Abstract

Recent studies specify that people are heterogeneous in terms of social preferences. In this paper, we analyze group incentives when a positive proportion of workers feel inequity aversion as defined by Fehr and Schmidt (1999). We study whether this heterogeneity may explain the existence of multiple variable payment schemes on the business place through workers’ self-selection. A ranking-tournament provides strong incentives to workers who only care about their own payoff but is useless for workers with social preferences due to the large \textit{ex post} inequality between final payoffs. An alternative compensation mode distributing equally the joint production may attract inequity averse workers if and only if selfish agents have no interest to introduce the revenue-sharing. Such a separating equilibrium implies high effort levels by both types of employees. Workers’ self-selection conducts to homogeneous groups and then adapted incentive mechanisms for each type of agents. Pareto gains are achieved from offering organizational choice to workers and the optimal contract is thus to propose both payment schemes with self-selection.

JEL Classification: M52, J31, J33, D63

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1 Introduction

Most organizations are divided in unities or departments in which every employee does approximately the same job. In general, the joint-output of the whole unity is observable by the manager but he is unable to distinguish precisely individual contributions. The wide growth in companies of performance-based payment schemes such as promotions and collective bonuses or team-work strengthens the need to provide employees working in groups incentives to increase their performance. In the business place, multiple organizational structures based on variable compensation modes exist. One might have thought that only one organizational structure, the more efficient one, would be used by all firms. However, the existence of a particular variable payment scheme always better than others is not obvious. The presence of these various incentive mechanisms in reality points out that people may choose different organizational structures according to their personal preferences and then, that a specific variable payment scheme is not adapted to the whole working population in terms of incentive effects. Indeed, the occurrence of multiple organizations may happen when workers are heterogeneous and may lead to a higher outcome for employees and companies.

Diverse personality characteristics typify workers. Lazear (2000) shows by an empirical study on an industrial company which switched from a fixed wage to a piece-rate pay that this change enhances globally the average of output levels per worker by 44 percent through incentive and sorting by abilities effects. Both effects are of the same extend\(^1\). Besides, firms paying workers under incentive contracts with some income risk are shown to employ more employees presenting risk-tolerance (Bellemare and Shearer, 2006). Ability, educational levels and risk preferences of people influence their choice of payment schemes, nevertheless, individuals differ by social preferences also. For instance, physicians, nurses, lawyers, notaries, real estate agents or accountants decide to work for themselves or to

\(^1\)He presents theoretical predictions and tests the impact of a shift from a fixed wage to a piece-rate pay in a large auto glass American company. Added to the incentive effect of the performance payment scheme, a selection effect is expected. Higher-ability workers should be more attracted by the piece-rate pay and work at a high effort level while low-ability workers should prefer the fixed wage. As a consequence, a raise of both the average and the variance of effort is predictable. The sorting of high-skilled workers through compensation modes is then demonstrated to be at least as important as their incentive effect.
belong to an association in cooperation with several other colleagues; salesmen or, more generally, all employees whose salary is composed by a large variable part decide to work for companies using individual or collective, absolute or relative, performance-based payment schemes; and some others choose between public and private sectors.

Recent work indicates that people actually have social preferences and that people furthermore are heterogeneous in this regard. In the business place, this means that different people like different organizations to differing degrees. In this connection, there may be Pareto gains from offering compensation/organizational choice to workers. Lazear (1989) suggests that "it may be important to sort workers in different groups depending on their personality" (p. 562). There may be no need to actually find out people’s personality types, at least not directly. A market design which allows people to select their payment scheme may get self-selection and then an identification of personality types ex post. The aim of the paper is to study whether the heterogeneity of workers’ social preferences, such as inequity aversion, may explain the existence of multiple organizational structures through workers’ self-selection. It is consequently important to analyze whether the existence of multiple variable payment schemes increases the average utility of employees and their global output, which would raise companies’ profits as well.

In the standard theory, individuals are assumed to be selfish in the sense that they are pursuing only their own material payoff. However, according to Fehr and Schmidt (1999), "this may be true for some (maybe many) people, but it is certainly not true for everybody" (p. 817)\(^2\). They have constructed a model based on inequity aversion considerations and show that if a positive proportion of individuals feel some inequity aversion, the gap between theory and experimental evidence can be filled. Therefore, it seems relevant to consider that fairness concerns can affect employees’ behavior when they face work incentives. Bolton and Ockenfels (2000) also propose a fairness model based on distributive consequences but they develop an alternative utility function based on the comparison by each agent between their own monetary payoff and the average payoff of the

\(^2\)Recent experimental studies show the clear existence of workers’ types according to their social preferences (Fehr and Gächter (2000), Fischbacher, Gächter and Fehr (2001), Burlando and Guala (2005), Gächter and Thöni (2005) and Fischbacher and Gächter (2006)) and underline the necessity to consider this heterogeneity to infer adapted incentives.
reference group. For an experimental comparison between Fehr and Schmidt’s and Bolton and Ockenfels’ models in favor of Fehr and Schmidt, we can have a look at Engelmann and Strobel (2000). Another literature studying individuals’ social preferences concentrates on fairness intentions instead of final distributions. Dufwenberg and Kirchsteiger (2004) analyze intentions for sequential games in continuation of the work done by Rabin (1993) for normal games. The contribution of Falk and Fischbacher (2006) lies in the consideration of both intentions and outcomes distribution to drive reciprocity.3

This work emphasizes the necessity to study how social preferences do affect workers’ behavior in response to incentives provided by a ranking tournament and a revenue-sharing compensation modes when the variable payment is a positive share of the group joint production.4 Tournaments are extensively used by companies in part because it requires a relative, rather than absolute, measure of individual outputs. Only a proportion of group-members receive a high prize which can be, for instance, a bonus or a promotion. This large use of tournaments has conducted to a vast theoretical literature starting by the famous article from Lazear and Rosen (1981).5 In two-workers groups, the payoffs distribution is degenerated in the sense that only one worker earns the whole variable pay. The tournament winner’s prize depending on workers’ output, collusion which may be observed in groups with especially few members when prized are fixed is ruled out here. The revenue-sharing splits equally the global production between workers of the same group.

The primary goal of this paper is to show that a situation with two types of people who have sorted into two different organizations, one using the tournament structure and the other one the revenue-sharing, in the following way is stable: workers without considerations for others’ payoff work under the tournament organization and play the unique equilibrium which is a high effort level and workers with inequity aversion are in the revenue-sharing organization and play an equilibrium corresponding to an effort level

3For a survey, see Sobel (2005).
5See McLaughlin (1988) for a survey.
strictly higher than the free-riding equilibrium predicted by theory when all players exclusively care about their own payoff. Under this configuration, no employee wants to move to the other organizational structure. More precisely, this separating equilibrium exists under the constraint that neither selfish nor inequity averse workers want to deviate for the other organization.

It is also important to show that mono-organizational situations may be unstable. On the one hand, if we assume that all individuals work under the tournament organization, people with a sufficiently high degree of inequity aversion prefer to break away for an outside option because the tournament induces very low effort levels equilibria and a weak utility due to the dramatic \textit{ex post} net payoffs inequality\textsuperscript{6}. An alternative revenue-sharing organization attracts this type of people and they perform better than under the tournament. In fact, if it is common knowledge that all the employees are fair-minded under the revenue-sharing, multiple symmetric equilibria exist including the free-ride equilibrium\textsuperscript{7}. The forward induction concept contributes to the reduction of the equilibria set at higher levels than the free-ride equilibrium. On the other hand, if all workers are assumed to work under the revenue-sharing, the outcome is very bad because selfish people pollute by shirking and as a consequence, everybody shirks. Then, inequity averse workers prefer to leave this organization and start another revenue-sharing organization without selfish people. Therefore, structures with a single variable payment scheme appear to be unstable. Workers’ self-selection may conduct to homogeneous groups and then adapted incentive mechanisms for each type of agents. Pareto gains are achieved from offering organizational choice to workers and the optimal contract is thus to propose both payment schemes with self-selection.

