Testing for Team Spirit - An Experimental Study

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Abstract

It is often suggested that team spirit counteracts free-riding. Testing for team spirit with field data is difficult, however, due to an inherent identification problem. In this paper test for team spirit experimentally. In a team work task we vary subjects' information about relative team performance while we leave unchanged the structure of explicit incentives. We find that subjects contribute more to their team's project when teams observe each others' performance. We attribute this result to the enhancement of team spirit caused by asymmetric peer effects between observing teams.

Keywords: team spirit, peer effects, organization of work, public goods experiments

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1 Introduction

"If one could enhance a common interest in nonshirking in the guise of team loyalty or team spirit the team would be more efficient. [...] The difficulty, of course, is to create economically that team spirit and loyalty. "

Alchian and Demsetz (1972: 790f.)

Team work can have important benefits. Such benefits arise, for instance, when there are efficiency gains due to knowledge transfer or specialization, or when the technology generates complementarities between the work of individuals. However, individual contributions to team output frequently cannot be enforced, which renders team work susceptible to free-riding (e.g., Holmström 1982). Since free riding hampers productivity, one would hardly expected firms to organize work in teams. On the contrary, business organizations make heavy use of teams. For example, Osterman (1994) finds that 55 percent from a 1992 survey of American establishments employ teams. According to Lawler (2001), even 72 percent of Fortune 1000 companies make use of work teams.

How can we explain that free riding in teams is not overwhelming? Modern work organizations commonly evaluate and reward teams according to the joint performance of team members. Yet, under standard economic assumptions these group incentives would have no effects to motivate workers. A way to circumvent the basic incentive problem is the use of competitive schemes which reward subjects according to relative performance (Lazear and Rosen 1981). Unfortunately, the implementation of the appropriate relative pay scheme is difficult to achieve in the field. For instance, relative rewards may be inefficient if contestants are asymmetric (Che and Gale 2003), or they may not be feasible practically, for example, when there are adverse effects on work morale that foil the intentions of the management.[1]

Recent theoretical contributions have proposed peer effects as a motive why workers abstain from free-riding in teams (e.g., Kandel and Lazear 1992, Barron and Gjerde 1997, Che and Yoo 2001, and Huck, Kübler, and Weibull 2001, Huck and Biel 2004). By peer effects this literature means that workers have social preferences which induce them to conform with actions of others, i.e., workers receive a disutility if their effort deviates from the effort of their peers.[2] Peer effects can raise contributions of the less productive workers if they follow the example of high performers. On the other hand, such effects can

[1] In some cases the implementation of relative rewards can even cause sanctions of peers against high performers. A likely reason for such behavior is that low performers try to reduce negative externalities caused by high performers on their wages under relative pay schemes. See, Fehr and Falk (2002).

[2] This interpretation of peer effects is conceptually different from rational imitation and information cascades, sometimes also called "conformity" or "social influence" (see, Bikhchandani, Hirshleifer, and Welch 1998).

also reduce the efforts of the productive workers if they are influenced by low performers. Therefore, the net impact of peer effects on total productivity is undetermined and which effect dominates is an important empirical question.

Despite its importance, our knowledge about the empirical relevance of peer effects is limited. Peer effects give rise to endogenous social interactions, which are generally difficult to identify because of confounding factors (Manski 1993). Such confounds arise, first, if members of a team share relevant individual characteristics. For example, teams may improve productivity regardless of peer effects if highly skilled workers can self-select into teams and in this way signal their abilities relative to low skilled co-workers. A second source of confounds is that a team may be exposed to unobserved exogenous factors that influence people's behavior. This case would apply, for example, if teams improve the opportunities to monitor and sanction free-riders for purely organizational reasons (Knez and Simester 2001). Although existing empirical studies have made important steps towards solving the identification problem with regard to endogenous social interactions (see, for example, Sacerdote 2001, Ichino and Maggi 2000, and the literature cited by these authors), the phenomenon of peer effects is still not well understood.

Recently, Falk and Ichino (2003) have applied experimental methods to identify peer effects empirically. In a field experiment subjects work for the experimenter and are paid independent of individual performance for the time they are working. The authors find that efforts of individual workers positively correlate with the observed output of other workers. An important observation is that when subjects work in pairs overall productivity rises. Finally, the authors find that peer effects induce the least productive subjects to work harder.

In this paper we ask whether the results provided by Falk and Ichino (2003) are generalizable to a situation where work is organized in teams. We take their results as starting point and ask whether peer effects reduces the incentive to free ride on team production. This task is demanding since it requires that peer effects are separated empirically from other motives why team members may influence each other. First, we need to exclude the possibility that team members have any economic incentive to react towards each other. For instance, if a worker's effort relative to others' within a team increases his prospects to get ahead, correlated behavior between team members could not be attributed to peer effects. Second, a large body of evidence confirms the relevance of reciprocity based effects of conditional cooperation (see, Croson 1998, Keser and van Winden 2000, Fischbacher, Gächter, and Fehr 2001, Falk, Fischbacher and Gächter 2003). Conditional cooperation is a motive according to which people reciprocate kind behavior of others. Thereby, a person's behavior is perceived as kind if it is beneficial for oneself. Within teams the own well-being depends on the efforts of other team members and as a consequence peer effects are inherently confounded with effects of conditional cooperation (see, Bardsley and Sausgruber 2005).

Taking into account these considerations, we conduct a laboratory experiment to evaluate the relevance of peer effects in teams. In our experiment subjects perform a standard team-work task. The basic idea to separate peer effects from alternative accounts is to have pairs of teams.[3] Subjects in team X observe their own team's behavior and they also observe the behavior of another team Y. Importantly, a subject's payoff in team X does not depend on the achievements of team Y: teams are payoff-independent. In this setup, reciprocal subjects in team X have no reason to cooperate conditionally on the behavior of subjects in team Y. Nor are there any economic incentives to contribute to team production at all. In contrast, peer effects between teams may exist irrespective of the fact that payoffs in teams are independent.

We test whether teams which can observe each other's performance are more productive than isolated teams because of peer pressure. We test whether peer effects exist and have the potential to give rise to "team spirit". By team spirit we mean that the presence of peer effects between teams leads to a social multiplier towards better outcomes.[4] The multiplier effect arises because the existence of peer pressure induces a strategic complementarity between contribution choices. The positive direction of the multiplier effect arises from asymmetric peer effects if low performers are more affected by peer pressure than high performers.

We find that subjects exert indeed more effort when teams can mutually observe each other's performance. We find evidence for peer effects between teams. Furthermore, these affects appear to be asymmetric, i.e., peer effects are stronger for those who contribute less effort than others. The paper proceeds as follows. In section 2 we describe the experimental procedures. In section 3 we propose a simple model to derive our hypotheses. Section 4 reports the results. Section 5 concludes.

