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Abstract: This paper reports on a two-task principal-agent experiment in which only one task is contractible. The principal can either offer a piece-rate contract or a (voluntary) bonus to the agent. Bonus contracts strongly outperform piece rate contracts. Many principals reward high efforts on both tasks with substantial bonuses. Agents anticipate this and provide high efforts on both tasks. In contrast, almost all agents with a piece rate contract focus on the first task and disregard the second. Principals understand this and predominantly offer bonus contracts. This behavior contradicts the self-interest theory but is consistent with theories of fairness.

Keywords: Incentives, Moral Hazard, Multiple Tasks, Fairness, Experiments.

JEL Classification Numbers: C7, C9, J3

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I. Introduction

In most principal-agent relationships, the principal has to induce the agent to engage in several tasks simultaneously. The agent's performance can often be measured fairly accurately in some tasks, but in others the available performance measures may be very noisy, or a verifiable performance measure that can be used to provide explicit incentives to the agent may not even exist. For example, a production worker may have to produce a certain amount of output which is easily measurable, but he may also have to make sure that the quality of output is high and that the machinery he is working with is properly maintained, which may be more difficult to monitor. A school teacher has to teach his students basic skills like the three R's (reading, writing, arithmetic), which can be measured in standardized tests, but he also has to stimulate their creativity and teach them social skills, which are much harder to evaluate.

In a seminal paper, Holmström and Milgrom (1991) analyzed optimal incentive provision in a multi-task principal-agent model. They show that there are important interaction effects between the incentives given for one task and the agent's incentives for engaging in other tasks. For example, if the different tasks are complements at the margin in the principal's payoff function, i.e. if it is important for the principal that the agent engages in all tasks rather than concentrating his efforts on a single one, it is optimal for the principal to reduce the incentives for the task that is easy to measure in comparison to a situation where the agent is engaged in just this task. The reason is that if the principal offers high-powered incentives for a task that is easy to measure and low-powered incentives for a task where measurement is difficult, then the agent will focus his efforts on the task that is rewarded and disregard the other task for which only small incentives can be offered.[1]

The distortions caused by explicit incentives in a multi-task environment may be the reason why we often observe implicit incentives through voluntary bonus payments. These bonuses are not contractually tied to verifiable performance measures. Instead, they are based on the principal's subjective evaluation of the agent's overall performance which cannot be verified to the courts. The problem with these implicit incentives is that the agent cannot enforce the bonus payment but has to trust that the principal will pay the bonus voluntarily.

[1] Note that if the performance measure for a task is very noisy, the principal will not offer high-powered incentives for this task because this would impose a high risk on the agent. If the agent is risk-averse the principal would have to compensate the agent with a high expected wage for the risk that the agent has to bear, which renders high-powered incentives unprofitable for the principal.

In this paper we report on a multi-task principal-agent experiment where the principal can choose which type of contract to offer an agent who has to expend effort on two tasks. The agent's efforts are complementary for the principal, in the sense that the agent should expend the same amount of effort on both tasks rather than choose an uneven effort allocation. The effort spent on task one is perfectly observable by the principal and easily verifiable by the courts, so contracting it is not a problem. The principal can also perfectly observe the effort spent on task two, but it is soft information that cannot be verified by the courts and therefore cannot be contracted. The principal can offer either a "piece rate contract" that pays a fixed base wage and a piece rate for each unit of effort spent on task one, or a "bonus contract" that just specifies a fixed wage for the agent but no piece rate. Instead, the principal announces that he might pay the agent a bonus if the latter's performance is satisfactory. However, both players know that the bonus payment is completely voluntary and that it cannot be enforced. Each principal and each agent interact anonymously and only once in the experiment.

A bonus contract cannot work if both parties are interested only in their own material payoffs as suggested by the traditional self-interest model. A purely self-interested principal will never make a voluntary bonus payment in a one-shot game. By a standard backward induction argument, the same result holds for any finitely repeated relationship. However, numerous experiments and field evidence have shown that many people also care about fairness and reciprocity.[2] Thus, the question arises whether concerns for fairness suffice as an enforcement device for inducing at least some principals to pay a bonus and encouraging the agents to work hard. In particular, we examine the question whether a bonus contract that only offers implicit incentives outperforms a piece rate contract making the agent's pay explicitly contingent on at least part of his effort. Furthermore, this is one of the first experiments where principals can choose which type of contract to offer. Thus, we can address the question whether real principals understand the explicit and implicit incentives these contracts provide and thus choose contracts efficiently.

Bonus contracts strongly outperform piece rate contracts in the experiments. Many (but not all) principals reward high efforts on both tasks with substantial bonus payments. Agents seem to anticipate this and many (but not all) of them provide high efforts on both tasks. In contrast, almost all agents under a piece rate contract focus their efforts on task one and disregard task two entirely. It

[2] See, e.g., the recent surveys by Camerer (2003) and Fehr and Schmidt (2003).

seems that principals understand these effects and their vast majority chooses to offer a bonus contract.

The experimental results clearly suggest that concerns for fairness and reciprocity affect the behavior of some of the players. However, this explanation is incomplete. There is scope for reciprocal behavior, not just with a bonus contract but also with a piece rate contract. A principal could offer a piece rate contract with a generous fixed wage in order to appeal to the fairness of the agents who could reciprocate by choosing high effort levels in both tasks in return. In fact, many of the principals who chose a piece rate contract did exactly this. However, while some agents responded with non-minimal effort levels for task two, many did not. On average, paying a generous wage in a piece rate contract turned out to be unprofitable. What explains this asymmetry between piece rate and bonus contracts?

Another open question concerns the behavior of the agents under a bonus contract. Bonuses were sufficiently large on average to make high effort levels profitable for the agents. However, a significant fraction of agents chose minimal effort levels nevertheless.

In Section IV, we show that the experimental results are consistent with theories of fairness that have been developed recently. In particular, we offer a theoretical explanation of the experimental results that is based on the theory of inequity aversion by Fehr and Schmidt (1999). This theory offers a simple and tractable model that captures some effects of fairness and reciprocity. The model assumes that players are heterogeneous. Some players are very strongly concerned about inequity, while others are only interested in their own material payoff. We show that the observed behavior is largely consistent with this theory and that the theory provides an answer to the questions raised above. We show that the interaction between the inequity averse and the selfish types of players gives rise to interesting new insights.

