The Robustness of Gift Exchange: An Experimental Investigation[1]

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Abstract

We report a gift exchange experiment which is differentiated from most of the literature by the following experimental design and implementation characteristics: the choice of equilibrium (interior rather than corner point), the choice of a matching mechanism that has been shown to best preserve the nature of one-shot interactions (rotation), extent of efficiency gains, and frames (abstract versus employer-worker).

Much of the observed play of our participants, especially responders, is at or close to equilibrium. Our results therefore stand in stark contrast to much of what has been reported in the literature. In particular, we find little evidence for positive reciprocity but substantial evidence for negative reciprocity.

Our results suggest strongly that laboratory gift exchange is highly sensitive to the parameterization of the gift exchange or implementation characteristics.

1 Introduction

Numerous studies seem to have shown that many people trust and positively reciprocate (e.g., Berg, Dickhaut, McCabe 1995; Ortmann, Fitzgerald, Boeing 2000; Fehr, Kirchsteiger, Riedl 1993; Fehr, Gächter, Kirchsteiger 1997). These results have been interpreted as showing that "the exclusive reliance on selfishness and, in particular, the neglect of reciprocity motives may lead to wrong predictions and to wrong normative inferences." (Fehr et al. 1997, p. 833). In fact, the argument has been pushed even further that incentives may undermine intrinsic motivation that people allegedly are endowed with.[1] Indeed, these seemingly robust findings suggest that the incentive compatible design of institutions and organizations (e.g., Smith 1759, 1776) may be too much of a good thing.

The well-documented experimental results on gift exchange (e.g., Fehr & Gächter 1998) are surprising when measured against the canonical game theoretic predictions[2] for one-shot or finitely repeated interactions.[3]

In our view, most gift exchange studies reported in the literature have features that appear to give the canonical game theory for one-shot and finitely repeated games not its best shot. Specifically, much of the literature features corner point solutions that allow only for deviations consistent with trust and positive reciprocity and thus systematically bias results in that direction whenever subject behavior is noisy (as much of experimental participant behavior surely is). In addition, the typical corner point solution tends to be rather unattractive because it yields only minimal payoffs for the subjects and hence gives them substantial incentives to move away from the equilibrium. This effect is reinforced by dramatic achievable efficiency gains.[4] For example, in Fehr et al. (1993) the achievable efficiency gains were up to 1100% and were still 300% at the maximal possible effort. Furthermore, offering a higher wage was risk free in Fehr et al. (1993), because a wage cost was increasing in the effort in a way that prevented losses. Hence an employer had a substantial incentive to try to initiate cooperation at an above equilibrium wage-effort combination, and this did not even involve risk of being exploited. In addition, with very few laudable exceptions the alleged one-shot and finitely repeated laboratory gift exchange experiments have often been implemented in problematic ways,

[1] It is not without a certain irony that, as economists start talking about intrinsic motivation, a sentiment is growing among psychologists that it is a myth rather than a reality (Eisenberger & Cameron 1996; Eisenberger et al. 1999; Hertwig & Ortmann 2001, p. 396)

[2] Recent theoretical developments (e.g., McKelvey & Palfrey 1995; McKelvey & Palfrey 1998; ; 2001; **????**;Goeree & Holt 2001; see also earlier Reny 1992 for similar arguments) have incorporated noise into explanatory models of experimental data; they model choice probabilities rather than choices and explains a wide variety of "anomalies". Canonical game theory, such as it it found in standard micro graduate textbooks (e.g., Kreps 1995 and Mas-Colell et al. 1995) doesn't.

[3] The experimental results on gift exchange are, however, quite in line with game theoretic predictions for indefinitely repeated interactions, as most people arguably conceptualize real life (e.g., Hoffman, McCabe, Smith 1996)

[4] Conceptuatlize these changes in participants' incentives as potential efficiency gains grow as gambles whose positive outcome increases dramatically.

as regards matching schemes and framing.

To the best of our knowledge, the robustness of laboratory gift exchange to parameterization and implementation issues such as the ones enumerated above has received little attention, if any. It is important at this point to distinguish two types of robustness. One, that we shall call second-degree robustness below, is concerned with the stability of experimental results to variations in experimental procedures such as matching schemes, framing, and subject pools (Hertwig & Ortmann 2001). The other, that we shall call first-degree robustness below, refers to sensitivity towards parametrization characteristics such as the nature of the equilibrium (corner point versus interior, the degree of asymmetry between the surplus that employers and workers can capture), or efficiency gains. Sweeping claims about the ubiquity of trust and reciprocity in laboratory gift exchange like the one above appear to suggest that both first- and second-degree robustness are well established in the literature despite the scarcity of systematic investigations of both forms of robustness as we shall discuss below. Theories that have been proposed to rationalize laboratory gift-exchange results (Fehr & Schmidt 1999; Bolton & Ockenfels 2000; Charness & Rabin forthcoming) predict second-degree robustness but sensitivity to the nature of the equilibrium and efficiency gains and hence not first-degree robustness. Specifically, they do not exclude the breakdown of gift exchange due to changes in parameterization. If indeed such breakdown occurred, it would prompt the fundamental question of what constitutes a representative parameterization. We will return to these issues in our concluding section.

We report a gift exchange experiment which is differentiated from most of the literature by the following experimental design and implementation characteristics/aspects. First, we construct interior equilibria. Second, we vary systematically the efficiency gains. Third, we vary systematically the framing of the laboratory decision problem. Fourth, we employ a matching mechanism that has been shown to best preserve the nature of one-shot strategic situations. We therefore address issues of both first- and second-degree robustness. In essence, we try to give the canonical game theory for one-shot and finitely repeated games a good shot at proving itself.

The paper is structured as follows: Section 2 presents our model of gift exchange. In Section 3 we present our experimental design and implementation and in section 4 we present our results. Section 5 provides a brief interpretation of our results and relates them to the literature. In Section 6 we proffer some concluding remarks.

2 Our model of gift exchange

Gift exchange games are sequential principal agent games in which the first mover (a principal such as an employer) can propose to the second mover (an agent such as a worker) an incomplete contract. The key characteristic of this contract is that a generous offer on the part of the principal, if reciprocated, will lead to welfare improving outcomes. In a one-shot game, reciprocal behavior would contradict canonical game theory's reliance on selfishness. Likewise, generous offers would be inconsistent with rational expectations of selfishness. In a finitely repeated game, by standard backward induction arguments, both generous offers and reciprocal behavior would be inconsistent with common knowledge of rationality and selfishness.

