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Sabotage in Tournaments: Evidence from a Laboratory Experiment

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Although relative performance schemes are pervasive in organizations, reliable empirical data on induced sabotage behavior are almost nonexistent. We study sabotage in repeated tournaments in a controlled laboratory experiment and observe that effort and sabotage are higher for higher wage spreads. Additionally, we find that also in the presence of tournament incentives, agents react reciprocally to higher wages by exerting higher effort. Destructive activities are reduced by explicitly calling them by their name "sabotage." Communication among principal and agents can curb sabotage when they agree on flat prize structures and increased output. If sabotage is not possible, the principals choose tournament incentives more often.

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In modern organizations, rewards based on relative performance are widely accepted as an essential component in the toolbox of incentive designers (Lazear 1999). According to estimates, a quarter of the Fortune 500 companies link parts of the individual merit pay of employees to a relative performance evaluation, for example, by "forced rankings" (Pfeffer and Sutton 1999). Internal promotion tournaments can also be regarded as relative performance schemes. The advantages credited to these schemes are manifold, ranging from diminishing the influence of global shocks, the sufficiency of ordinal ranking of output rather than absolute measurement, and the mitigation of hidden action problems. But incentive designers are also aware of a severe potential drawback: sabotage (Lazear 1989, Charness and Levine 2004). Sabotage can emerge when agents have the opportunity to diminish their competitors' performance and thereby increase their own chances of a higher position in the ranking, for example, by refusing to cooperate, by concealing viable information, by transferring false or misleading information, or even by destroying work tools needed by others.[1] Because sabotage can seriously harm the performance of organizations, it is of eminent importance to understand how different design characteristics of relative compensation schemes affect the behavior of agents. Unfortunately, sabotage activities can hardly be observed or verified. For natural reasons agents engaging in sabotage are very careful in hiding their activities. This turns the task of collecting reliable field data on sabotage into an almost unsolvable challenge.

To overcome this problem we study sabotage behavior in a controlled laboratory experiment. An experiment has the decisive advantage that one can precisely observe the effort and sabotage levels exerted by agents. Additionally, we are able to monitor how different design characteristics of relative performance schemes ceteris paribus affect behavior (for a discussion of the power of experiments in personnel and labor economics; see Falk and Fehr 2003). In our experiment, a principal can repeatedly offer tournament contracts to a group of agents. The contracts specify the total wage sum and the wage spread. The wage spread is the difference between the winner prize and the loser prizes. The agent who obtains the highest output will be rewarded with the winner prize, and the other agents will receive the loser prize.

[1] Outside of organizations sabotage also appears to be omnipresent whenever relative performance evaluation is encountered. For a prominent example from sports recall the Tonya Harding–Nancy Kerrigan case where Harding's rival Kerrigan was injured in an attack hatched by Harding's ex-husband to keep Kerrigan off the Olympic ice skating team in 1994. Or remember the fictitious but very illustrative chariot race with Charlton Heston in *Ben Hur* when he is sabotaged by his competitor Messala, who mounted blades on the hubs, designed to chew up opposing chariots. Other examples can be found in presidential election campaigns where tremendous effort is exerted to damage the other candidates' reputations by negative campaigning.

After having seen the contract, the agents simultaneously choose (productive) effort and (destructive) sabotage. Effort increases one's own output, and sabotage reduces the output of the other agents. Exerting effort and sabotage is costly for agents. The principal is rewarded proportionally to the total output reduced by a fraction of the wage costs. We study repeated tournaments between the same agents because this is arguably a very realistic setting for organizations in which the same employees compete, for example, for bonuses on a year-to-year basis. In a sense, repeated interactions are also a harder test for sabotage to occur because emerging social relations are likely to increase incentives for reciprocation and to lower incentives for destructive activities.

We provide clean evidence for one of the key conjectures on incentives provided by tournaments; i.e., individual *effort and sabotage* levels ceteris paribus increase with the wage spread (Lazear 1989). We find that the incentive effects of the wage spread are similar for different wage sums. Additionally, we observe that also in the presence of tournament incentives agents react reciprocally to a higher wage sum by increasing their effort.[2]

Because we are interested in coming close to tournament behavior in organizations, in an additional treatment we attach some flavor of a (morally and legally) reprehensible deed to the destructive activity (compare Abbink and Hennig-Schmidt 2006). We do this by framing the setting as an employment situation by explicitly speaking of "employer" and "employees" and, more importantly, by calling the two activities "effort" and "sabotage." This framing significantly reduces sabotage, suggesting that firms should indeed take care of explicitly calling sabotage activities by their name or using terms that allude to the immoral character of the activity, for example, when phrasing their codes of conducts or addressing their employees via newsletters.

Another important dimension by which to come closer to the organizational reality is to consider communication between principal and agents. This is what we do in a third treatment in which we allow the four players to communicate with each other by broadcasting text messages. Communication turns out to curb sabotage mainly because players agree on flat prize structures and increased output, which is in line with previous findings that "cheap talk" often helps to improve efficiency (see Crawford 1998, Brosig et al. 2002).

Reliable empirical data on sabotage behavior in tournaments are almost nonexistent. In an early questionnaire study, Drago and Garvey (1998) present evidence on the influence of incentives on helping effort in work groups. Workers were asked about the inclination of others in their group to help. The results suggest that helping effort is reduced when incentives in promotion tournaments are strong. Because helping effort can be seen as behavior opposite to sabotage, the tendency to behave destructively toward colleagues seems to increase with higher prize spreads. One has to bear in mind that these results are based on nonincentivized answers to sensitive questions that might be biased by other factors, like corporate culture or variations in sympathy toward colleagues. We are aware of only one empirical field study that deals with effort *and* sabotage in a competition. Garicano and Palacios-Huerta (2006) investigate an exogenous change in the reward structure of the FIFA (Fédération Internationale de Football Association) regulations on "sabotage" in soccer games. The number of forwards and the number of shots on goals are taken as proxies for the amount of productive effort, and the number of defenders and yellow cards measure sabotage. Exploiting data from a concurrently conducted competition involving the same teams and in which the prize structure did not change, they employ a difference-in-difference approach and report a tendency that proxies for both activities increase with the introduction of a higher prize spread. This is a quite interesting and important result, especially if one is interested in competitions between teams.

In a recent paper, Carpenter et al. (2010) very nicely illustrated how "office politics" are able to reverse the incentive effects of tournaments. In their real-effort experiment, agents can influence the performance measurement of their competitors. Quite interestingly, the anticipation of the harmful influence of competitors discourages agents to exert effort in the first place. Thus, sabotage from tournament incentives might be detrimental not only because of destroying output, but, additionally, because of preventing agents from exerting productive effort. Few other experiments investigate sabotage behavior.[3] Harbring

[2] Reciprocal reactions of workers under experimental fixed wage contracts are well documented (see, for example, Fehr et al. 1993, 1997, 1998; Fehr and Falk 1999; Fehr and Gächter 2000; Charness 2004; Brandts and Charness 2004; Irlenbusch and Sliwka 2005b; Charness and Kuhn 2007).

[3] A number of experimental studies deal with the analysis of productive effort choice in various tournament settings, for example, Bull et al. (1987), Schotter and Weigelt (1992), van Dijk et al. (2001), Harbring and Irlenbusch (2003), Orrison et al. (2004). For an overview and comparisons, see Harbring and Irlenbusch (2005). There are also empirical studies that analyze predictions from tournament theory with company data (for example, Knoeber and Thurman 1994, Eriksson 1999, Audas et al. 2004) or with data from sports (for example, Ehrenberg and Bognanno 1990; for an overview, see Szymanski 2003). None of these papers tackles the sabotage problem.

et al. (2007) study a different model of competition, i.e., a Tullock contest with heterogeneous agents for which sabotage can be individually addressed. They find that sabotage systematically varies with the composition of different types of contestants, for example, whether there are more underdogs than favorites or vice versa. Harbring and Irlenbusch (2008) compare tournaments of different sizes and also vary the fractions of winner prizes. They show that while tournament size has virtually no effect on behavior, a balanced fraction of winner and loser prizes appears to enhance productive activities.

Closest to our work are the papers by Falk et al. (2008) and Harbring and Irlenbusch (2005). To the best of our knowledge no other experimental studies exist in which the prize spread is varied and agents can exert sabotage. Falk et al. (2008) compare tournaments with and without sabotage possibilities. In their study the two agents have a binary choice whether they want to sabotage or not; i.e., sabotage cannot be gradually increased by an agent. Deciding to sabotage means destroying all of the output of the competitor. Moreover, they do not include an endogenous variation of the total sum of wages. The data convincingly demonstrate that agents' possibility to engage in sabotage induces the principal to choose smaller prize spreads because the frequency of sabotage choices is lower for low spreads. Harbring and Irlenbusch (2005) vary the magnitude of winner prizes while keeping the loser prize constant. They find that effort and sabotage increase with the winner prize. However, the effect of a higher prize spread cannot be disentangled from the effect of an increase of the total sum of wages. In the current paper the principal has two decision variables, (i) total sum of wages and (ii) prize spread, and thus the unconfounded effects of both parameters can be investigated. Additionally, as far as we know the effects of communication and framing have not been analyzed in a similar setting before.

The rest of this paper proceeds as follows. In §1, we introduce a simple tournament model that serves as the basic setting for our experiment. Section 2 describes the experimental design, the different treatments, and the experimental procedure. Section 3 presents our findings, §4 discusses our results, and §5 concludes.

