Inequity Aversion and Team Incentives*

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Abstract

We study optimal contracts in a simple model where employees are averse to inequity as modelled by Fehr and Schmidt (1999). A "selfish" employer can profitably exploit such preferences among its employees by offering contracts which create inequity off-equilibrium and thus, they would leave employees feeling *envy* or *guilt* when they do not meet the employer's demands. Such contracts resemble *team* and *relative performance* contracts, and thus we derive conditions under which it may be beneficial to form work teams of employees with distributional concerns who were previously working individually. Similar results are obtained for *status-seeking* and *efficiency concerns* preferences.

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1 Introduction

One of the most striking results from interview studies with firm managers and employees (Agell and Lundborg (1999), Blinder and Choi (1990), Campbell and Kamlani (1997)) is that employees report to care for the well being of their co-workers and not only for their own. In particular, employees compare co-workers' rewards and performance in the firm with their own. Bewley (1999) shows that 69% of firms' managers interviewed offer formal pay structures because they can create internal equity, which they believe employees care for. Asked why internal equity among employees is relevant for them, 78% of managers answered that it was important for morale and internal harmony and 49% responded that internal equity was key for job performance. Our aim is to capture how managers should structure reward schemes when their employees care for the distribution of payoffs among their co-workers in a simple model.

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We discuss how contracts can exploit distributional preferences to the manager's advantage. Our main result is that a "selfish" principal can devise schemes which exploit agents' preference for equity by offering them more equitable outcomes when managers' demands are met than when they are not. The reason is that equity affects the employees' incentives to work hard and thus, it affects job performance. Following Holmström and Milgrom's (1991) seminal paper, optimal contracts must account for everything employees care about. When agents care for equity the principal has two instruments at its disposal: monetary rewards and equity. By offering bonuses which generate more equity when employees perform the effort level desired by the manager than when they do not, the manager does not need to pay as high monetary incentives for employees to meet its demands and thus, he can elicit the desired effort levels paying lower bonuses than would have been possible had the agents not been inequity averse. Finally, because it may be relatively cheaper to provide incentives for agents to work hard in joint projects, it may be optimal to form work teams.

Distributional preferences and fairness considerations are one of the most frequent explanations of subjects' behaviour in a wide variety of experiments.[1] In prominent experimental work, Fehr and Schmidt (2000) have argued that fairness lead principals to write incomplete contracts which implement less severe incentives than conventional theory would predict. We develop a simple model in which a principal has to design a reward scheme for two agents who dislike inequity in the way envisaged by Fehr and Schmidt. However, the principal in our model is not distributional concerned and agents do not care for the principal's welfare, but only for the other agents' and their own. It seems natural to assume that welfare comparisons are enhanced by how close the interaction between agents is and that employees at the same hierarchical level interact more closely among themselves than with their superiors. Additionally, employees performing similar tasks have better information about each agents' cost of effort and find it easier to learn about co-workers' rewards than those of their superiors, making welfare comparisons more accessible. Finally, sociologists have argued that individuals rarely have altruistic feelings for others that have direct authority over their actions.[2] Thus, utility comparisons seem more meaningful among employees on the same hierarchical level than on different levels.[3]

We have chosen the Fehr and Schmidt (1999) utility function as a reduced form of social preferences due to its prominence and simplicity, although we later discuss *status seeking* and *efficiency concerns* preferences.[4] Notice that we do not discuss more complicated forms of social preferences which include reciprocal behaviour and intentions.[5] These preferences could play a role if we studied repeated interactions in the context of the firm. However, it would be crucial to study the reaction by agents to threats of inequity by the principal, which in turn may imply that employees would care for the

[1] See, for example, Blount and Bazerman (1996), Fehr and Schmidt (1999) and Engelmann and Strobel (2004).

[2] See Homans (1950) and Festinger (1954) for a summary.

[3] Dufwenberg and Kirchsteiger (2000) express doubts on which variables would be used to compare employees and employer's utilities. They wonder how meaningful is to compare employees' salaries with firm's profits or stock value.

[4] With simple parameter transformations we can obtain similar results for other types of distributional preferences which might be relevant in the workplace. In particular, our qualtative results would hold for the models proposed by Bolton and Ockenfels (2000), Bazerman, Loewenstein and Thompson (1989), Andreoni and Miller (1998), Cox and Friedman (2002), and the model without intentions by Charness and Rabin (2002).

[5] For good surveys on social preferences see Sobel (2000) and Fehr and Schmidt (2002b).

intentions signalled by the employer, from which we want to abstract.

Our model is very stylized. First, we focus on incentive compatibility, not on participation. We mainly discuss the case in which the participation constraint does not bind and thus both agents work for the firm, possibly for a minimum wage. In particular, we show that the Principal benefits from inequity aversion when agents have a higher reservation utility than in any possible outside option. Although we discuss the effects of changes in the value of this reservation utility, there are interesting cases in which the utility of working in a firm may be sufficiently higher than in any outside option: search costs of finding a different job, good matching with employers, specific human capital, disutility of unemployment or, as already said, the existence of minimum wages. We thus favour one of the possible interpretations of our model as showing how optimal bonuses to provide incentives for employees to perform an extra level of effort should be designed when employees, who work in the firm for a minimum wage, are inequity averse. Grund and Sliwka (2005) and Demougin and Fluet (2003) have further studied the effect of the participation constraint in tournaments among inequity averse agents. Agell (2004) reports inequity aversion effects among employees already working in real firms.

Second, we do not consider an uncertain production environment. In our model output is deterministic and informative about the effort level performed by each agent. We want to show how inequity aversion in itself changes the optimal contract, without adding uncertainty. In a paper independently written at the same time as this one, Itoh (2004) uses a model where output is uncertain and shows that inequity aversion calls for optimal contracts to specify both agents' rewards under all possible circumstances, which also occurs in our model. However, Itoh's mechanism is different from ours. In his model, each agent undertakes a different project and the principal writes the contract such that both agents always perform high effort. More equal (or more unequal) rewards are used in Itoh's paper to compensate for the risk of one of the agents' projects failing. In our study, inequity aversion determines in itself whether it is optimal to ask each agent to perform high or low effort, as we isolate its effect from uncertainty. Thus, our model shows how inequity aversion can be a reason to form work teams. We also show how unequal rewards must be optimally offered off-equilibrium to maximize the cost-saving effect of inequity aversion. Once the pure effect of inequity aversion on contracts is understood, complementary approaches are emerging.[6]

The rest of the article is organized as follows. Section 2 describes the model. Section 3 characterizes the optimal contract when agents have standard preferences. Section 4 characterizes the optimal contract when agents are inequity averse, including a discussion on how participation constraints affect results. Section 5 discusses optimal contracts when distributional preferences take other forms, such as *status seeking* and *efficiency concerns*. Section 6 concludes. Proofs are in the Appendix.

[6] See Bartling and von Siemens (2004a,b), Cabrales et al. (2002), Dur and Glazer (2003), Englmaier and Wambach (2002), Huck and Rey-Biel (2006) and Masclet (2002).

2 The Model

There are a Principal and two agents $i, j \in \{1, 2\}$ with $i \neq j$. Agents who work for the Principal (in the firm) receive the same minimum wage equal to $\overline{w} > 0$, production is normalized to $\overline{K}$ and agents' cost of working in this firm is normalized to 0. However, Agents can be asked to perform an extra level of effort (work hard) or not (shirk). If both agents work hard, the extra level of production is normalized to 1 (joint extra production). If only agent i works hard, the extra level of production is q_i, where $0 < q_i < 1$ (individual production by agent i). If both agents shirk, the extra level of production is 0. This extra level of output is observable and the extra level of effort is verifiable and contractible. Alternatively, agents who are not in the firm have an outside option whose value is normalized to 0.

Each agent's cost of working hard is $c_i > 0$. The cost of shirking is 0. A complete contract specifies the rewards (bonuses) offered to both agents for all possible extra levels of output. In order to standardize notation, assume the principal offers bonuses $\{b_1, b_2\}$ to agents 1 and 2 respectively when both agents work hard, $\{b_1^1, b_2^1\}$ when only agent 1 works hard and $\{b_1^2, b_2^2\}$ when only agent 2 works hard. If both agents shirk, bonuses are zero.[7]

The structure of the game is as follows: the Principal offers bonuses for all possible production levels, agents decide whether to enter the firm and then they simultaneously decide whether to work hard or shirk. Once production is realized, promised bonuses for the output level obtained are paid. Following Ma et al. (1988) we look at the contract such that the implemented production level is the unique equilibrium of the game played by the agents.[8] As the game is 2x2, the contract that implements a unique equilibrium makes the game played by the agents dominance solvable.[9]

The Principal seeks to maximize its profit, that is, production ($\overline{K}$), plus the extra production minus rewards paid (bonuses plus minimum wages).[10] Given the minimum bonuses needed to be paid in equilibrium to implement each production level and the productivity parameters (q_i and c_i), the Principal designs the contract that implements the level of extra production which maximizes its profit. Two different specifications for the agents' utility functions will be considered in Sections 3 and 4.

The structure of the game is known by the principal and the agents and, in particular, they both know the bonuses offered, the extra production level each agent achieves if working hard individually and each agents' cost of performing the extra effort. Agents cannot communicate among themselves.

Assume the following.

[7] This is implied by assumptions (R1) and (R2) below.

[8] We do so in order to avoid the problem in Demski and Sappington (1984) that given an optimal contract there may exist another pair of equilibrium strategies whose outcome, from the agents' point of view, pareto dominates the equilibrium outcome which the principal wants to implement and thus, the contract may not implement the optimal output level.

