Incentive Contracts versus Trust in Three-Person Ultimatum Games - An Experimental Study -

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Abstract

Whether incentive contracts perform better than trust in terms of productive efficiency is usually explored by principal-agent experiments (most involving only one agent). We investigate this issue in the context of a three-person ultimatum experiment, which is simpler and more neutrally framed than traditional principal-agent designs. Contrary to the game theoretic prediction, we find that (mutual) trust is as good as incentive contracts in inducing costly actions by employees. Moreover, we observe an interesting order effect when switching from one regime to the other. This could be important when considering institutional change since (according to our data) early behavioral patterns may be irreversible.

Keywords: Ultimatum Game, Incentives, Trust, Fairness, Greasing

JEL-Classification: C70, C90, D20

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1 Introduction

Incentive contracts, as propagated by the principal-agent literature,[1] are mostly employed in the context of private enterprises, whereas governmental agencies, due to their political nature and/or their difficulties in measuring performance, usually rely on mutual trust and reciprocity.

Incentive contracts presuppose that principals can deduce agent's work effort (at least probabilistically) from performance with the consequent possibility of conditioning payment on the latter. Thus, in case of incentive contracts, a self-interested agent works harder to obtain (at least on average) higher rewards, which (over)compensate the cost of additional effort.

The distinguishing feature of a mutual trust-reciprocity regime is the lack of any explicit incentive schemes: The employer pays only a flat reward, which theoretically should induce a self-interested employee to never engage in (costly) effort. Behaviorally, however, trust and reciprocity may generate outcomes at odds with this theoretical prediction. We speak of mutual trust when the employer pays his employee a generous wage independently of performance while the employee invests in costly effort without knowing how large the wage will be. The uncertainty of the employee's wage arises since the firm's surplus is stochastic and the wage may or not depend on it. Furthermore, the employee (employer) is reciprocity-minded, i.e. inclined to respond in kind, if decent levels of payment (effort) trigger decent effort and performance (rewards).[2]

In this paper we investigate whether a regime relying only on mutual trust and reciprocity is as bad as predicted by the theory or can trigger the same (if not superior) levels of productive efficiency as incentive contracts. To address this research question, we refrain from using a principal-agent framework with its usual ingredients like a stochastic production function, (non-linear) cost of effort (allowing for an interior solution), different risk attitudes, etc. We rather employ (like in González et al., 2002) the simpler and more neutral frame of a three-person ultimatum game, which does not presuppose the natural role conflict between employer and employees with its possible demand effect.[3] Furthermore, since there are two responders (the two bureaucrats/employees) with different tasks, we can explore not only vertical fairness (payoff distribution between employer and employees) but also horizontal fairness (payoff distribution

[1] See, for instance, Ross (1973), Holmström (1979), Shavell (1979), Grossman and Hart (1983).

[2] There is strong experimental evidence that people respond kindly to "gifts" and retaliate if they have been hurt. See Fehr and Gächter (1998) for some results.

[3] Note that in public bureaucracies usually both, the principals and the agents, are public employees.

among employees or bureaucrats).[4]

In the former experimental study (González et al., 2002), one responder in a three-person ultimatum game could punish "unfair" proposals, thus *reducing* the size of the pie. In this study, we allow one of the two responders to engage in special effort, which *increases* the expected value of the pie. To compare the trust-reciprocity regime with incentive pay, we distinguish two treatments. In one treatment (the trust-treatment), the responder decides about effort without knowing his share of the resulting increase in expected gains. In the other treatment (the incentive-treatment), the responder is allowed to condition his choice of effort on the expected increase in his payoff.

In Section 2 we introduce the basic three-person ultimatum game. Section 3 describes the experimental protocol and Section 4 develops our main hypotheses. After presenting and analyzing the results in Section 5, we conclude in Section 6 by summarizing our main findings.

2 The game

Imagine an applicant, X, wanting to initiate an investment and needing a permit to be granted by two bureaucrats, Y and Z, who both have veto power.[5] The investment produces certainly a surplus (the legendary pie in experimental studies of distributive justice) whose size, however, is uncertain: It could be either $\bar{\pi}$ or π (with $\bar{\pi} > \pi > 0$) depending partly on chance and partly on the effort decision of one bureaucrat. When applying for the permit, X proposes two allocations:

- $(\bar{x}, \bar{y}, \bar{z})$ with $\bar{x}, \bar{y}, \bar{z} > 0$ and $\bar{x} + \bar{y} + \bar{z} = \bar{\pi}$, and
- (x, y, z) with $x, y, z > 0$ and $x + y + z = \pi$

meaning that, in case of the $\bar{\pi}$ (π)-surplus, X demands $\bar{x}$ (x) for himself and offers $\bar{y}$ (y) and $\bar{z}$ (z) to Y, resp. Z.

Due, for instance, to his higher rank in the internal organization of the bureaucracy, Z can engage in "special" work effort compared to Y, whose effort can only be "normal". Special effort increases the probability of the highest surplus $\bar{\pi}$, but causes a positive cost ϵ for Z. Depending on the experimental treatment, before deciding whether to engage in special effort or not, Z may (the I- or incentive treatment) or may not (the T- or trust treatment) know his gains ($\bar{z}$ and z) from it. In the former case, Z can condition his choice of effort

[4]Vertical and horizontal fairness is also investigated by Güth et al. (2001).

[5]The situation can be interpreted as a private firm or person asking for a permit of some public authority or alternatively by imagining X as the manager or owner of a firm whose gains depend on the decisions of the two subordinates Y and Z.

on the difference in payoffs that he receives in case of $\bar{\pi}$ and in case of π.

After Z's choice of effort, both Z and Y separately evaluate the two proposals by X in the sense of approving or vetoing each of them. Here, only the high-ranked bureaucrat Z is assumed to know the complete allocation proposals $(\bar{x},\, \bar{y},\, \bar{z})$ and $(x,\, y,\, z)$, while Y is just informed about his own shares $\bar{y}$ and y.

Once the two bureaucrats have made their choices, chance selects between $\bar{\pi}$ and π with probability:

$$P(\ \bar{\pi} \mid \delta\ ) = 1 - P(\ \pi \mid \delta\ ) = w + \delta\Delta,$$

where $w,\, \Delta > 0$, $w + \Delta < 1$ and

$$\delta = \begin{cases} 0 & \text{if } Z \text{ does not engage in (special) effort;} \\ 1 & \text{otherwise.} \end{cases}$$

Thus, the decision process consists of the following four stages:

1. X proposes the two reward allocations $(\bar{x},\, \bar{y},\, \bar{z})$ and $(x,\, y,\, z)$ for $\bar{\pi}$, resp. π.

2. Z decides between $\delta = 0$ (normal effort) and $\delta = 1$ (special effort); in the I-treatment after learning about X's proposals of $\bar{z}$ and z, in the T-treatment without knowing X's proposals.

3. Y and Z, knowing only $\bar{y}$ and y, resp. $(\bar{x},\, \bar{y},\, \bar{z})$ and $(x,\, y,\, z)$, either veto or accept the proposals, whereby each bureaucrat decides separately for each proposal.

4. Finally, chance selects between $\bar{\pi}$ and π with probability $P(\ \bar{\pi} \mid \delta\ )$, resp. $1 - P(\ \bar{\pi} \mid \delta\ )$.

The payoffs for the players depend on whether the proposal selected by chance is accepted or not by both bureaucrats:

- Acceptance by both Y and Z yields either $(\bar{x},\, \bar{y},\, \bar{z} - \delta\epsilon)$ or $(x,\, y,\, z - \delta\epsilon)$ depending on the pie selected by chance.

- Refusal by at least one bureaucrat yields a very small surplus $\underline{\pi}$, which again X must distribute among the three parties. In this case, X proposes the allocation $(\underline{x},\, \underline{y},\, \underline{z})$, with $\underline{x},\, \underline{y},\, \underline{z} \geq 0$ and $\underline{x} + \underline{y} + \underline{z} = \underline{\pi}$, which then Y and Z can accept or reject. Acceptance by both Y and Z causes all players to get what X proposed for them, i.e., X earns $\underline{x}$, Y earns $\underline{y}$, and Z earns $\underline{z}$. Rejection by Y and/or Z leads to the payoff vector $(0, 0, 0)$.

