

Do incentive contracts crowd out voluntary cooperation?*

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Abstract: In this paper we provide experimental evidence indicating that incentive contracts may cause a strong crowding out of voluntary cooperation. This crowding out effect constitutes costs of incentive provision that have been largely neglected by economists. In our experiments the crowding out effect is so strong that the incentive contracts are less efficient than contracts without any incentives. Principals, nonetheless, prefer the incentive contracts because they allow them to appropriate a much larger share of the (smaller) total surplus and are, hence, more profitable for them.

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1. INTRODUCTION

This paper examines the interaction between material incentives and “non-economic”, fairness-related, methods of effort elicitation. We examine, in particular, to what extent the provision of material incentives crowds out voluntary cooperation. This question is important because economic theories rely heavily on the effectiveness of material incentives. Yet, if material incentives cause a crowding out of voluntary cooperation they may in fact decrease efficiency. There can thus be little doubt that the effectiveness and the limits of material incentives belong to the fundamental questions in economics. In the meantime there is a vast economic literature dealing with the effects of economic incentives (see Gibbons (1997) and Prendergast (1999) for surveys). There is also a large literature in social psychology that claims that economic incentives may crowd out intrinsic motivation and may, hence, have counterproductive effects (see, e.g., Deci and Ryan 1985, Deci Koestner and Ryan 2000, Eisenberger and Cameron 1996). With a few exceptions (Frey and Oberholzer-Gee 1997, Kreps 1997, Gneezy and Rustichini 2000a, Bohnet, Frey and Huck 2000) the economics literature has largely neglected the claims made by the psychologists. A main reason for this may be that there is sharp disagreement about the interpretation of the evidence. Frey and Jegen (2000), e.g., claim that there is “*compelling empirical evidence* for the existence of crowding out” (emphasis in the original). In contrast, Prendergast’s view is that “there is little conclusive empirical evidence” of crowding out effects (Prendergast 1999, p. 18).¹

Prendergast’s judgement is based on an important objection against the typical interpretation of the psychological evidence. In a typical experiment subjects in two groups perform an intrinsically interesting activity. In the first phase of the experiment subjects in the treatment group face performance-contingent rewards while in the control group no rewards are present. Then, in a second phase, the rewards in the treatment group are removed. If, in the second phase, the subjects in the treatment group perform less of the activity compared to subjects in the control group, crowding out of intrinsic motivation is said to prevail. However, if performance-contingent rewards increase the level of the activity in the first phase of the experiment, the subjects in the treatment group may simply be more satiated (or tired) in the second phase compared to the subjects in the control group. Thus, decreasing marginal returns to the activity suffices to explain why subjects in the treatment group perform less of the activity in the second phase.

A further important objection that can be raised against the economic relevance of the psychological experiments is that despite the presence of crowding out effects it may still be efficient to use material incentives. This is so because, from an economic viewpoint, the *total*

¹ For a sceptical interpretation of the evidence see also Kreps (1997).

effects of incentives are important. Suppose for a moment that in the second phase of a typical experiment there is indeed a crowding out of intrinsic motivation. Yet, as long as it is still possible in the second phase to induce more efficient effort levels in the treatment group, compared to the control group, by providing material incentives, the total effects of incentive provision are positive. Unfortunately, the psychological literature does not address this question because neither the material costs nor the material returns of the subjects' performance are specified in these experiments. It is, therefore, not possible to examine the efficiency consequences of potential crowding out effects.

In this paper we report the results of an experiment that is not subject to these objections because our experiment deviates in several dimensions from the typical psychological experiment described above. As we will see, in our experiment a potential crowding out effect cannot be attributed to subjects' satiation *and* we can assess the overall efficiency implications of subjects' behavior. In addition, we can examine the effects of material incentives on the distribution of the gains from effort provision. Finally, we can also study the interaction between the behavior of the agents and the behavior of the principals because in our experiment the agents face those incentive conditions that are chosen by the principals. This differs from the psychological experiments where the agents face predetermined incentive conditions that are chosen by the experimenter.

Our results show that material incentives may indeed cause a strong crowding out of voluntary cooperation. In our experiment the crowding out is so strong that those contracts, which provide explicit material incentives, are on average less efficient and elicit less effort from the agents, than contracts that do not provide any incentives at all. This result contradicts the standard economic model because this model predicts that the incentive contract will be much more efficient and elicit more effort than the contract without incentives.² Despite the efficiency loss principals overwhelmingly prefer the incentive contract. A potential reason for this might be that principals overestimate the extent to which agents are motivated by extrinsic incentives. Heath (1999) provides evidence indicating that this is often the case. However, in our context this is probably not the reason for the principals' preference. It turns out that the principals have a large material advantage from the provision of incentive-compatible contracts because they allow them to reap a much larger share of the smaller surplus. The redistributive effect of incentive-compatible contracts is sufficiently strong to over-compensate the induced efficiency loss.

² The standard economic analysis of incentive contracts rest on two assumptions. First, individuals are fully rational and second, individuals care only about their own income and their cost of effort. For seminal papers on the standard approach see, e.g., Holmström (1979), Grossman and Hart (1983), Hart and Holmström (1987) and Jewitt (1988).

In our view these results are important because voluntary cooperation is important in many real world contexts. Whenever agents have discretion over the intensity or the type of activity they perform in a principal-agent relationship, voluntary cooperation is very valuable for the principals. The relevance of voluntary cooperation for, e.g., the employment relation is neatly confirmed by the extensive study of Bewley (1995, 1999). Bewley reports that “managers claim that workers have so many opportunities to take advantage of employers that it is not wise to depend on coercion and financial incentives alone as motivators” (Bewley 1995, p. 252).

In the standard principal-agent approach the agents’ objective function is, in general, increasing and strictly concave in income, decreasing in effort and additively separable in the two arguments. If agents determine their effort by maximizing this objective function they do not cooperate voluntarily. If, in contrast, they work harder we speak of voluntary cooperation. Voluntary cooperation may come from different sources: Agents may simply be irrational or they may have an intrinsic preference for the activity. Agents may also feel an obligation to work hard and exhibit loyalty because the principal has been treating them well. In our experiment the agents’ propensity to respond to generous wages with generous effort levels is the source of voluntary cooperation. It turns out that in the absence of material incentives fair wages are rewarded with fair effort levels. In the presence of material incentives, however, many agents reduce reciprocation or even stop reciprocating fair wages with fair effort levels. This suggests that optimal contracts have to take into account the efficiency costs arising from the crowding out of voluntary cooperation. Since these costs arise because of the presence of fair-minded reciprocal agents, these agents have to be taken into account when designing optimal contracts. Thus, optimal contracts should not only be incentive compatible in the sense that they induce selfish agents to perform well, but they should also be fairness compatible in the sense that they avoid the crowding out of fairness-related voluntary cooperation.

We would like to stress that we do not interpret the crowding out of fairness-driven voluntary cooperation in our experiment as a general argument against material incentives. While our experiment shows that there are incentives that have counterproductive effects on fairness-driven voluntary cooperation we also believe that there are incentives which enhance such voluntary cooperation. The question is not whether to use or not to use material incentives. In our view, the crucial task is to identify fairness compatible material incentives that do not crowd out voluntary cooperation.

Recently, Gneezy and Rustichini (2000a, 2000b) reported very interesting evidence indicating counterproductive effects of explicit incentives. Our study goes beyond the results of Gneezy and Rustichini because, in contrast to Gneezy and Rustichini, we control for the effort costs. This makes it possible to construct a precise measure of voluntary cooperation

and the crowding out of voluntary cooperation. In addition, the control of effort costs enables us to examine the impact of material incentives on the overall efficiency and the distribution of the gains from trade. Moreover, it allows us to identify whether a contract is incentive compatible or not. By studying the agents' responses to incentive-compatible and to non-incentive-compatible contracts we gain a deeper understanding of the crowding out phenomenon. Finally, the control of the effort cost enables us to compute the optimal incentive-compatible contract that is predicted by the standard approach. Therefore, we can also study to what extent the principals' behavior is captured by the standard approach.

The remainder of this paper is organized as follows. In the next section we will describe the experimental design and the experimental procedures. In Section 3 we derive the behavioral predictions. Section 4 presents the results. In Section 5 we summarize and interpret our findings.

2. THE EXPERIMENTAL DESIGN AND PROCEDURES

The basic feature of our design is the comparison of two treatments in the context of a "gift exchange game" as developed by Fehr, Kirchsteiger and Riedl (1993). The first treatment, which forms the baseline, is the so-called "Trust-Treatment" (henceforth TT). Its main purpose is to establish the extent of voluntary cooperation in the absence of material incentives for cooperation. The second treatment is the "Incentive-Treatment" (henceforth IT). It is the same as the TT, except that material incentives for contractual compliance are introduced. Note that no subject participated in both treatments. In an experimental session we conducted either only the IT or only the TT. Therefore, the criticism Prendergast (1999) raised against the psychological experiments does not apply. As we will see, by comparing the agents' behavior in the IT with the behavior in the TT we can nevertheless examine whether there are crowding out effects.

2.1 The Trust-Treatment

The constituent game was a version of the “gift exchange game”, which comprises three stages. In the first stage principals make a contract offer, which consists of a fixed wage w and a *desired* effort level \hat{e} . Upon acceptance at the second stage, agents have to decide on an *actual* effort level e at the third stage. They are not committed by the principal’s desired effort level \hat{e} , i.e., they can choose $e \neq \hat{e}$. In the experiments, a principal’s profit is given by:

$$(1) \quad \mathbf{p} = \begin{cases} ve - w & \text{if the contract is accepted;} \\ 0 & \text{if no contract is concluded.} \end{cases}$$

ve is the return for the principal as a function of the agent’s actual effort e . In the experiments $v = 100$ and wages w have to obey $0 \leq w \leq 100$. Actual and desired effort levels have to be elements of the set $\{0.1, 0.2, \dots, 1\}$.

The agent’s payoff in the experiment is given by

$$(2) \quad u = \begin{cases} w - c(e) & \text{if the contract is accepted;} \\ 0 & \text{if no contract is concluded.} \end{cases}$$

Effort e causes disutility $c(e)$. In the experiments $c(e)$ was determined according to Table 1. Note that in the TT only $e^{\min} = 0.1$ is enforceable by the principal because higher effort levels are more costly and there is no opportunity to punish the agent for $e = e^{\min} < \hat{e}$.