Starting with Holmström and Milgrom (1991), there is a large amount of theoretical and empirical literature on multi-task principal-agent problems.[3] In particular, MacLeod and Malcomson (1989) and Baker, Gibbons and Murphy (1994) suggest that if some aspects of the agent's performance cannot be contracted upon, relying on subjective performance evaluation and voluntary

[3] See e.g. Prendergast (1999) for a survey of this literature. In a large empirical study Brown (1990) shows that "incentive pay (such as piece rates) is less likely in jobs with a variety of duties than in jobs with a narrow set of duties". Similarly, MacLeod and Parent (1999) report that "jobs with high powered incentives (piece or commission rates) tend to be associated with more worker autonomy and fewer tasks performed than hourly paid or salary jobs." This confirms the theoretical result that piece-rate contracts can be detrimental if the agent has to perform multiple tasks.

bonus payments might be optimal. These bonus payments are very similar to the bonus contracts in our experiments. However, the bonus payments in this literature are sustained as an equilibrium in an infinitely repeated game while our experiments are based on anonymous, one-shot relationships. Clearly, if the principal and the agent were to interact repeatedly in the experiment, the bonus contract would be much easier to sustain.[4] But the point of our experiments is that concerns for fairness can be sufficiently strong for sustaining a bonus contract even in a one-shot relationship.

There is now a substantial literature on economic experiments showing that concerns for fairness and reciprocity do have substantial effects on human behavior.[5] Previous work by Fehr, Kirchsteiger, and Riedl (1993); Berg, Dickhaut, and McCabe (1995); and Fehr, Gächter, and Kirchsteiger (1997) indicated that fairness concerns may play an important role in moral hazard contexts. However, these papers neither studied the interaction between fairness concerns and explicit incentives nor how the principals choose between explicit and implicit incentives. There have been several experimental studies in the past few years which examined how the provision of explicit incentives affects the agents' behavior in a moral hazard context. DeJong, Forsythe, Lundholm and Uecker (1985) showed how different institutional remedies, such as liability rules, mitigate the moral hazard problem. Schotter, Bull and Weigelt (1987) study the effects of piece rates and tournament incentives, and Güth, Klose, Königstein, and Schwalbach (1998) examined a multi-period principal agent game in which the principals could offer linear profit-sharing contracts. Keser and Willinger (2000); Güth, Königstein, Kovacs, and Zala-Mezo (2001); and Anderhub, Gächter, and Königstein (2002) also studied the performance of output-contingent wages in a moral hazard context.

The main contribution of our paper to this literature is twofold. First of all, our experiments are, to the best of our knowledge, the first in the literature that deal with a multi-task principal-agent model. The multi-task problem has received a lot of attention in the theoretical and empirical literature on optimal contracting, but no experiments have examined this problem yet. Second, the incentive structure is given exogenously in almost all economic experiments. In contrast, in our experiments the principal can choose what kind of incentives to offer. Thus, our experiments can be used to better understand how well real principals understand the incentives different types of contracts provide and whether they manage to choose contracts optimally.

[4] This is confirmed by Brown, Falk and Fehr (2004) and Falk and Gächter (2002).
[5] For a recent survey see e.g. Fehr and Schmidt (2003)

In a companion paper, Fehr, Klein and Schmidt (2004), we consider a single-task experiment in which the principal could also choose between different types of contracts. Instead of a piece-rate contract, the principal could impose a (bounded and stochastic) punishment on the agent for unsatisfactory performance. Furthermore, the principal had the additional option of using a "trust contract". A trust contract only offers a (generous) fixed wage and asks the agent to reciprocate the favor by choosing a high level of effort. It turned out that the trust contract performed very poorly. This is why we decided not to consider it explicitly in this paper. However, the principal could choose a piece-rate contract with a piece rate of 0 which is equivalent to a trust contract. Interestingly, not a single principal did so.

The rest of this paper is organized as follows. Section II introduces a simple multi-task principal-agent model and describes the experimental setup. Section III reports the results of the experiments. In Section IV, we develop a theoretical explanation of the results based on the theory of inequity aversion by Fehr and Schmidt (1999). While the experimental data clearly contradict the self-interest model, they are consistent with models of fairness and reciprocity such as the theory of inequity aversion. Section V summarizes our main results and offers some conclusions.

II. A Simple Multi-Task Principal-Agent Experiment

In the experiment, a principal wants an agent to carry out two tasks. The principal's gross profit, $v(e_1,e_2) = 10 \cdot e_1 \cdot e_2$, depends on the levels of effort, e_1 and e_2, that the agent expends on tasks one and two. The set of feasible effort choices is given by $e_i \in \{1, \ldots , 10\}$ in both tasks, and the total effort cost incurred by the agent is $c(e_1+e_2)$, where $c(\cdot)$ is given by Table 1.

Table 1: Effort cost function

$e=e_1+e_2$	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
c(e)	10	15	20	25	30	35	40	45	50	60	70	80	90	100	110	120	130	140	150

The cost function is $c(e_1,e_2)$ is strictly increasing and convex in both arguments. There exists a unique pair of first best effort levels

$$(e_1^*,e_2^*) = \arg\max\{v(e_1,e_2) - c(e_1,e_2)\} = (10,10) \quad (1)$$

that maximize total social surplus. Furthermore, as in Holmström and Milgrom (1991), the two tasks are complements at the margin for the principal but (perfect) substitutes at the margin for the agent, i.e., the higher the effort spent on one task, the more profitable an increase of the effort spent on the other task is for the principal, but also the more costly an increase of the effort spent on the other task for the agent.

Gross profits and effort costs cannot be contracted upon. Both parties observe both of the agent's effort levels, but only e_1 can be verified to the courts. Thus, the agent's wage contract can be conditional on e_1 but not on e_2. For example, we could interpret the two tasks as the efforts the agent expends on increasing the quantity and the quality of production of some good or service. The quantity of production is easily measurable and verifiable. However, the quality of production, while observable by the two parties, cannot be contracted upon as its verification to outsiders such as the courts is prohibitively costly.

The timing of events is as follows. At date 0, the principal makes a take-it-or-leave-it offer to the agent. If the agent rejects the offer, the game ends and both parties get a payoff of 0. If the agent accepts, he has to choose the efforts to be spent on tasks 1 and 2 at date 1. At date 2, wages and bonuses are paid and payoffs are realized.

