e_i\}} x^{\tau+1} \left[ \left( \frac{\bar{e}}{v} \right)^{2(\tau+1)} - \left( \frac{\bar{e}}{v} \right)^{2(\tau+1)} \right] \{ p(e_i) \left[ \eta_{HH} \tau+1 \tau+1 (1 - p(e_j)) + \eta_{HM} \right]^{\tau+1} + p(e_j) \right] \\
+ (1 - p(e_i)) \left[ \eta_{LM} \right]^{\tau+1} (1 - p(e_j)) + \eta_{LL})^{\tau+1} p(e_j) \} - e_i^v.
\] (15)

The first order condition is

\[
0 = x^{\tau+1} \left[ \left( \frac{\bar{e}}{v} \right)^{2(\tau+1)} - \left( \frac{\bar{e}}{v} \right)^{2(\tau+1)} \right] \{ \left[ \eta_{HH} \tau+1 \tau+1 (1 - p(e_j)) + \eta_{HM} \right]^{\tau+1} + p(e_j) \} = \eta_{LM} \left[ \eta_{LM} \tau+1 (1 - p(e_j)) + \eta_{LL} \right]^{\tau+1} p(e_j) \} - ve_i^{v-1}.
\] (16)

Because the function \( p(.) \) is strictly concave, the effort cost function is strictly convex, and the coefficient multiplying \( p'(.) \) is positive, the second order condition is met.

4.2. Non-disclosure

Utilizing reduced form (5), the agent’s stage 1 problem can be written

\[
\max_{\{e_i\}} x^{\tau+1} \left[ \left( \frac{\bar{e}}{v} \right)^{2(\tau+1)} - \left( \frac{\bar{e}}{v} \right)^{2(\tau+1)} \right] \{ p(e_i) \left[ \eta_{HH} (1 - p(e_j)) + \eta_{HM} p(e_j) \right]^{\tau+1} + p(e_j) \} + (1 - p(e_i)) \left( \eta_{LM} (1 - p(e_j)) + \eta_{LL} p(e_j) \right]^{\tau+1} \} - e_i^v.
\]

The first order condition is given by

\[
0 = x^{\tau+1} \left[ \left( \frac{\bar{e}}{v} \right)^{2(\tau+1)} - \left( \frac{\bar{e}}{v} \right)^{2(\tau+1)} \right] \{ \left[ \eta_{HH} (1 - p(e_j)) + \eta_{HM} p(e_j) \right]^{\tau+1} + p(e_j) \} = \eta_{LM} \left[ \eta_{LM} (1 - p(e_j)) + \eta_{LL} p(e_j) \right]^{\tau+1} p(e_j) \} - ve_i^{v-1}.
\] (17)
As in (16), the second order condition is met because the function \( p(\cdot) \) is strictly concave, the effort cost function is strictly convex, and the coefficient multiplying \( p'(\cdot) \) is positive.

4.3. Characterization of a Symmetric Nash Equilibrium for Disclosure and Non-disclosure

In each of the regimes of disclosure and non-disclosure, the question of whether a symmetric Nash equilibrium exists in the choice variables \( e_i \) arises and the the properties of such an equilibrium are of interest. As in the proof of Proposition 1, let

\[
L \equiv x^{\tau+1} \left[ (\frac{\varepsilon}{v})^{2\tau+1} - (\frac{\varepsilon}{v})^{2(\tau+1)} \right].
\]

Using (16) and (17) define

\[
B^d(p(e)) \equiv [(\eta_{HH})^{\tau+1}(1 - p(e)) + (\eta_{HM})^{\tau+1}p(e)] - [(\eta_{LM})^{\tau+1}(1 - p(e)) + (\eta_{LL})^{\tau+1}p(e)], \quad (18)
\]

and

\[
B^n(p(e)) \equiv [\eta_{HH}(1 - p(e)) + \eta_{HM}p(e)]^{\tau+1} - [\eta_{LM}(1 - p(e)) + \eta_{LL}p(e)]^{\tau+1}. \quad (19)
\]

In symmetric Nash equilibria for disclosure and non-disclosure, respectively, we have

\[
\Omega^i(p(e)) \equiv LB^i(p(e))p'(e) - ve^{\nu-1} = 0, \text{ for } i = d, n. \quad (20)
\]

The following assumption places boundary restrictions on the function \( p(e) \).