2 Experimental Design

Subjects participate in a standard linear public good game. This game constitutes a typical team dilemma, since every team member profits from the team output regardless of

[3] Falk, Fischbacher, and Gächter (2003) apply a similar experiment with overlapping teams to test for social interactions. The essential difference between this study and ours is that our teams do not overlap, which allows us to separate peer effects from reciprocal behavior.

[4] As in the above quote by Alchian and Demsetz (1992), the economic literature occasionally refers to team spirit (see also, Kandel and Lazear 1992). However, this literature provides no clear-cut definition of team spirit. Similarly, although human resource management invests considerable resources in team spirit building activities (e.g., Heermann 1997), there it is also not clear what team spirit exactly means. For instance, social psychology regards team spirit as a sense of collective responsibility for the team's success, a mentality of team members to go beyond themselves, an expression of positive group identity, or an enthusiastic loyalty towards the team (e.g., De Cremer and Van Dijk 2002).

whether he or she bears the cost of individual effort. Subjects are randomly organized into teams. There are 4 people in each team and each subject is endowed with 20 experimental points. The points can either be kept or invested into a joint team project that generates a payoff for everyone in the team. Payoffs are determined according to

$$\pi_i = 20 - x_i + \alpha \sum_{h=1}^{4} x_h. \tag{1}$$

Here, π_i is subject i's payoff in points, x_i is i's contribution to the team project, and α is the marginal per-capita return of contributing to the team project. In the experiment, α is set at a value of 0.4.

The game was repeated for 20 periods with constant composition of teams. In any period, at the time a new decision has to be made, subjects learn the total sum of contributions of their team as well as their private earnings in the previous period. In addition, we provide information about the average team earnings accumulated over all previous periods (see appendix AII, for a complete set of instructions).

Teams are randomly matched into pairs such that for every team X in the experiment there exists a team Y. Subjects in team Y are paid according to $\pi_j = 20 - y_j + \alpha \sum_{k=1}^{4} y_k$, where π_j and y_j denote payoff and contributions of subject j in team Y. Note that payoffs between teams X and Y are independent. A team's matched team remains the same throughout the experiment. The treatments exclusively vary the flow of information between teams. Everything else remains exactly the same. The structure of the treatment variation is illustrated in Table 1. In this table X and Y refer to teams within a pair.

Our main treatment is labelled "MUTUAL" (upper left cell): In this treatment paired teams are mutually informed about their performance. In addition to the information available about their own team, subjects of team X learn last period's overall contribution to the team project and accumulated average team earnings in team Y, and vice versa. Instructions ensured that the information structure was common knowledge. The information enables subjects to evaluate the relative team performance in the previous period as well as in the experiment as a whole.

Table 1: Illustration of treatment conditions (X-team's perspective towards Y-team)

		Team Y sees team X	
		Yes	No
Team X sees	Yes	MUTUAL	OBSERVER
team Y	No	OBSERVED	BASE

As a control treatment, we implement a mixed-information condition where the flow of information between paired teams is one-sided. This produces two types of teams/treatments: An X-team ("OBSERVER") sees how it performs relative to a Y-team, just as in MUTUAL. What is different now is that the Y-team ("OBSERVED") does not see how it compares to its paired X-team; OBSERVED-subjects know that there is another team learning their overall contributions and accumulated average team earnings.

Finally, we run a baseline, labelled "BASE" (lower right cell), which implements the standard version of the public good game. In this treatment no team is informed about another team.

3 Theoretical Predictions

To illustrate how we expect peer effects to operate in our design consider the following model. There are $i = 1, ..., m$ subjects in team X and $j = m + 1, ..., m + n$ subjects in team Y. There are $t = 1, ..., T$ periods. In the experiment we set $m = 4$, $n = 4$, and $T = 20$. In every period t, the utility U_{it} of a subject i depends on its material payoff, as specified in eq. (1), and it may depend on the difference between the subject's own contribution and the contribution of others in the *previous* period. In the literature this assumption is called "myopic best reply" (see, Huck, Normann, and Oechsler 1999).

We attribute a relation between own and others' efforts to two behavioral motives. First, there is *conditional cooperation*. Conditional cooperation is a motive relevant only towards members of the own team. This is so because a subject's material well-being in team X is not affected by the actions of team-Y members. Second, there are *peer effects*. Peer effects exist irrespective of whether the behavior of peers is materially relevant. In particular, in our setup it will be important whether subjects are influenced by the behavior of another team even if that team is irrelevant for the own payoff.

Conditional cooperation and peer effects both predict that subjects are influenced by the behavior of others. In this respect, we assume that this influence is through the *average behavior* of others. This assumption allows for a substantial simplification of the model and is standard in studies on social interactions (for the so-called *linear-in-means model*, see, Manski 1993). Moreover, the assumption is behaviorally warranted to the extent that average behavior certainly is a prominent indicator of the prevalent social norm (see, Moscovici 1985).

Consider subjects in treatments MUTUAL and OBSERVER, first. In this treatment members of team X can observe another team Y. The utility for subject i in team X is

$$U_{it} = 20 - x_{it} + \alpha \sum_{j=1}^{m=4} x_{jt} - \frac{\delta_i + \gamma_i}{2}(x_{it} - \overline{x}_{-i(t-1)})^2 - \frac{\gamma_i}{2}(x_{it} - \overline{y}_{(t-1)})^2. \quad (2)$$

Here, $(x_i - \overline{x}_{-i(t-1)})$ measures the difference between subject i's contribution and the average contribution of the other X-team members in the previous period. The term $(\delta_i + \gamma_i)$ measures the degree of responsiveness towards this difference. We assume that this effect is additively decomposable into the effect of conditional cooperation due to reciprocity $\delta_i \geq 0$, and the peer effect towards others $\gamma_i \geq 0$. The term $(x_i - \overline{y}_{(t-1)})$ measures the difference between subject i's contribution and the average contributions of another team, that of team Y. Since payoffs in team X are independent of contributions in team Y this difference should not matter for subjects with reciprocal motives. Therefore, the responsiveness towards this difference is only determined by γ_i, which again measures the degree to which a subject i is influenced by others due to peer effects. Notice that we assume the same influence of others through peer effects γ_i regardless of whether the others are members of the own or the other team. This assumption enables us to empirically identify peer effects against reciprocity.