We consider two different types of contracts using different means for inducing the agent to increase his efforts. First, the principal could offer a *piece rate contract* denoted by (e_1^*,e_2^*,w,s), that specifies a desired effort level for each task, (e_1^*,e_2^*), a fixed base wage, w, and a piece rate s (sharing rule) for every unit of actual effort e_1.[6] The problem with this *piece rate contract* is that it focuses the agent's attention on task one and may induce him to disregard task two. Alternatively, the principal can offer a bonus contract, denoted by (e_1^*,e_2^*,w,b^*). This contract also specifies a desired effort level for each task, (e_1^*,e_2^*), and a fixed wage, w, but it announces a non-binding bonus, b^* instead of the piece rate.[7] Both parties know that the bonus payment cannot be enforced and is completely voluntary. Payoffs are given by

[6] Holmström and Milgrom (1987) show that a linear incentive scheme is indeed optimal if the agent chooses the drift rate of a Brownian motion and has a CARA utility function. See also Hellwig and Schmidt (2002) for a generalization of this model.

[7] In both contracts, the binding part of the compensation had to cover the cost of the desired effort levels. That is, the bonus contract required $w \geq c(e_1^*+e_2^*)$, while the piece rate contract required $w + se_1^* \geq c(e_1^*+e_2^*)$. We imposed these constraints to guarantee that loss aversion of the agents would not affect the results.

$$M^A = \begin{cases} w + se_1 - c(e_1 + e_2) & for \quad a \quad piece \quad rate \quad contract \\ w + b - c(e_1 + e_2) & for \quad a \quad bonus \quad contract \end{cases} \tag{2}$$

$$M^P = \begin{cases} 10e_1e_2 - w - se_1 & for \quad a \quad piece \quad rate \quad contract \\ 10e_1e_2 - w - b & for \quad a \quad bonus \quad contract \end{cases} \tag{3}$$

where e_1, e_2 and b denote the effort levels and bonus payment actually chosen.

The predictions of the self-interest model are straightforward. Under any piece rate contract, a self-interested agent chooses his effort in the non-verifiable task to be $e_2 = 1$. Hence, the marginal revenue of e_1 is *10*. Given $e_2 = 1$, the agent's marginal cost of effort in task 1 is *5* if $e_1 \leq 9$, and *10* if $e_1 > 9$. Therefore, the profit-maximizing piece rate contract offers $w = 5$, $e_1^* = 9$, and $s = 5$, which induces the agent to accept the contract and to choose $e_1 = 9$ and $e_2 = 1$. Hence, the principal's monetary payoff from a piece rate contract is $M^P = 10 \cdot 9 \cdot 1 - 5 - 5 \cdot 9 = 40$ while the agent gets $M^A = 5 - c(9+1) + 5 \cdot 9 = 0$.

Under a bonus contract, a rational agent foresees that a self-interested principal will never pay the bonus; therefore, the agent chooses $e_1 = e_2 = 1$. Thus, the principal should offer $w = c(1+1) = 10$, while the announced bonus and the desired effort levels are cheap talk. In equilibrium, the agent accepts this offer, the principal's monetary payoff is $M^P = 10 \cdot 1 \cdot 1 - 10 = 0$ and the agent also gets $M^A = 10 - c(1+1) = 0$. Note that he maximum surplus, which is achieved if the agent chooses $e_1 = e_2 = 10$, is $v(10,10)-c(20) = 10 \cdot 10 \cdot 10 - 150 = 850$.

The prediction is less clear if the principal and the agent are not only interested in their own monetary payoffs, but are also motivated by fairness and reciprocity. In this case, a fair-minded principal may be willing to pay a generous bonus if the agent worked to her satisfaction in both tasks, which in turn may induce the agent to spend effort under a bonus contract. Similarly, if the principal pays a generous wage *w* upfront in the piece rate contract, the agent may reciprocate by expending non-minimal effort on task two. We offer a detailed theoretical analysis of this case in Section IV.

The experiments were conducted at the University of Munich with undergraduate students from the University and the Technical University of Munich (students of law, political science, engineering, etc.). We conducted three experimental sessions. In each session we had 20-24 subjects, half of them principals ("employers") the other half agents ("employees").

The two groups were located in separate but adjacent rooms. Before the experiment started, all subjects had to read detailed instructions and solve several exercises to make sure that all of them understood the rules of the experiment. Each session consisted of ten rounds. In each round, an agent was matched with a different principal. Thus, we have ten contracts with ten different contracting partners for each subject in each experimental session. In total we have 330 observations (contract offers).[8]

After each round, each subject had to compute his own payoff and that of his opponent. To rule out the possibility of reputation building, the outcome of each round was strictly confidential, that is, each principal-agent pair observed only what happened in their own relationship. They did not observe the contracts chosen by or offered to the other subjects in the room. Nor did they observe the past behavior of their current partner. Furthermore, matching was random and anonymous. Finally, the subjects collected their total monetary payoffs privately and anonymously at the end of the session. Each session lasted between two and two-and-a-half hours. A complete set of the instructions for all our experiments can be found on our webpage.[9]

In each session, every participant received an initial endowment of € 12.50 (≈US$ 15.60 at the time of the experiment). The experimental (token) payoffs were exchanged into money at the rate of 100 tokens = € 1. Thus, an employer and an employee could jointly earn a maximum surplus of € 8.50 (≈US$ 10.60) in each of the ten rounds. The highest total income of one individual was € 76 (US$ 95), an hourly wage of ca. € 38 (US$ 47.50). However, the variance of payoffs was quite high. The lowest income earned was just € 10 (US$ 12.50).

III. Experimental Results

The first important and very strong result is that the large majority of contract offers (267 out of 330) are bonus contracts (80.9 percent) while only 63 of the principals (19.1 percent) offer a piece rate contract. Six of the bonus contracts and seven of the piece rate contracts are rejected by the agents.

Insert Figure 1 here

[8] Note, however, that these observations are not fully independent because each subject is observed several times and there may be spillover effects. See also the discussion of the bonus regressions below.

[9] The full set of all our experimental instructions, in German and translated into English, are available at http://www.vwl.uni-muenchen.de/ls_schmidt/experiments/multi_task/index.htm .