In the narrative in this section we will use, for ease of exposition, employer - worker interaction to explain our model in which, hence, an employer chooses a wage and suggests an effort. While neither employer nor worker can adjust a wage that the employer has decided to offer, the worker can adjust his effort. Both gross revenue and effort cost are increasing in effort, typically in such a manner that there are efficiency gains. The wage *can [hier soll wohl was hin wie partly determines?]* determine the transfer from the employer to the worker.

Obviously, one key element of all gift exchange games is the cost function of effort. Typically, marginal costs of effort are assumed to be increasing. We follow here that well-established empirical regularity. Specifically, we used the following two cost schedules $c_1$and c_2:

e	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0
$c_1(e)$	0	1	2	4	6	9	12	16	20	25	30
e	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0
$c_2(e)$	0	1	2	4	6	9	12	15	19	23	27

As can be seen the only difference in these schedules are for high efforts which are somewhat lower for *[eher where costs are somewhat lower for]* $c_2(e)$. These cost schedules are used for both interior and corner point configurations. In the following we first discuss the interior equilibrium treatments and then turn our attention to the corner point equilibrium.

Payoffs for workers and employers are given by

$$U = w(\min(1 + \frac{1}{2}(e-1), 1.5) - c(e)$$

and

$$\Pi = em - w(\min(1 + \frac{1}{2}(e-1), 1.5)$$

where $m \in \{50, 80\}$. A couple of comments are in order: First, m is a multiplicator that scales the employer's return on the worker's effort. Second, the (gross) payoff function for the worker is increasing in the wage throughout and in effort for $e \in [1.0, 2.0]$. Specifically, it is linear in effort with slope $\frac{w}{2}$ for $e \in [1.0, 2.0)$ and constant for $e \geq 2$. Thus, the marginal (gross) payoff function is first positive at $\frac{w}{2}$ and then drops to zero. Since, furthermore, the marginal costs are positive and increasing, the payoff maximizing effort for the worker is (weakly) monotonic in wage but never exceeds 2. Specifically, the best-reply schedule of workers is

$$
\begin{aligned}
e^*(w) &= 1.0 \text{ for } w < 10 \\
&\in \{1.0, 1.2, 1.4\} \text{ for } w = 10 \\
&= 1.4 \text{ for } 10 < w < 20 \\
&\in \{1.4, 1.6, 1.8\} \text{ for } w = 20 \\
&= 1.8 \text{ for } 20 < w < 30 \\
&\in \{1.8, 2.0\} \text{ for } w = 30 \\
&= 2.0 \text{ for } 30 < w
\end{aligned}
$$

Note that the best-reply schedule of workers is the same for both cost schedules that we used. Since higher wages yield higher effort (given selfishness of the worker), the profit maximizing wage offer exceeds the minimal wage for m sufficiently large. This is particularly true for the values of m we have chosen here. In other words, for those parameter constellations that we employ we induced an interior equilibrium: for $m = 50$ and $m = 80$, our configuration yields the same two subgame-perfect equilibria, namely $w^* = 20, e^* = 1.8$ (if the worker chooses for $w = 20$ the maximal effort from the available set of best replies ($\{1.4, 1.6, 1.8\}$) and (otherwise) $w^* = 21, e^* = 1.8$.[5] The equilibrium payoffs are in the first case

$$
\begin{aligned}
U &= 1.4w - c(e) = 28 - 6 = 22 \text{ and} \\
\Pi &= 1.8m - 1.4w = 90 - 28 = 62 \text{ for } m = 50 \text{ and} \\
&= 144 - 28 = 116 \text{ for } m = 80
\end{aligned}
$$

and in the second case

$$
\begin{aligned}
U &= 1.4w - c(e) = 29.4 - 6 = 23.4 \text{ and} \\
\Pi &= 1.8m - 1.4w = 90 - 29.4 = 60.6 \text{ for } m = 50 \text{ and} \\
&= 144 - 29.4 = 114.6 \text{ for } m = 80.
\end{aligned}
$$

Hence the equilibria are clearly favoring the employer. A wage that only slightly exceeds the equilibrium wage might hence not be conceived as a sufficient reason to reciprocate because it only reduces inequality in favor of the employer. On the other hand, the employer bears all the risk of initiating potential cooperative outcomes.

Note that the equilibrium effort is below the maximal inducable effort 2.0 which requires a wage of 30 (or 31 if the worker chooses the lower effort from the set of best replies when indifferent). An equal split of the maximal joint payoff is achieved at $w = 60, e = 3.0$ for $m = 50$ (yielding $U = \Pi = 60$) and at $w = 89, e = 3.0$ for $m = 80$ (yielding $U = \Pi = 106.5$).

Our interior equilibrium treatments are distinguished by the potential efficiency gains. For the treatments with high efficiency gains we used the larger

[5] This multiplicity is caused by our restriction to integer wages.

multiplier $m = 80$ and the flatter cost curve c_2.[6] This implies efficiency gains at the equilibrium effort (i.e. when the effort is increased from 1.8 to 2.0) of 433% (since the employer gains 16 at a cost of 3 for the worker) and at the maximal effort (i.e. when the effort is increased from 2.8 to 3.0) of 300%. For the treatments with low efficiency gains we used the smaller multiplier $m = 50$ and the steeper cost curve c_1; for this configuration the efficiency gains are 233% at the equilibrium effort and 100% at the maximal effort.

In yet another treatment we induced almost a corner point equilibrium (which for the sake of economy we call corner point equilibrium). We replace the expression $(w(\min(1 + \frac{1}{2}(e-1), 1.5))$ with a transfer function that is constant in the effort for $e > 1.0$. Specifically, the payoff functions for workers and employers were given by

$$U = wn - c_1(e)$$

and

$$\Pi = 50e - wn$$

with $n = 1.0$ for $e = 1.0$ and $n = 1.5$ for $e > 1.0$. Thus, the marginal (gross) payoff function is 0 for $e \geq 1.2$. The best reply schedule for workers is thence

$$\begin{aligned} e^*(w) &= 1.0 \text{ for } w < 2 \\ &\in \{1.0, 1.2\} \text{ for } w = 2 \\ &= 1.2 \text{ for } 2 < w \end{aligned}$$

which yields the (subgame-perfect) equilibria $w^* = 2, e^* = 1.2$ (if the worker chooses for $w = 2$ the maximal effort from the available set of best replies $(\{1.0, 1.2\})$ and (otherwise) $w^* = 3, e^* = 1.2$. The equilibrium payoffs are in the first case

$$\begin{aligned} U &= 1.5w - c(e) = 3 - 1 = 2 \text{ and} \\ \Pi &= 1.2m - 1.5w = 60 - 3 = 57 \end{aligned}$$

and in the second case

$$\begin{aligned} U &= 1.5w - c(e) = 4.5 - 1 = 3.5 \text{ and} \\ \Pi &= 1.2m - 1.5w = 60 - 4.5 = 55.5. \end{aligned}$$

