Heterogeneous Agents, Incentives and Group Performance

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Version: April 2012

Abstract

Organizing work in teams may be beneficial for a principal since teams of agents can be more productive than individuals. But teams suffer from shirking incentives if work effort cannot be fully controlled. Furthermore, if there is self-selection – i.e., agents choose themselves whether to work in a team or individually – the principal might wonder whether this leads the "right" agents to join teams, i.e. agents that have high team productivity and are cooperative; or whether it invites the "wrong" agents, i.e. agents that have low team productivity and/or are egoistic. These questions are addressed in our experimental study. While standard neoclassical theory denies that team incentives have strategic value in this environment, we investigate and show that the principal can influence self-selection and increase performance by team incentives. Effort and task choice depend on productivity type but the allocation of agent types on tasks is rather inefficient.

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1 Introduction

Organizing work in teams may be beneficial for organizations since teams can be more productive than individuals. But teams might suffer from shirking incentives if work effort cannot be fully controlled.[1] The employer (principal) might wonder whether effort in teams (agents) can be increased by monetary incentives. Furthermore, if there is self-selection – i.e., agents choose themselves whether to work in a team or individually – the principal might wonder whether this leads the "right" agents to join teams, i.e. agents that have high team productivity and are cooperative; or whether it invites the "wrong" agents, i.e. agents that have low team productivity and/or are egoistic. There exists mixed evidence on sorting in the literature. Hamilton, Nickerson, and Owan (2003) analyze heterogeneous workers productivity and their sorting in individual or group piece rate payment schemes in the garment industry. They find that productivity of agents is improved if work is organized in teams. Contrary, Bäker and Pull (2010) show that self selection in teams is appealing for low productive agents.

These questions are addressed in our experimental study. In our principal-agent game there is one principal and 16 agents. The agents can choose either a group task (*GT*) or an individual task (*IT*) or no task (exit option). The group task has the structure of a public good game between four agents, so there are incentives to shirk by not providing effort in *GT*. The group return is split between the four team members and the principal according to a linear pay contract (*GT*-contract) that has been offered by the principal before the agents' choices of task. Alternatively, if agents choose *IT* they subsequently choose a productive effort resulting in an individual return which is split according to the *IT*-contract. The latter contract, as the *GT*-contract, is linear, comprising a fixed wage and a return share.

[1] A theoretical analysis of shirking can be found in the classical work of Alchian and Demsetz (1972). Experimental evidence for shirking in team are inter alia documented by Meidinger, Rullière and Villeval (2003) and Nalbantian, and Schotter (1997).

This game has been studied before in Königstein and Lünser (2011) for a homogenous population of agents as well as a heterogeneous population of agents. Under heterogeneity the agents differ with respect to their productivity in *GT*. We implement a new variant of the game by introducing observability of productivity types. Before the team members make their choice of effort in *GT* they are informed about all team members' productivities. This treatment, which differs from Königstein and Lünser (2011) where types were unknown to team members, allows the agents to discriminate their effort with respect to the teams productivity. As a consequence it might lead to stronger separation of player types between tasks.

We use the social preference model of Fehr and Schmidt (1999) as a workhorse to provide empirical predictions regarding the influence of contracts and productivity on task selection and effort in *GT*. The standard preference model of neoclassical economics is of no help here. It predicts zero effort in *GT* and no choice of *GT* at all, but these predictions are rejected right away by tons of data on public good experiments. Cooperation in public good games is predicted by several models of social preferences. We rely on the Fehr-Schmidt model for reasons of tractability. Comparing this model with other social preference models is not within the scope of our study.

Other studies on sorting into teams and team incentive and social preferences are e.g. Teyssier (2007), Teyssier (2008) and Vyrastekova et al. (2012). Teyssier (2007) theoretically investigates optimal group incentives for inequality averse agents. She shows that multiple payment schemes can be optimal if agents are inequity averse since these agents may prefer and perform better in teams. Teyssier (2008) investigates competition incentive schemes versus revenue sharing in teams. She reports that inequality averse agents prefer revenue sharing and perform better under that condition. Vyrastekova et al. (2012) investigates relations between trust, team sorting and team performance. She observes that agents who trusts relatively more than others select group task more often and perform comparably better in teams.

Our main hypotheses are, first, that the principal can positively influence effort in *GT* by offering higher return shares. Second, we predict that effort increase in team productivity. And finally, we predict that self-selection into *GT* depends on productivity and can be positively influence by the terms of the *GT*-contract. Overall, the compound hypothesis of social preferences and rational play results in structural variables (monetary incentives and productivity) having strategic value which they don't have under standard neoclassical preferences.

The paper continues as follows: Next we describe the experimental game in detail (section 2), and provide theoretical analyses and empirical hypotheses (section 3). Then we report experimental procedure (section 4) and empirical results (section 5). The final section summarizes findings and has concluding remarks.

