"Endogenous" Relative Concerns: The Impact of Workers' Characteristics on Status and Profits in the Firm

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April 2009

Abstract

This paper shows that it is individually rational for agents in a firm to develop and exhibit status concerns. Workers are, by their choices of status concerns, able to transfer surplus from the the firm to themselves. Further, relative concerns are shaped by the relative strengths and weaknesses of the workers in the firm. Finally, and surprisingly, a firm's profit is reduced (relative to the benchmark moral-hazard model) by workers who exhibit such "endogenous" relative concerns.

JEL Classifications: D86, L14, M52, M51.

Keywords: status, incentives, endogenous preferences, surplus transfer, profits.

*Thanks to Rick Harbaugh, Roy Gardner, Michael Rauh, Frank Page, Haluk Ergin, Ramon Casadesus-Masanell and Julio Rotemberg and seminar participants at Indiana University, Washington University and the University of Missouri for many helpful comments and discussions. The usual disclaimer applies.

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1 Introduction

Why do workers display concerns for status? Agents’ social concerns are usually thought to be a result of evolutionary pressure or a result of rational behavior.[1] Both explanations suggest that social concerns serve, or served, some purpose and benefit, or benefitted, the agents who developed them. However, if workers in a firm are better off in the presence of status concerns, can a firm benefit from the relative concerns of its employees? This paper addresses three questions: (1) Do agents find it in their interests to develop and exhibit status concerns within a firm? (2) If so, why? That is, what are the factors affecting such choices of status concerns? (3) Finally, what is the impact of such status concerns on firm profits?

The paper shows that workers find it in their interest to develop and exhibit concerns for status in a firm. By their choices of status concerns, agents are able to transfer surplus from the principal to themselves, thus increasing their “material utilities”. As expected, agents’ status concerns are influenced by the *relative* strengths and weaknesses of the agents in the firm. Finally, and contrary to expectation, firms cannot exploit its workers’ relative concerns; firm profits are lowered relative to the benchmark case with atomistic (or egotistical) workers.

[1] See Ball and Eckel (1998), Raub (1990) and Casadesus-Masanell (2004).

The idea that agents have relative social concerns dates back at least to Duesenberry (1949) and Leibenstein (1950) who drew attention to relative consumption effects on individual behavior. Since then, we have accumulated a lot of evidence for the presence of status concerns and their impacts on economic behavior in the firm and in the marketplace. See, for instance, Frank (1984 & 1985), Ball and Eckel (1996 & 1998), Ball et. al (2001), Layard (2005), Truyts (2008), Fershtman et al. (2003) and Fershtman et et al. (2008) for evidence from various sources in the field and from the laboratory.

There is also a substantial body of theoretical work in the agency literature that accounts for agents' preferences for status. Some of this work, including Goel and Thakor (2006), Auriol and Renault (2008), Küpper and Sandner (2008) and Besley and Ghatak (2008), has focused on the features of optimal contracts in the presence of status concerns. Other works have found that status concerns can, for instance, lead to higher effort from workers and/or lower wages (Fershtman et al. 2006, Goel and Thakor 2006 and Besley and Ghatak 2008), justify correlation of workers' wages (Fershtman et. al 2003), justify discriminatory contracts (Dhillon and Herzog-Stein 2009) and explain the hierarchical structure in firms (Dubey and Geanakoplos 2005 and Moldovanu et al. 2007).

While these works do help to explain the observed divergence between agency theory and observed compensation practices (see Baker, Jensen and Murphy 1988 and Prendergast 1999), they do not provide an explanation for the presence of such concerns in the first place. "If status is to play a role in economic behavior, then, the benefit of status in economic environments must be explored." (Ball and Eckel 1998, p. 501). This paper establishes the rationality of agents' status concerns in a firm and thus provides an explanation for their presence. It *then* shows that such "endogenous" status concerns generally lower firm profits.

The most common reason attributed to the development of social preferences is evolutionary pressure. Bernheim (1994) notes that "...individuals who are more highly regarded have greater opportunities to reproduce. Thus natural selection tends to favor those who are more concerned about esteem, popularity, or respect" (p. 843). The evolutionary argument is also used by Rotemberg (1994) to explain the emergence of altruism in the workplace and by Casadesus-Masanell (2004) to explain the emergence of "Trust in Agency". See also Rayo and Becker (2007) and Frank (1987). However, how relative concerns increase one's standing has not been analyzed.

Bernheim (1994) notes the role played by "behavioral conditioning" (the influence of culture and upbringing) in the development of an individual's preference for status. Bowles (1998) highlights the role of institutions and culture in shaping preferences. But this approach leaves unanswered the question of why society favors certain preferences.

Individuals might care about the actions or utilities of others to glean some information that others might possess. See, for instance Banerjee (1992), Bikhchandani et al. (1992) and Samuelson (2004). Another possible explanation in an agency setting is career concerns; a worker might care about the performance of his co-workers if his future earnings are dependent on his current (and future) relative performance. These explanations assume the presence of incomplete or asymmetric information or a dynamic decision-making environment. But we observe status concerns even in static one-shot interactions where the common knowledge assumption can be expected to hold (as in a moral-hazard game). See, for instance, the experimental results reported in Ball and Eckel (1996) and Ball et al. (2001). These explanations thus cannot explain why agents care about others in such interactions.

In this paper, we assume that an agent only cares about his "material utility" (Rabin 1993) or "intrinsic utility" (Bernheim 1994) and pursue an "instrumental" explanation for the development of relative social concerns.[2] We assume that agents develop concerns for status only if such concerns increase their material utility. The model in this paper incorporates, and depends crucially on, the hypothesis that players' social preferences are context-dependent (see Section 2.3). We model context-dependence by allowing agents to choose the intensity of their status concerns to suit the decision-making environment.

The model is a simple static linear principal-agent model with one principal and two heterogeneous agents and is most closely related to the model in Küpper and Sandner (2008) who allow for agents who display various forms of social concerns and explore their impact on firm profits. In particular, they characterize the types of workers (in terms of their social concerns) that a firm would like to hire to maximize its profits. The difference is that we allow for agents who can *choose* the intensity of their status concerns in a preliminary stage before the principal-agent game unfolds.

In our model, we find that it is individually rational for agents to develop and display relative concerns vis-à-vis their co-workers even in a one-shot interaction. The agents' choices of relative concerns actually hurt them, thus forcing the principal to increase compensation in order to ensure participation. By developing a concern for status, both agents are able to extract surplus from the principal thus increasing their material utilities.

In general, any differences in the characteristics of agents leads to their choosing non-zero status concerns. We find that the "weaker" agent (the agent who is less able or is more risk averse or faces a more uncertain production process) always chooses to display competitive relative concerns while the "stronger" agent always chooses to display pro-social concerns similar to altruism.[3] Compared to the standard model with atomistic agents, the weaker agent works harder in an attempt to "catch up" with the stronger agent while the stronger agent exerts less effort. The weaker agent secures a contract that offers higher total pay while the stronger worker extracts a contract that requires lower effort. These two effects together reduce the firm's profit in equilibrium. Surprisingly, it is the agents who exploit the substitutability between status and explicit contracts.

Section 2 introduces the model and defines important concepts used in the paper. Section 3 shows the rationality of agents' choices of status concerns in a firm and explores the factors affecting agents'

[2] Postlewaite (1998) provides a detailed discussion of the direct and instrumental approaches to modeling status concerns on the part of agents.

[3] Pro-social concerns in this case are similar to, but not the same as, social concerns analyzed by Bénabou and Tirole (2006). In our case, pro-social relative concerns simply mean that an agent prefers the other agent to do better than himself or herself.

status concerns. Section 4 analyzes the impact of such concerns on firm profit and establishes the condition under which a firm would prefer to hire a homogeneous workforce and Section 5 concludes. Appendix A contains all the proofs and Appendix B presents the standard moral-hazard model for purposes of comparison.

2 The Model

We consider a static principal-agent model of moral hazard that takes into account relative social concerns on the part of agents, i.e., the concern for status. The model is based on the LEN[4] model and is most closely related to Küpper and Sandner (2008).

We assume, for simplicity, that there is only one firm (principal) that can hire only two agents (from among many) who produce outputs of identical commodities that are both observable. Output of agent i, q_i, is assumed to be a non-deterministic function of his effort, e_i, as follows:

$$q_i = e_i + \epsilon_i, \quad i = 1, 2, \tag{1}$$

where ϵ_1 and ϵ_2 are jointly normally distributed with mean vector $\begin{bmatrix} 0 \\ 0 \end{bmatrix}$ and variance-covariance matrix $\Sigma = \begin{bmatrix} \sigma_1^2 & \sigma_{12} \\ \sigma_{12} & \sigma_2^2 \end{bmatrix}$. Since outputs are observable, they are contractible and the principal offers wages conditional on outputs. We restrict attention to linear wage schemes[5] of the following form:

$$w_i = \alpha_i + \beta_i q_i + \gamma_i q_j, \quad i, j = 1, 2, \quad i \neq j. \tag{2}$$

We only look at the interesting case where the principal needs to hire two agents to make positive profits. To focus attention on the formation of social concerns, we ignore the issue of bargaining to split the surplus between the principal and the agents and assume that both agents compete with other agents for a contract from the principal. The principal can thus make take-it-or-leave-it offers to the agents.

2.1 Agents

We assume that agent i has a constant absolute risk-aversion utility function of the form

$$U_A^i(y) = -\exp(-r_i y), \tag{3}$$

[4]**L**inear contracts, (Negative) **E**xponential utility and **N**ormally distributed errors - see Spremann (1987).