Figure 1 depicts the share of bonus contracts over time. In period 1, the share of bonus contracts already exceeds 70 percent and it never falls below that level. The principals experiment somewhat with the piece rate contract in some periods, but only 27 percent of the principals offer a piece rate contract more than three times. After period 1, the share of bonus contracts fluctuates between 75 and 88 percent and reaches 85 percent in the final period. The average share over all periods is 81 percent.

Result 1: *The large majority of principals choose a bonus contract.*

The agents' effort levels provided under different types of contracts assist in better understanding the prevalence of the bonus contract.

Insert Figure 2 here

Figure 2 shows that under the piece rate contracts, effort for task one is very high (8.95 on average over all periods) while effort for task two is quite low (2.75 on average).[10] While some subjects provide effort levels of 3 to 5 for task two in the first few periods, the effort level rapidly converges to the minimum of 1 in periods 9 and 10. Figure 2 also shows that the average effort levels for the two tasks under the bonus contracts are nearly indistinguishable and lie between the effort levels of tasks one and two under the piece rate contract. It turns out that the average sum of the effort levels is slightly lower for the piece rate (11.70) than for the bonus contracts (12.05), but the difference is statistically not significant.[11] However, the effort allocation is much more efficient under the bonus contracts because the two tasks are strong complements at the margin.

Graphs depicting averages frequently hide differences at a more disaggregated level. Therefore it is useful to take a closer look at the effort distributions under the bonus and the piece rate contracts (see Table 2). This table shows that most effort choices in the bonus contracts are close to or on the main diagonal, indicating efficient effort allocations across tasks. In addition, the effort distribution is bimodal. 25 percent of all observations (66 of 261) are at the minimal effort levels of 1 and 34 percent (89 of 261) are at effort levels greater or equal to 9 for both tasks. In contrast, under the piece rate contracts it is extremely rare for the agents to chose the minimal effort in the verifiable

[10] The drop of the average effort level for task one in the last period is driven by one observation with e_1=1 and the fact that there are only three piece rate contracts left in this period.

task, demonstrating the effectiveness of the piece rate in the elicitation of e_1. However, Table 2 also shows that the most frequent effort choice in the non-verifiable task is $e_2 = 1$. In fact, this is the case for 26 out of the total 56 piece rate contracts (46 percent). Thus, Table 2 underlines the highly inefficient effort allocation in the piece rate contracts.[12]

Insert Table 2 here

Result 2: *There is no statistically significant difference between the distributions of total effort ($e_1 + e_2$) provided under bonus contracts and under piece rate contracts. However, agents allocate their efforts evenly across tasks under the bonus contracts, while agents under the piece rate contracts concentrate their efforts on task one (that the piece rate rewards) and ignore task two.*

What explains the effort choices of the agents? The answer is fairly straightforward for the piece rate contracts. The piece rates offered by the principals are on average $s=10.34$ in all accepted contracts and are smaller than 5 only three times. Recall that the marginal cost of effort is 5 for $e_1 + e_2 \leq 10$ and 10 for $e_1 + e_2 > 10$. Thus, choosing an effort level of 9 or 10 for task one maximizes the agents' income, and in more than 80% of the effort choices this is what agents do. Somewhat more surprising is the fact that some agents choose non-minimal effort levels for task two under a piece-rate contract. A possible explanation is that some of the principals are quite generous in offering fairly high base wages. The average base over all accepted piece rate contracts is $w=100.4$. We estimated the effect of w on e_2 by using a Tobit model that takes the fact that e_2 is censored into account, because of the restriction that $1 \leq e_2 \leq 10$. The regression results show that w has a positive effect on e_2 that is significant at the 5% level. However, the coefficient for w is 0.016 which is fairly small. It implies that the principal has to increase the base wage by 62 Tokens in order to induce the agent to spend one additional unit of effort on task two.

Why do agents choose much higher (and more efficient) effort levels for task two under a bonus contract? The first observation is that some (but not all) principals make generous voluntary

[11] We conducted a Mann Whitney test. The null hypothesis that the distribution of total effort levels is the same under the bonus and under the piece rate contracts cannot be rejected at the 10% level.

bonus payments if the effort is to their satisfaction. This can be seen from Figure 3 which shows the average bonus payment for a given level of total effort (e_1+e_2).

Insert Figure 3 here

The figure shows that total effort levels below 10 were almost never rewarded. However, the bonus-effort relation increases strongly for total effort levels above 10. Agents who provided the maximum total effort level of 20 received an average reward of more than 250 tokens. Figure 3 also depicts the effort cost function, demonstrating whether it was profitable for the agents to choose non-minimal effort levels. The comparison between the bonus-effort relation and the effort cost function shows that the agents receive sufficiently high expected rewards for the two highest total effort levels, rendering the choice of these effort levels profitable. In particular, choosing the maximum effort levels turns out to be very profitable for the agents. Figure 3 also provides an explanation for why most effort choices are either minimal or maximal. Choosing an intermediate level of total effort (larger than 2 and smaller than 19) does not turn out to be profitable.

It is important to note that not all principals reward high effort with high bonuses. 45 out of 175 agents who provide a total effort larger or equal to 10 receive a bonus of zero. To further examine the determinants of bonus payments, we ran the following OLS-regression

$$b = \alpha_0 + \alpha_1 \cdot (e_1 + e_2) + \alpha_2 \cdot |e_1 - e_2| + \alpha_3 \cdot w + \alpha_4 \cdot e_1^* + \alpha_5 \cdot e_2^* + \alpha_6 \cdot b^* + \varepsilon, \qquad (4)$$

Thus the actual bonus payment b is modeled as a function of total effort, $e_1 + e_2$, but also of the absolute value of the effort difference, $|e_1 - e_2|$, in order to examine whether principals penalized unequal effort levels across tasks. In addition, the regression measures the impact of the base wage (w), the desired effort levels ($\cdot e_1^*$ and $\cdot e_2^*$), and the announced bonus (b^*).

Insert Table 3 here

[12] A Mann Whitney test confirms that the difference between the distribution of effort levels e_1 under the bonus and under the piece rate contracts is highly significant. The same holds for effort levels e_2 under the two contracts.

There are two potential problems with an OLS regression here. First, not all of our observations are independent of each other. Each principal interacted with ten different agents, so for each principal we have several observations of his actual bonus payments which are clearly not independent of each other. We also observe the effort choices of each agent several times, but for the explanation of the bonus payments the effort levels are given exogenously, so any correlation here does not matter. Therefore, we conducted a cluster analysis, where each of the 33 clusters contains the observations on one principal, and computed the robust standard errors.