These equilibria are even more biased in favor of the employer, but imply also a high risk for her. On the one hand, punishing the employer for a depressing outcome by rejecting the offer (which yields a payoff of 0 for both players) becomes rather inexpensive for the worker. On the other hand, exploitation of high wages intended to induce reciprocity has more severe consequences for the

[6] We chose two cost schedules that, to recall, were identical in the lower effort range (including and slightly exceeding the equilibrium effort) but differed slightly in higher effort choices. The first fact garantueed us that the equilibria would not be effected. The second fact allowed us to increase the difference between our high and low efficiency gain treatments.

Frame	Interior equilibrium		"Corner" equilibrium [C]
	low eff gains [L]	high eff gains [H]	
abstract [A]	3 (B)	2(Z)	2(B)
empl-wrkr [EW]	4(2B, 2Z)	2(Z)	

Table 1: Number of sessions for the individual treatments. Z=Zurich, B=Berlin

employer, because the best reply effort of the worker is lower. For example if the employer offers $w = 60$ (which coupled with $e = 3.0$ would still lead to a fair split $U = \Pi = 60$) and the worker chooses the best reply $e = 1.2$ then the payoffs are $U = 89, \Pi = -30$, whereas in the interior equilibrium low efficiency treatment the best reply is $e = 2.0$ which leads to payoffs $U = 81, \Pi = 10$.

3 Experimental design and implementation

3.1 Experimental design

We developed treatments along three dimensions, namely the nature of the equilibrium (interior vs. corner point), efficiency gains and frames. Specifically, for the interior equilibria we chose two realizations of efficiency gains (low and high) and two realizations of frames, namely one frame using - as is typical for much of experimental economics (Ortmann & Gigerenzer 1997) – abstract descriptors and another representing the laboratory environment as a small-scale replica of employer-worker interactions (see Harrison & Rutström 2001 and Harrison 2002 for arguments in favor of real-world frames).

For the corner point equilibrium we chose only the low efficiency gains and abstract frame implementation. We considered the corner-point equilibria the most striking feature of the "classical" gift-exchange experiments. This treatment serves to study the effects that the presence of an (almost) corner-point equilibrium alone has on the attempts to cooperate and their success. We chose the equilibrium to be slightly off the corner-point of zero wage and minimal effort in order to keep a fundamental aspect of the other treatments, namely that employers can induce a somewhat higher effort from a rational and selfish worker by paying a positive wage. This feature is only dramatically reduced but not eliminated in this treatment.

All in all, we conducted 13 sessions. For details of the design see Table 1.

3.2 Experimental implementation

All sessions were conducted in the experimental lab of the economics department at Humboldt University (B, between July 2000 and February 2001) or the Institute for Empirical Research in Economics at the University of Zurich (Z, in June 2001). The exact breakdown is indicated in Table 1. Subjects were recruited in line with the standard procedures in the two labs. The Berlin subject pool was predominantly economics and business administration students;

the Zurich participants were from a wide variety of fields. For the treatment EW-L two sessions each were conducted in Berlin and Zurich. While both wage offers and efforts were somewhat higher in Zurich, the differences are far from statistically significant (see Tables 5 and 7 in Section 4 for details.) Hence in the descriptive statistics we report pooled data from the Zurich and Berlin sessions in this treatment.

The experimental software was developed in z-Tree (Fischbacher 1999).

Participants seated themselves (Berlin) or were seated (Zurich) randomly. Excess subjects were paid a show-up fee that was in line with the conventions in the respective labs, i.e. DM 10 in Berlin and CHF 10 in Zurich.

Instructions (which were in German - for a sample translation see the appendix) were then read aloud. Questions were answered in the usual manner (e.g., privately or by repetition of the relevant passage of the instructions). At the end of the instructions we asked a dozen control questions to identify subject confusion. Each set of instructions included a flow diagram that illustrated the sequencing of decisions and summarized the key parameters of the session. The relation between the effort and the transfer from the employer to the worker was explained with the aid of a wage multiplier that depended on the effort. This multiplier was included in the table below the flow diagram that presented the cost schedule. (See the sample instructions in the appendix.)

The experiment was only started after all subjects had answered all questions correctly.

The experimental software included a profit calculator that allowed subjects to calculate both workers' and employers' payoffs for all admissible wage-effort pairs. There was no restriction on the time subjects could use the calculator. Individual subjects used the calculator up to nine minutes per period.[7]

Each session featured 12 subjects which were randomly assigned to one of the two roles and kept these roles throughout. Each of the subjects in a session was matched with each participant in the other role ("rotation matching") which has been shown to best preserve the one-shot nature of the interaction by precluding any indirect reputation or spillover effect (Kamecke 1997). We explained to subjects that their behavior in any one round could not affect any future interactions. For the exact wording, see the second paragraph of the sample instructions. We ran the maximum number of rounds (6) possible under this matching procedure.

In each round first all employers had to make an offer to the worker they were matched with for that period. On the left hand side of the computer screen the

[7] Individual employers use the calculator in at least 2 periods (mean 5.49, median 6, 52 of 78 employers use the calculator in all six periods). In the periods that the calculator is used, an individual employer makes on average 16.9 computations per period (median 12, maximum 123). The average time that an employer uses the calculator is 109.5 seconds per period (median 86 seconds, maximum 548 seconds). Workers use the calculator in more periods. While one worker never does, the others do so in at least 4 periods, 68 of 78 in all six periods (mean 5.76, median 6). On the other hand, workers perform fewer computations per period (mean 9.9, median 9, maximum 33) and use the calculator for a shorter time (mean 67.2 seconds, median 57 seconds, maximum 379 seconds). This is so because in most cases workers do not perform any computations for a wage other than that chosen by the employer.