[5]While it is generally accepted the linear contract is suboptimal, there are some possible justifications for its use in the standard moral-hazard case. See Holmstrom and Milgrom (1987) and Bose et al. (2007). In this case, we assume linear wage schemes merely for simplicity.

where $r_i \geq 0$ is agent i's coefficient of absolute risk-aversion. Agent i's cost of effort is given by $c_i(e_i) = \frac{1}{2}k_i e_i^2$, where k_i is agent i's ability parameter. His reservation utility, $\bar{U}^i$, is normalized to zero. In the LEN model, an agent's certainty equivalent is equal to the sum of his expected payoff and his risk-premium (see Bolton and Dewatripont 2005, Chapter 4, Section 2 for a derivation) and it is thus convenient to work with agents' certainty equivalents. Hence, we use the terms "expected utility" and "certainty equivalent" interchangeably from now on.

We also make the following assumption in the rest of the paper to ensure that the equilibrium contract parameters on own effort are indeed positive.

Assumption 1

$$4\sigma_i^2 > k_j r_j(\sigma_1^2\sigma_2^2 - \sigma_{12}^2), \quad i, j = 1, 2, \quad i \neq j.$$

2.1.1 Status

Following Rotemberg (1994) and Casadesus-Masanell (2004), we assume that an agent distinguishes between *material payoffs* (the object self) and *behavior payoffs* (the acting self). The distinction between material and behavior utilities is crucial. Material utilities are the only utilities that are *real* and are the utilities that agents want to maximize while behavior utilities are the preferences agents act according to, i.e., behavior utility are those preferences that an agent displays to the rest of the world while material utility are those preferences that really matter to him. Rotemberg (1994) also draws a distinction between an individual's "inner self" that is motivated by material utility and his "outer self" that acts according to behavior utility.

"One common theme in the literature on status is that it is valued not for its own sake, but rather for the benefits it brings with it" (Ball and Eckel 1998 p. 501.). Thus we assume that agents do not care about status itself; they merely use it as a tool to maximize their material utilities. This is in line with the evolutionary argument often used to explain the presence of certain traits and behaviors. While survival depends on the reproductive success of a species, evolutionary pressure also favors the adoption of certain traits and behaviors that, while they do not have any utility value in themselves, increase the chances of evolutionary success. The particular trait that we consider in this model is a concern for one's performance relative to another's. Thus, payoffs from status concerns are a part of an agent's behavior utility but are not a part of his material utility.

We now formally define these concepts as used in this paper. Since we use the terms expected utility and certainty equivalent interchangeably, we define everything in terms of certainty equivalents. Agent i's material payoffs are defined as follows

$$\text{Material Payoffs}_i = w_i - \frac{1}{2}k_i e_i^2, \quad i = 1, 2. \tag{4}$$

An agent's utility from material payoffs is thus

$$U_A^i = -\exp\{-r_i(\alpha_i + \beta_i e_i + \gamma_i e_j - \frac{k_i e_i^2}{2} + (\beta_i \epsilon_i + \gamma_i \epsilon_j))\}$$

with associated certainty equivalent

$$CEA_i = \alpha_i + \beta_i e_i + \gamma_i e_j - \frac{k_i e_i^2}{2} - \frac{r_i}{2}(\beta_i^2 \sigma_i^2 + 2\beta_i \gamma_i \sigma_{12} + \gamma_i^2 \sigma_j^2), \quad i, j = 1, 2, \quad i \neq j.$$

In addition to material payoffs, we assume that agents have social concerns, R_i, vis-a-vis each other.[6] The literature on social concerns has found evidence (mostly experimental) of many forms of social concerns - altruism, reciprocity, fairness and competitive concerns (see Fehr and Gächter 2000 and Charness and Rabin 2002, for instance). It is possible that agents are altruistic in a particular context (such as fund-raisers for flood victims) while are competitive in other contexts (such as a patent race). By restricting attention to the firm and then only to agents within the firm, we identify the people that an agent is likely to interact with - his co-workers. It is then natural to think of agents within a firm as competing with (or against) each other.

Therefore, we assume that an agent makes interpersonal comparisons with other agents in the firm. We assume that agents have relative concerns of the following form:

$$R_i = q_i - q_j. \tag{5}$$

Following earlier work in the literature, we refer to such relative interpersonal comparisons as concerns for status. In this case, since agents only compare themselves with other agents in the same firm, R_i thus captures a concern for "local" status (see Fershtman et. al. 2003 & 2006). Status defined this way is zero-sum, i.e., $R_i + R_j = 0$; an agent can gain status only at the expense of the other.

In the status literature, it is common to define status as being derived from the difference in agents' wages, $w_i - w_j$. We deviate from such a specification for the following reasons. First, wage information is not often made public, even within a firm. Thus, it is unrealistic to suppose that agents base their decision on unobservable variables.

Second, it is possible to interpret the difference in agents' outputs as the difference in the hierarchical levels they occupy. It is not hard for an employee to find out the job titles of his co-workers. Assume that a title is granted to an agent if his output falls in a pre-determined range associated with that title. So, if an employee could observe the job title of a co-worker, he could infer the range in which the output of the co-worker in question falls.[7] To interpret status concerns as difference in hierarchical levels, we would, technically, need to specify status as the difference in the threshold

[6]There has been some work on agents who compare themselves to the principal instead. See, for instance, Sandner (2008). When an agent has social concerns vis-a-vis the principal, it is also possible to think of trust relationships - see Casadesus-Masanell (2004) and Ramalingam and Rauh (2008). In this paper, we only focus on relative social concerns that agents have for each other.

[7]This, of course, relies on the assumption that the firm announces and commits to a particular mapping of outputs to hierarchical positions that the agent can then invert.

output levels for each agent's hierarchical position. The above specification is a simplification - we essentially assume that the firm's mapping of outputs to hierarchical positions results in a perfectly fine partition of the employees into hierarchical levels, i.e., assume that each output level is in a "class of its own".[8] In such an instance, by observing job titles that the firm makes public (assume this for simplicity), an agent can perfectly infer his co-worker's output. It is thus feasible to measure status as the difference in outputs. Status defined in this particular way makes it possible to interpret an agent as deriving status from being higher up in the hierarchy than his co-worker, a reasonably realistic and commonplace phenomenon.

Third, status is commonly thought of as being granted by outside observers. Indeed, symbols such as medals or trophies have no value in themselves and merely serve to inform outsiders of a victory. If status is to be granted by outsiders, it is essential that there be a signal that is readily and easily observable. In the absence of publicly observable wage information, job titles serve just such a purpose. The current specification of status thus allows status to be derived from, as one might expect, the social sphere of life. Once again, the identification of job titles with output levels instead of some threshold output level is merely a simplification.

Finally, as mentioned in Gächter et al. (2008), the empirical evidence for significant impacts of "pay comparison information" alone on employee behavior is "at best weak". While they note that combinations of pay and effort comparison information might significantly impact individual behavior, they argue that effort comparison information may influence behavior independent of pay comparison information. We use effort comparison alone (in our model, expected output is equal to effort).

This model ignores issues pertaining to comparisons within and across social groups. For instance, it can be argued that the average worker does not compare himself with Bill Gates. By restricting attention to local status, we have abstracted away from this complication. All workers are assumed to belong to the same (or similar) social group(s).

Given the above definition of R_i, agent i's behavior payoffs are given by the sum of his material payoffs and the payoff derived from status:

$$\text{Behavior Payoffs}_i = w_i - \frac{1}{2}k_i e_i^2 + \delta_i R_i, \quad i = 1, 2, \tag{6}$$

where $\delta_i \in \mathbb{R}$ is the importance agent i attaches to status. By allowing for $\delta_i \neq \delta_j$, we assume that the importance attached to status can be different for each agent. Indeed, experiments testing for social preferences find substantial individual variations in, for example, offers made by a Proposer in a Trust Game (see, for example, Fehr and Gächter 2000). In arguing that an agent can choose how important to make such concerns, we argue that agent i can choose δ_i. In the rest of the paper, we refer to agent i's choice of δ_i as his choice of "status concerns". Note that such a specification allows for the possibility that status payoff within the firm is not zero-sum, i.e., it is possible that $\delta_i \neq \delta_j$.

[8]Moldovanu et. al (2007) and Dubey and Geanakoplos (2005) identify instances when such a fine partition of employees is optimal. However, since they talk about partitioning employees, their specification is necessarily discrete. We make the continuity assumption simply for convenience.

Thus, while status is zero-sum, status payoff within the firm need not be.

Generally, agent i could choose how much importance to give to monetary payoff (w_i) in addition to choosing the importance of status payoffs. The above specification captures this general possibility too. By not specifying another coefficient on w_i we have, in effect, normalized the weight on w_i to be unity. We can thus interpret δ_i as the *relative* weight agent i puts on his status payoff.

Note that we allow an agent to have *negative* status concerns. If $\delta_i < 0$, agent i actually prefers agent j to have a higher status in the firm. Since there is evidence of many kinds of social concerns, there is no reason, a priori, to expect that all agents will have the same kinds of social concerns (see Küpper and Sandner 2008). By allowing $\delta_i < 0$, we also allow for "altruistic" agents within the firm. Agent i is (usually) defined to be altruistic if he puts positive weight, in his preferences, on agent j's outcome without regard to relative outcomes. In this case, $\delta_i < 0$ implies that agent i puts a positive weight on agent j's outcome. However, he also cares about his relative standing. Hence, strictly speaking, $\delta_i < 0$ does not make agent i altruistic. We refer to an agent with negative status concerns ($\delta_i < 0$) as an agent with "pro-social" relative concerns and an agent with positive status concerns ($\delta_i > 0$) as an agent with "competitive" relative concerns.[9] For the sake of simplicity and convenience, however, we refer to any form of social concerns in this model as concerns for status, with the understanding that such concerns can be competitive or pro-social.