[9] As we will see below, in all but one case, equilibrium uniqueness does not require to pay in equilibrium a higher sum of bonuses than required to obtain the optimal output level as one of the possible equilibria of the game played by the agents. Bonuses offered off-equilibrium, however, may differ depending on whether the equilibrium implemented is unique or not.

[10] We assume all production is sold at price equal to 1.

(C) *The sum of working agents' costs of extra effort is lower than the extra output produced.*

$$0 \leq c_i < q_i,$$

$$c_i + c_j < 1, \qquad \text{for } i, j \in \{1, 2\} \text{ with } i \neq j.$$

(R1) *Agents' Limited liability: Negative bonuses are not possible.*

$$b_i, b_i^i, b_i^j \geq 0, \qquad \text{for } i, j \in \{1, 2\} \text{ with } i \neq j.$$

(R2) *Bonuses are paid from the extra output produced.*

$$\begin{aligned} b_i + b_j &\leq 1, \\ b_i^i + b_j^i &\leq q_i, \quad \text{for } i, j \in \{1, 2\} \text{ with } i \neq j. \end{aligned}$$

(R3) *The Principal wants both agents to work in the firm.*

$$\overline{K} \geq 2\overline{w},$$

Assumption (C) implies that there always exists a surplus above the cost of effort performed. Assumption (R1) implies that "bonuses are bonuses", that is, there exists limited liability constraints restricting how much the principal can monetarily punish agents for not performing the extra effort required. Assumption (R2) is a budget constraint for the Principal, established at those levels for simplicity. Limited liability and budgetary constraints are important for the offers of the Principal to be credible. Notice that (R1) and (R2) should also be satisfied off the equilibrium of the game played by the agents.[11] Assumption (R3) ensures that the Principal is interested in hiring the two agents.

3 Optimal contract with standard agents

In this section we derive the optimal contract when agents are standard. Standard agents maximize their utility which equals the minimum wage ($\overline{w}$), plus their "direct utility" from the extra cost of effort, which equals the bonus they are offered minus the cost of the extra effort they may perform.

We first solve for the optimal contract necessary to implement each extra level of production and then, given the optimal bonuses, we derive conditions for each production level to be optimal. Although the solution of this problem is straightforward, we solve it here as reference for the following section.

3.1 Individual extra production with standard agents

The problem is the following:

[11] As it will be clear below, we impose budget constraints off-equilibrium to show the interesting interplay between creating inequity off-equilibrium via *envy* or *guilt*. Without budget constraints, the Principal could offer infinite bonuses to one agent off-equilibrium, maximizing the other agent's *envy* when not performing the optimal extra production level.

-The principal maximizes its profit:

$$Max\ \ \overline{K} + q_i - b_i^i - b_j^i - 2\overline{w}$$

subject to:

- Assumptions (R1) and (R2).
- In equilibrium, agents prefer to work in the firm than taking the outside option:

$$\begin{aligned} \overline{w} + b_i^i - c_i &> 0, \\ \overline{w} + b_i^j &> 0, \qquad \text{for } i, j = 1, 2, i \neq j. \end{aligned}$$

- Agent i prefers to work hard when agent j shirks: $b_i^i - c_i \geq 0$.
- Agent j prefers not to work hard when agent i works: $b_j^i \geq b_j - c_j$.

For the game to have a unique equilibrium with the lowest total reward cost paid by the principal, the following constraints are also necessary:

- Agent j strictly prefers to shirk when agent i works hard: $b_j^i > b_j - c_j$.
- Agent i strictly prefers to work hard when agent j works hard: $b_i - c_i > b_i^j$.
- Agent j strictly prefers to work hard when agent i shirks: $b_j^j - c_j > 0$.

The objective function and the restrictions are linear. Thus, the solution is straightforward:

$$\begin{array}{ll} b_i \in (c_i, 1 - b_j] & b_j \in [0, c_j), \\ b_i^i = c_i & b_j^i = 0, \\ b_i^j \in [0, b_i - c_i) & b_j^j \in [c_j, q_j - b_i^j) \ \text{ for } i, j \in \{1, 2\} \text{ with } i \neq j. \end{array}$$

The optimal contract is such that in equilibrium, the agent who individually works hard is exactly compensated for its cost of effort ($b_i^i = c_i$) while the agent shirking is paid no bonus ($b_j^i = 0$). The principal's profit in the unique equilibrium of the game is then equal to $\overline{K} + q_i - c_i - 2\overline{w}$. Off-equilibrium bonuses do not affect the principal's profits and thus, they can take any value in the intervals shown.

3.2 Joint extra production with standard agents

We here find the optimal contract to implement joint extra production as the unique equilibrium of the game played by the agents. The problem is the following:

-The principal maximizes its profit:

$$Max\ \overline{K} + 1 - b_1 - b_2 - 2\overline{w}$$

subject to:

- Assumptions (R1) and (R2).
- In equilibrium, agents prefer to work in the firm than taking the outside option:

$$\overline{w} + b_i - c_i > 0, \ \text{ for } i, j = 1, 2, i \neq j.$$

- Both agents prefer to work hard when the other agent works hard:[12]

$$b_i - c_i \geq b_i^j \text{ for } i, j = 1, 2, i \neq j.$$

For the game to have a unique equilibrium with the lowest total reward cost paid by the principal, the following constraints are also necessary:

- Let $b_i - c_i > b_i^j$ and $b_j - c_j \geq b_j^i$ then $b_i^i - c_i < 0$ and $b_j^j - c_j > 0$.

Again, the objective function and the restrictions are linear so the solution is straightforward:

$$\begin{array}{ll} b_i = c_i + \varepsilon & b_j = c_j, \\ b_i^i \in [0, c_i) & b_j^i = 0, \\ b_i^j = 0 & b_j^j \in (c_j, q_j], \quad \text{for } i, j = 1, 2, i \neq j. \end{array}$$

For joint extra production to be the unique equilibrium, it is necessary to add a negligible positive quantity $\varepsilon \to 0$ to one of the agents' equilibrium bonuses. As it happened with individual production, in an equilibrium with joint extra production agents are exactly compensated for their cost of extra effort.[13] [14] The principal's profits in the unique equilibrium of the game are equal to $\overline{K}+1-c_1-c_2-2\overline{w}$.

3.3 Optimal production level with standard agents

Given that in equilibrium agents are paid a bonus exactly equal to their cost of extra effort when they work hard, the principal decides the optimal production level by comparing its profits when joint extra effort is implemented ($\overline{K} + 1 - c_1 - c_2 - 2\overline{w}$) with its profits when individual extra effort by the agent with highest productivity net of its cost is implemented ($\overline{K} + q_i - c_i - 2\overline{w}$ for $q_i - c_i \geq q_j - c_j$ and $i, j = 1, 2, i \neq j$). The conditions for each extra level of production to be optimal for $i, j = 1, 2, i \neq j$, are:

- Individual extra effort by agent i if and only if $q_i - c_i \geq q_j - c_j$ and $q_i \geq 1 - c_j$,
- Individual extra effort by agent j if and only if $q_i - c_i < q_j - c_j$ and $q_j \geq 1 - c_i$,
- Joint extra effort if and only if $q_i < 1 - c_j$ and $q_j < 1 - c_i$.

4 Optimal contract with inequity averse agents

We follow Fehr and Schmidt's (1999) model of inequity aversion by adapting their utility function to our context with two agents. Inequity averse agents' utility function is U_i^{FS} where:

$$U_i^{FS} = \overline{w} + U_i - \alpha \max\left[U_j - U_i, 0\right] - \beta \max\left[U_i - U_j, 0\right] \quad \text{ for } \ i, j = 1, 2, \quad i \neq j,$$

[12] From here onwards, we take the minimum wage ($\overline{w}$) out of the incentive compatibility conditions of agents already working in the firm.

[13] We assume ε to be small enough such that profits and conditions for joint production to be optimal are not affected.

[14] Notice that the "most natural" contract, paying both agents a bonus equal to their extra cost of effort when they work hard and offering no bonus to an agent who shirks, does not implement a unique equilibrium in the subgame, as no extra production would also be an equilibrium.

where, as before, U_i is each agent's "direct utility" for the extra cost of effort and is equal to the bonus offered minus the cost of the extra effort performed.[15][16]

Assume the following:

(U1) *Agents dislike inequity:* $\alpha \geq 0$ and $\beta \geq 0$.

(U2) *Agents care more for their own direct utility than for inequity:* $\alpha < 1$ and $\beta \leq \frac{1}{2}$.

Assumption (U1) imposes inequity *aversion*. Agents derive disutility from direct utilities being unequal. In the following, α refers to *negative inequity aversion* or *envy* (dislike to being worse off than your peers), while β refers to *positive inequity aversion* or *guilt* (dislike to being better off than your peers). We assume that parameters α and β are the same among agents for simplicity.[17] Assumption (U2) implies that agents care more for their own direct utility than for the comparison with the other agent's direct utility. Fehr and Schmidt allow for $\alpha > 1$. We assume $\alpha \leq 1$ to show that even if inequity aversion is not dominant, its effects on the optimal contract design can still be substantial. Notice that $\beta \leq \frac{1}{2}$ is also necessary for inequity aversion not to be dominant. Otherwise, agents would be willing to transfer bonuses to the other agent ex-post. Additionally, Fehr and Schmidt impose $\beta \leq \alpha$, which we do not for generality.