1. A Simple Model of Tournaments with Sabotage

We employ a simple two-stage game with $n+1$ players, n agents, and one principal. The principal selects a wage contract in the first stage, and in the second stage agents can exert two activities: productive effort and sabotage. The principal can offer a wage contract by specifying a wage sum W as well as the compression of wages. In the simplest case she selects full wage compression, i.e., a fixed wage of W/n for each agent. If unequal wages are specified we assume that the agents compete in a tournament for a winner prize M. The losing $n-1$ agents each receive a loser prize m with $0 < m < M$. We denote the wage spread $(M-m)$ by Δ with $(nm+\Delta) = W$; i.e., the sum of winner and loser prizes equals the wage sum.

A strategy of an agent i is constituted by a pair (e_i, s_i), where e_i denotes effort, and s_i is the sabotage activity that reduces the output of all other agents. Exerting effort and sabotage is costly for each agent i. The costs are assumed to be convex. For simplicity we consider symmetric and quadratic cost functions of the form $C_e(e_i) = e_i^2/c_e$ and $C_s(s_i) = s_i^2/c_s$, respectively. The output y_i of agent i is determined by the following production function:

$$y_i = e_i + \varepsilon_i - \sum_{j \neq i} s_j, \tag{1}$$

with ε_i being a random variable that is uniformly distributed[4] over the interval $[-(\bar{\varepsilon}/2), +(\bar{\varepsilon}/2)]$ and assumed to be i.i.d. for each agent i. The random component, ε_i, resembles production luck or measurement error of output. The expected payoff for agent i is given by

$$\begin{aligned} E\Pi_i(e_i, e_{-i}, s_i, s_{-i}) &= f^w(e_i, e_{-i}, s_i, s_{-i})M + [1 - f^w(e_i, e_{-i}, s_i, s_{-i})]m \\ &\quad - C_e(e_i) - C_s(s_i) \end{aligned} \tag{2}$$

with $f^w(e_i, e_{-i}, s_i, s_{-i})$ denoting the probability for agent i to receive the winner prize if the other agents choose effort levels e_{-i} and sabotage activities s_{-i}.

To provide a benchmark for behavior in the experiment let us first have a look at the equilibrium prediction of the one-shot setting. For simplicity we assume that all players are rational, risk neutral, and purely money maximizing.[5] The expected payoff of an agent i can be written as

$$\begin{aligned} E\Pi_i(e_i, e_{-i}, s_i, s_{-i}) &= m + f^w(e_i, e_{-i}, s_i, s_{-i})\Delta \\ &\quad - e_i^2/c_e - s_i^2/c_s. \end{aligned} \tag{3}$$

[4] A uniformly distributed random term has the advantage that it can easily be understood by participants. For certain environments a normally distributed error term might be more intuitive. Using normally distributed error terms in tournament experiments could result in extreme outliers that would heavily distort the payoffs (which can become a serious problem if you pay the subjects). In fact, all other experimental studies on tournaments we are aware of are based on models with uniformly distributed error terms. Hence, using a uniform distribution makes it easier to compare our results with those of previous studies.

[5] For an illuminating analysis for inequity-averse agents, see Grund and Sliwka (2005).

If the principal chooses full wage compression $\Delta = 0$ (*fixed wages*), agents should neither exert effort nor sabotage. For positive prize spreads $\Delta > 0$, the first-order conditions are given by

$$\frac{\partial f^w(e_i, e_{-i}, s_i, s_{-i})}{\partial e_i}\Delta = \frac{2e_i}{c_e} \quad \text{and} \quad \frac{\partial f^w(e_i, e_{-i}, s_i, s_{-i})}{\partial s_i}\Delta = \frac{2s_i}{c_s}. \tag{4}$$

Provided our assumptions it is straightforward to show that in a symmetric equilibrium the marginal probabilities of winning depend only on the size of the interval (denoted by $\bar{\varepsilon}$) from which all random components ε_i in the production functions are drawn (for a detailed exposition, see, for example, Orrison et al. 2004, Harbring and Irlenbusch 2008); i.e., one can show that

$$\frac{\partial f^w(e_i, e_{-i}, s_i, s_{-i})}{\partial e_i} = \frac{\partial f^w(e_i, e_{-i}, s_i, s_{-i})}{\partial s_i} = \frac{1}{\bar{\varepsilon}}. \tag{5}$$

Thus, our first-order conditions for the one-shot setting reduce to

$$e^* = \frac{c_e \Delta}{2\bar{\varepsilon}} \quad \text{and} \quad s^* = \frac{c_s \Delta}{2\bar{\varepsilon}}. \tag{6}$$

These one-shot equilibrium predictions support standard conjectures about tournament incentives, i.e., that effort and sabotage increase with the wage spread but do not depend on the wage sum. Together with Equation (3) it becomes clear that for a given wage sum the (expected) payoff of agents is highest if the prize spread is zero because agents do not have to bear costs of effort and sabotage. It is worth noting that in our model an additional unit of effort has the same effect on improving own position in the ranking as has one additional unit of sabotage. The reason is that an additional unit of effort increases own output by one unit, whereas an additional unit of sabotage reduces the output of *all other competitors* by one unit. Thus, in equilibrium the marginal costs of the two activities have to be equal. To ensure that an interior solution exists and that agents have no incentive to deviate to activities of zero, the expected gain of an agent must not be lower than his cost, i.e., $\Delta/n > C_e(e^*) + C_s(s^*)$.

We assume that the principal's expected payoff increases in the total output of the agents

$$E\Pi_P(e, s) = \tau\left[E\left(\sum_i y_i\right)\right] - \theta W = \tau\left(\sum_i e_i - (n-1)\sum_i s_i\right) - \theta W. \tag{7}$$

By $\tau > 0$ it is indicated how much the principal values one unit of output. We further assume that the principal suffers a cost proportional to the promised wage sum and denote the fraction of the wage costs the principal has to bear by $\theta (0 < \theta \leq 1)$. One interpretation would be that the principal is a manager who implements the wage system and is rewarded in proportion to the output and the wage costs of his team.

Thus, in the symmetric equilibrium of the one-shot tournament setting the principal receives the following expected payoff depending on her choice of the prize spread Δ and the total wage sum W:

$$E\Pi_P(e^*, s^*) = \frac{\tau \Delta n[c_e - (n-1)c_s]}{2\bar{\varepsilon}} - \theta W. \tag{8}$$

This reflects the standard tournament result that the principal's payoff increases with the prize spread.[6] Note that ceteris paribus the principal's payoff is unaffected by the wage sum. If the principal anticipates the derived behavior of the agents and aims at maximizing her payoff, she chooses the highest possible wage spread and the lowest possible wage sum.

The analysis so far is based on one-shot tournaments. But we are more interested in repeated tournament settings because arguably they are of greater relevance for organizations. Unfortunately, it is not obvious in how far the predictions of the one-shot model transfer to a repeated situation. One would assume that in repeated interaction more efficient equilibria can be supported, for example, by trigger strategies.[7] One could think of equilibria comprising trigger strategies by which the principal threatens to pay a low wage sum for a certain number of periods if the agents do not exert high effort and refrain from sabotage. Agents, on the other hand, might threaten to exert low effort and some amount of sabotage in the future if the principal does not pay high wages. Additionally, if positive wage spreads are chosen by the principal, equilibria might be supported that comprise trigger strategies of agents against other agents. Agents may collude by agreeing on low effort and low sabotage levels and by threatening to exert higher effort and higher sabotage in the future if an agent

[6] This is true if effort and sabotage in equilibrium lead to positive output, i.e., $c_e > (n-1)c_s$. We assume that sabotage is sufficiently costlier than productive effort resembling the fact that in the workplace an agent usually has to exert some extra effort to conceal the destructive activity at least in front of the employer. Note that we implement identical cost functions for all agents. Lazear (1989) provides an analysis for heterogeneous personalities like "doves" and "hawks" by assuming differences in marginal costs of sabotage. A similar approach is taken in Harbring et al. (2007).

[7] Note that in our setting signals of past plays are noisy because after each round the principal and the agents only learn about the output of other agents and not about their actual effort and sabotage choices. Thus, we have a repeated game of imperfect public monitoring (Mailath and Samuelson 2006, Chap. 7) that might lead to inefficiencies when conditioning the trigger strategies.

does not obey the initial agreement. Equilibria comprising both variants of trigger strategies can also be possible. Because in any case sabotage is inefficient, i.e., it is costly for agents and payoff reducing for the principal, it seems safe to assume that in a repeated setting incentives for sabotage will be lower compared to the one-shot situation.

2. Experimental Design and Procedure

In our experiment we consider $n = 3$ agents, cost parameters of $c_e = 70$ and $c_s = 20$, and the size of the interval from which the random component is chosen as $\bar{\varepsilon} = 120$. Table 1 summarizes the design alternatives for the wage contracts. The principal can choose a wage sum $W \in \{300, 600\}$ as well as one of the five prize spreads Δ_j with $j = 0, \ldots, 4$. A prize spread of zero is denoted by Δ_0; i.e., all players receive the same fixed wage irrespective of the output they have achieved. Additionally, we allow the principal not to offer any contract at all, which results in a payoff of zero for the principal as well as all agents.