Agent i's utility from behavior payoffs is given by

$$\begin{aligned} U_A^i &= -\exp\{-r_i(w_i - \frac{k_i e_i^2}{2} + \delta_i(q_i - q_j))\} \\ &= -\exp\{-r_i[\alpha_i + \beta_i e_i + \gamma_i e_j - \frac{k_i e_i^2}{2} + \delta_i(e_i - e_j) \\ &\quad + (\beta_i + \delta_i)\epsilon_i + (\gamma_i - \delta_i)\epsilon_j]\}, \quad i, j = 1, 2, \quad i \neq j, \end{aligned}$$

with associated certainty equivalent given by

$$CEA_i = \alpha_i + \beta_i e_i + \gamma_i e_j - \frac{k_i e_i^2}{2} + \delta_i(e_i - e_j) - \frac{r_i V_i}{2}, \tag{7}$$

where $V_i = (\beta_i + \delta_i)^2\sigma_i^2 + 2(\beta_i + \delta_i)(\gamma_i - \delta_i)\sigma_{12} + (\gamma_i - \delta_i)^2\sigma_j^2$. We define an agent's behavior utility to be the certainty equivalent from his behavior payoffs.

However, we draw a distinction between material utility and the certainty equivalent from material payoffs. We define material utility, MA_i, to be the certainty equivalent from material payoffs *plus* the expected risk-premium from status concerns. Thus material utility is just behavior utility without expected status.

$$MA_i = \alpha_i + \beta_i e_i + \gamma_i e_j - \frac{k_i e_i^2}{2} - \frac{r_i V_i}{2} \tag{8}$$

where $V_i = (\beta_i + \delta_i)^2\sigma_i^2 + 2(\beta_i + \delta_i)(\gamma_i - \delta_i)\sigma_{12} + (\gamma_i - \delta_i)^2\sigma_j^2$. Note that the risk-premium term V_i includes the direct effect of agent i's status concerns δ_i, i.e., V_i is a function of δ_i, while the certainty

[9] See footnote 3.

equivalent of an agent's material payoffs does not contain δ_i or δ_j. By taking the direct effect of δ_i into account, we assume that there is a direct and real cost to displaying status concerns in terms of increased exposure to risk.

Below are the formal definitions of these concepts.

Definition 1 *An agent's **behavior utility**, CEA_i, is defined as the certainty equivalent of the expected utility from his behavior payoffs, as given in (7).*

Definition 2 *The **material utility of agent i**, MA_i, is defined as the certainty equivalent of the expected utility he receives from his material payoffs plus the risk imposed by his concern for status, as given in (8).*

2.2 Principal

The principal is assumed to be risk-neutral and his revenue is assumed to be equal to output, $q_1 + q_2$. His certainty equivalent is thus given by

$$CEP = e_1 + e_2 - (\alpha_1 + \beta_1 e_1 + \gamma_1 e_2) - (\alpha_2 + \beta_2 e_2 + \gamma_2 e_1). \tag{9}$$

The principal's reservation expected profit is assumed to be zero. His decision problem is to design contracts and to choose effort levels to maximize the above objective subject to individual rationality and incentive compatibility constraints for the two agents.

2.3 Equilibrium and Efficient Status Concerns

In order to explore the "economic value of status" (Ball and Eckel 1998), we make the assumption that player's social preferences are context-dependent. There is experimental and field evidence that suggests that preferences depend on the environment. Bowles (1998) and Zizzo (2003) present evidence from various sources that suggest that preferences are influenced by culture, institutions and other environmental factors. Sobel (2007) finds that "Markets Make People Appear Selfish". Palacios-Huerta and Santos (2004) construct a theoretical model where risk-aversion parameters are "endogenous to market arrangements" (p. 617) and present empirical evidence of such "endogeneity". See de Oliveira et al. (2009), Ramalingam and Rauh (2008) and Kapteyn et al. (1980) for further references.

Here, we focus on only one institution and assume that social concerns are nevertheless "endogenous". Based on earlier experimental studies, we posit that players' social preferences depend on the characteristics of the other players they interact with. For instance, Levine (1998) presents experimental evidence to support his claim that "In general, player's regard for one another may depend on who the opponent is,..." (p. 598). Eckel and Grossman (1996) find that student subjects in a dictator game experiment allocate more to a charity than to anonymous student subjects. In a series of ultimatum game experiments, Eckel and Grossman (2001) find that offers from women are more likely to be accepted. Such studies suggest that agents' social preferences depend on the other players in the game.

In the absence of convincing evidence, we do not claim that individuals' preferences are unstable. We merely work under the assumption that "preferences are stable, but are elicited to the extent that the particular institution allows" (Ramalingam and Rauh 2008, p. 2), i.e., that different preferences can be revealed in different contexts. However, it is not clear how contexts affect preferences. Thus, for modeling convenience, we allow agents in our model to choose the intensity of their social concerns.

Following the method outlined in Raub (1990), Rotemberg (1994) and Casadesus-Masanell (2004), we allow agents to choose their own concerns for status to maximize their "material utilities". Allowing preferences to be endogenous is merely a modeling tool that captures the hypothesis that agents' social concerns are affected by the context in which their decision is made, i.e., by the characteristics of the individuals they interact with (relative to their own). Such "endogeneity" of preferences captures rationality and rational behavior on the part of agents. As Raub (1990) notes, "choices of effective preferences are a result of the rational pursuit of natural interests" (p. 70).

In the model that we consider in this paper, we make the usual common knowledge assumption. Thus, an agent knows the environmental conditions in which he will make his subsequent effort choice when he chooses his status concerns, i.e., he knows the production processes of both agents. Further, he also knows his own characteristics and those of his co-worker, i.e., he knows his own risk-aversion and effort-cost parameters and those of his co-worker's. (Of course, common knowledge also implies that he knows that his co-worker knows these parameters too and that he knows that he knows and so on.) Thus, he need not exert any effort (and incur any cost) to inform himself of the parameters of the game. Lastly, we assume, as is standard in all economic models, that an agent faces no cost to using his cognitive abilities, i.e., being rational comes naturally to an agent. Therefore, we assume, following Casadesus-Masanell (2004), that agents can choose their status concerns *costlessly.*

In light of the above arguments, we define equilibrium status concerns as the status concerns chosen costlessly by the agents to maximize their material utilities in a strategic game before the principal-agent game. However, the agents' choices are subject to the constraint that the principal's expected profit be non-negative. If the principal's expected profit is negative, he will shut down and the agency relationship breaks down.

Definition 3 *The* ***equilibrium status concerns*** *are a Nash equilibrium of the first-stage strategic game played between the two agents described by* $\{\{1,2\}, A_i, MA_i\}_{i=1}^{2}$*, where* $A_1 = A_2 = \mathbb{R}$ *is the strategy set of the players and* MA_i *is the material utility of agent* i*. These choices are subject to the constraint that the principal's expected profit be non-negative.*

The equilibrium status concerns enable us to make statements about the value of status to the agents alone. To explore the value to the firm as a whole (the principal and the two agents), we characterize the (socially) efficient status concerns. We begin with another definition.

Definition 4 ***Material surplus,*** *MS, is defined as the sum of the expected material payoffs of the principal (profits) and the material utilities of each agent. $MS = CEP + MA_1 + MA_2$.*

Thus, material surplus is measured as follows:

$$MS = e_1 + e_2 - \frac{k_1 e_1^2}{2} - \frac{r_1 V_1}{2} - \frac{k_2 e_2^2}{2} - \frac{r_2 V_2}{2}. \tag{10}$$

We define the efficient status concerns as those that maximize the total *material* surplus in the firm, given the optimal incentive contracts offered by the principal and the effort levels chosen by the agents. Note that the moral hazard problem is still present. The efficient status concerns are those that are *constrained* efficient.

Definition 5 *The* ***efficient status concerns*** *are those that maximize the material surplus within the firm.*

By looking at the efficient status concerns, we can investigate if status concerns have any *social* value within the firm, i.e., we can see if there are any status concerns that increase the surplus within the firm above the moral-hazard benchmark. The maximum possible surplus generated by the efficient status concerns also serve as an upper bound on the firm's profits. This upper bound will be useful in determining the ideal status concerns from the point of view of the principal.

2.4 Timing in the Game

The setting is a principal-agent game with one preliminary stage where the agents choose their status concerns as a result of equilibrium behavior. Once status concerns are chosen, the principal's problem is one of designing the optimal linear contract given the agents' concerns for status. Each agent's problem is to choose his effort level given the contract offered and the status concerns chosen by him and his co-worker. The timing in the game is as follows:

1. The agents play a strategic game between themselves to costlessly choose their concerns for status to maximize their material payoffs, subject to the constraint that the principal's expected profit be non-negative.
2. The principal offers contracts $(\alpha_1, \beta_1, \gamma_1)$ and $(\alpha_2, \beta_2, \gamma_2)$.
3. Agents decide whether or not to accept the contracts. If agents accept the contracts, effort levels are chosen and payoffs are realized.

As is standard in principal-agent models, we solve the game by backward induction. The principal can look forward to the third stage of the game and solve for the agents' effort choices. In the second stage, the principal solves for the optimal contracts given the agents' choices of effort. In the first stage, the agents look forward and calculate the contracts chosen by the principal and choose their concerns for status given the contracts chosen by the principal.

Note the role played by truthful revelation and commitment. Once an agent chooses and displays his status concerns, he is committed to his truthful announcement. This assumption is based on studies that argue that falsification of preferences is costly and also reflects knowledge captured in adages such as "Old habits die hard". Once an agent's preferences are fixed, he finds it difficult to hide and/or change them. Since the principal believes (due to truthful revelation) the agents' announcements of their status concerns, he has no choice but to believe they will act according to their stated behavior utility functions, i.e., the principal cannot commit to a contract *before* agents choose their social concerns.