In the following subsections we study how the principal can exploit this externality to its advantage. We proceed as before, first solving for the optimal contract for each extra level of production and then discussing the conditions for each extra level of production to be optimal.

The following two subsections are written under the assumption that the participation constraints hold, no matter how much disutility agents obtain from inequity. That is, we are assuming that the minimum wage ($\overline{w}$) is sufficiently high, such that agents prefer to work in this firm than taking the outside option. The section concludes with a discussion of the effects on optimal contract design of such restriction not being satisfied.

4.1 Individual extra production with inequity averse agents

Define ICC_i^{ind} for $i = 1, 2$ as the constraints that make individual extra effort by agent i incentive compatible and ICC_i^{indU} as the constraints required for individual extra effort to be the unique equilibrium of the game played by the agents. The problem is the following:

-The principal maximizes its profit:

$$Max\ \overline{K} + q_i - b_i^i - b_j^i - 2\overline{w}$$

[15] While Fehr and Schmidt's (1999) original formulation refers to agents comparing "payoffs", other authors using their preferences in our context assume that only rewards enter into welfare comparisons but not the costs of effort (Grund and Sliwka (2002), Itoh (2004)). Our qualitative results hold with this alternative specification although more interesting issues appear when effort costs enter the comparison. Ultimately, this is an empirical question that may be context dependent. A first experimental study of this issue is Königstein (2000) who confirms that welfare comparisons are context dependent.

[16] Minimum wages ($\overline{w}$) are cancellled in the comparison among agents as they are assumed to be equal.

[17] We focus on asymmetries in productivity parameters instead than on social preferences assuming that they are more easily observable and measurable.

subject to:

- Assumptions (R1), (R2).
- In equilibrium, agents prefer to work in the firm than taking the outside option.
- (ICC_i^{ind}): $b_i^i - c_i - \alpha \max[b_j^i - b_i^i + c_i, 0] - \beta \max[b_i^i - c_i - b_j^i, 0] \geq 0$.
- (ICC_j^{ind}): $b_j^i - \alpha \max[b_i^i - c_i - b_j^i, 0] - \beta \max[b_j^i - b_i^i + c_i, 0] \geq$
$b_j - c_j - \alpha \max[b_i - c_i - b_j + c_j, 0] - \beta \max[b_j - c_j - b_i + c_i, 0]$.

For the game to have a unique equilibrium with the lowest total sum of bonuses paid by the principal, the following constraints are also necessary:

- The inequality in condition (ICC_j^{ind}) is strict.
- (ICC_i^{indU}): $b_i - c_i - \alpha \max[b_j - c_j - b_i + c_i, 0] - \beta \max[b_i - c_i - b_j + c_j, 0] >$
$b_i^j - \alpha \max[b_j^j - c_j - b_i^j, 0] - \beta \max[b_i^j - b_j^j + c_j, 0]$.
- (ICC_j^{indU}): $b_j^j - c_j - \alpha \max[b_i^j - b_j^j + c_j, 0] - \beta \max[b_j^j - c_j - b_i^j, 0] > 0$.

We describe a property of the solution to this problem in the following *Proposition*.

Proposition 1 *To implement individual extra production when agents are inequity averse bonuses paid in the equilibrium of the game played by the agents are the same as with standard agents ($b_i^i = c_i$ and $b_j^i = 0$).*

Intuitively, the agent who individually performs the extra effort in the equilibrium of the game must prefer to work hard than shirk, given that the other agent is shirking. Due to budget constraints (R2), agents are not paid any bonus when they both shirk and thus, the utility of both agents when they both shirk is the same and equal to $\overline{w}$. Inequity generates disutility and because there is no inequity when both agents shirk, it is optimal not to create inequity when only one agent works hard ($b_i^i - c_i = b_j^i$). Given that bonuses cannot be negative (Assumption (R1)), the minimum bonuses needed to be paid such that agent i chooses to individually work hard are $b_i^i = c_i$ and $b_j^i = 0$ and there is no inequity in equilibrium. For the game to have a unique equilibrium, bonuses offered off-equilibrium, i.e., when both agents work hard or when agent j individually works hard need to satisfy the inequalities given by ICC_j^{ind}, ICC_i^{indU} and ICC_j^{indU}. The proof of *Proposition* 1 rewrites these conditions in a more compact form. Notice, as an example, that if off-equilibrium all agents were offered no bonus, i.e., $b_1 = b_2 = b_i^j = b_j^j = 0$, the equilibrium would not be unique. For the equilibrium to be unique under the lowest total cost of bonuses for the principal, it is necessary that working hard is a dominant strategy for the agent who individually works hard in equilibrium (agent i) and thus, ICC_i^{indU} needs to hold. It is also necessary that the agent who shirks in equilibrium (agent j) chooses to individually work hard when the other agent shirks and thus, ICC_j^{indU} is also required.

4.2 Joint extra production with inequity averse agents

Define ICC_i^{JP} as agent i's incentive compatibility constraint for team extra level of production to be an equilibrium of the game (not necessarily unique) and ICC_i^{JPU} as the constraints required for the equilibrium to be unique corresponding to agent $i = 1, 2$. The problem is the following:

-The principal maximizes its profit:

$$Max\ \overline{K} + 1 - b_i - b_j - 2\overline{w}$$

subject to:

- Assumptions (R1), (R2).
- In equilibrium, agents prefer to work in the firm than taking the outside option.
- (ICC_i^{JP}): $b_i - c_i - \alpha \max[b_j - c_j - b_i + c_i, 0] - \beta \max[b_i - c_i - b_j + c_j, 0] \geq$
  $b_i^j - \alpha \max[b_j^j - c_j - b_i^j] - \beta \max[b_i^j - b_j^j + c_j]$.

For the game to have a unique equilibrium with the lowest total sum of bonuses paid by the principal, the following constraints are also necessary:

- Let the inequality in (ICC_i^{JP}) for agent i be strict, while for agent j be weak.
  Then:
  (ICC_i^{JPU}): $b_i^i - c_i - \alpha \max[b_j^i - b_i^i + c_i, 0] - \beta \max[b_i^i - c_i - b_j^i, 0] < 0$,
  (ICC_j^{JPU}): $b_j^j - c_j - \alpha \max[b_i^j - b_j^j + c_j, 0] - \beta \max[b_j^j - c_j - b_i^j, 0] > 0$.

We solve this problem in *Proposition* 4. First, *Propositions* 2 and 3 state general results that describe the worst possible punishment for each agent when they shirk. By punishing agents when they shirk, agents' ICC_i^{JP}s are relaxed and bonuses paid in equilibrium can be low.

Proposition 2 *To generate the worst possible punishment to an inequity averse agent who shirks, it is optimal to offer no bonus to the agent who shirks while the other agent individually works hard ($b_i^j = 0$).*

The intuition behind this result is that due to limited liability (R1), bonuses offered cannot be negative, and due to (U2) agents care more for their direct utility than for the comparison with the other agent, thus the disutility of an agent shirking is maximized when he is offered no bonus.

Proposition 3 *To generate the worst possible punishment to an inequity averse agent who shirks, it is optimal to offer extreme bonuses to the agent who individually works hard (agent i). If the potential effect of envy on the shirking agent (j) is relatively high ($\alpha(q_i - c_i) \geq \beta c_i$), agent i must be offered all the extra output when he individually works hard ($b_i^i = q_i$). If, in contrast, the potential effect of guilt is relatively high ($\alpha(q_i - c_i) < \beta c_i$), agent i must be offered no bonus when he individually works hard ($b_i^i = 0$).*

Agent j derives disutility both from *envy* and *guilt,* but not from both at the same time. The punishment from *envy* is maximized when the other agent is offered all available extra output ($b_i^i = q_i$), and thus the maximum disutility generated by *envy* is equal to $\alpha(q_i - c_i)$. The punishment from *guilt* is maximized when the other agent is not offered any bonus when he performs the costly extra effort *($b_i^i = 0$).* Thus the maximum disutility generated by *guilt* equals βc_i. Therefore, the relevant comparison is $\alpha(q_i - c_i) \gtreqless \beta c_i$. Using *Propositions* 2 and 3 the *envious* agent j obtains minimum utility when he shirks and agent i works because not only he does not get any reward (by *Proposition* 2), but experiences the maximum feasible *envy* as agent i is paid the maximum available reward. On the other hand, the *guilty* agent j obtains minimum utility when he shirks because not only he is paid no bonus but he also experiences the maximum feasible *guilt* because agent i is performing a costly effort and is paid the lowest feasible bonus, which given (R1) is zero.

Notice that without budget constraints and limited liability, the potential to maximize the punishment from *envy* and *guilt* would be less limited. The principal could threat an agent who shirks by offering the other agent an even higher bonus when he individually works (to maximize *envy*) or offer a negative bonus, a penalty (to maximize *guilt*). As previously discussed, we have assumed (R1) and (R2) to restrict attention to limited and credible threats of inequity.

We finally look at the optimal contract to implement joint production. The following *Proposition* 4 shows the optimal bonuses for all levels of extra production when joint extra production is implemented as the unique equilibrium of the game.

Proposition 4 *To implement joint extra production when agents are inequity averse, the optimal contract is as follows:*

1. An agent who shirks is offered no bonus ($b_i^j = b_j^i = 0$).

2. Case a) If the maximum feasible punishment for both shirking agents is generated via envy ($\alpha(q_i - c_i) \geq \beta c_i$ for $i = 1, 2$), both agents are offered all available extra output when they individually work hard ($b_i^i = q_i$ and $b_j^j = q_j$).