In the experiment, the value τ of one unit of output for the principal is set to $\tau = 3$, and the cost parameter is set to $\theta = 0.3$. Table 2 provides the corresponding effort and sabotage equilibrium predictions for the one-shot setting as well as the resulting expected output. The equilibrium effort and sabotage levels for all contracts should be in the feasible interval. Thus, we allow agents to choose integer values $e_i \in [0, \ldots, 100]$ and $s_i \in [0, \ldots, 50]$.[8]

We consider five treatments.[9] We have one baseline (Baseline) and two main treatments (Chat and Framing). These three treatments are variants of the basic setting described so far. Two additional treatments with less complex settings serve as a robustness check: In NoSabo, agents can only choose productive effort, but no sabotage. In W300, the principal cannot choose a high wage sum; i.e., the wage sum is fixed and equal to 300.

Baseline: In this treatment we avoid any value-laden terms. We do not speak of "sabotage" or "principal" or "agents." Instead we speak of players as being of type I and type II. The player of type I has to choose between a high or a low transfer and has to specify a spread. Players of type II choose two numbers A and B corresponding to the amount of effort and sabotage.

Chat: All four players are allowed to broadcast text messages during the whole game. Players cannot be individually addressed, but each message can be read by all other players (including the principal). All messages appear in a communication window on the screen similar to a chat forum. Participants are not allowed to use abusive language, to reveal their real identity, or to refer to any activity after the experiment.

Framing: The setting is framed as an employment situation. Roles of the "employer" or one of the three "employees" are assigned. The employer chooses an "employment contract" with a "high wage" or a "low wage." Employees choose a "work" intensity and a "sabotage" level.

The experiment was conducted in the Laboratory for Experimental Research at the University of Bonn and the Laboratory for Experimental Research at the University of Erfurt. All sessions were computerized, and the software was developed by using

Table 1 Design Alternatives for Wage Contracts

Prize spread Δ_j	Low wage level $W = 300$		High wage level $W = 600$	
Fixed wages $\Delta_0 = 0$	100 for each agent		200 for each agent	
	2 loser prizes m	1 winner prize M	2 loser prizes m	1 winner prize M
Tournament incentives				
$\Delta_1 = 48$	84	132	184	232
$\Delta_2 = 96$	68	164	168	264
$\Delta_3 = 144$	52	196	152	296
$\Delta_4 = 192$	36	228	136	328

Table 2 One-Shot Equilibrium Predictions for Each Prize Spread

	Fixed wages	Tournament incentives			
Prize spread Δ_j	$\Delta_0 = 0$	$\Delta_1 = 48$	$\Delta_2 = 96$	$\Delta_3 = 144$	$\Delta_4 = 192$
Effort	0	14	28	42	56
Sabotage	0	4	8	12	16
Output	0	6	12	18	24

Note. The effort and sabotage equilibrium predictions are derived for one-shot tournaments assuming that agents are risk neutral and are only interested in maximizing their own payoff.

[8] The concrete parameter values used in the experiment are necessarily arbitrary to some extent. When choosing the set of parameter values we had the following guidelines in mind. The cost parameters were chosen such that in the one-shot equilibrium an increase in the wage spread leads to higher output. As Equation (8) shows, the increase in sabotage is overcompensated by the increase in effort only if $c_e > (n-1)c_s$. The wage spreads were chosen such that in equilibrium the efforts and sabotage levels are integers and are strictly positive for wage spreads larger than zero. The latter makes it necessary that $\Delta/n > C_e(e^*) + C_s(s^*)$, which is equivalent to $(4\bar{\varepsilon}^2)/(n\Delta) > c_e + c_s$. The low wage sum of 300 is used to guarantee that for all wage spreads the loser prize is positive. The high wage sum of 600 guarantees that the increase in wages is substantial relative to the wage spreads, and together with the values of τ and θ the principal can make a positive profit in the one-shot equilibrium if she selects the highest wage spread. We also took care that the ranges of plausible payoffs of the principal and agents are large enough and are of a similar magnitude to provide both types of players with reasonable monetary incentives.

[9] Translations of the instruction sheets and their original instructions in German are available from the authors upon request.

RatImage (Abbink and Sadrieh 1995). Recruitment was done by Online Recruitment System for Economic Experiments (Greiner 2004) with a randomized allocation of subjects to treatments. In total, 336 students of different disciplines were involved. Each candidate was allowed to participate in one session only. To resemble the fact that tournaments are often repeatedly conducted with the same contestants—think of, for example, "seller of the year" contests—and to allow participants to familiarize themselves with the relatively complex strategic interaction, a session consisted of 30 repetitions (rounds) of the same tournament setting with fixed matching and roles.[10] The principal decides on the contract at the beginning of *each* round; the contract choice is communicated to the agents, and they take their decisions on efforts and sabotage levels. After each round, all players observed their own payoff, the output of each agent and the principal's payoff. Each session lasted for about two hours and participants earned €19.4 on average. After the instructions were read to the participants, they were randomly and anonymously divided into groups of four. Roles as principal and agents were also randomly allocated. Each group constitutes a statistically independent observation. We collected 24 observations with 96 subjects for each of the treatments Baseline and NoSabo, and 12 observations with 48 subjects for each of the other three treatments. In the experiment, the payoffs were given in "talers," all subjects received an endowment of 1,200 talers, and at the end talers were converted into euros by a previously known exchange rate of 200 talers per 1 euro. All subjects were paid anonymously and privately.

3. Results

3.1. Tournament Incentives

According to our analysis in §1, we would expect that effort and sabotage increase with widening the prize spread. This conjecture is in line with the behavior we observe. Figure 1 shows average effort and sabotage activities depending on the prize spread and the wage sum. The visual impression confirms that for a fixed wage sum, effort and sabotage increase with the prize spread.

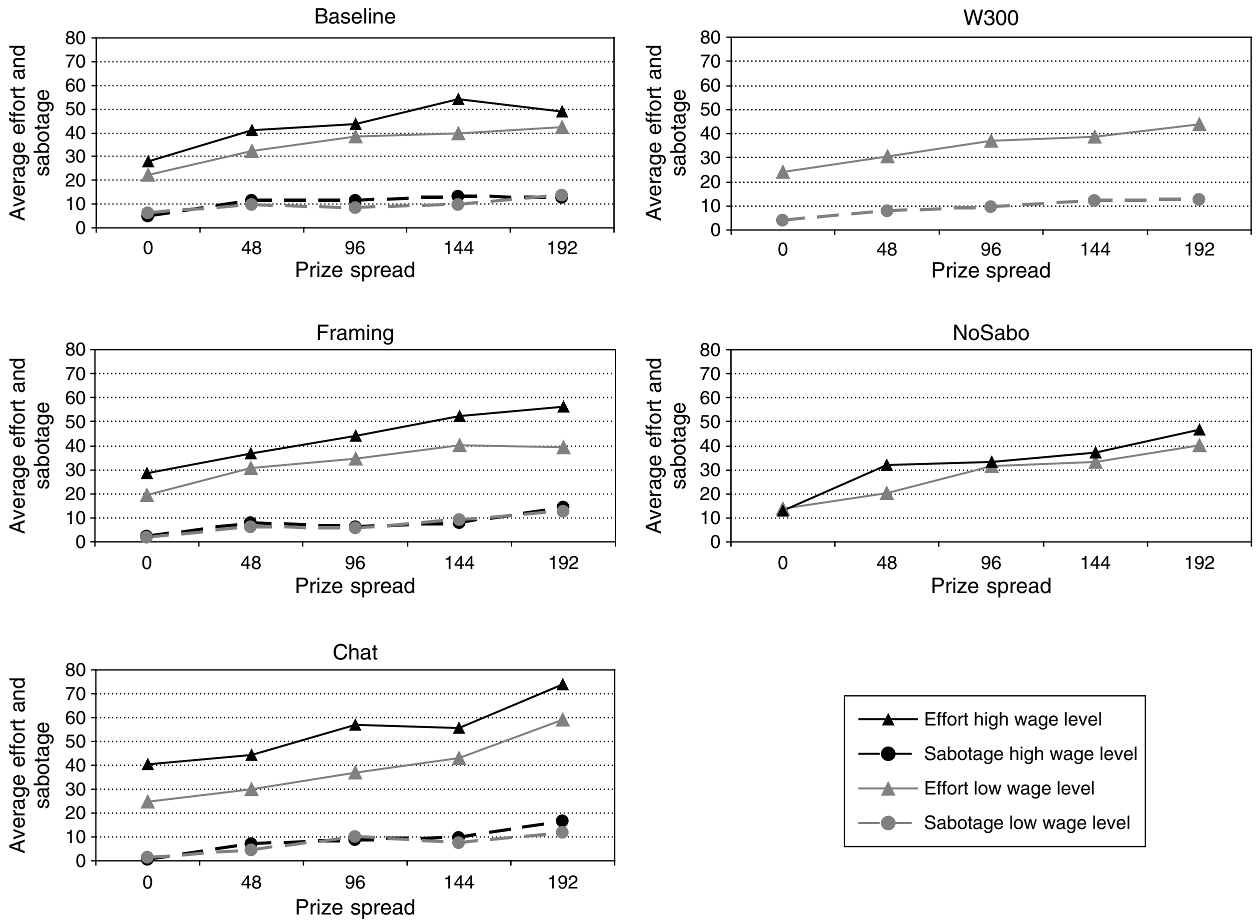
Table 3 summarizes the results of a regression analysis. We use generalized least squares (GLS) random effects estimates on individuals with robust standard errors for groups. In model (1) individual effort is the dependent variable. The variables Δ_j are dummy variables taking the value 1 if the respective prize spread $j = 1, \ldots, 4$ is chosen by the principal, and 0 otherwise. The category omitted here is the fixed wage with Δ_0, which serves as the reference situation. We find that the coefficients of the dummy variables for the prize spreads are all highly significantly positive. Thus, effort is higher with tournament incentives than with fixed wages. For example, relative to fixed wages, effort increases by 7.149 ceteris paribus if a tournament is implemented with the lowest positive prize spread Δ_1. Coefficients are increasing with an increasing prize spread, though not significantly for all comparisons made in pairs. The coefficient for Δ_1 is significantly smaller than that for Δ_2 (Wald test, two sided, Prob > $\chi^2 = 0.000$), and the coefficient for Δ_2 is significantly smaller than the one for Δ_3 (Wald test, two sided, Prob > $\chi^2 = 0.027$). The difference between the coefficients for Δ_3 and Δ_4 is not significant (Wald test, two sided, Prob > $\chi^2 = 0.112$).