3 Choices of Status Concerns

As defined earlier, the agent's behavior utility is given by (7) where the risk-premium is as defined earlier. These are the preferences the agent acts according to and his problem is to maximize (7) with respect to e_i. The solution to this problem is[10]:

$$e_i = \begin{cases} \frac{\beta_i+\delta_i}{k_i} & \text{if } \beta_i+\delta_i \geq 0 \\ 0 & \text{if } \beta_i+\delta_i < 0 \end{cases} . \tag{11}$$

Note that e_i is increasing in β_i and δ_i.

The principal's problem is to maximize CEP with respect to the contract parameters subject to the Incentive Compatibility (IC) constraints and the binding Individual Rationality (IR) constraints, i.e.,

$$\max_{\{\alpha_i,\beta_i,\gamma_i,e_i\}_{i=1}^2} \quad CEP = e_1 + e_2 - (\alpha_1 + \beta_1 e_1 + \gamma_1 e_2) - (\alpha_2 + \beta_2 e_2 + \gamma_2 e_1)$$

$$\text{subject to}$$

$$e_i = \frac{\beta_i + \delta_i}{k_i}, \quad i = 1, 2,$$

$$\alpha_i + \beta_i e_i + \gamma_i e_j - \frac{k_i e_i^2}{2} + \delta_i(e_i - e_j) - \frac{r_i V_i}{2} = 0, \quad i,j = 1,2, \quad i \neq j.$$

Note that we have assumed that the principal prefers positive effort from both agents. We assume this in everything that follows. Substituting in the constraints (at the optimum, the IR constraints

[10] CEA_i is strictly concave in e_i and the first-order condition is therefore necessary and sufficient. The first-order approach is, therefore, valid.

bind), we can solve for the optimal contract parameters[11]

$$\beta_i = -\delta_i + \frac{(1+\delta_i-\delta_j)\sigma_j^2}{\psi_j} \quad \text{and} \quad \gamma_i = \delta_i - \frac{(1+\delta_i-\delta_j)\sigma_{12}}{\psi_j} \quad i,j=1,2, \quad i \neq j,$$

where

$$\psi_i \equiv \sigma_i^2 + k_j r_j(\sigma_1^2\sigma_2^2 - \sigma_{12}^2) > 0, \quad i,j=1,2,\ i \neq j. \tag{12}$$

To sign the above expressions, we have used the fact that $\sigma_1^2\sigma_2^2 - \sigma_{12}^2 > 0$ (Σ is a variance-covariance matrix and is hence positive definite). α_1 and α_2 are chosen so that the IR constraints bind.[12]

$$\frac{\partial \beta_i}{\partial \delta_i} = \frac{-k_i r_i(\sigma_1^2\sigma_2^2 - \sigma_{12}^2)}{\psi_j} < 0 \quad \text{and} \quad \frac{\partial \beta_i}{\partial \delta_j} = \frac{-\sigma_j^2}{\psi_j} < 0.$$

Note that status and explicit incentives are substitutes from the point of the view of the principal.

$$\frac{\partial \gamma_i}{\partial \delta_i} = \frac{\psi_j - \sigma_{12}}{\psi_j} \quad \text{and} \quad \frac{\partial \gamma_i}{\partial \delta_j} = \frac{\sigma_{12}}{\psi_j}.$$

Thus, the principal can use lower incentives in the presence of status concerns. Also, note that status justifies the use of Relative Performance Evaluation even when the outputs of the two agents are unrelated, i.e., when $\sigma_{12} = 0$, a result that was emphasized very early on in the status literature. For instance, see Fershtman et. al (2003) and Goel and Thakor (2006). Also, incentives are decreasing in risk-aversion parameters and the variability of production, i.e., the risk-reward tradeoff still holds. For more details on the optimal contract in the presence of status concerns, see Goel and Thakor (2006) and Küpper and Sandner (2008).

The agents' effort levels are given by:

$$e_1 = \frac{(1+\delta_1-\delta_2)\sigma_2^2}{k_1\psi_2} \quad \text{and} \quad e_2 = \frac{(1-\delta_1+\delta_2)\sigma_1^2}{k_2\psi_1}. \tag{13}$$

3.1 Equilibrium Status Concerns

In equilibrium, the status concerns δ_1 and δ_2 are chosen by the agents to maximize the utility from their material payoffs in a strategic game between themselves, given the contract parameters. As defined above,

$$\begin{aligned} MA_i &= \alpha_i + \beta_i e_i + \gamma_i e_j - \frac{k_i e_i^2}{2} - \frac{r_i V_i}{2} \\ &= -\delta_i(e_i - e_j), \end{aligned}$$

[11] After substituting in the constraints, CEP is strictly concave and the first order conditions (FOC) are, thus, necessary and sufficient.

[12] This reflects the implicit assumption that all parties have "sufficient" funds, an assumption that is made throughout this paper.

where the second equality uses the fact that the contract is chosen so that agent i's IR constraint binds. Thus, an agent's material utility is just the negative of his expected status payoff. Put another way, $MA_i = \delta_i(e_j - e_i) = \delta_i R_j$. This is due to the zero-sum nature of status in this game ($R_i + R_j = 0$); one agent's status gain is equal to the other agent's status loss.

When status concerns are endogenous, the natural first question is if it is rational for agents to display/exhibit them. Note that we use the terms "display" and "exhibit" since the social concerns are only part of an agent's behavior utility, i.e., the utility function that he "displays" to the employer. Thus, by choosing a non-zero value of δ, a worker "displays" to his employer that he cares about status. The terms are not to be confused with the situation where an agent is endowed with a certain value of δ but chooses to display another value. The first result establishes the individual rationality of such status concerns.

Proposition 1 Equilibrium Status Concerns
(i) In general, agents choose to display non-zero concerns for status in the firm.
(ii) One agent chooses to display competitive concerns while the other chooses to display pro-social concerns.

In equilibrium, the material utilities of both agents are higher than in the benchmark case,

$$MA_1 = MA_2 = \frac{[k_1\sigma_1^2\psi_2 - k_2\sigma_2^2\psi_1]^2}{9k_1k_2\psi_1\psi_2[k_1\sigma_1^2\psi_2 + k_2\sigma_2^2\psi_1]} > 0 = MA_1^B = MA_2^B,$$

where the B superscript denotes the corresponding values from the benchmark model with no status concerns (see Appendix B). Both agents thus find it individually rational to display or exhibit concerns for status in the firm; status concerns are "instrumental" in raising their material utilities. Proposition 1 thus provides a rationale for the development of status concerns in a competitive setting. The equilibrium status concerns are

$$\delta_1 = \frac{k_1\sigma_1^2\psi_2 - k_2\sigma_2^2\psi_1}{3\left[k_1\sigma_1^2\psi_2 + k_2\sigma_2^2\psi_1\right]} \quad \text{and} \quad \delta_2 = \frac{-k_1\sigma_1^2\psi_2 + k_2\sigma_2^2\psi_1}{3\left[k_1\sigma_1^2\psi_2 + k_2\sigma_2^2\psi_1\right]}. \tag{14}$$

Note that $\delta_1 = -\delta_2$, i.e., one agent chooses to display competitive concerns while the other chooses to display pro-social concerns. The equilibrium contract parameters are

$$\beta_1 = \frac{k_1\sigma_1^2\psi_2(5\sigma_2^2 - \psi_2) + k_2\sigma_2^2\psi_1(\sigma_2^2 + \psi_2)}{3\psi_2\left[k_1\sigma_1^2\psi_2 + k_2\sigma_2^2\psi_1\right]}, \qquad \beta_2 = \frac{k_2\sigma_2^2\psi_1(5\sigma_1^2 - \psi_1) + k_1\sigma_1^2\psi_2(\sigma_1^2 + \psi_1)}{3\psi_1\left[k_1\sigma_1^2\psi_2 + k_2\sigma_2^2\psi_1\right]} \tag{15}$$

$$\gamma_1 = \frac{k_1\sigma_1^2\psi_2(\psi_2 - 5\sigma_{12}) - k_2\sigma_2^2\psi_1(\psi_2 + \sigma_{12})}{3\psi_2\left[k_1\sigma_1^2\psi_2 + k_2\sigma_2^2\psi_1\right]}, \qquad \gamma_2 = \frac{k_2\sigma_2^2\psi_1(\psi_1 - 5\sigma_{12}) - k_1\sigma_1^2\psi_2(\psi_1 + \sigma_{12})}{3\psi_1\left[k_1\sigma_1^2\psi_2 + k_2\sigma_2^2\psi_1\right]} \tag{16}$$

where $\beta_i > 0$ by Assumption 1. The agents' effort levels are

$$e_1 = \frac{\sigma_2^2[k_2\sigma_2^2\psi_1 + 5k_1\sigma_1^2\psi_2]}{3k_1\psi_2\left[k_1\sigma_1^2\psi_2 + k_2\sigma_2^2\psi_1\right]} > 0 \quad \text{and} \quad e_2 = \frac{\sigma_1^2[k_1\sigma_1^2\psi_2 + 5k_2\sigma_2^2\psi_1]}{3k_2\psi_1\left[k_1\sigma_1^2\psi_2 + k_2\sigma_2^2\psi_1\right]} > 0. \tag{17}$$

Part (i) of Proposition 1 also holds under more general specifications. In particular, it holds even if the agents are restricted to choosing non-negative values of δ.[13] It also holds when the number of agents is increased. Finally, it also holds under a certain specification of uncertainty. The result obtains if we assume that each agent knows only his own characteristics and that the principal knows the characteristics of both agents but each agent knows that the other's, for instance, cost of effort is "low" or "high" with probability p_L and $p_H = 1 - p_L$ respectively. However, we stick to the current specification for simplicity and because it allows for sharper contrasts between the agents in all the results (as in (ii) of Proposition 1).