In this setup, every period constitutes a subgame in which subjects play their best-reply towards previous contributions of others. From first-order conditions we derive subject i's best-reply functions as

$$x_{it}^*(\overline{x}_{-i(t-1)}, \overline{y}_{(t-1)}) = max[0, \frac{\alpha - 1 + (\delta_i + \gamma_i)\overline{x}_{-i(t-1)} + \gamma_i \overline{y}_{(t-1)}}{\delta_i + 2\gamma_i}]. \quad (3)$$

For $\gamma_i > 0$ it holds that $\partial x_{it}^* / \partial \overline{y}_{(t-1)} > 0$. Because empirical evidence on peer effects is still scant, this motivates our first hypothesis regarding the existence of peer effects:

Hypothesis 1 *If peer effects exists, the higher the average contribution of team Y in the previous period, the higher is a team-X subject's contribution to the own team project in the current period, i.e., $corr[x_{it}, \overline{y}_{(t-1)}] > 0$.*

One can see that with $\gamma = 0$ teams are strategically independent; however, with $\gamma > 0$ efforts in teams become strategic complements. Strategic complementarity is an important ingredient to endogenous social interaction effects. Most importantly, strategic complementarity can give rise to *social multiplier effects*. Consider the case where all subjects face an identical shock. Multiplier effects are present when the aggregate response exceeds the individual response to that shock. Likewise, if subject i, for instance, increases own contributions, this increases the marginal return to all other's contributions, thereby causing an aggregate response of all other subject. Our interest is to see whether peer effects can trigger social multiplier effects in the sense of team spirit:

Definition 1 *By "team spirit" we mean that a number of teams whose members can observe the teams' achievements are ceteris paribus more productive than a number of isolated teams.*

We now turn to question under which conditions team spirit can emerge in our design. Writing eq. (3) individually for all subjects i in team X and all subjects j in team Y constitutes a system of linear differences equations, which can be represented in matrix notation as

$$\mathbf{z}_t = max[0, \mathbf{c} + \mathcal{A}\mathbf{z}_{(t-1)}]. \quad (4)$$

Here, $\mathbf{z}_t$ denotes the vector of individual contributions in period t. $\mathbf{c}$ is a vector of constants with $c_i = (\alpha - 1)/(\delta_i + 2\gamma_i)$ in treatment MUTUAL, and $c_i = (\alpha - 1)/(\delta_i + \gamma_i)$ in treatment BASE. $\mathcal{A}$ is a matrix with dimension $k \times k$ and $k = (n+m)$, whose elements weigh last period's contributions of others as functions of individual i's δ_i and γ_i (a definition of $\mathcal{A}$ is provided in Appendix AI). For an initial condition $\mathbf{z}_0$ the general solution of eq. (4) is[5]

$$\mathbf{z}_t = max[0, \mathcal{A}^t\mathbf{z}_0 + \sum_{h=0}^{t-1} \mathcal{A}^h\mathbf{c}]. \quad (5)$$

In this equation, the second term, $\sum_{h=0}^{t-1} \mathcal{A}^h\mathbf{c}$, represents the intertemporal equilibrium level of $\mathbf{z}$. The first term, $\mathcal{A}^t\mathbf{z}_0$, is a complementary function which specifies the deviations of the time path from the intertemporal equilibrium. Without peer effects, i.e., $\gamma_i = \gamma_j = \gamma = 0$, the eigenvalues of matrix $\mathcal{A}$ have absolute values either smaller or equal to 1. In both these cases, $\mathbf{z}_t$ converges to zero as t grows larger.[6]

Introducing peer effects will now have two effects: first, it reduces the eigenvalues of $\mathcal{A}$. This effect enhances the decay of cooperation. However, a second consequence of peer effects is a reduction of the constant $\mathbf{c}$. This effect slows down the convergence to equilibrium. Whether peer effects reduce or enhance the decay of cooperation depends on the particular parameter constellation. In the next section we will illustrate the impact of peer effects on the aggregate contribution pattern.

3.1 Symmetric peer effects

In the previous section we pointed out that the overall impact of peer effects on the contribution dynamics are ambiguous. Yet, a simulation of the contribution pattern according

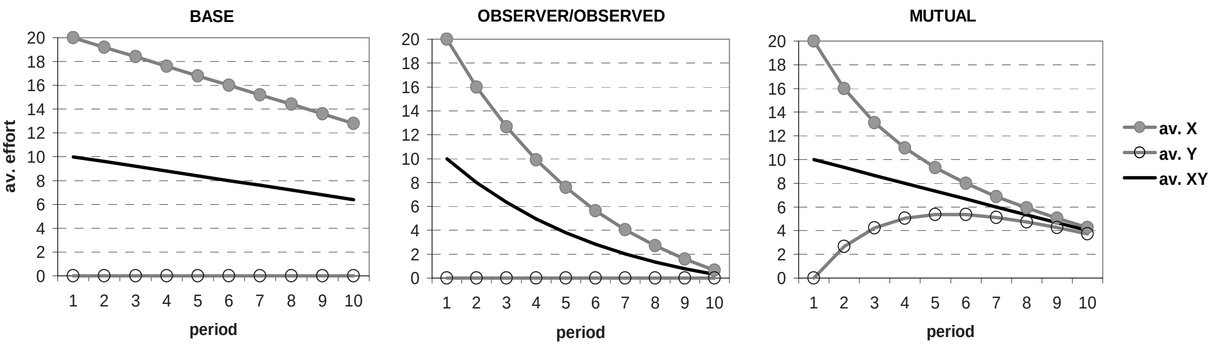
[5]We assume that an initial condition is exogenously given. For instance, subjects may have an exogenous ex ante belief about others' cooperativeness. Alternatively, one could assume that positive contributions have been enforced by a third party in period $t = 0$, before the game actually starts.

[6]Note that for eigenvalues equal to 1 it holds that $\alpha < 1$ and therefore $\mathbf{c} < 0$.

to eq. (5) with different parameter constellations can illustrate testable implications of peer effects in our design. We first consider cases where subjects are homogenous, i.e., $\delta_i = \delta_j = \delta$ and $\gamma_i = \gamma_j = \gamma = 0$, $\forall\, i \in X$ and $j \in Y$.

Case 1 ($\delta = 0.4$; $\gamma = 0.1$; $\mathbf{x}_0 = 20$; $\mathbf{y}_0 = 0$): Here, the X-team initially is fully productive whereas the Y-team contributes zero efforts. Call $\overline{xy}$ (TMT) the average aggregate effort in teams X and Y in the respective treatment. In this case it holds: $\overline{xy}$ (BASE) > $\overline{xy}$ (MUTUAL) > $\overline{xy}$ (OBSERVER/OBSERVED). This result is illustrated in Figure 1. The figure shows the simulation of average effort contributions for the first 10 periods in the respective treatments. In BASE, subjects in the X-team reduce efforts at a constant rate from one period to the next (see, "av.X" in the left panel of Figure 1). In OBSERVER, peer effects towards the other team accelerate the decay in cooperation ("av.X" in the central panel of Figure 1). In MUTUAL peer effects have two implications. First, as in OBSERVER, it reduces efforts in the productive X-team. Second, it stimulates efforts in the unproductive Y-team ("av.Y" in right panel of Figure 1). Case 1 is a case where team spirit cannot be observed on the aggregate, i.e., peer effects do not heave aggregate efforts in MUTUAL above those in BASE ("av.XY" in the left panel as compared to "av.XY" in the right panel of Figure 1).