The paper is organized as follow. Section 2 presents the basic tournament model with

\textsuperscript{6}Grund and Sliwka (2005) and Demougin and Fluet (2003) show that inequity aversion as defined by Fehr and Schmidt affects workers’ equilibrium strategies in tournaments. Kräkel (2000) obtains the same conclusions according to the concept of "relative deprivation" introduced by Stark (1987) but his model only allows for a desadvantageous inequity aversion. The study on personnel data from an English fruit farm by Bandiera, Barankay and Rasul (2005) shows that social preferences of workers have a negative impact on their productivity under relative incentives in presence of monitoring.

\textsuperscript{7}Biel (2004) and Bartling and von Siemens (2004) prove that inequity aversion helps in providing incentives when joint-production is equally shared between workers.
workers’ equilibrium behavior. The possibility to flee the tournament is analyzed in section 3. Section 4 presents the optimal contract proposed by the principal. Section 5 discusses the results and Section 6 concludes.

2 Ranking tournament with heterogeneous agents

Rank-order tournaments are known to strongly increase the average performance of employees who are supposed to be concerned exclusively by their own payoff. This section provides light on workers’ behavior when they are subjected to relative incentives in accordance with their degrees of inequity aversion. A tournament is not expected to provide the same incentive effect if workers have social preferences or not. Inequity averse workers may be negatively affected by the high inequality between net payoffs generated by the tournament. After a presentation of both types of workers considered in this study according to the Fehr and Schmidt’s model, we determine equilibrium effort levels and related utilities for both types of workers. We study the variation of equilibrium variables in function of inequity aversion degrees also.

2.1 Selfish and inequity averse agents

Different personality types exist among the working population. In this paper we distinguish agents according to their social preferences and, more precisely, to their degree of inequity aversion. We utilize the inequity aversion concept defined in the model developed by Fehr and Schmidt (1999). The question here is to know whether the presence of both selfish and inequity averse workers can affect the strength of incentives provided by a group performance-based compensation scheme. We assume that inequity averse workers are only affected by the payoff of their co-worker and neither by the payoff of workers belonging to another group or of the principal. This assumption seems the most adapted to our setting in which the relation between members of the same group seems the most evident and transparent in terms of revenues information; the more workers’ positions are different, the more the "wage secrecy" is important. Nevertheless, an inequity aversion may occur
between employees and employer but it is not under purpose here.

We follow the Fehr and Schmidt’s utility function which, in a two-players game, is the following for player $i$:

$$ u_i(x_i, x_j) = x_i - \alpha_i \max \{x_j - x_i, 0\} - \beta_i \max \{x_i - x_j, 0\} \quad i \neq j $$

(1)

where $x_i$ and $x_j$ represent the monetary payoffs. They assume that subjects can be averse to advantageous (represented by the parameter $\beta_i$) and disadvantageous (represented by the parameter $\alpha_i$) inequality. Moreover, they consider that earning less than the other player has a bigger negative impact on utility than earning more, which can be written: $\alpha_i \geq \beta_i$ with $0 \leq \beta_i < 1$. On the one hand, $\beta_i < 1$ captures the idea that the utility of worker $i$ is always increased when his payoff rises: he is not prepared to give up more (or the same amount) than his monetary payoff to reduce the inequality otherwise, being rational, his utility is reduced. On the other hand, Fehr and Schmidt exclude subjects who like earning more than others ($\beta_i < 0$) but, aware that this kind of preferences may exist, they show at the end of their paper that this restriction did not change the results in the games they considered. However, we can expect that the existence of this type of individuals may affect the equilibrium behavior in incentive games where the motivation plays an important role. Also, in this paper, we allow for $-1 < \beta_i < 0$ to capture the spitefulness of players$^9$. Besides, to keep the logic of Fehr and Schmidt that subjects are more sensitive to a disadvantageous compared to an advantageous inequality, we assume $\alpha_i \geq |\beta_i|$.

We consider an infinite population of workers. A proportion of workers $\rho$, $0 \leq \rho \leq 1$, are inequity averse defined as people with at least $\alpha \neq 0$ or $\beta \neq 0$ and $\alpha \geq |\beta|$ and $-1 < \beta < 1$; they are workers of type $t_A$. $(1 - \rho)$ players, type $t_S$ workers, are supposed totally selfish, i.e. $\alpha = \beta = 0$. For simplicity, we suppose all type $t_A$ workers having the same level of inequity aversion represented by $\alpha$ and $\beta$.

$^8$If the renunciation of a fraction of the monetary payoff is lower than the gain induced by the inequality reduction, the choice of the player is rational. This is possible even for $\alpha_i > 1$. Also, $\alpha_i$ does not need to be upper-bounded.

$^9$Frank (1985) and Mui (1995) relate the role of status seeking and envy.
2.2 The model

Workers hired by a firm, after being matched in pairs, produce a joint output depending exclusively on their effort level. They are supposed risk-neutral. In each two-workers group, employees invest simultaneously in a level of effort. The principal cannot establish the share of the group output due to one or the other worker with certainty. Worker $i$ produces the output $e_i$, $e_i \geq 0$, which represents his effort level. Employees who opt for a positive effort level are submitted to a quadratic cost function, $c(e_i)$, such that $c(e_i) = e_i^2$. We assume workers identical in terms of ability then, the production technology and the cost function of effort are the same for all workers. Moreover, the output produced by player $i$ is always higher than his cost to get this output level: $e_i \geq e_i^2 \iff e_i \in [0, 1]$. The monetary net payoff of worker $i$ is the difference between the gross payment he received depending on effort levels exerted by both workers in the group, $p_i(e_i, e_j)$, and the cost associated to $i$’s effort level, $x_i = p_i(e_i, e_j) - e_i^2$. We assume here that players are sensitive to inequality generated by final net payoffs instead of expected payoffs which seems closer to the idea of the Fehr and Schmidt’s model. Moreover, in the business world, as workers are able to observe the effort level of their co-worker and link their payoff and their investment in the task, it seems more realistic that they compare their final payoffs once the cost of effort deducted. Nevertheless, this question may be discussed.

Each group’s joint production is supposed perfectly observable by the principal but he is unable to determine which amount of effort is due to each worker. As workers can lie about their effort contribution, he must use a performance-based compensation mode in order to give employees incentives to work. We consider that workers receive a variable payment which is a share $\tau$, $\tau \in [0, 1]$, of the group joint-output, $Q$, $Q = e_i + e_j$. One performance-based payment scheme which does not need an absolute measure of individual performance but which provides important incentives to the workforce is the rank-order tournament. In a group of employees, payments are rewarded according to the rank of each worker’s performance relative to the performance of other workers in the group. As

\begin{footnote}
Workers’ equilibrium behavior has been derived also when the production function is $f(e_i)$ such that $f'(e_i) > 0$ and $f''(e_i) \leq 0$ and the cost function is $c(e_i)$ such that $c'(e_i) > 0$ and $c''(e_i) > 0$. The results are not qualitatively modified so, for simplification, we assume $f(e_i) = e_i$ and $c(e_i) = e_i^2$.
\end{footnote}
we consider a two-players tournament, prizes rewarded to workers are not fixed payments but are endogenous to workers’ output in order to avoid collusion problems. Therefore, the "winner" of the tournament earns the whole variable prize, $W(e_i, e_j) = \tau Q$, with $\tau$ chosen by the principal to maximize his profits, and the "loser" does not earn anything, $L = 0$. Keeping in mind that the individual output is not observable, we consider that the winner is not the worker with the highest effort level with certainty. According to the Tullock model (1980), the probability of earning the winner prize for each employee depends on the ratio between his output and the group joint production:

$$\Pr (p_i(e_i, e_j) = W(e_i, e_j)) = \Pr (p_i = W) = \frac{e_i}{Q}$$

(2)

The probability of winning the prize $W(e_i, e_j)$ is increasing in workers’ effort investment.