Proposition 1 also allows us to make statements about the relative importance of status to an agent. In equilibrium, we have $|\delta_i| = |\delta_j| < 1$. Thus, the weight on (or importance given to) status payoff is less than unity, i.e., agents put less weight on status payoffs relative to monetary payoffs (recall the interpretation of δ_i as the relative importance attached to status). We thus have a corollary to Proposition 1.

Corollary 1 Relative Importance of Status Concerns
Agents care more about monetary payoffs than they do about status payoffs.

This finding is in line with expectations. Monetary payoffs *directly* increase material payoffs while status concerns increase material payoffs only indirectly through their effect on wages or effort choices. Thus, an agent gives more importance to monetary payoffs than he does to status payoffs.[14]

From the equilibrium status concerns, we have

$$\delta_i > 0 (\Rightarrow \delta_j < 0) \quad \Leftrightarrow \quad k_i \sigma_i^2 \psi_j > k_j \sigma_j^2 \psi_i.$$

Under this condition, we have $e_i < e_j$ in equilibrium. Thus, in equilibrium, agent i receives a negative expected status payoff ($\delta_i(e_i - e_j) < 0$). Since $\delta_j < 0$, agent j also receives a negative expected status payoff ($\delta_j(e_j - e_i) < 0$). The negative expected status payoff reduces an agent's behavior utility. When the principal chooses the contract parameters, he has to ensure that the agents' behavior utility is at least zero to ensure participation. Since, in equilibrium, the behavior utility of the agents is reduced by their choices of status concerns, the principal is forced to increase the material utility[15] of the agents above zero ($MA_i^B = 0$) in order to induce them to enter the agency relationship. Thus, agents successfully design their "acting self" preferences to extract surplus from the principal and increase their material utilities above zero, i.e., it is individually rational for agents to display concerns for status within the firm even in a one-shot game.

The fact that agents display opposing status concerns derives from the fact (assumption) that status received by agent i, R_i, is just the negative of the status received by agent j, i.e., one agent

[13] In this case, part (ii) of Proposition 2 becomes: (ii) One agent chooses to display competitive concerns while the other chooses to display no relative concerns (zero status concerns).

[14] This result could be due to the fact that we do not allow for wealth accumulation in the model. It is conceivable that if an agent has already amassed substantial wealth, he will focus more on status payoff.

[15] Recall that behavior utility is just material utility plus the expected status payoff.

always gets negative status. The only way both agents can still receive positive material utility is for them to have opposing concerns for status, i.e., $\text{sign}(\delta_1) = -\text{ sign}(\delta_2)$. Opposing status concerns allow both agents to derive negative expected status payoffs, thus forcing the principal to increase the material utilities of both agents. The fact that the agents' status concerns are equal in magnitude merely reflects the fact that their problems are mirror-images (!) of one another. Thus, in equilibrium, one agent chooses to display competitive social concerns while the other agents chooses to display pro-social concerns.

By ensuring that his expected status payoff is negative, an agent precludes the possibility that the principal can rely on status payoffs to serve as an additional incentive for higher effort. Since an agent's utility is decreased by his choice of social concerns, the principal is, in fact, forced to rely even more heavily on explicit contractual parameters. Analysis of the factors influencing an agent's choice of status concerns identifies the contractual parameters that agents are able to influence. The following subsection carries out this analysis.

3.2 Factors Affecting Status Concerns

From the expressions for the equilibrium status concerns, it is easy to see that agents' choices of social concerns are influenced by the environmental conditions and by the characteristics of both agents as hypothesized. However, without further assumptions, it is not possible to disentangle the effects of each of these parameters on an agent's choice of status. Therefore, in the analysis that follows, we assume that all factors are equal across both agents except for the factor of interest.

Formally, the environmental conditions in this model are the variability of the production processes (σ_1^2, σ_2^2 and σ_{12}) and the agent characteristics are the risk-aversion and effort-cost parameters (r_1, k_1, r_2 and k_2). It can also be seen that σ_{12} plays no significant role in the determination of status concerns; at best, it plays the same role for both agents. Thus, for simplicity, we assume that $\sigma_{12} = 0$, i.e., that the agents' production processes are independent, in what follows.[16] Under this assumption, the equilibrium status concerns are given by

$$\delta_1 = \frac{k_1(1 + k_1 r_1 \sigma_1^2) - k_2(1 + k_2 r_2 \sigma_2^2)}{3[k_1(1 + k_1 r_1 \sigma_1^2) + k_2(1 + k_2 r_2 \sigma_2^2)]} \tag{18}$$

$$\delta_2 = \frac{-k_1(1 + k_1 r_1 \sigma_1^2) + k_2(1 + k_2 r_2 \sigma_2^2)}{3[k_1(1 + k_1 r_1 \sigma_1^2) + k_2(1 + k_2 r_2 \sigma_2^2)]}. \tag{19}$$

[16]When $\sigma_{12} \neq 0$, no clear conclusion can be reached. In particular, it is not possible to disentangle the effects of the individual factors.

3.2.1 Production Process

To isolate the effects of the production processes, we assume that $r_1 = r_2 = r > 0$ and $k_1 = k_2 = k > 0$, i.e., that agents are identical in all respects. The equilibrium status concerns are now

$$\delta_1 = \frac{kr(\sigma_1^2 - \sigma_2^2)}{3[2 + kr(\sigma_1^2 + \sigma_2^2)]} \quad \text{and} \quad \delta_2 = \frac{kr(\sigma_2^2 - \sigma_1^2)}{3[2 + kr(\sigma_1^2 + \sigma_2^2)]}.$$

Proposition 2 Effect of Production Uncertainty on Equilibrium Status Concerns
(i) All else equal, the agent who faces the more (less) uncertain production process chooses to display competitive (pro-social) concerns within the firm.
(ii) All else equal, the status concerns of an agent are increasing in own production uncertainty and decreasing in the production uncertainty of the other agent.
(iii) All else equal, the material utilities of agents are increasing in the difference between the production uncertainties of their two tasks.

3.2.2 Agent Characteristics

To focus attention on agent characteristics, we assume that $\sigma_1^2 = \sigma_2^2 = \sigma^2 > 0$, i.e., the agents face the same production process. We temporarily relax the assumptions on risk-aversion and effort-cost parameters.

Risk-Aversion Here, we further assume that the agents' effort-costs are the same in order to isolate the effects of risk-aversion, i.e., we assume that $k_1 = k_2 = k > 0$. In this case, the agents' choices of status concerns simplify to

$$\delta_1 = \frac{k\sigma^2(r_1 - r_2)}{3[2 + k\sigma^2(r_1 + r_2)]} \quad \text{and} \quad \delta_2 = \frac{k\sigma^2(r_2 - r_1)}{3[2 + k\sigma^2(r_1 + r_2)]}.$$

Proposition 3 Effect of Risk-Aversion on Equilibrium Status Concerns
(i) All else equal, the agent who is more (less) risk-averse chooses to display competitive (pro-social) concerns within the firm.
(ii) All else equal, the status concerns of an agent are increasing in own risk-aversion and decreasing in the risk-aversion of the other agent.
(iii) All else equal, the material utilities of agents are increasing in the difference between their coefficients of risk-aversion.

Effort Cost Interpreting higher effort costs as lower ability enables us to make statements about how equilibrium status concerns are affected by relative abilities of agents. To this end, we assume that $r_1 = r_2 = r > 0$ and allow k_1 and k_2 to be variable. We still assume that $\sigma_1^2 = \sigma_2^2 = \sigma^2 > 0$.

Now, the equilibrium status concerns are given by

$$\delta_1 = \frac{(k_1 - k_2)[1 + r\sigma^2(k_1 + k_2)]}{3[(k_1 + k_2) + r\sigma^2(k_1^2 + k_2^2)]} \quad \text{and} \quad \delta_2 = \frac{(k_2 - k_1)[1 + r\sigma^2(k_1 + k_2)]}{3[(k_1 + k_2) + r\sigma^2(k_1^2 + k_2^2)]}.$$

Proposition 4 Effect of Ability on Equilibrium Status Concerns
(i) All else equal, the agent with the lower (higher) ability chooses to display competitive (pro-social) concerns within the firm.
(ii) All else equal, the status concerns of an agent is increasing in own effort cost and decreasing in the effort cost of the other agent.
(iii) All else equal, the material utilities of both agents are increasing in the difference in effort cost between the two agents.

3.2.3 Discussion

For purposes of exposition, define agent i to be the "weaker" ("stronger") agent if he faces a more (less) uncertain production process ($\sigma_i^2 > (<)\sigma_j^2$) or if he is more (less) risk-averse ($r_i > (<)r_j$) or if he faces a higher (lower) effort cost ($k_i > (<)k_j$). The above propositions state that the weaker agent chooses to display stronger competitive concerns than does the stronger agent. In fact, only the weaker agent chooses competitive concerns. This result is counter-intuitive; one would normally expect the stronger agent to be more competitive. If agents were to care about winning, it would seem that the agent more likely to win would care more about status since that would increase his utility. The above results suggest otherwise. An understanding of this "puzzle" also make clear the process by which the agents extract surplus from the principal by their choices of status concerns.

The mismatch between the weaker (competitive) and the stronger (pro-social) agents ensures that the expected output of the stronger agent is greater than that of the weaker agent (recall that $\delta_i > 0 (\Rightarrow \delta_j < 0) \Leftrightarrow e_i < e_j$). Thus, the weaker agent expects a status loss while the stronger agent expects a status gain in equilibrium. The weaker agent acts competitively since his expected status loss forces the principal to compensate him for the loss. The stronger agent does not act competitively since his expected status gain will allow the principal to substitute status for explicit incentives that can increase his material utility; if the stronger worker were to develop competitive concerns, he would signal to the firm that his utility is increased by his status gain from winning, thus allowing the firm to reduce his wage payment. Instead he designs his social preferences in such a way that he too gets a negative expected status payoff.