Figure 1: Graphical illustration of case 1



Case 2 ($\delta = 0.4$; $\gamma = 0.1$; $\mathbf{x}_0 = 10$; $\mathbf{y}_0 = 10$): Here, all subjects initially exert the same effort. In this case it holds: $\overline{xy}$ (MUTUAL) > $\overline{xy}$ (OBSERVER/OBSERVED)> $\overline{xy}$ (BASE). Starting values and preference parameters are the same in all treatments. However, the treatments differ with respect to the vector $\mathbf{c}$. In OBSERVED and BASE $c_i = (\alpha - 1)/(\delta_i + \gamma_i)$, whereas in MUTUAL and OBSERVER $c_i = (\alpha - 1)/(\delta_i + 2\gamma_i)$. Hence, cooperation in efforts decays at a lower rate in MUTUAL and OBSERVER than in OBSERVED and BASE. Moreover, in MUTUAL this effect applies to both teams, X and Y. As a consequence, peer effects slow down the decay in cooperation in team X, which

in turn slows down the decay in cooperation in team Y, and so on. Here, peer effects have effort-enhancing effects on OBSERVER-teams and this effect enforces between teams in treatment MUTUAL: overall productivity rises and team spirit exists.

Case 3 ($\delta = 0.4;\ \gamma = 0.1;\ \mathbf{x}_0 = 0;\ \mathbf{y}_0 = 20$): Concerning the treatment effect between MUTUAL and BASE, this case is equivalent to case 1. What is different now is that peer effects will have strong effort-enhancing effects in the OBSERVER-teams and, different from MUTUAL, conformity towards an unproductive team does not accelerate the decay in cooperation in OBSERVED-teams. Hence we get: $\overline{xy}$ (OBSERVER/OBSERVED) > $\overline{xy}$ (MUTUAL) > $\overline{xy}$ (BASE).

Case 1 to 3 illustrate that homogenous preferences for conformity may have effort enhancing as well as effort withholding effects. Nevertheless, there is a testable implication of peer effects. In particular, in the above cases we observe that peer effects reduce the variance of contributions between teams. We state this as our second hypothesis.

Hypothesis 2 *Peer effects reduce the variance of effort contributions. Hence, if peer effects exists, the variance of efforts is smaller in treatment MUTUAL than in OBSERVER/OBSERVED. In OBSERVER/OBSERVED the variance of efforts is smaller than in BASE.*

3.2 Asymmetric peer effects and team spirit

Sacerdote (2001) reports peer effects in favor of low ability students. Similarly, Falk and Ichino (2003) report experimental results according to which unproductive workers are more influenced by others than productive ones. If this holds true also for our experiment, peer effects can produce positive social multiplier effects, i.e., team spirit, especially in treatment MUTUAL. The following cases 4 and 5 assume heterogeneity between teams which are nevertheless homogenous within a team. This assumption enables us to illustrate the implications of heterogenous preferences without modelling this heterogeneity on an individual basis.[7]

Case 4 ($\delta_i = 0.4;\ \gamma_i = 0,\ \forall\ i \in X;\ \delta_j = 0.4;\ \gamma_j = 0.1, \forall\ j \in Y;\ \mathbf{x}_0 = 20;\ \mathbf{y}_0 = 0$): This situation is the same as in case 1 with the only difference that subjects in the productive team X do not conform. This change has several effects which are shown in Figure 2. First, there is an effort-decreasing effect because cooperative subjects respond less to others' cooperation in the own team. As a consequence, X-team contributions in BASE decay faster than in case 1 (in the left panel of Figure 2 "av.X" is steeper than in Figure 1). However, there are also two effort-enhancing effects. The first one is that cooperative subjects in team X are less influenced by the unproductive team Y. Hence, X-teams

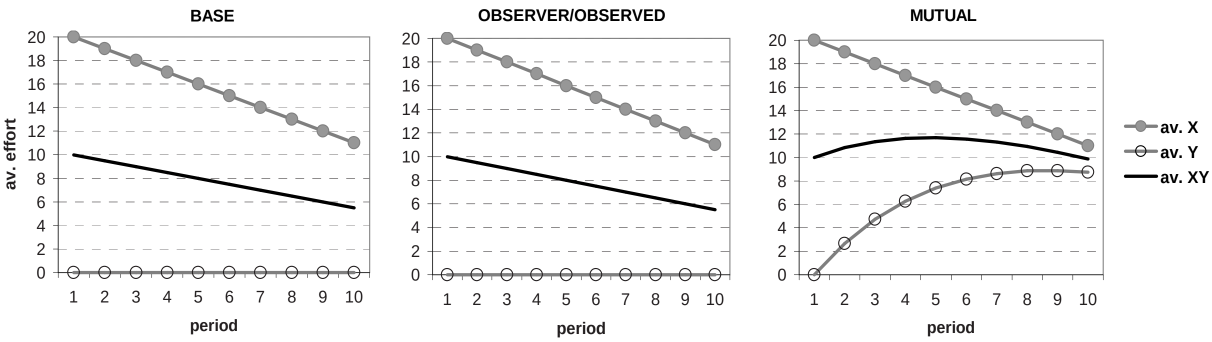
[7] In fact, the simulations reveal very similar results for within- and between-team heterogeneity.

exert higher efforts in treatments OBSERVER and MUTUAL (see "av.X" in the central and right panel of figure 2). The second positive effect on efforts arises because initially unproductive subjects in Y-teams are nevertheless influenced by high contributions of the other team in MUTUAL ("av.Y" in the right panel of figure 2). Overall, these effects result in the following predictions: $\overline{xy}$ (MUTUAL) $>$ $\overline{xy}$ (OBSERVER/OBSERVED) $=$ $\overline{xy}$ (BASE).