The prize spread coefficients in model (2) with individual sabotage as a dependent variable are all highly significantly positive. The coefficients again tend to increase with the prize spread (Δ_1 versus Δ_3: Wald test, Prob > $\chi^2 = 0.012$; Δ_2 versus Δ_4: Wald test, Prob > $\chi^2 = 0.001$). These results are also confirmed by regressions in which we replace the dummy variables for the different wage spreads by a variable for the absolute wage spreads. Effort and sabotage both significantly increase in the wage spread. The increases are smaller than predicted by the one-shot model discussed above. The prediction of the corresponding increases in the one-shot model for effort are 0.292 per unit of wage spread and 0.083 for sabotage. The actual increases according to the regressions are significantly smaller, with 0.110 for effort (Wald test, Prob > $\chi^2 = 0.000$) and 0.041 for sabotage (Wald test, Prob > $\chi^2 = 0.000$).[11] We also checked whether the tournament incentives are different for different

[10] One could argue that repeated tournaments are especially prone to collusion among the agents against the principal because agents might (implicitly) agree on exerting low effort and winning the prize in turns. In our data we do not observe indications for collusion. Even in the Chat treatment, agents do not discuss this possibility. This might be due to the fact that in our setting agents do not have the possibility to exclusively communicate with each other, i.e., to exclude the principal from their communication (for studies on collusion in tournaments, see Harbring 2006 and Sutter and Strassmair 2009).

[11] Additionally, we ran regressions separately for the first and second halves of the experiment. Incentive effects of the wage spreads are rather unchanged between both parts. Because we observe participants choosing zero for effort and sabotage, we also ran random effect tobit models on individuals. Because of these estimates, the increases are also highly significant with coefficients of 0.137 for effort and 0.079 for sabotage. We also conducted nonparametric tests comparing average effort and sabotage for fixed wages versus tournament incentives (i.e., contracts with positive wage spread). By applying the Wilcoxon signed rank test for dependent pairs, we can confirm the results from the regressions: effort and sabotage are higher under tournament incentives than under fixed wages in all treatments (except for effort in Chat). Note that some observations must be omitted from the analysis because one can only compare groups in which both types of contracts are actually chosen by the principal.

Figure 1 **Average Effort and Sabotage Aggregated over Group Averages per Contract and Treatment**



wage levels by introducing interaction variables into the regressions that interact the dummy variable *high wage sum* (taking the value 1 for cases in which the high wage level is chosen and 0 for the low wage level) and the variables Δ_j. One could have assumed that agents think of the prize spread in relative terms regarding the wage sum and that the same spread has a stronger impact on behavior for low wage sums. However, the resulting coefficients are not significant, which is consistent with the prediction that tournament incentives are similar for different wage sums. Figure 1 seems to suggest that the increases of effort and sabotage for an increasing wage spread are slightly higher in Framing and Chat compared to Baseline. Additional interaction variables between treatments and wage spreads (not reported here), however, show that the increases in the wage spread are not significantly different between the treatments.

Observation 1. Effort and sabotage increase with the prize spread.

The prediction from the one-shot model suggests that output resulting from effort and sabotage increases with widening the prize spread. However, as can be seen from Figure 2, outputs for a given wage sum stay rather constant for different wage spreads. Regression (3) from Table 3 confirms this impression. An analogous regression with a variable for the absolute amount of the prize spread reveals that output is slightly increasing in the absolute wage spread. The increase of 0.030 is significantly different from zero (Wald test, Prob $> \chi^2 = 0.048$) but appears to be small compared to the prediction of the one-shot model of 0.125.

To understand the finding that output is rather unchanged for increasing wage spreads—although it should increase according to the equilibrium prediction—we regress the difference between marginal costs of effort and marginal costs of sabotage on the wage spreads and on the treatment variations in model (4). This provides us with a measure on how far effort and sabotage are used in an optimal relation from the perspective of an individual agent. A negative (positive) value for this measure indicates that sabotage is too high (low) relative to effort or, alternatively, effort is too low (high) relative to sabotage. Recall that from a purely money maximizing perspective the difference of marginal costs should be equal

Table 3 Regression Results

	(1)	(2)	(3)	(4)
Dependent variable:	*Effort*	*Sabotage*	*Output*	*MC*(*Effort*)−*MC*(*Sabo*)
Prize spread $\Delta_1 = 48$	7.149***	4.351***	−1.505	−0.229***
	(2.480)	(0.680)	(2.360)	(0.078)
Prize spread $\Delta_2 = 96$	13.430***	5.319***	2.802	−0.147*
	(2.490)	(0.740)	(2.420)	(0.084)
Prize spread $\Delta_3 = 144$	17.580***	6.360***	4.902*	−0.132
	(2.290)	(1.130)	(2.640)	(0.110)
Prize spread $\Delta_4 = 192$	20.880***	8.153***	4.721	−0.212*
	(2.820)	(1.180)	(3.100)	(0.120)
High wage sum	8.936***	0.519	7.887***	0.203***
	(1.340)	(0.450)	(1.300)	(0.046)
Framing	0.222	−2.561**	5.348*	0.262**
	(2.300)	(1.110)	(3.220)	(0.130)
Chat	10.450***	−3.464***	17.410***	0.646***
	(3.700)	(1.300)	(3.920)	(0.140)
Round	−0.452***	−0.084**	−0.285***	−0.005
	(0.077)	(0.033)	(0.098)	(0.004)
Constant	27.730***	6.375***	14.940***	0.153
	(2.340)	(1.050)	(2.700)	(0.110)
R^2	0.127	0.154	0.066	0.079
Observations	3,699	3,699	3,699	3,699

Notes. Random effects GLS estimates on individuals with robust standard errors for groups are reported. Models (1)–(3) explain individual *effort*, *sabotage*, and *output*. Model (4) explains the difference between marginal costs of effort, $MC(Effort) = e_i/35$, and marginal costs of sabotage, $MC(Sabo) = s_i/10$.

*Weakly significant, $0.05 < \alpha \leq 0.10$; **significant, $0.01 < \alpha \leq 0.05$; ***highly significant, $\alpha \leq 0.01$.

to zero. All coefficients in model (4) capturing the effects of the prize spreads compared to fixed wages are negative, indicating that sabotage increases (significantly) stronger with a positive wage spread than would be optimal in relation to effort. Thus, when the wage spread is increased, we observe a tendency of agents to increase sabotage to a slightly larger extent than effort. In our setting with cost parameters of $c_e = 70$ and $c_s = 20$, this tendency is sufficient to offset the increase in effort by the increase of sabotage. Note that the constant in model (4) is not significantly different from zero, which indicates that the marginal costs of effort and sabotage are similar for a wage spread of zero.

3.2. Reciprocity

From the analysis of the one-shot tournament in the first section one would expect that effort and sabotage increase with the wage spread, but both activities should not be affected by the wage sum. However, as outlined above, we know from many experiments that an intentionally chosen high wage can induce agents to reciprocate with kindness. As discussed in the first section, incentives for reciprocation are even more likely in our setting because it involves repeated tournaments among the same players. A kind reaction of an agent to a generous wage can take two forms: Higher effort and/or lower sabotage. However, these two forms of a kind reaction have opposite effects for an agent on his chances of winning the tournament. A decrease in sabotage reduces the agent's own chances of winning, whereas exerting higher effort increases the chances of winning. Figure 1 indeed shows that effort is higher for the high wage sum than for the low wage sum in all three treatments. Sabotage, however, does virtually not differ for different wage sums. The highly significant coefficient for the dummy variable *high wage sum* in Table 3 validates that effort is significantly higher for the high wage level than for low wages, which can be interpreted as a reciprocal reaction of the agents to generous wages.

As conjectured we do not find a significant decrease in sabotage most likely because this would reduce an agent's chances to receive the winner prize.[12] Also, the coefficient for *high wage sum* in model (4) is significantly positive, showing that the relation between exerted effort and sabotage changes to relatively higher effort.