2 Experimental Game

The experimental game is the same as proposed by Königstein and Lünser (2011).[2] Consider a principal-agent-game with one principal (manager) and 16 agents (indexed below by $j = (1, 2, ..., 16)$). Work of agents can be organized either in individual tasks (*IT*) or in group tasks (*GT*). Productivities of agents differ between tasks and agents. Half of the agents are high productive the others low productive. The proportion of high and low productive agents is common knowledge while actual productivity is privately known. High productive agents have a productivity of 7.5 in *GT*. Low productive agents have a productivity of 2.5 in *GT*. We also refer to these players as high types or low types. In *IT* both types of players have the same productivity of 3. Thus low productive agents are relatively high productive in *IT* and high productive agents are relatively high productive in *GT*.

The principal offers two linear pay contracts, one for *IT* and one for *GT*. The agents can choose one of these contracts or reject both. Effort in *IT* results in an observable, individual return. In *GT* workers are organized in groups of four.

[2] Thus the description of the game is taken from there and is almost identical.

The effort choices of the four team members determine the joint return (group return). Prior to effort choices in *GT* the workers are informed about all team members' productivities.[3] The game is played over 10 periods. In each period the principal offers new pay contracts, each agent selects a task and chooses effort. The stages of the game are now described in detail.

Stage 1: The principal offers linear pay contracts for *IT* $w^{IT} = (f^{IT}, s^{IT})$ and *GT* $w^{GT} = (f^{GT}, s^{GT})$. Each contracts comprises a fixed wage f^{IT}, f^{GT} and a return share s^{IT}, s^{GT}. Fixed wages and return shares are restricted as follows:

$$s^{IT}, s^{GT} \in \{0\%, 10\%, ..., 100\%\}$$
$$f^{IT}, f^{GT} \in \{-15, -14, ..., +15\}$$

Stage 2: Each agent may choose one of the tasks (*IT* or *GT*) which means that he or she accepts the terms of the contract. If the agent neither accept w^{IT} nor w^{GT} he or she decides for the exit option where he or she earns nothing in this period. If w^{IT} is accepted, the agent works individually and will be paid according to w^{IT}. Accepting w^{GT} doesn't ensure that an agent will work in a group. Since agents are matched in teams of four, accepting w^{GT} is a preliminary decision. Those agents who cannot be matched are asked for an alternative (final) choice of either *IT* or the exit option.

Stage 3a: Agents *j* who decided for *IT* choose individual work effort $e_j \in \{0, 1, ..., 10\}$. Work effort is associated with the cost function $c(e_j) = 2e_j$. The individual return in *IT* is determined by $r_j^{IT} = 3e_j$.

Stage 3b: Agents *j* who decided for *GT* are informed about the productivities of their group members. Then they choose individual work effort

[3] This differs from Königstein and Lünser (2011) where the game is the same but productivity of team members are not observable.

$e_j \in \{0,1,...,10\}$. Work effort is associated with the cost function $c(e_j) = 2e_j$. The joint return in *GT* of group *k* is determined by

$$r_k^{GT} = \sum_{l=1}^{4} q_l e_l \ .$$

r_k^{GT} is a weighted sum of efforts of all group members with weights $q_j \in \{2.5, 7.5\}\ \forall\, j = 1, 2, \ldots, 16$ given by the individual productivity parameters. Individual productivity q_j is determined at the beginning of the game, is privately known and stays constant throughout all 10 periods. Payoffs of agents are determined as follows:

In *IT*:

$$\Pi_j^{IT} = f^{IT} + s^{IT} r_j^{IT} - c(e_j) \qquad (1)$$

In *GT*:

$$\Pi_j^{GT} = f^{GT} + s^{GT} \frac{1}{4} r_k^{GT} - c(e_j) \qquad (2)$$

for all members *j* of team *k*. If the exit option is chosen *j*'s payoff is 0. The principal's payoff is determined as follows. He or she has to pay fixed wages to all agents in *IT* and *GT* and collects residual returns. Thus the principal earns

$$\Pi_P = \sum_{j \in IT} \left((1 - s^{IT}) r_j^{IT} - f^{IT} \right) + \sum_{k \in GT} \left((1 - s^{GT}) r_k^{GT} - 4 f^{GT} \right) \qquad (3)$$

with $j \in IT$ representing an agent who has chosen *IT* and with $k \in GT$ representing a group of four agents who have chosen *GT*.

All subjects were informed that roles of players are randomly chosen and that roles as well as types of productivity are fixed for all ten periods. Furthermore all subjects know that they were playing a repeated game with a single principal facing 16 agents and that groups in *GT* were formed randomly in each period. The disclosure of productivities of team members was such that agents could not identify each other by player number or otherwise. Thus, they could not track each other's productivity or past choices.