The weaker agent works harder in equilibrium relative to the benchmark case ($\delta_i > 0$ implies that $e_i > e_i^B$, where the B superscript denotes a value from the benchmark model with no status concerns).[17] He has to be compensated for this and thus receives a higher wage in equilibrium relative to the benchmark wage; $\delta_i > 0 \Rightarrow w_i > w_i^B$. The increase in the wage payment more than

[17]The condition that ensures that $\delta_i > 0$ also ensures that $e_i^B < e_j^B$. Hence, it is possible to simultaneously have $e_i > e_i^B$, $e_j < e_j^B$ and $e_i - e_j < 0$, as is indeed the case.

compensates for his increased effort cost. Thus, the agent with positive status concerns is able to extract a "significantly" higher wage payment from the principal that then increases his material utility above zero.

The opposite is true for the stronger agent. The stronger agent works less in equilibrium but also receives a lower wage relative to the benchmark wage.[18] His reduction in effort cost more than compensates for the reduction in his wage. The agent with negative status concerns is able to influence the principal to offer a contract that requires "significantly" lower effort, thus increasing his material utility above zero.[19]

These results are similar to the findings of Bandiera et al. (2008). Using data on productivity and social networks of workers in a firm, they find that compared to when she has no ties to her co-workers, a worker exerts less effort if she is more able than her friends and exerts more effort if she is less able than her friends. In our analysis, we have effectively assumed that all workers are "friends"; we have abstracted away from the worker's choice of reference group.

Thus, both agents are able to force the principal to offer them more favorable contracts (relative to the benchmark case). Contrary to what one might expect, it is the agents who exploit the substitutability of status and explicit contracts. The principal is forced to rely more heavily on explicit incentives (in the case of the weaker agent) or to accept lower effort (in the case of the stronger agent); the principal is forced to substitute contractual parameters for the expected status *loss* faced by agents. The principal is thus forced to transfer some of the surplus to the agents.

This result also explains why an agent's status concerns are increasing as, all else equal, his relative weakness increases (parts (ii) and (iii) of Propositions 2 through 4). As an agent's relative weakness increases, the amount by which his expected output falls short of the other agent's increases if the agent is weaker. By increasing his concern for status (choosing a greater positive number) he can increase the expected status loss that is perceived by the principal, increasing the compensation that he can receive from the principal and thus his material utility. The opposite is true when an agent's relative strength increases - by decreasing his concern for status (choosing a lower negative number), the agent increases his expected status loss from producing more than the other agent. We thus have a corollary to the above propositions.

Corollary 2 Agents' Preference for Workforce Diversity
Agents' material utilities are increasing in workforce diversity, i.e., workers would like to work in a (infinitely) diverse workforce.

[18] We get the result that the stronger agent's effort is reduced relative to the benchmark model since we allow for negative status concerns.

[19] As an aside, the agent with positive (negative) status concerns faces a higher (lower) risk-premium in equilibrium relative to the benchmark case.

4 Implications for Firm Profits

A natural follow-up question, indeed one that has been asked often, is the question of the impact of status concerns on firm profits. This is the focus of this section. In order to answer this question, we take a slightly indirect route. We first calculate the maximum possible surplus that can be generated within the firm in the presence of status concerns. More precisely, we solve for the "efficient status concerns". If the firm were able to appropriate the entire surplus generated within the firm, the "efficient surplus" would then be an upper bound on the profits that the firm can hope to make. Statements on the impact on firm profits are made in relation to this upper bound.

The results of the previous section make clear that agents choose status concerns to exploit the differences in their characteristics. The following results are, therefore, necessarily a result of such workforce "diversity". Define a *diverse workforce* as one where workers differ in at least one characteristics, i.e., $r_1 \neq r_2$ or $k_1 \neq k_2$ or $\sigma_1^2 \neq \sigma_2^2$. The following result calculates this upper bound on firm profits and shows that a firm's profits are always reduced (relative to the benchmark model) by hiring a diverse workforce, as suggested by the results of the previous section.

Proposition 5 Efficient Concerns for Status
With a diverse workforce,
(i) The (constrained) efficient concerns for status are such that $\delta_1 = \delta_2 = 0$.
(ii) The upper bound on a firm's profit is equal to its profit in the benchmark case.

Proposition 5 tells us that status concerns on the part of agents cannot generate a higher surplus than in the benchmark model. If $\delta_1 = \delta_2 = 0$, we are back to the standard moral-hazard case and there are no distortions other than those caused by moral hazard. Constrained Pareto-efficiency requires status *payoff* within the firm to be zero (zero-sum), not just status which is always zero-sum.

This solution arises since only material payoffs matter for fitness. Any effort devoted to acquiring status is thus a waste from society's point of view - while increased effort does increase output (and revenue), it also increases the disutility from effort (at an increasing rate).[20] Status concerns thus introduce an additional source of inefficiency in the agency relationship.[21] The efficient solution thus eliminates the inefficiency introduced by concerns for status. The standard model thus depicts a (second) best-case scenario - a benchmark.[22] We thus have the following corollary to Proposition 5.

Corollary 3 Inefficiency of the Equilibrium Status Concerns

[20]Note that this is a result of (weakly) decreasing returns to scale in production and convex effort costs. When the production technology displays increasing returns to scale, these results may not hold.

[21]We can see that marginal cost of effort is $k_i e_i$ and the "true" or "real" marginal benefit is β_i. In the presence of status concerns, the marginal benefit is $\beta_i + \delta_i$. Status concerns thus drive a wedge between marginal benefit and cost, thus causing an inefficiency.

[22]If the principal were forced to offer contracts of the form $w_i = \alpha_i + \beta_i q_i$, i.e., if he were forced to choose $\gamma_1 = \gamma_2 = 0$, then the efficient status concerns are unequal and non-zero. In this case, status concerns have some social value and serve as substitutes for relative compensation schemes. However, firms have the freedom to design their compensation schemes and γ_1 and γ_2 allow the firms to counter the effects of status on surplus extraction. Also, from the solution to the principal's problem above, we can see that the principal prefers to choose $\gamma_1, \gamma_2 \neq 0$. We thus assume that the principal is allowed the use of relative compensation schemes.

With a diverse workforce, non-trivial status concerns are inefficient; in general, they reduce total surplus generated within the firm relative to the standard moral-hazard model.

In this simple model, we can calculate the differences from the benchmark model explicitly. Material surplus is lower in equilibrium than in the benchmark case,

$$MS - MS^B = \frac{-2[k_1\sigma_1^2\psi_2 - k_2\sigma_2^2\psi_1]^2}{9k_1k_2\psi_1\psi_2[k_1\sigma_1^2\psi_2 + k_2\sigma_2^2\psi_1]} < 0.$$

A lower total surplus combined with positive shares for both agents ($MA_i > 0$) automatically implies that the firm's share of the surplus, i.e., its profit is reduced. The firm's profit is lower in equilibrium relative to its benchmark profit, i.e., the profit that it would have earned with atomistic agents. In this simple model, we can also explicitly calculate the difference in firm profit,

$$CEP - CEP^B = \frac{-4[k_1\sigma_1^2\psi_2 - k_2\sigma_2^2\psi_1]^2}{9k_1k_2\psi_1\psi_2[k_1\sigma_1^2\psi_2 + k_2\sigma_2^2\psi_1]} < 0.$$

Propositions 2 through 4 say that the material utilities of agents are increasing in the difference in the agents' characteristics. Combined with Proposition 5, this implies that as the difference in agent characteristics increases, a greater share of the already reduced surplus is transferred to the agents, i.e., the firm's share of the surplus is decreasing in the difference in agent characteristics. The principal's loss due to surplus transfer is thus minimized when the difference in agent characteristics is minimized, i.e., when agents are identical in all respects.

Proposition 6 Effect of a Diverse Workforce on Firm Profits
(i) With a diverse workforce, agents' choices of status concerns, in general, strictly lower the firm's profit relative to the benchmark case.
(ii) The firm's share of the surplus is decreasing in workforce diversity.
(ii) If a firm could hire workers who are identical in all fundamental characteristics, i.e., $r_1 = r_2$, $k_1 = k_2$, and $\sigma_1^2 = \sigma_2^2$, then it can guarantee itself the entire surplus.

Part (i) of Proposition 6 implies that a firm can *never* gain from the relative social concerns (rivalry in Küpper and Sandner 2008) of its workers when the workers can choose the intensity of their rivalry. In particular, the firm cannot rely on the potential incentive properties of status to generate higher profits. The reasons for this result were already presented in the discussion in the previous section.

Parts (ii) and (iii) of Proposition 6 say that a sufficient condition for a firm to prevent any surplus transfer to the workers is that workers are identical in all respects. In this case, the equilibrium choices of status concerns of both agents are zero (see the expressions for the equilibrium status concerns). When workers are identical, the expected outputs of both agents are equal and thus their expected status payoffs are zero. Agents cannot reduce their behavior utility by their choices of status concerns and hence cannot force the principal to increase their material utilities. By hiring a homogeneous workforce, a firm can remove the possibility that agents can substitute explicit incentives for status, i.e., avoid being "exploited" by its workers.

Based on Proposition 6, it is tempting to conclude that a firm would do well to, if it could, hire identical agents. However, the earlier results only make statements about the loss due to surplus transfer to its workers. Hiring identical agents may *not* be the best solution from the point of view of maximizing profit. Hiring identical agents who are both extremely risk-averse or both have high effort costs leads to a decrease in productive effort and/or an increase in the wage payments. While the principal keeps the entire surplus, his profits are, however, reduced. Thus, in making hiring decisions, the firm must tradeoff the reduction in profit due to surplus extraction with the reduction in profit due to higher wage payments. It is thus possible that a firm might still prefer to hire a diverse workforce even if it leads to surplus extraction. The next result characterizes the condition under which a firm would prefer a homogeneous workforce to a diverse one.