Case b) If the maximum feasible punishment for one shirking agent (i) is generated via envy and for the other agent (agent j) is generated via guilt ($\alpha(q_j - c_j) \geq \beta c_j$ and $\alpha(q_i - c_i) < \beta c_i$ for $i, j = 1, 2,\ i \neq j$), then one agent is offered all available extra output when he individually works hard ($b_j^j = q_j$) while the other agent is offered no bonus when he individually works hard ($b_i^i = 0$).

Case c) If the maximum feasible punishment for both shirking agents is generated via guilt ($\alpha(q_i - c_i) < \beta c_i$ for $i = 1, 2$), then one agent is offered all available extra output when he individually works hard ($b_j^j = q_j$) while the other agent is offered no bonus when he individually works hard ($b_i^i = 0$). Which agent is offered all available extra output is determined by the relative maximum effect of guilt and envy for each agent.

3. Indifference between working hard and shirking when the other agent works hard determines the bonuses agents are paid in equilibrium (b_i and b_j), as long as bonuses are positive. Otherwise, agents are paid no bonus ($b_i = 0$ for $i = 1, 2$).

The intuition for this result is as follows. First, following *Proposition* 2 an agent who shirks when the other agent individually works hard is offered no reward ($b_i^j = b_j^i = 0$). This minimizes agents' direct utility when they shirk, providing more incentives for them to work hard. Second, the utility of a shirking agent can be further minimized by creating inequity through the reward offered to the agent who individually works hard. Following *Proposition* 3 the shirking agent obtains minimum utility when the agent who individually works hard is offered extreme bonuses, i.e., either all available extra output ($b_i^i = q_i$) or no bonus at all ($b_i^i = 0$). this is determined by whether $\alpha(q_i - c_i) \gtreqless \beta c_i$.

In cases *a)* and *b)* in *Proposition* 4, it is optimal to maximize the punishment to the shirking agent and thus, extreme bonuses are offered to the agent who individually works hard. In case *c)* it is not optimal to maximize the punishment to the shirking agent as the equilibrium of the game played by the agents would not be unique. Both agents shirking would also be an equilibrium in which the utility of both agents would pareto dominate the utility when they both work and thus, the principal would not be certain that such contract would implement joint production when it is optimal to do so. The expression for the bonuses paid in equilibrium in each of the three cases is shown in the proof of *Proposition* 4, although we here explain case *b)* graphically.

Case *b)* shows the optimal bonuses paid when it is optimal to exploit agent i's *envy* and agent j's *guilt*, and thus, it is optimal to offer all available extra output to agent j when he individually works hard ($b_j^j = q_j$) and no bonus to agent i when he individually works hard ($b_i^i = 0$). Equilibrium bonuses are obtained by equating the utility of each agent when both agents work hard to the utility of each agent when they shirk given that the other agent individually works hard. Indifference curves are drawn in Figure 1 below as combinations of b_i and b_j such that agents' utility when they both work hard is the same as when they shirk and the other agent individually works hard. The principal seeks to maximize profits and thus, chooses equilibrium bonuses such that both agents' choose to work hard (which occurs in the shaded area in Figure 1) and such that the sum of equilibrium bonuses is the minimum possible. Given the slopes of the indifference curves defined by (U1) and (U2), this occurs at the unique point at which both agents' indifference curves intersect. Figure 1 shows the case were $\alpha(q_j - c_j) \geq \beta c_i$ and thus, agent i suffers more from *envy* when he individually shirks than agent j suffers from *guilt* when he individually shirks. Therefore, equilibrium wages are on the left hand side of the 45^o line implying that in equilibrium agent i obtains less direct utility than agent j. A symmetric graph can be drawn for the case $\alpha(q_j - c_j) < \beta c_i$.

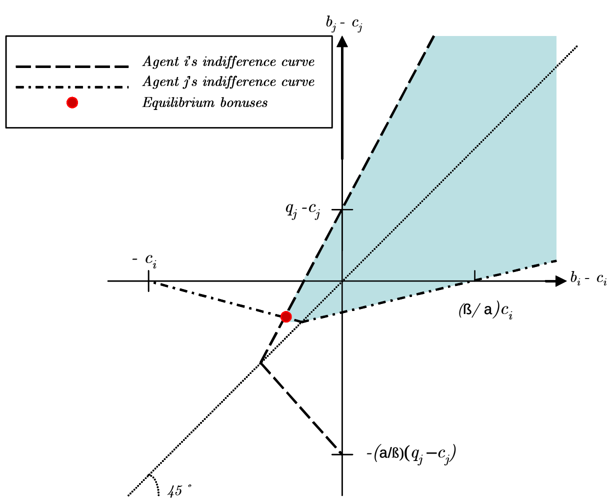

Figure 1: Equilibrium bonuses when *envy* dominates for agent i, *guilt* dominates for agent j and $\alpha(q_j - c_j) > \beta c_i$

Finally, using the results of *Proposition* 4 we conclude the following:

Corollary 1 *The principal obtains higher profits when implementing joint production with inequity averse agents than with standard ones.*

Intuitively, the principal could always implement joint production by exactly compensating both agents for their cost of effort when they work hard, and offering them no reward when they shirk. The reason is that in equilibrium, when both agents are exactly compensated for their costs of effort, there is no inequity and thus, utilities are the same as direct utilities. In particular, as we discuss below, this is what will happen when $\overline{w}$ is not high enough for the participation constraint to be satisfied. However, when $\overline{w}$ is sufficiently high, the principal can do better than exactly compensate agents' costs of extra effort. Following *Proposition*s 2 to 4 , the principal can generate inequity off the equilibrium of the game such that inequity averse agents' utilities are lower than standard agents' direct utilities. Thus, by paying agents a bonus lower than their cost of extra effort but maintaining more equity in equilibrium than off-equilibrium, joint production is optimally implemented at a lower total cost for the principal than with standard preferences.

Notice that each agents' equilibrium bonuses are not necessarily lower than in the standard case, but the sum of the two bonuses paid is. This does not mean that equity is maximized when joint extra production is implemented nor that bonuses paid in equilibrium are the same for both agents. Bonuses paid just need to be sufficiently close for both ICC_i^{JP}s to hold at the lowest total cost of bonuses in equilibrium for the principal.

4.3 Optimal production level with inequity averse agents

We here look at the conditions for each level of extra production to be optimal and, in particular we state the main result of this paper.

Proposition 5 *Inequity aversion may be in itself a reason to demand joint extra production by agents who compare themselves, even if the productivity of some agents is low.*

Notice that from previous results it is obvious that whenever the conditions for joint extra production to be optimal with standard agents are satisfied ($q_i < 1 - c_j$ for $i, j = 1, 2,\ i \neq j$) it is still optimal to implement joint extra production when agents are inequity averse. However, while the total sum of bonuses needed to be spent in equilibrium to implement individual production is the same with standard and inequity averse agents, from *Corollary* 1 the total sum needed to implement joint extra production may be lower with inequity averse agents. Thus, it is possible that under same values for the productivity parameters, it may be optimal to implement individual production by standard agents while it may be optimal to implement joint extra production with inequity averse agents. Obviously, changes of equilibrium implemented from individual production by one agent to individual production by the other agent are not possible. The proof of Proposition 5 in the Appendix shows the conditions under which each level of extra production are optimal.

Notice that our argument relies on welfare comparisons among all agents working in the firm. Therefore, our model should be interpreted as employees working in the firm who compare each others' welfare, no matter if they are asked to perform the extra level of effort or not. The design of optimal bonuses taking into account such welfare comparisons allows the Principal to decide whether it is preferable to demand an extra level of effort from an individual or from a group of agents. Our main result shows that even if due to strictly productive reasons it may not be desirable to ask unproductive agents to perform the extra level of effort, the fact that other agents doing the extra level of effort compare their welfare with that of the unproductive ones may be a reason in itself to demand extra levels of effort from both types of agents. This is due to the possibility of obtaining higher extra output at a lower cost in bonuses than when agents do not compare their welfare.

4.4 Effects of the Participation Constraint on Optimal Contracts

Up until now, we have assumed that the minimum wage ($\overline{w}$) when working in the firm was high enough such that in equilibrium agents preferred to be in the firm than taking the outside option. We have obtained however, that with inequity aversion agents in the firm may derive disutility from welfare comparisons with other agents in the firm and thus, if the minimum wage is not sufficiently high, they may prefer to quit the firm and take the outside option. Therefore, the exogenous value of the minimum wage limits the extend up to which inequity aversion can be exploited by the Principal to obtain and extra level of effort from both agents at a total sum of bonuses that may not cover each agents' individual cost of performing the extra level of effort.

We here look at the conditions on the participation constraints for the case when it is optimal to demand an extra level of effort from both agents. This is the most relevant one as it is the case where inequity aversion may change the optimal output decision by the Principal.