3 Theoretical Analysis and Behavioral Hypotheses

We describe in an intuitive manner theoretical solutions to the game from the perspective of efficiency as well as individual rationality conditional on egoistic or social preferences. A more detailed analysis can be found in Königstein and Lünser (2011).

The efficient solution of the game mandates low type agents to choose *IT* and provide maximal effort and high type agents to choose *GT* and provide maximal effort. To see this note that marginal productivities are higher than marginal cost at all effort levels, that the low type agent is more productive in *IT* than in *GT* and that this is vice versa for the high type agent. These choices maximize the joint payoff of the principal and all agents together and this payoff could be distributed evenly or unevenly by an appropriate choice of the contract. However, this collectively optimal outcome cannot be reached under individual rationality if players have egoistic preferences. Namely, as in any public good game it is not rational to contribute positive effort in *GT*. Therefore, effort in *GT* will be zero no matter how strong monetary incentives s^{GT} are, and the principal should not offer a positive fixed wage f^{GT}. The best that the principal may do is to induce all agents to choose *IT* and provide maximal effort. This can be reached by a contract that satisfies $s^{IT} \geq 2/3$ (incentive compatibility constraint) and $f^{IT} \geq 20 - 30 \cdot s^{IT}$ (participation constraint).

This solution, which follows from the standard assumption of economics of egoistic and rational players, will not be able to explain the empirical data. *IT* is instructive to view it as a benchmark case, but it has been shown in many public good experiments that participants cooperate, indeed. And we find cooperation as well (see below). Therefore, to have any chance of matching theory and data one needs a more complex theoretical model. Social preference models offer an alternative that is able to explain cooperation in public good games. Assuming social preferences of the Fehr-Schmidt[4] type – henceforth FS – Königstein and Lünser (2011) show that there exist subgame perfect equilibria in which agents choose *GT* and positive effort if agents are sufficiently inequality averse: E.g. if all agents are inequality averse the existence conditions for this solution are

$$\beta_j \geq 1 - \frac{5}{16} s^{GT} \text{ for low types and } \beta_j \geq 1 - \frac{15}{16} s^{GT} \text{ for high types.}$$

These conditions show that cooperation is reached more easily among highly productive types, if players are inequality averse and if monetary incentives are stronger. Thus, contrary to the benchmark solution with egoistic preferences the solution with FS-preferences predicts that the principal's design of the *GT*-contract has strategic value: Team production may vary with incentives. Specifically, our empirical hypotheses are as follows:

Hypothesis 1.a: In GT a higher return share s^{GT} *offered by the principal induces higher effort.*

Hypothesis 1.b: In GT effort of high productive types is larger than that of low productive types.

Hypothesis 1.c: Effort in GT is positively correlated with the degree of inequality aversion.

The influence of the second payoff variable, the fixed wage, is less clear. On the one hand changes in f^{GT} leave payoff differences between team members unaffected for all effort choices. Therefore f^{GT} should have no influence on effort in *GT*. On the other hand, the solution proposed by Königstein and Lünser (2011) assumes that considerations of equality are taken only with respect to other team members but not with respect to the principal. If however, the participants in the experiment consider the principal's payoff as well, they might respond higher fixed wages by reciprocally choosing higher effort. An additional complication is that fixed wage and return share should be correlated negatively. This is predicted theoretically via the participation contraint and it will in fact hold empirically. For these reasons we do not propose a clear influence of f^{GT} of effort in *GT*.

[4] See Fehr and Schmidt (1999).

Since Hypothesis 1 proposes positive effort in *GT* this should affect the choice of task as well. The agent's choice of task is not necessarily *IT* as predicted for egoistic players but it may be *GT*. Specifically, it depends on expected earnings under both tasks and thus it depends on fixed wage, return share and productivity type.

Hypothesis 2.a: GT is chosen more likely the higher the offered GT-payment is and the lower the offered IT-payment is. Offered payments depend on both, fixed wages and return shares.

Hypothesis 2.b: GT is chosen more likely by high productive types than by low productive types.

Hypothesis 2.c: The probability of choosing GT is positively correlated with the degree of inequality aversion.

Hypotheses 1.a, 1.b, 2.a and 2.b were also investigated in Königstein and Lünser (2011). They did not study 1.c and 2.c since they did not take measures of inequality aversion. Furthermore, a novel feature of our design here is that the team members observe each other's productivity type before choosing effort. This allows agents to discriminate their effort choice with respect to the average productivity of the team. Consequently, under observable types it will be more difficult for low productive types to successfully join teams than under non-observable types. Therefore we predict a stronger, and thus more efficient, separation of types in our experiment than under non-observable types as in Königstein and Lünser (2011).

Hypothesis 3: Separation of productivity types is stronger here than in Königstein and Lünser (2011) in the sense that of all agents who choose GT the proportion of low types vs. high types is smaller here than in Königstein and Lünser (2011).

