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RECIPROCITY IN TEAMS: A BEHAVIORAL EXPLANATION FOR UNPAID OVERTIME

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Abstract

Relying on the relevance of other-regarding preferences in workplaces, the paper provides a behavioral explanation for the puzzle of unpaid overtime. It characterizes the optimal compensation schemes offered by the employer which induce overtime by exploiting workers' horizontal reciprocity under both symmetric and asymmetric information about workers' action. Finally, the paper shows that reciprocity furnishes a rationale for the composition of teams of reciprocal workers when the production technology induces negative externality among the employees' efforts.

KEY WORDS: Overtime, Horizontal Reciprocity, Negative Reciprocity.

JEL CLASSIFICATION: D03; D83; J33.

1 Introduction

There is considerable evidence that unpaid overtime is worked in modern industrialized societies.[1] Eurostat reports that in 2001 the average European wage-earner was paid for only about 5 out of 9 hours worked overtime per week (Eurostat, 2004). In Canada, the percentage of employees working overtime increased from 18.6% in 1997 to 22.6% in 2007, with 11.4% of overtime work unpaid (Statistics Canada, 2008). Firms demand overtime in response

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[1] Overtime is defied as all hours worked in excess of the normal hours, ILO (2004). 48 hours per week are considered as "normal", ILO Hours Work (Industry) Convention (No.1, 1919). The report points out that overtime "does not necessarily need to be linked to compensation".

to market fluctuations. From the employee's perspective, even if paid overtime may entail negative consequences in terms of health, safety and family life, it is still often seen as the way to increase the base salary (ILO, 2004). Overtime depends on national labor legislation, but some common features can be identified.[2] For instance, men are more likely than women to work overtime and to be paid for it. In most European countries, overtime is mainly worked by employees aged 55 and over, with less than 50% of it being paid. Overtime by machine operators is for the most part paid, while overtime by managers and professionals is often unpaid (Eurostat, 2004). Why do employees work overtime without compensation? Bell and Hart, (1999) test some of the economic determinants of unpaid overtime exertion on data from the British Labour Force Survey. Employer/employee uncertainty over task completion times, linked to the level of union collective bargaining agreements, has a negative effect on the probability of unpaid overtime exertion. Similarly, the probability of undertaking unpaid overtime is negatively related to the productivity of individual workers in the presence of team job scheduling, where low-productivity workers have to spend more time on completing their task than their high productive colleagues. Furthermore, a large amount of unpaid overtime is documented in sectors characterized by high standard hourly wages, which could be consistent with the gift exchange hypothesis.

Several studies on paid and unpaid overtime evidence the existence of a link between worked overtime hours and positive future outcomes. This relationship is consistent with the two main research hypotheses which have been investigated. The first explains overtime as an investment in human capital. Employees choose to undertake overtime in order to acquire specific human capital, in order to minimize the risk of being fired and/or maximize the probability of having better conditions (promotion, higher wage, etc.), (Van Echtelt et al., 2007). The second hypothesis considers overtime to be action, not necessarily productive, by which workers signal their intrinsic motivation or ability (Anger, 2008). Empirical investigations are not entirely convincing in regard to the strength of such explanations and their disconnection. An analysis on German socio-economic panel data (GSOEP) by Pannenberg (2005) reveals a long-term labor real earnings effect associated with unpaid overtime for male workers in West Germany. Conversely, even if a considerable amount of female unpaid overtime is documented, the investment component is not statistically significant. Using the same data, Anger (2008) exploits the variations in collectively bargained hours between industries to verify whether they imply different overtime thresholds for workers with the same number of actual worked hours. This analysis provides support for the signaling value of unpaid overtime; however, its results hold for West German workers but not for workers in East Germany. Booth et al. (2003), on analyzing the British labor market, compare unpaid and paid overtime and report no difference in the impact on the probability of a subsequent promotion. Similarly, a study on temporary workers in Sweden found that unpaid overtime has no effect on favoring the passage from temporary to permanent employment (Meyer and Wallette, 2005). Moreover, what is the explanation for the evidence of unpaid overtime in the public sector, where a promotion is not decided solely by the boss (Eurostat, 2004)? Or, why should workers at the end of their careers or at the top of their organization's hierarchy work unpaid overtime (Pannenberg, 2005)?

These conflicting results show that unpaid overtime cannot be exhaustively explained in

[2] See, among others, Mizunoya (2001) who analyzes the USA, Canada, Japan, Germany and the UK.

terms of the investment or signaling device hypotheses. Moreover, different groups of workers may have different reasons for undertaking unpaid overtime. Offered in what follows is a complementary explanation for this phenomenon which focuses on workers' Other-Regarding Preferences[3] (hereafter, ORP). Individuals are not motivated solely by self interest; they also care - positively or negatively - about material payoffs from relevant others whom they choose as referents. By including ORP in the analysis, the aim here is to explain unpaid overtime by focusing on horizontal reciprocity. Reciprocity concerns the willingness to respond fairly to kind action and unfairly to nasty actions (Rabin, 1993). We focus on horizontal rather than vertical reciprocity[4] in order to capture what, according to the Social Comparison Theory, is a natural tendency: people make comparisons, especially with others with the same status as themselves (Festinger, 1954). Moreover, mutual-help among employees (Corneo and Rob, 2003), the social sanctioning of free riders (Carpenter and Matthews, 2009), and social support among co-workers (Mossholder et al., 2005) may be interpreted as manifestations of reciprocity. In the workplace, it seems evident that repetitive interactions and team work create an environment in which each worker may affect the team's activity and the compensation of other team members if team bonuses are included in the individual worker's compensation. In contexts of this kind, horizontal reciprocity matters because each worker compares what s/he (and other team mates) earns with what s/he would have obtained as a consequence of an alternative choice by his/her colleagues.[5] It follows that the incentive system in an organization needs to be designed carefully because effort choices may be affected not only by the monetary compensation but also by the way in which ORP respond to own and other agents' payoffs. Intrinsic motivation crowding-out (Gneezy and Rustichini, 2000), and an over-justification effect (Bénabou and Tirole, 2006) are examples of unexpected negative effects.

We analyze an employer demanding overtime from two workers. As in Cox et al. (2007), the worker's utility function has two parts: the worker's material payoff and a component which weights the colleague's material payoff through the fairness of his/her chosen strategies. The fairness of the colleague's action is evaluated by looking at its material consequences on the worker's utility function.[6] We show that employee reciprocity may be exploited to elicit productive overtime without full compensation. This happens when the employer offers a relative compensation scheme which promises a high monetary payment to the worker that undertakes overtime when the colleague refuses to do so, and no compensation otherwise. Therefore the worker choosing to undertake overtime prevents the colleague from gaining the high monetary compensation and induces the colleague's negative orientation toward him/her. It follows that a worker motivated by negative reciprocity is willing to undertake

[3] Fehr and Fischbacher, (2002) and Rotemberg, (2006) review respectively experimental and theoretical results on ORP in the workplace.

[4] Vertical reciprocity has been extensively analyzed since the seminal paper by Akerlof, (1982). For a survey of experimental results see Fehr and Gächter, (2002).

[5] In Kahneman et al. (1986) this definition refers to a comparison between what the worker (and other team mates) earns and what s/he thinks s/he (and other team mates) is entitled to.

[6] Appendix A1 discusses Cox et al.'s (2007) formulation and derives the ones used here. For a discussion on the role of belief s and expectations as well as real behavior in conceptualizing reciprocity, see Perugini et. al., (2003).

underpaid or unpaid overtime in order to prevent the colleague gaining from being the only one to do so. We characterize the conditions under which employees motivated by reciprocity work unpaid overtime. This result seems to be consistent with empirical evidence provided by Van Echtelt et al. (2007), who, on analyzing the Time Competition Survey on a sample of Dutch firms, find that work pressure (defined as workers' negative motivation) is predictive of spending additional unpaid hours at work. This phenomenon is particularly evident in post-Fordist work contexts (i.e. the knowledge industry, financial services, professional services, education, research, etc.) where strong work pressure induces time competition among employees. Van Echtelt et al. (2007) evidence that working in post-Fordist organizations is clearly associated with overtime, while it is negatively associated with household responsibilities and gender.

