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Positive and negative reciprocity in the labor market

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Abstract

Traditional gift-exchange experiments were designed with corner equilibria so that evidence of positive reciprocity could not be disentangled from one-sided errors. Our first treatment replicates the traditional design and finds that effort is an increasing function of wage for mid-range wage offers, but this relationship is not significant for high and low offers. The second treatment has an interior equilibrium, asymmetric marginal costs of reciprocity (positive and negative) and lower efficiency gains. There is evidence of a decrease in the deviations from the subgame perfect Nash equilibrium. However, there is still significant reciprocal behavior (positive and negative).

JEL classification: C72; C91; J30

Keywords: Trust; Reciprocity; Gift-exchange games; Incomplete contracts; Labor relations

1. Introduction

> "I had been advised early in life that sound decisions came from a cool head ... I had grown up accustomed to thinking that the mechanisms of reason existed in a separate province of the mind, where emotion should not be allowed to intrude, and when I

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> thought of the brain behind that mind, I envisioned separate neural systems for reason and emotion." Damásio (1994)

Homo oeconomicus, traditionally modeled as a rational and self-interested actor aiming to maximize material payoffs, seems to be partially challenged by recent discoveries in neurology and economics showing that emotions are influential in individual cognitive processes and decision-taking. In economics, there is now a large body of experimental evidence based on the use of a variety of games (trust, ultimatum, dictator and moonlighting games) demonstrating that people care not only about material payoffs, but also take into account fairness and the perceived intentions of those who interact with them. An important finding of trust or gift-exchange experiments is that a significant number of subjects behave reciprocally (Abbink et al., 2000; Charness, 2000; Charness and Haruvy, 2002; Fehr and Falk, 1999; Falk et al., 2000; Fehr et al., 1993, 1998a, 1998b; Fehr et al., 1997).

The experimental evidence supporting trust and reciprocal behavior can be questioned due to the experimental design. In fact, most papers analyzing reciprocity create a potential bias favoring trust and positive reciprocity. In traditional gift-exchange experiments and assuming selfish subjects, equilibrium is a corner solution. Therefore, any error resulting from inexperience or confusion may be misread as reciprocal or trusting behavior. This is a similar problem to the one addressed in public-good games where the mutual defection equilibrium, being a corner pair of actions, tends to overestimate cooperation (see Palfrey and Prisbrey, 1996, 1997; Ledyard, 1995; Andreoni, 1995).

The main purpose of this paper is to analyze the robustness of reciprocal behavior using a new experiment that allows for positive and negative reciprocity in the same domain of choice and designed to be relatively more hostile to positive than negative reciprocity. Recently, the robustness of the gift exchange is also being addressed by other authors with different designs (Charness et al., 2002; Engelmann and Ortmann, 2002).

It is worth clarifying at this stage the meaning of the key concepts, trust and reciprocity (positive and negative), as they are to be understood here. In the context of a two-stage game played with two subjects, *trust* means that subject *A* is willing to rely on subject *B* and 'offers' him something, so that if *B* does not 'counter-offer,' *A* will be worse off than he would have been had he not trusted *B*. Positive reciprocity is considered here as an act conditional on a trust initiative. *B* reciprocates *A*'s positive offer (trust), choosing an action that will increase *A*'s payoff and will not maximize his own. Negative reciprocity, on the other hand, occurs in the form of the action of *B,* who punishes the absence of trust, or even an offense by *A*, by reducing A's payoff at a cost to himself. Therefore, trust and reciprocity are particular patterns of behavior within the choice domain of the subjects.

Different motivations may underlie reciprocal behavior. Reciprocity may be driven by aversion to inequality (see Bolton and Ockenfels, 2000; Fehr et al., 1997; Fehr and Schmidt, 1999) or by the perceived intentions of others (see Rabin, 1993; Charness and Haruvy, 2002). However, reciprocity is not consistent with pure selfishness. In fact, a selfish agent would never sacrifice his own resources in order to punish or reward others if such an action brought him no monetary advantage.

This paper addresses several problems that can be tackled if we consider variations to the traditional gift-exchange design. Is reciprocity robust when equilibrium is not a corner solution? What is the effect of allowing positive and negative reciprocity in the same domain

of choice? What is the effect on both types of reciprocity when the marginal cost of negative reciprocity is lower than the marginal cost of positive reciprocity? What is the influence of an inevitable inequality of payoffs on subjects' behavior?

A standard gift-exchange treatment (GET) was conducted and the results were consistent with the patterns of trust and reciprocal behavior reported in the literature. We also show that the specific design introduces wage cut-points that significantly affect behavior.

In addition, a new treatment was created, the gift/offense-exchange treatment (GOET), to test the sensitivity of subjects' behavior to environmental changes. The design of this treatment is simple; it has an interior equilibrium, asymmetric marginal costs of reciprocity (negative reciprocity is 'cheaper' than positive reciprocity), and lower efficiency gains from a trust-reciprocity relationship. Results show that more workers' choices are consistent with selfish behavior, which suggests that traditional gift-exchange experiments may have overestimated positive reciprocity. In fact, one-sided errors may have been misread as positive reciprocity. However, the GOET also shows that a significant number of workers still behave reciprocally (positively or negatively).

The following section presents the design, procedures and results of the standard GET. Section 3 introduces the new treatment, the GOET, and presents the experiments' results. Section 4 discusses and compares the results of both treatments, and Section 5 concludes, addressing the robustness of gift exchanges.

2. Gift-exchange treatment (GET)

2.1. Payoff functions and cut-points

The gift-exchange treatment (GET) closely follows a strand of papers that analyze reciprocity within the framework of labor relations. In the GET, each firm selects a wage (w) in a first stage, and each respective worker responds with an effort level (e) in a second stage. Since workers' behavior is an act conditional on a firm's initiative, it may be classified as reciprocal. Firms' behavior, on the other hand, can be classified as trusting or distrusting.