A second potential problem arises because principals could not make negative bonus payments, i.e. they could not penalize agents for low efforts. Therefore we also conducted a Tobit regression that takes into account that bonus payments are censored at 0.

All three regressions yield very similar results. The impact of total effort is always highly significant. The effect of the effort difference is also highly significant and negative, i.e., principals penalize uneven effort allocations across tasks. Thus, agents have a good reason to equalize effort levels across tasks. The impact of the base wage is always negative, indicating that a higher wage paid ex ante implies a lower bonus payment ex post. However, this effect is significant only at the 10% level. The desired effort levels and the announced bonus are never significant.

It is interesting to have a closer look at the Tobit estimation. This regression shows that if agents supply a total effort of less than 10, then the principals would like to punish them by paying negative bonuses. But, of course, bonuses are restricted to be nonnegative, so most principals choose a bonus payment of 0 in this case. Note that principals pay on average a base wage of 146[13], and they seem to expect at least a total effort of 10 in exchange for this. However, if total effort supplied exceeds 10, then principals are prepared to pay (on average) 28 tokens for each additional unit of effort.

Result 3: *If the agent's effort is above 10, some (but not all) principals make significant voluntary bonus payments. The average bonus increases in total effort and decreases in effort differences. Providing the maximum total effort and equalizing the effort across tasks is the most profitable strategy for agents if they face a bonus contract.*

Given the more efficient effort allocation under bonus contracts, it is not surprising that principals' revenues as well as their profits are much higher than under piece rate contracts. In all ten periods, the principals' average profit under bonus contracts is higher than that under piece rate contracts. If we average over all ten periods, the principals earn 237 tokens in a bonus contract. In contrast, the principals' income from a piece rate contract is only 67 tokens. Moreover, in many cases principals' profits turn out to be negative under a piece rate contract. This is due to the fact that some principals tried to induce higher effort levels on task two by paying generous wages, but many of the agents responded with $e_2 = 1$, causing severe losses to generous principals. In contrast, principals never incurred losses with a bonus contract.

Interestingly, a very similar picture arises with regard to the agents' monetary payoff. In each of the ten periods, the agents earn substantially higher incomes under bonus contracts than under piece rate contracts. Thus, bonus contracts Pareto dominate piece rate contracts because both actors, principals and agents, are better off.

Insert Figure 4 here

Result 4: *The bonus contract not only generates a higher social surplus than the piece rate contract. It also Pareto dominates the piece rate contract because both actors, principals and agents, are better off*

It is interesting to note that the principals seem to understand the superiority of the bonus contract from the very beginning of the experiment and already choose this contract predominantly in the first period.

IV. Theoretical Interpretation of the Results

At first glance, the experimental results seem to be a clean confirmation of the basic insights of the multi-task principal-agent literature: they show that people react in the predicted manner to explicit monetary incentives such as piece rates. Furthermore, if some of the agent's tasks cannot be monitored, giving explicit incentives for those that can be monitored distorts the agent's effort

[13] This is significantly higher than the wage of 100.40 that is offered on average with an incentive contract. However, it has to be kept in mind that principals were required to offer a fixed wage that covers at least the agent's cost if he chooses the desired effort levels e_1^* and e_2^*. Thus, if $e_1^*=e_2^*=10$, the principal has to offer at least $w=c(20)=150$.

allocation. He concentrates on the tasks that he is paid for and disregards those that are not explicitly rewarded. Therefore, giving the agent explicit incentives need not be optimal. The experiments show that it may be better to rely on subjective performance evaluation and voluntary bonus payments that reward the agent for his overall performance.

However, at a closer look the interpretation of the experimental results is far less clear. On the one hand, the results for the piece rate contracts seem to be roughly consistent with the self-interest model which assumes that all players are only interested in their own material payoffs. The self-interest model predicts that if player 2 offers a sufficiently high piece rate, player 1 will choose the maximum effort level in task one and disregard task two completely. It also predicts that the principal will choose the fixed wage in such a way that the agent is just held down to his reservation utility. However, we do observe that some principals offer fairly generous wages and that some agents choose effort levels for task two in excess of the minimum effort level.

On the other hand, the experimental results for the bonus contracts flatly contradict the self-interest model. The self-interest model predicts that no bonuses will be paid and that therefore agents will not expend any effort on any of the two tasks. We observe, however, that many (but not all) principals make generous bonus payments that render maximum effort levels profitable for the agents. Indeed, most (but not all) agents choose very high effort levels in both tasks under a bonus contract. Furthermore, the large majority of principals seem to anticipate this and offer bonus contracts.

These results suggest that, at least for some players, concerns for fairness or reciprocity may have affected behavior: when the agents provided high effort, many principals reciprocated by paying high bonuses. However, this explanation does not answer the following questions:

1. Under the bonus contracts, principals reciprocate high effort levels of the agents by paying sufficiently high bonuses, making it profitable for the agents to expend high effort. Under the piece rate contracts, however, agents seem to reciprocate generous wage offers from the principals much less often. Some agents do choose non-minimal effort levels for task two if they are offered a high fixed wage, but the effect is small and not sufficient for making generous wage payments profitable for the principals. What explains this asymmetry?
2. Under a bonus contract, even a purely self-interested agent should expend high effort on both tasks. Nevertheless, there is a significant fraction of agents who choose minimal effort levels.

In the following we will argue that these puzzles can be resolved by the theory of inequity aversion (Fehr and Schmidt, 1999). The choice of this theory does not mean that other theories of social preferences (e.g. Bolton and Ockenfels 2000, Levine 1998, Falk and Fischbacher 1999, Charness and Rabin 2002, Cox and Friedman 2002, Dufwenberg and Kirchsteiger 2004) are not able to also rationalize the data.[14] A main reason for applying inequity aversion is tractability.