Hypotheses 1 to 3 are our main behavioral hypotheses. It should be mentioned that our experiment is not intended to test and propose the FS-preference model against other social preference models. Cooperation in public good games is also predicted by other social preference models. Showing which one is more successful is not within the scope of our study. We rather rely on the

FS-model as a workhorse. The mere fact that social preferences can generate cooperation (if preference parameters are chosen appropriately) is an important step forward compared to standard neoclassical preferences. Namely, the influence of structural variables like monetary incentives may change with changes in preferences and it makes little sense to assume preferences that are immediately refuted by the data as it is the case with standard neoclassical preferences.

4 Experimental Procedures

The experiment was conducted at the experimental economics lab at the University of Erfurt. It was computerized by using the software z-Tree (Fischbacher, 2007) and all participants are recruited via ORSEE (Greiner, 2004). In total 153 students of various disciplines participated in the experiment. Each student participated only in one session. In the laboratory participants were separated by cabins. They received written instructions and examples to ensure that they had understood the rules of the game.

Participants were randomly and anonymously assigned to one of the roles. Roles were labelled “participant A” for the principal, “participant B” for agents with low productivity and “participant C” for agents with high productivity. The game was played according to the rules described above. At the end of each period the period payoffs were calculated by the computer program and displayed on screen. Agents were informed about their own payoff and group return of their own team. The principal was informed about task selection as well as all return resulting from IT and GT. Payoffs were shown in points and the exchange rate of EUR and points was commonly known. The exchange rate was 1 Euro per 100 points for the principal and 1 Euro per 10 points for agents. Show-up fees were 0.5 Euro for the principal and 5 Euro for agents. [5]

[5] The experimental procedures of the principal agent game are almost the same as in Königstein and Lünser (2011). Thus the description is partially taken from there.

After the participants had played the game we ran additional experiments and used questionnaires to collect additional data on individual characteristics. We elicit social preferences as proposed by Danneberg et al. (2007) and risk preferences as proposed by Holt and Laury (2002). Both elicitation mechanisms were incentivized. Screenshots of the procedure as well as the instructions of the game are attached to Appendix A. Finally, the participants had to fill out the 16-PA personality questionnaire of Brandstätter (1988) and some questions about socio-demographics (gender, age, etc.).

Sessions took about one hour and 45 minutes. Average earnings where about 15 €. Decisions were taken privately and payments were made such that subjects did not see each other's payments.

5 Empirical Results

5.1 Descriptive Statistics

Table 1 presents an overview of the collected experimental data. Since the game had 10 periods and we ran 9 sessions we collected a total of 90 principal decisions and 1440 agent decisions. The majority of agents decided for the group task rather than the individual task or none. Effort in *GT* is positive and is on average about 4.5. Contract design is such that the four contract variables are correlated. Table 2 shows Spearman rank correlation coefficients. Specifically, return share and fixed wage in *GT* as well as return share and fixed wage in *IT* are negatively and highly significantly correlated. This should be expected from a theoretical viewpoint. It has to be taken into account later since it may lead to multicollinearity in regression analyses. Return shares of the two tasks and both fixed wages are positively but not significantly correlated.

Table 1: Overview of Experimental Data

Number of Periods		10	
Number of Principal Choices	Contract Design	90	
Number of Agent Choices	Task Choice, Effort	1440	
Contract Design (Mean, Std. Dev.)	Return Share *GT*	63.6%	(27.3)
	Fixed Wage *GT*	-0.8	(7.8)
	Return Share *IT*	69.3%	(22.1)
	Fixed Wage *IT*	-2.5	(7.1)
Choice of Task (Freq.)	Group Task (*GT*)	928	
	Individual Task (*IT*)	370	
	None (Exit Option)	142	
Effort (Mean, Std. Dev.)	Group Task (*GT*)	4.511	(3.084)
	Individual Task (*IT*)	5.831	(3.410)

Table 2: Correlations of Contract Variables

Correlation	Spearman's Rho	P-Value
Return Share *GT* ~ Fixed Wage *GT*	-0.534	0.000
Return Share *IT* ~ Fixed Wage *IT*	-0.483	0.000
Return Share *GT* ~ Return Share *IT*	0.139	0.192
Fixed Wage *GT* ~ Fixed Wage *IT*	0.167	0.116
		N = 90

5.2 Effort in *GT*

We now look at effort in *GT*. As expected a substantial fraction of the participants choose *GT* and provide positive effort in teams. Figure 1 shows frequency distributions separately for high productive types and low productive types (Fig. 1.a), and furthermore separately for teams of different levels of average productivity (Fig. 1.b). While it seems that effort increases in average team productivity (see Figure 1.b), a difference between high and low types can hardly be detected (see Figure 1.a).