TABLE 1. *Effort levels and costs of effort for the agent in TT and IT.*

| e, \hat{e} | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 1 |
|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|----|
| $c(\hat{e}), c(e)$ | 0 | 1 | 2 | 4 | 6 | 8 | 10 | 12 | 15 | 18 |

2.2 The Incentive-Treatment

The basic difference between the IT and the TT is that in the IT principals have the possibility to punish agents whose effort choice falls short of \hat{e} , *provided* the agent’s shirking can be verified. In particular, principals’ contract offers in the IT also specify – in addition to w and \hat{e} – a fine f that has to be paid to the principal in case that $e < \hat{e}$ can be verified.

Verification of shirking happens with probability $0 < s < 1$. With probability $1 - s$ shirking cannot be verified and, hence, the principal is committed to pay w . Therefore, a principal's (expected) payoff in the IT is

$$(3) \quad \mathbf{p} = \begin{cases} ve - w & \text{if the contract is accepted and } e \geq \hat{e}; \\ ve - w + sf & \text{if the contract is accepted and } e < \hat{e}; \\ 0 & \text{if no contract is concluded.} \end{cases}$$

An agent who does not shirk earns the contractually agreed-upon wage and has to bear the effort costs, i.e. her utility is $w - c(e)$. This is also the utility in case of unverifiable shirking. In case of verifiable shirking the wage is reduced by the fine f . Therefore, an agent's (expected) payoff is given by

$$(4) \quad u = \begin{cases} w - c(e) & \text{if the contract is accepted and } e \geq \hat{e} \\ w - c(e) - sf & \text{if the contract is accepted and } e < \hat{e}. \\ 0 & \text{if no contract is concluded.} \end{cases}$$

In the experiment the probability with which shirking could be verified was $s = 1/3$. The fine had to obey the restriction $0 \leq f \leq 13$.³ All other parameters and restrictions were the same as in the TT. In both treatments all players knew their own payoff function and the payoff function of the trading partners, i.e., v , $c(e)$ as given in Table 1, s and the feasible values of w and f were known by all players.

2.3 Procedures and common features

After their arrival all subjects were randomly allocated to their roles as principals and agents, respectively. All subjects kept their role during the whole experiment. A subject only participated in one treatment. The experiments were manually conducted. After subjects were assigned to their role, agents and principals had to go in two different, yet adjacent rooms where they sat remote from each other. Subjects first had to read their instructions (see Appendix) and then they had to answer a set of control questions to test their

³ In reality there are often limits to principals' sanctioning possibilities. Some of these limitations are due to legal regulations, norms, or collective bargaining agreements. It is also possible that these limits arise endogenously because the monitoring technology is not perfect or if there is a problem of "moral hazard" on the principals' side. In addition, agents may also face liquidity constraints that prohibit large fines.

understanding of payoff calculations. The experiments only started after all subjects gave correct answers to all questions.

In both treatments there were six subjects in the role of a “principal” and eight subjects in the role of an “agent”. At the beginning principals first had to decide privately on a contract offer by entering it into a decision sheet. In the IT, after principals had made their choice, they had to roll a six-sided die, which determined whether shirking, in case it occurred, could be verified. In particular, if the numbers 1 and 2 turned up, the agent’s effort choice could be verified, i.e., in case of shirking the principal could collect her specified fine f . If a number between 3 to 6 turned up, shirking was not verifiable. After all principals had made their choice (and in the IT rolled the die) all contract offers were made public by writing them on the blackboard in the principals’ room. Then the principals’ contract offers were transmitted to the agents’ room, where they were also written on the blackboard. The agents could then choose – in a random order – among the available contract offers. Each principal could only employ one agent and each agent could only accept one job. Hence, there was an excess supply of agents, which created strong competitive pressure among the agents. Both principals and agents knew the exact number of players on each side of the market. The reason for this was that we wanted to prevent that principals offer high wages simply because they fear the rejection of their offers.

Agents who accepted a contract had to determine their *actual* effort level. They had to insert their choice into a decision sheet. In the IT they had to make this decision before knowing whether their effort choice can be verified, or not. However, immediately after they have made their choice they were *privately* informed about verification, i.e., whether they had to pay the fine in case of shirking.⁴ After an agent had determined her effort choice, the experimenter informed the principal (and nobody else) with whom the agent was matched about the actual effort level. Thus effort levels were private information of the two parties involved in a trade. This rules out any group effects regarding the choice of effort levels. At the end of the third stage principals and agents had to calculate their payoffs. After payoffs were calculated a new market was opened. To allow for learning and to test the robustness of decisions, we had twelve periods (called “trading days”) in which the above-described market was operative. This was common knowledge among all players in the market.

In the experiment we avoided possible “value-laden” terms and spoke of a “buyer-seller”-relationship. Wages were called “prices”; effort was termed “quality”, and the fine

⁴ We also informed the non-shirkers whether they would have had to pay the fine if they had shirked. This was done to enhance the credibility of our random verification procedure. Technically, agents were informed about verification by checking the appropriate box on their decision sheets (see instructions in the Appendix). Thus, since *all* agents were informed about verification they could not identify the shirkers among them.

was described in a neutral way as a “potential price deduction”. See the instructions in the Appendix for further details on framing.

Before we put forward our behavioral predictions we want to stress that our experimental procedures ensured that nobody was ever informed about the identity of their trading partners. Thus, a player who concluded a contract only knew that this contract was concluded with somebody on the other side of the market. Players did not know the identification numbers of their trading partners nor did they know their current trading partner’s past behavior. It was thus completely impossible for a player to gain an individual reputation.⁵ Note also that principals could not make offers to specific agents. They only could make offers to the market, i.e., the whole group of agents, and then individual agents could accept one of the available offers in a random order. Thus, even if agents would have had the opportunity to gain an individual reputation for, e.g., being a good performer, it would have been impossible for them to gain from this reputation because it was impossible for the players to select their trading partners. All these experimental procedures were implemented to enhance the one-shot nature of a trading day.

3. BEHAVIORAL PREDICTIONS

3.1 *Behavior in the Trust Treatment (TT)*

Due to the one-shot nature of our game, a rational agent whose preferences are given by (2) will always choose the minimal effort e^{min} because higher effort levels are costly and yield no return for the agent. Consequently, the principal will offer the minimal wage that is necessary to induce the agent to accept the contract, i.e., the principal pays $w^{min} = 1$ and the agent accepts this.⁶ In the following we call this the standard hypothesis for the TT.

However, the situation changes substantially if sufficiently many agents have a propensity to respond reciprocally to contract offers. We call a person reciprocal if she responds to actions that are perceived as hostile, e.g., to an unfair contract offer, in a hostile manner while she responds to actions that are perceived as kind in a kind manner. In the context of our TT, reciprocity means that the agent is willing to reward a generous contract offer by choosing a high effort, although this is costly and yields no material benefits for the

⁵ In this regard it is also important that the offers were written on the blackboard in a *random order*. We implemented a random order to prevent possible identification of principals. Therefore, it was not possible that individual principals could gain a reputation for particular offers.

⁶ Wage offers had to be integers. Therefore, if agents have selfish preferences a wage offer of 1 can be an equilibrium outcome. Of course, wage offers of zero can also be an equilibrium outcome. In the following we always concentrate on the strict equilibrium in which agents are strictly better off when they accept the contract.

agent. In this case, principals should be able to positively influence an agent's effort choice by paying a "generous" wage $w > w^{min}$. In our experiment a contract (w, \hat{e}) is the more generous the higher the offered rent $r \equiv w - c(\hat{e})$ for the agent is, i.e., the more the agent gets paid in excess of the effort costs implied by the desired effort level \hat{e} . In contrast to a selfish agent, a reciprocal agent will also be willing to *increase* her effort level in response to increases in r . Provided sufficiently many agents respond reciprocally, it pays for the principal to trust the agents by offering them a contract with $r > r^{min} \equiv 1$. Hence, reciprocal responses induce efficiency-enhancing voluntary cooperation.⁷

A typical finding in previous experiments is that in addition to the purely self-interested agents there is a large fraction of agents who – instead of setting $e = e^{min}$ as predicted by standard theory – choose effort levels that depend positively on the rents offered by the principal. Despite the presence of a non-negligible fraction of purely self-interested agents all experiments with the gift exchange game find a statistically highly significant positive wage-effort relationship (see, e.g., Fehr, Kirchsteiger and Riedl 1993, Fehr, Gächter and Kirchsteiger 1997). Reciprocity-driven voluntary cooperation has also been observed under rather high stake levels (Fehr and Tougareva 1996).⁸

These results suggest that there is a critical mass of reciprocal agents that may, on average, render trust profitable: Under conditions where only trust contracts are feasible, principals can elicit considerable efficiency-enhancing "voluntary cooperation" in the form of above-minimum effort choices, provided they offer generous contracts. It is, therefore, an important question how voluntary cooperation is affected by explicit material incentives.

3.2 Behavior in the Incentive Treatment (IT)

In the following we first present the predictions for the case of rational and selfish individuals. A risk-neutral agent who is rational and selfish will perform at the desired effort level (i.e., $e = \hat{e}$) if the No-Shirking Condition (NSC)

⁷ This claim can be derived rigorously from recently developed models of equity and reciprocity (see e.g. Dufwenberg and Kirchsteiger (1999), Falk and Fischbacher (1999), Bolton und Ockenfels (2000), and Fehr and Schmidt (1999)). In the model of Fehr and Schmidt (1999), e.g., the principal can elicit reciprocal responses from inequity averse agents by offering them sufficiently high wages such that at $e = e^{min}$ the agent earns more than the principal. Inequity averse agents will then respond by increasing effort above e^{min} because this reduces the inequality between the principal and the agents.