Results similar to ours have been obtained in a different framework by the theoretical studies of Rey-Biel (2008) and Dur and Sol (2009). In Rey-Biel (2008) a principal exploits, still offering a relative performance contract, the inequity aversion of his/her agents to induce effort without fully compensating its cost. However, in Rey-Biel's paper, agents derive disutility from differences between themselves and others, while in our model workers are not interested in the relative final payoff rank per se, but instead use it as a reference for the co-worker's fairness evaluation. In our framework, indeed, the worker evaluates the colleague's fairness by comparing the material consequences of the chosen strategy against those of the strategy which is not chosen. In Dur and Sol's (2009) model, workers can devote part of their effort to social interaction with their colleagues. In equilibrium, positive reciprocity arises because a worker treated kindly will care more about the wellbeing of his/her colleagues. This implies an increase in job satisfaction which off-sets lower wages. As in our model, monetary incentives and ORP are substitute means that an employer may use in order to obtain a certain output, but the characterization of reciprocity is different. In the model used here, reciprocity relates to what happens in the workplace (and hence is deeply affected by the incentive system), while in Dur and Sol's (2009) model being kind means showing "interest in the colleague's personal life, offering a drink after working hours...", (p. 2).

Finally, we show that horizontal reciprocity may furnish a rationale for the composition of teams of workers even when the production technology induces negative externality among the workers' efforts. Gould and Winter (2009) show that the presence of strategic interdependencies among the workers' actions affects the worker's action choice. This must therefore be taken into account when designing the optimal compensation scheme. Intuitively, when strategic complementarity (substitutability) occurs among the workers' actions, given a change in one player's action, the other player has an incentive to move in the same (opposite) direction. In Gould and Winter's (2009) model, a principal can employ one or two agents to carry out sequentially an individual task which contributes to the success of a project. When the production technology exhibits strategic complementarity, the task completion by one agent contributes more to the success of the entire project if also the other agent completes his/her task. By contrast, in the presence of strategic substitutability, the marginal contribution of a worker who succeeds in his/her task is higher when the other worker does not succeed. Therefore, Gould and Winter (2009) show that, depending on the value of the project, the principal may find it optimal to employ only one agent or both in the presence of strategic substitutability of the production technology. We show that workers' reciprocity is a reason for composing teams of two workers in situations where one standard worker would be employed. Our result is based on the endogenous complementarity (Potter and Suetens, 2009) among workers' actions induced by reciprocity which mitigates the impact of the negative externalities imposed on the agents by the production technology.

The paper is organized as follows. Section 2 illustrates the model and discusses the definition of horizontal reciprocity. Section 3 characterizes the optimal contract under both symmetric and asymmetric information. Section 4 presents some extensions. Section 5 concludes. All the proofs are in the Appendix.

2 The Model

We model overtime provision in a frame where a risk-neutral employer (P) engages a team of two risk neutral workers: A_i, with $i \in \{1, 2\}$, where the index refers to the timing of the worker's action.[7] The employer and the workers contract some activities additional to those included in the job contract, typically *overtime* or *extra-effort*. For this reason we assume the participation constraints have been satisfied.[8] The employer asks each worker to undertake *overtime*. Let $a_i \in \{0, e\}$ with $i = 1, 2$, be the worker's decision, where $a_i = 0$ and $a_i = e > 0$, indicate whether or not the worker refuses to undertake overtime. The cost of undertaking overtime is $c(e) = c > c(0) = 0$.We assume that workers are identical with respect to productivity and disutility of effort and that they can observe their colleagues' choice. Finally let $X(\gamma, a_i, a_j) = \gamma(a_i + a_j)$ be the production function.[9] The timing of the overtime game is as follows: at $t = 0$ the employer offers a compensation scheme for the overtime provision: $w_i(a_i, a_j)$, for $i, j = \{1, 2\}$ and $i \neq j$. At $t = 1$, worker 1, having observed the compensation scheme, decides whether or not to undertake overtime. At $t = 2$ worker 2, having observed both the compensation scheme and the action chosen by the team mate, chooses a_2. Finally production is realized and compensations are paid. We solve the game by backward induction. The employer maximizes the following profit function:

$$\Pi = \gamma(a_i + a_j) - (w_i + w_j) \tag{1}$$

If $\gamma > \frac{w_i}{e_i}$,with $i = 1, 2$, the employer obtains her highest profit when both workers undertake overtime.

Let M_i denotes the worker's *material* payoff: that is, the compensation received minus the cost[10] of undertaking overtime:

$$M_i(w_i, c_i) = w_i(a_i, a_j) - c_i(a_i) \tag{2}$$

Workers maximize the following utility function:

[7] Henceforth, we will assume that the employer is female and that the employees are male.

[8] In the rest of the paper we will use the term 'game' to denote the "overtime provision game". We assume that there is no interdependence between this game and the "normal working time" game.

[9] We only need to assume that the production function is increasing in agents' effort, and we focus on the case in which employer's profit is maximized when agents exert extra effort. Our results are not affected by the functional form of the production function, therefore, we assume a linear function in order to keep the frame as simple as possible.

[10] We assume that c is the material equivalent of the disutility from overtime provision.

$$U_i(M_i, M_j, \rho_i, r_i) = M_i + \rho_i r_{i,\sigma_j} M_j \quad (3)$$

where the exogenous parameter $\rho_i \in [0, 1)$ measures the impact of reciprocity concern in worker i's utility function. We define as *standard* those workers with $\rho_i = 0$ and who care only about their own material payoff. *Reciprocal* workers are those workers who have $\rho_i > 0$ and also care about the colleague's material payoff. The *reciprocity term* r_{i,σ_j} determines the sign (positive or negative) of worker's i reciprocity. Denote by H_i and L_i respectively the highest and the lowest material payoff for A_i. Let σ_j and σ_j' be two strategies of A_j, with $\sigma_j \neq \sigma_j'$. The reciprocity term of A_i, given that A_j chooses the strategy σ_j, is defined as follows:

$$r_{i,\sigma_j} = \frac{\underset{\{\sigma_i\}}{max}\{M_{i,\sigma_j}\} - \underset{\{\sigma_i\}}{max}\{M_{i,\sigma_j'}\}}{H_i - L_i} \in [-1, +1] \quad (4)$$

The reciprocity term in (4) is determined by the difference between the maximum material payoff that A_i can obtain - given the strategy σ_j chosen by A_j- and the maximum material payoff that A_i could have obtained under the alternative strategy choice $\sigma_j\prime$. This difference is then normalized by $H_i - L_i$.[11] When $r_{i,\sigma_j} > 0$, A_i positively evaluates A_j's material payoff. Hence if $M_j > 0$ (< 0), it enters A_i's utility function as a positive (negative) *externality.*

The reciprocity term accounts for the *intentionality* of A_j's choices. A_i evaluates A_j 's kindness by comparing how the A_j's chosen and not chosen strategies affect his own material payoff.[12]

In what follows we design the optimal compensation scheme that an employer should offer to induce workers to undertake overtime. We accordingly assume that workers are already within the firm and that the participation constraints are satisfied. Nevertheless, to avoid trivial solutions, we assume that the employer cannot trigger her workers with negative compensations, nor promising unlimited compensations even if they are not paid in equilibrium. Hence, we fix a budget $B > 0$ and we assume $w_i \geq 0$, for both $i \in \{1, 2\}$ such that $w_1 + w_2 \leq B$.

3 The Optimal Compensation Scheme

In the next subsections we derive the optimal compensation schemes both in the case where the employer observes the agents' actions (subsection 3.1) and in the case where the employer does not observe the individual action but only the final output produced (subsection 3.2). In both subsections 3.1 and 3.2 we assume that the employer observes both the employees' type ρ_i, and that employees observe each other's action. Finally, in subsection 3.3 we characterize the optimal compensation scheme that requires the least payment to be offered out of equilibrium.

[11] The magnitude of r_{i,σ_j} is determined by the numerator of eq.(4). We assume that $r_{i,\sigma_j} = 0$ if the $H_i = L_i$ is equal to 0.

[12] The relevance of *unchosen* alternatives constitutes the main difference with respect to distributional models à la Fehr and Schmidt, (1999), where only the final relative distribution matters, Falk et al. (2003).

3.1 The Symmetric Information Case

When the employer observes employees' actions, the compensation scheme can be conditional on them. Let us use $w_i^S(a_i, a_j)$ for $i, j = 1, 2$ with $j \neq i$ to denote the optimal compensation scheme for standard workers ($\rho_i = 0$). This scheme will be used as benchmark. The optimal compensation scheme $w_i^S(a_i, a_j)$ is such that, irrespectively of the action chosen by the team mate, each worker receives a compensation $w_i^S(e_i, a_j) = c$ if he works overtime and $w_i^S(0, a_j) = 0$ otherwise,[13] for both $i, j = 1, 2$,with $j \neq i$. The employer pays an amount of compensation equal to $2c$ and obtains $\Pi^S = 2(\gamma e - c)$ as profit.