To keep things simple, for the rest of the paper, we assume that agents can differ in only one respect - the cost of effort k. Thus, $r_1 = r_2 = r$ and $\sigma_1^2 = \sigma_2^2 = \sigma^2$. We also assume that $k \in \{k_1, k_2\}$ and, without loss of generality, $k_1 > k_2$, i.e., there are only two types of workers. Once again, we assume that $\sigma_{12} = 0$ since correlation in production plays no role in the analysis. The equilibrium profit with a diverse workforce is

$$CEP_D = \frac{k_1^2 r\sigma^2(2 + k_1 r\sigma^2) + 34k_1k_2(1 + k_2 r\sigma^2) + k_2^2(1 + k_2 r\sigma^2)^2 + k_1^2[1 + 34k_2 r\sigma^2(1 + k_2 r\sigma^2)]}{18k_1k_2(1 + k_1 r\sigma^2)(1 + k_2 r\sigma^2)[k_1(1 + k_1 r\sigma^2) + k_2(1 + k_2 r\sigma^2)]} > 0, \tag{20}$$

while the equilibrium profit (also equal to the benchmark profit) with a homogeneous workforce is

$$CEP_H = \frac{1}{k(1 + kr\sigma^2)} > 0. \tag{21}$$

where k is the cost of effort of both agents. The tradeoff mentioned above is clear from the fact that the above expression is decreasing in k. It is a well-known result in agency theory that the higher an agent's effort cost, the higher the wage payment required to induce participation and, hence, lower the firm's profit.

Proposition 7 Firm's Preference for Workforce Diversity
A firm would prefer to hire a homogeneous work force if and only if it could hire the more able workers, i.e., iff $k = k_2$.

This result is intuitive and is a result of the tradeoff mentioned above. When $k = k_1$, the reduced share of the total surplus with a diverse workforce is still greater than the entire surplus generated with a homogeneous workforce. However, when $k = k_2$, the total surplus is greater than the total surplus generated with a diverse workforce. Note that this result depends only on the assumption that there is a difference between k_1 and k_2 and does *not* depend on the magnitude of the difference.[23]

[23] The results are the same if we allow agents to differ in a characteristic other than the cost of effort. The important thing is that we can only allow agents to differ in one respect to be able to make any meaningful statements. In all cases, the firm prefers a homogeneous workforce if and only if it is able to hire both agents who are of the "strong" type.

While it is not surprising that firms prefer workers of high ability, this result merely points out that firms must make hiring decisions based on agents' *fundamental* characteristics, i.e., their risk-aversion, cost of effort and the variability of their production processes. Endogeneity of status concerns implies that a firm's decision to hire a homogeneous or diverse workforce cannot be based on the agents' concerns for status themselves, as in Fershtman et. al. (2006) and Küpper and Sandner (2008).

5 Conclusion

The model presented in this paper provides an explanation for the development of status concerns by workers in a firm. In the context of a simple static linear principal-agent model, this model shows that it is individually rational for agents to develop and exhibit relative concerns for status even in a static interaction where common knowledge can be expected to hold. By their choices of social concerns, agents are able to transfer surplus from the firm to themselves. As a result, the firm's profit is lowered relative to the benchmark model with atomistic agents. Surprisingly, we find that it is the firm that is "exploited" by the agents in the presence of status concerns.

The agents' choices of status concerns are influenced by their relative strengths and weaknesses (vis-à-vis each other) and by environmental factors. The "weaker" agent finds it in his interest to display competitive relative concerns while the "stronger" agent finds it rational to display pro-social relative concerns similar to altruism. The weaker agent is able to extract a contract that offers a "significantly" higher wage payment while the stronger agent is able to extract a contract that calls for "significantly" lower effort. By doing so, agents are able to extract surplus from the principal, thus increasing their material utilities. The model in this paper therefore provides theoretical support for Levine's (1998) conclusion that agents care about who they interact with.

The model generates realistic predictions about human behavior that are in line with what we generally observe in human society. We would expect a person to feel pro-social concerns towards those who are less able than himself or those who work in a more uncertain environment than himself. We would also expect a person to compete more vigorously with those he considers more able than himself. It is thus possible that a similar model can explain human behavior in other contexts where relative performance might matter. However, by only looking at local status, the model abstracts away from agents' choices of reference groups, an avenue that we intend to pursue in further work.

A Appendix: Proofs

Proof of Proposition 1:

(i) To begin with, we ignore the constraint that the principal's expected profit is non-negative and verify that it is satisfied in equilibrium. Since the contract is chosen so that the IR constraints bind, the equilibrium status concerns solve the following problems:

$$\max_{\{\delta_1 \in \mathbb{R}\}} MA_1 = -\delta_1(e_1 - e_2) = -\delta_1 \left(\frac{(1+\delta_1-\delta_2)\sigma_2^2}{k_1\psi_2} - \frac{(1-\delta_1+\delta_2)\sigma_1^2}{k_2\psi_1} \right)$$

$$\max_{\{\delta_2 \in \mathbb{R}\}} MA_2 = -\delta_2(e_2 - e_1) = -\delta_2 \left(\frac{(1-\delta_1+\delta_2)\sigma_1^2}{k_2\psi_1} - \frac{(1+\delta_1-\delta_2)\sigma_2^2}{k_1\psi_2} \right)$$

MA_i is strictly concave in δ_i and we have a unique interior equilibrium. Solving the two FOC simultaneously, we have

$$\delta_1 = \frac{k_1\sigma_1^2\psi_2 - k_2\sigma_2^2\psi_1}{3\left[k_1\sigma_1^2\psi_2 + k_2\sigma_2^2\psi_1\right]} \quad \text{and} \quad \delta_2 = \frac{-k_1\sigma_1^2\psi_2 + k_2\sigma_2^2\psi_1}{3\left[k_1\sigma_1^2\psi_2 + k_2\sigma_2^2\psi_1\right]}. \tag{A.1}$$

At the equilibrium, e_1, e_2 and $CEP > 0$ and, as we would expect, the material utilities of both agents are positive:

$$MA_1 = MA_2 = \frac{[k_1\sigma_1^2\psi_2 - k_2\sigma_2^2\psi_1]^2}{9k_1k_2\psi_1\psi_2[k_1\sigma_1^2\psi_2 + k_2\sigma_2^2\psi_1]} > 0 \quad (= MA_1^B = MA_2^B).$$

This is important since if agent k received negative material utility, he would choose $\delta_k = 0$ which would guarantee him zero material utility. Since $CEP > 0$ in equilibrium, we have a principal-agent relationship. Thus, the profit constraint is non-binding in equilibrium, i.e., the principal's profit constraint is non-binding in equilibrium. Assumption 1 guarantees that $\beta_1, \beta_2 > 0$ in equilibrium. Unless $k_1\sigma_1^2\psi_2 - k_2\sigma_2^2\psi_1 = 0$, we have $\delta_1 \neq \delta_2 \neq 0$. Thus, in general, agents *choose* to display unequal and non-zero status concerns.

(ii) Further, we have $\delta_1 = -\delta_2$ ($\Rightarrow MA_1 = MA_2$). ∎

Proof of Proposition 2:

(i) From the above expressions, we can see that

$$\delta_i > (<) 0 \quad \Leftrightarrow \quad \sigma_i^2 > (<) \sigma_j^2.$$

(ii) Since $\delta_1 = -\delta_2$, we focus, without loss of generality on δ_1.

$$\frac{\partial \delta_1}{\partial \sigma_1} = \frac{4kr\sigma_1(1+kr\sigma_2^2)}{3[2+kr(\sigma_1^2+\sigma_2^2)]^2} > 0 \quad \Rightarrow \frac{\partial \delta_2}{\partial \sigma_1} < 0 \quad \text{and}$$

$$\frac{\partial \delta_1}{\partial \sigma_2} = \frac{-kr\sigma_2^2(1+kr\sigma_1^2)}{3[2+kr(\sigma_1^2+\sigma_2^2)]^2} < 0 \Rightarrow \frac{\partial \delta_2}{\partial \sigma_2} > 0.$$

(iii) Recall that, at equilibrium, $MA_1 = MA_2$. Hence, we state the comparative statics in terms of MA_1. In this case, $MA_1 = \frac{kr^2(\sigma_1^2-\sigma_2^2)^2}{9(1+kr\sigma_1^2)(1+kr\sigma_2^2)[2+kr(\sigma_1^2+\sigma_2^2)]}$ and

$$sign\left(\frac{\partial MA_1}{\partial \sigma_1}\right) = sign(\sigma_1^2 - \sigma_2^2) \quad \text{and}$$

$$sign\left(\frac{\partial MA_1}{\partial \sigma_2}\right) = -sign(\sigma_1^2 - \sigma_2^2).$$

If $\sigma_1^2 - \sigma_2^2 > 0$, an increase in σ_1 or a decrease in σ_2 imply that there is an increase in the difference between the production uncertainties of the two tasks. The above comparative statics then imply that there is an increase in MA_1, and hence in MA_2. If $\sigma_1^2 - \sigma_2^2 < 0$, a decrease in σ_1 or an increase in σ_2 imply that there is an increase in the difference between the production uncertainties of the two tasks. Once again, the comparative statics imply that material utilities are increasing in the difference between the production uncertainties of the two tasks. ∎

Proof of Proposition 3:

(i) From the above expressions for δ_1 and δ_2, it is clear that

$$\delta_i > (<) 0 \quad \Leftrightarrow \quad r_i > (<) r_j.$$

(ii) Since $\delta_1 = -\delta_2$, we focus, without loss of generality on δ_1.