Assume that agent i shirks off-equilibrium and that $\alpha(q_j - c_j) \geq \beta c_j$ for $i \neq j$. Thus, due to incentive compatibility reasons it would be optimal to make agent i *envious* and offer all individual extra output to the agent who works hard off-equilibrium ($b_j^j = q_j$). However, given that it is still optimal to offer no reward to the shirking agent ($b_i^j = 0$), the participation constraint of the shirking agent will not hold when:

$$\overline{w} < \alpha(q_j - c_j).$$

In such cases, the maximum bonus that can be offered to agent j when individually doing the extra effort such that the participation constraint of the shirking agent holds is $b_j^j = \frac{\overline{w}}{\alpha} + c_j > 0$. Notice that this creates exact equality when agent i shirks and thus, the minimum bonus cost of providing incentives to agent i to work hard, given that agent j also works hard would be the same as with standard agents. Alternatively, the Principal could make agent i feel *guilt* when shirking by setting $b_j^j = 0$. This creates inequity off-equilibrium and thus, the possibility of a lower bonus to provide incentives to agent i.However, $b_j^j = 0$, will only satisfy agent i's participation constraint for sufficiently high $\overline{w}$,in particular for $\overline{w} > \beta c_j$. Otherwise, the Principal must set $b_j^j = c_j$ and as there is no inequity when only agent i shirks, $b_i = c_i$. Thus, for low enough $\overline{w}$, inequity aversion does not decrease the cost of implementing joint extra effort by agent i.

Assume now that agent i shirks off-equilibrium but that $\alpha(q_j - c_j) < \beta c_j$ for $i \neq j$. It is still optimal to offer no reward to the shirking agent ($b_i^j = 0$). Thus, due to incentive compatibility reasons it would be optimal to make agent feel i *guilty* and offer no bonus to the agent who works hard off-equilibrium ($b_j^j = 0$). Notice that if $b_j^j = 0$, agent j's participation constraint would not hold unless $\overline{w} \geq (1+\alpha)c_j$. This is not important since participation constraints only need to hold in the implemented equilibrium (joint extra production) and, given the incentive compatibility constraints, also for the agent who shirks off-equilibrium (i) but not for the agent who individually works off-equilibrium (j).[18] But when $b_j^j = 0$ the participation constraint of agent shirking off-equilibrium only holds for sufficiently high $\overline{w}$,in particular for $\overline{w} > \beta c_j$. Otherwise, the Principal must set $b_j^j = c_j$ and as there is no inequity when only agent i shirks, $b_i = c_i$. Thus, equivalently, for low enough $\overline{w}$, inequity aversion does not decrease the cost of implementing joint extra effort by agent i.

Ultimately, for a low enough $\overline{w}$, and in particular, for $\overline{w} \leq \beta c_j$, it may not be possible to create inequity off-equilibrium ($b_j^j = c_j$ and $b_i^j = 0$), and the joint extra level of effort will be implemented by paying exactly the same bonuses as when agents are not inequity averse. In that case, inequity averse agents will be paid a bonus equal to their cost of effort when they work hard, and there will be no inequity in equilibrium. Therefore, the extent to which agents derive utility when working in the firm for a minimum wage, either because of a minimum wage or other reasons, determines, together with their degree of inequity aversion and their productivity parameters, the extent up to which distributional preferences can be exploited by the Principal.

Finally, notice that when normalizing the value of the outside option to zero, we are implicitly assuming that the extent to which agents suffer from utility comparisons when taking the outside option is more limited than inside the firm. However, it is still very plausible that agents would suffer from utility comparisons outside the firm. For example, they may feel *guilty* for leaving other agents behind, or they may be employed in a different firm in which distributional concerns are equally exploited. In such cases, the value of the outside option would be lower with respect to the firm, opening again the possibility of exploiting inequity aversion inside the firm.

5 Status and Efficiency seeking Preferences

It can be argued that in some contexts, other types of distributional preferences might be more relevant than inequity aversion. In particular, in very competitive firms, agents might not dislike inequity but instead they might enjoy it, at least as long as it is the other agent who is worse off than them. Such agents will not feel *guilt* but *spite* when being better off than their peers, while they will still feel *envious* when being worse off. We call these agents "Status Seeking", interpreting having higher status as being higher in the ranking of agents' welfare, i.e., as being better off than other agents.

In other contexts in which each agent contributes a lot to total production, agents might feel disutility when shirking because the total amount of extra output, and thus, the total amount of bonuses available to be distributed among agents, gets smaller when they shirk. We call these agents

[18] Although when $b_j^j = 0$ and $b_j^j = 0$ joint extra production may not be an unique equilibrium, as both agents will prefer to shirk given that the other agent is shirking. This the same problem that arises in *Case c)* of *Proposition 4*.

"Efficiency Seeking", interpreting efficiency as the sum of agents' welfare net of the costs of the extra level of effort.[19]

Following Charness and Rabin (2002), by simply changing the range of values parameters α and β in the Fehr and Schmidt utility function can take, it is possible to look at the array of possible purely distributional concerns in a unified model. We thus use a re-parametrization of the Fehr and Schmidt model to explore its consequences in optimal contract design.

5.1 Reward Design with Status Seeking Preferences

Assume now that $\alpha \in [0, 1)$, $\beta < 0$ and $|\beta| \leq 1$. This means that agents are still averse to disadvantageous inequity but like advantageous inequity. The following two *proposition*s cover the key issues of contract design when agents are status seeking, assuming one again that the participation constraint is satisfied.

Proposition 6 *To implement individual production when agents are status seeking, bonuses paid in the equilibrium of the game are the same as with standard agents ($b_i^i = c_i$ and $b_j^i = 0$).*

As it happened with inequity averse agents, the optimal contract to implement individual extra production implies paying the agent who individually works hard (i) a bonus exactly equal to its cost of performing extra effort (c_i) and paying no bonus to the shirking agent. The reason is that in the right hand side (RHS) of ICC_i^{ind} there is no production and thus, both agents are paid no bonus and no agent is ahead. One could argue that since agent i likes being better off than its peer, it would be easier to provide incentives for agent i to work hard by making him better off than agent j when agent i individually works. However, given that it is still optimal to pay no bonus to agent j when he shirks (due to (R1) the principal cannot pay him less), the only way to make agent i better off than agent j is by offering a bonus to agent i above its cost of performing the extra effort, which cannot be optimal.

We now look at the optimal contract to implement joint production.

Proposition 7 *To implement team production when agents are status seeking the sum of bonuses paid in equilibrium is lower than with standard agents. The optimal contract is as follows:*

$$\begin{array}{ll} b_i = c_i - \frac{\alpha^2(q_i-c_i)-\alpha(\beta-1)(q_j-c_j)}{\alpha+(1-\beta)} < c_i & b_j = c_j + \frac{\alpha\beta(q_j-c_j)-\alpha(1+\alpha)(q_i-c_i)}{\alpha+(1-\beta)} < c_j, \\ b_i^i = q_i & b_j^i = 0, \\ b_i^j = 0 & b_j^j = q_j, \qquad \textit{for} \;\; i,j = 1,2, i \neq j. \end{array}$$

Notice that to implement team production, the only way to use inequity off the equilibrium of the game is by generating disutility via *envy* on the agent who shirks, and thus it is optimal to offer no bonus to the agent who shirks and all individual output to the agent who individually works hard. The reason is that *spite* provides utility to the shirking agent, making its ICC_i^{JP} more difficult to

[19] In fact, Engelmann and Strobel (2004) find in a comparative test of distributional preferences that in the laboratory most data are better explained by efficiency concerns than by other distributional preferences such as inequity aversion.

hold. Rewards paid in the equilibrium of the game are defined by case *a)* in the proof of *Proposition* 4. Now things are even better for the principal. As agents like to be better off than each other, the bonus paid in equilibrium to the agent who is best off is lower than with inequity aversion. Notice that as in case *a)* in *Proposition* 4, the agent who suffers more from *envy* off-equilibrium is the one who will optimally be worse off in the equilibrium, i.e., if $q_j - c_j \geq q_i - ci$ then the optimal b_i and b_j are such that $b_j - c_j \geq b_i - c_i$. Finally, notice that with status seeking agents when team production is implemented, both agents are paid in equilibrium a bonus lower than their cost of effort.

Following results in section 4.3, the principal finds it optimal to implement team production when $q_i > 1 - c_j + \frac{\alpha(1-2\beta)(q_j-c_j)+\alpha(1+2\alpha)(q_i-c_i)}{\beta-1-\alpha}$ for $i, j = 1, 2$, $i \neq j$. Otherwise, the principal implements the individual extra level of production by the agent for which $q_i - c_i$ is highest.

5.2 Reward Design with Efficiency Seeking Preferences

Assume now that $\alpha < 0$, $\beta \in [0, 1/2)$, and $|\alpha| \leq |\beta|$. This implies that agents care for the weighted sum of direct utilities, putting more weight on each own's direct utility than on the other agent's direct utility. this leaves the possibility for the principal to exploit efficiency seeking preferences. The following two *Proposition*s cover the key issues of contract design when agents are efficiency seeking.

Proposition 8 *To optimally implement individual extra level of production when agents are efficiency seeking, the sum of bonuses paid in the equilibrium of the game is the same as with standard agents* ($b_i^i + b_j^i = c_i$)

Intuitively, the agent who individually works hard in equilibrium (agent i) must choose to work hard given that agent j shirks. When both agents shirk bonuses are zero and thus, agent i should obtain positive utility when working hard for its ICC_i^{ind} to hold. However, the only way to use that agent i is efficiency concerned to implement an equilibrium in which i individually works hard and paying a lower bonus than its cost of effort is by offering "more efficient bonuses". i.e., a total sum of bonuses that adds up to more than agent i's cost of performing the extra effort. This is a contradiction. Thus, individual extra level of production cannot be implemented with a total sum of bonuses paid in equilibrium lower than the cost of the extra effort of the agent who individually works hard. Notice that with efficiency seeking agents equilibrium bonuses are not necessarily equal to the cost of effort of the agent who individually works hard, although the sum of bonuses paid must be equal to it.

We now look at the optimal contract to implement the team extra level of production.