⁸ In Fehr and Tougareva (1996) subjects earned, on average, the monetary income of ten weeks in a gift exchange experiment similar to the one presented in this paper. Further papers that report reciprocity in (versions of) the gift exchange experiment include Charness (1996); Hannan, Kagel and Moser (1999); Van der Heijden, Nelissen, Potters and Verbon (1998); and Falk, Gächter and Kovács (1999). Although these experiments were conducted in many different countries and with different subject pools the results were qualitatively very similar.

$$(5) \quad sf \geq c(\hat{e})$$

is satisfied.⁹ The agent will perform at the desired level if the expected fine sf in case of shirking is larger than the costs of contractual compliance, which are given by $c(\hat{e}) - c(e^{min}) = c(\hat{e})$ because $c(e^{min}) = 0$ (see Table 1). It is easy to check that with our parameterization of $s = 1/3$ and $f \leq 13$ effort costs of 4.33 can be enforced. Hence, according to the effort cost function in Table 1, the largest effort level that can be enforced by an incentive-compatible contract, which we denote by \hat{e}^* , is given by $\hat{e}^* = 0.4$. More generally, the best reply effort choice e^* of a risk-neutral agent who is rational and selfish is given by:

$$(6) \quad e^* = \begin{cases} e^{min} & \text{for all } f, \hat{e} \text{ that obey } (1/3)*f < c(\hat{e}) \\ \hat{e} & \text{for all } f, \hat{e} \text{ that obey } (1/3)*f \geq c(\hat{e}). \end{cases}$$

A necessary condition for the acceptance of a contract in the IT is that the “participation constraint”

$$(7) \quad w \geq c(e^*)$$

holds. According to (7) the agent has to be compensated in any case for the disutility of effort that arises if the agent actually chooses $e = \hat{e}$.

Since the marginal revenue of effort is 10 while the marginal cost of effort is always strictly below 10, a profit-maximizing principal who keeps the agent at her reservation utility, will always prefer the highest enforceable effort level $\hat{e}^* = 0.4$. Thus in equilibrium

$$(8) \quad \begin{aligned} \hat{e} &= e = \hat{e}^* = 0.4 \\ w &= c(\hat{e}^*) + 1 = 5 \\ f &= f^{max} = 13 \end{aligned}$$

holds.¹⁰ In the following we refer to (6) and (8) as the standard hypothesis in the IT. If the behavior of the agents in the IT obeys (6), $e - e^*$ will be zero, i.e., there will be no voluntary cooperation. Moreover, agents’ behavior will then not respond to variations in the rent

⁹ Condition (5) assumes risk neutrality. This is justified in view of the calibration results in Rabin (2000). Rabin has shown that risk aversion is highly implausible for the typical stake level prevailing in laboratory experiments. Even small degrees of risk aversion over the typical experimental stakes imply an absurd degree of risk aversion over larger stakes. Thus, if one assumes the validity of expected utility theory, one is essentially forced to assume risk neutrality over the typical experimental stake levels.

¹⁰ There is another, non-strict subgame perfect equilibrium, in which $w = 4, f = 13, \hat{e} = \hat{e}^* = 0.4$ holds and where the agent accepts the contract and chooses $e^* = 0.4$. For empirical purposes the slight difference between these two equilibria is negligible.

offered so that it is not possible to induce positive voluntary cooperation ($e - e^* > 0$) by offering a generous rent. In addition, self-interested agents also will not reduce their effort below e^* in response to low rents. Therefore, if agents in the IT behave in a completely self-interested way, firms have no reason to pay a rent. As a consequence, we also should not observe any correlation between \hat{e} and offered rents.

The situation is again substantially different if in the presence of explicit incentives reciprocal behavior appears as strongly as in the TT. If agents behave reciprocally in the IT there will be two effects. First, for sufficiently high wages it is possible to elicit effort levels above e^* , i.e., agents are willing to cooperate voluntarily with the principal when they face fair offers. Second, for sufficiently low (unfair) wages the agents will shirk even if this decreases their expected income. This kind of shirking is a retaliatory response to unfair wages.¹¹

The question is, however, to what extent reciprocal fairness is affected by the opportunity to use incentive contracts in the IT. While there is much evidence on the regularities of reciprocal behavior in the absence of explicit incentives little is known when explicit incentives are possible. Do explicit incentives foster the propensity to behave reciprocally or do they reduce it? Are explicit incentives complements or substitutes to the payment of fair wages? Do they affect positive and negative reciprocity in different ways or in the same way? Which features of an incentive contract interact with the propensity to reciprocate? Are there fairness compatible incentives that keep reciprocity-driven voluntary cooperation intact and fairness incompatible incentives that reduce reciprocity-driven voluntary cooperation? So far these are open questions.

In the context of our experiment it seems possible that the incentives in the IT weaken the agents' reciprocal behavior in response to generous contract offers. In this regard it is particularly interesting to compare agents' behavior in the TT with their behavior in the IT *when they face non-incentive-compatible contracts*. Note that in these two situations self-interested agents will always choose e^{min} . In contrast, reciprocal agents will choose $e > e^{min}$ for sufficiently high r . The question, however, is whether the propensity to cooperate voluntarily remains unaffected by the IT.

One psychological reason for the removal of voluntary cooperation in the IT may be that reciprocity requires trust to be effective. The threat of a punishment in our incentive

¹¹ Note that in the IT agents can retaliate by choosing effort levels *below* the best reply level e^* in case that $e^* > e^{min}$. For the contracts predicted by the standard hypothesis retaliation is in fact very cheap because the NSC is "binding", i.e., the agent is nearly indifferent between working and complete shirking. Note that the low expected costs of shirking are not simply an artifact of our experimental design but an inherent feature of the incentive compatibility condition. Any binding incentive compatibility condition has the consequence that shirking is cheap. Yet, by raising the rent level principals can induce reciprocal agents to decrease the under-performance ($e - e^* < 0$).

contracts may be perceived as being incompatible with such trust. On the contrary, a contractually determined fine is likely to express suspicion, which may “crowd out” reciprocity. In addition, while the “psychological message” of a generous contract in the TT is consistent, one may argue that this is not the case in the IT. The principal in the TT who offers a generous rent and desires a high effort basically conveys the following message: “I have offered you a generous contract. Please respond with a generous effort level”. This is an appeal to cooperate *voluntarily*. In contrast, the psychological message of a generous contract attempting to elicit $e > e^*$ in the IT is: “I have offered you a generous contract. Please respond with a generous effort level. However, if you do not reward my generosity, I will punish you”. It seems to us that agents may well perceive this message as “psychologically contradictory” because the appeal to the “good will” of the agent is destroyed by the punishment threat. In metaphorical terms, the “stick” may destroy the effectiveness of the “carrot”. In view of these arguments we put forward the following hypothesis regarding the crowding out of voluntary cooperation:

COMPLETE CROWDING-OUT HYPOTHESIS: Agents in the IT will not provide any excess effort irrespective of the rent offered while in the TT positive excess effort can be elicited by sufficiently high rent offers.

PARTIAL CROWDING-OUT HYPOTHESIS: In the IT agents provide, ceteris paribus, less excess effort than in the TT and the response of the excess effort to the offered rent is smaller in the IT than in the TT.

Our crowding-out hypotheses are expressed in terms of excess effort. Since the revenue function of the principals is linear in effort the excess effort is proportional to the excess revenue $v(e - e^*)$ that is created by voluntary cooperation. Thus, excess effort is a good measure of voluntary cooperation from the principals’ viewpoint. One may, however, argue that excess effort is not a good measure of voluntary cooperation from the agents’ viewpoint because the effort cost function is (slightly) convex. This means that at a higher level of e^* it is more expensive to provide one unit of excess effort than at a lower level of e^* . From the agents’ point of view the cost difference $c(e) - c(e^*)$ is, therefore, a better measure of voluntary cooperation. For this reason we have also tested the above crowding-out hypotheses with the cost-measure of voluntary cooperation.¹²

¹² Note how crucial the control of the effort cost is for the measuring of crowding out. Only the control of the effort cost enables us to identify e^* and, hence, voluntary cooperation ($e - e^*$). By comparing ($e - e^*$) across different incentive conditions we can measure crowding out. To our knowledge there is no psychology experiment that controls for the effort cost.

4. RESULTS

The experiments were conducted at the University of Zurich in November and December 1997. In total 126 undergraduates from universities in Zurich participated in our experiments. All participants were recruited from a large database to minimize the likelihood that they know each other.¹³ We conducted nine sessions with 8 principals and 6 agents each. In the IT we ran four and in the TT five sessions. To allow for learning and to be able to test for the stability of our results, we made it common knowledge that there will be twelve “trading days” as described above.

In the TT principals offered in total 357 contracts, of which all but one were accepted. In the IT the total number of offered contracts was 287 and 7 of them (2.4 percent) were rejected. In principle, losses were possible in these experiments. Therefore, we endowed all subjects with an additional amount of 9 Swiss Francs. All losses had to be covered by this endowment and the earnings made during the experiments. Subjects were paid in cash immediately after the experiments. An experiment lasted between 2 and 2.5 hours. Subjects earned on average 50 Swiss Francs (about \$36 at the time) including a show-up fee of 15 Swiss Francs.

Before we provide a detailed statistical analysis of our hypotheses we present the evidence at a more descriptive level. Our first result provides insights into the average contract offered by the principals in the TT and the IT.

Result 1: *In the TT principals offer, on average, higher wages and higher rents and demand higher effort levels than in the IT. The average fine in the IT is close to the maximum fine. Despite this, a big majority of contract offers in the IT violates the No-Shirking Condition.*

Support for R1 is provided in Table 2 and Figure 1a. Table 2 summarizes the average behavior over all periods in the IT and the TT and compares them with the standard hypothesis for both treatments. It shows that the average wage and the average rent offered in the TT are considerably higher than in the IT. The same regularity is exhibited by median wages and median rents. The median wage (rent) is more than two times larger in the TT than in the IT. Table 2 also provides information on the average and median fines. Note that the median fine is exactly the maximal fine of $f = 13$ and the mean fine is close to the

¹³ A post-experimental questionnaire confirmed that indeed most subjects had never met another participant before.

maximal fine. In fact, principals in the IT imposed the maximum fine in 69 percent of all cases and only in 4 contracts they chose $f = 0$.