Case 5 ($\delta_i = 0.4;\ \gamma_i = 0.1,\ \forall\ i \in X;\ \delta_j = 0.4;\ \gamma_j = 0, \forall\ j \in Y;\ \mathbf{x}_0 = 0;\ \mathbf{y}_0 = 20$): This is the same as case 3 with the only difference that now the productive subjects in the Y-team do not conform. The effects of this change are analogous to those described in case 4, with the difference that OBSERVED-team Y is not influenced to reduce efforts. The predictions in this case are: $\overline{xy}$ (MUTUAL) $=$ $\overline{xy}$ (OBSERVER/OBSERVED) $>$ $\overline{xy}$ (BASE). We conclude from cases 4 and 5 that peer effects have the potential to stir team spirit if those who contribute high efforts are less susceptible to conformity than others:

Hypothesis 3 *"Team spirit" may arise if peer effects are asymmetric in the sense that these effects are stronger for subjects who provide low effort than for those who provide high efforts. If team spirit exists, effort in MUTUAL shall be higher than in other treatments.*

Figure 2: Graphical illustration of case 4



4 Experimental Results

Experiments were run between May and June 2002, at the Faculty of Social and Economic Sciences at the University of Innsbruck. Nine experimental sessions were conducted with a total of 212 undergraduate students from various majors as participants. 72 subjects participated in MUTUAL, 64 in the mixed information treatments, i.e., 32 each in OBSERVED and OBSERVER; and 76 in BASE. The average subject earned Euro 8 (US $

8) within approximately 30 minutes. The experiments were programmed and conducted using the software z-Tree (Fischbacher 1999).

The following section 4.1 reports our results regarding the existence of peer effects. In section 4.2 we test whether peer effects can give rise to effort enhancing effects in the guise of team spirit.

4.1 The existence of peer effects

Table 2 shows the results of an OLS regression using data from treatments MUTUAL and OBSERVER, i.e., from treatments where an X-team can observe a Y-team. Individuals' own contributions in period t are regressed on explanatory variables in period $t-1$. Using lagged values for explanatory variables accounts for the classical simultaneity problem in estimating social interaction effects. The numbers in parentheses show robust standard errors adjusted for clustering on independent groups (i.e., pairs of teams). To test for hypothesis 1 we estimate a subject's best response function as defined in eq. (3). The results of this estimation are shown in column (1) of table 2 (columns (2) and (3) will be discussed later). A constant is included in the regression to account for the starting value $\mathbf{z}_0$. Variable t is a linear time trend to capture the term $((\alpha-1)/(\delta_i+2\gamma_i))$ in eq. (3).

Consistent with many previous experiments the time trend is significantly negative (e.g., Ledyard 1993). The positive and significant coefficient on previous average efforts of the own team, $\overline{x}_{-i(t-1)}$, is commonly referred to as conditional cooperation: a subject is more likely to contribute to team production the more the others of the own team have contributed in the previous period (see, the literature cited in the introduction). As mentioned above, we attribute this result to a combined effect of reciprocity and peer effects.

Our main interest is whether team Y has any influence on team X. Such relevance is indeed confirmed by a positive and significant coefficient on variable $\overline{y}_{j(t-1)}$. In eq. (3) the coefficient on $\overline{y}_{j(t-1)}$ is $(\gamma_i/(\delta_i+2\gamma_i)$. Hence, the regression provides evidence for peer effects, i.e., $\gamma_i>0$. This finding is consistent with Falk and Ichino (2003) and reconfirms the results obtained Bardsley and Sausgruber (2005). We state this as our first result:

Result 1 *In line with hypothesis 1, team efforts positively correlate with efforts of a payoff-irrelevant second team. Peer effects exist.*

Hypothesis 2 is a consequence of peer effects between teams. A variance ratio test reveals that the standard deviation of efforts is smaller in treatment MUTUAL than in treatments OBSERVER/OBSERVED (7.25 vs. 7.79, p=0.004). As predicted the variance is also smaller in MUTUAL than in BASE (7.25 vs. 7.72, p=0.008). These results confirms hypothesis 2. On the other hand, the standard deviation does not differ between treatments OBSERVER/OBSERVED and BASE (7.79 vs. 7.72, p=0.627).

Result 2 *In line with hypothesis 2, the variance of team efforts is smaller in MUTUAL than in both OBSERVER/OBSERVED and BASE. No effect exists between OBSERVER/OBSERVED and BASE.*

Table 2: OLS regression with robust standard errors: MUTUAL and OBSERVER

	Dependent variable: x_{it}
Independent variable	Coefficient (robust std. error)
t	-0.102*
	(0.050)
$\overline{x}_{-i(t-1)}$	0.640***
	(0.108)
$\overline{y}_{j(t-1)}$	0.157*
	(0.086)
	N= 1292
	F(3, 16) = 92.1***
	R^2=0.323

Notes: *** = significance at 1%, * = significance at 10%

4.2 Team spirit: peer effects on the aggregate

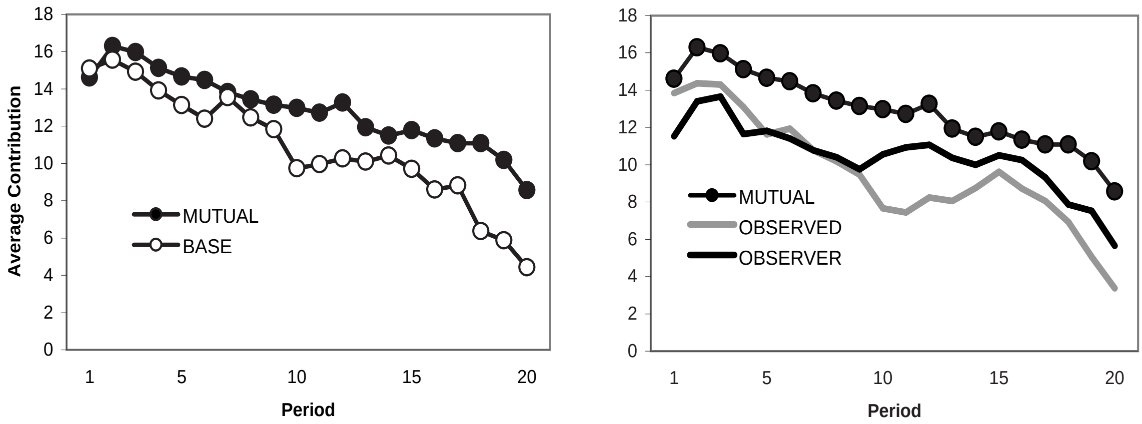
The results of the previous section show that peer effects between teams exist. In this section we evaluate the relevance of these effects on the aggregate efficiency. Figure 3 shows the time pattern of average effort contributions. The left panel shows contributions in treatments MUTUAL and BASE. Apparently, efforts in MUTUAL are higher than in BASE. Overall, the mean contribution are significantly different between these two treatments (12.9 vs 10.9, p=0.061[8], Wilcoxon rank-sum test, one-sided) and it can be seen that the difference grows larger from one period to the next.[9]

The right panel shows average contributions in OBSERVER/OBSERVED. For the ease of comparison this figure also includes contributions in MUTUAL. Efforts in MUTUAL

[8]The same p-value is obtained form a regression-based one-sided t-test which calculates robust standard errors adjusted for clustering on independent groups.