Figure 1.a: Effort in *GT* by agent's productivity type

Figure 1.b: Effort in *GT* by average productivity of teams

To gain a more accurate view we have to control for other influencing factors. This is done in a regression analysis reported in Table 3. It is a Tobit regression analysis on effort choice in *GT* as dependent variable with lower bound 0 and upper bound 10. The influence of return share, fixed wage and productivity was estimated separately for symmetric teams – i.e., all four team members have the same productivity – and asymmetric teams. In asymmetric teams the variables return share, fixed wage, team productivity and a dummy for asymmetric teams (the reference category are symmetric and highly productive teams) are highly statistically significant.[6]

Result 1.a and 1.b: The influences of return share and productivity clearly support Hypotheses 1.a and 1.b.

For symmetric teams neither the return share nor the fixed wage have a significant influence. But this hardly weakens Results 1.a and 1.b for two reasons: First, insignificance does not mean that Results 1.a and 1.b are wrong but just that they don't hold for all subgroups. Second, symmetric teams comprise only a small fraction (6.5%) of all teams. We will look at the influence of incentives in symmetric teams in more detail below. Symmetric teams of low productivity provide significantly lower effort than symmetric teams of high productivity (see dummy low team productivity). Furthermore there is a decrease in provision of effort over time (see the influence of period).

To illustrate the results we estimated a revised version of model 1 eliminating the insignificant regressors return share and fixed wage for symmetric teams (see Table B1 in the Appendix B). Relying on this regression model Figure 2 shows predicted values of effort in *GT* for different levels of the return share and for different teams. Accordingly, symmetric teams with high average productivity of 7.5 provide higher effort than all other teams and do so independent of the offered return share. Average effort is about 7. This is different for asymmetric teams. These teams have an average productivity of 3.75, 5.0 or 6.25, and effort responds strongly to changes in return share s^{GT}; at low return share levels effort is close to minimal; at high return share levels effort is about 6. The predicted effort lines are ordered according to productivity which illustrates that effort is positively correlated with average productivity of the team. Finally, the predicted effort line is flat for symmetric teams of low productivity

[6] To account for repeated measurement the standard errors where determined by assuming clustering on individuals. Since the choice of effort in *GT* is made conditional on the choice of task there might be a selection bias in effort choices. To check this possibility we estimated an alternative specification following the Heckman procedure Heckman (1979). We found the selection effect to be insignificant.

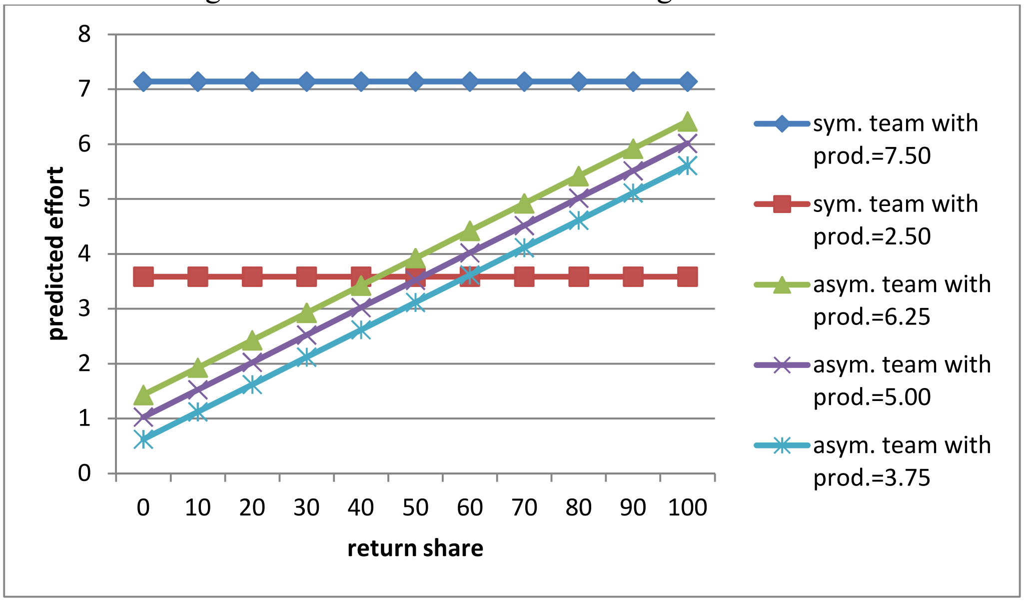
(productivity = 2.5). At high return share levels ($s^{GT} > 0.6$) predicted effort in these teams is lowest of all teams. However, at low levels of return share it is larger than effort in teams that are asymmetric but have higher average productivity. Symmetry seems to stimulate higher effort.