(A.2) \( p(0) = p'(\infty) = 0, p(\infty) = 1, \) and \( p'(0) > 0. \)

In addition, we will utilize

(A.3) The functions \( p(e) \) and \(-e^\nu \) are sufficiently concave so as to imply that \( \Omega^i(p(e)) < 0, \) for \( i = d, n. \)
Assumption (A.2) is fairly standard and assumption (A.3) guarantees a decreasing marginal net benefit function in each problem. For disclosure it implies that

\[ 0 > L\{- (\eta_{HH})^{\tau+1} + (\eta_{HM})^{\tau+1} + (\eta_{LM})^{\tau+1} - (\eta_{LL})^{\tau+1}\}(p')^2 \]

\[ + L\{[(\eta_{HH})^{\tau+1}(1 - p) + (\eta_{HM})^{\tau+1}]p - [(\eta_{LM})^{\tau+1}(1 - p) + (\eta_{LL})^{\tau+1}]p\}p'' \]

\[ - v(v - 1)e^{v-2}, \text{ for all } e, \]

and for non-disclosure it implies that

\[ 0 > L\{(\tau + 1)[\eta_{HH}(1 - p) + \eta_{HMP}]^{\tau}(-\eta_{HH} + \eta_{HM}) \]

\[ - (\tau + 1)[\eta_{LM}(1 - p) + \eta_{LLP}]^{\tau}(-\eta_{LM} + \eta_{LL})\}(p')^2 \]

\[ + L\{[(\eta_{HH}(1 - p) + \eta_{HMP})^{\tau+1} - [(\eta_{LM}(1 - p) + \eta_{LLP})^{\tau+1}]p'' \]

\[ - v(v - 1)e^{v-2}, \text{ for all } e \]

We have

**Lemma 2.** A unique symmetric Nash Equilibrium in \( e \) exists under each of the disclosure rules, if (A.1)-(A.3) hold.

### 4.4. Comparisons

Let \( e^d \) denote the solution to (16) and let \( e^n \) denote the solution to (17). Further let \( p^d = p(e^d) \) and \( p^n = p(e^n) \). In the following proposition we consider the case where the firm faces a favorable production situation and \( \sigma \) is convex.

**Proposition 5.** Assume that (A.1)-(A.3) hold. Let the production situation be favorable, let \( \tau > 1 \), and let \( \sigma \) be convex. Then
(i) $e^d > e^n$, and

(ii) $E \left[ \pi^d (\theta, s) \right] > E \left[ \pi^n (\theta) \right]$, if

$$2\gamma(\tau) > \frac{\gamma(\tau)\sigma_H^* + (1 - \gamma(\tau))\sigma_L^*}{\sigma_M^*} > 1.$$ 

(***)

Next, we consider the case where the firm has an unfavorable production situation and where $\sigma$ is sufficiently concave such that the condition

$$\frac{\theta_H}{\theta_L} (\sigma_H - \sigma_M) < (\sigma_M - \sigma_L)$$

(21)

holds. By $s_H - s_M = s_M - s_L$, concavity of $\sigma$ implies that $(\sigma_H - \sigma_M) < (\sigma_M - \sigma_L)$, but (21) insists that the more restrictive condition $(\sigma_M - \sigma_L) > \frac{\theta_H}{\theta_L} (\sigma_H - \sigma_M)$ is met. We have

**Proposition 6.** Assume that (A.1)-(A.3) hold. Let the production situation be unfavorable, let $\tau < 1$, and let $\sigma$ be sufficiently concave such that (21) holds. Then

(i) $e^n > e^d$.

(ii) $E \left[ \pi^n (\theta) \right] > E \left[ \pi^d (\theta, s) \right]$, if

$$2\gamma(\tau) \leq \frac{\gamma(\tau)\sigma_H^* + (1 - \gamma(\tau))\sigma_L^*}{\sigma_M^*} \leq 1.$$ 

(***)

Propositions 5 and 6 extend our earlier results to the case where the agent can exert costly effort to increase the probability of having high human capital in the firm. Proposition 5 says that if the principal faces a favorable production situation and $\sigma$ is convex, then commitment to a policy of disclosure elicits greater human capital effort than does a policy of non-disclosure. The Condition (***) states, from Proposition 2, that there are rising marginal returns to status, but that they are not too strongly rising. In this case, a greater effort under disclosure translates into a greater
probability of a high human capital level which in turn implies a greater expected profit, as long as rising returns to status are not too extreme.