The following proposition describes the optimal compensation scheme when workers are reciprocal.

Proposition 1 *Under symmetric information and $\rho_i > 0$ for $i = 1, 2$ the optimal compensation scheme is a tournament that induces negative reciprocity. Each worker receives a monetary compensation equal to B if and only if he is the only one undertaking overtime, and no compensation otherwise. In equilibrium, if $B \geq (\frac{1}{\min\{\rho_i, \rho_j\}} + 1)c$, then the employer obtains the maximum output level $2\gamma e$ without paying any compensation.*

Proof. See Appendix A2. ∎

The optimal compensation scheme in proposition 1 induces a unique equilibrium in dominant strategies, in which the second mover undertakes overtime irrispectively of the action of the first mover, and the first mover undertakes overtime as well.

Figure 1 represents the optimal compensation scheme. The intuition of the result is as follows. Consider worker 2 first. Suppose worker 1 has chosen his action. If worker $2's$ action does not affect worker 1's material payoff, then worker 2 chooses the action that maximizes his own material payoff.

This is the case when $a_1 = 0$. If worker 2's action modifies worker 1's material payoff, then worker 2 chooses the action that maximizes his own utility, which is not necessarily the action that gives to him the maximum material payoff. Indeed, in this case reciprocity plays a role, since worker 1's material payoff enters as an externality into worker 2's utility function. If worker 1 chooses $a_1 = e$, this prevents worker 2 from gaining his highest material payoff $w_2(0, e_2) = B$ and therefore motivates worker 2 to have a negative attitude toward worker 1. It is for this reason that worker 2 prefers to undertake overtime even if this action reduces his material payoff.

Since worker 1's overtime choice enters in worker 2's utility function as a negative externality and this externality is increasing with the value of $w_1(e_1, 0)$, the employer will find it convenient to fix out of equilibrium the highest possible compensation for $w_1(e_1, 0) = B$. In this way, worker 2 will prefer to work unpaid overtime to avoid such a large negative externality. In fact, if the negative externality is higher than the cost of doing overtime, worker 2 will work for free in order to avoid the situation of not working overtime while agent 1 does

[13] This is only one of the several possible optimal compensation schemes. Note that $w_1(e_1, 0)$ and $w_1(0, 0)$ refer to output levels that, given the incentives provided to A_2, are never produced. This implies $w_1(e_1, 0)$ and $w_1(0, 0)$ can take any value in the interval $[0, B]$. Depending on the values specified for each of them, we have different optimal compensation schemes implementing $2\gamma e$ at the cost of $2c$.

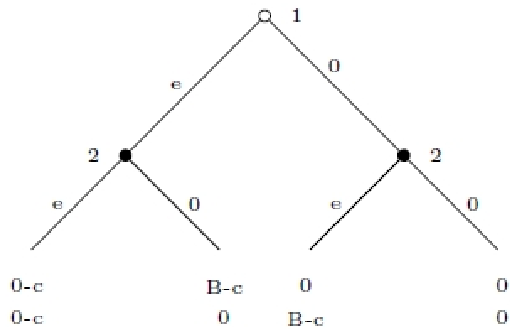

Figure 1: The optimal compensation scheme for reciprocal agents under symmetric information.

so, receiving $w_1(e_1, 0) = B$. On a similar argument, worker 1 anticipates worker 2's behavior and chooses to provide overtime as first.

The minimum level of payment that must be offered out of equilibrium to induce unpaid overtime is $\underline{B} = (\frac{1}{\min\{\rho_i, \rho_j\}} + 1)c$. Note that $\underline{B}$ is increasing with the disutility of effort c and decreasing with ρ_i with $i = 1, 2$. Intuitively, for any given compensation offered out of equilibrium the higher the impact of the workers's reciprocity concern the easier it becomes for the employer to induce unpaid overtime. Note that when ρ_i is close to 1, meaning that worker i weights the worker j's material payoff almost as his own, the B that must be offered out of equilibrium approximates $2c$, which is the budget required to induce overtime by standard workers. In a similar way, the greater is the disutility of workers' effort, the larger is the $\underline{B}$ that must be offered to exploit reciprocity concerns.[14]

In our model, if the employer demands overtime to both employees, a compensation scheme inducing *positive* reciprocity is always more costly than a compensation scheme offered to standard employees.[15]

In addition, note that when the employer is able to observe ρ, she always prefers to demand overtime from reciprocal types because she obtains the highest output at no cost.

Proposition 2 *The employer prefers to employ reciprocal workers rather than standard workers.*

Proof. See Appendix A.5. ■

In the Appendix, we rank the employer's preferences regarding the composition of teams. We show that a team composed of two reciprocal workers is always preferred to a team

[14] By offering this compensation scheme, the employer puts her workers in a situation similar to a sequential prisoner's dilemma, where each worker is unable credibly to commit to not providing overtime once the colleague has abstained from doing so. Of course, one could reasonably object that a repetition of this game could provide the agents with an incentive for colluding. However, we believe that the one-shot nature of our game better captures the non-regularity of overtime demand.

[15] See Appendix A.3 for a formal proof. In Appendix A.4 we also show that, when the optimal compensation scheme designed for standard workers is offered to reciprocal workers, the ORP are neutralized.

composed of a standard worker and a reciprocal worker. Hence, a team composed of a standard and a reciprocal worker is always preferred to team composed only of standard workers.

3.2 The Asymmetric Information Case

In this section and for the rest of the paper we assume that the employer only observes the employees type ρ and output level produced by the team.[16] Under asymmetric information a complete compensation scheme specifies the rewards offered to each worker *conditional* on the *total output* and it is profit maximizing. In this regard, three different output levels can be defined: $2\gamma e > \gamma e > 0$, depending on whether, respectively, two agents, one agent, or any agent undertake overtime.
As under symmetric information, we take as benchmark the case with standard workers. In this case, the scheme assigns to each worker a compensation equal to $w_i(2\gamma e) = c$, if $2\gamma e$ is produced, and no compensation otherwise.[17] The employer obtains $\Pi^S = 2(\gamma e - c)$ by paying an amount of compensations equal to $2c$.[18]

Proposition 3 *Under asymmetric information, if $\rho_i > 0$ for both $i = 1, 2$, then the optimal compensation is an asymmetric payment scheme that induces negative reciprocity. Worker 1 receives a positive monetary compensation equal to B if and only if γe is produced and Worker 2 receives a positive monetary compensation equal to B if and only if 0 is produced. When $B \geq \max\left\{\frac{c}{\rho_1}, c\frac{1+(1+4\rho_2)^{\frac{1}{2}}}{2\rho_2}\right\}$, the employer obtains $2\gamma e$ without paying any compensation in equilibrium.*

Proof. See the Appendix A.6. ■

The optimal compensation scheme in proposition 3 induces a unique equilibrium which survives the iterated elimination of dominated strategies. In equilibrium, the second mover undertakes overtime in the first subgame but not in the second one, and the first mover undertakes overtime. The intuition of this result is similar to that for proposition 1. Inspection of Figure 2 shows that the main difference with respect to the symmetric information case is that the employer cannot condition the compensation scheme on the individual actions but only on the output level.

Consider worker 2. If A_1 does not undertakes overtime, A_2 will not undertake overtime because this action maximizes his material payoff: $w_2(0) = B$. If A_1 undertakes overtime,

[16] There are indeed many situations in which managers cannot monitor workers while the workers can observe each other: for example, in professional jobs and research activities.

[17] As in the symmetric information case, this is only one of the several possible compensation schemes that maximize the employer's profit. Given the incentives provided to A_2, γe is never produced. Hence, depending on the value specified for $w_1(\gamma e) \in [0, B]$ we have different optimal compensation schemes implementing $2\gamma e$ at the cost equal to $2c$.

[18] Note that, since both the employer (principal) and the workers (agents) are risk neutral, under asymmetric information we do not observe loss of efficiency due to the distortion in the risk allocation among the parties.

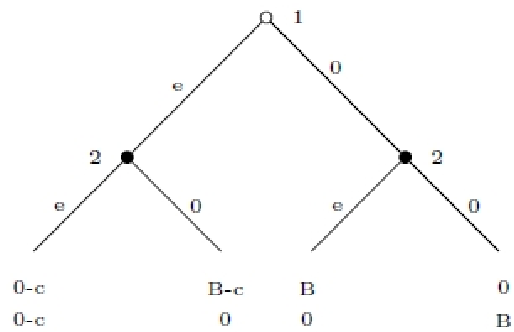

Figure 2: The optimal compensation scheme for reciprocal agents under asymmetric information.