[9]In the last period, efforts in MUTUAL are almost twice as high as in BASE (8.6 vs. 4.4 points, p=0.021).

Figure 3: Time series of average contributions



are significantly higher than in OBSERVED (p=0.062). The difference between MUTUAL and OBSERVED is close to being significant (p=0.124). Although effort contributions are slightly higher in OBSERVER than in OBSERVED, this difference is not significant (10.4 vs. 9.6, p=0.390). Finally, the differences between efforts in BASE and OBSERVER are not significant (10.9 vs. 10.4, p=0.479), nor are those between BASE and OBSERVED (10.9 vs. 9.6, p=0.198).

With respect to the OBSERVER/OBSERVED conditions we regard two observations as particularly noteworthy. First, being observed has no effect on efforts as compared to BASE. The literature sometimes hypothesizes such effects, e.g., under the notion of esteem (Brennan and Pettit 2000). For instance, some people are more likely to refrain from jaywalking or littering on the street when they are observed by others. Notice, however, that self-esteem is different from peer effects. Self-esteem is hypothesizes to arise if one's actions are *observed* by others. Peer effects, in contrast, arise if one *observes* the actions of others.

Second, although contributions in OBSERVER are slightly above those in OBSERVED, this difference is insignificant. This observation tells us that mutual observability is essential to trigger team spirit, i.e, multiplier effects caused by peer effects. Case 4 has illustrated that such a result may obtain if subjects who contribute high efforts are not influenced by others. It is noteworthy that efforts in the OBSERVER-condition are also not much higher than in BASE. We know from psychological experiments about the relevance of social identification. A large body of research on in- and out-group phenomena investigates whether and why people are more apt to cooperate with members of a socially identified in-group (e.g., De Cremer and van Dijk 2002). However, careful experimental research by Yamagishi and Kiyonari (2000) has revealed that in-group favoritism quickly fades away when subjects learn about the true cooperativeness of the other players. That there is no treatment effect between OBSERVER and OBSERVED, indicates that team-identification is of little relevance in our design. In fact, we use neutral wording and assure complete anonymity of interactions. These precautions leave indeed little room for social identification of subjects within teams.

Overall, our observations are consistent with the results from the simulations in cases 2 and 4 (see, section 3). In case 2 peer effects slow down the decay in cooperation in MUTUAL and OBSERVER such that contributions in these treatments exceed those in treatments OBSERVED and BASE. In case 4 high contributors are less influenced by others through peer effects than low contributors. As a consequence, effort contributions in MUTUAL exceeded those of all other treatments. We now turn to the question whether such asymmetric peer effects exist in our experimental data.

4.3 Are peer effects asymmetric?

A natural way to answer this question is to evaluate the treatment effect between MUTUAL and BASE for different percentiles of the contribution distribution. If the presence of another team in treatment MUTUAL affects equally productive and unproductive subjects, the treatment effect shall not differ between lower and higher percentiles.

Table 3: Estimates of asymmetric treatment effects between MUTUAL and BASE: quantile regressions

		Quantile				
		0.15	0.3	0.5	0.7	0.85
(1)	*BASE*	-5***	-5***	-4***	-2*	0
	(N=2240)	(1.240)	(0.503)	(0.968)	(1.051)	(0.134)
(2)	*BASE*	-5***	-5***	-6***	-2*	0
	(N=1936)	(0.788)	(0.894)	(1.342)	(0.918)	(0.150)

Notes: Bootstrapped standard errors in parentheses; *** = significance at 1%, * = significance at 10%.

Row (1) of Table 3 reports the estimated treatment effect for the 15th, 30th, 50th, 70th, and 85th percentile of the contribution distribution. Row (2) is explained in the next section. The results show that subjects who contribute at the lower part of the distribution are more affected by the treatment variation, compared to high-contributors. For subjects in the highest percentile there is no treatment effect at all. Tests for significance illustrate the magnitude of these effects: the difference in the treatment effect is not significant between the 30th and 50th percentile (p=0.264); it is significant between the 50th and 70th percentile (p=0.001). We summarize these findings as a separate result:

Result 3 *Peer effects are asymmetric: subjects who contribute less to team production are more affected by the variation of treatments between MUTUAL and BASE, compared to high contributors. In line with hypothesis 3, asymmetric peer effects can consistently explain team spirit as reason why effort contributions in MUTUAL exceed those in OBSERVER/OBSERVED and BASE.*

4.4 Peer effects and imitation

So far we have seen that peer effects exist between payoff-independent teams. Furthermore, we have found that the experimental data can be consistently explained by team spirit emerging from asymmetric peer effects. In this section we discuss whether learning can provide an alternative account to explain our experimental results.

Typically, in the context of a repeated public good game by learning we mean that subjects learn to choose the individually rational payoff-dominant strategy. Since the dominant strategy is to contribute zero, this interpretation of learning cannot explain our results. However, people employ several modes of learning in dynamic games and some of these generate predictions quite similar to our results (for a survey, see, Camerer 2003, Ch. 6). To illustrate, take imitation of successful behavior as a particularly intuitive learning mode.[10] In our design, subjects can observe the average behavior and the outcome achieved by another team. This information enables subjects in team X to learn about the relation between aggregate effort contributions and average payoff in team Y. Furthermore, imitation would exhibit asymmetric effects since members of an unproductive team have a higher potential to learn than those of a productive team.

Our design is not powerful enough to strictly differentiate between peer effects and imitation. However, we can ask whether the previous results also hold when X-team subjects have a reduced incentive to imitate the observed Y-team. Following this intuition, row (2) of Table 3 (see, previous subsection) re-estimates the same quantile regressions as in row (1) with the only difference that the sample in treatment MUTUAL is reduced to those observations where the own team performed better than the observed team in the previous period. Apparently, if the own team has achieved better outcomes than the observed team, an imitator has little incentive to be influenced by that team. Row (2), nevertheless, shows similar asymmetric treatment effects between low and high percentiles of the contribution distribution as before: with the only exception of the 50th percentile, subjects who contribute at the lower part of the distribution are more affected by the treatment variation than high-contributors. We therefore regard it is very unlikely that our previous results were just due to imitation.

[10] The empirical relevance of imitation has been established for instance by Huck, Normann, and Öchsler (1999).