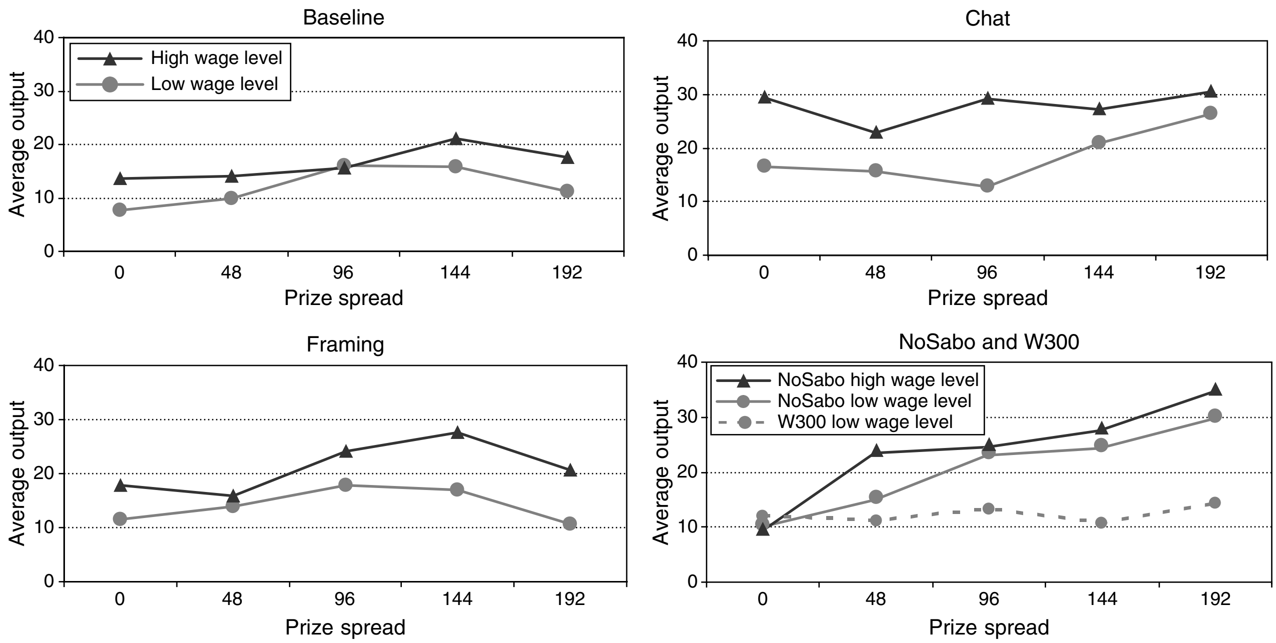
Observation 2. Effort increases with the wage sum, but sabotage does not decrease.

Model (3) in Table 3 reveals that the output of an agent is indeed higher when the principal provides a high wage sum. But because sabotage is not reduced on average, the increase of output of about eight units per agent is slightly too small to compensate the principal for his higher wage costs.[13] This might be one reason why the low wage is chosen more often than the high wage sum (with the exception of the treatment Chat in which a high fixed wage is predominantly offered by the principal; see Figure 3).

[12] To check whether the increase in effort is indeed due to reciprocity and not only due to a repeated game effect, we ran ordinary least squares regressions (not reported here) with robust standard errors for groups for last-round behavior with the same variables as depicted by Table 3. Also, in the last round effort is significantly higher for the high wage sum than for low wages, but sabotage does not differ. Additionally, we conducted a treatment W300 (see below) in which the wage sum was fixed to the low wage level of 300; i.e., the principal could only choose the prize spread but not the wage sum. We do not find any significant differences in effort and sabotage levels between W300 and the low wage level in Baseline.

[13] For each additional unit of output, the principal's payoff increases by $\tau = 3$. Because there are three agents whose output is increased by eight units each, the principal's payoff from output is increased by 72 ($= 3 \times 3 \times 8$) when he offers a high wage sum. However, the principal also has to bear his fraction ($\theta = 0.3$) of the additional wage costs of 300. Thus, his costs increase by 90 when he chooses the high wage sum, leaving him on average with a net loss of 18. Note that the principal might not immediately discover this average net loss because output is distorted by noise components.

Figure 2 **Average Output Aggregated over Group Averages per Contract and Treatment**



3.3. How to Reduce Sabotage

So far we have not analyzed possible differences between the treatments. The two treatments Framing and Chat are intended to analyze possible ways of curbing sabotage. Additionally, as argued above, both treatments also bring the sabotage setting closer to the organizational reality. Table 4 reports nonparametric comparisons between treatments by applying the Mann–Whitney U-test. Our results indicate that sabotage is indeed reduced by framing the situation as an employment context and explicitly using the term "sabotage." Sabotage is significantly lower in Framing than in Baseline, particularly if high wages and fixed wages are selected. In line with this, the dummy variable *Framing* is significantly negative in model (2) in Table 3. This reduction in sabotage leads to an increase in output (see model (3)) and to an improvement of the relation of the amount of effort in relation to the amount of sabotage (see model (4) in Table 3 and also the nonparametric results in Table 4).

Observation 3. Framing as an employment situation and explicitly calling sabotage by its name

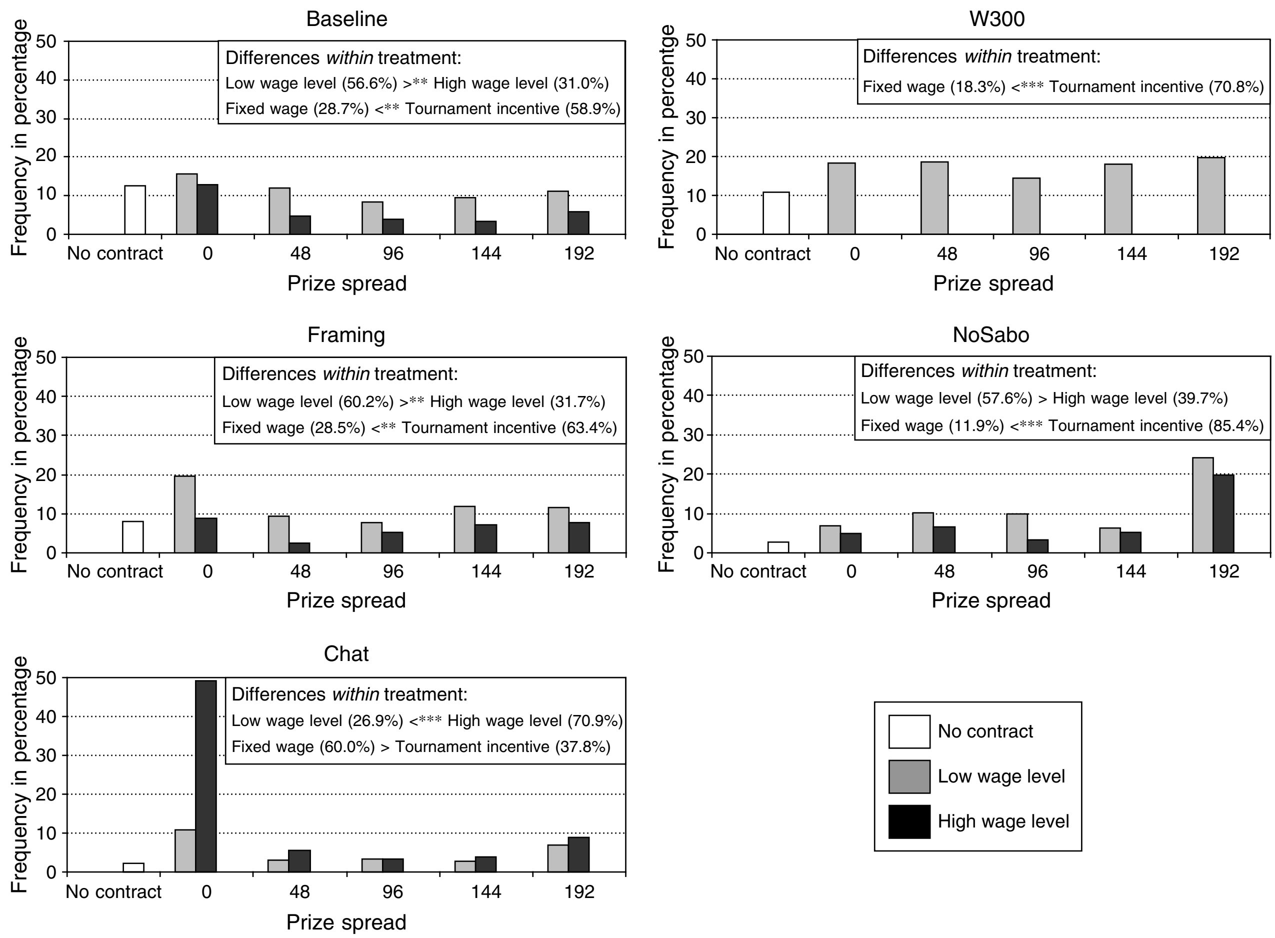
Table 4 **Comparisons of Overall Averages Between Treatments**

	Baseline	vs.	Framing	Baseline	vs.	Chat
Effort	34.3	<	35.0	34.3	<**	43.6
Low wage level	32.1	<	33.9	32.1	<	39.2
High wage level	39.1	<	40.2	39.1	<	46.8
Fixed wages	24.9	>	22.2	24.9	<*	35.5
Tournament incentives	37.9	<	39.4	37.9	<*	46.8
Sabotage	9.5	>*	7.1	9.5	>***	4.4
Low wage level	9.4	>	9.0	9.4	>**	5.5
High wage level	10.6	>**	7.9	10.6	>***	3.9
Fixed wages	5.7	>*	2.3	5.7	>	1.4
Tournament incentives	11.0	>	9.9	11.0	>***	8.2
Output	15.4	<*	20.8	15.4	<***	34.7
Low wage level	13.3	<	15.9	13.3	<***	28.1
High wage level	18.0	<**	24.4	18.0	<***	38.9
Fixed wages	13.6	<	17.6	13.6	<***	32.6
Tournament incentives	16.0	<	19.6	16.0	<***	30.4

Notes. Comparisons between treatments with groups as independent observations are shown. By using the Mann–Whitney U-test (two-tailed), we report the level of significance at which the null hypothesis can be rejected in favor of the alternative hypothesis that average values are above Baseline (<) or below Baseline (>).