Table 3: Regression Analysis of Effort Choice in *GT*

Variable		*Coefficient*	*Robust Std. Error*	*P-Value*
Asymmetric Team	*Return Share*	0.050	0.008	0.000
	Fixed Wage	0.071	0.028	0.012
	Team Productivity	0.323	0.141	0.023
	Dummy Asym. Team	-8.932	3.328	0.007
Symmetric Team	*Return Share*	-0.015	0.043	0.478
	Fixed Wage	0.079	0.112	0.729
	Dummy Low Team Productivity	-3.495	1.201	0.004
Period		-0.266	0.056	0.000
Constant		9.720	3.220	0.003
Model Statistics:	N = 800 P-Value: 0.000 Pseudo R2: 0.0324			
Dependent Variable:	Effort in *GT*			
Method:	Tobit Regression			

Overall it seems that in high productive and symmetric teams effort is close to the upper bound so there is little scope for monetary incentives to further increase cooperation. This may explain why the return share has no significant influence in these teams. In symmetric and low productive teams effort does not respond positively to return share variations either. In such teams average individual productivity is 2.5 while individual marginal cost is 2. Thus, the team as a whole can benefit from higher production only at very high return shares ($s^{GT} > 0.8$).

Figure 2: Predicted Value Plot for Regression Model 1



Notes: Figure 2 displays predicted values of effort in *GT* for teams according to average team productivity dependent on return share. The calculation of the predicted value based on the regression model in Table B1 at Appendix B.

Contrary to Hypothesis 1.c inequality aversion as measured by the Danneberg et al experiment had no significant influence on effort in *GT*. We tried several regression specifications (not reported here) but never found significance for effort in *GT*. We see two possible reasons for this. First, effort in *GT* is taken conditional on self-selection into *GT*. It may be that only the selection of *GT* is positively influenced by inequality aversion (which will turn out below) but not the effort in *GT* conditional on that choice. Secondly, the Danneberg et al. experiment might be a weak empirical measure of FS-preferences. There is some indication of this possibility due to the large fractions of players for which either the α-measure or the β-measure is missing (36 of 144 agent = 25%).

5.3 Choice of Task

According to the game rules the agents may choose one out of three tasks, *GT* or *IT* or none of these (exit option). The frequencies of choices are shown in

Table 4.[7] Accordingly agents of high productivity type choose *GT* more frequently than low productivity types.

Table 4: Frequency of Task Choices

Agent's Choice	Group Task	Individual Task	Exit Option	Total
Low Productive Agents	441	205	74	720
High Productive Agents	487	165	68	720
Total	928	370	142	1440

Table 5: Regression Results of Task Choices

Choice of Tasks, multinomial logistic regression			
	GT versus IT		
Variable	*Coefficient*	*Std. Error*	*P-Value*
Share in GT	0.036	0.004	0.000
Fix in GT	0.133	0.016	0.000
Share in IT	-0.032	0.005	0.000
Fix in IT	-0.177	0.019	0.000
HT	0.476	0.166	0.004
Alpha-high	0.499	0.191	0.009
Alpha-missing	0.268	0.234	0.252
Beta-high	0.284	0.175	0.104
Beta-missing	-0.359	0.285	0.207
Period	0.237	0.096	0.014
Period^2	-0.016	0.008	0.052
Constant	-0.506	0.550	0.358
	Exit Option versus IT		
Variable	*Coefficient*	*Std. Error*	*P-Value*
Share in GT	-0.002	0.006	0.695
Fix in GT	-0.094	0.021	0.000
Share in IT	-0.021	0.008	0.008
Fix in IT	-0.260	0.031	0.000
HT	0.404	0.334	0.226
Alpha-high	0.801	0.403	0.047
Alpha-missing	-0.097	0.625	0.877
Beta-high	0.335	0.336	0.318
Beta-missing	-1.377	0.586	0.019
Period	0.382	0.232	0.101
Period^2	-0.019	0.017	0.283
Constant	-2.959	1.023	0.004
Model Statistics:	N = 1440 P-Value: 0.000 Pseudo R^2: 0.2462		

[7] These are frequencies of initial task choices. Final choices differed somewhat since agents in *GT* had to be matched in teams of 4 participants. Specifically, the number of final choices of *GT* was 800.

To investigate the influence of contract design and productivity on task choice we ran a multinomial logit regression reported in Table 5. The upper panel of Table 5 shows estimation results for the choice of *GT* versus the reference category *IT*. The lower panel shows estimation results for the choice of the exit option versus *IT*. We are mainly interested in the choice of *GT* versus *IT* therefore we focus on the upper panel. With respect to the influence of return shares and fixed wages we find that each of the four estimated coefficients shows the predicted sign and is highly statistically significant.[8]

Result 2.a: In line with Hypothesis 2.a the probability of choosing GT increases in the payment offered by the GT-contract (s^{GT}, f^{GT}) and decreases in the payment offered by the IT-contract (s^{IT}, f^{IT}).