### 2.3 Workers’ equilibrium behavior

The von Neumann-Morgenstern utility of agent $i$ is increasing in the payoff he earns and decreasing in his cost of effort. It is given by:

$$E[V_i(e_i, e_j)] = \Pr (p_i = W) . v_i(W) + (1 - \Pr (p_i = W)) . v_i(L) \quad i \neq j$$

(3)

The utility associated with prizes differs according to workers’ inequity aversion. Theoretical literature on tournaments shows that this payment scheme provides important incentives to work hard when employees exclusively care of their own payoff. Nevertheless, the result may be different when workers have a utility depending on the other group-member’s payment. Indeed, a rank-order tournament induces a low expected utility for inequity averse agents by generating a dramatic ex post inequity when final net of cost payoffs are compared.

The utility of worker $i$ of type $t_A$ is then\textsuperscript{11}:

$$\begin{cases}
  v_i(W) = \tau Q - e_i^2 - \beta \left[ \tau Q - e_i^2 + e_j^2 \right] & \text{if he wins the tournament} \\
  v_i(L) = -e_i^2 - \alpha \left[ \tau Q - e_j^2 + e_i^2 \right] & \text{if he loses the tournament}
\end{cases}$$

\textsuperscript{11}We insure that the winner of the tournament earns always more than the loser: $\tau Q - e_i^2 > e_j^2 \iff \tau \geq \frac{e_j^2 + e_i^2}{Q}$; it is verified at the equilibrium.
The expected utility of an inequity averse agent $i$ is then decreasing in $\alpha$ and $\beta$:

$$E[V_i(e_i, e_j)] = \frac{e_i}{Q} \left[ \tau Q - \beta \left( \tau Q - (e_i^2 - e_j^2) \right) \right] + \frac{e_j}{Q} \left[ -\alpha \left( \tau Q + (e_i^2 - e_j^2) \right) \right] - e_i^2 \quad (4)$$

If we consider a worker $k$ who is only interested in his own payoff, his utility depends exclusively on his own effort investment:

$$E[V_k(e_k)] = \tau e_k - e_k^2 \quad \forall e_j \quad (5)$$

As workers find their equilibrium strategy by maximizing their expected utility function, people who only care of their own payoff have a dominant strategy whatever the type of the other worker in the group is:

$$e_k^* = \frac{\tau}{2}$$

The equilibrium effort level is increasing with the share given to workers.

Inequity averse agents have a different behavior depending on their opponent’s type. Under complete information about the type of their co-worker in the group, the equilibrium strategy of a worker of type $t_A$ is:

$$e_{AA}^* = \frac{2(1 - \beta)}{2 + \alpha - \beta} e_S^* \text{ if his opponent is of type } t_A \text{ as well}$$

$$e_{AS}^* = \begin{cases} 
\frac{2 - \alpha - 3\beta}{2(1 - \beta)} e_S^* & \text{if } \alpha + 3\beta < 2 \\
0 & \text{otherwise} \end{cases} \text{ if his opponent is of type } t_S\text{.}^{12}$$

**Proposition 1** Under complete information, groups composed exclusively by selfish workers produce a higher output than groups composed by inequity averse workers: $e_S^* > e_{AA}^*$. Besides, when at least one worker in the group is inequity averse, the joint output is bigger for a homogeneous group: $e_{AA}^* > e_{AS}^*$.

The equilibrium effort level for an inequity averse worker is decreasing in his degrees of advantageous and disadvantageous inequity aversion.

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12 The reaction function of a type $t_A$ worker competing against a worker $j$, deduced from the maximization of his utility function, is then: $e_{Aj}^* (e_j) = \frac{\tau}{2} - \frac{\alpha + \beta}{2(1 - \beta)} e_j$. 

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The equilibrium effort level of a worker of type $t_A$ is decreasing with $\alpha$ and $\beta$ whatever the type of his co-worker is. Moreover the slope of the equilibrium effort decline is steeper with workers’ advantageous inequity aversion degree than with their disadvantageous one. Consequently, in this case, the tournament does not provide good incentives to inequity averse workers if $\alpha$ and $\beta$ are too high. In this kind of tournaments, groups including one or two inequity averse workers produce a lower performance than groups exclusively composed by selfish workers. This difference depends on values of $\alpha$ and $\beta$; the higher workers’ advantageous and/or disadvantageous inequity aversion is, the lower is the joint-production of the group. Besides, from the reaction function of a type $t_A$ worker, we can infer that the equilibrium effort level of an inequity averse worker is decreasing with the effort level of the other group-member. An inequity averse worker has even a lower performance when he faces a selfish worker compared to the situation where his opponent is inequity averse too. We can note that an inequity averse worker facing another type $t_A$ worker always provides a positive effort level whatever $\alpha$ and $\beta$ are while an inequity averse worker facing a selfish one chooses a zero effort level as soon as $\alpha + 3\beta \geq 2$.

Proposition 1 is established under the assumption that each worker’s type is common knowledge. Nevertheless, it seems more realistic to consider that workers’ personality types are private information. We assume that the proportion of inequity averse people in the working population is known by all of the workers. Type $t_A$ workers must maximize their expected utility knowing only the probability to compete against a selfish or another inequity averse employee. Knowing that the equilibrium effort level of inequity averse workers decreases as their co-worker’s effort level increases, we deduce that the equilibrium effort level of inequity averse workers under incomplete information is lower than their effort level when it is common knowledge that they face another inequity averse worker and bigger than their effort level when they face a selfish worker. Their equilibrium effort level is then increasing with the proportion of inequity averse workers in the sample$^{13}$:

$$e_A^* = \begin{cases} \frac{2-\alpha-3\beta+\rho(\alpha+\beta)}{2(1-\beta)+\rho(\alpha+\beta)} e_S^* & \text{if } \alpha (1-\rho) + \beta (3-\rho) < 2 \\ 0 & \text{otherwise} \end{cases}$$

$^{13}$The number of workers supposed to be infinite, the type of one particular individual does not affect his beliefs about his opponent’s type.
Corollary 1 Under incomplete information, there exists a unique Bayesian equilibrium such that the equilibrium strategy of an inequity averse worker, increasing with $\rho$, is $e_A^* \in \left[ e_A^{AS*}, e_A^{AA*} \right]$ and the equilibrium strategy of a selfish worker is his dominant strategy, $e_S^*$. 

The equilibrium strategy of inequity averse workers is obviously lower than the optimal effort level of selfish workers. When inequity aversion of people is private information, the equilibrium effort level of inequity averse workers is decreasing with the number of selfish workers in the pool. The expected utility received by a type $t_S$ worker is optimal at the equilibrium and is independent of his opponent’s effort level. However, type $t_A$ workers derive a very low, even negative, expected utility when their inequity aversion degrees are high due to the degenerated allocation of incomes.