*Weakly significant, $0.05 < \alpha \leq 0.10$; **significant, $0.01 < \alpha \leq 0.05$; ***highly significant, $\alpha \leq 0.01$.

Figure 3 Average Frequencies of Contracts Chosen by the Principals in Each Treatment Aggregated over Groups



Notes. "No contract" refers to the cases in which the principal refrained from offering a contract. Thus, cases for "low wage level," "high wage level," and "no contract" sum up to 100%. The same is true for "fixed wages," "tournament incentives," and "no contract." Comparisons between two contract situations within groups with dependent pairs are shown. By using the Wilcoxon signed rank test (two-tailed), we state the level of significance at which the null hypothesis can be rejected in favor of the alternative hypothesis that the frequency of the type of contract is above (>) or below (<) the second type of contract.

*Weakly significant, $0.05 < \alpha \leq 0.10$; **significant, $0.01 < \alpha \leq 0.05$; ***highly significant, $\alpha \leq 0.01$.

reduces destructive activities compared to a neutral framing.

As expected, introducing communication among the principal and the three agents in Chat also has a considerable impact on behavior. Effort significantly increases and sabotage significantly decreases when communication is allowed, which results in significantly higher output of 17.41 (Table 3). Also the relation of effort and sabotage is improved significantly compared to Baseline, as can be seen in model (4) in Table 3. Additional interaction variables between treatments and wage sum (not reported here) show that the increase in effort due to the high wage sum is significantly higher in the treatment Chat compared to the other treatments, which confirms the visual impression from Figure 1. The regression results regarding the comparison of Baseline on the one hand and Framing and Chat on the other hand are all confirmed by nonparametric tests (Table 4).

Observation 4. Communication reduces sabotage and increases effort compared to a treatment without communication.

It is worth mentioning that the positive effect of the dummy variable *Chat* on effort and its negative effect on sabotage disappear in a regression restricted only to data from the last round. This indicates that the cooperation enhancing effect of communication survives only as long as the interaction is repeated. Whether the increases in effort and the reduction in sabotage come with different contracts chosen by the principals is investigated in the next section.

3.4. Contracts

Figure 3 provides the frequencies of the different contracts chosen by the principals. The contract with the largest prize spread and the low wage level favored by the analysis in §1 is not the most frequent choice in any of the three treatments.

Table 5 Comparison of Contract Percentages Between Treatments: Baseline vs. Framing and Baseline vs. Chat

	Baseline	vs.	Framing	Baseline	vs.	Chat
Low wage level	56.6	$<$	60.2	56.6	$>^{***}$	29.9
High wage level	31.0	$<$	31.7	31.0	$<^{***}$	70.9
Fixed wages	28.7	$>$	28.5	28.7	$<^{**}$	60.0
Tournament incentives	58.9	$<$	63.4	58.9	$>^{*}$	37.8
No contract	12.4	$>$	8.1	12.4	$>^{***}$	2.2

Notes. No contract refers to the cases in which the principal refrained from offering a contract. Thus, cases for *low wage level*, *high wage level*, and *no contract* sum up to 100%. The same is true for *fixed wages*, *tournament incentives*, and *no contract*. Comparisons between treatments with groups as independent observations are shown. By using the Mann–Whitney U-test (two-tailed), we report the level of significance at which the null hypothesis can be rejected in favor of the alternative hypothesis that average values are above Baseline ($<$) or below Baseline ($>$).

*Weakly significant, $0.05 < \alpha \leq 0.10$; **significant, $0.01 < \alpha \leq 0.05$; ***highly significant, $\alpha \leq 0.01$.

Nonparametric testing of the frequencies of each contract type shows that tournament incentive contracts are more frequently chosen than fixed wages in Baseline and Framing (see also Figure 3). In Chat, the high fixed wage is more frequently selected by the principal than the tournament incentive contracts with the high wage sum (Wilcoxon signed rank test, $\alpha = 0.0995$, two-tailed). The high fixed wage is even chosen in almost 50% of the cases in Chat.

Whereas in Baseline and in Framing low wages are more often selected than high wages, the opposite is the case in Chat. It seems that in Baseline and Framing, the choice of contracts is closer to the prediction discussed in §1 than in Chat: More frequently incentive contracts are selected than fixed wages, and more often low wages are implemented than high wages. Table 5 shows nonparametric comparisons of contracts between treatments. It becomes clear that there are no significant differences of contract choices between Baseline and Framing. The contracts offered in Chat implement high wages significantly more often than in Baseline. Contracts in Chat also use tournament incentives in significantly fewer cases than in Baseline.

Observation 5. Communication leads participants to coordinate on high fixed wages.

To gain a deeper understanding of the mechanisms that result in Observations 4 and 5, we take a closer look at the individual behavior in Chat. We find that in half of the groups, fixed wages are chosen in over 60% of the rounds, including even the last one. Although there is no significant difference of efforts between these "fixed-wage" groups and the other groups that predominantly go for the tournament incentives, sabotage amounts, on average, to only 0.5 in the "fixed-wage" groups, compared to an average of 8.4 in the other groups (Mann–Whitney U-test, $\alpha = 0.004$, two-tailed). The communication protocols reveal that in the "fixed-wage" groups agents negotiate with the principal and convince him to choose fixed wages in return for high effort and low sabotage.[14] These agreements turn out to be quite stable over rounds even if one agent persistently free rides on the others' high efforts. In contrast, in the groups that predominantly rely on tournament incentives, either no such negotiations are observed or the negotiations fail as soon as participants deviate from the agreements.

3.5. Robustness Checks

In this paper, we deliberately implement a repeated tournament setting in which the principal can offer a new contract in each round. This allows us to observe reciprocal reactions of the agents as well as communication effects on the interaction of principal and agents. However, as rightly mentioned by the reviewers, such a design can cause a reversed causality between tournament incentives on the one hand and effort and sabotage on the other hand, particularly if agents do not fully adjust to contract changes over rounds. For example, the principal might respond to high sabotage with lower wage spreads or to low effort levels with high spreads. Although these two forms of reversed causalities would in fact strengthen our results—because they would imply a tendency toward a negative correlation between tournament incentives and effort and sabotage—one might also imagine reversed causalities going into the opposite direction. To suppress potential effects of reversed causality in the analysis, we run regressions with the

[14] The following sample protocol transcript (group 4, round 1) reveals a typical negotiation pattern (original protocols are in German and are available from the authors upon request):

Type I: I give everyone 200 talers, and you take 60 as number a and 0 as number b
Type II-Y: we'll see
Type II-Z: that's okay for me
Type II-X: ok
Type II-Z: then y has to participate
Type II-Y: I participate
Type II-Z: then, go for it

data of only the first round. It turns out that, according to these regressions, effort significantly increases by 0.162 per unit of wage spread ($p = 0.000, z = 4.12$), and sabotage significantly increases by 0.040 per unit of wage spread ($p = 0.025, z = 2.31$).

To be even on a safer side, we ran three additional baseline treatments with $\Delta_0 = 0$, $\Delta_2 = 96$, and $\Delta_4 = 192$ (with 3×24 new subjects) where we randomly assigned the wage spreads to groups of one principal and three agents and kept the contract fixed for 20 rounds. The principals do not have a choice in these treatments, which is known to the agents. It turns out that the incentive effect on effort and sabotage is even stronger than in our original baseline. Effort and sabotage both significantly increase in the wage spread. In a regression analogous to that in Table 3, effort increases by 17.356 ($p = 0.000, z = 5.63$) for $\Delta_2 = 96$ and by 25.588 ($p = 0.000, z = 7.53$) for $\Delta_4 = 192$ relative to fixed wages ($\Delta_0 = 0$), with the difference between Δ_2 and Δ_4 also being significant (Wald test, two-sided, Prob > $\chi^2 = 0.005$). This is also confirmed by Mann–Whitney U-tests (two-tailed): $p = 0.004$ for Δ_0 versus Δ_2, and $p = 0.037$ for Δ_2 versus Δ_4. Sabotage increases by 7.366 ($p = 0.000, z = 4.53$) for $\Delta_2 = 96$ and by 12.545 ($p = 0.000, z = 5.66$) for $\Delta_4 = 192$ relative to fixed wages ($\Delta_0 = 0$), with the difference between Δ_2 and Δ_4 also being significant (Wald test, two-sided, Prob > $\chi^2 = 0.041$). Again this is confirmed by Mann–Whitney U-tests (two-tailed): $p = 0.007$ for Δ_0 versus Δ_2, and $p = 0.109$ for Δ_2 versus Δ_4. In a regression in which we replace the dummy variables for the different wage spreads by a variable containing the absolute wage spread, we find that effort significantly increases by 0.133 per unit of wage spread ($p = 0.000, z = 7.27$). Sabotage significantly increases by 0.065 per unit of wage spread ($p = 0.000, z = 5.63$).