Wages and effort levels are arguments of the firm's payoff function, $\pi = \pi(w, e)$ with $\partial\pi/\partial w < 0$ and $\partial\pi/\partial e > 0$, and of the worker's payoff function, $u = (w, e)$ with $\partial\pi/\partial w > 0$ and $\partial\pi/\partial e < 0$. The effort cost function ($c(e)$) is increasing with effort ($\partial c(e)/\partial e > 0$) and convex ($\partial^2 c(e)/\partial e^2 > 0$).

The subgame perfect Nash equilibrium, assuming selfish agents, is the minimum wage offer and the minimum effort choice in every contingency. However, experimental evidence has consistently shown firms' willingness to trust, offering wages higher than minimum, and workers' willingness to reciprocate, revealed by higher effort levels in response to higher wage offers (i.e. a positive correlation between wage offers and effort choices).

It should be emphasized that the payoff functions and the parameters used (which will be presented below) create cut-points that may have a significant influence on subjects' behavior. These cut-points are implicit thresholds that define three different frames of decision. Consider first that there is a certain wage, $\underline{w}^c$, which will be labeled as the low cut-point,

below that the following inequality holds:

$$\pi_i(w_i, e_j) - u_j(w_i, e_j) > 0 \text{ for } w < \underline{w}^c, \forall e_j \quad (1)$$

This means that whatever the worker's choice, the firm's profit is always higher than the worker's payoff. A selfish worker maximizes his payoff, choosing the minimum effort level ($e = e_{\min}$). A reciprocal worker will equally choose the minimum effort level in order to penalize the firm for the low wage offers. Selfishness and reciprocity may explain minimum effort. Therefore, it is not possible to discriminate between a selfish and a reciprocal worker.

There is also another wage, $\overline{w}^c$, labeled the high cut-point, above which a worker's payoff, independently of his choice, is always higher than a firm's payoff:

$$\pi_i(w_i, e_j) - u_j(w_i, e_j) < 0 \text{ for } w > \overline{w}^c, \forall e_j \quad (2)$$

In the case of wages higher than the high cut-point, workers are always better off than the firm. Thus, reciprocal workers will choose higher effort levels. However, as the effort domain is censored above and reciprocators are already choosing relatively high effort levels at $\overline{w}^c$, marginal wage increases will be associated with lower marginal effort increases when compared with moderate wages (within the range $\underline{w}^c < w < \overline{w}^c$).

For wages higher than $\underline{w}^c$ and lower than $\overline{w}^c$, the higher the firm's wage offer, the higher will be the reciprocal worker's effort choice. In contrast, a selfish worker will always choose $e = e_{\min}$. Thus, it is possible to discriminate between a selfish and a reciprocal worker. In this sense, the prediction of the effort level varies with the worker type.

To summarize, we expect that reciprocal behavior can be observed in mid-range wages, but not at high and low wages where inequality is unavoidable.

2.2. Experimental design and procedures

Two experimental sessions were conducted with the gift-exchange game described above: at the first stage, a firm offers a wage, w, to the worker with whom it has been matched. The worker, at the second stage, has to decide how much effort to provide, e. These two stages constitute a period of the game. In each session, there were twelve periods to allow the subjects to gain an understanding of the game structure and to enable the study of potential convergence properties. It should be pointed out that in each period, firms and workers were matched with different opponents so that a firm (or worker) was never re-matched with the same worker (or firm).[1]

The firm's payoff function, in terms of experimental money, was given by $\pi = (v - w)e$, where v stands for an exogenously given redemption value equal to 120. The worker's payoff function was defined by $u = w - c_0 - c(e)$, where c_0 denotes the opportunity cost of being in a labor relation and is equal to 20. The term $c(e)$ represents a strictly increasing effort-cost function ($c(e) = (10e - 1)^{1.3}$), which is presented in Table 1.[2] To

[1] The procedure used followed that described by Cooper et al. (1996), which was theoretically justified by Kamecke (1997).

[2] The payoff functions are identical to those used in the traditional gift exchange literature. This allows comparability of our results and also enables us to test the same type of hypothesis. In fact, we all test reciprocity as given

Table 1
Effort levels and associated costs in the GET

e	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
$c(e)$	0	1	2	4	6	8	10	12	15	18

exclude the loss-aversion effects described by Tversky and Kahneman (1991) as a possible explanation of experiments' results, wage offers were restricted to the interval [20,120].[3]

With the parameters used, the low cut-point, $\underline{w}^c$, is equal to 30 experimental money units and the high cut-point, $\overline{w}^c$, to 79 experimental money units. The null hypothesis that cut-points do not affect the relationship between effort levels and wages will be tested against the alternative hypothesis of interference of cut-points on subjects.

The subjects of these experimental sessions were undergraduate students of ISEG/Technical University of Lisbon with no prior knowledge of experimental economics. They participated voluntarily and for the first time in an economics experiment. For the recruitment of subjects, only monetary incentives were used.

Before the beginning of each experimental session, a random mechanism determined whether a subject was included in the group of twelve firms or twelve workers. Subjects in the role of firms and subjects in the role of workers were located in different rooms to avoid the possibility of identifying trading partners. It was common knowledge that partners' identities would never be revealed. This procedure and the procedure of no re-matching ensured that no reputation could be developed; thus firms' wage offers were the only way to trigger workers' reciprocal behavior.

Since payoff functions and procedures were common knowledge, each subject could compute his own and his opponent's payoffs. To guarantee that each subject understood the payoff calculations, a set of control questions was included in the instructions. Experimental sessions did not start until all subjects answered each question correctly.