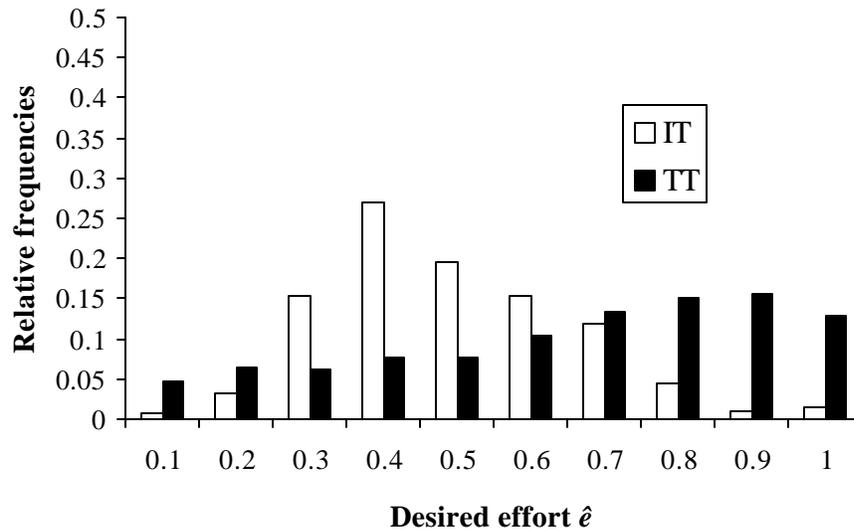
TABLE 2. *Contracts and actual effort levels in TT and IT – averages over all periods.*

| | Trust-Treatment (TT) | | | | Incentive-Treatment (IT) | | | | |
|--------------|---------------------------|-----------|------|------|--|------|-----------|------|------|
| | N = 356 | | | | N = 280 | | | | |
| Predictions: | $(w^*=1, e^*=0.1); r^*=1$ | | | | $(w^*=5, f^*=13, \hat{e}^*=0.4, e^*=0.4); r^*=1$ | | | | |
| Actual: | w | \hat{e} | e | r | w | f | \hat{e} | e | r |
| Mean | 30.2 | 0.65 | 0.37 | 20.6 | 19.7 | 11.7 | 0.49 | 0.27 | 13.8 |
| Median | 34.0 | 0.70 | 0.30 | 22 | 15.0 | 13.0 | 0.50 | 0.30 | 10 |
| Std.dev. | 17.6 | 0.27 | 0.26 | 13.3 | 12.6 | 2.6 | 0.17 | 0.17 | 10.9 |

With regard to the effort demanded Table 2 indicates that \hat{e} is considerably larger in the TT. On average, $\hat{e} = 0.65$ in the TT while principals desire only $\hat{e} = 0.49$ in the IT. Figure 1a shows the distribution of \hat{e} in both treatments. The figure indicates that the whole distribution in the TT is shifted to the right compared to the distribution of \hat{e} in the IT. The difference in the desired effort level is also confirmed statistically. If we perform a Tobit-regression of \hat{e} on a constant and an IT-dummy, the coefficient for the IT-dummy is significantly negative ($p < .017$).¹⁴ From Figure 1a we can also infer that the majority of contract offers in the IT is not incentive compatible. The figure illustrates that more than 50 percent of all contracts in the IT demand effort levels above the maximal enforceable level of $\hat{e} = 0.4$. In fact, 54 percent of all contracts in the IT demand effort levels above 0.4. A further remarkable fact in Figure 1a is that the mode of \hat{e} is exactly 0.4, the value predicted by the standard hypothesis.

¹⁴ The IT-dummy takes on the value of 1 if the observation is from the IT. We use Tobit instead of OLS because \hat{e} is censored on both sides. In addition, the significance claim is based on robust standard errors.

Figure 1a: Distribution of desired effort



The frequent use of maximal fines together with the considerably lower wages in the IT convey the impression that principals in the IT relied to a large extent on the “stick” and much less on the “carrot” compared to the TT. It is, therefore interesting to see the consequences of this strategy for actual effort levels.

Result 2: *On average, actual effort levels are lower in the IT compared to the TT. This is due to three reasons: (i) A non-negligible fraction of agents shirked in the IT even if the No-Shirking Condition was met. (ii) Voluntary cooperation ($e - e^* > 0$) vanishes almost completely for incentive-compatible contracts. (iii) If the NSC was violated in the IT agents chose the minimum effort in the big majority of cases while in the TT effort levels above the minimum were provided in the majority of cases.*

A first indication for R2 is given in Table 2, which shows that the mean of the actual effort level is lower in the IT. Further support for R2 is provided by Figure 1b, which presents the distributions of *actual* effort levels. It shows that the distribution of effort has considerably more mass at lower levels in the IT. In particular, in the IT only 7.5 percent of the effort levels are above 0.5, whereas in the TT effort levels above 0.5 account for about 27 percent of all effort choices. This causes a significant difference in the average effort across treatments. If we perform a Tobit-regression (with robust standard errors) of e on a constant and an IT-dummy, the coefficient for the IT-dummy is significantly negative ($p < .07$).

The distribution of effort choices in the IT shows two peaks – one at the effort level 0.1 and the other at 0.4. This is interesting since these two levels are the best replies according to the standard hypothesis described in (6). Note also that best reply effort levels can only lie between 0.1 and 0.4 in the IT. It is remarkable that 85 percent of the effort choices actually are in this range (and, hence, can possibly be best replies). In the TT the only best reply effort level is $e^* = 0.1$. Less than a third of the effort choices in the TT comply with this prediction.

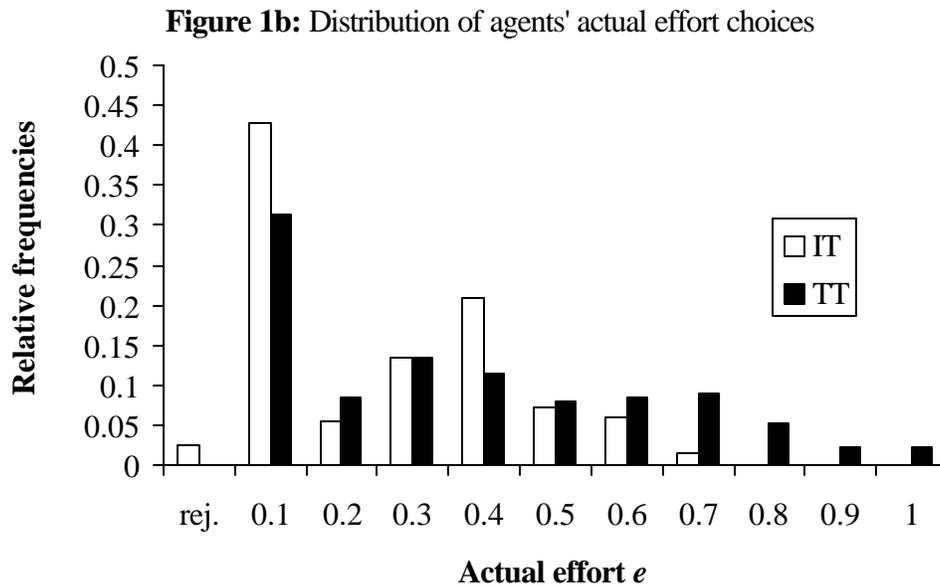


Table 3 throws light on the reasons for the higher effort levels in the TT. The table separates actual choices along two dimensions: (i) Does actual effort deviate from the best reply effort e^* , i.e., to what extent is there excess effort or under-performance? (ii) Does the contract meet the NSC?

The first interesting result in Table 3 concerns effort behavior in cases where the NSC is met. The final column of the table informs us that the NSC was met in 41.3 percent (115 out of 280) of all contracts in the IT. The table also indicates that in 16.5 percent of these cases (19 out of 115) agents shirked. In the big majority of these cases agents shirked fully, i.e., $e = e^{min}$. Moreover, only in two cases did an agent provide excess effort when the NSC was met. This means that voluntary cooperation is almost completely removed, i.e., *for incentive-compatible contracts the complete crowding out hypothesis is supported*. These regularities also mean that, on average, agents in the IT provide less than the best reply effort when they face incentive-compatible contracts.

TABLE 3. *Agents' deviation from the best reply effort level e^* in the IT and the TT*

| Treatments: | | | $e < e^*$ | $e = e^*$ | $e > e^*$ | Sum |
|-------------|---------------------------------------|-----|-----------|-----------|-----------|-----|
| | | | N | N | N | N |
| IT | <i>No Shirking Condition (6) met?</i> | no | - | 102 | 63 | 165 |
| | | yes | 19 | 94 | 2 | 115 |
| | Sum | 19 | 196 | 65 | 280 | |
| TT | | | | 112 | 244 | 356 |

Note: Entries are number of cases in the respective category. e^* denotes the best reply effort choice according to (6).

How did the agents respond to non-incentive-compatible contracts? In 62 percent of those cases in which the NSC was violated in the IT (102 out of 165), effort choices conform to the best reply level $e^* = 0.1$, i.e., agents shirk fully. If we compare this with the effort behavior in the TT we observe a big contrast because in 69 percent of all contracts in the TT (244 out of 356) agents provide effort above the minimum. The fact that in 62 percent of the non-incentive-compatible IT-contracts agents deliver the minimal effort, while in 69 percent of the TT-contracts they provide effort above the minimal level, is quite remarkable because from the viewpoint of standard economic theory agents should behave in the same way in these two situations. This can be taken as a first indication that voluntary cooperation is also crowded out in case of non-incentive-compatible contracts.

More generally, it is remarkable that agents in the IT chose a best reply in 196 out of 280 cases (i.e., in 70 percent). In the TT only 31.5 percent of the effort choices were best replies. This difference is significant according to a conservative Mann-Whitney test using the percentage of best replies in each session as an observation. ($p < 0.014$). This difference in best reply behavior holds despite the fact that in the IT it is cognitively more complex to determine e^* than in the TT.

In view of R2 it is interesting to know to what extent the crowding out of voluntary cooperation reduces the total surplus S , defined as the total material payoffs from a contract, in the IT relative to the TT. Before we present this result it is worthwhile to emphasize that the standard hypotheses for the TT and the IT imply that S is more than two times higher in the IT. However, in stark contrast to this hypothesis we can report the following result:

Result 3: *The total surplus S is on average higher in the TT than in the IT. This holds irrespective of whether we compare the TT-contracts with incentive-compatible or with non-incentive-compatible IT-contracts. The profit for the principals is highest for*

incentive-compatible contracts, second highest for TT-contracts and lowest for non-incentive-compatible IT-contracts.