The game theoretic solution, assuming opportunistically rational players, can be derived by backward induction. If g (> 0) denotes the smallest feasible reward for both bureaucrats, then in the T-treatment Y and Z should accept X's proposals if their shares ($\bar{y}$, $\bar{z}$) and (y, z) are positive and at least equal to g. But then X, rationally anticipating such behavior, will assign for both pies $\bar{\pi}$ and π only the minimal amount g to Y and Z. On the other hand, Z will rationally anticipate the flat fees chosen by X and not engage in special effort. For the T-treatment, the solution is thus described by

- X proposing ($\bar{\pi} - 2g$, g, g) and ($\pi - 2g$, g, g), and
- Y and Z always accepting (since $\bar{y}$, $\bar{z}$, y, $z = 0$ are excluded), without Z exerting any special effort (i.e., $\delta = 0$).

Under the I-treatment, incentive compatibility requires $(\bar{z} - z)\Delta > \epsilon$, which induces $\delta^* = 1$ for a risk neutral player Z. The only change in the solution, compared to the T-treatment, is thus that $\bar{z}^*$ must be set equal to the smallest value of $\bar{z}$ satisfying $(\bar{z}-g)\Delta > \epsilon$, which implies $\bar{z}^* > g+\epsilon/\Delta$. The Y-component of the solution remains unchanged (i.e., $\bar{y}^* = y = g$), while X rationally demands the residuals $\bar{x}^* = \pi - g - \bar{z}^*$ and $x^* = \pi - 2g$ for the $\bar{\pi}$-, resp. π-, pie.

3 Experimental procedures

We performed our experiment at the laboratory of the Max Planck Institute in Jena (Germany). Overall, we run 4 sessions with a total of 105 participants, all students at the University of Jena. One session involved 24 participants and each of the other three sessions 27. The experiment was computerized with the help of z-Tree (Zurich Toolbox for Readymade Economic Experiments; Fischbacher, 1999). Each session needed about two hours. The average earning per subject was 12.89 Euro, ranging from a minimum of 2.35 Euro to a maximum of 27.75 Euro. After being seated at a computer terminal, participants received written instructions (see the Appendix for an English translation). Questions were answered privately.

In each session, eight (resp. nine) three-person groups (X, Y, Z) interacted for a total of 12 rounds in a stranger design, i.e. groups were randomly assembled every round. The role of each subject (X, Y or Z) was randomly assigned at the beginning and kept constant over the entire experiment. To collect more than just one independent observation, in an experimental session with 27 (24) participants we distinguished three matching groups with 9 (twice 9, once 6) participants each. In order to discourage repeated game-effects, participants were not told that re-matching was restricted to matching groups.

Each session consisted of two subsequent parts of 6 rounds each. Each part employed either the T- or the I-treatment (within-subjects factor) whereas the order of treatments was a between-subjects factor: In two sessions subjects experienced the T-treatment in part 1 (i.e. in the first six rounds) and the I-treatment in part 2 (i.e. in the last six rounds) while in the remaining two sessions they experienced the treatments in the reverse order. The instructions distributed at the beginning of the experiment informed participants only about the rules of the first treatment that they encountered. Instructions about the second treatment were distributed at the end of the first part.

As for parameters values, the three pies at stake $\bar{\pi}$, π and $\underline{\pi}$ amounted to 135, 45, resp. 15 tokens. Z's cost of effort ϵ was 10 tokens. Furthermore, since we employed the strategy method for players Y and Z and wanted to limit Y's and Z's decisions, we used discrete choice sets. Specifically, X's offers to Y and Z were constrained as follows: $\bar{y}$, $\bar{z} \in \{15, 30, 45, 60\}$; y, $z \in \{5, 10, 15, 20\}$; and $\underline{y}$, $\underline{z} \in \{0, 2, 4, 6, 8, 10, 12, 14\}$.

Thus, in the T-treatment, the game theoretic solution prescribes for X to propose $\bar{y}^* = \bar{z}^* = 15$, $y^* = z^* = 5$ and $\underline{y}^* = \underline{z}^* = 2$ in case of 135, 45, resp. 15 tokens. Offers should, furthermore, be always accepted[6] by Y and Z without any special effort by Z.

As for the probability parameters, we set $w = 1/4$ and $\Delta = 1/2$ implying probability 3/4 for $\bar{\pi}$, resp. 1/4 for π, if $\delta = 1$, and exchanged probabilities if $\delta = 0$. Given these parameters, in the I-treatment, incentive compatibility requires X to choose $(\bar{z}^* - 5)/2 > 10$, i.e. $\bar{z}^* > 25$, in order to unambiguously induce a risk neutral player Z to engage in special effort.[7]

4 Research hypotheses

The first two hypotheses concern players' behavior in the T-treatment as opposed to that in the I-treatment.

Although (common knowledge of) rationality requires (risk neutral) Z-players to never engage in effort under the T-treatment and engage in effort when $(\bar{z} - z)/2 > 10$ under the I-treatment, special effort ($\delta = 1$) by Z may be observed also in the T-treatment if Z either trusts X (i.e., believes that X will offer him more than the minimal reward) or is reciprocity-minded (i.e., willing to take costly actions in response to high rewards). Many experimental studies within the last two decades indicate that trust and reciprocity allow for

[6] There is a minor ambiguity concerning $\underline{y} = 0$ and $\underline{z} = 0$ that could also be rejected.

[7] Actually in the experiment, due to our restricted choice set, $\bar{z}^* \geq 30$, so that the incentive should suffice for all reasonable levels of risk aversion.

mutually profitable cooperation in dilemma type situations.[8] In view of such strong evidence, we investigate whether trust and reciprocity are equivalent (or even superior) to incentive contracts in motivating effort decisions. Thus we propose:

Hypothesis 1 *The T-treatment is as effective as the I-treatment in inducing special effort ($\delta = 1$) by Z.*

Z's willingness to engage in special effort in the T-treatment might be anticipated by a reciprocity-minded or trustful X-player who consequently would offer him more than the minimal reward also in the T-treatment. This would therefore engender proposals not different from those in the I-treatment (where maximization of own monetary payoffs entails more than marginal amounts to Z), suggesting:

Hypothesis 2 *The amount allocated by proposers X to players Z will not differ significantly across treatments.*

The next two hypotheses focus on the different roles of the two responders and concern aspects of fairness. Following Güth et al. (2001), in a hierarchic organization, horizontal fairness refers to fairness between the members of one layer and vertical fairness to fairness between layers. Our game is a three-person ultimatum game with two responders of whom only one knows the complete allocation proposals. Game theoretically, information about another responder's reward should not influence the own decision, nor should the different information of the two responders influence proposals. Behaviorally, however, the better informed Z-responder may compare his own rewards with those of Y, especially if he feels entitled (due to his privileged position or his choice of $\delta = 1$) to get more than Y.[9] Thus, Z may prefer proposals which favor him by recognizing his higher rank or which at least are horizontally fair. We therefore test also the following hypothesis:

Hypothesis 3 *Regardless of the pie size and the treatment, the better informed responder Z will more likely accept proposals giving him more (or, at least, no less) than Y.*

[8]That firms' wage setting is constrained by workers' views of what constitutes a fair wage and by workers' reciprocal responses to the wage offered has been shown, for instance, by Agell and Lundberg (1995) and Bewley (1995). Further evidence on the relevance of reciprocal behavior in mitigating the contract enforcement problem can be found in Fehr et al. (1997), Fehr et al. (1999), Schmidt et al. (1999).

[9]In the terminology of González et al. (2002), to ask for "greasing".

Since these issues might be anticipated by X, his allocation proposals may also be influenced by the asymmetric condition of the two responders. This suggests:

Hypothesis 4 *The fact that Z can observe what his peer Y gets but not vice versa, associated with the "power" of Z to exert special effort, will make X propose allocations with no smaller rewards to Z than to Y.*

Combining hypotheses 2 and 4, we expect the latter to hold true in both treatments.

5 Experimental results

5.1 Proposals

We start our analysis with X-participants' behavior. Table 1 reports the empirical distribution of proposals for all possible combinations ($\bar{y}$, $\bar{z}$) and (y, z) under the T- and the I-treatments. The table is split in two panels that correspond to the order in which the treatments were played (IT versus TI).

The first thing to notice about X's decisions is the general and significant deviation from the game theoretic solution.[10] Only one single proposer in all 6 rounds of the T-treatment under the TI-order and for the $\bar{\pi}$-pie did opportunistically assign minimal rewards to the responders. Let us therefore investigate in more detail how X's decisions deviate from their theoretical predictions.

Which distributions of the pies did X propose? Did he grant, in accordance with our hypotheses, no smaller rewards to Z than to Y regardless of the treatment and the pie? Table 2 provides a concise picture of the relation between offers. It displays for each pie and each treatment the percentage of symmetric (i.e., horizontally fair) and asymmetric (i.e., favoring one responder) proposals, separating again the data according to the order of treatments.