Frame	Interior equilibrium: low eff gains [L]	Interior equilibrium: high eff gains [H]	"Corner" equilibrium [C]
abstract [A]	31.4 (108) 1.78 (102)	37.4 (72) 1.68 (64)	22.9 (72) 1.33 (56)
empl-wrkr [EW]	32.3 (144) 1.73 (137)	51.4 (72) 1.84 (70)	

Table 2: Average wage offers (top) and average efforts in case of acceptance (bottom) by treatment. Number of data points on which averages are based in parantheses

profit calculator was displayed. On the right hand side of the computer screen they could enter their wage offer and an effort they suggested to the worker. Wage offers had to be integers between 0 and 100 (0 and 200 for $m = 80$). After all employers had made their offers, the workers were informed about the wage chosen and the effort suggested by the employer they were matched with. Workers also had the profit calculator available on the left. On the right we asked them to enter their decision whether they want to accept or reject the offer and, in case of acceptance, their effort level. A rejection led to zero payoffs for employers and workers. The use of the profit calculator was not restricted to the wage actually chosen by the employer. When all workers had made their choice, all players were informed about the choices in their pair and about their own payoff. No subject was ever informed about the choices of any other employer or worker.

4 Results

Descriptive statistics. In Table 2 (which uses as template Table 1) we report for each cell in the top row the average wage offers across all experimental sessions (and in parentheses the number of data points on which the averages are based) and in the bottom row the average effort in case of acceptance (and in parentheses the number of data points on which the averages are based).

In Table 3 we condition the wage offer data on whether an offer was accepted or rejected; in each cell the first row denotes the acceptance case, the second directly below the rejection case. The distribution of wage offers and efforts chosen (in case of acceptance) is shown in Figures 1 and 2, respectively.

We observe the following facts:

1. The majority of wage offers is clustered slightly above the equilibrium offer for all treatments except EW-H.

2. The majority of wage offers in the EW-H treatment lies substantially above the equilibrium.

3. In treatment C, the majority of wage offers is below most wage offers in all interior equilibrium treatments. However, there is a non-negligible

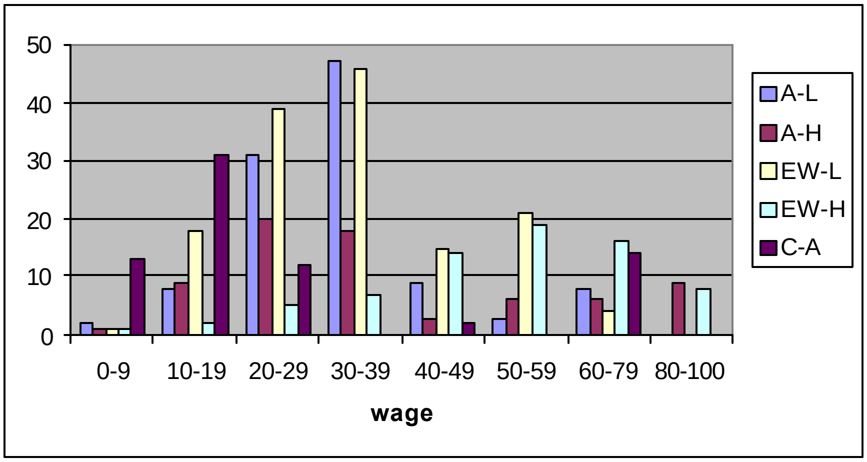

Figure 1: Distribution of wage offers by treatment (in absolut numbers).

Frame	Interior equilibrium		"Corner" equilibrium [C]
	low eff gains [L]	high eff gains [H]	
abstract [A]	32.49 (102) 12.5 (6)	40.3 (64) 14.5 (6)	27.5 (56) 6.94 (16)
empl-wrkr [EW]	33.24 (137) 12.86 (7)	52.21 (70) 23 (2)	

Table 3: Average wage offers by treatment and acceptance (top) and rejection (bottom), numbers of observations in parantheses.

number of very high wage offers as well. This implies that average wage offers in treatment C are substantially above the corner point equilibrium.

4. The distribution of wage offers for the interior equilibria treatments is clearly affected by the efficiency gains. In the abstract frame, this effect materializes only as a number of very high wage offers for high efficiency gains. In contrast, for EW-H, the whole wage distribution is shifted to the right relative to EW-L. This is also reflected in the average wage offers. In the abstract frame, the relatively small number of very high wage offers translates into an increase of approximately 20 % only. In contrast, for EW-H, average wage offers are about 60 % higher than in EW-L. The variance of the treatments with high efficiency gains is clearly higher than that in the treatments with low efficiency gains (Mann-Whitney test, $p < 0.01$).

5. The distribution of wage offers for the interior equilibria seems also affected by the frame. For low efficiency gains, we observe for the EW frame a

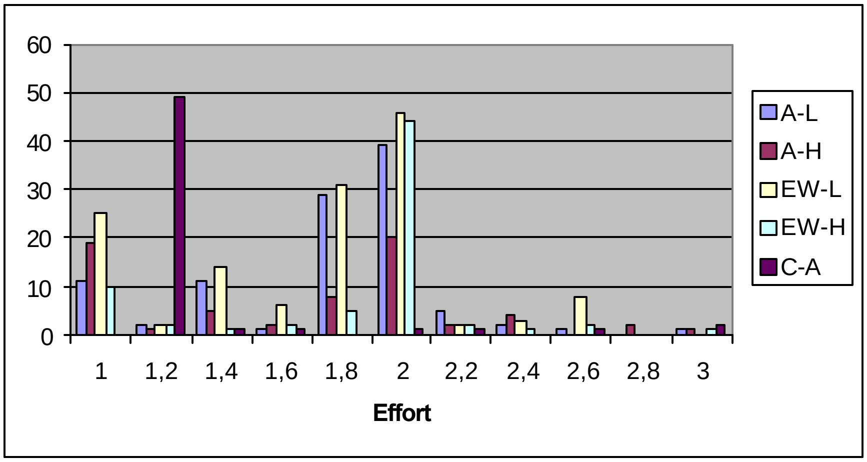

Figure 2: Distribution of chosen efforts by treatment (in absolute numbers).

higher share of both offers below and substantially above the equilibrium, resulting in nearly identical averages. For high efficiency gains, we again observe a substantial upward shift of the whole distribution, resulting in about 40 % higher average wages.

6. Together, high efficiency gains and EW frame lead to a substantial shift upward in wage offers relative to A-L, with high efficiency gains (A-H vs A-L) and EW frame (EW-L vs A-L) alone having much less of an impact.

7. The corner point equilibrium leads to an overall more dispersed set of wage offers (low equilibrium wages cause a higher number of low wages, but also low equilibrium efficiency leads to more high wage offers). Using the variance in the individual sessions as independent observations, the difference between the corner point equilibrium treatment and the other treatments with low efficiency gains just misses significance (Mann-Whitney test, $p = 0.14$) which is still a strong result given that there are only two sessions in the corner point treatment.