R3 basically means that the incentive opportunities in the IT allow principals to increase their profits relative to the TT but that this is associated with an efficiency loss. Support for R3 is presented in Table 4, which compares the actual and the predicted surplus and shows principals' and agents' average profits from a contract. Note, first that in the TT the realized surplus equals 33 while it is only 21.5 for non-incentive-compatible contracts and 27.5 for incentive-compatible contracts. Thus, relative to the surplus predicted by the standard hypothesis for the TT we observe a more efficient outcome in the TT that is due to agents' voluntary cooperation. Although to a lesser extent this is also true for those IT-contracts that are not incentive compatible. However, actual efficiency is lower than the predicted efficiency for incentive-compatible contracts. Taken together, this means that the total surplus is considerably higher in the TT compared to the IT.

TABLE 4: *Average profits and average total gains per contract.*

| | Trust-Treatment | Incentive-Treatment | |
|--|-------------------------------|-------------------------------|-----------------------------------|
| | | NSC violated | NSC holds |
| Predicted surplus S^* (<i>according to the standard hypotheses</i>) | $v e^{min} - c(e^{min}) = 10$ | $v e^{min} - c(e^{min}) = 10$ | $v \hat{e}^* - c(\hat{e}^*) = 36$ |
| Realized Surplus S | 33.0 | 21.5 | 27.5 |
| Profit Principal | 7.1 | 1.9 | 18.2 |
| Profit Agent | 25.9 | 19.6 | 9.2 |

Table 4 also shows how the use of incentive-compatible contracts in the IT allows the principals to create a big change in the distribution of the gains from trade. In the TT principals reap only 21.5 percent (7.1/33) of the total surplus while in the IT they receive 66 percent (18.2/27.5) of the lower total surplus when they propose incentive-compatible contracts. The table also indicates that incentive-compatible contracts are much more profitable for the principals than non-incentive-compatible IT-contracts. In view of these large profit differences, it is surprising that 59 percent of all contracts in the IT are *not* incentive compatible. This figure hides, however, a strongly increasing time trend in the share of incentive-compatible contracts. While in period 1 only 17 percent of all IT-contracts

were incentive compatible, the share of incentive-compatible contracts rises to 63 percent in the final two periods.

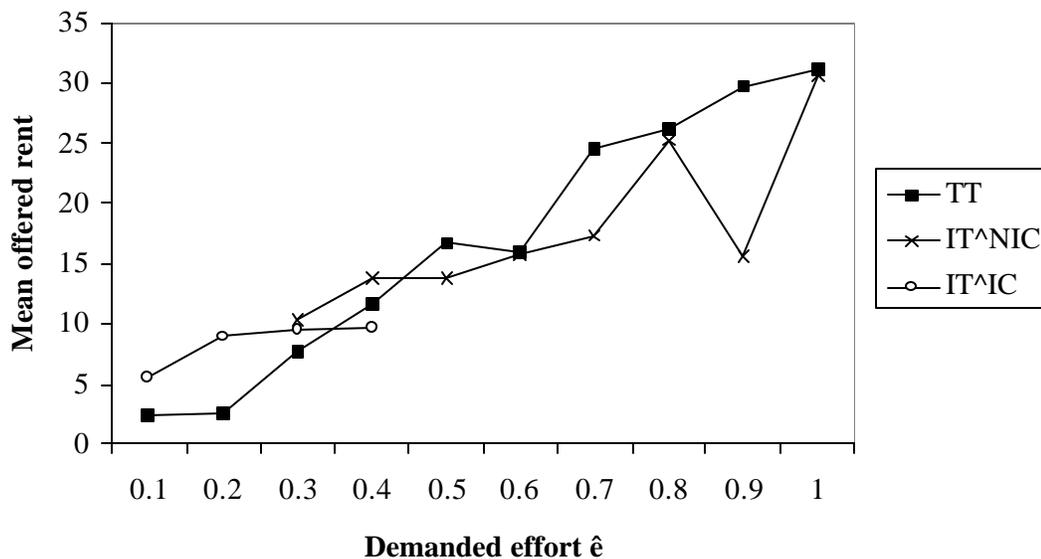
In our view R2 and R3 are quite remarkable because they indicate that in the absence of incentives the outcome may well be more efficient than predicted by the standard approach while the use of incentives may trigger factors that decrease efficiency relative to the standard prediction. Taken together this may render the complete absence of incentives, like in our TT, more efficient. It is, therefore, quite important to better understand the behavioral forces behind R2 and R3. From R1 we already know that principals in the IT are considerably less generous than principals in the TT. This suggests the possibility that the driving force behind R2 and R3 is given by principals' reluctance to make generous offers in the IT. Perhaps, the possibility of fining agents in the IT has seduced principals to use only the "stick" and to forget about eliciting effort by the "carrot" of generous offers. The principals' generosity can be measured by examining how much rent they offered at any given desired effort level. The higher the rent offered at a given desired effort, the higher is the offered share of the surplus for the agent. If principals in the IT offered lower rents for given levels of the desired effort we would have an indication that they were less generous. Moreover, if agents responded to this decrease in principals' generosity with a lower effort level we would have an explanation for the lower efficiency in the IT.

A different possibility is, however, that the driving force for the lower efficiency in the IT is not the lack of principals' generosity but the lack of agents' willingness to respond reciprocally to generous offers in the IT. Perhaps it was not possible for the principals to increase voluntary cooperation in the IT by offering more generous rents because the threat of fining agents for malfeasance reduced the agents' propensity to cooperate voluntarily. In this case the payment of low rents in the IT would be better interpreted as the principals' response to the agents' unwillingness to provide sufficient effort increases in response to rent increases. To examine these two possibilities in more detail we look first at the principals' generosity.

Result 4: *On average, principals in the IT did not offer lower rents at given desired effort levels. Both in the IT and in the TT principals increased the offered rent if they demanded higher effort levels, i.e., in both treatments they offered to share the gains that result from higher effort levels.*

The fact that principals in both treatments offered higher rents when they demanded higher effort levels can be interpreted as an appeal to the agents' reciprocity. Support for R4 is given in Figure 2 and in Table 5. Figure 2 depicts the relation between the offered rent and the demanded effort. It shows that for incentive-compatible contracts in the IT the principals offered even higher rents than for comparable contracts in the TT. For example, for a desired effort of 0.2 principals in the TT offered roughly a rent of 2.5 while the incentive-compatible contracts in the IT offered, on average, a rent of 9. Thus, principals are definitely not less generous in the IT when they offered incentive-compatible contracts. If we compare TT-contracts with the non-incentive-compatible contracts in the IT the picture is not very different. The r - \hat{e} -relation for the TT and for the non-incentive-compatible contracts in the IT is rather similar. The only major exception concerns the rent for $\hat{e} = 0.9$. However, the relatively low rent in the IT at $\hat{e} = 0.9$ cannot be taken too seriously because it is based on only three observations.

Figure 2: Principals' offered rents as a function of demanded effort



Further support for R4 is given in Table 5 where we report the results of the following regression:

$$(9) \quad r_{it} = \alpha_0 + \alpha_1 IT^{NIC} + \alpha_2 IT^{IC} + \alpha_3 \hat{e}_{it} TT + \alpha_4 \hat{e}_{it} IT^{NIC} + \alpha_5 \hat{e}_{it} IT^{IC} + \mathbf{e}_{it}$$

$$t = 1, \dots, 12; i = 1, \dots, 72.$$

The variables IT^{NIC} (IT^{IC}) are dummies that indicate contracts from the IT that are not incentive compatible (incentive compatible) while TT is a dummy for contracts in the TT. The coefficients α_1 and α_2 measure thus the intercept for non-incentive-compatible and for incentive-compatible contracts *relative to the TT* while α_0 is the intercept for the TT. The other coefficients measure the slope of the r - \hat{e} -relation for the TT and the two types of contracts in the IT. Since the rent cannot be below zero we have used a censored regression. In addition, we report robust standard errors and the associated z-values.

TABLE 5. *Principals' offered rents as a function of demanded effort \hat{e} .*

| Dependent variable: <i>rent</i> | | |
|---|------------------------------------|---------|
| Independent variable | coefficient (robust std. error) | z-value |
| Constant (α_0) | -3.3944*** (1.0455) | -3.25 |
| IT^{NIC} (α_1) | 7.1539 (4.6115) | 1.55 |
| IT^{IC} (α_2) | 11.2946*** (3.2738) | 3.45 |
| $\hat{e}_{it} TT$ (α_3) | 36.3507*** (1.6434) | 22.12 |
| $\hat{e}_{it} IT^{NIC}$ (α_4) | 21.4159*** (7.7330) | 2.77 |
| $\hat{e}_{it} IT^{IC}$ (α_5) | 4.7978 (8.4400) | 0.57 |
| N = 636 LL = -2317.6 Wald $\chi^2(5)$ = 601.18 p = 0.000 | | |

Note: The estimation procedure is censored regression with robust standard errors. $\hat{e}_{it} IT^{NIC}$ ($\hat{e}_{it} IT^{IC}$) is an interaction variable of the treatment dummy IT^{NIC} (IT^{IC}) with the desired effort \hat{e} . $\hat{e}_{it} TT$ denotes the interaction between the TT and the desired effort. Numbers in parentheses are robust standard errors. ***, **, * denote significance at the 1-, 5- and 10-percent level, respectively.

For our purposes the following results in Table 5 deserve mentioning: First, α_2 is significantly positive and rather high which indicates that incentive-compatible contracts in the IT offered considerably higher rents at low desired effort levels than comparable contracts in the TT.

Second, both TT-contracts and non-incentive-compatible IT-contracts offer steep rent increases for higher demanded effort levels, which is indicated by the fact that α_3 and α_4 are significantly positive and relatively high. Moreover, although α_3 is bigger than α_4 , it is not significantly different from α_4 . This is due to the relatively high standard error for α_4 . Moreover, the intercept for non-incentive-compatible IT-contracts, α_1 , is also not significantly different from the intercept α_0 in the TT. This confirms that non-incentive-compatible contracts in the IT were, in general, also not less generous than contracts in the TT. As a consequence, the lower overall effort levels in the IT cannot be attributed to less generosity by the principals. In the next step we examine, therefore, agents' effort behavior in more detail.