In Fehr and Schmidt (1999), we looked for a simple model that captures the effects of fairness and reciprocity in a tractable way and that can be applied to many different classes of games.[15] The theory of inequity aversion has two main components: First, it assumes that some people are not only concerned about their own material payoff but also care about inequity or, in our context, inequality.[16] Second, the theory acknowledges that people differ. Some people are very much concerned about inequality and have a high willingness to pay in order to reduce it, while others only care about their own material payoff. In the two-player case, the utility function of an inequity averse player is given by

$$U_i(x) = x_i - \alpha_i \max\{x_j - x_i, 0\} - \beta_i \max\{x_i - x_j, 0\}, \tag{5}$$

$i \in \{1,2\}$, $i \neq j$, where $x=(x_1,x_2)$ denotes the vector of monetary payoffs and $\beta_i \leq \alpha_i$, $0 \leq \beta_i < 1$. In this utility function, the term weighted with α_i measures the utility loss that stems from inequality to i's disadvantage, while the term weighted with β_i measures the loss from advantageous inequality. Note that if $\alpha_i = \beta_i = 0$, then player i behaves as in the self-interest model.

In Fehr and Schmidt (1999), we first calibrated the distribution of the parameters α_i and β_i by using the existing experimental evidence on ultimatum and dictator games in the literature. Then, we applied the calibrated model to several other classes of games (public good games, market games,

[14] For example, it is easy to see that the theories by Bolton and Ockenfels (2000) and Charness and Rabin (2002) make roughly the same predictions in our context as the Fehr-Schmidt model. All three theories have equality as the reference point for fairness. Like Fehr and Schmidt, Bolton and Ockenfels rely on inequality aversion. With just two players the two models yield qualitatively very similar results. Charness and Rabin have an additional term in the utility function assuming that people care about total surplus maximization. However, in our context the bonus payment of the principal is a simple transfer payment that leaves total surplus unaffected. Therefore, the surplus maximization motive in Charness and Rabin (2002) cannot explain the power of the bonus contract. Instead, it is the fairness motive in their theory that yields similar predictions as the Fehr-Schmidt model.

[15] For a detailed discussion of other attempts to model "fairness" in social interactions see Fehr and Schmidt (2003).

[16] There is no generally accepted notion of *fairness*, but probably all fairness definitions imply that equals should be treated equally. In our experiments, the subjects enter the laboratory as equals. They have no information about their opponents and do not know with whom they trade. Thus, in these very simple environments, it seems natural to define *equality* as the reference point for a fair payoff distribution.

gift exchange games etc.) and showed that our calibrated model is consistent with the experimental evidence on these games as well.

The solution of the multi-task principal-agent game in this paper is straightforward using the calibrated model of inequity aversion. In fact, it is sufficient in this simple model to distinguish two types of players: inequity averse players ($\alpha_i,\beta_i \geq 0.5$) are willing to give up own resources in order to reduce inequality that is to their advantage. For example, an inequity averse principal will pay a bonus that equalizes the monetary payoffs of principal and agent, and an inequity averse agent will expend effort on task two in a piece rate contract if he is offered a generous wage. Selfish players ($\alpha_i,\beta_i < 0.5$) will simply maximize their own material payoff. Following the calibration in Fehr and Schmidt (1999), we assume that there are roughly 40% inequity averse and 60% selfish players. The qualitative results are robust to changes in this distribution as long as there is a significant fraction of both inequity-averse and selfish players. Here, we just want to provide an intuitive explanation as to why this model can explain the qualitative features of our experimental results. The full analysis is relegated to the Appendix that can be found on our webpage.[17]

Consider a piece rate contract first. If a selfish agent is offered a piece rate contract, he will accept it, choose the minimum effort of 1 on task two and an effort level of 9 or 10 (if the piece rate s is at least 5 or 10, respectively) on task one. An inequity averse agent will also work hard on task one. However, this type wants to equalize payoffs. Therefore, if he is offered a high wage, he will expend more than the minimum effort level on task two in order to increase the principal's profit. However, in order to induce an inequity averse agent to expend sizeable amounts of effort, the principal would have to pay half of the maximum total surplus upfront to the agent. For example, in order to induce an inequity averse agent to choose the efficient levels of effort, $e_1 = e_2 = 10$, the principal would have to offer a fixed wage of 575. This is very risky, because all the selfish agents will simply take this money and not expend any effort on task two. Assuming that roughly 60% of the agents are selfish, the theory of inequity aversion predicts that it is not profitable for the principal to pay high wages to the agent.[18]

Furthermore, it is also risky for the principal to hold down the agent to his reservation utility. Inequity averse agents will reject such a contract in order to ensure that both players receive a payoff

[17] Please visit http://www.vwl.uni-muenchen.de/ls_schmidt/experiments/multi_task/index.htm .

[18] In fact, this is not profitable as long as there are more than 45% of selfish players.

of zero. In fact, 7 out of 63 piece rate contracts were rejected (11 percent), and all of them involved very low wages for the agent.

Consider now a bonus contract. Clearly, a selfish principal will never pay a bonus. However, an inequity averse principal will pay a bonus that just equalizes the payoffs of the principal and the agent. Even if the probability of facing an inequity averse principal is just 40 percent, it is still profitable for a selfish agent to expend the maximum effort level on both tasks. The reason is that it is much cheaper for the agent to expend high effort upfront than it is for the principal in the piece rate contract to pay a high wage upfront. For example, providing the efficient effort levels $e_1 = e_2 = 10$ involves a cost of 150 for the agent. Suppose that the fixed wage offered by the principal is also $w=150$.[19] If the agent faces an inequity averse principal, he will get a bonus of 425. Thus, as long as the probability of facing a fair principal is larger than 35%, choosing the maximum effort levels maximizes expected profits.

However, this calculation holds only for a selfish agent. An inequity averse agent will *not* expend any effort. The reason is that if the principal does not pay the bonus, an inequity averse agent does not only suffer from the monetary loss. He suffers in addition from the inequality that is generated if the principal does not pay the bonus. Therefore, an inequity averse agent will play it safe and choose a low effort level.[20] Nevertheless, if there are enough selfish agents, it is still profitable for the principal to offer a bonus rather than a piece rate contract.

The analysis of the entire game, including stage 1 when the principal chooses which contract to offer, is complicated by the fact that the principal's choice of contract could reveal information about his type which could affect the agent's beliefs as to whether he will receive a bonus or not. However, it can be shown that the selfish type of principal always wants to mimic the contractual offer of the inequity averse type. Therefore, there are only pooling equilibria in which both types of principals offer the same type of contract. In the Appendix we show that there is a unique equilibrium under a mild condition on the beliefs of the agents in which both types of principals offer the same bonus contract.