8. As Table 3 shows, in all treatments rejections of wage offers are triggered by comparatively low wage offers.

9. In contrast to wage offers, there are no discernible differences in effort choices between interior equilibrium treatments. Efforts are heavily clustered throughout at equilibrium and maximal best-reply effort. Hence the average effort choices are close to the equilibrium in all treatments.

10. The only difference that might qualify as discernible is effort choices in EW-H which overwhelmingly are at the maximal best-reply effort. This

Frame	Interior equilibrium		"Corner" equilibrium [C]
	low eff gains [L]	high eff gains [H]	
abstract [A]	246	419	118
	221	264	180
empl-wrkr [EW]	231	421	
	226	394	

Table 4: Average payoffs by treatment for employers (top) and workers (bottom) in Experimental Currency Units. ECUs were exchanged in the L treatments at a rate of 1 ECU=0.10 DM (Berlin) or 1 ECU=0.10 CHF (Zurich) and in the H treatments at a rate of 1 ECU=0.05 CHF. Participants in Zurich were paid a show-up fee of 10 CHF in addition.

is clearly a function of the higher wage offers in EW-H since the majority of effort choices are at the best reply. See also Table 6 below.

11. In treatment C, virtually all effort choices are at the equilibrium but the number of rejections is substantially higher than in the other treatments.

Table 4 shows the average payoffs for employers and workers by treatment (in Experimental Currency Units and excluding show-up fees to keep the Berlin and Zurich data comparable).

Statistical analysis. These are not independent observations. To analyze whether the treatment variables have significant influence on wage offers and effort choices, we therefore estimate random-effects cross-sectional time-series regression models. Table 5 reports the coefficients for dummy variables for high efficiency gains, abstract frame, corner point equilibrium and Zurich sessions. Top rows refer to the analysis for wage offers, middle rows to effort choices, and bottom rows to excess efforts, i.e. differences between efforts and best-reply efforts. The bottom part of the table reports analyses for specific dummy variables for relevant subsets of the data.

The only significant influence on effort choices is the corner point equilibrium. In line with the theoretical prediction, effort is substantially and significantly lower than in the interior equilibrium treatments. Indeed, for the analysis of the difference between effort and best reply effort, the corner point equilibrium has a positive impact (probably because negative differences were restricted to 0.2 and negative reciprocity was hence executed by rejections.) Confirming the descriptive statistics, the only significant determinant of wage offers is the extent of efficiency gains: High efficiency gains extract significantly larger wage offers than low efficiency gains. As the separate analysis for the different frames shows, this is primarily driven by an effect in the Employer-Worker Frame. We particularly note that the dummy variable Zurich has neither substantial nor significant influence.

Trust and reciprocity. We note that wage offers are higher than equilibrium would dictate. We also note that this could be trust in positive reciprocity or, similar to what we typically observe in ultimatum games, it could be an

	All Treatments	Excluding C-A
Constant	34.47 (7.928)** 1.741 (18.599)** -0.120 (-1.998)*	34.47 (8.225)** 1.741 (18.402)** -0.120 (-2.182)*
High	13.211 (1.972)* -0.04 (-0.275) -0.057 (-0.615)	13.211 (2.046)* -0.04 (-0.272) -0.057 (-0.668)
Abstract	-5.810 (-1.195) -0.006 (-0.061) 0.026 (0.386)	-5.810 (-1.240) -0.006 (-0.060) 0.026 (0.422)
Corner-Point	-5.728 (-0.904) -0.411 (-2.960)** 0.220 (2.441)*	
Zurich	-0.359 (-0.054) 0.061 (0.420) 0.045 (0.480)	-0.359 (-0.056) 0.061 (0.416) 0.045 (0.525)
	A-L and A-H	EW
High	6.051 (0.863) -0.117 (-0.787) -0.078 (-0.876)	19.153 (6.092)** 0.113 (1.036) 0.023 (0.337)
	L	H
Abstract	-0.870 (-0.311) 0.059 (0.508) 0.049 (0.676)	-13.972 (-1.550) -0.169 (-1.424) -0.049 (-0.713)
	A-L and C-A	
C-A	-8.449 (-1.523) -0.466 (-3.249)** 0.191 (1.766)+	
	EW-L	
Zurich	3.722 (1.167) 0.142 (0.970) 0.083 (0.864)	

Table 5: Coefficients for dummy variables for high efficiency gains (High), abstract frame (Abstract), corner point equilibrium (Corner), and Zurich sessions (Zurich), z-statistics in parantheses, top for wageoffers, middle for efforts, bottom for difference between effort and best-reply effort. $+$ = significant at $p = .1$ $*$ = significant at $p = .05$, $**$ = significant at $p = .01$.

	Below BR	Equal BR	Above BR	Rejection
A-L	23 (21%)	70 (65%)	9 (8%)	6 (6%)
A-H	22 (31%)	32 (44%)	10 (14%)	8 (11%)
EW-L	44 (31%)	80 (56%)	13 (9%)	7 (5%)
EW-H	15 (21%)	48 (67%)	7 (10%)	2 (3%)
Subtotal	104 (26%)	230 (58%)	39 (10%)	23 (6%)
C-A	0 (0%)	49 (68%)	7 (10%)	16 (22%)
Total	104 (22%)	279 (60%)	46 (10%)	39 (8%)

Table 6: Absolut and relative numbers of effort choices below, at, or above the worker's best reply and of rejections

attempt to prevent negative reciprocity. Of course, it could also reflect altruism or inequality aversion given that the equilibrium payoffs (which subjects had time to evaluate) favored the employer. Little such "generous" behavior is found on the worker side. Table 6 shows, for each treatment, the relative number of effort choices that are equal to, above, or below workers' best replies to actual wage offers as well as the numbers of rejections. (In case of a wage offer that let the worker be indifferent, i.e. 10, 20, or 30, we counted any of the efforts in the set of best replies as equal to the best reply.)

As Table 6 shows, in all treatments the vast majority of effort choices (60%) is at the best reply and more effort choices are below (22%) the best reply than are above (10%). Since the best reply is always in the lower half of the range of possible efforts, random errors should produce deviations towards choices above the best reply rather than below. Using selfishness of the worker as a benchmark, positive reciprocity would imply effort choices above the best reply in reaction to high wage offers, while negative reciprocity would lead to effort below the best reply in the case of low wage offers. Figure 3 shows the average deviation of effort from the best reply dependent on the worker's payoff implied by best reply effort for the given wage offer.