Proposition 9 *To optimally implement team production when agents are efficiency seeking the sum of bonuses paid in equilibrium is lower than with standard agents. The optimal contract is as follows:*

$$\begin{aligned}
&b_i = c_i + \tfrac{\beta^2}{\alpha+(1-\beta)} c_i > c_i && b_j = c_j - \tfrac{\beta(1-\beta)}{\alpha+(1-\beta)} c_i < c_j, \\
&b_i^i = 0 && b_j^i = 0, \\
&b_i^j = 0 && b_j^j = c_j, \quad \textit{for} \ \ c_i > c_j.
\end{aligned}$$

Contrary to previous sections, now extreme rewards (all production or no production at all) are not offered to all agents off the equilibrium of the game. In particular, agent j is offered a bonus equal to its cost of effort when he individually works hard ($b_j^j = c_{j,}$). The reason is that offering no bonus to all agents off equilibrium, the equilibrium of the game would not be unique. Notice that if $b_i^i = b_j^i = b_i^j = b_j^j = 0$, then no extra production is clearly an equilibrium of the game, as agents obtain the same bonuses when they both shirk than when they individually work hard and there is more efficiency when they both shirk, as bonuses are the same and equal to zero but no agent performs the extra level of costly effort. To obtain uniqueness, it is necessary to offer a bonus that compensates one agent for its cost of effort when he individually works hard, in order for him to choose to work hard, given that the other agent is shirking. The choice of which agent is offered a bonus equal to its effort cost when individually working hard is determined by agents' costs of effort. Notice that *Proposition* 9 says that the agent who has a smaller cost of extra effort (agent j) is the one that must be offered a bonus equal to its cost of extra effort when he individually works hard. The reason is that, by offering a bonus equal to zero to the agent with highest cost ($b_i^i = 0$), the principal creates more inefficiency off-equilibrium and thus implement team extra level of production as the unique equilibrium of the game with the lowest possible total sum of bonuses paid. Also notice that the agent with the highest cost is paid in equilibrium a bonus higher than its cost of effort ($b_i = c_i + \frac{\beta^2}{1+\alpha-\beta} c_i > c_i$ as $\beta < \frac{1}{2}, \left|\alpha < \frac{1}{2}\right|$), while the other agent is paid a bonus sufficiently lower than its cost of effort ($b_j = c_j - \frac{\beta(1-\beta)}{1+\alpha-\beta} c_i < c_j$), such that the total sum of bonuses paid in equilibrium is lower than the sum of both agents' cost of performing the extra effort ($b_i + b_j < c_i + c_j$).

Finally, it is optimal to implement team production when agents are efficiency concerned whenever $1 - c_j + \frac{\beta(1-2\beta)}{1+\alpha-\beta} c_i > q_i$ and $1 - c_i + \frac{\beta(1-2\beta)}{1+\alpha-\beta} c_i > q_j$ for $c_i > c_j$. If these conditions are not satisfied, the principal implements individual production by the agent for which $q_i - c_i$ is highest.

6 Discussion

Our model offers two novel results. First, if welfare comparisons among employees exist within the firm, they should not be ignored and contracts should specify rewards for all agents under all possible circumstances. Second, optimally taking into account the design of bonuses offered to distributionally concerned employees may provide a new reason by itself to demand joint effort, even when efforts are not complementary or there are no informational problems.

We have chosen the simplest possible model in which such points can be made. First we have focused on incentive compatibility instead of on participation because there are realistic situations in which employers cannot force employees down to their participation constraint. Our model uses a minimum wage for the participation constraint to be satisfied and discusses the effects of changes in this minimum wage. Other alternatives such as reservation utilities, search costs of new jobs, disutility of unemployment or good matching with the employer would produce the same results. Taken together, our results imply that the more attached employees are to their jobs, the more the employer can exploit their inequity concerns. Notice that the analysis of the participation constraint is specially tricky when dealing with interdependent preferences because it is not clear what the reference point is when the agent takes the outside option. In particular, a more careful analysis of the participation constraint should make strong assumptions on whether agents feel equally inequity averse when in other firms or whether they may feel envious or guilty for other agents left behind in the original firm. As this behavioural questions are unresolved yet, we have focused on incentive compatibility.

Second, we have abstracted from uncertainty in production to be able to discuss the pure effect of inequity aversion. We argue that inequity aversion is in itself a possible reason to demand joint production, whether output is deterministic or not, and we show how the optimal contract must be changed accordingly. The closely related paper by Itoh (2004), makes a different point: when inequity averse agents participate in different projects which can succeed or fail, more equal (or unequal contracts) must be offered to compensate for the risk of the other agent's project falling. Thus, Itoh uses equality in rewards to compensate for uncertainty while our model shows how rewards must be allocated to provide extra incentives to work harder even if employers are restricted by limited liability. There are many real situations in which an extra level of effort may produce a deterministic output, such as staying longer hours in the office or contributing to the administrative duties of a department. What we argue is that if employers realize that their employees feel envy, guilt, spite or efficiency concerns, they may not need to pay a bonus covering the cost of those extra hours or those extra duties, as long as threats of inequity when they shirk are optimally designed.

Despite its simplicity, our model provides a new rationale for team and relative performance contracts in contexts with no informational asymmetries. In both these types of contracts, agents are threatened with welfare inequities when some employees work harder than others. In team contracts, when a member of the team shirks, the team's performance is less successful and thus, other members of the team who work hard do not see their efforts rewarded, for which the shrinking agent might feel guilty. Therefore, agents might decide not to shirk even if rewards offered to them are low in order to avoid feeling guilty for the members of the team who work hard. In relative performance contracts, when an agent shirks hard he will be ranked low, and thus, he will be worse off than higher ranked agents, for which he may actually feel envious. Thus in competitive contexts it may not be necessary to offer such high rewards when agents are envious of each other and compete not to be ranked lower than their peers. Thus, welfare comparisons among peers can be used by the employer to provide incentives to work hard. Our results show that team and relative performance contracts may be optimal even in many work situations in which output is deterministic and/or effort is easily observable by managers.

Our model highlights how behavioural Contract Theory can be useful to study issues of organization in the firm. Both the Human Resources Literature and the Personnel Economics Literature have studied these issues before.[20] The contribution of our study is that it indicates how comparisons among agents can be affected by the design of the contract. Our model suggests that optimal contracts may depend on the strength of welfare comparisons. If that is the case, it may be possible to affect the strength of those comparisons in the workplace. We have here assumed everything was given and observable. However, in real firms the employer might be able to influence which information is

[20] See Lazear (1995).

easily available to its employees, once it has been clarified which variables enter employees' welfare comparisons in different contexts. In particular, decisions such as whether to make salaries publicly available to co-workers or not, or the allocation of office space (which might affect the observability of effort by co-workers) could be illuminated by issues here discussed. Although in many firms rewards are kept secret[21] and employees work in separate and closed offices, we have here provided a factor that in some cases may push towards the opposite direction.

7 Proofs

Proof of Proposition 1

Bonuses paid in the equilibrium of the game played by the agents (b_i^i, b_j^i) appear in ICC_i^{ind}. By (R2) the value of the right hand side of ICC_i^{ind} is zero and both agents obtain the same utility when they both shirk. By (U1) α and β are positive. By choosing $b_i^i - c_i = b_j^i$, the terms that compare direct utilities in ICC_i^{ind} are equal to zero and do not subtract utility in the Left Hand Side of the condition. The principal's objective is to maximize $q_i - b_i^i - b_j^i$. By setting $b_i^i = c_i$ and $b_j^i = 0$ the principal maximizes profits with ICC_i^{ind} holding.

For individual production by agent i to be an equilibrium, ICC_j^{ind} needs also to hold. The following inequalities define the off-equilibrium bonuses for ICC_j^{ind}, ICC_i^{indU} and ICC_j^{indU} to hold, with $b_j^i = 0$, which is the lowest possible bonus paid to agent j in equilibrium. The restrictions shown are the result of rearranging conditions ICC_j^{ind}, ICC_i^{indU} and ICC_j^{indU} and simplifying the terms that compare direct utilities. There are four cases depending on whether $b_i - c_i \lesseqgtr b_j - c_j$ and $b_i^j \lesseqgtr b_j^j - c_j$. Of these four cases, the combination $b_i - c_i < b_j - c_j$ and $b_i^j > b_j^j - c_j$ violates ICC_j^{ind} if ICC_i^{indU} and ICC_j^{indU} hold and thus this case is removed, and we are left with a$_1$), a$_2$) and b):

a) If $b_j^j - c_j \geq b_i^j$ then: $b_j^j - c_j > \frac{-\beta}{1-\beta} b_i^j$ and

a$_1$) If $b_j - c_j \geq b_i - c_i$ then: $b_i - c_i > b_i^j + \frac{\alpha}{1+\alpha}(b_j - b_j^j)$ and $b_j - c_j < \frac{\beta}{1-\beta}(c_i - b_i)$,

a$_2$) If $b_j - c_j < b_i - c_i$ then: $b_i - c_i > \frac{1}{1-\beta}[(1+\alpha)b_i^j - \beta(b_j - c_j) - \alpha(b_j^j - c_j)]$ and $b_j - c_j < \frac{\alpha}{1+\alpha}(b_i - c_i)$.

b) If $b_i^j > b_j^j - c_j$ then: $b_i - c_i > b_i^j + \frac{\beta}{1-\beta}(b_j^j - c_j)$, $b_j - c_j < \frac{\alpha}{1+\alpha}(b_i - c_i)$ and $b_j^j > c_j + \frac{\alpha}{1+\alpha} b_i^j$.