Additionally, because the strategic interactions in our main treatments are relatively complex, we also investigate two simplified environments as a robustness check. In one additional treatment we simplify the action space of the agents by analyzing a setting without sabotage. In another treatment we reduce the action space of the principal and look at a setting in which only one wage sum is available.

In NoSabo, agents can only exert productive effort but destructive sabotage is not feasible. This would be the case, for example, if contestants work in different regions. We are particularly interested in whether agents in such an environment react to different wage spreads with comparable effort changes as observed in our baseline treatment. In fact, this would be expected from the perspective of our analysis in §1. Visual inspection of Figure 1 confirms this conjecture. The regression reported in Table 6 (model (1)) shows that effort significantly increases for all prize spreads relative to fixed wages.[15]

Table 6 Regression Results for W300 and NoSabo

	(1)	(2)	(3)	(4)	(5)
Dependent variable:	*Effort in NoSabo*	*Effort in W300*	*Sabotage in W300*	*Output in W300*	*MC(Effort) − MC(Sabo) in W300*
Prize spread $\Delta_1 = 48$	9.957*** (3.272)	10.170*** (3.215)	4.692*** (0.806)	0.762 (3.071)	−0.179* (0.099)
Prize spread $\Delta_2 = 96$	14.670*** (3.178)	15.200*** (5.099)	5.845*** (1.081)	3.517 (3.839)	−0.151 (0.101)
Prize spread $\Delta_3 = 144$	20.770*** (3.487)	15.940*** (4.711)	7.647*** (1.597)	0.660 (3.047)	−0.310*** (0.102)
Prize spread $\Delta_4 = 192$	26.900*** (3.962)	21.170*** (4.703)	8.190*** (1.816)	4.806* (2.651)	−0.215** (0.103)
High wage sum	6.354*** (2.123)				
Round	0.000 (0.098)	−0.469** (0.182)	−0.105** (0.052)	−0.260* (0.153)	−0.003 (0.005)
Constant	12.980*** (2.292)	29.340*** (4.655)	5.754*** (1.311)	17.810*** (2.842)	0.265*** (0.0742)
R^2	0.108	0.077	0.091	0.008	0.0149
Observations	2,103	963	963	963	963

Notes. Random effects GLS estimates on individuals with robust standard errors for groups are reported. Models (1)–(3) explain individual *effort*, *sabotage*, and *output*. Model (4) explains the difference between marginal costs of effort, $MC(Effort) = e_i/35$, and marginal costs of sabotage, $MC(Sabo) = s_i/10$.

*Weakly significant, $0.05 < \alpha \leq 0.10$; **significant, $0.01 < \alpha \leq 0.05$; ***highly significant, $\alpha \leq 0.01$.

With respect to effort levels we find one interesting difference between Baseline and NoSabo: effort is significantly higher in case of fixed wages in Baseline than in NoSabo (see nonparametric results depicted in Table 7). One might conjecture that agents are rather keen on being offered fixed wages in Baseline because tournament incentives provide incentives for sabotage, which incur additional costs for the agents. And, therefore, agents try to be kind to the principal in case of fixed wages. Moreover, Figure 1 reveals that in NoSabo, average effort exerted in return for the high wage sum lies above the average effort in return for the low wage sums. The difference is significant as can be seen from the coefficient for the dummy variable *high wage sum* in Table 6 (model (1)). Note that output is significantly higher in NoSabo than in Baseline except for fixed wages (Table 7) which is quite intuitive given the absence of sabotage. As above we again find that the increase in output due

[15] An analogous regression (not reported here) in which the four dummy variables for the wage spreads are replaced by one variable indicating the absolute amount of the prize spread indeed reveals that effort is significantly increasing by 0.133, which is basically the same as the increase of effort of 0.110 in the three main treatments reported above.

Table 7 **Comparisons of Overall Averages Between Baseline and W300 as well as NoSabo**

	Baseline	vs.	W300	Baseline	vs.	NoSabo
Effort	34.3	<	35.1	34.3	>	33.9
Low wage level	32.1	<	35.1	32.1	>	28.1
High wage level				39.1	>	33.3
Fixed wages	24.9	>	22.5	24.9	>***	14.6
Tournament incentives	37.9	<	38.0	37.9	>	36.3
Sabotage	9.5	<	9.7			
Low wage level	9.4	<	9.7			
High wage level						
Fixed wages	5.7	>	4.2			
Tournament incentives	11.0	<	11.1			
Output	15.4	<	15.7	15.4	<***	33.9
Low wage level	13.3	<	15.7	13.3	<***	28.1
High wage level				18.0	<***	33.3
Fixed wages	13.6	<	14.2	13.6	<	14.6
Tournament incentives	16.0	>	15.9	16.0	<***	36.3

Notes. Comparisons between treatments with groups as independent observations are shown. By using the Mann–Whitney U-test (two-tailed), we report the level of significance at which the null hypothesis can be rejected in favor of the alternative hypothesis that average values are above Baseline (<) or below Baseline (>).
***Highly significant, $\alpha \leq 0.01$.

to high wages does not compensate the principal for her higher wage costs.[16]

In an environment in which sabotage is not feasible, one would assume that the principal is more likely to choose higher prize spreads because she does not have to fear that high incentives trigger destructive activities. Figure 3 reveals that indeed the largest prize spread is actually chosen in about 45% of all contracts, which is considerably more than in the other treatments. Table 8 confirms that in NoSabo tournament incentives are proposed in 85.4% of the contracts, which is significantly more than in Baseline.

Observation 6. If sabotage is not possible, the principals choose tournament incentives more often.

In a different treatment that we denote by W300, we keep the wage sum fixed on the low level. This treatment is motivated by a situation in which the principal is not able to raise wages to a higher level, for example, because of strict budget constraints or company policy.

Figure 1 and models (2) and (3) in Table 6 show that effort and sabotage robustly increase in each of the prize spreads also in this treatment. From the negative coefficients for the prize spread dummies in model (5) it can be seen that the costs spent for sabotage again increase relatively more with the wage spreads than the costs of effort relative to fixed wages. A similar regression for output reveals that output significantly increases by 0.021 per unit of wage spread increase. This is a very modest increase similar to the increase in the other three treatments of 0.030 (see above). In fact, as can be seen in model (4) of Table 6, the coefficients for the individual prize spread dummies are not significant. Table 7 confirms that comparing effort, sabotage, and output levels between W300 and Baseline yields no significant difference. Also regarding the chosen contracts there is virtually no difference between W300 and Baseline as can be seen from Table 8. Tournament incentives are chosen in 70.8% of the contracts, which is significantly more often than fixed wages (see Figure 3).

4. Discussion

Our data show that effort as well as sabotage activities increase with widening the wage spread in tournaments, which is in line with standard theory. In our study, output does not increase with the wage gap because participants seem to intensify sabotage more than productive effort (which might partly be due to our specific parameter constellation, e.g., the relationship of cost of effort and sabotage).

We find indicators that participants increase sabotage more compared to the increase in effort when the prize spread becomes larger. One possible explanation may be that participants overestimate the effect of sabotage compared to effort when the contest intensifies; e.g., they may think that sabotage has a larger effect because it is deducted from *each* agent's output which is—of course—a mistake from a strategic

[16] The average payoff of all players in a round, i.e., the principal and the three agents, can be interpreted as a measure for efficiency. We find that average efficiency in Baseline (64.5) is close to our equilibrium prediction (63.3) and highly significantly lower than in NoSabo (125.8, equilibrium would predict 152.4) and in Chat (129.4; both comparisons with Baseline: Mann–Whitney U-test, $\alpha = 0.000$, two-tailed). Thus, the exertion of sabotage implies a large efficiency loss as it reduces the agents' payoff as well as the principal's payoff. Introducing communication, however, strongly increases efficiency.

Table 8 Comparison of Contract Percentages Between Treatments: Baseline vs. NoSabo and Baseline vs. W300

	Baseline	vs.	W300	Baseline	vs.	NoSabo
Low wage level	NA			56.6	<	57.6
High wage level				31.0	<	39.7
Fixed wages	28.7	>	18.4	28.7	>***	11.9
Tournament incentives	58.9	<	70.8	58.9	<***	85.4
No contract	12.4	>*	10.8	12.4	>***	2.7

Notes. No contract refers to the cases in which the principal refrained from offering a contract. Thus, cases for *low wage level*, *high wage level*, and *no contract* sum up to 100%. The same is true for *fixed wages*, *tournament incentives*, and *no contract*. Comparisons between treatments with groups as independent observations are shown. By using the Mann–Whitney *U*-test (two-tailed), we report the levels of significance at which the null hypothesis can be rejected in favor of the alternative hypothesis that average values are above Baseline (<) or below Baseline (>).

*Weakly significant, $0.05 < \alpha \leq 0.10$; ***highly significant, $\alpha \leq 0.01$.

perspective. Or, agents may have a certain "taste for sabotage," as suggested by one of the reviewers. Analyzing individual sabotage behavior we find that a majority of agents frequently use the sabotage option. Whereas only 5.6% of agents never engage in sabotage in Baseline, 20.8% exert sabotage in each round, and 70.8% exert sabotage in at least half of the rounds (about 80% already in the first round).[17] Further studies are necessary to investigate motives for engaging in sabotage, differentiating different types of "saboteurs" and the dynamics of sabotage in a repeated setting.

The design of our experiment allows us to disentangle the effect of the wage spread from the effect of the wage level. Increasing the wage level enhances productive effort, indicating positive reciprocity; i.e., agents respond with higher efforts if wages are increased.