As can be seen from Figure 3 there is a positive relation between the effort - best reply difference and workers' payoff (at best reply effort). Since the difference is, however, rarely positive, our result seems in line with negative rather than positive reciprocity.[8]

[8] Note that in the interior equilibrium treatments negative reciprocity is relatively cheap at low wages (where only it applies). For example, for wages 11, 21, and 31, choosing an effort of 1.0 instead of the best reply effort (1.4, 1.8, or 2.0, respectively) costs the worker 0.2, 2.4, or 6.5, respectively, but the employer loses 17.8, 31.6, or 34.5, respectively, in the treatments with low efficiency gains, and even 29.8, 55.6, or 64.5, in the treatments with high efficiency gains. The relative costs of negative reciprocity by rejections (instead of best-reply effort) are, for non-trivial wages, higher, e.g. at wages 11 or 21 the costs for the worker are 11.2 or 23.4 and the loss for the employer (i.e. the punishment) is 56.8 or 60.6 (low efficiency gains treatment) and 98.8 or 114.6 (high efficiency gains treatment). Positive reciprocity at high wages is somewhat more expensive than negative reciprocity (just because we did not allow dramatic efficiency gains). Since the transfer is independent of the effort for $e \geq 2.0$, the costs and benefits of positive reciprocity are independent of the wage for $w > 30$. For $e \geq 2.0$, in the low efficiency gains treatments, increasing the effort by 0.2 always yields a benefit of 10

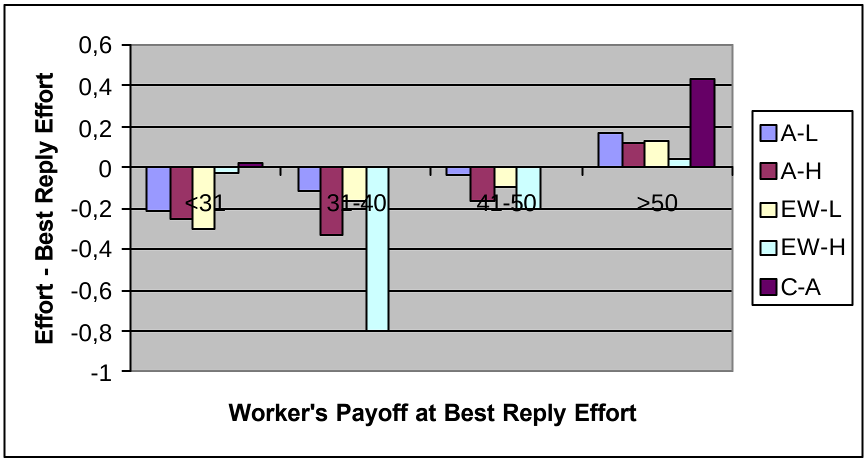

Figure 3: Difference between chosen effort and best reply effort for the given wage offer by treatment and worker's payoff at best reply effort.

In fact, the preceding analysis underestimates the role of negative reciprocity since rejections of low wage offers are a form of negative reciprocity. The last column of Table 6 shows the number of rejections per treatment and Table 3 compares the average wage offers that are accepted with those that are rejected. In all treatments, average rejected offers are less than half of the average accepted wage offers, indicating that rejections are indeed a negatively reciprocal reaction to low wage offers. Only in treatment C-A are the positive differences between effort and best reply more substantial than the negative differences. This, however, is the result of the best reply being bounded by 1.2 in this treatment. Negative reciprocity could (almost) only be exercised by rejections in this treatment and the number of rejections is by far the highest in C-A (22% compared to 6% in the other treatments).[9]

Table 7 shows coefficients for a random-effects regression model for the dependence of the excess effort (i.e. difference between effort and best reply) on

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for the employer. The marginal costs for the worker increase from 3 (when choosing 2.2) to 4 (when increasing the effort to 2.4 or 2.6) and eventually to 5. In the high efficiency gains treatment, the marginal benefit for the employer is 16, and the marginal costs for the worker do not exceed 4.

[9] The relative costs for negative reciprocity by choosing an effort 1.0 instead of the best reply effort (which is generally 1.2) is much higher than in the interior equilibrium treatments (for wages of 3, 11, or 21, the costs for the worker are 0.5, 4.5, or 9.5, respectively and the loss for the employer 8.5, 4.5 or even -0.5). Rejections, in comparison, are more efficient as punishment. For the same wages, the costs for the worker are 3.5, 15.5, or 30.5, and the loss for the employer 55.5, 43.5, or 28.5. Due to lower marginal effort costs for lower effort, positive reciprocity is cheaper in that range than in the interior equilibrium treatments. Hence it is consistent with traditional economic reasoning that compared to the interior equilibrium treatments, we see slightly more positive reciprocity in the corner treatment and negative reciprocity exhibited by rejections instead of lower effort.

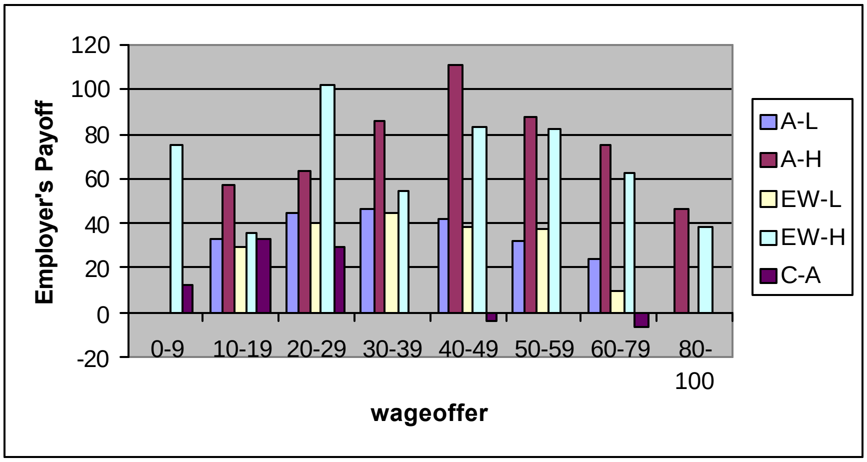

Figure 4: Employer's average profits by treatment and wage bracket.

the wage offer as well as treatment dummies. The lower part shows the coefficient for wage offer by treatment. In each cell the top line refers to the complete data, the middle line to the data restricted to wage offers below or equal to 30 (because up to 30 the best reply is increasing in the wage offer) and the bottom line to wage offers larger than 30.