Under complete information about the other group-member type, an inequity averse worker derives a higher expected utility if his opponent is inequity averse too than if he is selfish, whatever $\alpha$ and $\beta$ are respecting the assumptions described in section 2.1:

$$E \left[ V_A (e_A^{AA*}, e_A^{AA*}) \right] \geq E \left[ V_A (e_A^{AS*}, e_S^*) \right] \forall \alpha, \beta, \alpha \geq |\beta| \text{ and } -1 < \beta < 1 \quad (6)$$

At the equilibrium, the expected utility of an inequity averse worker is decreasing with $\alpha$ whatever the type of the other group-member is. When $\beta$ is increasing, its negative effect on workers’ utility is clear if the group is heterogeneous even though the decline is slower than the one induced by the augmentation of $\alpha$. Further, if the group is composed by two inequity averse workers, when $\alpha$ and $\beta$ reach a sufficiently high level, the equilibrium expected utility is increasing with $\beta$ due to the decrease of both workers’ effort level.

Under incomplete information, the equilibrium expected utility of inequity averse workers, $^{11}E [V_A] = \rho E [V_A (e_A^*, e_A^*)] + (1 - \rho) E [V_A (e_A^*, e_S^*)]$, increases as the proportion of the population with social preferences raises. This result is obtained because their equilibrium expected utility is higher when the group is homogeneous than when they compete against a selfish employee as it is in the full information situation:

$$E \left[ V_A (e_A^*, e_A^*) \right] \geq E \left[ V_A (e_A^*, e_S^*) \right] \forall \alpha, \beta, \alpha \geq |\beta| \text{ and } -1 < \beta < 1 \quad (7)$$
The development of this section has proven that inequity averse and selfish workers do not have the same equilibrium behavior. Indeed, we obtain an asymmetric equilibrium with higher effort investments in their job by employees who only care about their own payment. Workers sensitive to inequalities between net payoffs invest a very low effort level at the equilibrium and receive a very low utility as well due to the tournament design which is to allocate a high prize to a single employee among contestants. Conclusions about the incentive effect of tournaments cannot be generalized to the whole working population when people are heterogeneous in terms of social preferences.

3 "Break-away" of fair-minded workers

In the previous section, we assumed people compensated under a rank-order tournament. However, in the business place, workers have the choice to work under different organizations characterized by various compensation modes and at least, they always have the choice to participate in the production process or not to work. Indeed, in the principal-agent theory, the contract proposed by the principal is based on a participation constraint added to an incentive constraint. The considerable *ex post* inequality generated by the tournament induces an awfully low expected utility for inequity averse workers when their degrees of inequity aversion are sufficiently high. In this section, we identify in the first place people who prefer to leave the tournament for an outside option and then, among these "tournament-breakers", we characterize people who are attracted by another variable payment scheme based on an equally share of the global output. The final goal of this section is to show that a separating equilibrium with selfish people working under the tournament and inequity averse ones under the revenue-sharing may exist and infers high effort levels by all the workers.

3.1 Leave for an outside option

We consider an outside option, strategy $X$, which consists of staying out of the organization, which means out of the tournament game. Following the context of the principal-agent
theory, the outside option gives individuals their reservation utility, \( u_0 \geq 0 \), which is identical for all workers. As people who leave the tournament for the outside option are not directly connected to other people, they do not compare their payoff to others’. Then, \( u_0 \) is independent of others’ payoff even for fair-minded workers.

A selfish worker \( k \) prefers to work under the tournament than to take the outside option if:

\[
V_k(e^*_S) = \tau e^*_S - e^*_S^2 \geq u \iff \tau \geq 2\sqrt{u} \quad (8)
\]

As the expected utility derived at the equilibrium by an inequity averse worker from being compensated according to a tournament is decreasing in \( \alpha \) and \( \beta \), his participation constraint is harder to be satisfied when his inequity aversion degrees are high. The participation constraint is the following:

\[
II_{E[V_A]} = \rho E[V_A(e^*_A, e^*_S)] + (1 - \rho)E[V_A(e^*_A, e^*_S)] \geq u \quad (9)
\]

We characterize \( \beta^*(\alpha) \) such that \( \rho E[V_A(e^*_A, e^*_A)] + (1 - \rho)E[V_A(e^*_A, e^*_S)] = u \). Then, workers with \( \beta \geq \beta^*(\alpha) \) do not verify the tournament participation constraint and prefer to receive their reservation utility than to work under the tournament. It is equivalent to say that when \( \alpha \) and \( \beta \) are big enough, workers prefer to avoid the tournament because caring too much about others’ payoffs, their utility by earning a wage very different from their opponent in the tournament is lower than the one they can get from staying out of the organization. The more the disadvantageous inequity aversion of the worker is high, the more the threshold on advantageous inequity aversion to prefer the outside option than the tournament is low.

If inequity averse workers leave the tournament for an outside option, we must be sure that once this flight done, i.e. once all the selfish workers are employed under the tournament but all the inequity averse workers chose the outside option, they have no interest to deviate which signifies, to introduce the tournament when all the contestants are selfish. We have \( E[V_A(e^*_A, e^*_S)] = E[V_A(e^*_A, e^*_S)] \) for \( \rho = 0 \). It implies that if inequality (9) is unproven, \( E[V_A(e^*_A, e^*_S)] < u \) is inevitably verified. Once all type \( t_A \) workers with \( \beta \geq \beta^*(\alpha) \) have quit the tournament for their reservation utility, none of them have an interest to deviate by going back under the tournament. We find an equilibrium described
by the following proposition.

**Proposition 2** Under incomplete information, it exists a separating perfect Bayesian equilibrium with strategy profiles such that \((e_S^* | t_S)\) and \((X | t_A)\) whatever the beliefs on workers’ type are if type \(t_A\) workers are characterized by \(\beta \geq \beta^*(\alpha)\).

Once the sorting done, none of the workers, whatever their type is, have an interest to deviate from this issue. For the remaining of the paper, we consider that advantageous inequity aversion of type \(t_A\) workers is such that \(\beta \geq \beta^*(\alpha)\). Indeed, the case we need to focus on corresponds to the situation in which inequity averse workers prefer to avoid the tournament. Nevertheless, we will discuss different cases corresponding to various inequity aversion levels in section 5.

### 3.2 Leave for another organization

On the labor market, workers choose to enter or not an organization but they also choose the organization they want to work with. Indeed, inequity averse workers may be more interested in working under a compensation mode which does not create such a strong inequality between workers’ payoffs. The idea here is to consider another payment scheme more adapted to inequity averse workers in terms of expected utility derived. This alternative organization to the tournament, so called revenue-sharing, divides equally the outcome between group members. The objective is to verify whether a separating equilibrium such that selfish workers work under the tournament compensation mode and inequity averse ones under the revenue-sharing exists. Also, we assume that already one inequity averse individual works under the revenue-sharing with inequity aversion degrees high enough to reach an equilibrium with a higher effort level than the "free-riding equilibrium"\(^{14}\). A higher utility should be induced. This payment scheme is parented to public goods games in the sense that the whole group contribution is equally shared between workers whatever their

\(^{14}\)The "free-riding equilibrium" is the well-known unique equilibrium when all players of the game are supposed to have no social considerations.
investment is. Consequently, workers who do not care about the other group-member’s payoff invest a low effort level\textsuperscript{15}. The revenue-sharing may attract inequity averse workers who do not support an important \textit{ex post} inequality under the constraint that selfish workers have no interest to introduce the revenue-sharing and "shirk" by free-riding. We note $v, v \in [0, 1]$, the share of the joint-output distributed to workers.