In case of the small pie the mode is to reward both responders equally (53.8% on average over all 24 rounds). The main diagonals of the four matrices on the right hand side of Table 1 show that, independently of treatment and treatments' order, "full-equity" (assigning 15 tokens to all three group members) is predominant. Only one proposer in two consecutive periods of the T-treatment and in one period of the I-treatment under the TI-order offered 20 to both responders. There is therefore a strong tendency of proposers to be

[10] The theoretical solution in case of the $\bar{\pi}$-pie predicts $(\bar{y}, \bar{z})$ = (15, 15) under the T-treatment and $(\bar{y}, \bar{z})$ = (15, 30) under the I-treatment; in case of the π-pie, the solution requires (y, z) = (5, 5) under both treatments. From Table 1, nearly no X-participant made such proposals.

Table 1: Empirical distribution of X's proposals for the $\bar{\pi}$- and the π-pies with respect to both treatments and both treatments' orders.

IT-order

I-treatment (rounds 1-6)

$\overline{z}$

		15	30	45	60
	15				
$\overline{y}$	30		17.6	32.4	0.9
	45		17.6	31.5	
	60				

z

		5	10	15	20
	5			0.9	
y	10		13.0	23.1	0.9
	15		20.4	38.0	0.9
	20	2.8			

T-treatment (rounds 7-12)

$\overline{z}$

		15	30	45	60
	15			0.9	
$\overline{y}$	30	0.9	13.9	47.2	
	45		13.0	23.1	
	60		0.9		

z

		5	10	15	20
	5				
y	10		18.5	24.1	1.9
	15	0.9	17.6	35.2	
	20		0.9	0.9	

TI-order

T-treatment (rounds 1-6)

$\overline{z}$

		15	30	45	60
	15	1.0			
$\overline{y}$	30		13.7	29.4	2.9
	45		13.7	27.5	6.9
	60	2.0	1.0	1.0	1.0

z

		5	10	15	20
	5				
y	10		2.9	18.6	4.9
	15		19.6	46.1	2.9
	20	2.0	1.0		2.0

I-treatment (rounds 7-12)

$\overline{z}$

		15	30	45	60
	15				
$\overline{y}$	30		10.8	35.3	4.9
	45		9.8	35.3	2.0
	60		2.0		

z

		5	10	15	20
	5				2.9
y	10	2.9	5.9	11.8	7.8
	15		5.9	52.9	2.9
	20		1.0	4.9	1.0

Note: All numbers are in %.

Table 2: Percentage of equal and unequal offers in case of $\bar{\pi}$- and π-pies, separately for each treatment and each treatments' order.

	IT-*order*					
	$\bar{z} > \bar{y}$	$\bar{z} = \bar{y}$	$\bar{z} < \bar{y}$	$z > y$	$z = y$	$z < y$
I-treatment	33.3	49.1	17.6	25.9	50.9	23.1
T-treatment	48.1	37.0	14.8	25.9	53.7	20.4
	TI-*order*					
	$\bar{z} > \bar{y}$	$\bar{z} = \bar{y}$	$\bar{z} < \bar{y}$	$z > y$	$z = y$	$z < y$
T-treatment	39.2	43.1	17.6	26.5	51.0	22.5
I-treatment	42.2	46.1	11.8	25.5	59.8	14.7

Table 3: Wilcoxon rank-sum test comparing X's offers to Y and Z (averaged over the first six and the last six rounds) in case of $\bar{\pi}$- and π-pies.

	Null Hypothesis	p-value	
IT-*order*			
I-treatment	$\bar{z} \leq \bar{y}$	0.0790	*
	$z \leq y$	0.4048	
T-treatment	$\bar{z} \leq \bar{y}$	0.0069	*
	$z \leq y$	0.2977	
TI-*order*			
T-treatment	$\bar{z} \leq \bar{y}$	0.1034	
	$z \leq y$	0.5000	
I-treatment	$\bar{z} \leq \bar{y}$	0.0088	*
	$z \leq y$	0.0505	*

* Reject H_0.

horizontally (and also vertically) fair when there is only little to share, namely only 45 tokens.

In contrast, whatever the treatment and their order, the most frequent proposal when distributing 135 tokens is $(\bar{x}, \bar{y}, \bar{z}) = (60, 30, 45)$ with 152 out of altogether 420 observations (36.2%), followed by the full-equity proposal $(\bar{x}, \bar{y}, \bar{z}) = (45, 45, 45)$ with 123 observations (29.3%).

Hypothesis 4 only claims that X will not assign less to Z than to Y. Let us, however, check first whether X even attempts to "grease" the more powerful responder by offering more to him than to Y. The results of the Wilcoxon rank-sum test for the null hypothesis that $\bar{z} \leq \bar{y}$ (resp. $z \leq y$) against the alternative $\bar{z} > \bar{y}$ (resp. $z > y$) are summarized in Table 3. In case of the π-pie there is, in general, no evidence of X trying to grease Z (with the exception of the I-treatment under the TI-order). In contrast, in case of the $\bar{\pi}$-pie, only the T-treatment in the TI-order does not support preferential treatment of Z by X. More generally, when the pie is large ($\bar{\pi}$) proposers become more greedy, mainly at the expense of the less informed and powerful players Y.

Quite unexpectedly, according to Tables 1 and 2, higher offers to Z are more frequent for the treatment played in the second part (i.e., in the last six rounds), suggesting some *experience effect*. This is confirmed by the extended median test (Conover, 1980) comparing the average differences $(\bar{z} - \bar{y})$ (resp. $(z - y)$) for $\bar{\pi}$ (resp. π) between the first six rounds and the last six rounds for each order. The corresponding null hypothesis[11] is rejected at the 0.005 level ($T = 10.777$) for the IT-order, and at the 0.025 level ($T = 5.024$) for the TI-order. This shows that X-participants learn both to be more greedy and to grease Z. Our major results so far can be summarized as follows:

Result 1 *Proposals are quite sensitive to the size of the pie: While the distribution in case of 45 tokens exhibits both horizontal and vertical fairness, both types of fairness do not show up as prominently in case of 135 tokens.*

Result 2 *The frequency of greedy demands by X (in the sense of taking more than one third of the pie) and preferential treatment of Z (in the sense of giving more to him than to Y) increase both with the pie size ($\bar{\pi}$ versus π) and experience (last six versus first six rounds).*

These results support Hypotheses 2 and 4 mainly as claims concerning inexperienced proposers: Offers to Z do not depend on the treatment (but rather on the pie size) and they are seldom smaller than offers to Y. Greasing becomes more frequent in the treatment that subjects played second, i.e. after X has become more experienced.

Finally, when there was disagreement about the distribution of $\bar{\pi}$ or π and players could only share $\underline{\pi} = 15$, proposers were strongly fairness oriented. On the one hand, the most frequent allocation was $(\underline{x}, \underline{y}, \underline{z}) = (7, 4, 4)$, irrespective of the treatment and their order. On the other hand, Y and Z were usually treated equally. Table 4 summarizes X's behavior in case of $\underline{\pi}$-pie.

Thus the tendency to rely more on (horizontal) fairness when the pie is smaller, already confirmed for $\bar{\pi}$ versus π, extends also to the smallest pie, $\underline{\pi}$, which results in case of conflict.

[11] The null hypothesis, H_0, can be stated as: "There is no difference in the median of the differences $(\bar{z} - \bar{y})$ (resp. $(z - y)$) between the first six rounds and the last six rounds".

Table 4: X's proposals to Y and Z in case of $\underline{\pi} = 15$.

IT-*order*	$\underline{z} > \underline{y}$	$\underline{z} = \underline{y}$	$\underline{z} < \underline{y}$	$(\underline{z}, \underline{y}) = (4, 4)$	n
I-treatment	20.0 %	63.3 %	16.6 %	46.7 %	30
T-treatment	3.2 %	77.4 %	19.4 %	71.0 %	31
TI-*order*	$\underline{z} > \underline{y}$	$\underline{z} = \underline{y}$	$\underline{z} < \underline{y}$	$(\underline{z}, \underline{y}) = (4, 4)$	n
T-treatment	15.4 %	69.2 %	15.4 %	65.4 %	26
I-treatment	17.5 %	64.7 %	17.6 %	52.9 %	17

Note: n denotes the number of times in which the game with $\underline{\pi}$ was played.