Note that Wage Offer has a highly significant but small positive impact on excess efforts in all treatments. Interestingly, the impact is negative (or essentially zero) for wage offers below 30 which implies that increases in effort are roughly in line with increases in best-reply efforts.

The crucial question for the robustness of gift exchange is whether reciprocity is sufficiently strong to make high wage offers worthwhile. Figure 4 shows the profits of employers by wage brackets.

Figure 4 illustrates that the optimal wage in the low efficiency treatment is slightly above the equilibrium wage. In contrast, in the high efficiency treatments wages that are substantially above the equilibrium tend to be profitable. (The noise, especially of the EW-H data, is due to differences in the distribution of wage offers. Also contributing to the variance in payoffs at the lower end of the wage offers is the number of sessions per treatment.) Raising the wage to the equilibrium wage increases the profit stronger than predicted because lower wages are sometimes answered by negative reciprocity. For the same reason, it pays to increase the wage even slightly above the equilibrium. This is confirmed by Table 8 which shows coefficients for Wage Offer in a random-effects time-series regression for the employer's payoff, by treatment and by wage bracket (top row: all wage offers, second: offers smaller than 40, which is above the equilibrium wage but below 60, the wage required for equal payoffs at maximal effort, third: offers above 20, the equilibrium wage in all treatments except for

	All Treatments	Excluding C-A
Constant	-0.424 (-8.936)**	-0.415 (-8.407)**
	-0.041 (-0.384)	-0.025 (-0.203)
	-0.4618 (-4.535)**	-0.449 (-5.936)**
Wage Offer	0.0087 (9.034)**	0.0085 (7.996)**
	-0.007 (-1.747)$^{+}$	-0.0077 (-1.602)
	0.0097 (5.562)**	.0095 (6.389)**
High	-0.170 (-3.168)**	-0.166 (-3.138)**
	-0.012 (-0.121)	-0.020 (-0.198)
	-0.292 (-2.777)**	-0.290 (-4.841)**
Abstract	0.066 (1.743)$^{+}$	0.065 (1.739)$^{+}$
	0.029 (0.460)	0.030 (0.472)
	0.096 (1.228)	0.090 (1.979)*
Corner-Point	0.250 (4.747)**	
	0.134 (1.656)$^{+}$	
	0.191 (1.522)	
Zurich	0.039 (0.744)	0.039 (0.761)
	-0.086 (-1.044)	-0.080 (-0.952)
	0.116 (1.090)	0.112 (1.806)$^{+}$
	EW-H	EW-L
Wage Offer	0.0056 (2.614)**	0.0137 (5.935)**
	-0.0365 (-3.278)**	0.0027 (0.369)
	0.0078 (2.758)**	0.0145 (3.243)**
	A-H	A-L
Wage Offer	0.0067 (2.935)**	0.0116 (5.351)**
	-0.0191 (-1.505)	-0.0008 (-0.103)
	0.0082 (2.928)**	0.0118 (4.682)**
	C-A	
Wage Offer	0.0097 (4.024)**	
	-0.0012 (-0.521)	
	0.0329 (1.191)	

Table 7: Coefficients for wage offer and dummy variables for high efficiency gains (High), abstract frame (Abstract), corner point equilibrium (Corner), and Zurich sessions (Zurich) in cross-sectional time series regression for difference between effort and best-reply effort, z-statistics in parantheses. Top: All wage-offers, middle: wageoffers less or equal to 30, bottom: wage offers larger than 30. $+$ = significant at $p = .1$, $*$ =significant at $p = .05$, $**$ = significant at $p = .01$.

	All Treatments	Excluding C-A
Wage Offer	-0.205 (-2.908)**	-0.115 (-1.475)
	0.926 (5.481)**	0.857 (4.495)**
	-0.593 (-6.695)**	-0.541 (-6.224)**
	0.434 (1.155)	0.397 (1.056)
	EW-H	EW-L
Wage Offer	-0.505 (-3.005)**	0.033 (0.317)
	-0.414 (-0.404)	0.812 (4.502)**
	-0.698 (-3.460)**	-0.386 (-3.079)**
	2.317 (0.555)	0.501 (1.505)
	A-H	A-L
Wage Offer	-0.037 (-0.186)	-0.068 (-0.555)
	1.779 (2.561)**	0.783 (4.202)**
	-0.619 (-2.922)**	-0.586 (-4.705)**
	0.577 (0.350)	0.150 (0.468)
	C-A	
Wage Offer	-0.588 (-4.162)**	
	1.162 (2.859)**	
	-0.490 (-0.597)	
	(insufficient obs.)	

Table 8: Coefficients for wage offer in cross-sectional time series regression for employer's payoff, z-statistics in parantheses. Top row: All wageoffers, second: wageoffers less than 40, third: wage offers larger than 20, bottom: wage offers between 20 ad 40. $+$ = significant at $p = .1$, $*$ =significant at $p = .05$, $**$ = significant at $p = .01$.

C-A, bottom: offers between 20 and 40.) Employer's payoff is significantly increasing in Wage Offer for low wage offers but decreasing for high wage offers. Note that the positive coefficient on Wage Offer for the range 20 - 40 suggest that it pays to raise offers somewhat above the equilibrium. Note also that for the corner point equilibrium the optimal wage offers lie substantially above the equilibrium but below that for other treatments. Last but not least we note that in this treatment the high-wage offers lead to negative payoffs for employers.

5 Discussion

We interpret our results as follows: First, as summarized in Facts # 1 - 3 above, we see attempts at eliciting gift exchange on the part of employers in both interior and corner point scenarios. These offers typically are (but see Fact # 2) "small commitments" (Watson 2002).

Second, as evidenced by Facts # 8 - 11, Table 6, and Figure 3), in all treatments workers typically maximize their payoffs given offers and show little positive reciprocity. Indeed, they exhibit quite some negative reciprocity towards low wage offers (where doing so is relatively cheap).

Third, the employers' small commitments are hence largely unsuccessful in eliciting efforts above the workers' best reply but they are rational in that their absence increases negative reciprocity. While the wages are somewhat above the equilibrium wage (20 or 21), they only marginally exceed the wage (30 or 31) necessary to induce the maximal best reply (2.0). As evidenced by Figure 3, larger commitments rarely increase the effort and almost never are profitable (Figure 4).

As regards the corner point equilibrium, we find, fourth, that attempts to elicit gift exchange are more pronounced than for the interior equilibria (Fact # 3), but worker behavior is hardly affected (Fact # 11). This causes the wage data to be more noisy in this case than in the interior equilibrium treatment with low efficiency gains (Fact # 7). The added noise seems to result from behavior settling close to the equilibrium not being satisfactory (as is the case for the interior equilibrium.)