A_2 has an incentive to work overtime as well. When A_2 is motivated by negative reciprocity, not providing overtime (allowing A_1 to gain $w_1(\gamma e) = B$) may be even worse than working unpaid. The negative orientation of A_2 follows from the fact that A_1, by choosing to provide overtime rather to abstain, prevents him from obtaining his highest material payoff.
The key assumption behind this result is that, while we assume that the employer cannot monitor workers' actions, we still assume that she is able to distinguish reciprocal workers from standard ones. This enables her to offer a scheme inducing unpaid overtime under asymmetric information.

The minimum level of payment that the employer must offer out of equilibrium to induce unpaid overtime is different for each worker and we denote it $\underline{B^A}$=max$\left\{\frac{c}{\rho_1}, c\frac{1+(1+4\rho_2)^{\frac{1}{2}}}{2\rho_2}\right\}$. Note that $\underline{B^A}$ [19]is increasing in the disutility of effort and decreasing in ρ_i,with $i = 1, 2$. This result implies that when workers exhibit identical ρ, worker 2 requires the highest payment out of equilibrium to undertake unpaid overtime, then $\underline{B^A}$=$c\frac{1+(1+4\rho_2)^{\frac{1}{2}}}{2\rho_2}$. Finally to be noted is that, for both ρ tending to 1, the $\underline{B^A}$ that must to be offered out of equilibrium is slightly higher than c, which is actually the standard worker' compensation. As the ρ approximate to 0, the $\underline{B^A}$ that must be offered out of equilibrium goes to $+\infty$.

3.2.1 The least budget-demanding optimal compensation scheme

In the previous sections we have assumed the employer has an unlimited amount of money B to offer out of equilibrium**.** As highlighted above, depending on B, several optimal compensation schemes may be defined. However, it is likely that in some situations (i.e. binding financial constraint) the budget is limited. Since the credibility of the payments fixed out of equilibrium plays a crucial role in our framework, it makes sense to identify the optimal scheme requiring the lowest possible level of B. Let us provide the following definition to such scheme.

[19]Where the index "A" allows its distinction from the $\underline{B}$ offered under symmetric information.

Definition 1 *The least budget-demanding (LBD) optimal compensation scheme is the optimal compensation scheme requiring the smallest payment B to be offered out of equilibrium such that both workers undertake unpaid overtime.*

In this respect we can show that:

Proposition 4 *For any ρ_i and ρ_j, with $\rho_i > \rho_j$, a LBD optimal compensation scheme always exists and it assigns the first move to the worker j (leader) and the second move to the worker i (follower). The optimal compensation scheme is an asymmetric compensation scheme like the one described in Proposition 2.*

Proof. See the Appendix A.7. ∎

This result contains an implication particularly useful for *job design* if only limited budget are available to the employer. Since she knows the reciprocity concern of each worker, she will always find convenient to assign the second move to the worker with the higher ρ, obtaining the desired outcome at no cost.

4 Extensions

4.1 The Optimal Compensation Scheme with Budget Constraint

In the previous sections we assumed the employer has a budget sufficient to induce unpaid overtime. Let B^F denote the feasible budget. Here we analyze the case where $B^F$is lower than the level required respectively in proposition 1 and 3.

Proposition 5 *When* $0 < B^F < \underline{B} = c(\frac{1}{\min\{\rho_i,\rho_j\}} + 1) \quad \left(< \underline{B}^A = \max\left\{ \frac{c}{\rho_1}, c\frac{1+(1+4\rho_2)^{\frac{1}{2}}}{2\rho_2} \right\} \right)$, *the employer obtains $2\gamma e$ by paying to the employees a sum of compensations lower than the one paid to standard employees. Savings are increasing in the amount of the feasible budget.*

Proof. See the Appendix A.8. ∎

The result can be explained by the *substitutability* between reciprocity concerns and monetary incentives, i.e. material payments. When $B^F \in [\underline{B}; +\infty)$, reciprocity concerns and incentives are *perfect substitutes*. When $0 < B^F < \underline{B}$, reciprocity concerns and monetary incentives are *imperfect substitutes*. Therefore, in this second case, in order to obtain the highest output, the employer must pay in equilibrium an amount of compensation lower than that required by standard workers but greater than zero. That is, even if overtime must be paid, some savings can be still achieved with respect to the benchmark case. This result highlights that, in our model, reciprocal workers are always preferred to standard workers.

4.2 Production Technology with Negative Externalities

In the previous sections we assumed a functional form which did not impose any *technological interdependencies* among the workers.[20] Now consider a production technology with some *negative externalities:* $X'(\gamma, \beta, a_i, a_j) = \gamma(a_i + a_j) - \beta(a_i a_j)$ with $\gamma > \beta > 0$, where β measures the level of negative externality form *joint overtime* exertion. It is also assumed that two workers undertaking overtime are more productive than one: $X(2\gamma e - \beta e^2) > X(\gamma e) > 0$ and furthermore assume that the employer maximizes her profits when only one standard worker undertakes overtime: $\Pi(\gamma, 0_i, e_j) > \Pi(\gamma, e_i, e_j) > 0$ for $i = 1, 2$ and $i \neq j$.

When both these assumptions hold, we obtain the following result:

Proposition 6 *Under a production technology characterized by negative externalities: $X'(\gamma, \beta, a_i, a_j)$, when $\beta \in \left(\frac{\gamma e - c}{e^2}; \frac{\gamma}{e}\right)$, the employer will employ one worker, if he exhibits standard preferences, while she will form a team of two workers if they are reciprocal.*

When the employer creates a team of reciprocal workers, the joint overtime provision can be obtained at no cost by offering a compensation scheme as in Proposition 1 (3). Negative externalities may arise in productive settings where the agents' skills are partially substitutes rather than complements, or in those situations where some form of congestion in production may result from the workers performing their job activity together. Our model complements the finding by Gould and Winter (2009), who analyze how the effort choices of selfish workers interact according to the production technology. Gould and Winter (2009) analyze a case where, in the presence of negative externalities, the employer may find it convenient to hire one worker rather than two, if the value of the project she wants to realize is not sufficiently high. We show that reciprocity concerns, representing a form of endogenous complementarity among the workers (Potter and Suetens, 2009), mitigates the negative externalities imposed by the production technology. By hiring reciprocal workers and by offering them a compensation scheme like those defined in propositions 1 and 3, the principal obtains the desired output at no monetary cost.

5 Discussion

In this paper we have presented a stylized model which uses horizontal reciprocity to provide a rationale for unpaid overtime. We have shown that when the employer has a budget sufficient to offer credible compensations out of equilibrium, she can always induce reciprocal workers to undertake productive overtime without fully compensating its cost. This result holds both under symmetric and asymmetric information. We have also identified the minimal budget required to support a scheme inducing unpaid overtime. In addition, we have shown that when the employer has a budget below that amount, even when positive monetary

[20] According to Potter and Suetens (2009) a game is characterized by strategic complements (substitutes) if $\forall i, j$ and $i \neq j$: $\frac{\partial^2 u_i}{\partial a_i \partial a_j} > 0$ (< 0). Games characterized by strategic substitutability or strategic complementarity have externalities by their nature; this (at least locally) follows from the fact that: $\frac{\partial^2 u_i}{\partial a_i \partial a_j} > 0$ (< 0) implies: $\frac{\partial u_i}{\partial a_j} > 0$ (< 0).

compensation is paid, some savings can still be made by exploiting the workers' reciprocity concerns. These results may have important implications for the ideal team composition. Indeed, the employer always prefers teams of reciprocal workers rather than teams with one standard and one reciprocal worker. Consequently, a "one standard/one reciprocal" team is always preferred to a team composed only of standard workers. We have developed an extension of the basic model which highlights the importance of horizontal reciprocity in the design of incentive systems characterized by a production technology imposing negative externalities among the workers. In this case, the employer will demand overtime from one worker if he is standard, while she will prefer to employ teams of two workers if they are reciprocal.

Our results also match those situations where employees are asked to perform an additional task or to put in an additional amount of effort not specified by the job contract, even if these additional requirements do not imply overtime to be undertaken by the workers. The focus on task completion time rather than on clock time, in fact, has been defined as one of the main characteristics of post-Fordist jobs, and it changes the way in which employees manage their job activities.