5.2 Y-responses

The acceptance rates of Y-participants for each of the 4 possible values of $\bar{y}$ and $\underline{y}$, for each treatment and both treatments' orders are graphically displayed in Figure 1. The figure reveals the following effects: (i) Contrary to the game theoretic prediction, the minimal offer is mostly rejected, regardless of the size of the pie and the treatment; (ii) the percentage of Y-participants rejecting the lowest share of the big pie (i.e., $\bar{y} = 15$) is significantly higher for the IT-order than for the reverse order;[12] (iii) while acceptance rates increase monotonically with X's offers under the TI-order with a 100%-acceptance of the maximal $\bar{y}$- and $\underline{y}$-offers, this is not true for the IT-order where, whatever pie and treatment, an almost 100%-acceptance rate can be observed only for the full-equity allocation.

The two latter findings suggest that Y's behavior does not depend on the treatment, but rather on the order in which treatments were played. To explore this more thoroughly, we have looked at the frequency with which Y-participants exhibit monotonic acceptance strategies.[13] Tables 5 and 6 contain the results of such analysis for the $\underline{\pi}$-, resp. $\overline{\pi}$-, pie. As expected, monotonic behavior dominates the main diagonals of both tables (referring to the TI-order): Regardless of the size of the pie, when the T-treatment was played first, Y-participants tended to accept monotonically. This "natural" pattern does not apply, however, to the off-diagonals of the two tables (referring to the IT-order). Here a substantial percentage of Y-participants reveals non-monotonic responses.

[12] The two-tailed non-parametric Wilcoxon signed-rank test for paired observations, conducted separately for the two pies, rejects the null hypothesis that acceptance rates are the same for the two orders in case of the $\overline{\pi}$-pie ($p = 0.0025$) but not in case of the $\underline{\pi}$-pie ($p = 0.6097$).

[13] If one accepts y', monotonicity requires to accept also all $y'' > y'$.

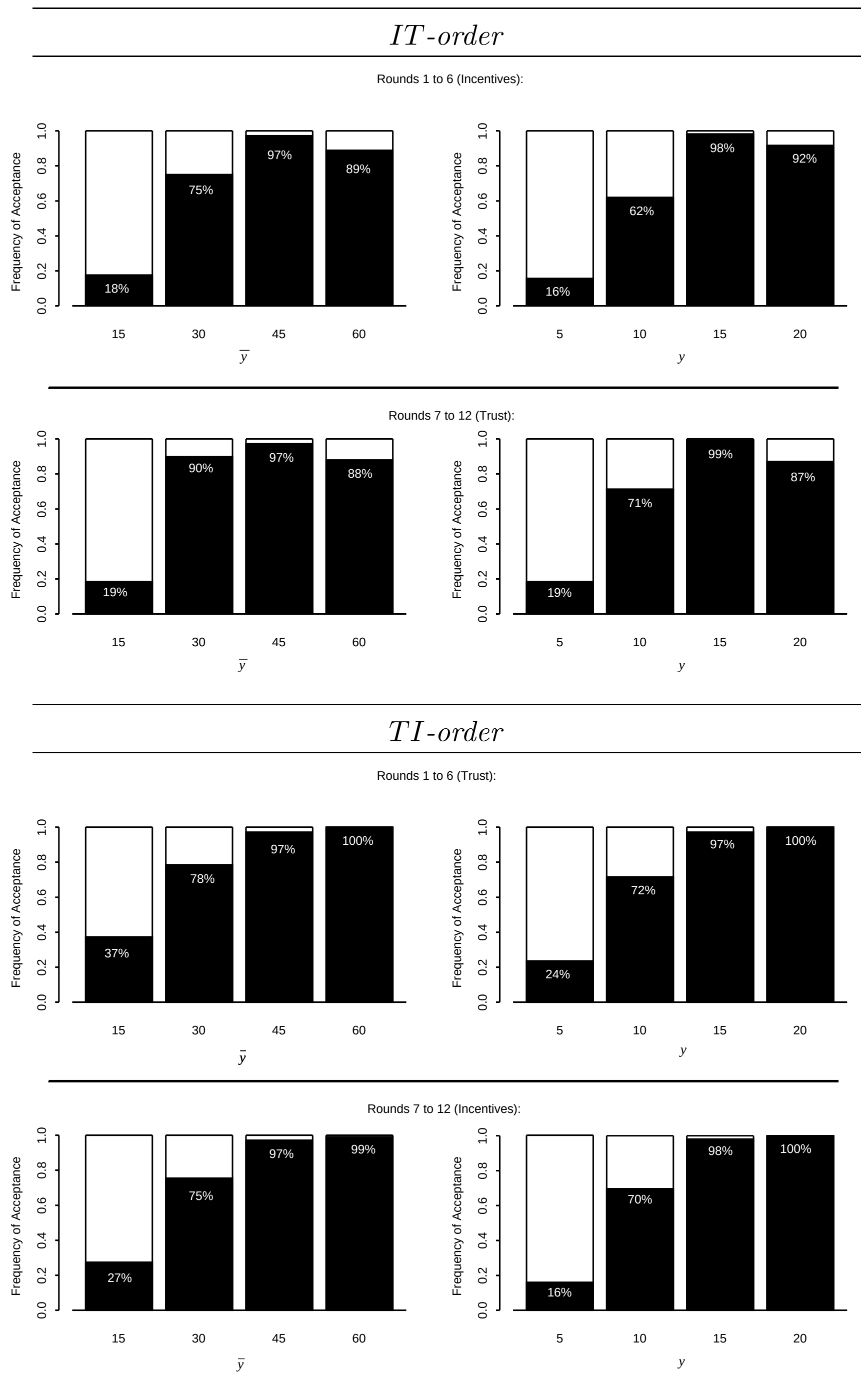

Figure 1: Y's observed acceptance rates for the $\bar{\pi}$- and the π-pies with respect to both treatments and both treatments' orders.

Thus, while Y's behavior is more in line with the opportunistic assumptions of game theory under the TI-order, some non-monetary preferences are crowded in under the IT-order. Since Y only knows his own reward, in the latter case

Table 5: Y's monotonic behavior in case of $\pi = 45$.

		Treatment	
		Trust	Incentives
Timing	Early	100%	61.11%
	Late	27.78%	100%

Table 6: Y's monotonic behavior in case of $\bar{\pi} = 135$.

		Treatment	
		Trust	Incentives
Timing	Early	100%	55.55%
	Late	33.33%	94.12%

we can only speculate about the criteria on which Y bases his decision (e.g., his beliefs regarding the whole allocation or the amount allocated to Z, a desire to punish X for being too greedy, etc.). Given what Y knows, it seems reasonable to assume that Y decides by comparing his own with the average reward. In this case, a preference for generally fair allocations (in the sense of equal shares for all three group members) would explain why Y even rejects offers favoring him.[14] On the other hand, a preference for "being treated fairly" (individual fairness) might explain why most Y-participants reject minimal (yet positive) offers.

To investigate Y's motivations in more detail, we estimated a Probit model of the form

$$\text{Prob}(\text{"}Y\text{ accepts"}) = F(\beta'\mathbf{x})$$

where $\mathbf{x}$ is a vector of explanatory variables including y, the squared deviation from the full-equity reward $(y - \pi/3)^2$ (a proxy of general fairness), and a dummy variable ι which takes value of one under the I-treatment. The test results, presented in Table 7, statistically confirm that Y's acceptance behavior does not depend on the treatment (T versus I), and that only the IT-order crowds in fairness motivations. We therefore can state:

Result 3 *Y's behavior depends strongly on the order in which treatments are played. When the I-treatment comes first, Y-participants reveal a strong intrinsic concern for fairness which is crowded out when the T-treatment is played first.*

[14] Güth et al. (2002 and forthcoming) also observed considerable shares of non-monotonic responses in their (ultimatum) newspaper experiments and explain them by an intrinsic interest in fair outcomes.

Table 7: Binomial Probit Model for Y's acceptance rate.

	$\bar{\pi}$		π		$\bar{\pi}$		π	
	TI	IT	TI	IT	TI	IT	TI	IT
Intercept	-1.0029	1.4928*	-2.3726	0.419	-1.5643**	1.7609**	-2.2667**	0.3733
	(1.209)	(0.671)	(1.924)	(0.631)	(0.375)	(0.215)	(0.427)	(0.613)
y	0.0646*	0.0071	0.294*	0.0711*	0.0755**		0.2816**	0.0713*
	(0.029)	(0.012)	(0.149)	(0.036)	(0.013)		(0.046)	(0.036)
$(y-\pi/3)^2$	-0.0004	-0.0027**	0.0011	-0.0177**		-0.0030**		-0.0176**
	(0.001)	(0.001)	(0.013)	(0.005)		(0.000)		(0.005)
ι	-0.1818	0.1789	-2.372	-0.0837				
	(0.301)	(0.277)	(0.314)	(0.265)				
log-likelihood	-45.2898	-51.4251	-41.3811	-56.4076	-45.5537	-51.8212	-41.4600	-56.4574
R. log-likelihood	-74.2480	-86.0656	-80.7077	-90.3219	-74.2480	-86.0656	-80.7077	-90.32189

* Significant at the 5% level
** Significant at the 1% level

Figure 2 shows that Result 3 holds true also with respect to $\underline{\pi}$, the very small pie which players can share in case of conflict for $\bar{\pi}$ and π.