5 Conclusion

In a recent study Falk and Ichino (2003) have established the empirical relevance of peer effects between individuals. In this paper we test whether such peer effects are generalizable to explain why free riding in teams is not excessive. In particular, we test whether the opportunity of teams to compare each others' performance stirs a spirit of teams towards greater effort. By team spirit we mean social multiplier effects caused by peer effects and the fact that members of an unproductive team choose as standard for the own effort that of another, productive team.

We have argued that testing for team spirit is difficult in the field because it is hardly possible to find a setting in which the effects of both, endogenous and exogenous characteristics of a team can be controlled for simultaneously. To avoid this problem of identification we propose an experimental design in which team members contribute to independent team projects. Apart from varying the information regarding the relative team performance, the incentive structure is held constant across all treatments. By this means we disentangle the motivating effects of team spirit against alternative accounts. The main result is that teams are more productive when teams can observe each others performance. In contrast, we do not find enhanced contributions under conditions of unilaterally observing or being observed by another team.

To explain these findings we provide a detailed account of team spirit as an implication of peer effects. Thereby, an essential ingredient of team spirit is that peer effects are asymmetric: team spirit evolves if peer effects are stronger for unproductive than for productive teams. Our results 1 and 2 establish the existence of peer effects between teams. Result 3 shows that these effects are asymmetric: the effort enhancing peer effects outweigh the effort withholding ones.

An important question is whether effort enhancing effects between teams arise from team spirit or whether such effects are an outflow of imitating behavior between teams. We address this question empirically by confining the data set to cases where imitation would not make sense from a learning perspective. This analysis reveals that our results regarding the existence and asymmetry of peer effects remain valid also when imitation less of a concern.

Our study suggest that already a little information may go a long way, i.e. the public announcement of relative performance measures can trigger a spirit of teams towards greater efforts. In our design a subjects' welfare is independent of relative team performance and there are no stakes for rivalry between teams. The paper, therefore, differs fundamentally from a growing number of studies about the motivating effects of tournament-based, competitive pay-schemes (Nalbantian and Schotter 1997), or the effects of between-group competition on within-group cooperation (for a survey see Bornstein 2003). These studies impose incentives on individuals to compete between teams, removing the opportunity to isolate implicit motivating effects of team spirit. We also do not add anything to ease monitoring or sanctioning that could explain more cooperation in teams, for instance, due to a social norm of reciprocity (Carpenter and Matthews 2001). Our finding may explain, for instance, why team incentives can raise productivity against standard theoretical predictions (e.g., Ichniowsky, Shaw, and Prennushi 1997, Boning, Ichniowsky, and Shaw 2001). Finally, previous experimental studies by Schotter and Weigelt (1992) and Bornstein and Ben-Yossef (1993) have found that relative compensation results in higher efforts even if this is not supported by the solution of a non-cooperative game. We think that the prevalence of team spirit provides an intuitive explanation for such empirical observations.

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Appendix AI: Definition of variables in treatment MUTUAL

There are $i = 1, ..., m$ subjects in team X and $j = m+1, ..., (m+n)$ subjects in team Y. Consider $m = 4$ and $n = 4$ and call x_{it} subject $i's$ contribution in the X-team and y_{jt} subject $j's$ contribution in the Y-team in period t. Eq. (5) is: $\mathbf{z}_t = max[0, \mathcal{A}^t \mathbf{z}_0 + \sum_{h=0}^{t-1} \mathcal{A}^h \mathbf{c}]$. Here, $\mathbf{z_t}$ denotes the vector of contributions with $\mathbf{z_t'} = \{x_{1t}, x_{2t}, x_{3t}, x_{4t}, y_{5t}, y_{6t}, y_{7t}, y_{8t}\}$. $\mathbf{c}$ is a vector of constants: $\mathbf{c}' = \{\frac{\alpha-1}{\delta_1+2\gamma_1}, \frac{\alpha-1}{\delta_2+2\gamma_2}, \frac{\alpha-1}{\delta_3+2\gamma_3}, \frac{\alpha-1}{\delta_4+2\gamma_4}, \frac{\alpha-1}{\delta_5+2\gamma_5}, , \frac{\alpha-1}{\delta_6+2\gamma_6}, \frac{\alpha-1}{\delta_7+2\gamma_7}, \frac{\alpha-1}{\delta_8+2\gamma_8}\}$. Finally, $\mathcal{A}$ is a matrix that weighs contributions from the previous period as function of individual parameters $\delta_{i,j}$ and $\gamma_{i,j}$:

$$\mathcal{A} = \begin{pmatrix}
0 & \frac{1}{3}\frac{\delta_1+\gamma_1}{\delta_1+2\gamma_1} & \frac{1}{3}\frac{\delta_1+\gamma_1}{\delta_1+2\gamma_1} & \frac{1}{3}\frac{\delta_1+\gamma_1}{\delta_1+2\gamma_1} & \frac{1}{4}\frac{\gamma_1}{\delta_1+2\gamma_1} & \frac{1}{4}\frac{\gamma_1}{\delta_1+2\gamma_1} & \frac{1}{4}\frac{\gamma_1}{\delta_1+2\gamma_1} & \frac{1}{4}\frac{\gamma_1}{\delta_1+2\gamma_1} \\
\frac{1}{3}\frac{\delta_2+\gamma_2}{\delta_2+2\gamma_2} & 0 & \frac{1}{3}\frac{\delta_2+\gamma_2}{\delta_2+2\gamma_2} & \frac{1}{3}\frac{\delta_2+\gamma_2}{\delta_2+2\gamma_2} & \frac{1}{4}\frac{\gamma_2}{\delta_2+2\gamma_2} & \frac{1}{4}\frac{\gamma_2}{\delta_2+2\gamma_2} & \frac{1}{4}\frac{\gamma_2}{\delta_2+2\gamma_2} & \frac{1}{4}\frac{\gamma_2}{\delta_2+2\gamma_2} \\
\frac{1}{3}\frac{\delta_3+\gamma_3}{\delta_3+2\gamma_3} & \frac{1}{3}\frac{\delta_3+\gamma_3}{\delta_3+2\gamma_3} & 0 & \frac{1}{3}\frac{\delta_3+\gamma_3}{\delta_3+2\gamma_3} & \frac{1}{4}\frac{\gamma_3}{\delta_3+2\gamma_3} & \frac{1}{4}\frac{\gamma_3}{\delta_3+2\gamma_3} & \frac{1}{4}\frac{\gamma_3}{\delta_3+2\gamma_3} & \frac{1}{4}\frac{\gamma_3}{\delta_3+2\gamma_3} \\
\frac{1}{3}\frac{\delta_4+\gamma_4}{\delta_4+2\gamma_4} & \frac{1}{3}\frac{\delta_4+\gamma_4}{\delta_4+2\gamma_4} & \frac{1}{3}\frac{\delta_4+\gamma_4}{\delta_4+2\gamma_4} & 0 & \frac{1}{4}\frac{\gamma_4}{\delta_4+2\gamma_4} & \frac{1}{4}\frac{\gamma_4}{\delta_4+2\gamma_4} & \frac{1}{4}\frac{\gamma_4}{\delta_4+2\gamma_4} & \frac{1}{4}\frac{\gamma_4}{\delta_4+2\gamma_4} \\
\frac{1}{4}\frac{\gamma_5}{\delta_5+2\gamma_5} & \frac{1}{4}\frac{\gamma_5}{\delta_5+2\gamma_5} & \frac{1}{4}\frac{\gamma_5}{\delta_5+2\gamma_5} & \frac{1}{4}\frac{\gamma_5}{\delta_5+2\gamma_5} & 0 & \frac{1}{3}\frac{\delta_5+\gamma_5}{\delta_5+2\gamma_5} & \frac{1}{3}\frac{\delta_5+\gamma_5}{\delta_5+2\gamma_5} & \frac{1}{3}\frac{\delta_5+\gamma_5}{\delta_5+2\gamma_5} \\
\frac{1}{4}\frac{\gamma_6}{\delta_6+2\gamma_6} & \frac{1}{4}\frac{\gamma_6}{\delta_6+2\gamma_6} & \frac{1}{4}\frac{\gamma_6}{\delta_6+2\gamma_6} & \frac{1}{4}\frac{\gamma_6}{\delta_6+2\gamma_6} & \frac{1}{3}\frac{\delta_6+\gamma_6}{\delta_6+2\gamma_6} & 0 & \frac{1}{3}\frac{\delta_6+\gamma_6}{\delta_6+2\gamma_6} & \frac{1}{3}\frac{\delta_6+\gamma_6}{\delta_6+2\gamma_6} \\
\frac{1}{4}\frac{\gamma_7}{\delta_7+2\gamma_7} & \frac{1}{4}\frac{\gamma_7}{\delta_7+2\gamma_7} & \frac{1}{4}\frac{\gamma_7}{\delta_7+2\gamma_7} & \frac{1}{4}\frac{\gamma_7}{\delta_7+2\gamma_7} & \frac{1}{3}\frac{\delta_7+\gamma_7}{\delta_7+2\gamma_7} & \frac{1}{3}\frac{\delta_7+\gamma_7}{\delta_7+2\gamma_7} & 0 & \frac{1}{3}\frac{\delta_7+\gamma_7}{\delta_7+2\gamma_7} \\
\frac{1}{4}\frac{\gamma_8}{\delta_8+2\gamma_8} & \frac{1}{4}\frac{\gamma_8}{\delta_8+2\gamma_8} & \frac{1}{4}\frac{\gamma_8}{\delta_8+2\gamma_8} & \frac{1}{4}\frac{\gamma_8}{\delta_8+2\gamma_8} & \frac{1}{3}\frac{\delta_8+\gamma_8}{\delta_8+2\gamma_8} & \frac{1}{3}\frac{\delta_8+\gamma_8}{\delta_8+2\gamma_8} & \frac{1}{3}\frac{\delta_8+\gamma_8}{\delta_8+2\gamma_8} & 0
\end{pmatrix}.$$

Appendix AII: Experimental Instructions (*Original Instructions were in German. These are the instructions for treatment MUTUAL. Those for all other treatments are available on request.*)

Thank you for participating in the experiment. If you read these instructions carefully and follow all rules, you can earn money. The money will be paid out to you in cash immediately after the experiment. During the experiment we shall not speak of Euro but rather of points. Points are converted to Euro at the following exchange rate: 100 Points = 1.50 Euro It is forbidden to speak to other participants during the experiment. If you have any question, please ask us. We will gladly answer your questions individually. It is very important that you follow this rule. Otherwise, we shall have to exclude you from the experiment and from all payments. Participants of this experiments are randomly assigned into groups of 4 members, i.e., there are three more persons forming a group together with you. The composition of groups will remain the same during the whole experiment, i.e. there will always be the same persons in your group. The identity of your group members will not be revealed to you at any time. At the start of each period, each participant gets 20 points. We will refer to these points as your endowment. Your task is it to decide, how many of your 20 points you want to contribute to a project or to keep for yourself. Your income consists of two parts: (1) Points that you keep (2) Your "income from the project". This income is calculated as follows: Your income from the project 0.4 *times* the *sum* of contributions of all group members to the project The income of the other members of your group is determined in the same way, i.e. each group member receives the same income from the project. Suppose, for example, that the total contributions to the project by all members in your group sum up to 60. In this case you and every other member of your group receives $0.4 \times 60 = 24$ points as income from the project. Suppose that you and the other 3 members of your group in total contribute only 10 points to the project. In this case every group member receives $0.4 \times 10 = 4$ points as income from the project. For each point that you keep for yourself you earn an income of one point. If you contribute that point to the project, instead, the sum of contributions to the project would rise by one point, and your income from the project would rise by $0.4 \times 1 = 0.4$ points. However, the income of the other group members would also rise by 0.4 points, such that the total income of the group would rise by $4 \times 0.4 = 1.6$ points. Your contribution to the project, therefore, raises the income of the other members of your group. On the other hand, you earn from each point that other members of your group contribute to the project. For each point that another group member contributes, you earn $0.4 \times 1 = 0.4$ points. You take your choice via the computer. At the beginning of every period you see a decision screen.

Original instructions contained a decision screen here.

In the area at the bottom you enter how many of your 20 points you want to contribute to the project. The main area of the screen above consists of two parts: On the left you find the information concerning *your group*. First you see your contribution of the previous period. Below you find the sum of contributions to the project of all members in your group. The next line below shows your income of the previous period. Your income is determined as the sum of points that you have kept for yourself and the income from the project. A bit further down you see the "average group income of all previous periods". This number shows the average income of your group added over all previous periods together. Remark: In the first period (as here in the figure of the screen) there are no previous periods yet. For this reasons all numbers in the figure show zero yet.

On the right side of the screen you find information regarding *another group*. Just as your group, this other group consists of four participants. The four participants forming the other group will be the same during the whole experiment. The income of these four participants is determined in the same way as yours, i.e. all members of the other group decide how many of their 20 points they want to contribute to a project. The project of the other group is completely independent of your project. The first line shows the sum of contributions to the project of all members in the other group. The second line a bit below shows the average income of the other group added over all previous periods. Please note: Members of your and the other group mutually observe each other, i.e. the other group sees the same information regarding your group as you see regarding the other group. After all participants have made their contributions a new period starts, in which you decide again how many of your 20 points you want to contribute to the project. In total there will be 20 periods.