Finally, two points should be addressed. First, our model considers only horizontal reciprocity and, mainly for tractability reasons, it does not allow for any form of vertical fairness. We acknowledge that our "extreme" result of unpaid overtime provision may be mitigated by the presence of vertical reciprocity. Vertical reciprocity considerations, indeed, may induce the employer to concern herself with the perceived fairness of the compensation scheme offered to the employees. Allowing for vertical reciprocity in our model may induce the employer to offer a compensation scheme "better" from the employees' point of view in order to avoid their retaliation. Compensation schemes inducing unpaid overtime, indeed, could be perceived by their employees as unfair action by the employer. Nevertheless, we believe that the importance of horizontal reciprocity should be considered even in the presence of different fairness norms. To our knowledge, there are no theoretical studies on the interactions between vertical and horizontal reciprocity; nevertheless, several empirical studies suggest that horizontal fairness may interact with workers' reciprocity toward the employer. Gächter et al. (2008) report experimental evidence indicating that when a worker is exposed to social information about another referent worker (horizontal comparisons), the worker's vertical reciprocity response toward the principal is weakened. A different empirical result has been obtained by Barr and Serneels (2009), who on combining individual wages and experimental data from a trust game conducted with workers from Ghanaian manufacturing firms, find the existence of a positive relationship between workers' reciprocating tendencies and individual productivity at both firm and individual level. These two studies evidence that the interactions between different fairness norms should be investigated further, both theoretically and empirically, and especially in relation to the strategic context in which they take place.

Second, unlike in our model, where the employer could determine how to assign the order of moves to the employees, there is also the case where overtime is demanded from the workers simultaneously. In this case, employees face a simultaneous prisoner's dilemma, where the dominant strategy for each worker is to undertake overtime, so that the NE in pure strategies supports the outcome in which both workers undertake unpaid overtime. Even in a simultaneous move game, our main result holds: the employer will prefer to employ reciprocal workers, thus obtaining unpaid overtime. However, we chose a sequential game on the conviction that, at least in workplaces, it is actual behaviors more than beliefs and expectations that drive the reciprocal response between workers. Consistently, Cox et al.'s (2007) model defines reciprocity in sequential games where the fairness judgment is essentially based on actual behaviors, rather than, as in the psychological game theory literature, on beliefs and expectations.

Our simple model has emphasized that the optimal contract for reciprocal workers differs considerably from the optimal contract for standard agents. In particular, an employer dealing with workers motivated by reciprocity can always benefit from a relative performance contract which uses competition between employees to achieve the desired outcome. The higher the payment that the principal can promise out of equilibrium, the easier it will be to induce reciprocal workers to undertake underpaid or unpaid overtime. In real firms, our results may have interesting implications: if managers can credibly promise certain benefits to reciprocal workers out of equilibrium, they can exploit the employees' other-regarding preferences as sources of non-monetary incentives to enhance productivity. Professional services, research institutions, and the knowledge industry are organizational settings in which the workers' willingness to work hard to obtain career advancement or bonuses can be exploited by the employer inducing competition. In this regard, we may argue that, for real managers, our less striking result - underpaid rather than unpaid overtime - may be the most important one, because it represents a certain source of economic advantage for the organization which minimizes the possible drawback associated with unpaid overtime: namely, a negative attitude toward the employer.

A Appendix

A.1 Utility for Reciprocal workers

We define the utility function of reciprocal workers using a simplified formulation of reciprocity presented in Cox et al. (2007, p. 22). Let consider the formulation presented in their paper (eq.1):[21]

$$U_i(M_i, M_j, \theta_i(s,r)) = \begin{cases} \frac{M_i^\alpha + \theta_i(s,r) M_j^\alpha}{\alpha} & \text{if } \alpha \in (-\infty, 0) \cup (0,1], \\ (M_i M_j)^{\theta_i(s,r)} & \text{if } \alpha = 0, \end{cases}$$

where player j is the first mover and player i the second mover, U_j and U_i represent the utility function of each player and M_i and M_j are the material payoffs each player receives, α is the parameter of elasticity of substitution among the players' utility functions and $\theta(r, s)$ is the emotional state. Depending on the value of α preferences may be linear (if $\alpha = 1$) or strictly convex (if $\alpha < 1$). Cox et al. (2007) uses the concept of emotional state, θ, to characterize the attitude of player i toward player j. It represents the willingness to pay own payoff for other's payoff. The emotional state is assumed to be increasing both in the status, s, and in the level of reciprocity, r. The status

[21]The functional form is tested through experiments on a dictator game, a Stackelberg duopoly game, a mini-ultimatum game and an ultimatum game with both random and contest role assignment.

is defined as the "generally recognized asymmetries in players' claims or obligations" (p. 23) while the reciprocity corresponds to the difference between the maximum payoff that player i can afford given the choice made by j and a reference payoff "neutral in some appropriate sense" (p. 23).

Our definition of reciprocity is a simplified version of the functional form proposed by Cox et al (2007). In particular, we impose $\alpha = 1$ and by assuming identical workers, we abstract from the status concern. Finally, for the sake of simplicity, we assume that the emotional state is a linear function of reciprocity, i.e. $\theta(r_i) = \rho_i \cdot r_{i,\sigma_j}$ where $\rho_i \in [0, 1)$ represents the impact of reciprocity concern on worker i's utility function, and r_{i,σ_j} is the reciprocity term accounting for worker j's fairness.

A.2 Proof of Proposition 1

According to Proposition 1 the optimal compensation scheme is:

$$w_i(e_i, e_j) = w_i(0, e_j) = w_i(0, 0) = 0; \quad w_i(e_i, 0) = B, \text{ for } i, j \in \{1, 2\} \text{ with } i \neq j \tag{A.2.1}$$

Note that for A_1, strategies and actions coincide. On the contrary, for A_2 strategies are defined as follows: $\sigma_2^a = \{e, e\}$; $\sigma_2^b = \{e, 0\}$; $\sigma_2^c = \{0, e\}$ and $\sigma_2^d = \{0, 0\}$.

In equilibrium, reciprocity for A_1 and A_2 are respectively defined as:

$$\begin{aligned} r_{1,\sigma_2^a} &= \frac{-w_1(e_1, 0) + c}{w_1(e_1, 0)} < 0 \\ r_{2,e} &= \frac{-w_2(0, e_2) + c}{w_2(0, e_2)} < 0 \end{aligned}$$

To induce both workers to undertake overtime in equilibrium, the following incentive compatibility constraints (hereafter, ICCs) must hold:

$$w_1(e_1, e_2) - c + \rho_1 r_{1,\sigma_2^a} w_2(e_1, e_2) \geq w_1(0, e_2) + \rho_1 r_{1,\sigma_2^a} w_2(0, e_2), \tag{A.2.2}$$
$$w_2(e_1, e_2) - c + \rho_2 r_{2,e} w_1(e_1, e_2) \geq w_2(e_1, 0) + \rho_2 r_{2,e} w_1(e_1, 0). \tag{A.2.3}$$

By substituting (A.2.1) respectively into (A.2.2) and (A.2.3) we obtain:

$$0 \geq c + \rho_1(-B + c), \tag{A.2.4}$$
$$0 \geq c + \rho_2(-B + c). \tag{A.2.5}$$

Rearranging (A.2.4) and (A.2.5) yields

$$B \geq c\left(\frac{1}{\rho_i} + 1\right) \quad \text{for } i = 1, 2 \ , \tag{A.2.6}$$

where B is the monetary compensation to be offered out of equilibrium to induce both workers to undertake unpaid overtime ($w_i(e_i, e_j) = 0$).

We proceed now proving that the compensation scheme in (A.2.1) induces a unique equilibrium in dominant strategies in which A_2 undertakes overtime both in the first and in the second subgame and A_1 undertakes overtime.

First we show that $\sigma_2^a = (e, e)$ is the dominant strategy for A_2. If A_1 chooses to undertake overtime, $a_1 = e_1$, the reciprocity for A_2 is given by:

$$r_{2,e_1} = \frac{\max\{(0-c),(0)\} - \max\{(B-c),0\}}{(B-c)-(0-c)} = -\frac{B-c}{B} < 0. \tag{A.2.7}$$

The utility A_2 gets if he undertakes overtime is: $-c + \rho_2 r_{2,e_1}(-c)$, while the utility from not undertaking it is: $\rho_2 r_{2,e_1}(B-c)$.