The subjects' ability to compute the implications of their choices on mutual payoffs (firm and respective worker) is essential in order to enable them to express an inequality-aversion motivation (if they have it). Additionally, the common information of wage and effort domains allows the worker to gauge the trustfulness of the firm and allows the firm to know the extent of the worker's possible reciprocation. Moreover, it should be noted that wage and effort choices were only known by the firm and the worker who were involved in a given labor relation. Each pair knew nothing of the decisions of other pairs, so the options of others could not serve as a reference standard. This procedure was implemented to rule out group-pressure effects and, consequently, to contribute further to isolate firms' wage offers as the only way to trigger reciprocal behavior.

by a *positive* relationship between effort and wage against the null hypothesis of no relationship (since the best reply of workers is *always* minimum effort). Other, more complex functions not only may introduce confusion in subjects, but can also make the workers' best reply a *positive* function of wage (e.g. Engelmann and Ortmann, 2002). Thus, their null hypothesis is different.

[3] Note, however, that workers may incur losses if they choose a non-minimum effort when responding to minimum or very low wages. This type of behavior is explained neither by reciprocity nor selfishness.

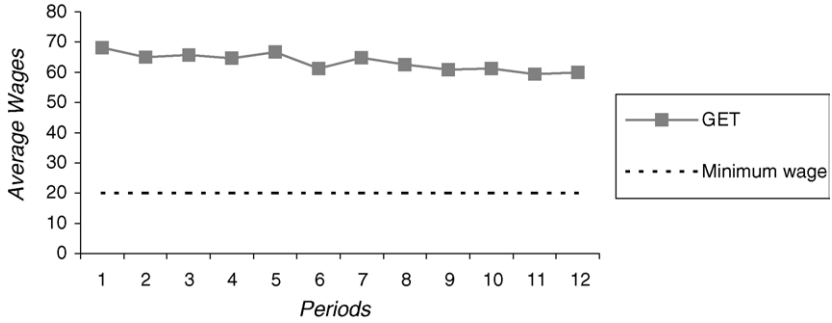

Fig. 1. Evolution of wage offers in the GET.

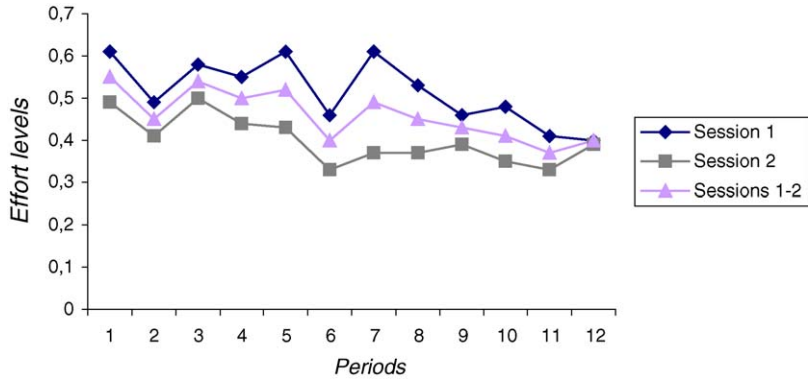

Fig. 2. Average effort per period in the GET.

2.3. Results

In each experimental session, 24 subjects were present. Average earnings of a 2-h session were € 8.68 for each subject, which was, according to the majority of responses to an optional questionnaire, sufficient to motivate their participation in future experiments.

The subjects in the role of firms behaved heterogeneously (coefficient of variation of 0.27 for the two sessions) and far from the predictions of conventional game theory. As Fig. 1 shows, wage offers were higher than equilibrium (minimum wage) in each period and did not converge on it. In fact, firms were willing to trust, as reported in the literature of gift-exchange experiments.

Also consistent with previous experiments, workers[4] chose effort levels far from the game theory prediction as shown in Fig. 2. In fact, the effort choice in accordance with selfishness ($e = 0.1$) was only chosen by 30 out of 288 workers (10.4%).

[4] Note that workers, like firms, also act heterogeneously (coefficient of variation of 0.5036 considering the two sessions).

Table 2
Tobit regressions for the GET (effort level as dependent variable)

Independent variables	Regression			
	1	2	3	4
Constant	−0.138664 (0.054286)			−0.115296 (0.087298)
D_3				0.739300 (0.347364)
w	0.009201 (0.000818)	0.008796 (0.000636)	0.0087875 (0.0008093)	0.009023 (0.001388)
$w \times D_1$				−0.009369 (0.004792)
$w \times D_3$				−0.008815 (0.004038)
LnL	−5.84262	76.3074	0.177842	0.559150
LR		164.30004	12.040924	12.80354

Note: There are 288 observations. Standard errors are in parentheses. Regression 1 is the Tobit regression two-sided censored; regression 2 allows for individual fixed effects; regression 3 for period dependent intercepts; regression 4 tests the influence of cut-points. D_1 and D_3 are dummy variables: $D_1 = 1$, if $w < \underline{w}^c$ and 0 elsewhere and $D_3 = 1$, if $w > \overline{w}^c$ and 0 elsewhere. LnL identifies the log of the likelihood function. LR stands for the value of the likelihood ratio statistic for the null hypothesis that all dummy variables in regressions 2 and 3 are equal to each other and for the null hypothesis that dummy variables D_1 and D_3 in regression 4 are not significant.

In order to investigate if there is causality between firms' and workers' choices at the individual level, the Spearman rank correlation between wages and effort levels was calculated for each worker. For 75% of the workers, there is a positive and significant (at the 5% level) correlation between wage offers and effort levels (i.e. the majority of workers behaved reciprocally).