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[19] Recall that principals have to offer a fixed wage that covers at least the agent's cost fort he suggested effort levels e_1* and e_2*.

[20] This interpretation suggests that the selfish agents work while the fair agents shirk. It would be very interesting to test this hypothesis independently. However, for this we need an experimental design that allows us to determine the degree of fairness of each participant independently of his behavior in the multi-task experiment. This goes beyond the scope of the present paper but we hope to be able to address this question in future research. We are grateful to the editors, Christian Schultz and Steinar Holden, for pointing this out.

Thus, the theory of inequity aversion is largely consistent with our qualitative experimental results. Furthermore, it offers an explanation for the two questions raised above. Appealing to the fairness of the agents in a piece rate contract does not pay off because the principal would have to transfer half of the maximum social surplus upfront to the agent which is very expensive if the agent turns out to be selfish. On the other hand, appealing to the fairness of the principal in a bonus contract is less costly for the agent. If the principal does not pay the bonus, the agent only looses his effort cost. Furthermore, only a self-interested agent will provide the efficient effort level under a bonus contract. Inequity averse agents choose low effort if they believe that the probability of facing a selfish principal to be significant, because they suffer additionally from the inequality generated by selfish principals who do not pay the bonus.

Note that the interaction of selfish and inequity averse players is crucial for the analysis. If all players were inequity averse, both types of contracts would implement the first best allocation. If all players were selfish, the bonus contract would perform miserably and all principals would go for the piece rate contract. The interaction between the two types explains the more complicated behavior observed in the experiments.

V. Concluding Remarks

The experiments discussed in this paper confirm that strong explicit incentives can be detrimental in a multi-task environment where the performance in only some tasks can be contracted upon. If an agent is offered a piece rate for one task but no explicit incentives on the other, then he is likely to concentrate his efforts on the task that is being rewarded and to neglect the other. A possible solution to this problem is a bonus contract where the principal can base the agent's reward on her subjective performance evaluation which offers a more holistic picture of the efforts of the agent. However, such a bonus payment is voluntary and cannot be enforced by the courts. Nevertheless, even in the anonymous and one-shot situation of the experiments, many (but not all) principals reward high efforts on both tasks with substantial bonus payments. Agents seem to anticipate this and many of them choose high effort on both tasks. Principals seem to understand the functioning of the different types of contracts and predominantly opt for bonus contracts.

These experimental results contradict the self-interest theory but they are consistent with the theory of inequity aversion. In particular, this theory offers an explanation as to why concerns for fairness suffice as an enforcement device for bonus contracts but not for piece rate contracts. It shows that the contract should be structured in such a way that the party who can "cooperate" at a lower cost moves first. In the experiment, it is less costly for the agent to expend effort than for the principal to pay half of the social surplus upfront to the agent. Therefore the agent should first expend his effort and then the principal should reward him, and not the other way round.

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Table 2: Effort distribution in bonus and piece rate contracts

Effort distribution in bonus contracts

$e_1 \backslash e_2$	1	2	3	4	5	6	7	8	9	10
1	66	1								
2				1						
3	1	1	3	1	1		1			
4		1	1	6	2			1		1
5				1	16	5				
6					4	7	4			
7						1	12	6		
8					1	1	6	10	2	2
9	1						2		20	2
10					1			2	4	63

Effort distribution in piece rate contracts

$e_1 \backslash e_2$	1	2	3	4	5	6	7	8	9	10
1	1									
2										
3										
4				1						
5	1					1				
6	1	1								
7				1				1		
8		1		2						
9	8	1	3	2						
10	15	2	4	3	1	4		1		1

Table 3: Determinants of bonus payments (S1-S3)

Dependent variable: Bonus payments	(1) (Robust standard errors)	(2) (Robust standard errors & clusters)	(3) (Tobit)
Constant	-73.46*** (22.30)	-73.46*** (34.39)	-294.51*** (48.75)
Total effort	12.26*** (0.84)	12.26*** (1.64)	28.03*** (2.39)
Effort Difference	-25.20*** (5.86)	-25.20*** (7.79)	-23.06** (10.91)
wage	-0.04* (0.12)	-0.04* (0.19)	-0.34* (0.20)
Demanded effort (task 1)	3.17 (5.41)	3.17 (7.06)	-2.98 (12.41)
Demanded effort (task 2)	0.63 (4.87)	0.63 (6.92)	-11.05 (12.08)
Announced bonus	0.02 (0.06)	0.02 (0.08)	-0.20 (0.12)
No. of observations	317	317	317
Adjusted R^2	0.53	0.53	0.12 (Pseudo R^2)

Table reports the coefficients from OLS and Tobit regressions. Robust standard errors are in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Figure 1: Share of bonus and piece rate contracts (S1 - S3)

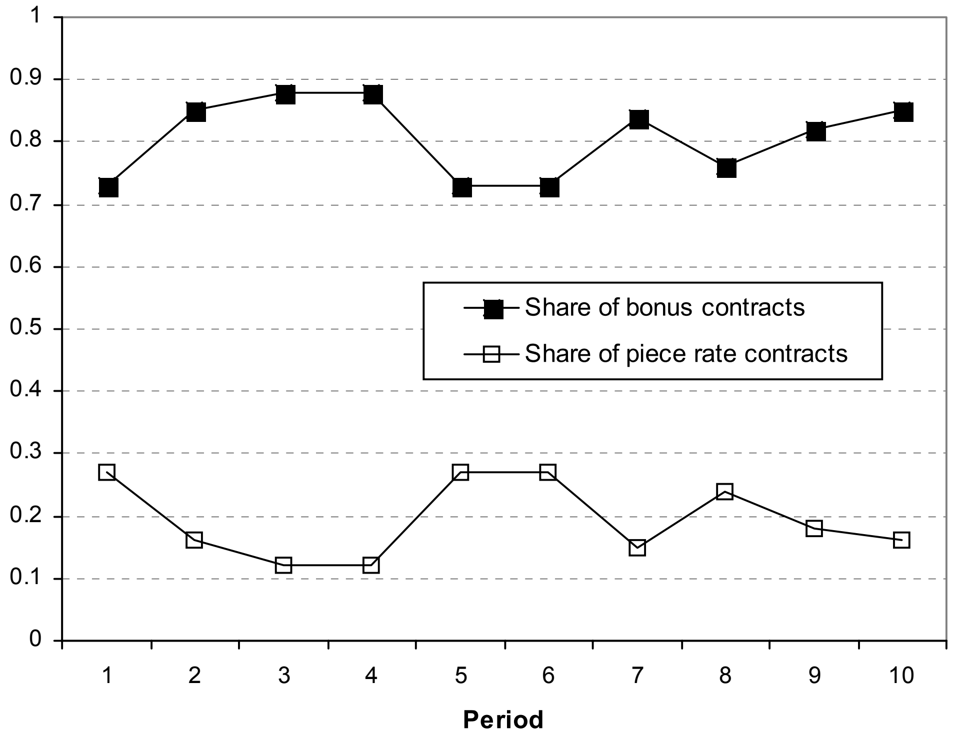

Figure 2: Average effort in piece rate and bonus contracts (S1 - S3)