Fifth, we find that efficiency gains interact with framing in important ways (Fact # 6). As evidenced by Fact # 5, framing the situation as employer-worker relationship does not have a substantial impact for low efficiency gains but does so for high efficiency gains. Similarly, as evidenced by Fact # 4, high efficiency gains have a small effect only in the abstract frame but a substantial effect in the employer-worker frame. Interestingly, though, the preceding statements hold for wage offers only. Effort choices seem to be unaffected by both efficiency gains and framing, given wage offers.

Surveying the lay of the trust and reciprocity field, Van der Heijden and her colleagues (2001) assert that "by now there is much experimental evidence that people engage in reciprocal exchange. People are observed to return favors even in the absence of binding pre-commitments." (2001, 280).[10] Our results suggest strongly that gift exchange is much less robust than is commonly asserted (e.g., Fehr and Gächter 1998).

Recall that our conclusion is concerned with first-degree robustness, i.e., the sensitivity to parameterizations characteristics such as the nature of the equilibrium or efficiency gains, as well as second-degree robustness, i.e., the stability of experimental results to variations in experimental procedures such as framing. As we pointed out at the outset, we intentionally did not attempt to stress-test second-degree robustness (by, say, studying the effect of payoff tables). Rather we started with a design and implementation that would give canonical game theory a good shot at proving itself. We believe, and our belief seems to be confirmed by the interaction effects of efficiency gains and framing, that testing for first- or second- degree robustness one at a time, is potentially misleading.

Charness and Kagel and their collaborators have, in parallel work, stress-

[10] We hasten to stress that these authors themselves have a somewhat more differentiated view of these issues. Specifically, they explore the robustness of a repeated experimental gift exchange game with respect to matching (partners vs strangers) and game form (normal vs extensive).

tested second-degree robustness of laboratory gift exchange with intriguing results. Drawing on a standard corner point design, Charness, Frechette, & Kagel (2001), for example, find that the degree of gift exchange is "surprisingly sensitive to an apparently innocuous change - whether or not a comprehensive payoff table is provided in the instructions." Specifically, they find that, for US undergraduate students, the presence of a payoff table reduces gift exchange sharply. The authors correctly call for a similar study with European students to better understand that effect. While we did not provide such a payoff table (our experimental sessions were conducted during July 2000 - June 2001; theirs were conducted in May 2001), the Charness et al. results suggest that our provision of a payoff calculator may be partially responsible for the comparatively low degree of gift exchange in our data.

Also drawing on a standard corner point design, Hannan, Kagel, & Moser (forthcoming) find in addition that US "undergraduate students provide substantially *less* effort than do MBAs". They interpret their finding as resulting from previous work experience (and hence different priors or understandings) that MBAs bring to the laboratory. A similar argument has recently been made more generally by Harrison and Rutström (2001). It is interesting to note that the frames being used in these two studies were of the employer-worker kind. Hannan et al. also investigate the effects of different efficiency gains. For both undergraduates and MBAs they find higher wage offers for higher productivity firms but no difference in the wage-effort relation. This is roughly in line with our results.

Fehr & Gächter (2002) construct an interior equilibrium by allowing employers to include punishment or bonus into the contract. They find that, compared to a corner point control treatment, excess effort (voluntary contribution in their terminology) is substantially reduced. They also find an interesting interaction with the framing because this effect is much stronger for the punishment treatment than the bonus treatment.

The preceding three articles provide further evidence that both first- and second-degree robustness of gift exchange are more fragile than previous accounts suggest (e.g., Fehr & Gächter 1998). It is noteworthy that theories such as Bolton & Ockenfels (2000), Fehr & Schmidt (1999), and Charness & Rabin (forthcoming) that have been proposed to explain experimental results of gift exchange and related social dilemma scenarios within a game theoretic framework are not insensitive to variations in parameterizations (e.g., differential efficiency gains). Hence, experimental results that question first-degree robustness can partially be rationalized by these theories. They are, however, insensitive to issues of implementation and hence experimental results rejecting second-degree robustness suggest that these theories do not tell the complete story. In particular, they are unable to explain the important interaction effects that we identified above.

An interesting observation concerns the use of the profit calculator by the workers. While 68 of the 78 workers use the calculator in all six periods, only 8 workers ever enter a wage other than that chosen by the employer, 7 only one other wage, 6 of these only in one period. Indeed some of these computation appear to result from typos. Only one worker uses the calculator to extensively explore the realm of outcomes that would have been possible if the employer had chosen another wage. While ignoring counterfactual wages is consistent with standard game theory, our observation casts some doubts on the validity of reciprocity models like Falk and Fischbacher (1999) where the evaluation of the fairness of a choice depends on the consequences of other available options. The possible argument that workers might have evaluated the outcome of other wages without the use of the calculator, does not seem warranted given because the workers use the calculator quite extensively for the given wage.

6 Concluding remarks

Much of the observed play of our participants is at or close to equilibrium. Our results therefore stand in stark contrast to much of what has been reported in almost all of the literature. In particular, we find little evidence for positive reciprocity but substantial evidence for negative reciprocity. Our results suggest strongly that laboratory gift exchange is highly sensitive to the parameterization of the gift exchange or implementation characteristics.

To our mind the key issue is what constitutes "realistic" parameterization and implementation characteristics. While we realize that this issue is bound to be a contentious one, keeping in mind the "parallelism postulate" (Plott 1990) strikes us as imperative because of the immediate policy implications that emerge from the gift exchange research.

While neglect of reciprocity motives may indeed lead to wrong predictions and to wrong normative inferences, there are clearly scenarios - like ours - where reciprocity manifests itself as negative reciprocity and thus incentive-compatibility may be as important, or possibly even more, than canonical game theory suggests. The key question is how dense the set of such scenarios is.

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A Instructions

All instructions were in German (even those for the Swiss subjects). The complete set of instructions can be accessed at http://home.cerge-ei.cz/Ortmann/instructions.html. The following is a translation of the instructions of the employer-worker frame with low efficiency gains. The instructions for the other treatments were essentially the same. We only substituted a different multiplicator for the treatments with high efficiency gains. For the abstract frame words like employer, worker, and basic wage were substituted with participant X, participant Y, and payment component, respectively. The instruction for the corner point equilibrium treatment were identical to those in the abstract frame except for the different multiplier (and corresponding changes in the examples).