IT-*order* TI-*order*

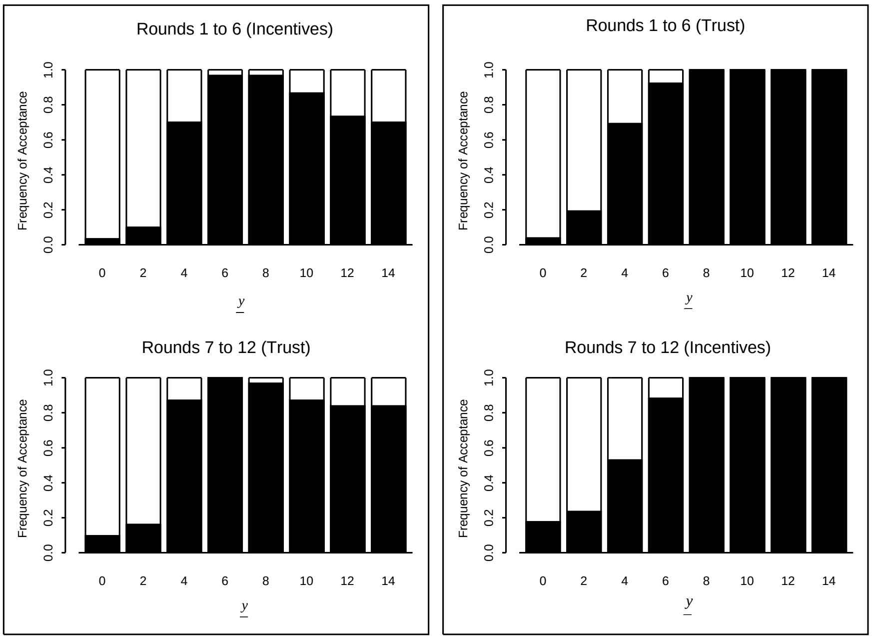

Figure 2: Y's observed acceptance rates for the $\underline{\pi}$-pie with respect to both treatments and both treatments' orders.

What should we conclude from this unexpected order effect for the acceptance behavior of Y-participants? In our view, the TI-order can be seen as the natural order in which contractual relationships evolve[15] and reversing this order triggers unnatural reactions like non-monotonic responses rejecting the basic idea of incentive pay (assuming that higher payments inspire a better performance). This poses an interesting problem for mechanism design, namely that it may be partly irreversible: When restructuring bureaucracies, for instance by introducing newly incentive schemes, one cannot simply go back to the former status quo. As suggested by our results for the IT-order, there can be a much stronger concern for general fairness (for the case at hand, in the sense of equal shares of the surplus among group members) if incentive schemes are replaced by trust schemes.

[15]In its early development, mankind had to rely on trust and reciprocity when trying to avoid dilemma-type outcomes (even non-human primates display behavior suggesting trust and reciprocity; see de Waal, 1982). Artifacts of incentive engineering, such as piece rate-wages and incentive contracts, were most probably introduced when labor division started causing principal-agent problems.

5.3 Z-behavior

Let us explore first whether (in accordance with our Hypothesis 1 but contrary to the theoretical prediction) Z-participants engage in effort also in the T-treatment, and then whether they require higher (or, at least, no smaller) rewards than Y due to their more privileged position.

5.3.1 Effort choices

The average levels of effort in each round of the T- and the I-treatment are visualized in Figure 3, resp. 4. Regarding the T-treatment, 61.76% of Z-participants who experienced it in the first 6 rounds decided to engage in effort and this percentage increases to 75% after previously experiencing the I-treatment.[16] For the I-treatment, effort was observed in 61.11% of the cases when being first and in 62.04% of the cases when being second. Comparing Figure 3 to Figure 4 it is easy to see that there is no significant difference in average levels of effort between the two treatments when they are both played first (i.e., in rounds 1 to 6). When Z-participants, however, experienced the alternative treatment before, the T-treatment is relatively more effective in inducing effort than the I-treatment ($p = 0.0335$ according to a Wilcoxon signed-rank test for paired observations).

Figures 3 and 4 only describe Z's effort responses to the actual proposals $(\overline{z}, z)$ made by X. Due to the strategy method, we also observed Z's effort decision for every feasible combination $(\overline{z}, z)$. From these data we see that the relative frequency of effort is, on average, 3.34 percent-points lower when the I-treatment follows the T-treatment. This difference, although small, is statistically significant at the 0.0348 level (using the Wilcoxon signed-rank test for paired differences). Therefore, previous exposure to the T-treatment seems to moderately (but significantly) reduce the efficacy of the incentive scheme to trigger special effort ($\delta = 1$) of Z-participants. We thus observe an unexpected but interesting order effect as for Y-participants, which we summarize by:

Result 4 *The T-treatment and the I-treatment do not differ significantly in terms of provided effort when they are played first. But, when Z-participants have experienced the alternative treatment before, the efficacy of the incentive scheme is reduced and effort is significantly higher under the T-treatment.*

Result 4 supports Hypothesis 1, but does not say much about the factors influencing Z's decisions. For the I-treatment game theory predicts that a risk

[16] This increase in relative frequency of effort when the T-treatment followed the I-treatment is significant at the 0.0312 level according to a Wilcoxon signed-rank test for paired observations.

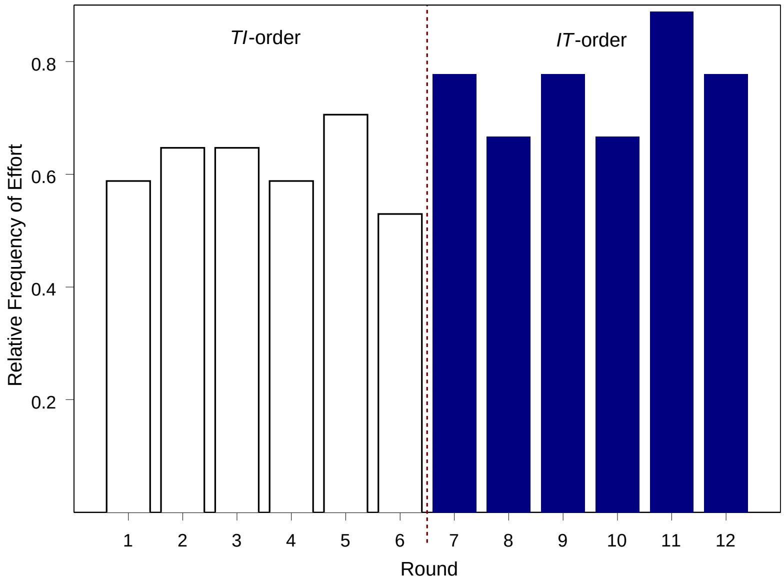

Figure 3: Z's average levels of effort in each round of the T-treatment.

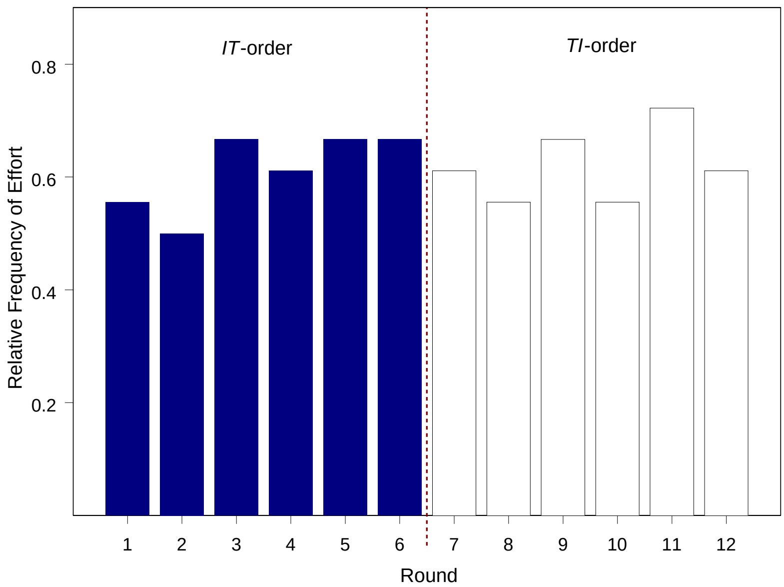

Figure 4: Z's average levels of effort in each round of the I-treatment (play data).

neutral player Z should engage in effort only when $(\overline{z} - z) > 20$. More generally, the frequency of effort should be correlated positively with $\overline{z}$ and negatively with z. Figure 5 displays the relative frequency of effort decisions for all possible values of z separately for each single $\bar{z}$.