$$\begin{aligned} \frac{\partial \delta_1}{\partial r_1} &= \frac{2k\sigma^2(1+kr_2\sigma^2)}{3[2+k\sigma^2(r_1+r_2)]^2} > 0 \quad \Rightarrow \frac{\partial \delta_2}{\partial r_1} < 0 \quad \text{and} \\ \frac{\partial \delta_1}{\partial r_2} &= \frac{-2k\sigma^2(1+kr_1\sigma^2)}{3[2+k\sigma^2(r_1+r_2)]^2} < 0 \Rightarrow \frac{\partial \delta_2}{\partial r_2} > 0. \end{aligned}$$

(iii) Recall that, at equilibrium, $MA_1 = MA_2$. Hence, we state the comparative statics in terms of MA_1. In this case, $MA_1 = \frac{k\sigma^2(r_1-r_2)^2}{9(1+kr_1\sigma^2)(1+kr_2\sigma^2)[2+k\sigma^2(r_1+r_2)]}$ and

$$\begin{aligned} sign\left(\frac{\partial MA_1}{\partial r_1}\right) &= sign(r_1 - r_2) \quad \text{and} \\ sign\left(\frac{\partial MA_1}{\partial r_2}\right) &= -sign(r_1 - r_2). \end{aligned}$$

Using arguments similar to those used in the proof of Proposition 2, the comparative statics imply that material utilities are increasing in the difference between the coefficients of risk-aversion of the two agents. ∎

Proof of Proposition 4:

(i) From the above expressions for δ_i and δ_j, it is clear that

$$\delta_i > (<) 0 \quad \Leftrightarrow \quad k_i > (<) k_j.$$

(ii) Since $\delta_1 = -\delta_2$, we focus, without loss of generality on δ_1.

$$\begin{aligned} \frac{\partial \delta_1}{\partial k_1} &= \frac{2k_2(1+2k_1r\sigma^2)(1+k_2r\sigma^2)}{3[(k_1+k_2)+r\sigma^2(k_1^2+k_2^2)]^2} > 0 \quad \Rightarrow \frac{\partial \delta_2}{\partial k_1} < 0 \quad \text{and} \\ \frac{\partial \delta_1}{\partial k_2} &= \frac{-2k_1(1+k_1r\sigma^2)(1+2k_2r\sigma^2)}{3[(k_1+k_2)+r\sigma^2(k_1^2+k_2^2)]^2} < 0 \quad \Rightarrow \frac{\partial \delta_2}{\partial k_2} > 0. \end{aligned}$$

(iii) Recall that, at equilibrium, $MA_1 = MA_2$. Hence, we state the comparative statics in terms of MA_1. In this case, $MA_1 = \frac{(k_1-k_2)^2[1+r\sigma^2(k_1+k_2)]^2}{9k_1k_2(1+k_1r\sigma^2)(1+k_2r\sigma^2)[(k_1+k_2)+r\sigma^2(k_1^2+k_2^2)]}$ and

$$\begin{aligned} sign\left(\frac{\partial MA_1}{\partial k_1}\right) &= sign(k_1 - k_2) \quad \text{and} \\ sign\left(\frac{\partial MA_1}{\partial k_2}\right) &= -sign(k_1 - k_2). \end{aligned}$$

Using arguments similar to those used in the proof of Proposition 2, the comparative statics imply that material utilities are increasing in the difference between the effort costs of the two agents. ∎

Proof of Proposition 5:

(i) The efficient concerns for status are those values of δ_1 and δ_2 that maximize the total *material* surplus. Under the present definition of status, material surplus (MS) is defined as follows

$$\begin{aligned} MS &= e_1 + e_2 - \frac{k_1e_1^2}{2} - \frac{r_1V_1}{2} - \frac{k_2e_2^2}{2} - \frac{r_2V_2}{2} \\ &= \frac{1}{2}\frac{(1-(\delta_1-\delta_2)^2)\left[k_1\sigma_1^2\psi_2 + k_2\sigma_2^2\psi_1\right]}{k_1k_2\psi_1\psi_2}. \end{aligned}$$

The first-order necessary conditions are

$$\frac{\partial MS}{\partial \delta_1} \leq 0 \quad \text{and} \quad \frac{\partial MS}{\partial \delta_2} \leq 0.$$

In this case, $\frac{\partial MS}{\partial \delta_1} = -\frac{\partial MS}{\partial \delta_2}$. So, the FOC imply $\frac{\partial MS}{\partial \delta_1} = -\frac{\partial MS}{\partial \delta_2} \leq 0$ and $\frac{\partial MS}{\partial \delta_2} \leq 0$, both of which can be satisfied only if $\frac{\partial MS}{\partial \delta_2} = 0 = -\frac{\partial MS}{\partial \delta_2}$. We now have one equation in two variables. Thus, we can only solve for δ_i in terms of δ_j. This gives

$$\delta_1 = \delta_2. \tag{A.2}$$

The above argument says that any candidate for a maximum must satisfy the above condition. The Hessian is always zero and we could have problems with local maxima. But, at a candidate solution, the material surplus is independent of status concerns:

$$MS = \frac{1}{2}\frac{\left[k_1\sigma_1^2\psi_2 + k_2\sigma_2^2\psi_1\right]}{k_1k_2\psi_1\psi_2}.$$

The material surplus at any local maximum is the same, thus implying that every candidate is a global maximizer. We thus have multiple global maxima given by $\delta_1 = \delta_2$.[24] [25]

However, when $\delta_1 = \delta_2 \neq 0$, $MA_1 = -MA_2 \neq 0$. This implies that one agent gets negative material utility at the efficient level of status concerns. From a *Pareto*-efficiency point of view, this is not acceptable; $MA_1 = MA_2 = 0$ in the benchmark model. Thus, the constrained Pareto-efficient status concerns are such that $\delta_i = \delta_2 = 0$.

(ii) When $\delta_1 = \delta_2 = 0$, we are back to the benchmark model with no status concerns. ∎

[24] We can put to rest any worries about a candidate being a global *minimum*. It is possible to find values of δ_1 and δ_2 that give negative values for MS, for instance $\delta_1 = -3$ and $\delta_2 = 0$.

[25] The above is just a "formal" mathematical argument. From even a cursory glance at MS, we can see that it is maximized when $\delta_1 = \delta_2$.

Proof of Proposition 7:

From the expressions for CEP_H and CEP_D, we have the following.
If $k = k_1$ (where k is the cost of effort of both agents in the homogeneous case),

$$sign(CEP_H - CEP_D) = sign(k_2 - k_1), \quad \text{and}$$

if $k = k_2$,

$$sign(CEP_H - CEP_D) = sign(k_1 - k_2).$$

Given the assumption that $k_1 > k_2$, the result follows. ∎

B Appendix: Benchmark Model with No Status Concerns

We present the results from the benchmark static moral-hazard model where agents do not have status concerns for purposes of comparison. The results from this model represent the second-best since there is an inefficiency due to moral hazard.

The benchmark model is one where $\delta_i = \delta_j = 0, i, j = 1, 2$. Absent status concerns, agent i's utility function is given by

$$U_A^i = -\exp\{-r_i(\alpha_i + \beta_i e_i + \gamma_i e_j - \frac{k_i e_i^2}{2} + (\beta_i \epsilon_i + \gamma_i \epsilon_j))\}$$

with associated certainty equivalent

$$CEA_i = \alpha_i + \beta_i e_i + \gamma_i e_j - \frac{k_i e_i^2}{2} - \frac{r_i}{2}(\beta_i^2 \sigma_i^2 + 2\beta_i \gamma_i \sigma_{12} + \gamma_i^2 \sigma_j^2), \quad i, j = 1, 2, \quad i \neq j.$$

Note that agent i's material utility is equal to his behavior utility. Agent i's problem is to maximize CEA_i with respect to e_i and effort choice is given by

$$e_i = \frac{\beta_i}{k_i}, \quad i = 1, 2.$$

Note that agent i's effort is increasing in incentives β_i.

The principal's problem is to maximize CEP (given by (9)) subject to the (binding) individual rationality (IR) and incentive compatibility (IC) constraints. The solution is

$$\beta_i^B = \frac{\sigma_j^2}{\psi_j} \in [0, 1] \quad \text{and} \quad \gamma_i^B = \frac{-\sigma_{12}}{\psi_j} \gtreqless 0 \Leftrightarrow \sigma_{12} \lesseqgtr 0,$$

where

$$\psi_i \equiv \sigma_i^2 + k_j r_j (\sigma_1^2 \sigma_2^2 - \sigma_{12}^2) > 0, \quad i, j = 1, 2, \ i \neq j. \tag{B.1}$$

At the solution, the effort levels are given by

$$e_1^B = \frac{\sigma_2^2}{k_1 \psi_2} > 0 \quad \text{and} \quad e_2^B = \frac{\sigma_1^2}{k_2 \psi_1} > 0, \tag{B.2}$$

and the wages received by the agents are given by

$$w_1^B = \frac{\sigma_2^2}{2k_1 \psi_2} > 0 \quad \text{and} \quad w_2^B = \frac{\sigma_1^2}{2k_2 \psi_1} > 0. \tag{B.3}$$

The total surplus at the equilibrium (equal to the firm's profit since the IR constraints bind) is given by

$$MS^B = \text{Profit}^B = CEP^B = \frac{1}{2}\frac{\left[k_1\sigma_1^2\psi_2 + k_2\sigma_2^2\psi_1\right]}{k_1k_2\psi_1\psi_2} > 0. \tag{B.4}$$

Note that in the benchmark model, the material payoff of an agent is equal to his behavior payoff. The binding IR constraint implies that the material utility of an agent is zero in the benchmark case, i.e., $MA_1^B = MA_2^B = 0$.

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