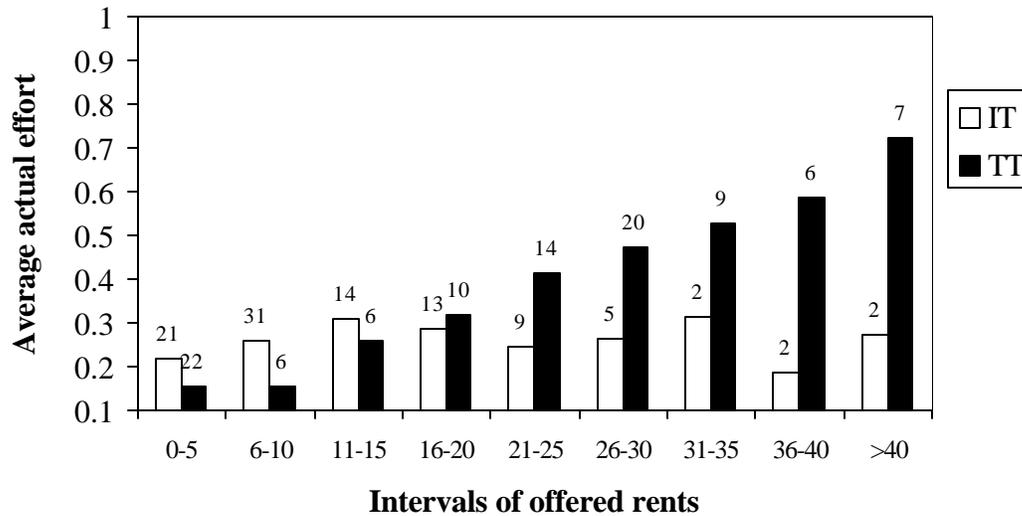
Result 5: *Agents' average effort in the TT exhibits a strong positive correlation with the offered rent level. In the IT there is no such relationship.*

Figure 3 provides support for R5. It illustrates the relation between the actual average effort and the offered rent in both treatments. In addition, the numbers above the bars in the figure provide information about the distribution of offered rents. They indicate, e.g., that in 31 percent of all contracts in the IT principals offered a rent in the interval 6-10. Figure 3 unambiguously shows that the average effort in the TT is strongly increasing in the offered rent. This is also supported by formal statistical measures. For example, the non-parametric Spearman rank correlation $\mathbf{r}(e,r)$ between average effort and rents in the TT is $\mathbf{r}(e,r) = 0.983$ ($p < 0.0001$). This positive correlation between effort and rents is not just an artifact of aggregation. It also prevails at the individual level. To show this we have computed the Spearman rank correlation between effort and offered rents for each individual agent in the TT. It turns out that 60 percent of the agents exhibit a significantly positive correlation at the 5 percent level. The other 40 percent have an insignificant correlation. In the IT, however, the average effort seems to be largely independent of the rent. This is also indicated by the Spearman rank correlation between effort and rents in the IT ($\mathbf{r}(e,r) = 0.117$, $p = 0.765$). Holding principals' generosity as measured by their rent payment constant, agents in the IT – except for rents below 15 – provide less effort than agents in the TT. For example, for rents above 40, agents in the TT were willing to supply a mean effort level of 0.72. For the same rent payment agents in the IT only provided a mean effort level of 0.28.

The strong positive correlation between effort and rents in the TT means that principals had a strong incentive to offer high rents in this treatment. In contrast, the absence of such a positive correlation in the IT means that higher rent offers yielded no economic benefits for the principals. It is, therefore, not surprising that principals made much less generous offers

in the IT: While 66 percent of the offered rents in the IT are *below or equal* to 15, 66 percent of all contract choices in the TT imply rents *above* 15.

Figure 3: Average actual effort as a function of offered rents
(Numbers above bars are percentage of cases)



Profit-maximizing principals are interested in the total effort they can elicit at the different rent levels. Figure 3 is informative about the material incentives for the principals to pay generous rents. However, the figure does not yield precise insights into the validity of our crowding-out hypotheses. The next result is, therefore, related to these hypotheses.

Result 6: *The **complete** crowding out hypothesis is confirmed for incentive-compatible contracts. There is virtually no voluntary cooperation in this case. The **partial** crowding out hypothesis is confirmed because agents in the IT provide, in general, considerably less excess effort and the excess effort does not respond positively to the offered rent.*

Support for R6 comes from Figure 4 and Table 6. Figure 4 illustrates how excess effort responds to the offered rent in the TT and the IT. For the IT we distinguish between incentive-compatible contracts (IT^{IC}) and non-incentive-compatible contracts (IT^{NIC}). Moreover, to examine the robustness of behavior over time we also divide the data into three time intervals. Note that in the TT $e^* = 0.1$, whereas in the IT e^* is determined according to (6) and can at most be 0.4. Hence, in the IT $(e - e^*) \in [-0.3, 0.9]$ and in the TT $(e - e^*) \in [0, 0.9]$. Figure 4 neatly confirms the weak crowding-out hypothesis because it shows that excess effort is for almost all rent intervals bigger in the TT and responds more

strongly to the rent level than in the IT. For example, while the excess effort is strongly positively related to the offered rent in the TT it does not respond in an obvious way for non-incentive-compatible IT-contracts. For incentive-compatible contracts the average excess effort is virtually never positive and in several cases even negative. These regularities are robust over time, i.e., they hold true for all three time intervals.

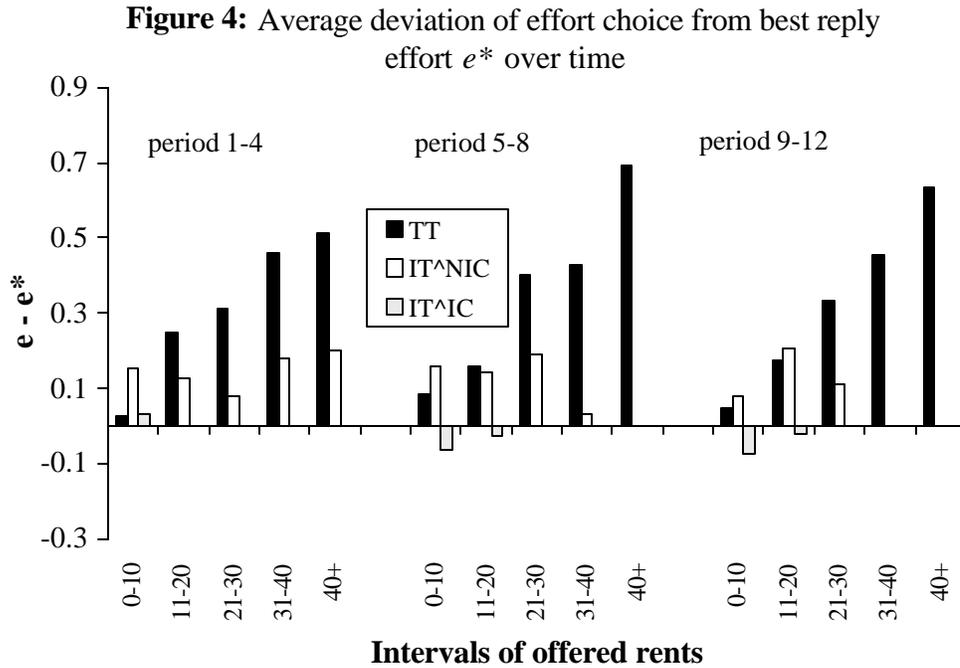


Table 6 provides econometric evidence for R6. We report the results of the following regression separately for all three time intervals and for the whole experiment:

$$(10) \quad (e - e^*)_{it} = \beta_0 + \beta_1 IT^{NIC} + \beta_2 IT^{IC} + \beta_3 r_{it} TT + \beta_4 r_{it} IT^{NIC} + \beta_5 r_{it} IT^{IC} + \mathbf{e}_{it}$$

$$t = 1, \dots, 12; i = 1, \dots, 72.$$

As in regression (9) we have also taken into account the censoring of the dependent variable in the estimation of equation (10). In addition we report again the robust standard errors. In (10) \mathbf{b}_0 measures the excess effort in the TT if principals offer no rent. \mathbf{b}_1 measures the excess effort at zero rents for non-incentive-compatible IT-contracts relative to \mathbf{b}_0 , and \mathbf{b}_2 measures the same for incentive-compatible IT-contracts. \mathbf{b}_3 is the coefficient for the response of excess effort to rents in the TT while \mathbf{b}_4 and \mathbf{b}_5 measure the excess effort response in the IT for non-incentive-compatible and for incentive-compatible contracts, respectively. The partial crowding out hypothesis predicts that excess effort is more responsive to rents in the TT compared to the IT, i.e., \mathbf{b}_3 is larger than \mathbf{b}_4 and \mathbf{b}_5 .

TABLE 6. *Response of voluntary cooperation ($e - e^* > 0$) and under-performance ($e - e^* < 0$) to offered rents e^* .*

| | Dependent variable: $e - e^*$ | | | | | | | |
|--------------------------------|---|-------------|--|-------------|--|-------------|---|-------------|
| | all periods | | periods 1-4 | | periods 5-8 | | periods 9-12 | |
| | coef. (rob. s.e.) | z- value | coef. (rob. s.e.) | z- value | coef. (rob. s.e.) | z- value | coef. (rob. s.e.) | z- value |
| const. (β_0) | 0.0065 (0.0129) | 0.50 | -0.0176 (0.0267) | -0.66 | 0.0196 (0.0201) | 0.98 | 0.0086 (0.0208) | 0.41 |
| IT^{NIC} (β_1) | 0.1206*** (0.0292) | 4.13 | 0.1486*** (0.0480) | 3.09 | 0.1471** (0.0619) | 2.38 | 0.0733 (0.0515) | 1.42 |
| IT^C (β_2) | -0.1068*** (0.0295) | -3.62 | 0.0433 (0.0367) | 1.18 | -0.1500** (0.0617) | -2.43 | -0.1302*** (0.0477) | -2.73 |
| $r_{it}TT$ (β_3) | 0.0130*** (0.0007) | 17.86 | 0.0132*** (0.0014) | 9.28 | 0.0136*** (0.0011) | 11.79 | 0.0127*** (0.0013) | 10.00 |
| $r_{it}IT^{NIC}$ (β_4) | 0.0009 (0.0013) | 0.69 | 0.0007 (0.0017) | 0.42 | -0.0009 (0.0030) | -0.30 | 0.0036 (0.0036) | 1.00 |
| $r_{it}IT^C$ (β_5) | 0.0047*** (0.0021) | 2.80 | -0.0009 (0.0009) | -0.99 | 0.0065 (0.0040) | 1.63 | 0.0060* (0.0036) | 1.66 |
| | N = 636 LL = 119.09 Wald $\div^2(5)=545.7$ p = 0.000 | | N = 214 LL = 44.61 Wald $\div^2(5)=266.9$ p = 0.000 | | N = 209 LL = 39.24 Wald $\div^2(5)=216.9$ p = 0.000 | | N = 213 LL = 39.55 Wald $\div^2(5)=178.43$ p = 0.000 | |

Note: The estimation procedure is censored regression with robust standard errors. IT^{NIC} (IT^C) denotes a dummy for the IT-treatment with non-incentive-compatible (incentive-compatible) contracts. $r_{it}TT$ is an interaction variable of a dummy for the treatment TT with the variable r_{it} , which is measured as $w - \alpha(\hat{e})$. $r_{it}IT^{NIC}$ ($r_{it}IT^C$) is an interaction variable of r_{it} with IT^{NIC} (IT^C). Rejected contract offers are excluded. Robust standard errors are in parentheses. ***, **, * denote significance at the 1-, 5- and 10-percent level, respectively.