Result 2.b: High productive types choose GT more likely than low productive types.

The latter is indicated by the positive and significant coefficient of dummy high productivity. Table 5 furthermore reports positive influences of the FS-preference parameters α and β. A joint test for $\alpha = \beta = 0$ shows that the coefficients are jointly statistically significant (p = 0.016). We collect this finding as

Result 2.b: GT is chosen more likely by individuals that are more inequality averse.

Finally we find that the probability of choosing *GT* increases over time and does so at a decreasing rate (see variables period and period^2).

A subtle question with respect to the influence of productivity is whether productivity simply shifts the probability of choosing *GT* upward or whether high types respond in a different manner on return share or fixed wage than low types. Table B2 in the Appendix B reports a refined regression model that allows for interaction effects of the dummy high productivity and the four payment variables. While three of the four interaction terms are significant the main effect

[8] Standard errors are adjusted for clustering on individuals.

of dummy high productivity becomes insignificant. We consider this result as non-conclusive.

As a final step in the empirical analysis we want to assess Hypothesis 3. Table 6 shows predicted values (according to the regression model of Table 5) for the fraction of low types and high types under observable productivity for two different levels of s^{GT}. All variables of the regression model except s^{GT} and dummy high production were set to mean values. For comparison Table 6 also shows the respective predictions under non-observable productivity as reported in Königstein and Lünser (2011). In line with Hypothesis 3 there is stronger separation of types when types are observable; the fraction of low productivity types entering *GT* is smaller than with non-observable productivity. But the separation is far from being efficient. Efficiency calls for a percentage of high types in *GT* of 100%. The self-selection of participants into tasks has led to an allocation of types that is only somewhat more efficient than a random allocation of types which would lead to an expected fraction of 50%.

Table 6: Separation of Productivity Types

	Observable Productivity		Non-observable Productivity (Königstein/Lünser)	
	$s^{GT} = 0.5$	$s^{GT} = 0.8$	$s^{GT} = 0.5$	$s^{GT} = 0.8$
Low Productive Agents	46.1%	48.3%	48.4%	49.3%
High Productive Agents	53.9%	51.7%	51.6%	50.7%

6 Summary and Concluding Remarks

In our experiment we find that effort in *GT* increases in the return share offered by the principal (result 1.a). The terms of the linear *GT*-contract also influence the choice of task (result 2.a.). Thus, monetary incentives have strategic value for self-selection into teams and for the degree of team cooperation even if the group task has the structure of a public good game. This is counter to the standard neoclassical prediction but it can be rationalized assuming FS-preferences.

Team cooperation increases in the team's average productivity (result 1.b). The participants anticipate this in their task choice which leads high productivity types to choose *GT* more likely than low productivity types (result 2.b). But the separation of types is far from complete: Theoretically, the efficient allocation of types requires all high types to choose *GT* and all low types to choose *IT*. But in fact, for $s^{GT} = 0.5$ the empirically predicted proportion of high types is just 53.9%. Thus, self-selection leads to a very inefficient allocation of types to tasks. This result is moderated by observability (result 3). If the team members are informed about types prior to effort choices, the separation of types is stronger than under unobservable types as reported by Königstein and Lünser (2011).

However, there is a large gap for possible efficiency gains and one might speculate why the allocation of types is so inefficient. Again this question should be discussed within a framework of social preferences. The regression model for the choice of task showed that the FS-preference parameters have positive and significant influence on the probability of choosing *GT* (result 2.c). This suggests that there are low productive but inequality averse agents who enter teams in order to prevent inequality. In addition there might be a fraction of egoistic types that enter teams in order to shirk.[9] But the fraction of egoists must be small because otherwise cooperation in teams would cease rather fast.

Counter to what should be expected the FS-preference parameter did not prove significant within the *GT*-effort-regression. Thus, it may be that only the choice of task is correlated with inequality aversion but not the effort choice which is conditional the task choice. Another possibility we mentioned is that the empirical measure of FS-preference parameters is weak and should be improved.

We found some indication that at low levels of incentives symmetric teams of low types show higher levels of cooperation than asymmetric teams of higher average productivity. It seems that symmetry helps to establish cooperation. But

[9] This is in line with the findings of Bäker and Pull (2010), Teyssier (2008) and Vyrastekova et al. (2012)

since only a small fraction of our observations are on symmetric groups, this effect should be seen as preliminary.

In concluding we emphasize that the compound model of FS-preferences and rationality was successful in producing theoretical predictions that are well supported by the data. Of course, other models of social preferences might have been used instead. But to discriminate between such models was not our issue here. Rather we studied the influence of team incentives and productivity within a social preference framework to allow for predictions that are not to be rejected right away, which is the case if one follows the standard assumption of egoistic preferences.

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Appendix A – Instructions

Instructions for the Experiment (translated from German)

You are participating in two decision experiments. At the end you will be paid according to your performance. Therefore it is important, that you understand the following instructions.