Overtime exertion is the optimal action for A_2 in first subgame if

$$-c + \rho_2 r_{2,e_1}(-c) > \rho_2 r_{2,e_1}(B-c). \tag{A.2.8}$$

By substituting (A.2.7) in to (A.2.8) and simplifying it, (A.2.8) yields $-c > \rho_2(-B-c)$ which always holds when (A.2.6) holds. Therefore we have proved that, when $B \geq c\left(\frac{1}{\rho_2}+1\right)$, in the first subgame the optimal action for A_2 is $a_2 = e_2$.

Suppose A_1 chooses $a_1 = 0$, the reciprocity for A_2 is given by:

$$r_{2,0} = \frac{\max\{(B-c),(0)\} - \max\{(0-c),0\}}{(B-c)-(0-c)} = \frac{B+c}{B} > 0. \tag{A.2.9}$$

The utility A_2 gets if he undertakes overtime is: $B-c$, while the utility from not undertaking it is 0. So, when $B > c$ the optimal action for A_2 in the second subgame is $a_2 = e_2$. When assumption (A.2.6) holds, $B > c$.

Consider A_1. We want to prove that $a_1 = e_1$ is the A_1'dominant strategy.

If A_2 plays $\sigma = \sigma_2^a$, the reciprocity for A_1 is given by:

$$r_{1,\sigma_2^a} = \frac{\max\{(0-c),(0)\} - \max\{(B-c),0\}}{(B-c)-(0-c)} = -\frac{B-c}{B} < 0. \tag{A.2.10}$$

The utility A_1 gets if he undertakes overtime is $-c + \rho_1 r_{1,\sigma_2^a}(-c)$, while the utility from not undertaking it is: $\rho_1 r_{1,\sigma_2^a}(B-c)$. Overtime exertion is the optimal action for A_1 if:

$$-c + \rho_1 r_{1,\sigma_2^a}(-c) > \rho_1 r_{1,\sigma_2^a}(B-c). \tag{A.2.11}$$

By substituting (A.2.10) in to (A.2.11) and simplifying it, (A.2.11) yields $-c > -\rho_1 B$, which always holds when (A.2.6) holds. Therefore we have proved that, when $B \geq c\left(\frac{1}{\rho_1}+1\right)$ and given that A_2 plays σ_2^a, the optimal action for A_1 is $a_1 = e_1$.

Suppose now that A_2 chooses $\sigma_2^b = \{e, 0\}$, in this case A_1's reciprocity is:

$$r_{1,\sigma_2^b} = \frac{\max\{(0-c),(0)\} - \max\{(B-c),0\}}{(B-c)-(0-c)} = -\frac{B-c}{B} < 0. \tag{A.2.12}$$

The utility A_1 gets if he undertakes overtime is $-c + \rho_1 r_{1,\sigma_2^b}(-c)$, while the utility from not undertaking it is: $\rho_1 r_{1,\sigma_2^b}(B-c)$.Overtime exertion is the optimal action for A_1 if $-c + \rho_1 r_{1,\sigma_2^b}(-c) > \rho_1 r_{1,\sigma_2^b}(B-c)$ holds, which is exactly the case we have proved in (A.2.11).

Suppose A_2 chooses $\sigma_2^c = \{0, e\}$, in this case A_1's reciprocity is:

$$r_{1,\sigma_2^c} = \frac{\max\{(B-c),(0)\} - \max\{(0-c),0\}}{(B-c)-(0-c)} = \frac{B+c}{B} > 0. \tag{A.2.13}$$

The utility A_1 gets if he undertakes overtime is $B-c$, while the utility from not undertaking it is $\rho_1 r_{1,\sigma_2^c}(B-c)$. To undertake overtime is always better than not undertaking it, since $B-c > \rho_1 r_{1,\sigma_2^c}(B-c)$ always holds given that ρ_1 and r_{1,σ_2^c} are both smaller than 1 by assumption.

Last, suppose A_2 chooses $\sigma_2^d = \{0,0\}$, in case A_1's reciprocity is:

$$r_{1,\sigma_2^d} = \frac{\max\{(B-c),(0)\} - \max\{(0-c),0\}}{(B-c)-(0-c)} = \frac{B+c}{B} > 0. \tag{A.2.14}$$

The utility A_1 gets if he undertakes overtime is $B-c$, while the utility from not undertaking it is 0.To undertake overtime is always better than not undertaking if $B > c$,which is the case if (A.2.6) holds. Therefore $a_1 = e$ is A_1' s dominant strategy.

A.3 A compensation scheme inducing positive reciprocity

A.3.1 Symmetric information case

In this section we prove that a compensation inducing *positive* reciprocity for the exertion of overtime by both workers is more costly than the compensation scheme for standard workers. The total compensation paid to standard workers is $w_1^s(e_1,e_2) + w_2^s(e_2,e_1) = 2c$.
Now, consider A_1. When A_2 chooses strategy σ_2^a then the reciprocity of A_1 is:

$$r_{1,\sigma_2^a} = \frac{\max\{w_1(e_1,e_2)-c, w_1(0,e_2)\} - \max\{w_1(e_1,0)-c, w_1(0,0)\}}{H_1 - L_1}. \tag{A.3.1.1}$$

Since $H_1 - L_1 > 0$ then $r_{1,\sigma_2^a} > 0$ if the numerator is positive. As $w_1(e_1,0) = w_1(0,0) = 0$ then $\max\{w_1(e_1,0)-c, w_1(0,0)\} = w_1(0,0) = 0$, and it suffices to show that
$\max\{w_1(e_1,e_2)-c, w_1(0,e_2)\} > 0$. This inequality holds in two cases:

(1a) if $\max\{w_1(e_1,e_2)-c, w_1(0,e_2)\} = w_1(e_1,e_2) - c > 0$. This implies $w_1(e_1,e_2) > c$;

(2a) if $\max\{w_1(e_1,e_2)-c, w_1(0,e_2)\} = w_1(0,e_2) > 0$. In this case, $r_{1,\sigma_2^a} = \frac{w_1(0,e_2)}{w_1(0,e_2)+c} > 0$.

Similarly, reciprocity for A_2,

$$r_{2,e} = \frac{\max\{w_2(e_1,e_2)-c, w_2(e_1,0)\} - \max\{w_2(0,e_2)-c, w_2(0,0)\}}{H_2 - L_2}; \tag{A.3.1.2}$$

is positive if the numerator is positive.

As $w_2(0,e_2) = w_2(0,0) = 0$, then $\max\{w_2(0,e_2)-c, w_2(0,0)\} = w_2(0,0) = 0$.
Therefore, $r_{2,e_1} > 0$ if

(1b) if $\max\{w_2(e_1,e_2)-c, w_2(e_1,0)\} = w_2(e_1,e_2) - c > 0$. This implies $w_2(e_1,e_2) > c$;

(2b) if $\max\{w_2(e_1,e_2) - c, w_2(e_1,0)\} = w_2(e_1,0) > 0$. In this case, $r_{2,e} = \frac{w_2(e_1,0)}{w_2(e_1,0)+c} > 0$.

By substituting these results respectively into A_1 and A_2 ICCs (A.2.2 and A.2.3) we obtain:

$$
\begin{aligned}
w_1(e_1,e_2) - c + \rho_1 \frac{w_1(0,e_2)}{w_1(0,e_2)+c} w_2(e_1,e_2) &\geq w_1(0,e_2) + \rho_1 \frac{w_1(0,e_2)}{w_1(0,e_2)+c} w_2(0,e_2), \\
w_2(e_1,e_2) - c + \rho_2 \frac{w_2(e_1,0)}{w_2(e_1,0)+c} w_1(e_1,e_2) &\geq w_2(e_1,0) + \rho_2 \frac{w_2(e_1,0)}{w_2(e_1,0)+c} w_1(e_1,0).
\end{aligned}
$$

By combining $1a$ and $1b$ with $2a$ and $2b$, we analyze the four possible cases where reciprocity is positive for both workers.

- Case $1a$ and $1b$. A compensation scheme where $w_1(e_1,e_2) > c$ and $w_2(e_1,e_2) > c$ are paid is necessarily more costly than the scheme proposed to standard workers which costs $2c$.