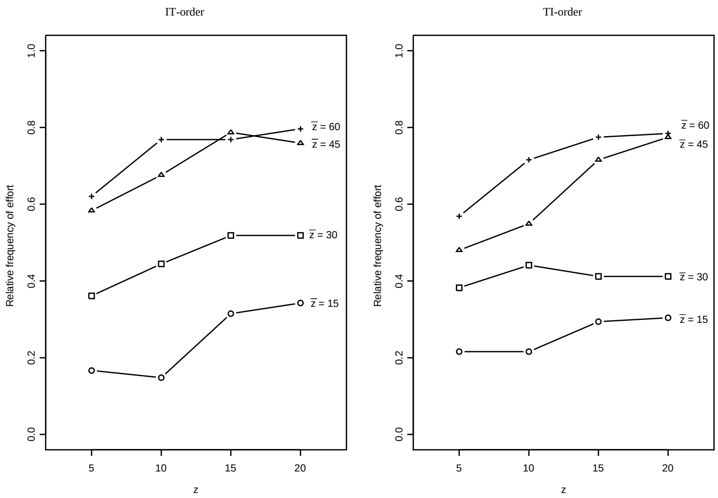

Figure 5: Z's average levels of effort for all values of z and each value of $\overline{z}$ (strategy method-data).

Qualitatively in line with the theoretical prediction, effort becomes more frequent when $\overline{z}$ increases but, at odds with the theory, also when z increases. The incentive compatibility constraint, requiring Z to react to different combinations $(\overline{z}, z)$ by choosing effort so as to maximize his expected monetary reward is therefore not supported by the experimental data. Effort decisions appear to be motivated, and to a considerable extent even dominated, by non-monetary preferences. In particular, reciprocity considerations may explain why in the I-treatment Z-participants engage in (costly) effort also when the relative attractiveness of $\bar{\pi}$ is reduced by a high level of z. Since, for both pies, X offers him more than the minimal reward, Z reciprocates (i.e., responds in kind) by exerting special effort.

Result 5 *Contrary to incentive compatibility, decent rewards (z) in case of the small pie (π) trigger special effort ($\delta = 1$) of Z.*

5.3.2 Z-acceptance behavior

Table 8 lists the acceptance rates of Z-participants for all possible combinations ($\bar{y}$, $\bar{z}$) and (y, z) under the T- and the I-treatments. Like in Table 1, the data are split in two panels corresponding to the order of treatments.

Table 8: Z's observed acceptance rates for the $\bar{\pi}$- and the π-pies with respect to both treatments and both treatments' orders.

IT-order

I-treatment (rounds 1-6)

	$\overline{z}$	15	30	45	60
$\overline{y}$	15	0.26	0.61	0.85	0.93
	30	0.21	0.63	0.96	0.98
	45	0.25	0.55	0.96	0.94
	60	0.23	0.46	0.71	0.94

	z	5	10	15	20
y	5	0.18	0.46	0.83	0.90
	10	0.15	0.56	0.94	0.96
	15	0.14	0.46	0.94	0.94
	20	0.15	0.37	0.72	0.94

T-treatment (rounds 7-12)

	$\overline{z}$	15	30	45	60
$\overline{y}$	15	0.17	0.63	0.85	0.89
	30	0.20	0.72	0.97	0.94
	45	0.23	0.53	0.93	0.90
	60	0.22	0.43	0.73	0.91

	z	5	10	15	20
y	5	0.11	0.25	0.82	0.89
	10	0.14	0.36	0.93	0.94
	15	0.19	0.41	0.87	0.94
	20	0.19	0.31	0.72	0.92

TI-order

T-treatment (rounds 1-6)

	$\overline{z}$	15	30	45	60
$\overline{y}$	15	0.30	0.74	0.94	0.95
	30	0.45	0.75	0.96	0.96
	45	0.44	0.68	0.96	0.95
	60	0.45	0.62	0.83	0.96

	z	5	10	15	20
y	5	0.18	0.52	0.86	0.93
	10	0.29	0.58	0.92	0.94
	15	0.42	0.58	0.95	0.95
	20	0.37	0.54	0.84	0.91

I-treatment (rounds 7-12)

	$\overline{z}$	15	30	45	60
$\overline{y}$	15	0.41	0.69	0.95	0.96
	30	0.37	0.74	0.98	0.99
	45	0.36	0.66	0.99	0.99
	60	0.35	0.54	0.85	0.94

	z	5	10	15	20
y	5	0.30	0.57	0.93	0.94
	10	0.31	0.61	0.98	0.99
	15	0.36	0.67	0.95	0.99
	20	0.36	0.59	0.88	0.92

Contrary to the game theoretic solution, offers granting the minimal rewards to both Z and Y were mostly rejected, especially for the small pie. Furthermore, regardless of the treatment and their order, acceptance rates tend to increase monotonically with $\bar{z}$ and z. Reading-through the cells above the main diagonal of the 8 subtables reported in Table 8 reveals that, except for $(\bar{y}, \bar{z}) = (15, 30)$ and $(y, z) = (5, 10)$, all other combinations with a greater $\bar{z}$- (resp. z-) than $\bar{y}$- (resp. y-) component have very high acceptance rates (generally, above 90%). Averaging over treatments and pies, 93.4% of Z-participants were willing to accept proposals favoring them rather than Y. The respective percentage in case of equal offers was 68.28%, which increases to 83.1% when excluding the most frequently rejected combinations $(\bar{y}, \bar{z}) = (15, 15)$ and $(y, z) = (5, 5)$. Finally, only 44.81% of Z-participants accepted offers granting more to Y than to them. However, regarding the offers favoring Y, the acceptance by Z appears to depend on the size of the pie with more acceptance in case of the big pie: When 135 tokens are at stake, 47.3% of Z-participants accepted Y-preferring offers with this percentage falling by 5 percent-points for 45 tokens only.

More generally, whatever the amount given to Y, Z seems more willing to accept X's offers in case of the big pie. Table 9 displays Z's average acceptance rates for each of the two pies, separately for each treatment and each treatments' order. The table clearly shows that the average acceptance rates are always significantly higher for the $\bar{\pi}$-pie than for the π-pie.

Furthermore, while for the big pie treatments do not differ significantly with respect to Z's acceptance of low rewards,[17] for the small pie the acceptance rate of low z-offers is significantly higher under the I-treatment than under the T-treatment: In case of IT- (TI-) order, offers z of 5 and 10 were accepted 30.8% (47.1%) of the times under the I-treatment and 24.5% (43.5%) of the times under the T-treatment, revealing that also Z's acceptance rates depend on the order in which treatments were played. More specifically, the TI-order triggers, in general, lower rejection rates than the IT-order. Thus, taking into account also Result 3 about Y's behavior, it seems that the "more natural" TI-order induces more game theoretic behavior than the reverse order.

To sum up our major findings about Z's behavior:

Result 6 *Regardless of the pie size, the treatment and the treatments' order, Z's acceptance rates increase monotonically with the Z-shares of the pie.*

Result 7 *Offers are more frequently accepted in case of the big pie ($\bar{\pi}$).*

Result 8 *Z's acceptance rates are higher under the TI-order than under the IT-order.*

[17]Under the IT-order, Z's acceptance rates of $\bar{z} = 15$ and $\bar{z} = 30$ were 0.40 and 0.39 for the I-, resp. T-, treatment. The respective rates in case of TI-order were 0.51 and 0.55.

Table 9: Z's average acceptance rates for the $\bar{\pi}$- and the π-pies.

	Z's average acceptance rate		Wilcoxon signed-rank test
	$\bar{\pi}$	π	p-value
IT-order:			
I-Treatment	65.45%	60.36%	0.0007
T-Treatment	64.06%	56.13%	0.0016
TI-order:			
T-Treatment	74.63%	67.46%	0.0004
I-Treatment	73.59%	71.01%	0.0616

Note: The Wilcoxon signed-rank test was performed on the average acceptance rates paired at each cell position in the matrices shown in Table 8.

These results are partly in line with Hypothesis 3. Acceptance by Z is in general more frequent for proposals granting him more than Y. This means that Z-participants are not very interested in (horizontal) fairness. Being aware of their own privileged position, they feels entitled to get more than Y, i.e. to ask for greasing. Nevertheless, when the pie is largest, players Z are less willing to reject offers with $(\bar{z} - \bar{y}) < 0$.