Inequity averse workers’ utility function is then written:

$$U_i(e_i, e_j) = \begin{cases} 
\frac{1}{2}v(e_i + e_j) - e_i^2 - \alpha(e_i^2 - e_j^2) & \text{if } e_i > e_j \\
\frac{1}{2}v(e_i + e_j) - e_i^2 - \beta(e_j^2 - e_i^2) & \text{if } e_i < e_j \\
\frac{1}{2}v(e_i + e_j) - e_i^2 & \text{if } e_i = e_j 
\end{cases}$$

As we assumed that workers compare their net payoffs, even in an egalitarian distribution of the output produced, the utility of workers is reduced if both group-members do not realize the same effort level.

**Proposition 3** If it is common knowledge that all workers compensated under the revenue-sharing payment scheme are type $t_A$ workers, there exist multiple symmetric equilibria $\hat{e}_A$ such that:

$$\frac{v}{4(1+\alpha)} \leq \hat{e}_A \leq \frac{v}{4(1-\beta)}. \quad (10)$$

PROOF: see the Appendix.

Therefore, when it is common knowledge that all participants in the revenue-sharing are fair-minded, the free-ride equilibrium is not unique. As type $t_A$ workers are supposed identical, all the equilibria of the revenue-sharing game are symmetric. Their interval increases with inequity aversion degrees: the lower bound of the equilibria set is increasing with $\alpha$ and the upper bound with $\beta$. Consequently, the Pareto optimum, $\hat{e}^{OP} = \frac{v}{2}$, of the revenue-sharing game becomes an equilibrium if it is common knowledge that all the participants have a degree of advantageous inequity aversion high enough, $\beta \geq \frac{1}{2}$. Fair-minded workers with $\beta > 0$ who avoid the tournament for the revenue-sharing are able to reach an equilibrium inducing a higher effort level than the free-riding equilibrium under the

\textsuperscript{15}The experimental evidence shows however that many people contribute more than the theory predicts (see Ledyard (1995) for a survey) which supports a heterogeneity of types.
constraint that selfish workers do not have any interest to introduce the revenue-sharing game.

Nevertheless, as we cannot assume that players coordinate their expectations on a particular equilibrium and as the Nash equilibrium concept does not resolve the problem of multiple equilibria selection when strategies are weakly dominated, we need to apply one of its refinements to restrict the set of equilibria. The concept of forward induction\textsuperscript{16} allows for this equilibria selection. Asheim and Dufwenberg (2003) treat a very similar intuition to ours although they do not base workers’ characteristics on the Fehr and Schmidt’s model. They show that forward induction makes the selection of the Pareto-dominant equilibrium possible in a coordination game with discrete strategies (they use another group incentive game: "forcing contracts"). According to the definition advanced by Cooper et al. (1992), a coordination game consists of multiple, Pareto-ranking and pure strategy Nash equilibria. Henceforth, the revenue-sharing game with players having a sufficiently high advantageous inequity aversion is included in this category of games.

Agent $i$ prefers to play under the revenue-sharing game than to take the outside option if $U_i(\hat{e}_A, \hat{e}_A) \geq u$ with $\hat{e}_A \in \left[ \frac{2u}{4(1+\alpha_2)}, \frac{u}{4(1-\beta)} \right]$. Then, a worker choosing the revenue-sharing sends a signal to other workers that he enters the game with the objective to earn more than $u$, i.e. he wants to reach an equilibrium\textsuperscript{17}, $\hat{e}_A$, from the set of possible equilibria defined by (10) such that $U_i(\hat{e}_A, \hat{e}_A) \geq u \iff v\hat{e}_A - \hat{e}_A^2 \geq u$. If we assume $e_A$ being the effort level which keeps the worker indifferent between the outside option and the revenue-sharing, i.e. $v e_A - e_A^2 = u$, the set of equilibria is then restricted to $\hat{e}_A$ such that:

$$\hat{e}_A \in [e_A, e^{OP}] \iff \hat{e}_A \in \left[ \frac{v - \sqrt{v^2 - 4u}}{2}, \frac{v}{2} \right] \text{ with } v \geq 2\sqrt{u}$$

A worker with $\beta \geq \hat{\beta}$ prefers to enter the revenue-sharing than to take the outside option. The advantageous inequity aversion threshold is then:

$$\hat{\beta} = 1 - \frac{u}{4e_A} \quad (11)$$

\textsuperscript{16}The main theoretical works about the concept of forward induction includes Kohlberg and Mertens (1986), van Damme (1989) and Battigalli and Siniscalchi (2002).

\textsuperscript{17}We consider here groups exclusively composed by inequity averse workers because we analyse the possible issue where selfish workers are employed under the tournament.
For the remaining of the paper, we assume that inequity averse workers have an advantageous inequity aversion degree verifying $\beta \geq \hat{\beta}$ in addition to $\beta \geq \beta^*(\alpha)$. Moreover, we can consider that the equilibrium effort level is never higher than the Pareto optimum because whatever the strategy of $j$ is, the expected utility of worker $i$ is decreasing as his effort level increases beyond the optimal effort level without taking into account the reduction due to inequity.

Each group is composed once players have entered the revenue-sharing game, which means that a worker having chosen to leave the tournament and not to take the outside option infers that he plays with someone who did the same choice as him. Consequently, both workers send a signal about their intentions to play a higher effort level than $e_A$. The objective here is to show that the free-ride issue does not belong to the set of equilibria. Also, we assume that $e_A > \hat{e}_S$ with $\hat{e}_S$ the free-ride equilibrium, $\hat{e}_S = \frac{v}{4}$. The necessary condition to observe an equilibrium under the revenue-sharing payment scheme higher than the free-ride equilibrium is that selfish workers prefer to work under the tournament than introducing the revenue-sharing and taking advantage of fair-minded workers by playing their dominant strategy, $\hat{e}_S$, which is to free-ride. Due to people’s incapacity of selecting an effort level equilibrium under the revenue-sharing with certainty, this condition must be verified $\forall \hat{e}_A \in [e_A, \hat{e}^{OP}]$. It is written:

$$V_S(e^*_S) \geq \max_{\hat{e}_A \in [e_A, \hat{e}^{OP}]} U_S(\hat{e}_A, \hat{e}_S) \iff V_S(e^*_S) \geq U_S(\hat{e}_A, \hat{e}_S)$$

with $\hat{e}_A$, the equilibrium effort level providing the maximum expected utility, increasing with the advantageous inequity aversion degree of inequity averse workers, $\hat{e}_A = \left\{\begin{array}{ll}
\frac{v}{2} & \text{if } \beta \in \left[\frac{1}{2}, 1\right) \\
\frac{v}{4(1-\beta)} & \text{if } \beta \in \left[\hat{\beta}, \frac{1}{2}\right)
\end{array}\right.$

It is equivalent to: $\tau e^*_S - \frac{v}{2} (\hat{e}_A + \hat{e}_S) \geq e^2_S - \hat{e}^2_S$

$$\iff \left\{\begin{array}{ll}
4\tau^2 - 5v^2 \geq 0 & \text{if } \beta \in \left[\frac{1}{2}, 1\right) \\
4\tau^2(1-\beta) - v^2 (3-\beta) \geq 0 & \text{if } \beta \in \left[\hat{\beta}, \frac{1}{2}\right)
\end{array}\right.$$

Condition (12) is verified if $\tau$ is high enough and $v$ low enough. The more $\beta$ is high, the more the upper bound of the equilibria set is elevated and then, the more the utility derived by a selfish worker who shirks is important. Hence, inequality (12) is harder to be verified.
At the same time, inequity averse workers must prefer to work under the revenue-sharing once the sorting done:

\[
E \left[ V_A(e_A^{AS*}, e_S^*) \right] \leq \min_{\hat{e}_A} U_A(\hat{e}_A, \hat{e}_A) \forall \hat{e}_A \text{ such that } U_A(\hat{e}_A, \hat{e}_A) \geq u
\]

\[\iff E \left[ V_A(e_A^{AS*}, e_S) \right] \leq u\]

We showed in subsection 3.1 that this inequality is always verified if advantageous inequity aversion of type \( t_A \) workers is such that \( \beta \geq \beta^*(\alpha) \), which means that inequity averse workers never gain from leaving the revenue-sharing for the tournament.