The positive correlation between wage and effort is also confirmed at the aggregated level by a two-sided censored Tobit regression $e = \alpha + \beta w + \varepsilon$ (effort levels higher than maximum are censored to the maximum and effort levels lower than minimum are censored to the minimum). In fact, as regression 1 in Table 2 shows, the coefficient of wages is positive and statistically significant.

Regression 2 in Table 2, where dummies for individual subjects replace the constant, tests differences among individuals. The likelihood ratio test rejects, at the conventional significance levels, the hypothesis of no differences among workers. This point confirms the mentioned heterogeneity among workers. Differences across time were tested using regression 3 in Table 2, where dummies for the period replace the constant. The likelihood ratio test does not reject the hypothesis of no differences across time. Similarly, the likelihood ratio test also rejects the hypothesis that the slopes are period-dependent (LR-statistics = 11.44 with 11 degrees of freedom). Thus, reciprocity does not vanish with time.

Table 2 also presents the results of a Tobit regression estimated to analyze the influence of wage cut-points on subjects' behavior. With that purpose, two dummy variables D_1 and D_3 were defined: $D_1 = 1$ if $w < \underline{w}^c$ and 0 elsewhere, and $D_1 = 1$ if $w > \overline{w}^c$ and 0 elsewhere. Consistent with the theoretical considerations developed in Section 2.1, there is no significant relation between wages and effort levels when wages are below the low cut-point or above the high cut-point. In fact, the results of regression 4 do not allow the rejection of the hypothesis that the coefficient associated with w is equal to minus the coefficient associated with $w \times D_3$ and equal to minus the coefficient associated with

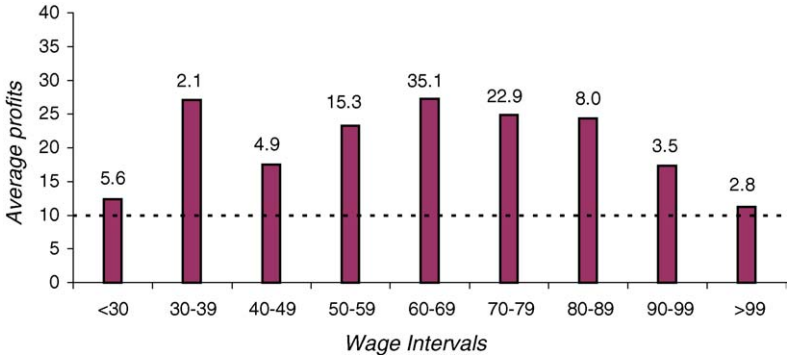

Fig. 3. Average profit and percentage of labor relations by wage interval in the GET.

$w \times D_1$. In fact, the relation between wages and effort levels is almost flat when wages are below the low cut-point or above the high cut-point.

Given the conditional behavior of workers, it is important to evaluate firms' wage choices. Fig. 3 shows that there is a domain in which average profits have increased with wage offers.[5] In addition, it shows that firms offered wages that gave them higher profits with higher frequency (according to the percentage of wage proposals expressed above the bars). This suggests that firms' behavior was rational in terms of the results, since by offering higher wages (given workers' conditional effort choices) they received higher profits than predicted by conventional game theory (represented by the dashed line).

To analyze further the effect of subjects' behavior on payoffs, we have calculated firms' and workers' payoffs, taking the results of regression 1 in Table 2 as describing subjects' behavior. For each wage value, the effort level was calculated, as well as the resulting payoffs. These results are plotted in Fig. 4, which also shows the firm and worker subgame perfect Nash equilibrium payoffs and the most efficient egalitarian payoff ($\pi = u = 41$, which is obtained when $w = 79$ and $e = 1$).

As shown in Fig. 4, for a significant range of the wage domain, both firms and workers had higher payoffs than equilibrium. Moreover, for wages below 68 experimental money units, both sides of the market had higher payoffs as wages rose, that is, firms and workers benefited from a trust-reciprocity relationship.

3. Gift/offense-exchange treatment (GOET)

3.1. Experimental design and procedures

A new treatment was developed in which the equilibrium is interior to the workers' choice domain to disentangle error from reciprocity. In this treatment, there is the possibility of

[5] The only exception is the interval 30–39, which was influenced by a worker choice of an effort level of 0.9 in response to a wage of 38 experimental money units. Note that 73.3% of the firms offered wages in the range 50–79.

Fig. 4. Estimated payoffs in relation to wages in the GET.

Table 3
Effort levels and associated costs in the GOET

e	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
$c(e)$	2	1.6	1.3	1.1	1	2	3.5	5.2	7.1

exchanging gifts (high wage offer, high effort level) and offenses (low wage offer, low effort level), hence the title, the gift/offense-exchange treatment (GOET). Workers can reciprocate positively and negatively in the same domain of choice. However, the marginal costs of positive reciprocity are higher than the marginal costs of negative reciprocity. Finally, the prospects of efficiency gains from a trust-reciprocity relationship are smaller than in the previous treatment.

The GOET is similar to the GET: in the first stage, firms offer wages, and in the second stage, workers choose effort levels. The payoff functions and procedures are the same as in the GET. The main difference is a new effort cost function, presented in Table 3.

The effort cost is minimum at the average effort level so the equilibrium effort for selfish workers is now 0.5. There is a framing effect because workers' best reply is in the middle of the effort domain, which increases the attraction of this choice. In contrast to the GET, this equilibrium is now interior, so errors can occur for both sides, thereby not favoring reciprocity. If a worker is reciprocal, he can reward a firm's wage offer by choosing an effort level higher than 0.5 and punish an unkind offer by choosing an effort level lower than 0.5. Thus, workers can reciprocate either positively or negatively in the same dimension of choice, although with asymmetric marginal costs.