Proof of Proposition 2

Agent i's utility when he shirks, given that agent j works is:

$$\overline{K} + b_i^j - \alpha \max\left[b_j^j - c_j - b_i^j, 0\right] - \beta \max\left[b_i^j - b_j^j + c_j, 0\right] - \overline{w}.$$

Notice that inequity aversion imposes that an agent obtains disutility either from being better off or worse off than the other agent, but not from both at the same time.

[21] Even if Bewley (1999) reports that 87% of managers interviewed think that their employees know each others' wages.

a) If agent i is worse off than agent j, the effect of *envy* dominates and $b_j^j - c_j - b_i^j \geq 0$. Thus, to minimize the utility of agent i when he shirks, $b_i^j = 0$, as the derivative of agent i's utility with respect to the bonus offered to agent j equals $1 + \alpha > 0$, by assumption (U1).

b) If agent i is better off than agent j, the effect of *guilt* dominates and $b_i^j - b_j^j + c_j \geq 0$. Thus, to minimize the utility of agent i when he shirks, $b_i^j = 0$, as the derivative of agent i's utility with respect to the bonus offered to agent j equals $1 - \beta > 0$, by assumption (U2).

Proof of Proposition 3

By *Proposition* 2, the bonus that maximizes agent j's punishment when agent i individually works hard is $b_j^i = 0$.

The utility of agent j when agent i individually works hard is thus equal to:

$$\overline{K} - \alpha \max\left[b_i^i - c_i, 0\right] - \beta \max\left[-b_i^i + c_i, 0\right] - \overline{w}$$

where by (R1) and (R2),

$$b_i^i \in [0, q_i],$$

and by (C),

$$0 \leq c_i \leq q_i.$$

Thus, minimizing agent j's utility implies:

$$b_i^i = q_i \qquad \text{if} \quad \alpha(q_i - c_i) \geq \beta c_i$$

and

$$b_i^i = 0 \qquad \text{if} \quad \alpha(q_i - c_i) < \beta c_i.$$

Proof of Proposition 4

First, from *Proposition 2* it is optimal not to bonus agents when they shirk, in order to create incentives for both agents to work.

$$b_i^j = b_j^i = 0.$$

We now show the remaining bonuses in each of the three cases referred in Proposition 4.

Case *a):* If $\alpha(q_i - c_i) \geq \beta c_i$ for $i = 1, 2$, it is optimal to choose $b_i^i = q_i$. Conditions (ICC^{JPU})s hold using results in *Proposition* 2. The principal maximizes $1 - b_1 - b_2$ subject to both (ICC^{JP})s. Using the slopes of the indifference curves given by (U1) and (U2), the conditions optimally hold with equality and profits are maximized at the unique point at which the indifference curves intersect. Let j be the agent for whom $q_j - c_j \geq q_i - c_i$, then:

$$\begin{aligned} b_i &= c_i - \tfrac{\alpha^2(q_i - c_i) - \alpha(\beta - 1)(q_j - c_j)}{\alpha + (1-\beta)} < c_i & \qquad b_i^i &= q_i, \\ b_j &= c_j + \tfrac{\alpha\beta(q_j - c_j) - \alpha(1+\alpha)(q_i - c_i)}{\alpha + (1-\beta)} \gtreqless c_j & \qquad b_j^j &= q_j. \end{aligned}$$

Given (R1), if $c_i < \frac{\alpha^2(q_i-c_i)-\alpha(\beta-1)(q_j-c_j)}{\alpha+(1-\beta)}$ then $b_i = 0$ and b_j is determined by indifference. If $c_j < -\left(\frac{\alpha\beta(q_j-c_j)-\alpha(1+\alpha)(q_i-c_i)}{\alpha+(1-\beta)}\right)$then $b_j = 0$ and b_i is determined by indifference.

Case *b):* If $\alpha(q_i - c_i) < \beta c_i$ and $\alpha(q_j - c_j) \geq \beta c_j$ for $i, j = 1, 2$, $i \neq j$, it is optimal to choose $b_i^i = 0$ and $b_j^j = q_j$. The two cases are created by whether the intersection of both indifference curves occurs at a point where $b_i - c_i \lesseqgtr b_j - c_j$.

- Let $\alpha(q_i - c_i) < \beta c_i$ and $\alpha(q_j - c_j) \geq \beta c_j$: Then

$$b_i^i = 0 \quad b_j^j = q_j, \quad \text{ and:}$$

- For $\alpha(q_j - c_j) \geq \beta c_i$ then:

$$b_i = c_i - \frac{\alpha\beta c_i + \alpha(1-\beta)(q_j - c_j)}{\alpha + (1-\beta)} < c_i \qquad b_j = c_j + \frac{\alpha\beta(q_j - c_j) - \beta(1+\alpha)c_i}{\alpha + (1-\beta)} \gtreqless c_j.$$

Given (R1), if $c_i < \frac{\alpha\beta c_i+\alpha(1-\beta)(q_j-c_j)}{\alpha+(1-\beta)}$ then $b_i = 0$ and b_j is determined by indifference.If $c_j < -\left(\frac{\alpha\beta(q_j-c_j)-\beta(1+\alpha)c_i}{\alpha+(1-\beta)}\right)$ then then $b_j = 0$ and b_i is determined by indifference.

- For $\alpha(q_j - c_j) < \beta c_i$ then:

$$b_i = c_i + \frac{\beta^2 c_i - \alpha(1+\alpha)(q_j - c_j)}{\alpha + (1-\beta)} > c_i \qquad b_j = c_j - \frac{\alpha^2(q_j - c_j) + \beta(1-\beta)c_i}{\alpha + (1-\beta)} < c_j.$$

Given (R1), if $c_j < \frac{\alpha^2(q_j-c_j)+\beta(1-\beta)c_i}{\alpha+(1-\beta)}$ then and $b_j = 0$ and b_i is determined by indifference.

Case *c):* If $\alpha(q_i - c_i) < \beta c_i$ for $i = 1, 2$, inequity off equilibrium would be maximized by setting $b_i^i = 0$ and $b_j^j = q_j$. However the equilibrium of the game played by the agents would not be unique. Inequity off-equilibrium has to be the maximum possible subject to one of the agents obtaining higher utility when he individually works than when he does not. Thus, one of the agents is offered a bonus equal to all available output when he individually works hard instead of no bonus. Therefore, off-equilibrium one agent suffers the maximum effect of *guilt* when he shirks while the other suffers the maximum effect of *envy* ($b_i^i = 0$ and $b_j^j = q_j$ for $i, j = 1, 2$, $i \neq j$). Thus, one of the indifference curves is satisfied at the "optimal" level (for the agent who suffers *guilt* when he shirks) while the other is satisfied at the "suboptimal" level (for the agent who suffers *envy* when he shirks). The optimal bonuses paid are obtained at the intersection of one of the "optimal" and one of the "suboptimal" indifference curves. The conditions indicate for which of the four possible cases, profits are maximized.

- Let $\alpha(q_i - c_i) < \beta c_i$, $\alpha(q_j - c_j) < \beta c_j$. Then for $c_j \geq c_i$:

  - For $\alpha(q_j - c_j) \geq \beta c_i$:

    - if $(1 - 2\beta)[\alpha(q_j - c_j) - \beta c_j] \geq (1 + 2\alpha)[\alpha(q_i - c_i) - \beta c_i]$, then:

$$b_i = c_i - \tfrac{\alpha\beta c_i+\alpha(1-\beta)(q_j-c_j)}{\alpha+(1-\beta)} < c_i \qquad b_i^i = 0,$$

$$b_j = c_j + \tfrac{\alpha\beta(q_j-c_j)-\beta(1+\alpha)c_i}{\alpha+(1-\beta)} \lesseqgtr c_j \qquad b_j^j = q_j,$$

Given (R1), if $c_i < \frac{\alpha\beta c_i+\alpha(1-\beta)(q_j-c_j)}{\alpha+(1-\beta)}$ then $b_i = 0$ and b_j is determined by indifference. If $c_j < -\left(\frac{\alpha\beta(q_j-c_j)-\beta(1+\alpha)c_i}{\alpha+(1-\beta)}\right)$ then $b_j = 0$ and b_i is determined by indifference.

- if $(1 - 2\beta)[\alpha(q_j - c_j) - \beta c_j] < (1 + 2\alpha)[\alpha(q_i - c_i) - \beta c_i]$, then:

$$b_i = c_i - \frac{\alpha^2(q_i-c_i)+\beta(1-\beta)c_j}{\alpha+(1-\beta)} < c_i \qquad b_i^i = q_i,$$

$$b_j = c_j + \frac{\beta^2 c_j-\alpha(1+\alpha)(q_i-c_i)}{\alpha+(1-\beta)} \lesseqqgtr c_j \qquad b_j^j = 0.$$

Given (R1), if $c_i < \frac{\alpha^2(q_i-c_i)+\beta(1-\beta)c_j}{\alpha+(1-\beta)}$ then $b_i = 0$ and b_j is determined by indifference. If $c_j < -\left(\frac{\beta^2 c_j-\alpha(1+\alpha)(q_i-c_i)}{\alpha+(1-\beta)}\right)$ then $b_j = 0$ and b_i is determined by indifference.