The same logic applies to Proposition 6 where the principal faces an unfavorable production situation. Here, non-disclosure leads to greater human capital effort which leads to greater $p$, if $\sigma$ is sufficiently concave so that condition (21) is met, but it must be true that falling returns to status are not so extreme that condition (***) is violated. Under these assumptions greater $p$ implies greater expected profit under non-disclosure.

When rising or falling returns to status are extreme and violate (***) or (****), then while the results on effort still hold, there is no guarantee that an increase in $p$ will in fact lead to a rise in expected profit. The results on profit in Propositions 5 and 6 can then be overturned.

5. Conclusion

We study the choice of disclosure policies as an organizational design problem in the presence of agents with status concerns. Our work has novel testable implications.

If the organization’s production situation is sufficiently favorable – the sensitivity of cash flow production to effort is high and/or the sensitivity of personal effort cost to effort is low – then disclosure has a positive motivational effect on agents and maximizes the principal’s profits net of wages. Otherwise, non-disclosure is the principal’s preferred policy.

In addition, agents always prefer disclosure to non-disclosure because more information allows them to better condition their effort choices. Our model thus points to status concerns as a potential source of disagreement between principals and agents about the proper level of organization-wide transparency in principal-agent relationships. Tensions are likely to arise in unfavorable production

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7It is easy to show that assumptions (21) and (***) are not inconsistent. Let $\sigma = (1 - e^{-10\epsilon_1}), \theta_H = .6, \theta_L = .4,$ and $\tau = .5$. In this case, both assumptions are met with the right side of (21) given by $6.3888(10)^{-3}$ and the left side of (21) is $1.1578(10)^{-2}$. The middle term of (***) is .99855 and the left side is .89898. Each of these is less than unity.
situations.

With status concerns, hiring more talented employees may not be always better for the principal. As more talented employees reduce each other's chances of achieving high status and dull each other's motivation to exert effort, the principal may want to avoid hiring more talented employees. This local effect can also be global when agents' returns to status are sufficiently increasing.

Disclosure policies can also affect firm-specific investments made by agents with status concerns. If the organization is in a sufficiently favorable production situation and agents' returns to status are increasing, then disclosure can induce more firm-specific investment by agents and lead to more profits for the principal. Similar results obtain with non-disclosure when the production situation is sufficiently unfavorable and agents' returns to status are decreasing.

Appendix

Proof of Proposition 1: (i) Subtracting (8) from (7), we have

\[
sign \left\{ E \left[ \pi^d (\theta, s) \right] - E [\pi^u (\theta)] \right\} \\
= sign \{ p\theta_H [p(\eta_{HM})^\tau + (1 - p)(\eta_{HH})^\tau - (p\eta_{HM} + (1 - p)\eta_{HH})^\tau] \\
+ (1 - p)\theta_L [p(\eta_{LL})^\tau + (1 - p)(\eta_{LM})^\tau - (p\eta_{LL} + (1 - p)\eta_{LM})^\tau] \} , \tag{1.a}
\]

where \( \eta_{jk} \equiv \theta_j \sigma (s_k) \) for \( j \in \{H, L\} \) and \( k \in \{H, L, M\} \). Rewriting (1.a), non-disclosure dominates if

\[
p(\eta_{HM})^\tau + (1 - p)(\eta_{HH})^\tau < (p\eta_{HM} + (1 - p)\eta_{HH})^\tau \text{ and}
\]

\[
p(\eta_{LL})^\tau + (1 - p)(\eta_{LM})^\tau < (p\eta_{LL} + (1 - p)\eta_{LM})^\tau . \tag{1.b}
\]

These conditions hold if \( \tau < 1 \). That is, \( (\theta \sigma)^\tau \) is a concave function of \( (\theta \sigma) \).
(ii) Disclosure dominates if the reverse inequality in (1.b) holds, and this holds if \( \tau > 1 \).

(iii) Let \( \varnothing \) be defined as

\[
\varnothing = \frac{v}{(\tau + 1)} + 1 \left( \frac{v}{(\tau + 1)} \right) - \frac{v}{(\tau + 1)^2} = \frac{v}{(\tau + 1)} + \frac{\tau}{\tau + 1} \theta \sigma(s) - \frac{v}{(\tau + 1)^2} \theta \sigma(s) \left( \frac{v}{\tau + 1} - E[\theta \sigma(s)] \right).
\]

Because \( (\tau + 1) > 1 \), \( (\theta \sigma)^{\tau + 1} \) is a convex function of \( (\theta \sigma) \). Thus, the expression (1.c) is positive and the result holds.