Therefore, it exists a separating equilibrium in which all people are identical or better off compared to the situation in which everybody plays the tournament. Inequity averse workers who quit the production process when only the tournament is available prefer to move to the revenue-sharing if they know that one fair-minded worker belongs already to this organization. It conducts to proposition 4 which shows that once workers have sorted in the way that selfish players choose the tournament and inequity averse people choose the revenue-sharing, nobody has an advantage to deviate.

**Proposition 4** A separating perfect Bayesian equilibrium with strategy profiles such that \((e_S^* \mid t_S)\) and \((\hat{e}_A \mid t_A)\) and beliefs such that \(b_i(t_S \mid e_S^*) = b_i(t_A \mid \hat{e}_A) = 1\) exists if \( \tau \) and \( v \) are such that inequality (12) is satisfied.

Fair-minded workers receive a very low expected utility when they work in an organization applying a compensation mode, such as a tournament, yielding to a dramatic ex post inequality between team-members’ payoffs. For sufficiently high inequity aversion degrees, these workers are even ready to quit the tournament to receive only their reservation utility in order to avoid this important inequality. Nevertheless, if we consider another organization which distributes equally the joint-output between group-members, we observe that workers with sufficiently high degrees of inequity aversion leave the tournament for the revenue-sharing under the condition that selfish workers are given incentives to prefer the tournament and inequity averse workers are given incentives to participate in the
revenue-sharing instead of staying out of the production process. Hence, all workers invest
a positive and high effort level in their job. \((1 - \rho)\) is the share of workers compensated
according to the tournament and \(\rho\) to the revenue-sharing. The object now is to analyze
the optimal contract in an industrial sector in which workers have the choice between two
organizations proposing two different distributions of payoffs among group-members and
have the option to choose an outside option.

4 Global game and optimal contract

We showed in the previous section that inequity averse workers prefer to run away from the
tournament for an egalitarian partnership payment scheme while selfish workers make a
higher expected utility under tournaments. The incentive effect of both performance-based
payment schemes are then improved when workers are allowed to self-select themselves
into the organization using the compensation mode the most adapted to their preferences.
The sorting of workers under each compensation mode implies homogeneous groups in
the sense that workers in a particular group have the same degree of social preferences
(in terms of inequity aversion). Knowing that they are working with someone having
the same considerations, the incentive effect under compensation modes involving either
a competitive or a cooperative behavior is improved. None of the players decide not to
enter none of the games which means that every agent adds his contribution to the global
output by working, which is not the case when only the tournament exists. Not considering
the possible self-selection of workers when they differ by their degree of inequity aversion
may conduct to a very important misunderstanding of organizations’ incentives design.
The step of the study presented in this section is to show that offering workers the choice
between two variable compensation modes is not only beneficial to them but it provides
higher profits to the principal also.

We consider in the global game that both types of workers can choose the organization,
characterized by its compensation system, they want to work with. Consequently, this
game is composed by two stages:
- 1\textsuperscript{st} stage: players choose simultaneously to enter the tournament \((T)\), the revenue-sharing \((R)\) or to take the exit option \((X)\);

- 2\textsuperscript{nd} stage: players who chose to participate in one of the two games at the 1\textsuperscript{st} stage are matched with another worker having done the same choice and then, they simultaneously decide their effort level without any information about the type of their co-worker.

Three options are offered to the principal. He may propose only one payment scheme which would be the tournament or the revenue-sharing. The other option is to propose both the tournament and the revenue-sharing with self-selection.

The first step is to define the optimal contract under each situation. The action variables of the principal are the share of the global output given to workers under the tournament, \(\tau\), and the revenue-sharing, \(v\).

The maximization program of the principal when he proposes only the tournament is written:

\[
\max_{\tau_{\text{tour}}} \Pi_{\text{tour}} = (1 - \rho)(1 - \tau)\hat{e}_S
\]
\[
s.t. (8)
\]

The optimal share\footnote{We assume \(u \leq \frac{1}{15}\) in order to be more realistic and to obtain an optimal contract independant of people reservation utility; if \(u > \frac{1}{15}\), \(\tau_{\text{tour}}^* = 2\sqrt{u}\).} is \(\tau_{\text{tour}}^* = \frac{1}{2}\).

When he proposes only the revenue-sharing, his maximization program is\footnote{When the only payment scheme is the revenue-sharing, selfish agents play their dominant strategy which is to free-ride, \(\hat{e}_S\), and inequity averse workers play \(\hat{e}_S\) also if \(\rho \leq \frac{1}{1+\alpha}\) and \(\hat{e}_A = \frac{1+\rho}{1+\alpha(1-\rho)}\hat{e}_S\) if \(\rho > \frac{1}{1+\alpha}\).}:

\[
\max_{\tau_{\text{tour}}} \begin{cases} 
\Pi_{\text{rev}} = (1 - v)\hat{e}_S & \text{if } \rho \leq \frac{\alpha}{1+\alpha} \\
\Pi_{\text{rev}} = (1 - v)(\rho \hat{e}_A + (1 - \rho)\hat{e}_S) & \text{if } \rho > \frac{\alpha}{1+\alpha}
\end{cases}
\]
\[
s.t. \ v \geq 2\sqrt{u}
\]

The optimal share is then \(v_{\text{rev}}^* = \frac{1}{2}\).

The offer of the tournament or the revenue-sharing when we consider mono-organizationnal
structures depends on the percentage of inequity averse agents in the whole working population. The more \( \rho \) is elevated, the more the principal’s profit is high under the revenue-sharing and low under the tournament. Consequently, the principal’s interest to use the tournament mechanism design is decreasing with \( \rho^{20} \).

Besides, the maximization program of the principal when he proposes the tournament and the revenue-sharing with self-selection is the following\(^{21}\):

\[
\max_{\tau_{\text{selec}}, v_{\text{selec}}} \Pi_{\text{selec}} = (1 - \rho)(1 - \tau) e_5^* + \rho(1 - v) \hat{e}_A \text{ with } \hat{e}_A \in [\underline{e}_A, \overline{e}_A] \\
\text{s.t.} (8) (12)
\]

We note \( \hat{e}_A = \frac{v}{2(1 - \gamma)} \). The optimal share given to workers under the tournament, \( \tau^*_\text{selec} \), is a linear increasing function of the share given under the revenue-sharing: \( \tau^*_\text{selec} = \frac{\sqrt{\beta}}{2} v^*_\text{selec} \).

\[
v^*_\text{selec} = \begin{cases} \\
\frac{\sqrt{5(1 - \gamma)(1 - \rho)^2} + \rho}{3 - 3\rho - 5\gamma(1 - \rho)} & \text{with } \gamma \in [\hat{\beta}, \frac{1}{2}] \text{ if } \beta \in \left[\frac{1}{2}, 1\right) \\
\frac{\gamma(1 - \gamma)(1 - \rho) + \rho}{3 - 3\rho - 5\gamma(1 - \rho) - \beta(1 + \gamma(1 - \rho))} & \text{with } \gamma \in \left[\hat{\beta}, \beta\right] \text{ if } \beta \in \left[\hat{\beta}, \frac{1}{2}\right), \ A = \sqrt{3 - 4\beta + \beta^2}
\end{cases}
\]

The principal increases the share given to workers under the revenue-sharing as the proportion of fair-minded workers into the whole population raises. Moreover, this share increases with \( \gamma \) which indicates the level of the effective equilibrium effort level. Nevertheless, nobody is able to evaluate correctly \( \hat{e}_A \), which means that the principal must establish the contract based on his expectations concerning the equilibrium effort level played in various groups. Therefore, the less his estimation of \( \hat{e}_A \) is correct, the more his profit is lower than the optimal profit.