Next, we analyze Z's behavior when there was no agreement about the distribution of $\bar{\pi}$ or π, and thus only $\underline{\pi} = 15$ remain to be distributed. Z's acceptance rates for all possible combinations ($\underline{y}$, $\underline{z}$), for both treatments and both treatments' orders are given in Table 10.

The nearly universal tendency was to reject offers giving either 0 or 2 to both responders with a 0%-acceptance rate for $(\underline{y}, \underline{z}) = (0, 0)$.[18] However, offers with $\underline{z} = \{0, 2\}$ and $\underline{y} > 2$ had a positive (although very low) acceptance rate when the allocation of $\underline{\pi}$ took place in the first 6 rounds, i.e for the I- (resp. T-) treatment under the IT- (resp. TI-) order. The two subtables on the left hand side of Table 10 (referring to the first six rounds) show that acceptance rates for offers $\underline{z}$ of 0 and 2 increase with the share of $\underline{\pi}$ allocated to Y. Hence, when agreements on $\bar{\pi}$ or π failed in the first six rounds, Z was willing to accept the lowest possible rewards (including even 0) provided that Y got more than 2. This behavioral pattern does not extend, however, to the last six rounds.

A further data feature made evident by Table 10 is that, also for $\underline{\pi}$ (like for $\bar{\pi}$ and π), Z's acceptance rates tend to increase monotonically with $\underline{z}$ (with the only exception of the I-treatment in the IT-order where a 100%-acceptance

[18]Only one Z-participant accepted to grant the whole pie $\underline{\pi}$ to X.

Table 10: Z's observed acceptance rates for $\underline{\pi} = 15$ with respect to both treatments and both treatments' orders.

IT-order

I-treatment (rounds 1-6)

		$\underline{z}$							
	∗	0	2	4	6	8	10	12	14
$\underline{y}$	0	0.00	0.10	0.60	0.83	0.83	0.83	0.83	0.83
	2	0.07	0.07	0.63	0.90	0.93	0.87	0.87	
	4	0.10	0.17	0.87	1.00	0.97	0.93		
	6	0.13	0.20	0.77	0.97	0.97			
	8	0.13	0.20	0.73	0.90				
	10	0.13	0.20	0.73					
	12	0.13	0.20						
	14	0.13							

T-treatment (rounds 7-12)

		$\underline{z}$							
	∗	0	2	4	6	8	10	12	14
$\underline{y}$	0	0.06	0.10	0.26	0.55	0.74	0.90	0.90	0.94
	2	0.00	0.10	0.35	0.65	0.81	0.94	0.94	
	4	0.03	0.06	0.48	0.77	0.90	1.00		
	6	0.06	0.19	0.48	0.84	0.90			
	8	0.10	0.19	0.45	0.74				
	10	0.06	0.16	0.42					
	12	0.06	0.16						
	14	0.06							

TI-order

T-treatment (rounds 1-6)

		$\underline{z}$							
	∗	0	2	4	6	8	10	12	14
$\underline{y}$	0	0.00	0.15	0.58	0.85	0.88	0.92	0.92	0.92
	2	0.08	0.23	0.58	0.81	0.88	0.92	0.92	
	4	0.15	0.23	0.54	0.81	0.92	0.92		
	6	0.35	0.35	0.58	0.73	0.81			
	8	0.27	0.27	0.46	0.62				
	10	0.31	0.27	0.46					
	12	0.31	0.27						
	14	0.31							

I-treatment (rounds 7-12)

		$\underline{z}$							
	∗	0	2	4	6	8	10	12	14
$\underline{y}$	0	0.06	0.18	0.59	0.76	0.82	1.00	1.00	1.00
	2	0.06	0.18	0.53	0.76	0.88	1.00	1.00	
	4	0.06	0.12	0.53	0.82	0.88	1.00		
	6	0.06	0.06	0.41	0.88	0.88			
	8	0.06	0.06	0.35	0.53				
	10	0.06	0.06	0.12					
	12	0.06	0.06						
	14	0.06							

rate is observed for the allocation $(\underline{x}, \underline{y}, \underline{z}) = (5, 4, 6)$).

6 Conclusions

In bureaucracies the usual incentive contracts studied in principal-agent theory are hardly ever applicable. In public administrations there is usually no profit in which bureaucrats may participate nor a continuous measure of performance on which their earnings may be conditioned. It seems therefore (theoretically) crucial to improve such administrations in their efficiency by introducing incentive schemes when more effort improves only the probability of better versus worse performance.

This suggested to compare a regime based on mutual trust and reciprocity (still the dominating principle in most public administrations) with incentive pay (in the form, for instance, of granting earlier promotion to better performing bureaucrats). In our view, the basic aspects of such situations are well-captured by our experimental design of an extended ultimatum game, which has the additional advantage of allowing for comparisons of behavior with earlier (and simpler) ultimatum experiments.

As in earlier principal-agent experiments we show that a trust-reciprocity regime is not as bad as suggested by opportunistic game-theoretical reasoning. Our data reveal also an interesting order effect of the two regimes: Substituting trust and reciprocity by incentive pay yields effects different from those caused by the inverted order. Thus, when considering the introduction of incentive pay in public administrations, one must be aware that going back to the old regime could negatively affect performance.

References

Agell, J. & Lundberg, P. (1995), 'Theories of Pay and Unemployment: Survey Evidence from Swedish Manufacturing Firms', *Scandinavian Journal of Economics* **97**, 295–308.

Bewley, T. F. (1995), 'A Depressed Labor Market as Explained by Participants', *American Economic Review, Papers and Proceedings* **85**, 250–254.

Conover, W. J. (1980), *Practical nonparametric statistics, 2nd. ed.*, New York: John Wiley and Sons.

de Waal, F. (1982), *Chimpansee Politics*, Baltimore: Johns Hopkins University Press.

Fehr, E. & Gächter, S. (1998), How Effective are Trust- and Reciprocity-Based Incentives?, *in* A. Ben-Ner & L. Putterman, eds, 'Economics, Values and Organizations', Cambridge: Cambridge University Press.

Fehr, E., Gächter, S. & Kirchsteiger, G. (1997), 'Reciprocity as a Contract Enforcement Device', *Econometrica* **65**, 833–860.

Fehr, E., Klein, A. & Schmidt, K. M. (1999), 'Individual vs. Joint Ownership: An Experimental Analysis of the Endogenous Allocation of Ownership Rights', Discussion Paper, University of Munich.

Fischbacher, U. (1999), 'Zurich Toolbox for Readymade Economic Experiments', Working Paper No. 21, University of Zurich, Switzerland.

González, L., Güth, W. & Levati, M. V. (2002), 'Speeding up Bureaucrats by Greasing Them. An Experimental Study', Discussion Paper No. 5, Papers on Strategic Interaction, Max Planck Institute for Research into Economic Systems, Jena, Germany.

Grossman, S. & Hart, O. (1983), 'An Analysis of the Principal-Agent Problem', *Econometrica* **51**, 7–45.

Güth, W., Königstein, M., Kovács, J. & Zala-Mezõ, E. (2001), 'Fairness Within Firms: The Case of One Principal and Multiple Agents', *Schmalenbach's Business Review* **53**, 82–101.

Güth, W., Schmidt, C. & Sutter, M. (2002), 'Bargaining outside the Lab - A Newspaper Experiment of a Three Person-Ultimatum Game', Discussion Paper No. 11, Papers on Strategic Interaction, Max Planck Institute for Research into Economic Systems, Jena, Germany.

Güth, W., Schmidt, C. & Sutter, M. (forthcoming), 'Fairness in the Mail and Opportunism in the Internet - A Newspaper Experiment on Ultimatum Bargaining', *German Economic Review* .

Holmström, B. (1979), 'Moral Hazard and Observability', *Bell Journal of Economics* **10**, 74–91.

Ross, S. A. (1973), 'The Economic Theory of Agency: The Principal's Problem', *American Economic Review* **63**, 134–139.

Schmidt, K. M., Kremhelmer, S. & Fehr, E. (1999), 'Why Are Contracts Incomplete: An Experimental Examination', Discussion Paper, University of Munich.

Shavell, S. (1979), 'Risk Sharing and Incentives in the Principal and Agent Relationship', *Bell Journal of Economics* **10**, 55–73.

Appendix: Experimental Instructions

The following instructions were originally written in German. We report the instructions that we used when the treatments were played in the TI-order. The instructions for the IT-order were adapted accordingly.

A. Instructions in the T-treatment

The following instructions were distributed at the beginning of the experiment.

Welcome and thanks for participating in this experiment.