- Case $2a$ and $2b$. Rearranging the ICCs:

$$
\begin{aligned}
w_1(e_1,e_2) - c - w_1(0,e_2) + \rho_1 \frac{w_1(0,e_2)}{w_1(0,e_2)+c} w_2(e_1,e_2) \geq 0 \quad &, \\
w_2(e_1,e_2) - c - w_2(e_1,0) + \rho_2 \frac{w_2(e_1,0)}{w_2(e_1,0)+c} w_1(e_1,e_2) \geq 0 \quad &.
\end{aligned}
$$

  Note that both constraints are never satisfied for $w_1(e_1,e_2) < c$ and $w_2(e_1,e_2) < c$.

- Case $1a$ and $2b$ (case $2a$ and $1b$ is symmetric). We need to prove $w_1(e_1,e_2) + w_2(e_1,e_2) < 2c$. Rearranging the ICC for A_2 we obtain $w_2(e_1,e_2) \geq w_2(e_1,0) + c - \rho_2 \frac{w_2(e_1,0)}{w_2(e_1,0)+c} w_1(e_1,e_2)$. By subtracting this inequality from $w_1(e_1,e_2) + w_2(e_1,e_2) < 2c$ yields $w_1(e_1,e_2)(1 - \rho_2 \frac{w_2(e_1,0)}{w_2(e_1,0)+c}) + w_2(e_1,0) - c < 0$. Since by $(1a)$, $w_1(e_1,e_2) > c$, this inequality is never satisfied and consequently any saving can be made under positive reciprocity.

A.3.2 Asymmetric information

The same arguments used in section A.3.1 can be used to prove the result under asymmetric information. Note that in this case the reciprocity for worker 1 and 2 are respectively:

$$
r_{1,\sigma_b} = \frac{\max\{w_1(2\gamma e) - c, w_1(0)\} - \max\{w_1(\gamma e) - c, w_1(\gamma e)\}}{H_1 - L_1}, \tag{A.3.2.1}
$$

$$
r_{2,e} = \frac{\max\{w_2(2\gamma e) - c, w_2(\gamma e)\} - \max\{w_2(\gamma e) - c, w_2(0)\}}{H_2 - L_2}. \tag{A.3.2.2}
$$

A.4 Standard Compensation Scheme for Reciprocal workers

A.4.1 Symmetric information case

Consider the set of optimal compensation scheme for standard workers. Applying it to reciprocal workers yields:

$$
\begin{aligned}
&w_1(e_1,e_2) = c; \quad w_1(e_1,0) \in [0,B]; \quad w_1(0,e_2) = 0; \quad w_1(0,0) \in [0,B]; \\
&w_2(e_1,e_2) = c; \quad w_2(e_1,0) = 0; \quad w_2(0,e_2) = c; \quad w_2(0,0) = 0;
\end{aligned} \tag{A.4.1.1}
$$

By substituting (A.4.1.1) in the ICC for A_1 (A.2.2) we can easily see that since A_1's choices do not affect the material payoff of A_2 then the *reciprocity component* in the utility function cancels since $w_2(e_1, e_2) = w_2(0, e_2)$. The ICC of A_1 coincides with the ICC of standard workers.

Now, consider now A_2 and substitute (A.4.1.1) in (A.2.3). It easy to see that when $w_1(e_1, 0) = c$, as for A_1, the reciprocity component of the utility function is neutralized. Note that, when $w_1(e_1, 0) \neq c$, substituting A.4.1.1 in the definition of reciprocity in (A.3.1.2) by assumption $r_{2,e}= 0$, (see section 2).

A.4.2 Asymmetric information case

Applying the set of optimal compensation schemes for standard worker to reciprocal worker:

$$\begin{aligned} w_1(2\gamma e) &= c;\ w_1(\gamma e) \in [0, B]\,;\ \ w_1(0) = 0; \\ w_2(2\gamma e) &= c;\ w_1(\gamma e) = w_1(0) = 0; \end{aligned} \tag{A.4.2.1}$$

by substituting this compensation scheme in the ICCs of each workers can be shown that each action worker does not affect the material payoff of the other, so for this reason, the reciprocity component in the utility function cancels out. In the frame of asymmetric information we are considering here, the multiplicity of optimal compensation schemes does not play any role, since, by calculating reciprocity of A_2 from (A.1.3.2) when (A.4.2.1) is offered, we obtain: $r_{2,e}=\frac{0}{c}= 0$.

A.5 Proof of Proposition 2

In this section we prove that the employer has the following rank over team composition: team composed by two reciprocal workers are always preferred to teams composed by a standard worker and a reciprocal worker. Consistently, this latter team composition will be always preferred over team composed by two standard workers.

A team of standard workers produces $2\gamma e$ at a cost equal to $2c$. In subsection A.2 we show that a team of reciprocal workers produces the same output at zero cost for the employer. Let us consider the case of a team composed by a standard worker and a reciprocal worker.

Suppose $\rho_1= 0$, $\rho_2> 0$. To induce A_1 to undertake overtime a compensation scheme as the one described in subsection 3.1 ($w_1^S(e, a_2) = c$ and $w_1^S(0, a_2) = 0$) must be offered. On the contrary, A_2 chooses e_2 if paid according to (A.2.1). By substituting (A.2.1) in (A.2.3) we obtain:

$$w_2(e_1,e_2) \geq c - \rho_2 \frac{B}{B+c}[w_1(e_1,0) - c].$$

Since the employer wants to maximize her profit, she will offer a $w_2(e_1,e_2)$ such that the ICC holds with equality. At this point:

- if $w_1(e_1, 0) - c > 0$ then $w_2(e_1, e_2) < c$,namely, A_2 will undertake *under*-paid overtime. Hence by offering $w_1(e_1, 0) = B > c$, the employer gets the output $2\gamma e$ by paying a sum of compensation lower than $2c$;

- if $\frac{B}{B+c}(B - c) \geq \frac{c}{\rho_2}$, A_2 will work *unpaid* overtime. In this case, the employer obtains $2\gamma e$ by paying a sum of compensations equal to c.

A.6 Proof Proposition 3

According to Proposition 3 the optimal compensation scheme is:

$$\begin{array}{ll} w_1(2\gamma e)= w_1(0)= 0; & w_1(\gamma e) = B\ ; \\ w_2(2\gamma e)= w_1(\gamma e)= 0; & w_1(0) = B. \end{array} \quad (A.6.1)$$

The definitions of reciprocity for A_1 and A_2 in equilibrium are:

$$r_{1,\sigma_b}=\frac{-w_1(\gamma e)}{w_1(\gamma e)+c},\ r_{2,e}=\frac{-w_2(0)}{w_2(0)+c}.$$

In equilibrium, to induce both workers to undertake overtime, the following ICCs must hold:

$$w_1(2\gamma e) - c + \rho_1 r_1[w_2(2\gamma e) - c] \geq w_1(0) + \rho_1 r_1 w_2(0), \quad (A.6.2)$$

$$w_2(2\gamma e) - c + \rho_2 r_2 w_1(2\gamma e) \geq w_2(\gamma e) + \rho_2 r_2 w_1(\gamma e). \quad (A.6.3)$$

By substituting (A.6.1) respectively into (A.6.2) and (A.6.3) we obtain:

$$0 \ \geq\ c + \rho_1 \frac{-w_1(\gamma e)}{w_1(\gamma e)+c}[w_2(0) - c] \quad (A.6.4)$$

$$0 \ \geq\ c + \rho_2 \frac{-w_2(0)}{w_2(0)+c} w_1(\gamma e) \quad (A.6.5)$$

Assume $w_1(\gamma e) = w_2(0) = B$. Rearranging (A.6.4) and (A.6.5) yields

$$B \ \geq\ \frac{c}{\rho_1}, \quad (A.6.6)$$

$$\frac{\rho_2}{c}B^2 - B - c \ \geq\ 0, \quad (A.6.7)$$

where $B \geq \frac{c}{\rho_1}$ is the monetary payment the employer must offer out of equilibrium in order to induce A_1 to exert unpaid overtime ($w_1(2\gamma e) = 0$).

Solving $\frac{\rho_2}{c}B^2 - B - c = 0$ yields

$$B_1, B_2 = c\frac{[1 \pm (1+4\rho_2)^{\frac{1}{2}}]}{2\rho_2}\ . \quad (A.6.8)$$

Due to limited liability constraint the negative root makes no sense. Finally, the employer will offer out of equilibrium a level of B such that:

$$B \geq \max\left\{ \frac{c}{\rho_1}, c\frac{1+(1+4\rho_2)^{\frac{1}{2}}}{2\rho_2} \right\}\ . \quad (A.6.9)$$

Now we have to show that the compensation scheme in (A.6.1) induces a unique equilibrium which survives the iterated elimination of dominated strategies. In this equilibrium A_2 's dominant strategy is $\sigma_2^b = \{e, 0\}$ and A_1 's best reply is $a_1 = e$.