Table 6 shows that this holds true in each time interval and, hence, also for the regression with the data from all periods. While β_3 is always positive and highly significant, β_4 is never significantly different from zero and in periods 5 – 8 even negative. β_5 , the measure of the excess effort response for incentive-compatible contracts, is significantly positive when the data from all periods are used. However, β_5 is much smaller than β_3 . These estimates clearly indicate that paying higher rents was profitable in the TT but not in the IT. A rent increase by 10 units increases the (excess) effort in the TT by roughly 0.13 units, i.e., the rent increase causes a revenue increase of 13. In case of non-incentive-compatible contracts in the IT (excess) effort does not respond at all to the rent offered and for incentive-

compatible IT-contracts the excess effort response is too small to be profitable. A rent increase by 10 units in an incentive-compatible contract reduces under-performance on average by roughly 0.05 effort units, which is tantamount to a revenue increase of 5 units.

We have also regressed the cost measure of voluntary cooperation, $c(e) - c(e^*)$, on the variables in equation (10). The results of this regression are very similar to those reported in Table 6. In the TT there is a robust positive impact of the rents on $c(e) - c(e^*)$, while no such relation exists for the non-incentive-compatible IT-contracts. However, for the incentive-compatible IT-contracts the results differ somewhat from those of Table 6. When measured in cost terms, it is no longer possible to reduce the agents' under-performance by paying higher rents. This is further evidence for the claim that in the IT the agents' behavior cannot or only weakly be affected by varying rent levels.

6. SUMMARY AND INTERPRETATION

This paper shows that reciprocity-driven voluntary cooperation may indeed be crowded out by incentive contracts. Moreover, the crowding out is sufficiently strong so that incentive contracts are on average less efficient than contracts without incentives. In our context crowding out means that agents are less willing to cooperate voluntarily at the same offered rent level when the contract stipulates a fine for shirking. When the principals had the opportunity to punish agents they made less generous contract offers on average, i.e., they relied less on the "carrot" and more on the "stick". However, whenever principals demanded relatively high effort levels in the IT they offered similarly generous rents to the agents than in the TT. Therefore, it seems likely that the low overall rent offers by the principals were a response to the crowding out of voluntary cooperation in the incentive treatment.

Why do the principals persist in fining agents when this causes the crowding out of voluntary cooperation? In our view there are basically two reasons for this. First, principals earn much higher profits when they stipulate fines in an incentive-compatible contract. Remember that incentive-compatible IT-contracts generate a profit that is more than two times larger than the profit in the TT. This induces profit-maximizing principals to propose contracts with a fine. Second, even if principals are not selfish but care instead also for fairness they will prefer to fine shirking agents. This is most easily explained with the help of the Fehr-Schmidt model but other models of fairness like, e.g., Falk and Fischbacher (1999) or Bolton and Ockenfels (2000) have the same implications. Fair principals prefer to use fines because shirking induces, in general, a severe payoff inequality in favor of the

agents. Since fair principals dislike disadvantageous inequality they will fine shirking agents because this decreases the disadvantageous inequality.¹⁵

A further question is why the principals in the IT proposed so many non-incentive-compatible contracts. There are, in principle two candidate explanations here. The first is that it is cognitively demanding to design an incentive-compatible contract and principals needed time to learn this. The second potential explanation is that principals did not anticipate the crowding out of voluntary cooperation in the IT and – as a consequence – they frequently demanded non-incentive-compatible effort levels at the beginning of the experiment. The fact that non-incentive-compatible desired effort levels were in general associated with generous rent offers provides support for the second explanation for it suggests that the principals tried to appeal to the agents’ reciprocity. However, this does not rule out that the first explanation has also some validity.

Why was there less voluntary cooperation in the IT compared to the TT? We conjecture that the explicit threat of punishment in the IT has destroyed the “good will” of the fair agents so that they were no longer willing to cooperate voluntarily. It seems that positive reciprocity is not compatible with the threat of punishing agents for malfeasance. The punishment threat seems to make the appeal to positive reciprocity ineffective. This suggests the possibility that a positive framing of the incentive does not crowd out voluntary cooperation.¹⁶

What are the implications for the design of optimal contracts? Our results and the results of some other papers (Gneezy and Rustichini 2000a and 2000b, Bohnet, Frey and Huck 2000) show that material incentives can have counterproductive effects even if agents face only a single task. While this suggests that one should take crowding out effects seriously, it does not mean that material incentives will generally impair efficiency. The presence of fairness-related voluntary cooperation in the TT indicates that incentives should be designed in such a way that they do not inhibit voluntary cooperation or, at least, minimize any negative impact on voluntary cooperation. Optimal contracts should be, so to speak, also fairness compatible. So far little is known about how fair different incentives are perceived and to what extent different incentives enhance or decrease voluntary cooperation. Yet, the

¹⁵ Note also that if the fine causes advantageous inequality in favor of the principal fair principals in the Fehr-Schmidt sense will, in general, also prefer to fine shirking agents. This is so because in the Fehr-Schmidt model inequity aversion is asymmetric, i.e., the aversion against disadvantageous inequality is larger than the aversion against advantageous inequality.

¹⁶ Remember that we never used the terms “fine” or “punishment” in our experimental instructions. Instead we described the fine as a “potential price deduction”. Nevertheless, a deduction means that something is explicitly taken away and perhaps this is already sufficient to create hostile responses. Instead of imposing a fine with probability 1/3 in case of shirking it would be possible to reduce a promised bonus with probability 1/3 in case of shirking. Perhaps the agents respond differently to this frame.

powerful effects of repeated game incentives on performance in the repeated gift exchange experiments by Gächter and Falk (1999) suggest that repeated game incentives may well prevent crowding out effects. Future research should examine this question in more detail.

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APPENDIX: INSTRUCTIONS

These instructions were originally written in German. Here we present the instructions of our Incentive-Treatment. The instructions of the Trust-Treatment were identical, except for those differences in design that are peculiar to the Incentive-Treatment.

Introductory Remarks (*identical for buyers and sellers*)

The experiment, in which you participate today, is part of a research project that is funded by various research funds. Its purpose is to study decision making in markets. Your income in this experiment consists of Fr. 15.- for your show-up and all payment that you will earn during the experiment according to your decisions and those of other participants. During the experiment your income will be calculated in points where **1 point = 8 Rappen**. Calculated in points, the show-up fee of Fr. 15 amounts to 187.5 points. In addition you will receive an endowment of 112.5 points, which implies that **in total** you will have **300 points** at your disposal to cover losses that may occur during the experiment. **However, with your own decisions you can always prevent losses with certainty. At the end of the experiment all points, which you earned during the experiment will be summed up, exchanged into Swiss Francs, and paid out to you in cash immediately.**

First we would like to ask you to read these instructions carefully, and then to answer the control questions. After all participants have correctly answered all questions, we will start with the experiment, in which you will need the 12 decision sheets and the leaflet which have been handed out to you together with these instructions. **Please notice that all written information that you receive from us, is for your private use only. You are not allowed to transmit any information to other participants of this experiment. It is also prohibited to communicate with the other participants. Otherwise we would have to break off the experiment. If you have questions, please ask us.**

General Information (*identical for buyers and sellers*)

- In this experiment there are buyers and sellers. The experiment comprises 12 trading periods.
- Each trading day consists of two stages. At the **first stage** each buyer decides on an offer, which contains the conditions under which the buyer is prepared to buy a commodity from a seller. Such an offer consists of a price, a desired quality and a potential price deduction. There are ten possible quality levels.
- At the **second stage** a random mechanism determines an order according to which the sellers can choose among the available offers. No seller is obliged to accept a bid, and no buyer is forced to make an offer. All sellers who have accepted an offer, have to decide which quality they will actually deliver. Choosing a quality level entails costs for the seller. After the seller has determined the “actual quality” the respective seller will be informed about it.
- In principle the seller can choose a quality level that is higher, equal, or lower than the desired quality. If the actual quality is lower than the desired quality, then the potential price deduction specified in the contract is due with a probability of 33.3 percent. Hence, when the actual quality is lower than the desired quality, the specified price deduction is **on**

average due in one out of three cases. The seller will only learn after his actual quality choice whether the price deduction is due or not. A trading day is over after all sellers, who have accepted an offer, have determined their actual quality and each participant has been informed whether there is a price deduction.

- There are more sellers than buyers. All sellers and buyers know this. Each seller (or buyer, resp.) can only sell (buy) one unit per trading day. In the following you will find an exact description of the stages, i.e., which decisions are possible, and an exact description of how payoffs are calculated.

Detailed Information for Buyers

In the market a certain commodity is traded and each seller sells the same commodity. Each seller can sell to each buyer and each buyer can buy from each seller. The market is organized as follows. We open the market for a trading day and you will receive from us **100 points** for each commodity that you buy. This amount is the same for all buyers. Each buyer and each seller knows that you will receive 100 points per unit of the commodity. You now have the possibility to make an offer. **An offer consists of a price, a desired quality and a potential price deduction.** For making an offer the following rules hold:

1. Per trading day you are only allowed to make one offer. You are not obliged to make an offer.
2. Concerning the "**desired quality**" the following holds: There are **ten possible quality levels**, from which you can choose your desired quality. The lowest quality is 0.1 and the highest one is 1. Below, the impact of the seller's delivered quality on your payoff will be described in more detail. It holds true that your payoff in points is the higher the higher the delivered quality is. A quality choice entails **quality costs** for the seller. **On the leaflet you will find the table with all feasible quality levels and the associated quality costs! All sellers have the same cost schedule.**
3. The price can **at most be 100** and has **at least to cover the seller's quality cost**. For example, if you ask for the quality level 0.3, you have to offer at least a price of 2, for a quality of 0.3 entails costs of 2 units for the seller. Prices have to be in **integers**. In summary, for the determination of the price the following rule holds:

100 price quality costs.