The instructions are identical for all participants. If you have any question, please ask us. It is prohibited to communicate with the other participants during the experiment. Otherwise, we shall have to exclude you from the experiment and from all payments.

During the experiment, we shall not speak of euro but rather of tokens and your entire earnings will be calculated in tokens. At the end of the experiment the total amount of tokens you have earned will be converted to euro at the following rate:

1 token = 0.05 euro

and the obtained amount will be immediately paid to you in cash.

Detailed Information on the Experiment

In this experiment, three participants at a time will interact with each other over a sequence of periods. Thereby you will be interacting, in each period, with two other participants. The composition of the groups will randomly change after each period. That is, your group members will be different from a period to the next one.

Each of the three group members will be randomly assigned to one of three roles: X, Y or Z. Which role you acquire will be told to you at the beginning of the experiment and you will keep your role over the entire experiment.

Structure of each period

In each period, the three group members can share 135, 45 or 15 tokens. Which of these three amounts will be finally available depends partly on the behavior of the three interacting persons.

Each period may consist of two different phases:

– In the first phase either 135 or 45 tokens can be distributed. (How this can be achieved will be explained on the next pages.)

– The second phase will be played only if the three group members fail to reach an agreement in the first phase. In phase 2, only 15 tokens are available and can be distributed.

The task of each group member in phase 1 is what we describe first.

Phase 1

- **X**-*participants' task*

If you are an X-participant, you must make two proposals: One about how to divide 135 tokens, and another one about how to divide 45 tokens.

When the amount to be divided is 135, X proposes the distribution ($\bar{x}$, $\bar{y}$, $\bar{z}$) where $\bar{x}$ is what X wants to keep for her/himself, and $\bar{y}$ and $\bar{z}$ are what X wants to give to Y, resp. Z. X's proposal must fulfil two conditions:

1. $\bar{x} + \bar{y} + \bar{z} = 135$, i.e. the 135 tokens must be completely exhausted; and
2. $\bar{y}$, $\bar{z} \in \{15, 30, 45, 60\}$, i.e. X can give Y and Z either 15 or 30 or 45 or 60 tokens. *Please note that these restrictions apply only to Y and Z. X can assign any amount to her/himself.*

When the amount to be divided is 45, X proposes the distribution (x, y, z) where x is what X wants to keep for her/himself, and y and z are what X wants to give to Y, resp. Z. X's proposal must again fulfil two conditions:

1. $x + y + z = 45$, i.e. the 45 tokens must be completely exhausted; and
2. y, $z \in \{5, 10, 15, 20\}$, i.e. X can give Y and Z either 5 or 10 or 15 or 20 tokens. *Again these restrictions apply only to Y and Z.*

- **Y**-*participants' task*

If you are a Y-participant, you must decide for each possible offer $\bar{y}$ and y by X whether you would accept it or not.

When the tokens to be distributed are 135, you will face the following table:

$\bar{y}$	15	30	45	60
Y's choice				

For each amount $\bar{y}$ that X can offer you (i.e. 15, 30, 45 and 60), you must insert in the corresponding blank entry of the table either "**y**" (for **y**es) if you want to accept it or "**n**" (for **n**o) if you want to reject it.

When the tokens to be distributed are 45, you will face the following table:

y	5	10	15	20
Y's choice				

and again, for each amount y that X can offer you (in this case: 5, 10, 15 and 20), you must insert in the corresponding blank entry of the table either "**y**" if you want to accept it or "**n**" if you want to reject it.

- **Z**-*participants' task*

If you are a Z-participant, you have two different tasks.

I. First, you determine the probabilities for the event that 135 or 45 tokens are available. You can compare these probabilities with a twelve-sided dice: The probabilities depend on whether you choose a twelve-sided dice called **S** or a twelve-sided dice called **E**. Whereas the **S**-dice is free, the **E**-dice costs you 10 tokens.

- If you choose the **S**-dice, 45 tokens will be available when − in throwing the dice − numbers 1, 2, 3, 4, 5, 6, 7, 8 or 9 appear while 135 tokens will be available when numbers 10, 11 or 12 appear. In probabilistic terms, this means that 45 tokens will be available with probability 75% and 135 tokens with probability 25%.
- If you choose the **E**-dice, the probabilities are exchanged: 135 tokens will be available when numbers 1, 2, 3, 4, 5, 6, 7, 8 or 9 appear, and 45 tokens when numbers 10, 11 or 12 appear.

II. Your second task, as Z-participant, is to decide between acceptance and rejection of all possible proposals ($\bar{x}$, $\bar{y}$, $\bar{z}$) and (x, y, z) by X.

Differently from Y, you can condition your choice on both your own amount and the amount given to Y (i.e. you know what you would get as well as what Y would get).

When the tokens to be distributed are 135, you will face the following table:

		$\bar{z}$			
		15	30	45	60
$\bar{y}$	15				
	30				
	45				
	60				

For each amount $\bar{y}$ and $\bar{z}$ that X can offer to Y and you (i.e. 15, 30, 45 and 60), you must insert in the corresponding blank entry of the table either "**y**" (for **y**es) if you want to accept it or "**n**" (for **n**o) if you want to reject it.

When the tokens to be distributed are 45, you will face the following table:

		z			
		5	10	15	20
y	5				
	10				
	15				
	20				

and again, for each amount y and z that X can offer to Y and you (in this case: 5, 10, 15 and 20), you must insert in the corresponding blank entry of the table either "**y**" if you want to accept it or "**n**" if you want to reject it.

- *Payoffs in phase 1*

At the end of phase 1, the twelve-sided dice determines the token amount (135 or 45) to distribute among the three group members as depending on Z's choice between S

and E. For the selected amount, we will check whether Y and Z accept the proposal by X or not.

– If both Y's and Z's decision is "Yes", then each person gets what X has proposed.

– Otherwise, if Y's and/or Z's decision is "No", we proceed with the second phase.

Phase 2

If the experiment continues with the second phase, **only 15 tokens are available** and can be distributed.

X-participant must propose how to divide the 15 tokens among the three group members. X chooses: ($\underline{x}$, $\underline{y}$, $\underline{z}$), meaning that X keeps $\underline{x}$ for her/himself, and gives $\underline{y}$ and $\underline{z}$ to Y and Z respectively. X's proposal must fulfill two conditions:

1. the 15 tokens are completely exhausted (i.e. $\underline{x} + \underline{y} + \underline{z} = 15$), and
2. only even amounts can be given to Y and Z (i.e. $\underline{y}$, $\underline{z} \in \{0, 2, 4, 6, 8, 10, 12, 14\}$).
   Again these restrictions apply only to Y and Z.

Simultaneously, Y-participant must decide for each possible offer $\underline{y}$ by X whether (s)he would accept it or not. Thus, Y must insert "**y**" for acceptance or "**n**" for rejection in each of the 8 entries of the following table:

$\underline{y}$	0	2	4	6	8	10	12	14
Y's choice								

At the same time, Z-participant must also decide between acceptance and rejection of each possible proposal ($\underline{x}$, $\underline{y}$, $\underline{z}$) by X. Differently from Y, who only can react to her/his own amount $\underline{y}$, Z can react to $\underline{y}$ and $\underline{z}$. So, (s)he knows what (s)he would get as well as what Y would get. Thus, Z must insert "**y**" for acceptance or "**n**" for rejection in each of the 36 entries of the following table:

$\underline{z}$

$\underline{y}$ \ *	0	2	4	6	8	10	12	14
0								
2								
4								
6								
8								
10								
12								
14								

When all three group members have made their choice, we check whether Y and Z

accept X's proposal.

- *Payoffs in phase 2*

– In case of acceptance by both Y and Z all persons get what X has proposed, i.e. X earns $\underline{x}$, Y earns $\underline{y}$, and Z earns $\underline{z}$.

– In case of rejection by Y and/or Z all three group members earn nothing.

B. Instructions in the I-treatment

The following instructions were distributed at the end of the sixth round.

From now on, if you are a Z-participant, you have the possibility to condition your choice between S and E on the amount that X offers you in case of 135 or 45 tokens. Thereby, when deciding between S and E, you will face the following table:

		$\bar{z}$			
		15	30	45	60
z	5				
	10				
	15				
	20				

In the top-left blank entry of the table, for instance, you must insert either "S" or "E" when X offers you 15 out 135 tokens and 5 out of 45 tokens. In the bottom-left blank entry you must insert either "S" or "E" when X offers you 15 out 135 tokens and 20 out of 45 tokens. And so on.

Your second task (deciding between acceptance and rejection of all possible offers by X) will remain unchanged.

Note: You need to fill out all the 16 entries of the above table before you can perform your second task.