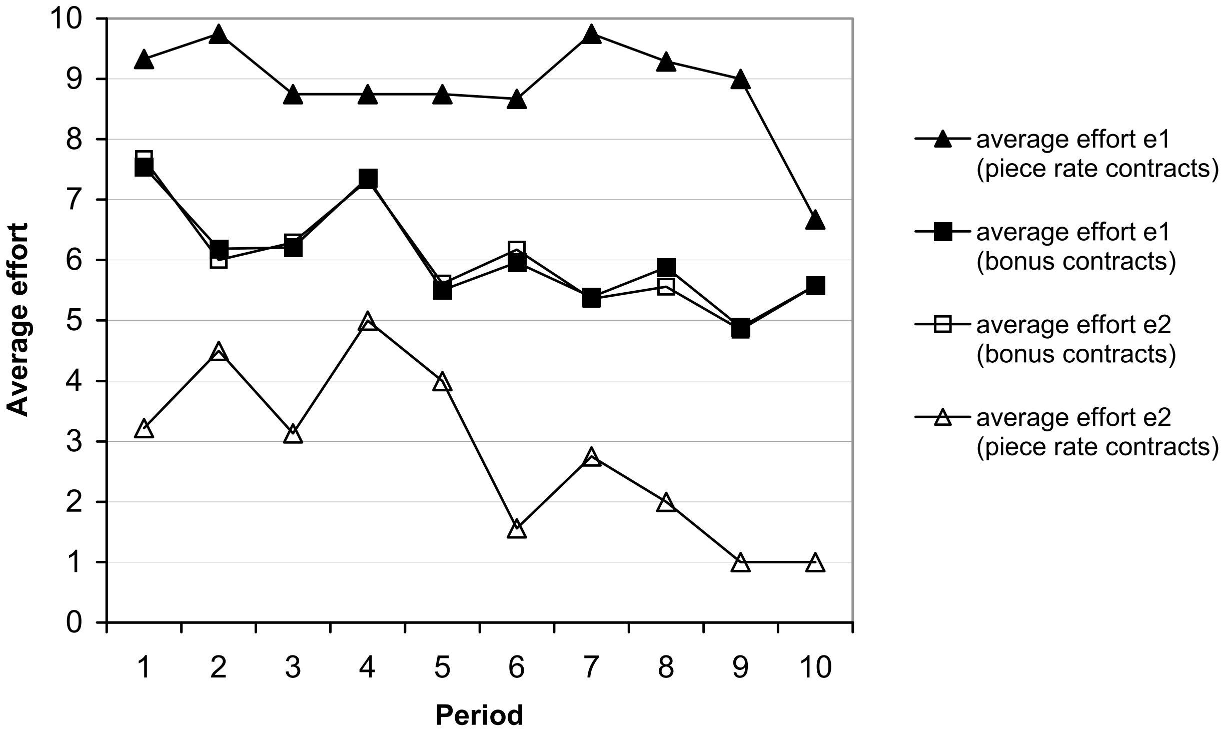

Figure 3: Average bonus and effort as a function of total effort (S1 - S3)

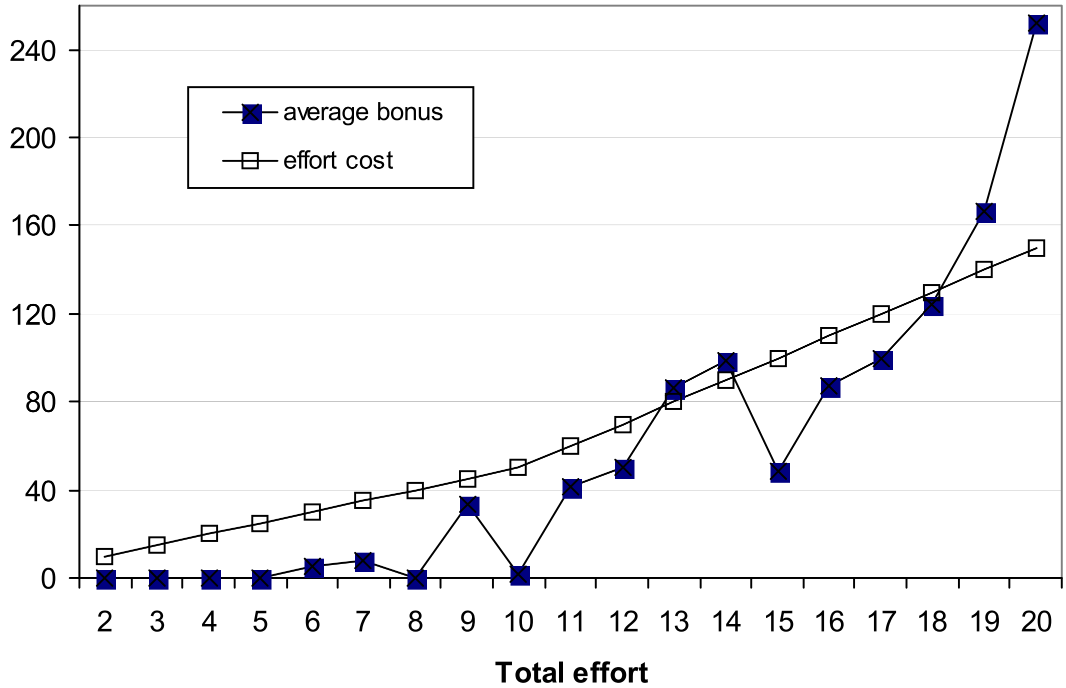

Figure 4: Average payoffs under bonus and piece rate contracts (S1 - S3)