**Proof of Corollary 1:** For \( \tau > 1 \), the result is obvious from Proposition 1. Consider the second statement. We have that

\[
TS^d(\theta, s) = x^{\tau + 1}[(\frac{e}{v})^{2\tau} - (\frac{e}{v})^{2\tau + 1}][\theta \sigma(s)]^\tau \theta + x^{\tau + 1}[(\frac{e}{v})^{2\tau + 1} - (\frac{e}{v})^{2(\tau + 1)}][\theta \sigma(s)]^{\tau + 1} \\
= x^{\tau + 1}[(\frac{e}{v})^{2\tau} - (\frac{e}{v})^{2\tau + 1}][\theta \sigma(s)]^\tau \theta + \frac{e}{v} \theta \sigma(s),
\]

\[
TS^n(\theta) = x^{\tau + 1}[(\frac{e}{v})^{2\tau} - (\frac{e}{v})^{2\tau + 1}][\theta E[\sigma(s)|\theta]]^\tau \theta + x^{\tau + 1}[(\frac{e}{v})^{2\tau + 1} - (\frac{e}{v})^{2(\tau + 1)}][\theta E[\sigma(s)|\theta]]^{\tau + 1} \\
= x^{\tau + 1}[(\frac{e}{v})^{2\tau} - (\frac{e}{v})^{2\tau + 1}][\theta E[\sigma(s)|\theta]]^\tau \theta + \frac{e}{v} \theta E[\sigma(s)|\theta],
\]

Note \( \tau = r/(1 - r) \), so that \( r = \varepsilon/v = \tau/(\tau + 1) \). The sign of \( E[TS^d - TS^n] \) = sign of

\[
E[\theta \sigma(s)]^\tau \theta + \frac{\tau}{\tau + 1} \theta \sigma(s) - E[\theta E[\sigma(s)|\theta]]^\tau \theta + \frac{\tau}{\tau + 1} \theta E[\sigma(s)|\theta]]).
\]
The sign of this expression is that of

\[
p^{\theta_H}\{[p^n_H + (1 - p)n^n_{HH}] - [p^n_H + (1 - p)n_{HH}]^\tau\}
\]

\[+(\tau + 1)p\{[p^n_H + (1 - p)n^n_{HH}] - [p^n_H + (1 - p)n_{HH}]^{\tau + 1}\}
\]

\[+(1 - p)^{\theta_L}\{[p^n_L + (1 - p)n^n_{LM}] - [p^n_L + (1 - p)n_{LM}]^\tau\}
\]

\[+(\tau + 1)(1 - p)\{[p^n_L + (1 - p)n^n_{LM}] - [p^n_L + (1 - p)n_{LM}]^{\tau + 1}\}.
\]

The first two lines of this expression (high branch) are symmetric to the last two lines, so let us consider the first two lines or the high branch. The limit of the high branch as \( \tau \to 0 \) is 0 and the limit as \( \tau \to 1 \) is

\[
\frac{1}{2}p\{[p^n_H + (1 - p)n^n_{HH}] - [p^n_H + (1 - p)n_{HH}]^2\} > 0.
\]

Take

\[
\lim_{\tau \to 0} \frac{\partial}{\partial \tau} \left( p^{\theta_H} \{[p^n_H + (1 - p)n^n_{HH}] - [p^n_H + (1 - p)n_{HH}]^\tau\} \right.
\]

\[\left. +\frac{\tau}{\tau + 1}p\{[p^n_H^{\tau + 1} + (1 - p)n^{\tau + 1}_{HH}] - [p^n_H + (1 - p)n_{HH}]^{\tau + 1}\} \right) =
\]

\[p^{\theta_H} \{p \ln n_H + (1 - p) \ln n_{HH} - \ln[p^n_H + (1 - p)n_{HH}]\}.
\]

By concavity, \( p \ln n_H + (1 - p) \ln n_{HH} - \ln[p^n_H + (1 - p)n_{HH}] < 0 \). Using these facts, it follows that the high branch is negative for small \( \tau < 1 \) and positive for larger \( \tau < 1 \). The same results hold for the last two lines of the low branch, so that the proof is complete. □