At the optimum, we obtain:

\[
\begin{cases} \\
\Pi^*_\text{selec} (\tau^*_\text{selec}, v^*_\text{selec}) \geq \Pi^*_\text{tour} (\tau^*_\text{tour}) \forall \hat{e}_A \in [\underline{e}_A, \overline{e}_A] \text{ and } \forall \beta \in \left[\hat{\beta}, 1\right) \\
\Pi^*_\text{selec} (\tau^*_\text{selec}, v^*_\text{selec}) \geq \Pi^*_\text{rev} (v^*_\text{rev})
\end{cases}
\]

**Proposition 5** If the principal knows \( \rho \) with certainty and that inequity averse workers are such that their advantageous inequity aversion degree is greater than \( \beta^*(\alpha) \) and \( \hat{\beta} \),

\(^{20}\Pi^*_\text{tour} \geq \Pi^*_\text{rev} \) if \( 0 \leq \rho \leq \frac{1}{2} \) when \( \rho \leq \frac{\alpha}{1 + \alpha} \) (case 1) and if \( 0 \leq \rho \leq \frac{-(1 + \alpha)\sqrt{2(1 + \alpha)}}{1 - \alpha} \) when \( \rho > \frac{\alpha}{1 + \alpha} \) (case 2). We can note that if \( 0 \leq \alpha < 1 \), the tournament is always preferred to the revenue-sharing in case 1, but the tournament in case 2 may be chosen only if \( 0 \leq \alpha < 1 \).

\(^{21}\)As we cannot select a unique equilibrium under the revenue-sharing, we must consider the whole set of equilibria as a possible issue.
he always prefers to propose both payment schemes with self-selection.

The principal always profits by proposing both the tournament and the revenue sharing payment schemes with self-selection instead of the tournament only. The profit deduced is strictly increasing with the effort level equilibrium under the revenue-sharing. Although a positive proportion of inequity averse workers induces superior profits when the principal proposes both payment schemes, these profits are increasing with the proportion of inequity averse workers only if the equilibrium effort level under the revenue sharing equals or almost equals the Pareto optimum\textsuperscript{22} under the condition that $\rho$ is high enough\textsuperscript{23}. It is clearly decreasing for $\hat{e}_A$ such that $\gamma \in \left[\beta, 0.493\right]$. It may be explained by the fact that the optimal share given to workers is increasing with $\rho$ which is then more costly for the principal.

The share given to workers under the tournament depends positively on $\rho$. It induces that when the population is exclusively composed by selfish people, the principal adapts $v^*_\text{selec}$ and $\tau^*_\text{selec}$ to the context and $\tau^*_\text{selec} = \tau^*_\text{tour}$. As constraint (12) is verified, selfish workers choose the tournament with certainty and then, we obtain $\Pi^*_\text{selec}(\tau^*_\text{selec}, v^*_\text{selec}) = \Pi^*_\text{tour}(\tau^*_\text{tour})$. Therefore, as soon as the principal knows with certainty the proportion of the working population who have social preferences, he has a strict advantage to propose both compensation modes. Nevertheless, the principal may not know $\rho$ perfectly and must in this case make an estimation $\hat{\rho} = \rho + \Delta$ with $\Delta \in [-\rho, 1 - \rho]$. To over-estimate $\rho$ is the most costly to the principal because it induces higher $\tau^*_\text{selec}$ and $v^*_\text{selec}$ than necessary. Nevertheless, proposing self-selection provides almost always higher profits than proposing only the tournament except for values of $\rho$ very closed to 0 ($\rho < 0.028$). Even if the principal makes some estimation errors about the proportion of inequity averse people in the working population, it is unlikely that he would loose profits by proposing both payment schemes with self-selection.

\textsuperscript{22}To be more precise, the necessary condition to observe $\frac{\partial \Pi^*_\text{selec}}{\partial \rho} > 0$ is to have $\hat{e}_A$ such that $0.493 < \gamma \leq \frac{1}{2}$ if $\beta \geq \frac{1}{2}$. If $\beta \in \left[\beta, \frac{1}{2}\right)$, the interval on $\gamma$ and $\beta$ is even more reducted and cases are such rare that we consider only cases related to $\beta \geq \frac{1}{2}$.

\textsuperscript{23}Few examples: for $\gamma = 0.493, \rho > 0.996$ is needed to obtain $\frac{\partial \Pi^*_\text{selec}}{\partial \rho} > 0$; for $\gamma = 0.497, \rho > 0.75$ is needed; for $\gamma = 0.5, \rho > 0.528$ is needed.
To offer an organizational choice to workers is then in everyone’s interest. On the one hand, all workers realize a high effort level due to the realization of homogeneous groups driven by employees’ choices. Selfish people work under the tournament and inequity averse workers under the revenue-sharing. On the other hand, the principal gains to propose both payment schemes with self-selection to agents through the global improvement of workers’ productivity. Pareto gains are then achieved.

5 Discussion

We have assumed through the whole paper that inequity aversion of workers is such that they prefer to leave the tournament for an outside option, $\beta \geq \beta^*(\alpha)$, but prefer to participate in another game, the revenue sharing, instead of the outside option, $\beta \geq \hat{\beta}$. Nevertheless, other cases exist.

![Fig. 1. Different categories of workers in function of \( \alpha \) and \( \beta \)](attachment:fig1.png)

According to the graph, we can differentiate four cases. In case 1, the principal proposes both payment schemes (case analyzed previously) and his optimal profit is $\Pi^*_{{select}}$; In case 2, no inequity averse worker choose to enter either game ($\beta \geq \beta^*(\alpha)$ and $\beta < \hat{\beta}$) then, the
principal chooses to implement only the tournament and his profit is \( \Pi_{\text{tour}}^* \) with a unique equilibrium effort level, \( e_S^* \); In cases 3 and 4, the principal proposes only the tournament and his profit is \( \Pi_{\text{tour}}^* \) with \( e_S^* \) and \( e_A^* \) at the equilibrium\(^{24} \), noted \( (\beta < \beta^*(\alpha)) \Pi_{\text{tour}}^* \). In case 4, the proposition of the tournament or the revenueIf we suppose that the principal cannot observe the level of social preferences of workers, he has to take into account probabilities of ranges on \( \alpha \) and \( \beta \) to decide to implement only the tournament or to give workers the choice between the tournament and the revenue-sharing. We note by \( p_1 \) the probability to observe inequity aversion degrees such that \( \beta \geq \beta^*(\alpha) \) and \( \beta \geq \hat{\beta} \), by \( p_2 \) the probability such that \( \beta \geq \beta^*(\alpha) \) and \( \beta < \hat{\beta} \) and by \( p_3 \) the probability such that \( \beta < \beta^*(\alpha) \). He proposes self-selection, under the constraint that \( p_1 + p_2 + p_3 = 1 \), if\(^{25} \):

\[
p_1 \Pi_{\text{selec}}^* (\tau_{\text{selec}}^*, v_{\text{selec}}^*) \geq p_2 \Pi_{\text{tour}}^* (\tau_{\text{tour}}^*) + p_3 (\beta < \beta^*(\alpha)) \Pi_{\text{tour}}^* (\tau_{\text{tour}}^*) \tag{14}
\]

Replacing \( p_2 \) by \( 1 - p_1 - p_3 \), we obtain that inequality (14) is verified if \( p_3 \) is not too big and \( p_1 \) high enough with the restriction increasing with \( p_3 \). As a general result, the probability that \( \alpha \) and \( \beta \) are such that \( \beta < \beta^*(\alpha) \) must be low enough while the probability to have \( \alpha \) and \( \beta \) such that \( \beta \geq \beta^*(\alpha) \) and \( \beta \geq \hat{\beta} \) must be high enough in order to observe the proposition of the tournament and the revenue sharing with self-selection to workers by the principal.