This cost schedule can be approximated by the function[6]

$$c(e) = \begin{cases} 1 + (10e - 5)^{1.3} & if \quad e \geq 0.5 \\ 1 + p(0.5 - e) & if \quad e < 0.5 \end{cases} \tag{3}$$

[6] The cost function is convex, so that the marginal cost of positive or negative reciprocity starting from the equilibrium is positive and increasing. Note that the marginal cost of positive reciprocity in the GET and in the GOET is approximately the same.

A possible rationalization of this cost function is that there is a constant subjective unitary cost below $e = 0.5$, to which a penalty p should be added if the worker chooses an effort level lower than 0.5.[7] This penalty punishes the worker for choosing an effort level lower than defined in an implicit contract that, by hypothesis, is 0.5. The penalty is higher when the deviation from that value is greater and is given by $p = (0.5 + 5(0.5 - e))$ for $e < 0.5$. Effort levels higher than 0.5 have disutility costs associated.

This design does not implement symmetry in reciprocity. We designed asymmetric possibilities to reciprocate inspired in Smith (1998) approach that negative reciprocity is simply the 'policeman' who punishes those who fail a trust initiative. That is, the meaning of negative reciprocity is merely to enforce positive reciprocity.

With the purpose of avoiding loss-aversion, wage proposals were now restricted to the interval [23,120]. The lower limit was imposed so that workers could retaliate against a minimum wage proposal without incurring losses while supporting costs. It is to be remembered that the definition of reciprocity involves the willingness to sacrifice resources (i.e., supporting costs).

As in the GET, we can predict the impact of the low cut-point, which is now equal to 31 experimental money units, and of the high cut-point, which now assumes the value of 71 experimental money units. In the GET, all possible workers' behavior (selfish or reciprocal) led to the choice of the same minimum effort level in response to a wage offer below the low cut-point. Now, in the GOET, selfishness leads to an effort level of 0.5, while reciprocity brings about the choice of a smaller effort level. Therefore, contrarily to the GET, a 'flat' (nearly zero) coefficient for wage offers below this cut-point can only be expected if selfishness prevails. On the other hand, if negative reciprocity prevails for low wages, there should be no effect of the lower cut-point. Moreover, the effect of the high cut-point remains basically the same as in the GET.

3.2. Results

In each experimental session of the GOET, 24 subjects were present. Average earnings per 2-h session were € 8.17. As previously, the gains were considered sufficient to encourage subjects to participate in a future experiment.

Subjects in the role of firms behaved heterogeneously (coefficient of variation of 0.45 for the two sessions) and far from the predictions of conventional game theory. As Fig. 5 shows, there was a drastic wage decline in early periods, but after that, the wage offers stabilized at around 40 experimental money units. However, it was still far above the minimum wage.

On the other hand, subjects in the role of workers chose effort levels near the conventional game theory equilibrium, according to Fig. 6 (their heterogeneity can be illustrated through the coefficient of variation of 0.43 considering the two sessions). The 0.5 effort level was chosen in 145 cases (50.35%). Thus, when equilibrium is not a corner solution, deviations from it decline considerably.

[7] This is a rationalization of the cost function that was not included in the instructions to the subjects because the goal was to study workers' behavior free of any conditions such as the obligation to fulfill a required effort level. The transposition of this rationalization to the instructions would decrease the propensity to reciprocate.

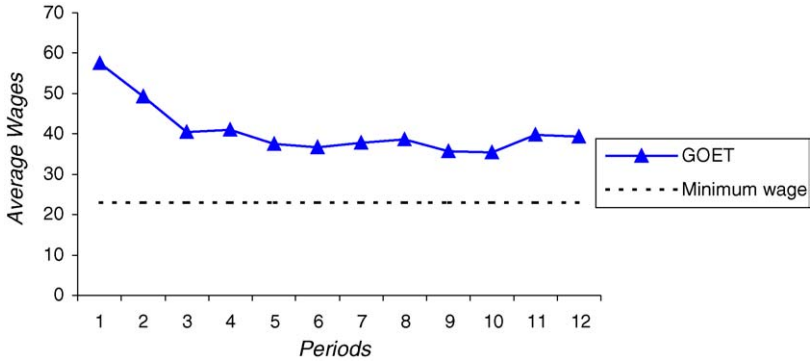

Fig. 5. Evolution of wage offers in the GOET.

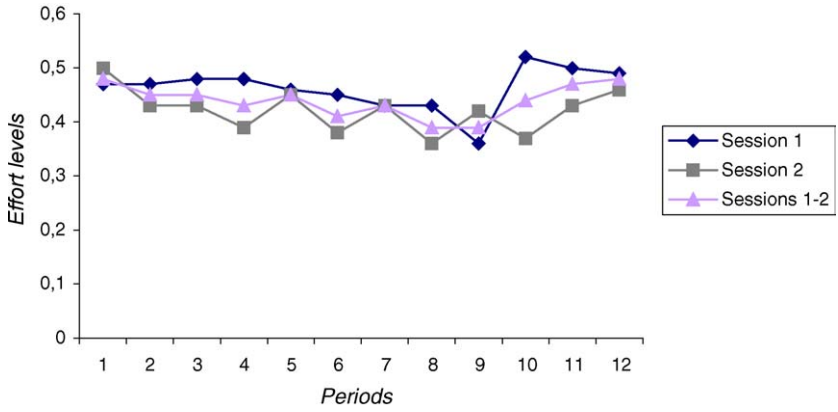

Fig. 6. Average effort per period in the GOET.