**Proof of Proposition 2:** (i) Let \( p = 0.5 \), then the left side \((LHS)\) of (9) is zero and (9) becomes \( \sigma^*_M \geq \sigma^*_M \cdot 2(1 - \gamma) \). By \( (1 - \gamma) < 0.5 \), ">” holds. Next, let \( p \in (1 - \gamma, 0.5) \). In this case, The right side \((RHS)\) of (9) is negative while the \( LHS > 0 \), so that > holds. This result
does not depend on the condition (*). Finally, let \( p \in (0, 1 - \gamma) \). Given (*), the result \( > \) holds if 
\[ (1 - 2p) > 2(1 - \gamma - p) \]
which is true if \( 1 > 2(1 - \gamma) \). The latter is true, so that the result \( > \) holds.

(ii) and (iii) Let \( p \in (0.5, 1) \). Rewrite (9) as

\[
LHS(p, \tau) = \frac{2p - 2(1 - \gamma)}{2p - 1} \geq \frac{\gamma(\tau)\sigma_H^* + (1 - \gamma(\tau))\sigma_L^*}{\sigma_M^*} = RHS(\tau).
\]

The \( LHS > 1 \) for all \( p \in (0, 1) \) and for all \( \tau \geq 0 \). Further, \( \lim_{p \to 0.5} LHS = +\infty \), \( \lim_{p \to 1} LHS = 2\gamma \), \( \partial LHS/\partial p < 0 \), and \( \partial LHS/\partial \tau > 0 \). First assume that

\[
2\gamma(\tau) \geq \frac{\gamma(\tau)\sigma_H^* + (1 - \gamma(\tau))\sigma_L^*}{\sigma_M^*} \tag{2.a}
\]

Both sides of (2.a) are greater than unity. Further, \( LHS(p, \tau) > RHS(\tau) \), for all \( p \in (0.5, 1) \).

If the converse of (2.a) is satisfied, then \( \exists \hat{p}(\tau) \in (0.5, 1) \) such that \( LHS(\hat{p}, \tau) = RHS(\tau) \), \( LHS(p, \tau) > RHS(\tau) \), for \( p \in (0.5, \hat{p}) \), and \( LHS(p, \tau) < RHS(\tau) \), for \( p \in (\hat{p}, 1) \). We have that

\[
\hat{p}(\tau) = \frac{\gamma(\tau)\sigma_H^* + (1 - \gamma(\tau))\sigma_L^* - 2(1 - \gamma(\tau))\sigma_M^*}{2\gamma(\tau)\sigma_H^* + (1 - \gamma(\tau))\sigma_L^* - \sigma_M^*}.
\]

This completes case 1.

(iv)-(vi) Next let \( p \in (0, 1 - \gamma) \). Here, \( p < 0.5 \), so that (9) can be expressed

\[
LHS(\tau) = \frac{\gamma(\tau)\sigma_H^* + (1 - \gamma(\tau))\sigma_L^*}{\sigma_M^*} \geq \frac{2(1 - \gamma(\tau) - p)}{1 - 2p} = RHS(p, \tau) > 0.
\]

By assumption, \( LHS(\tau) \leq 1 \), and \( RHS(p, \tau) < 1 \), for all \( p \in (0, 1) \) and \( \tau \geq 0 \). We have that

\[
\frac{\gamma(\tau)\sigma_H^* + (1 - \gamma(\tau))\sigma_L^*}{\sigma_M^*} \geq 2(1 - \gamma(\tau)), \text{ then for all } p \in (0, 1 - \gamma), 2(1 - \gamma(\tau)) > RHS(p, \tau) \text{ and the > result holds. If } \frac{\gamma(\tau)\sigma_H^* + (1 - \gamma(\tau))\sigma_L^*}{\sigma_M^*} < 2(1 - \gamma(\tau)), \text{ then from the above limit and monotonicity conditions, } \exists \hat{p} \in (0, 1 - \gamma) \text{ such that } LHS(\tau) < RHS(p, \tau), \text{ for } p \in (0, \hat{p}), LHS(\tau) = RHS(\hat{p}, \tau), \text{ and } LHS(\tau) > RHS(p, \tau), \text{ for } p \in (\hat{p}, (1 - \gamma)).
If \( p \in (1 - \gamma, 0.5) \), then we have from (9) the result \( > \), because this result did not depend on (*)\). Finally let \( p \in (0.5, 1) \). We rewrite (9) as
\[
LHS(p, \tau) = \frac{2p - 2(1 - \gamma)}{2p - 1} \geq \frac{\gamma(\tau)\sigma_H^\tau + (1 - \gamma(\tau))\sigma_L^\tau}{\sigma_M^\tau} = RHS(\tau).
\]