Consider A_2. Suppose $a_1 = e$, then the reciprocity of A_2 is:

$$r_{2,e} = \frac{\max\{(0-c),(0)\} - \max\{(0-c),B\}}{(B)-(0-c)} = -\frac{B}{B+c} < 0. \quad (A.6.10)$$

The utility A_2 gets if he undertakes overtime is $-c + \rho_2 r_{2,e}(-c)$, while the utility from not undertaking it is: $\rho_2 r_{2,e}(B-c)$.Overtime exertion is the optimal action for A_2 if

$$-c + \rho_2 r_{2,e}(-c) > \rho_2 r_{2,e}(B-c). \quad (A.6.11)$$

Substituting (A.6.10) in to (A.6.11) and simplifying it, (A.6.11) yields $-c(B+c) > -\rho_2 B^2$ which holds when $B \geq c\frac{1+(1+4\rho_2)^{\frac{1}{2}}}{2\rho_2}$.

Suppose now $a_1 = 0$, then the reciprocity of A_2 is:

$$r_{2,0} = \frac{\max\{(0-c),(B)\} - \max\{(0-c),0\}}{(B)-(0-c)} = \frac{B}{B+c} > 0. \quad (A.6.12)$$

The utility A_2 gets if he undertakes overtime is $-c + \rho_2 r_{2,0} B$, while the utility from not undertaking it is: B. Not undertaking overtime in the second subgame is the optimal action for A_2 if $B > -c + \rho_2 r_{2,0}(B)$ holds, which is always the case, since $B > \rho_2 r_{2,0} B$, given that $\rho_2 < 1$ and $r_{2,0} < 1$. Therefore we have proved that σ_2^b is the A_2 's dominant strategy.

Now we want to prove that $a_1 = e$ is A_1's best reply to σ_2^b. When A_2 chooses $\sigma = \sigma_2^b$ this is the reciprocity for A_1:

$$r_{1,\sigma_2^b} = \frac{\max\{(0-c),(0)\} - \max\{(B-c),B\}}{(B)-(0-c)} = -\frac{B}{B+c} < 0. \quad (A.6.13)$$

The utility A_1 gets if he undertakes overtime is $-c + \rho_1 r_{1,\sigma_2^b}(-c)$, while the utility from not undertaking it is: $\rho_1 r_{1,\sigma_2^b} B$. Undertaking overtime is the optimal action for A_1 if $-c + \rho_1 r_{1,\sigma_2^b}(-c) > \rho_1 r_{1,\sigma_2^b} B$ holds, which is the case when $B > \frac{c}{\rho_1}$.

A.7 Proof of Proposition 4

Here we want to prove that the LBD optimal compensation scheme assigns the second move to the worker that exhibit the highest ρ. Start from the (A.6.9) . It contains two conditions that refer to the first and second mover: $B_1 \geq \frac{c}{\rho_1}$ and $B_2 \geq c\frac{1+(1+4\rho_2)^{\frac{1}{2}}}{2\rho_2}$, respectively, such that:

When

$$\forall \rho_1 \neq \rho_2, \text{ if } \rho_1(1+\rho_1) \geq \rho_2 \Rightarrow c\frac{1+(1+4\rho_2)^{\frac{1}{2}}}{2\rho_2} > \frac{c}{\rho_1} \quad (A.7.1)$$

Suppose, without loss of generality,that $\rho_i > \rho_j$.

If the first move is assigned to i, $A_{1=i}$, then $\rho_{1=i}(1+\rho_{1=i}) > \rho_{2=j}$ and the binding condition is $B_2 \geq c\frac{1+(1+4\rho_j)^{\frac{1}{2}}}{2\rho_j}$.

Suppose, on the contrary, that the second move is assigned to i, $A_{2=i}$.Two things may happen:

1) $\rho_{1=j}(1+\rho_{1=j}) < \rho_{2=i}$ such that $B_1 \geq \frac{c}{\rho_j}$ is the binding condition;

2) $\rho_{1=j}(1+\rho_{1=j}) \geq \rho_{2=i}$ such that $B_2^* \geq c\frac{1+(1+4\rho_i)^{\frac{1}{2}}}{2\rho_i}$ is the binding condition.

We know that $\forall\rho,\ B_2 > B_1$.namely:

$$c\frac{1+(1+4\rho)^{\frac{1}{2}}}{2\rho} > \frac{c}{\rho} \tag{A.7.2}$$

Consider case 1). By assigning the second move to agent i the binding condition would be $B_1 = \frac{c}{\rho_j}$, while by assigning to him the first move $B_2 = c\frac{1+(1+4\rho_j)^{\frac{1}{2}}}{2\rho_j}$. From (A.7.2) we see that $B_1 < B_2$.

Consider now case 2). By assigning the second move to agent i, the binding condition would be $B_2^* = c\frac{1+(1+4\rho_i)^{\frac{1}{2}}}{2\rho_i}$, while assigning to him the first move $B_2 = c\frac{1+(1+4\rho_j)^{\frac{1}{2}}}{2\rho_j}$. Again, from (A.7.2) we see that $B_2^* < B_2$. Therefore, we have proved that by assigning the second move to the agent with the highest ρ, the least budget-demanding optimal compensation scheme is offered.

A.8 Proof of Proposition 5

In this section we want to prove that, when $B > 0$ is lower than the level inducing workers to provide unpaid overtime, the employer could always obtain overtime by paying in equilibrium a total compensation lower than to $2c$.

A.8.1 Symmetric information

Denote by B^F the feasible budget and assume $B^F < c\left(\frac{1}{\min\{\rho_i,\rho_j\}}+1\right)$. In this case the ICCs for A_1 and A_2 are given by:

$$\begin{aligned} w_1(e_1,e_2) &\geq c - \rho_1\frac{B^F+c}{B^F - w_1(e_1,e_2)}[B^F - w_2(e_1,e_2)], \\ w_2(e_1,e_2) &\geq c - \rho_2\frac{B^F+c}{B^F - w_2(e_1,e_2)}[B^F - w_1(e_1e_2)]. \end{aligned}$$

In order to maximizes her profit, the employer will set $w_1(e_1,e_2)$ and $w_2(e_1,e_2)$ such that the previous ICCs hold with equality. Let check if $w_1(e_1,e_2)+w_2(e_1,e_2) < 2c$. Rearranging it suffices to show

$$\begin{aligned} c - \rho_1\frac{B^F+c}{B^F - w_1(e_1,e_2)}[B^F - w_2(e_1,e_2)] + c - \rho_2\frac{B^F+c}{B^F - w_2(e_1,e_2)}[B^F - w_1(e_1e_2)] &< 2c, \\ -\rho_1\frac{B^F+c}{B^F - w_1(e_1,e_2)}[B^F - w_2(e_1,e_2)] - \rho_2\frac{B^F+c}{B^F - w_2(e_1,e_2)}[B^F - w_1(e_1e_2)] &< 0, \end{aligned}$$

which is always verified since by assumption $w_1(e_1,e_2)+w_2(e_1,e_2) \leq B^F$.

A.8.2 Asymmetric information

When $B^F < \frac{c}{\rho}$ and $B^F < \frac{c(1+(1+4\rho)^{\frac{1}{2}})}{2\rho}$ the ICCs for A_1 and A_2 becomes respectively:

$$\begin{aligned} w_1(2\gamma e) &\geq c - \rho_1 \frac{B^F}{B^F + c - w_1(X^{2\gamma e})}[B^F + c - w_2(2\gamma e)] \ , \\ w_2(2\gamma e) &\geq c - \rho_2 \frac{B^F}{B^F + c}[B^F - w_1(2\gamma e)]. \end{aligned}$$

The employer obtains $2\gamma e$ paying a sum of compensations lower than $2c$ if:

$$c - \rho_1 \frac{B^F}{B^F + c - w_1(2\gamma e)}[B^F + c - w_2(2\gamma e)] + c - \rho_2 \frac{B^F}{B^F + c}[B^F - w_1(2\gamma e)] < 2c$$
$$-\rho_1 \frac{B^F}{B^F + c - w_1(2\gamma e)}[B^F + c - w_2(2\gamma e)] - \rho_2 \frac{B^F}{B^F + c}[B^F - w_1(2\gamma e)] < 0$$

Since $w_1(2\gamma e) + w_2(2\gamma e) \leq B^F$ then the inequality is always verified.

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