However, at the individual level, the correlation between wages and effort levels exists and is significant for 50% of workers (using the Spearman rank correlation). The same conclusion can be drawn from the two-sided censored Tobit regression 1 in Table 4. Therefore, reciprocal behavior still exists when the equilibrium is interior and not a corner solution, but there was a considerable decrease when compared with the reciprocal pattern of behavior in the GET. [8] Note that, similar to the GET, the likelihood ratio test rejects the hypothesis of no differences among workers (regression 2 of Table 4) and does not reject the hypothesis of no differences across time (regression 3 of Table 4).

To test the influence of cut-points on subjects' behavior in the GOET, a two-sided censored Tobit regression, similar to the one made for the GET, was estimated (regression 4 in Table 4). The dummy variable D_1 is not statistically significant, neither when introduced

[8] Following a referee's suggestion we have calculated a two-sided Tobit regression for off-equilibrium workers' choices. The coefficient of wage offers is higher than the one of regression 1 ($\beta = 0.009061$). Therefore, the off-equilibrium choices clearly follow a reciprocal pattern.

Table 4
Tobit regressions for the GOET (effort level as dependent variable)

Independent variable	Regression			
	1	2	3	4
Constant	0.260757 (0.030977)			0.210542 (0.039213)
w	0.00404 (0.000686)	0.00411 (0.000489)	0.004131 (0.000721)	0.005542 (0.0009932)
$w \times D_3$				−0.00163 (0.000780)
LnL	−29.2695	76.1924	−26.7112	−27.0793
LR		210.9238	5.1166	4.3804

Note: There are 288 observations. Standard errors are in parentheses. Regression 1 is the Tobit regression two-sided censored; regression 2 allows for individual fixed effects; regression 3 for period dependent intercepts; regression 4 tests the influence of cut-points. D_3 is a dummy variable: $D_3 = 1$, if $w > \bar{w}^c$ and 0 elsewhere. LnL identifies the log of the likelihood function. LR stands for the value of the likelihood ratio statistic for the null hypothesis that all dummy variables in regressions 2 and 3 are equal to each other and for the null hypothesis that dummy variable D_3 in regression 4 is not significant.

in the slope parameter nor in the constant term. This is consistent with our previous prediction that the relation between wages and effort levels is not flat for wages below the low cut-point, assuming the dominance of the negative reciprocity effect. Above the high cut-point, the slope decreases, but this impact is less significant than it was in the GET. This is a result of the approximation of workers' choice to the equilibrium and the consequent lower responsiveness to wage variations.

It should be emphasized that we observe negative reciprocity in the GOET. In 90 labor relations (31.25% of the total), workers chose effort levels lower than equilibrium (i.e. workers were willing to sacrifice resources to punish firms' unkind offers). However, when wage offers were generous, workers rewarded firms. In 53 of the cases (18.4% of the total), workers chose effort levels higher than equilibrium. That is, besides negative reciprocity we observe also positive reciprocity despite its higher marginal costs (when compared with negative reciprocity).

Fig. 7 depicts the average profits as a function of wage offers. This figure clarifies that firms did not have incentives to offer higher wages. In fact, due to workers' near equilibrium effort choices (see Fig. 6), they obtained higher profits if they proposed lower wages although they could not obtain a payoff as high as the subgame perfect Nash equilibrium (represented by the dashed line, which results from $w = 23$ and $e = 0.5$).

Fig. 8 plots firms' and workers' payoffs as a function of wages, using the results of regression 1 in Table 4 as subjects' behavior. Moreover, Fig. 8 also introduces firm- and worker-subgame perfect Nash equilibrium payoffs and the most efficient egalitarian payoff (which is equal to approximately 44 experimental money units and is obtained with a $w = 71$ and $e = 0.9$).

Fig. 8 shows that firms had higher profits for low wage offers and that the greater the deviation from the wage predicted by conventional game theory, the lower were firms' payoffs. Note, however, that firms could never obtain the equilibrium profit, due to workers' negative reciprocity. On the other hand, for wages higher than equilibrium, workers could obtain higher gains than conventional game theory predicts.

In summary, in early periods, firms made relatively high wage offers. As workers responded with effort levels near the equilibrium, showing little willingness to reward

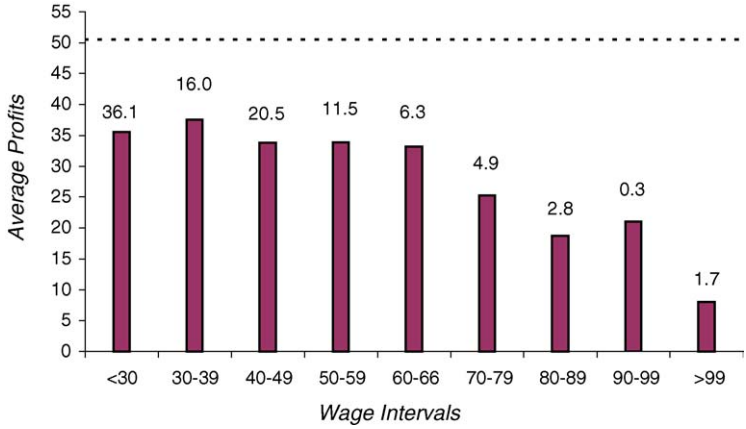

Fig. 7. Average profit and percentage of labor relations by wage interval in the GOET.