We have that \( LHS(p, \tau) > 1 \) for all \( p \in (0, 1), \tau \geq 0 \). By \( \sim(*) \), \( RHS(\tau) \leq 1 \), so that \( LHS(p, \tau) > RHS(\tau) \) for all \( p \in (0.5, 1) \) and the result holds. ■

**Proof of Lemma 1:** \( 1 - \tau[\frac{1}{(1-p)+p\frac{\sigma}{\sigma_H^\tau}} - 1] < 0 \) iff \( \tau > \frac{1}{\lim_{\tau \to 0} \Gamma(p, \frac{\sigma}{\sigma_H^\tau})} = \Gamma(p, \frac{\sigma}{\sigma_H}) \) Clearly, \( \lim_{\tau \to 0} \Gamma(p, \frac{\sigma}{\sigma_H}) = \infty, \lim_{\tau \to 0} \Gamma(p, \frac{\sigma}{\sigma_H}) = \frac{\sigma}{\sigma_H - \sigma}, \) and \( \partial \Gamma(p, \frac{\sigma}{\sigma_H})/\partial p < 0 \). given that \( \Gamma \) is continuous in \( p \), the results hold. Using (12), \( \partial E[\pi^n(\theta)]/\partial p < 0 \), for all \( p \in (\hat{p}, 1) \). ■

**Proof of Proposition 3:** In light of Lemma 1, take the limit of (12) as \( p \to 0 \). We obtain
\[
\partial E[\pi^n(\theta)]/\partial p \geq 0 \text{ iff } \frac{(\frac{\sigma}{\sigma_H})^\tau}{1 + \tau(1 - \frac{\sigma}{\sigma_L})^\tau} \geq \frac{(\theta_L^\tau)^\tau}{(\theta_H^\tau)^\tau}.
\]

With \( \theta_L^\tau \) fixed and \( \frac{\sigma}{\sigma_H} \to \infty, \frac{\sigma}{\sigma_L} \to 1 \), this inequality becomes \( > \) and \( \partial E[\pi^n(\theta)]/\partial p > 0 \) for small \( p \). We have ruled out boundary maxima and \( E[\pi^n(\theta)] \) is continuous on a compact set. Thus, an interior maximum exists. ■

**Proof of Proposition 4:** We have shown that \( \partial E[\pi^n(\theta)]/\partial p \) is negative at \( p = 0 \) and positive at \( p = 1 \). Also \( E[\pi^n(\theta)]|_{p=0} = I[\theta_L \sigma(s_M)]^\tau < I[\theta_H \sigma(s_M)]^\tau = E[\pi^n(\theta)]|_{p=1} \). We need only show that \( E[\pi^n(\theta)]|_{p=1} \) dominates \( E[\pi^n(\theta)] \) for any \( p \in (0, 1) \) under the stated conditions. With the stated assumptions and these results, we need only show
\[
\theta_H^{\tau+1} > \theta_H^{\tau+1}p[p + (1 - p)(\frac{\sigma_H}{\sigma_M})^\tau] + \theta_L^{\tau+1}(1 - p)[p(\frac{\sigma_L}{\sigma_M} + (1 - p)]^\tau.
\]

With \( \frac{\sigma}{\sigma_M} \) small, \( [p + (1 - p)(\frac{\sigma_H}{\sigma_M})^\tau] \to 1 \) and \( [p(\frac{\sigma_L}{\sigma_M} + (1 - p)]^\tau \to (1 - p)^\tau \), so that the condition

34
becomes

$$\theta^\tau_{H} > p \theta^\tau_{H} + (1 - p) \theta^\tau_{L}(1 - p)^\tau.$$  

This is true. ■

**Proof of Lemma 2**: If a symmetric Nash equilibrium exists it is unique by (A.2) because \( \Omega^i(p(e)) \) are strictly decreasing in \( e \). Next, for existence note that \( \lim_{e \to 0} \Omega^i(p(e)) = L[(\eta_{HH})^{\tau+1} - (\eta_{LM})^{\tau+1}]p'(0) - 0 > 0 \), for \( i = d, n \). Moreover, \( \lim_{e \to \infty} \Omega^i(p(e)) = L[(\eta_{HM})^{\tau+1} - (\eta_{LL})^{\tau+1}]p'(\infty) - \infty < 0 \), for \( i = d, n \). By continuity of \( \Omega^i(p(e)) \), an equilibrium exists. ■