A growing body of research suggests that voluntary cooperation can actually be crowded out by incentives (Gneezy and Rustichini 2000, Fehr and Rockenbach 2003, Heyman and Ariely 2004, Irlenbusch and Sliwka 2005a; for an overview, see Bowles 2008). In light of this evidence, our result of agents' reciprocal behavior in the presence of tournament incentives cannot necessarily be expected. Gächter et al. (2009) compare incomplete employment contracts in one-shot and repeated gift exchange settings with two players. They find that crowding out of voluntary cooperation between principal and agent is much less pronounced in repeated settings and can even convert into a crowding-in effect. This might partly explain our observation given that we also investigate a repeated setting. Irlenbusch and Ruchala (2008), however, find indications that high tournament incentives crowd out voluntary cooperation among team members in a repeated setting.

In the present experiment, agents show reciprocal reactions toward the principal by exerting higher effort in response to a higher wage. Exerting higher effort simultaneously serves two potential objectives of the agents: (i) being reciprocal to the principal *and* (ii) increasing the individual chances of winning the tournament. Thus, the reciprocal action of the agents is actually reinforced by the tournament incentives, which might be an additional reason why in our setting reciprocity is not eroded by incentives. This intuition is supported by the observation that agents do not react reciprocally by reducing their sabotage. Although lower sabotage would also be beneficial for the principal, it would reduce their own chances to win the tournament. Thus, being reciprocal to the principal by exerting higher effort is in line with the tournament incentives, whereas being reciprocal by exerting lower sabotage is not. A further explanation for why sabotage is not affected by a change in the wage level might be that sabotage is interpreted as a unit of exchange in the agent–agent relationship and effort as a unit of exchange in the principal–agent relationship. Or, agents perceive the increase in wage levels as a "gift" from the principal and reciprocate by giving a gift back to the principal, and hence exert higher efforts. If principals had the chance to punish agents, maybe agents would feel that punishing in return would be an appropriate action, i.e., exerting a higher sabotage.

This observation suggests that agents' reciprocal reaction, for example, to increase wages, may help to intensify productive effort in an organization. However, our findings indicate that it is not straightforward to assume that in the presence of tournament incentives harmful activities can be reduced by a supervisor's or employer's kind actions.

Framing our experimental setting as an employment situation and labeling the two activities as

[17] In Chat, 33.3% of agents never exert sabotage (Framing, 8.3%), whereas 2.8% sabotage in each round (Framing, 5.6%), and 22.2% exert sabotage in at least half of the rounds (Framing, 36.1%). In the first round, 41.7% of agents sabotage in Chat and 55.6% in Framing.

"work" and "sabotage" shows a clear effect of reducing sabotage. Our intuition is that calling sabotage by its name highlights the immorality of the destructive activity. This, however, is likely to be only part of the story. Abbink and Hennig-Schmidt (2006), for example, compare neutral and loaded instructions in a bribery game. Certainly this also highlights the immorality of corruption, but no significant differences in behavior are observed. In fact, the evidence on the effects of using "loaded" versus "neutral" instructions in experiments is mixed (Levin et al. 1998). Samuelson and Allison (1994) observe that arbitrary role assignments with labels like "supervisor," "leader," or "guide" systematically influence individual resource requests in a resource sharing task. Burnham et al. (2000) use different expressions to denote the person to whom one is matched within a trust game. They find that calling the other person "partner" instead of "counterpart" significantly increases trust and trustworthiness, at least in the beginning of a repeated interaction. Weber et al. (2004) suggest that frames focus attention on specific situational characteristics. People then ask themselves for the normative context of the situation ("What does a person like me do in a situation like this?") and choose an appropriate action.

Our findings as well as previous results (for example, Burnham et al. 2000) seem to indicate that frames have a stronger effect on decisions if they influence the interpretation of the relationship toward others with whom one directly interacts. In our setting, participants are in an employment situation, and sabotage directly reduces the expected payoff of the other employees in the group as well as of the employer. In contrast, for example, in the bribery game by Abbink and Hennig-Schmidt (2006), "private payments" or corrupt decisions by a public official do not negatively affect the payoff of the respective direct interaction partner. Instead, they may only result in reduced payoffs of the anonymous community in the experiment, i.e., the general public.

In our additional treatments with constant prize spreads over rounds (see §3.5 on robustness checks), we showed principals the framed version of the instructions in addition to the neutrally framed ones. In a nonincentivized questionnaire[18] we asked principals which of the two instructions they would prefer if they had the choice. Interestingly, the principals' responses indicate that only few (3 out of 18) participants actually anticipated that denoting sabotage by its actual term could potentially reduce the destructive activities exerted by agents. This result is in line with other findings on judgments of frames. Blount and Larrick (2000), for example, find that in an ultimatum bargaining game participants consistently fail to select the procedural frame that maximizes their expected payoff. Similarly, Liberman et al. (2004) show that framing the prisoner's dilemma game as a "community game" increases cooperation compared to calling it a "Wall Street game." Again participants not taking part in the game are not able to give sufficient weight to the name of the game. Thus, the task to predict the effect of frames seems to be particularly hard. This makes it even more important to provide explicit recommendations to organizations encouraging them to advise employees against "uncooperative" behavior within the company, for example, by devoting considerable parts of their codes of corporate conduct to harmful forms of behavior, and to include explicit terms like "sabotage" in their communication strategy.

5. Concluding Remarks

Organizations are well advised to take the problem of sabotage seriously. We have shown that even in a repeated setting agents react to increases in tournament incentives by exerting more effort, but also more sabotage. Second, and probably undervalued by standard tournament theory, our study shows that agents react reciprocally to higher wages by exerting higher effort even in the presence of tournament incentives. However, sabotage is not reduced. Making agents aware that destructive activities are in fact "sabotage," for example, by using a language that leaves no doubt about the immorality of the activity, tends to mitigate the problem. Interestingly, we find that introducing a communication device—or bringing the setting closer to reality where communication seems to be a natural option—drastically reduces the number of tournament incentive contracts. Apparently, in our repeated setting, principal and agents are able to endogenously coordinate on high fixed wages that yield high effort and low sabotage in return. This agreement in fact raises efficiency; i.e., payoffs for principals and agents are significantly higher in Chat than in Baseline. The fact that many companies

[18] In this questionnaire we also asked principals what message they would like to send to agents if they had a chance to do so in the beginning of the game. The analysis of the messages reveals that principals ask agents to keep sabotage low and effort high. If principals had the chance to implement different prize structures, some principals threatened to set wages to zero if agents did not act according to the principal's request. We find no indications that framing arises endogenously, i.e., principals speak of "number A" (effort) and "number B" (sabotage). Future studies may investigate the effect of different communication structures (for example, of a one-way speech/message of the principal toward agents) or compare the effect of an endogenously selected framing with an exogenously given framing. This may help to clarify how an effective communication strategy in an organization should be implemented.

are reluctant to make excessive use of relative performance evaluation schemes, like "rank and yank" systems, seems to reflect our finding. As shown in an additional treatment in an environment in which sabotage is not possible, stronger tournament incentives result in considerably higher output than compressed or fixed wages.

Our experimental approach enables us to directly relate incentivized behavior to well-established conjectures about the influence of tournaments. Of course, findings from the laboratory might not be transferable to organizations on a one-to-one basis. Facing the inherent problems of collecting reliable data on sabotage, however, laboratory experiments provide a valuable—not to say a mandatory—step toward a better understanding of behavior under relative performance evaluation schemes.

Although much research has been conducted highlighting the benefits of incentive provision, systematic work on potential downsides seems to be relatively sparse. In this respect our findings may also inform a better understanding of potential pitfalls created by strong competition in more general settings other than organizations, like highly competitive markets. Recently, for example, destructive fights resulted from the fierce competition for passengers in Mumbai between the drivers of "Padminis" (older, less equipped cabs) and drivers of modern taxis with air conditioning and other comforts.[19] Another prominent example is the competition among scientists for publications, academic prizes, patents, etc. This highly competitive environment does not encourage, but rather inhibits the sharing of information with colleagues or/and the scientific community, which is likely to be socially inefficient (see, for example, Haeussler et al. 2009, Walsh et al. 2005). Additionally, our findings could be related to the general concept of "organizational citizenship behavior" (OCB; see Bateman and Organ 1983, Organ 1988). OCB emphasizes forms of employees' extra-role behavior that go above and beyond behavior that is formally required by their job description but is seen as essential for the organization's effectiveness. One important form of citizenship behavior often mentioned is helping behavior that may include information sharing or cooperating with colleagues (for an overview, see Podsakoff et al. 2000). Strong tournament incentives based on relative performance are likely to impede cooperative activities like helping each other because this deteriorates one's relative position (see Deckop et al. 1999 for a study on the relationship of pay for performance and OCB). Those employees who tend to voluntarily help others, for example, could be discouraged to do so when tournament incentives are introduced because helping others reduces the chances of winning the tournament.

We have conducted an economic experiment allowing us to speculate on possible implications regarding OCB in the context of competition among individuals in organizations. Further analyses seem necessary; e.g., the wage spread variable could be incorporated in other studies focusing on OCB. Our results give reason to believe that the dispersion of wages due to relative performance should be considered as a relevant variable in future work on OCB.

[19] We are grateful to one of the reviewers for pointing to these occurrences (see Bellman 2009).

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