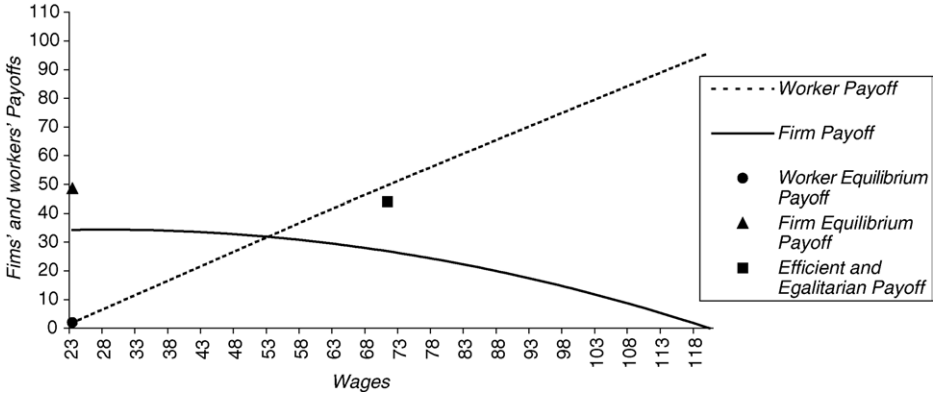

Fig. 8. Estimated payoffs in relation to wages in the GOET.

firms' kind acts, firms decreased their proposals, obtaining higher profits. Thus, firms seem to have updated their beliefs concerning workers' reciprocal behavior and adapted to it. This may explain the wage decrease observed in Fig. 5 in early periods. However, due to the negative reciprocity of workers, firms never obtained a payoff as high as the conventional game theory prediction.

4. A cautious comparison of GET and GOET

The shift of the equilibrium to the interior of the workers' choice domain and the smaller expected gains from the trust-reciprocity relationship led workers and firms alike to approach the prediction of conventional game theory. This evidence is consistent with

Table 5
OLS regression $\frac{e-e^e}{e^{\max}-e^{\min}} = \alpha + \beta D + \delta \frac{w-w^e}{w^{\max}-w^{\min}} + \theta \frac{w-w^e}{w^{\max}-w^{\min}} \times D + \varepsilon$

Independent variables	
Constant	0.039434 (0.035725)
D	−0.191451 (0.039997)
$\frac{w-w^e}{w^{\max}-w^{\min}}$	0.824832 (0.076724)
$\frac{w-w^e}{w^{\max}-w^{\min}} \times D$	−0.406961 (0.102642)

Note: There are 576 observations. Standard errors are in parentheses. D is a dummy variable that assumes value one for observations of the GOET and value zero for observations of the GET.

the initial presumption that every noise or error benefited reciprocal behavior in the GET.

The results seem to indicate that firms' behavior was determined by updated beliefs concerning reciprocity. In fact, in the GET, firms had confidence in a trust-reciprocity relationship and were not disappointed along the twelve periods of the game. This trustfulness was reinforced by two factors: workers could only reciprocate positively and the prospect of mutual gains from cooperation was significant. However, in the GOET, there was a breakdown in confidence in early periods. As workers' choices were near equilibrium, firms lost confidence in their reciprocity and decreased their wage offers. This can be explained by the smaller potential gains from cooperation. However, the possibility of positive and negative reciprocity may explain why wages did not fall to the minimum.

To examine further the difference between treatments, taking into account slight differences in parameters, the following OLS regression was estimated:

$$\frac{e - e^e}{e^{\max} - e^{\min}} = \alpha + \beta D + \delta \frac{w - w^e}{w^{\max} - w^{\min}} + \theta \frac{w - w^e}{w^{\max} - w^{\min}} \times D + \varepsilon \tag{4}$$

The endogenous variable is the difference between observed and equilibrium effort as a proportion of the effort range. The independent variable is the difference between observed and equilibrium wage as a proportion of the wage range. We further introduced a dummy variable D in the slope and in the constant term. Variable D assumes value one for observations of the GOET and value zero for observations of the GET.

As the results of Table 5 show, besides the significant positive correlation between wages and effort, the dummy variable is also significant (at the conventional significant levels) in the constant term and in the slope. That is, workers' effort choices varied according to the treatment. However, there was a clear reduction in reciprocal behavior in the GOET, as confirmed by the negative coefficient of the dummy variable that influences the slope.

Although there was a reduction in reciprocal behavior in the new treatment with interior equilibrium, reciprocity did not vanish. The new experimental design also shows that, besides positive reciprocity, negative reciprocity exists as well in labor experimental markets, and is even stronger in some environments. Finally, it should be pointed out that comparisons between GET and GOET should be made with great caution since the designs are different. The GET has a corner equilibrium while the GOET has an interior equilibrium. Firms are better off in the GOET equilibrium than in the GET equilibrium. On the other hand, workers have a similar low payoff in equilibrium in both treatments.

5. Discussion: on the robustness of reciprocity

This paper analyzes reciprocal and selfish behavior in a corner equilibrium design (gift-exchange treatment – GET) and an interior equilibrium design (gift/offense exchange treatment – GOET). The traditional treatment (GET) replicates existing papers and shows that there are hidden thresholds (wage 'cut-points') that have an effect on observable reciprocal behavior. In fact, when workers are always worse off irrespective of their choices, no reciprocity is observed, and the same occurs when workers are always better off and receive high wages. However, these wage cut-points lose their significance in the GOET.

The new treatment (GOET) allows subjects to reciprocate either positively or negatively, but deliberately makes negative reciprocity 'cheaper' for the worker (i.e. at a lower marginal cost). The effort level that minimizes workers' costs, being the average (in GOET) and not the minimum (as in GET), also reinforces the attraction of the equilibrium in the new design.