4. The potential price deduction has not to be lower than 0 and larger than 13:

13 potential price deduction 0.

The potential price deduction has to be stated in integers.

If you have decided on a price, a potential price deduction and a desired quality, please insert them in the box "**proposed offer**" on your **decision sheet**.

After you have made your offer, you have to roll a six-sided die. Rolling the die determines whether the price deduction is due in case of an under-provision of the desired quality. The following rule hold: If the numbers **1 or 2** show up (with a probability of 1/3) the price deduction is exacted in case of an under-provision; if the numbers **3, 4, 5, or 6** show up, the price deduction will not be implemented. Please insert the result in the box "**Price deduction due in case of under-provision?**" on your **decision sheet**.

Your offer will be written on the blackboard and transmitted to the sellers. In the sellers' room all offers on a trading day will be written on the blackboard in a **random order**. Moreover, on each trading day a random mechanism determines the order according to which sellers are

allowed to choose amount the offers. **The sellers will not learn which buyer has made which offer and you as a buyer will not learn which seller has accepted which offer.** Each seller can only accept one offer per trading day. The sellers cannot make counteroffers.

After a seller has accepted an offer, he determines the “actual quality” of the commodity, i.e., he chooses a quality level from the quality levels mentioned on the leaflet. Hence, the sellers can choose among exactly the same quality levels as you can. As already mentioned, for the seller choosing a quality entails quality costs.

When a seller determines the “actual quality” of the sold commodity, he does not know whether in case the actual quality falls short of the desired quality the price deduction will be implemented or not. Hence, the seller does not know the numbers that showed up in your throwing of the die. The seller only knows that an under-provision leads to a price deduction with a probability of 1/3.

Each seller personally and completely anonymously decides on the actual quality of which only you will be informed (i.e., it will be inserted in the row “actual quality” on your decision sheet). You will not learn the identity of the seller. Hence, no other buyer and no other seller will learn about the actual quality choice of “your” seller.

If the seller has made an actual quality choice that falls short of your desired quality and if the price deduction is due (i.e., if the die numbers are 1 or 2) then you only have to pay the seller the offered price minus the price deduction. If the price deduction is not due, you have to pay the offered price.

You now have all necessary information to calculate your own payoff as well as the payoff of “your” seller. This ends a trading day and the next one starts. In total there will be 12 trading days during which you can earn money.

The Calculation of Buyer’s Payoffs at the End of a Trading Day (*for sellers this sheet was adapted accordingly but was otherwise identical*)

At the end of a trading day there are the following possibilities:

1. If you have not made an offer, or if your offer has not been accepted by a seller, you have not bought a unit and your **payoff is 0 points**.
2. Your offer has been accepted and the seller’s *actual* quality conforms to or is higher than your desired quality. In this case your payoff and the payoff of your seller is (in points):

| | | |
|------------------------|---|---|
| Your payoff | = | $100 \times \text{actual quality} - \text{price}$ |
| Seller’s payoff | = | $\text{Price} - \text{quality costs}$ |

3. Your offer has been accepted, but the seller has chosen a lower than your desired quality.

(a) The price deduction cannot be exacted, because the die numbers 3, 4, 5 or 6 showed up. In this case your payoff and the payoff of your seller is:

| | | |
|------------------------|---|---|
| Your payoff | = | $100 \times \text{actual quality} - \text{price}$ |
| Seller’s payoff | = | $\text{Price} - \text{quality costs}$ |

(b) The die numbers 1 and 2 showed up, i.e., the price deduction can be implemented. In this case your payoff and the payoff of your seller is:

| | | |
|------------------------|---|--|
| Your payoff | = | $100 \times \text{actual quality} - \text{price} + \text{price deduction}$ |
| Seller's payoff | = | $\text{Price} - \text{quality costs} - \text{price deduction}$ |

Each seller and each buyer is informed about the details of this payoff calculation. Hence, “your” seller can calculate your payoff in points and you can calculate the payoff of “your” seller. Do you have any questions?

Buyers' Control Questionnaire (*for sellers the control questionnaire was adapted accordingly but was otherwise identical*)

1. You have not made an offer. What is your payoff?
2. (*not asked with sellers*) You would like to demand an effort level of 0.7.
 - (a) What is the highest feasible price?
 - (b) What is the lowest price that you have to offer?
 - (c) What is the maximal potential payoff deduction?
3. You have made the following offer:

Price = 40
Desired quality = 0.8
Potential price deduction = 10

 - (a) The actual quality of “your” seller is 0.8 and die numbers 1 and 2 showed up.
 What is your payoff? What is the payoff of “your” seller?
 - (b) The actual quality of your seller is 0.2 and die numbers 1 and 2 showed up.
 What is your payoff? What is the payoff of “your” seller?
 - (c) The actual quality of your seller is 0.2 and die number 5 showed up.
 What is your payoff? What is the payoff of “your” seller?
4. You have made the following offer:

Price = 15
Desired quality = 0.9
Potential price deduction = 13

 - (a) The actual quality of “your” seller is 0.9.
 What is your payoff? What is the payoff of “your” seller?
 - (b) The actual quality of your seller is 0.1 and die numbers 1 and 2 showed up.
 What is your payoff? What is the payoff of “your” seller?
 - (c) The actual quality of your seller is 0.1 and die number 3 showed up.
 What is your payoff? What is the payoff of “your” seller?

Leaflet (*identical for buyers and sellers*)

Points for buyer per unit bought: 100

For making an offer the following rules hold:

$100 \geq \text{price} \geq \text{quality costs}$

$13 \geq \text{potential price deduction} \geq 0$

Quality and cost of quality for the seller:

| quality | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 1 |
|------------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|----------|
| cost of quality | 0 | 1 | 2 | 4 | 6 | 8 | 10 | 12 | 15 | 18 |

Buyers' decision sheet (1 per period; 12 sheets in total)

(The decision sheet of sellers was adapted accordingly but was otherwise identical)

| Proposed offer | |
|--|--|
| Price (p) | |
| Desired quality | |
| Potential price deduction (s) | |
| Price deduction due in case of under-provision? (Please mark the appropriate box) | |
| Die numbers 1, 2 | Die numbers 3, 4, 5, 6 |
| <input type="radio"/> Yes | <input type="radio"/> No |
| Seller's actual quality (q) | |
| | |
| Payoff of the concluded deal | |
| No offer made | |
| Payoff = | |
| If the desired quality has been delivered or exceeded | |
| Your payoff $100 \times q - p =$ | Payoff seller $p - \text{costs of quality} =$ |
| If the actual quality fell short of the desired quality | |
| Price deduction is due | |
| Your payoff $100 \times q - p + s =$ | Payoff Seller $p - c(q) - s =$ |
| Price deduction is <u>not</u> due | |
| Your payoff $100 \times q - p =$ | Payoff Seller $p - c(q) =$ |

Detailed Information for Sellers

In the market a certain commodity is traded and each seller sells the same commodity. Each seller can sell to each buyer and each buyer can buy from each seller.

Each buyer receives from us on each trading day 100 points, which he can use for buying a commodity. All buyers and sellers know this.

The organisation of the market is as follows: We open the market for one trading day. First, without communicating with other buyers, each buyer can make an offer. **An offer consists of a price, a desired quality and a potential price deduction.** There are ten possible quality levels from which the buyer, and you as a seller, respectively, can choose. The lowest quality is 0.1 and the highest quality is 1. The impact of the quality of the delivered good on the payoffs will be described below in more detail. In general, however, it holds true that a high quality increases your cost and the payoff of the buyer. On the leaflet you will find a table with all possible quality levels and the associated quality costs of your quality choice.

When all buyers had the opportunity to make an offer, all offers are transmitted to this room. The offers will be written on the blackboard in a random order. You will not learn which buyer made which offer. Then a random device determines the order according to which you as a seller can choose among the offers. We implement this as follows. You have to draw one out of 8 cards that are numbered from 1 to 8. The seller who picks card no. 1 is the first who has the opportunity to pick an offer; the seller who draws card no. 2 is the second to pick an offer, and so on. You will make your choice as follows: When it is your turn to make a choice, you

state your **seller number** and your chosen offer. On a trading day you can accept only one offer. You are not obliged to accept an offer. **The buyers will not be informed which offer you have accepted; they will only know, whether their offer has been accepted or not.** The offer you have chosen will be deleted from the blackboard and then the next seller makes a choice among the remaining offers.

If you have accepted an offer, we ask you to insert on your **decision sheet** the price, the desired quality and the potential price deduction into the box **“Accepted Offer”**. Now you have to decide which quality level you will deliver. As already mentioned, the choice of a quality level is associated with quality costs that you have to bear. **On the leaflet you will find the table with the feasible quality levels and the associated costs for you! Both the buyers and the sellers know this table.** Please insert your actual quality level on your decision sheet in the row **“Actual Quality”**. No other seller will be informed about your quality choice. **We therefore ask you not to talk about your “actual quality”**. Each buyer is only informed about the “actual quality” of “his” seller. Moreover, the buyer will **not** learn the identity of “his” seller. Hence, the anonymity of your quality choice is completely secured.

Whether the potential price deduction is due or not, depends on your quality choice and on chance. If you have delivered or exceeded the desired quality you will receive the accepted price in any case and the price deduction is **not** exacted. If, however, your actual quality fell short of the desired quality, the price deduction may be implemented. Whether the price deduction is due, depends on the result of the following procedure: “your” buyer rolls a six-sided die. If the numbers 1 and 2 turn up, the price deduction will be implemented. If the numbers 3, 4, 5, or 6 show up, the price deduction will not be implemented. We will indicate whether the price deduction – in case of an under-provision of quality – is due or not, by checking the respective box on your decision sheet. You will receive this information after you have determined your actual quality level.

You now have all necessary information to calculate your own payoff as well as the payoff of “your” seller. This ends a trading day and the next one starts. In total there will be 12 trading days during which you can earn money.