Besides, under our framework, we considered the marginal return of effort investment equal to one under the revenue-sharing. In public goods games, it is usual to observe the effort productivity higher than one to represent the benefit of cooperation. It means to change the gross payment from \( \frac{n}{2}Q \) to \( \frac{n}{2}Q,g \) with \( g \in [1,2] \). A separating equilibrium is still achievable at the cost of an incentive constraint more restrictive than (12) but is also compensated by an increase of the equilibrium effort level under the revenue-sharing. Therefore, considering a marginal return on investment higher than one does not change the conclusions displayed previously.

Our final remark concerns the number of periods to consider. We analyzed one period

\(^{24} \)The \( \tau \) optimal equals \( \tau_{\text{tour}}^* \).

\(^{25} \)As the expected profit function of the principal is different from the previous section, we maximized the one considered here to find the optimal contract and it is shown that there is no difference between both cases, the optimal \( \tau \) equals \( \tau_{\text{tour}}^* \).
interactions between workers to emphasize the impact of fairness preferences on incentives. Nevertheless, we can expect that the sorting improves workers’ productivity even for long-term relations. In the revenue-sharing, a long-term interaction may lead to a decline of cooperation. However, when all the workers are fair-minded, the cooperation might last even if interactions are repeated for a long time. In tournaments, it is known that incentives can be weakened because of a collusion which emerges between agents when prizes are fixed. If all the players in the tournament like winning or do not like losing, this collusion might not appear.

6 Conclusion

The main result of our analysis is that the coexistence of heterogeneous types of workers in terms of inequity aversion may justify the presence of multiple performance-based payment schemes on the business place. In the particular case of group incentives, various organizations are more efficient than only one mechanism if and only if agents of each type have an incentive to choose to work under the variable payment scheme the most adapted to them. Homogeneous groups are then constructed in this way. People differing by their social preferences, they react differently when they set in a competitive environment. Workers who are exclusively concerned by their own payoff are strongly and positively affected by this kind of incentives. However, inequity averse workers negatively touched by the \textit{ex post} inequality between payoffs invest a low effort level and are even ready to leave the tournament for an outside option if their advantageous and disadvantageous inequity aversion are high enough. When an alternative firm proposes an equally share of the joint output between employees of the group, workers with social concerns move to this new alternative and are able to reach an equilibrium with a higher effort level than their equilibrium strategy under the tournament if it is common knowledge that all the workers are fair-minded.

By analyzing the global game in which workers choose at a first stage to work either under a ranking tournament or a revenue-sharing payment scheme with the possibility to flee away for an outside option and their effort level at a second stage, it is shown that a
separating equilibrium may exist. A self-selection of workers such that selfish agents prefer to work under the tournament and inequity averse workers under the revenue-sharing may happen if fair-minded workers have a sufficiently high advantageous inequity aversion and under the necessary condition that selfish workers have no interest to introduce the revenue-sharing. Once the sorting realized, behaviors are stable and nobody has an advantage to choose the outside option and all the workers face incentives which lead them to invest a high effort level. Indeed, the compensation mode agents work under is efficient because homogeneous groups in terms of social preferences are formed. The optimal contract for the principal is then to propose both payment schemes, the tournament and the revenue-sharing, with self-selection whatever the proportion of fair-minded workers is if their advantageous and disadvantageous inequity aversion degrees are high enough.

The conclusions of this paper enlighten the importance of considering workers’ self-selection when they have the possibility to choose their payment scheme not based on heterogeneous abilities but rather on social preferences disparities. A business environment which allows people to select their payment scheme may induce an identification of personality types *ex post*. One particular group incentive design cannot be efficient when the working population is heterogeneous. Various performance-based compensation modes are needed on the business place to insure adapted incentives for different types of workers. The condition is that no one has an interest to deviate from the separating equilibrium. Self-selection of workers is then essential to analyze more properly work incentives.

The first direct work would be to test these predictions by business data. Nevertheless, as social preferences of workers are not observable in reality, it should be tested experimentally. Another study would be to differentiate workers by their skills level also in order to determine which effect is stronger and if it is of everyone’s interest to have homogeneous groups in terms of both abilities and social preferences. Considering diverse workers’ personality types, self-selection must be considered to obtain a more accurate analysis of incentives provided by variable pay.

**APPENDIX**

*Proof of Proposition 3.* As $U_i(e_i, e_j)$ is different when $e_i > e_j$ and $e_i < e_j$, we check the
conditions under which player \( i \) of type \( t_A \) does not have an interest to deviate.

Type \( t_A \) workers are assumed identical so, they have the same equilibrium strategy.

We consider an issue with symmetric strategies \((\hat{e}_A, \hat{e}_A)\) and we control whether agents have an interest to deviate.

- Deviation for \( e_i > \hat{e}_A \)?

The worker does not deviate if \( U_i(\hat{e}_A, \hat{e}_A) \geq U_i(e_i, \hat{e}_A) \)

\[
\iff v\hat{e}_A - \frac{1}{2}v(e_i + \hat{e}_A) - e_i^2 - \alpha (e_i^2 - \hat{e}_A^2)
\iff \hat{e}_A \geq \frac{\frac{v}{2(1+\alpha)}}{e_i}
\]

As the equilibrium is symmetric,

\[
\iff \hat{e}_A \geq \frac{\frac{v}{4(1+\alpha)}}{e_i}
\]

It means that a worker of type \( t_A \) does not want to deviate from the issue \((\hat{e}_A, \hat{e}_A)\) for \( e_i > \hat{e}_A \) if \( \hat{e}_A \) is such that \( \hat{e}_A \geq \frac{\frac{v}{4(1+\alpha)}}{e_i} \).

We use the same method to determine if type \( t_A \) workers have an interest to deviate for a lower effort level.

- Deviation for \( e_i < \hat{e}_A \)?

The worker does not deviate if \( U_i(\hat{e}_A, \hat{e}_A) \geq U_i(e_i, \hat{e}_A) \)

\[
\iff v\hat{e}_A - \frac{1}{2}v(e_i + \hat{e}_A) - e_i^2 - \beta (\hat{e}_A^2 - e_i^2)
\iff \hat{e}_A \leq \frac{\frac{v}{2(1-\beta)}}{e_i}
\]

As the equilibrium is symmetric,

\[
\iff \hat{e}_A \leq \frac{\frac{v}{4(1-\beta)}}{e_i}
\]

It means that a worker of type \( t_A \) does not want to deviate from the issue \((\hat{e}_A, \hat{e}_A)\) for \( e_i < \hat{e}_A \) if \( \hat{e}_A \) is such that \( \hat{e}_A \leq \frac{\frac{v}{4(1-\beta)}}{e_i} \).

References