Evidence of a decrease in the deviations from the subgame perfect Nash equilibrium suggests that reciprocity is overestimated in the literature. However, the fact that 50% of wage-effort choices are consistent with a trust-reciprocity relationship is quite significant. Moreover, the evidence of more negative reciprocity than positive reciprocity may be a consequence of the asymmetric marginal costs of reciprocal behavior.[9] Evidence is consistent with the following hypothesis: *ceteris paribus,* an increase in the marginal cost of reciprocity should decrease the proportion of actions according to the pattern of reciprocity. This is a hypothesis that can be tested with further experiments. Additionally, an experiment could also be devised in which the Nash equilibrium is the same level of effort in both treatments.[10]

What can be concluded concerning the robustness of gift exchange? Charness et al., 2002 remind us that even a seemingly innocuous change (providing a comprehensive payoff table instead of mere payoff functions) may have a significant impact on reciprocal behavior. If robustness means behavior invariance with respect to experimental procedures and the specification and parameterization of payoff functions, evidence in this paper also supports the non-robustness of gift exchanges. However, if the hypothesis stated above is correct, it would not be difficult to design a treatment with very high marginal costs of reciprocal behavior so that subjects behave 'selfishly'.

Therefore, a different approach to 'robustness' of gift exchange is not to consider that *homo reciprocans* displaces (or is displaced by) *homo oeconomicus,* but that we are in the presence of subjects who, in certain precise contexts, behave selfishly whereas in others behave reciprocally. Thus, reciprocity is a pattern of behavior that may be considered 'robust' because it emerges in specific environments where the marginal costs of such behavior are reasonable, but not prohibitive. This may be relevant in labor markets and other principal-agent environments with incomplete contracts and asymmetric information.

[9] Engelmann and Ortmann (2002), with a different design allowing for wage rejections, also find more evidence of negative reciprocity than positive reciprocity. Including rejections as a case of negative reciprocity, 40% of choices can be considered reciprocal. However, their design is still more hostile to positive reciprocity. Not only are marginal costs of positive reciprocity relatively higher (as in our treatment), but also the workers' best reply is an *increasing* function of wage in part of the domain (see Footnote 2).

[10] An example is a different *GET*with the equilibrium at $e = 0.5$. We would like to thank Arno Riedl for this suggestion.

It also opens up an interesting research agenda since it suggests focusing on characteristics that promote certain types of behavior. An improved knowledge of these characteristics will enhance the ability to design better economic, social and political institutions.[11]

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References

Abbink, K., Irlenbusch, B., Renner, E., 2000. The moonlighting game: an experimental study on reciprocity and retribution. Journal of Economic Behavior and Organization 42, 265–277.

Andreoni, J., 1995. Cooperation in public-goods experiments: kindness or confusion? American Economic Review 85, 891–904.

Bolton, G., Ockenfels, A., 2000. ERC: A theory of equity, reciprocity, and competition. American Economic Review 90, 166–193.

Charness, G., 2000. Responsibility and effort in an experimental labor market. Journal of Economic Behavior and Organization 42, 375–384.

Charness, G., Haruvy, E., 2002. Altruism, equity and reciprocity in a gift-exchange experiment: an encompassing approach. Games and Economic Behavior 40, 203–231.

Charness, G., Frechette, G., Kagel, J., 2002. How robust is laboratory gift exchange? mimeo, University of California at Santa Barbara.

Cooper, R., DeJong, D.V., Forsythe, R., Ross, T., 1996. Cooperation without reputation: experimental evidence from prisoner's dilemma games. Games and Economic Behavior 12, 187–218.

Damásio, A., 1994. Descartes' Error – Emotion, Reason and the Human Brain. Avon Books, New York.

Engelmann, D., Ortmann, A., 2002. The robustness of gift exchange: a reconsideration. mimeo, Prague.

Falk, A., Fehr, E., Fischbacher, U., 2000. Testing theories of fairness – intentions matter. Working Paper, Institute for Empirical Research in Economics, University of Zurich.

Fehr, E., Falk, A., 1999. Wage rigidity in a competitive incomplete contract market. Journal of Political Economy 107, 106–134.

Fehr, E., Schmidt, K.M., 1999. A theory of fairness, competition and cooperation. Quarterly Journal of Economics 114, 817–868.

Fehr, E., Gächter, S., Kirchsteiger, G., 1997. Reciprocity as a contract enforcement device: experimental evidence. Econometrica 65, 833–860.

[11] We thank Manfred Holler for having pointed out that there is some similarity between a trust-reciprocity relationship and logrolling in politics.

Fehr, E., Kirchsteiger, G., Riedl, A., 1993. Does fairness prevent market clearing? an experimental investigation. Quarterly Journal of Economics 108, 437–459.

Fehr, E., Kirchsteiger, G., Riedl, A., 1998a. Gift-exchange and reciprocity in competitive experimental markets. European Economic Review 42, 1–34.

Fehr, E., Kirchler, E., Weichbold, A., Gächter, S., 1998b. When social norms overpower competition: gift exchange in experimental labor markets. Journal of Labor Economics 6, 324–351.

Kamecke, U., 1997. Rotations: matching schemes that efficiently preserve the best reply structure of a one shot game. International Journal of Game Theory 26, 409–417.

Ledyard, J.O., 1995. Public goods: a survey of experimental research. In: Kagel, J., Roth, A. (Eds.), The Handbook of Experimental Economics. Princeton University Press, Princeton, pp. 111–194.

Palfrey, T.R., Prisbrey, J.E., 1996. Altruism, reputation and noise in linear public goods experiments. Journal of Public Economics 61, 409–427.

Palfrey, T.R., Prisbrey, J.E., 1997. Anomalous behavior in public goods experiments: how much and why? American Economic Review 87, 829–846.

Rabin, M., 1993. Incorporating fairness into game theory and economics. American Economic Review 83, 1281–1302.

Smith, V., 1998. The two faces of Adam Smith. Southern Economic Journal 65, 1–19.

Tversky, A., Kahneman, D., 1991. Loss aversion in riskless choice: a reference-dependent model. Quarterly Journal of Economics 106, 1039–1061.