**Proof of Proposition 5**: (i) Because under (A.3) \( \Omega^i(p(e)) \) are strictly decreasing and by inspection of (20), \( e^d \geq e^n \), if \( B^d(p(e)) \geq B^d(p(e)) \), for all \( e \). Now \( B^d(p(e)) > B^d(p(e)) \) if

\[
\{(\eta_{HH})^{\tau+1}(1 - p(e)) + (\eta_{HM})^{\tau+1}p(e)\} \\
- [\eta_{HH}(1 - p(e)) + \eta_{HM}p(e)]^{\tau+1} \\
> \{(\eta_{LM})^{\tau+1}(1 - p(e)) + (\eta_{LL})^{\tau+1}p(e)\} \\
- [\eta_{LM}(1 - p(e)) + \eta_{LL}p(e)]^{\tau+1}, \text{for all } e. \tag{5.a}
\]

Let \( \eta \equiv \theta \sigma \) and note that (5.a) is met if \( \eta^{\tau+1} \) satisfies the condition that the expression

\[
(\eta + \Delta)^{\tau+1}(1 - p(e)) + \eta^{\tau+1}p(e) - [(\eta + \Delta)(1 - p(e)) + \eta p(e)]^{\tau+1} \tag{5.b}
\]

is increasing in \( \eta \) and \( \Delta \). This is true because the left side of (5.a) is of the form (5.b) with \( \eta_{HM} = \eta \) and \( \eta_{HH} = \eta + \Delta_2 \), where \( \Delta_2 = \theta_H(\sigma_H - \sigma_M) \), and the right side of (5.a) is of the form (5.b) with \( \eta_{LL} = \eta \) and \( \eta_{LM} = \eta + \Delta_1 \), where \( \Delta_1 = \theta_L(\sigma_M - \sigma_L) \) and \( \Delta_2 > \Delta_1 \). To see that \( \Delta_2 > \Delta_1 \), note by \( s_H - s_M = s_M - s_L \) and \( \sigma \) convex in \( s_i \), \( (\sigma_H - \sigma_M) > (\sigma_M - \sigma_L) \). With \( \theta_H > \theta_L \), \( \Delta_2 > \Delta_1 \).

Expression (5.b) is increasing in \( \eta \) if its derivative in \( \eta \) is positive. Computing this derivative it is
given by

\[(\tau + 1)[(\eta + \Delta)^\tau(1 - p) + (\tau + 1)\eta^\tau p] - (\tau + 1)[(\eta + \Delta)(1 - p) + (\tau + 1)\eta]^\tau p > 0,\]

by \((\tau + 1)\eta^\tau\) convex in \(\tau > 1\). Analogously, taking the derivative of (5.b) with respect to \(\Delta\), we have

\[(\tau + 1)(\eta + \Delta)^\tau(1 - p) - (\tau + 1)[(\eta + \Delta)(1 - p) + (\tau + 1)\eta]^\tau(1 - p) > 0,\]

by \((\eta + \Delta)^\tau > [(\eta + \Delta)(1 - p) + (\tau + 1)\eta]^\tau\). It follows that \(e^d > e^n\).

(ii) Consider

\[
\text{sign} \left\{ E \left[ \pi^d (\theta, s) \right] - E \left[ \pi^n (\theta) \right] \right\} 
\]

\[
= \text{sign} \{ [p^d \theta_H (p^d(\eta_{HM}))^\tau + (1 - p^d)(\eta_{HH})^\tau] - p^n \theta_H (p^n \eta_{HM} + (1 - p^n)\eta_{HH})^\tau \} 
\]

\[
+ [(1 - p^d) \theta_L (p^d(\eta_{LM}))^\tau + (1 - p^d)(\eta_{LM})^\tau] 
\]

\[
- (1 - p^n) \theta_L (p^n \eta_{LL} + (1 - p^n)\eta_{LM})^\tau \},
\]

where in equilibrium \(p^j = p(e_i^j)\) for \(j = d, n\) and \(i = 1, 2\). We have that \(p^d > p^n\). From Proposition 1, \(E \left[ \pi^d (\theta, s) \right] |_{p=p^n} - E \left[ \pi^n (\theta) \right] |_{p=p^n} > 0\). It then suffices to show that \(E \left[ \pi^d (\theta, s) \right] |_{p=p^d} - E \left[ \pi^d (\theta, s) \right] |_{p=p^n} > 0\). A sufficient condition for the latter is that \(dE \left[ \pi^d (\theta, s) \right] /dp > 0\), for all \(p \in [0, 1]\), which is true under (**) by Proposition 2. ■