- For $\alpha(q_j - c_j) < \beta c_i$:
  - if $\alpha(1 + 2\alpha)(q_j - c_j - q_i + c_i) \geq \beta(1 - 2\beta)(c_j - c_i)$, then:

$$b_i = c_i + \frac{\beta^2 c_i-\alpha(1+\alpha)(q_j-c_j)}{\alpha+(1-\beta)} > c_i \qquad b_i^i = 0,$$

$$b_j = c_j - \frac{\alpha^2(q_j-c_j)+\beta(1-\beta)c_i}{\alpha+(1-\beta)} < c_j \qquad b_j^j = q_j,$$

Given (R1), if $c_j < \frac{\alpha^2(q_j-c_j)+\beta(1-\beta)c_i}{\alpha+(1-\beta)}$ then $b_i = 0$ and b_j is determined by indifference.

  - if $\alpha(1 + 2\alpha)(q_j - c_j - q_i + c_i) < \beta(1 - 2\beta)(c_j - c_i)$, then:

$$b_i = c_i - \frac{\alpha^2(q_i-c_i)+\beta(1-\beta)c_j}{\alpha+(1-\beta)} < c_i \qquad b_i^i = q_i,$$

$$b_j = c_j + \frac{\beta^2 c_j-\alpha(1+\alpha)(q_i-c_i)}{\alpha+(1-\beta)} \lesseqqgtr c_j \qquad b_j^j = 0.$$

Given assumption (R1), if $c_i < \frac{\alpha^2(q_i-c_i)+\beta(1-\beta)c_j}{\alpha+(1-\beta)}$ then $b_i = 0$ and b_j is determined by indifference. If $c_j < -\left(\frac{\beta^2 c_j-\alpha(1+\alpha)(q_i-c_i)}{\alpha+(1-\beta)}\right)$ then $b_j = 0$ and b_i is determined by indifference.

Proof of Corollary 1

From *Proposition* 4, there are three possible cases:

-If $b_i = c_i - \dfrac{\alpha(\beta-1)(q_j-c_j)-\alpha^2(q_i-c_i)}{\beta-1-\alpha}$, $b_j = c_j - \dfrac{\alpha\beta(q_j-c_j)-\alpha(1+\alpha)(q_i-c_i)}{\beta-1-\alpha}$ then

$$b_i + b_j = c_i + c_j - \frac{\alpha(1-2\beta)(q_j-c_j)+\alpha(1+2\alpha)(q_i-c_i)}{\beta-1-\alpha} < c_i + c_j \text{ by (C), (U1) and (U2).}$$

- If $b_i = c_i - \dfrac{\alpha\beta c_i + \alpha(1-\beta)(q_j-c_j)}{1+\alpha-\beta}$ and $b_j = c_j - \dfrac{\beta(1+\alpha)c_i - \alpha\beta(q_j-c_j)}{1+\alpha-\beta}$ then,

$$b_i + b_j = c_i + c_j + \frac{(1+2\alpha)\beta c_i + \alpha(1-2\beta)(q_j-c_j)}{\beta-1-\alpha} < c_i + c_j \text{ by (C), (U1) and (U2).}$$

- If $b_i = c_i - \dfrac{\alpha(1+\alpha)(q_j-c_j)-\beta^2 c_i}{1+\alpha-\beta}$ and $b_j = c_j - \dfrac{\beta(1-\beta)c_i + \alpha^2(q_j-c_j)}{1+\alpha-\beta}$ then,

$$b_i + b_j = c_i + c_j + \frac{\alpha(1+2\alpha)(q_i-c_i)+\beta(1-2\beta)c_j}{\beta-1-\alpha} < c_i + c_j \text{ by (C), (U1) and (U2).}$$

Proof of Proposition 5

The proof of *Corollary* 1 shows the three possible rewards paid in equilibrium depending on conditions in *Proposition* 4. Conditions for the principal to find optimal to implement team extra level of production under the three possible sets of equilibrium bonuses paid when agents are inequity averse are:

- If $b_i = c_i - \frac{\alpha^2(q_i-c_i)-\alpha(\beta-1)(q_j-c_j)}{\alpha+(1-\beta)}$ and $b_j = c_j + \frac{\alpha\beta(q_j-c_j)-\alpha(1+\alpha)(q_i-c_i)}{\alpha+(1-\beta)}$, then joint production is optimal when $q_i > 1 - c_j - \frac{\alpha(1+2\alpha)(q_i-c_i)+\alpha(1-2\beta)(q_j-c_j)}{\alpha+(1-\beta)}$.

- If $b_i = c_i - \frac{\alpha\beta c_i+\alpha(1-\beta)(q_j-c_j)}{\alpha+(1-\beta)}$ and $b_j = c_j + \frac{\alpha\beta(q_j-c_j)-\beta(1+\alpha)c_i}{\alpha+(1-\beta)}$, then joint production is optimal when $q_i > 1 - c_j + \frac{(1+2\alpha)\beta c_i+\alpha(1-2\beta)(q_j-c_j)}{\alpha+(1-\beta)}$.

- If $b_i = c_i + \frac{\beta^2 c_i-\alpha(1+\alpha)(q_j-c_j)}{\alpha+(1-\beta)}$ and $b_j = c_j - \frac{\alpha^2(q_j-c_j)+\beta(1-\beta)c_i}{\alpha+(1-\beta)}$, then joint production is optimal when $q_i > 1 - c_j + \frac{\alpha(1+2\alpha)(q_i-c_i)+\beta(1-2\beta)c_j}{\alpha+(1-\beta)}$.

- Otherwise, the principal implements individual production by the agent for which $q_i - c_i$ is highest.

Given restrictions on the parameters and comparing with Section 3.3, the result is straightforward.

Proof of Proposition 6

Bonuses paid in the equilibrium of the game (b_i^i, b_j^j) appear in ICC_i^{ind} and ICC_j^{ind}. By (R2) the value of the right hand side of ICC_i^{ind} is zero and both agents obtain the same utility when they both shirk. As $\alpha > 0$, the only possible way to make condition ICC_i^{ind} hold under a lower total bonus cost is by setting $b_i^i - c_i \geq b_j^i$. However, by (R1), $b_j^i \geq 0$, and thus, $b_i^i \geq c_i$. The minimum bonus needed to be paid in equilibrium are thus $b_i^i = c_i$ and $b_j^i = 0$.

Proof of Proposition 7

As $\beta < 0$, agents only obtain disutility from *envy.* To maximize the effect of *envy* off the joint production equilibrium, the agent who shirks off equilibrium is offered no bonus ($b_i^j = 0$ for $i, j = 1, 2$ and $i \neq j$) and the agent who works is offered all available production ($b_i^i = q_i$ for $i = 1, 2$). The expression for the equilibrium bonuses paid follows calculations in case *a)* in *Proposition* 4.

Proof of Proposition 8

Assume agent i individually works hard off the equilibrium of the game. Efficiency concerns implies that agents care for the weighted sum of direct utilities, putting more weight on each own's direct utility than on the other agent's direct utility:

a) If $U_j \geq U_i$, agent i's utility can be written as $(1+\alpha)U_i - \alpha U_2$, which is a weighted sum since $\alpha < 0$ and $|\alpha| < \frac{1}{2}$.

b) If $U_j < U_i$, agent i's utility can be written as $(1-\beta)U_i + \beta U_2$, which is a weighted sum since $\beta \in [0, \frac{1}{2})$.

For ICC_i^{ind} to hold, agent i must obtain non-negative utility when he works given that agent j shirks. Assume $b_i^i < c_i$, then it is necessary that $b_j^i > c_i - b_i^i$ as $|\alpha| < \frac{1}{2}$. Obviously, given (R1), this implies $b_i^i + b_j^i \geq c_i$. Finally, $b_i^i \geq c_i$ cannot be optimal as it implies $b_i^i + b_j^i \geq c_i$. Notice that $b_i^i = c_i$ and $b_j^i = 0$ is not the only possible combination such that the condition holds.

Proof of Proposition 9

To maximize the effect of inefficiency off-equilibrium, all agents should be offered no bonus off-equilibrium, no matter whether they work hard or not. However, by doing so, no production would be an equilibrium as ICC_i^{JPU} for $i = 1,2$ would not hold. Thus, working has to be a dominant strategy for one of the agents (agent i). For ICC_i^{JPU} to hold but at the same time not provide incentives for agent j to shirk when agent i individually works, it is optimal to set $b_i^i = c_i$ and $b_j^i = 0$. When agent j individually works, maximum inefficiency is generated by setting $b_i^j = b_j^j = 0$. The remaining two equilibrium bonuses are obtained at the intersection between the minimum lines defined by both ICC_i^{JP}'s for $i = 1,2$:

$$b_i - c_i - \beta(b_i - c_i - b_j + c_j) \geq 0,$$
$$b_j - c_j - \alpha(b_i - c_i - b_j + c_j) \geq -\beta c_i,$$

which yields: $b_i = c_i + \frac{\beta^2}{1+\alpha-\beta}c_i$ and $b_j = c_j - \frac{\beta(1-\beta)}{1+\alpha-\beta}c_i$.

Notice that the sum of bonuses paid in equilibrium equals $b_i + b_j = c_i + c_j - \frac{\beta(1-2\beta)}{1+\alpha-\beta}c_i$. As $\alpha < 0$, $\beta \in [0, 1/2)$, and $|\alpha| \leq |\beta|$ then $\frac{\beta(1-2\beta)}{1+\alpha-\beta} > 0$ and thus, it is optimal to set $b_j^j = c_j$ for the agent for which the cost of effort is lowest, i.e., for $c_j > c_i$ and $i, j = 1, 2$, $i \neq j$.

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