**Proof of Proposition 6:** (i) With an unproductive agent, we have that \((\tau + 1) = \frac{e^d}{e^d} = (1, 2)\). In this case the function \((\eta)^{\tau+1}\) is convex and its first derivative, \((\tau + 1)(\theta\sigma)^\tau\), is a concave function.

Condition (5.a) from the proof of Proposition 5 tells us that non-disclosure generates greater effort.
if
\[
\{((\eta_{HH})^{\tau+1}(1-p(e)) + (\eta_{HM})^{\tau+1}p(e)) - [\eta_{HH}(1-p(e)) + \eta_{HM}p(e)]^{\tau+1}\}
\]
\[
< \{((\eta_{LM})^{\tau+1}(1-p(e)) + (\eta_{LL})^{\tau+1}p(e)) - [\eta_{LM}(1-p(e)) + \eta_{LL}p(e)]^{\tau+1}\}, \text{ for all } e. \quad (6.a)
\]

Condition (6.a) is met if the function $\eta^{\tau+1}$ satisfies the condition that the expression
\[
(\eta + \Delta)^{\tau+1}(1-p(e)) + \eta^{\tau+1}p(e) - [(\eta + \Delta)(1-p(e)) + \eta p(e)]^{\tau+1}
\] is decreasing in $\eta$ and increasing in $\Delta$. This is true because the left side of (6.a) is of the form (6.b) with $\eta_{HM} = \eta$ and $\eta_{HH} = \eta + \Delta_2$, where $\Delta_2 = \theta_H(\sigma_H - \sigma_M)$, and the right side of (6.a) is of the form (6.b) with $\eta_{LL} = \eta$ and $\eta_{LM} = \eta + \Delta_1$, where $\Delta_1 = \theta_L(\sigma_M - \sigma_L)$ and $\Delta_2 < \Delta_1$, by condition (21). Taking the derivative of (6.b) with respect to $\eta$, we obtain that (6.b) is decreasing in $\eta$ if
\[
(\tau + 1)(\eta + \Delta)^\tau(1-p(e)) + (\tau + 1)\eta^\tau p(e) - (\tau + 1)[(\eta + \Delta)(1-p(e)) + \eta p(e)]^\tau < 0. \quad (6.c)
\]

Condition (6.c) is the condition for concavity of $(\tau + 1)\eta^\tau$ in $\eta$. The proof of Proposition 5 shows that (6.b) is increasing in $\Delta$. Thus, (6.a) holds, and $e^a > e^d$.

(ii) We have that
\[
sign[E\left[\pi^d(\theta, s)\right] - E(\pi^n(\theta))]
= \sign\{(p^d\theta_H(p^d(\eta_{HM}))^\tau + (1-p^d)(\eta_{HH})^\tau) - p^n\theta_H(p^n\eta_{HM} + (1-p^n)(\eta_{HH})^\tau)
+[(1-p^d)\theta_L(p^d(\eta_{LL}))^\tau + (1-p^d)(\eta_{LM})^\tau)
-((1-p^n)\theta_L(p^n\eta_{LL} + (1-p^n)(\eta_{LM})^\tau)\}
\]
Further from part (i), \( p^n > p^d \). From Proposition 1, \( E \left[ \pi^d (\theta, s) \right] |_{p=p^n} - E \left[ \pi^n (\theta) \right] |_{p=p^n} < 0 \). It then suffices to show that \( E \left[ \pi^d (\theta, s) \right] |_{p=p^n} - E \left[ \pi^d (\theta, s) \right] |_{p=p^n} < 0 \). From the proof of Proposition 5, the latter condition is true if \( dE \left[ \pi^d (\theta, s) \right] /dp > 0 \) for all \( p \in [0, 1] \). A sufficient condition is then (***) from Proposition 2.

References