Instructions for Experiment 1

-Roll Assignment

17 participants are taking part in the decision experiment 1. Each participant has one of three roles. One participant is of the type A (**player A**), eight participants are of the type B (**player B**) and eight participants are of the type C (**player C**). Your type is randomly determined at the beginning of the experiment and is displayed to you on your screen. Your type remains constant throughout the experiment and is shown on the top of the screen to remind you of your role assignment.

-Payoff

The experiment consists of several periods. During the experiment payoffs are measured in points and displayed on your account. At the beginning each participant's account has an amount of 50 points. Profits are added to your account and losses are subtracted from your account. In the case of a negative account balance you continue to participate in the experiment. Due to profits you can again obtain a positive account balance. At the end your payoffs are converted into Euro and paid to you in cash. If your account balance is negative at the end, you receive a payoff of 0 Euro for experiment 1. The following rules apply to the conversion of points into Euros:

- For player B and C: 10 points = 1 Euro
- For player A: 100 points = 1 Euro

- Other Details

Please note that during the experiment **communication is not allowed**. If you have any questions, please raise your hand out of the cubicle. All decisions are made anonymously. No other participant will experience your name and your monetary payoff.

Best of luck!

Experiment 1 consists of **10 periods** and **17 players**: one player of type A, eight players of type B and eight players of type C.

Procedures for each period:

1. Player A proposes a payment scheme for an individual project (**Project I**) and a payment scheme for a group project (**Project II**) which are announced to all players B and C. Payment scheme I determines the payoff for project I and consists of a *return share I* (percentage of the individual return) and a *fixed wage I.* Payment scheme II determines the payoff for project II and consists of a *return share II* (percentage of the group return) and a *fixed wage II.*

2. Each player B or C decides whether he or she accepts payment scheme I, payment scheme II or neither of them.

3.a. **Participation in Project I**

Given a player B or C accepts the payment scheme I, he or she participates in project I (**individual project**) and chooses an investment level (0, 1, …, 10) with the corresponding investment costs (investment cost = 2* investment level). The chosen investment level determines the individual return (individual return = 3* investment level).

Thus the following payoffs results:

period payoff player B (C) =	**individual return** * ***return share I*** **+ *fixed wage I*** **− investment costs**

period payoff player A =	**individual return * (100% -** ***return share I*****) –** ***fixed wage I***

This means: Player B (C) receives the agreed *return share I* of the individual return plus the *fixed wage I* minus the own investment costs. Player A receives the remaining return share of the individual return minus the *fixed wage I.*

Displayed information to the players: Player B (C) is informed about individual return and own payoff for the particular period. Player A is informed about the number of players in individual projects. Additionally, he or she is informed about the sum of all individual returns and the sum of the payoffs from individual projects.

3.b. **<u>Participation in Project II</u>**

Given that several players B or C accepted the payment scheme II, groups of 4 members are formed out of the players who want to participate in project II (**group project**). Group members can be of different types. The group composition is random. Redundant participants can't participate in a group project. They are informed and can decide, whether to alternatively accept payment scheme I or not. If so, see point 3.a. If not, see point 3.c.

Each of the four members of a group choose an investment level (0, 1, …, 10) with the corresponding investment costs (investment cost = 2 x investment level) without the knowledge of the other group members decisions. You will be informed about types of your group members (type B or type C) before choosing investment level. The chosen individual investment level determines the individual return contribution for each group member.

Individual return contribution of participant B = 2.5 * investment level
Individual return contribution of participant C = 7.5 * investment level
The sum of the four individual return contributions is the group return.
Thus the following payoff results:

period payoff player B (C) =	**group return * (*return share II*)/4 + *fixed wage II* − investment costs**

period payoff player A =	**group return * (100% - *return share II*) –4 * *fixed wage II***

This means: Each group member receives one fourth of the agreed share of the group return (*return share II*) plus the *fixed wage II* minus the own investment costs. Participant A receives the remaining share of the group return minus the four fixed wages.

Displayed information to the players: Player B (C) is informed about the group return and own period payoff. Participant A is informed about the number of participants in group projects, the sum of all group returns and the sum of payoffs from group projects.

3.c. **<u>No participation on a project</u>**

Given a player B (C) has neither accepted payment scheme I nor payment scheme II, he or she participates in no investment project in this period and receives the payoff 0.

Rules for the payment scheme:

- The return share can equal 0%, 10%, …, or 100%.
  Return shares I and II can be different.
- The fixed wage can equal -15, -14, …, 0, 1, … or 15.
  Fixed wages I and II can also be different.

Within the given limitations return share and fixed wages can be arbitrary chosen. A positive fixed wage means a payment of player A to the respective player B (C). A negative fixed wage means a payment of a player B (C) to player A.

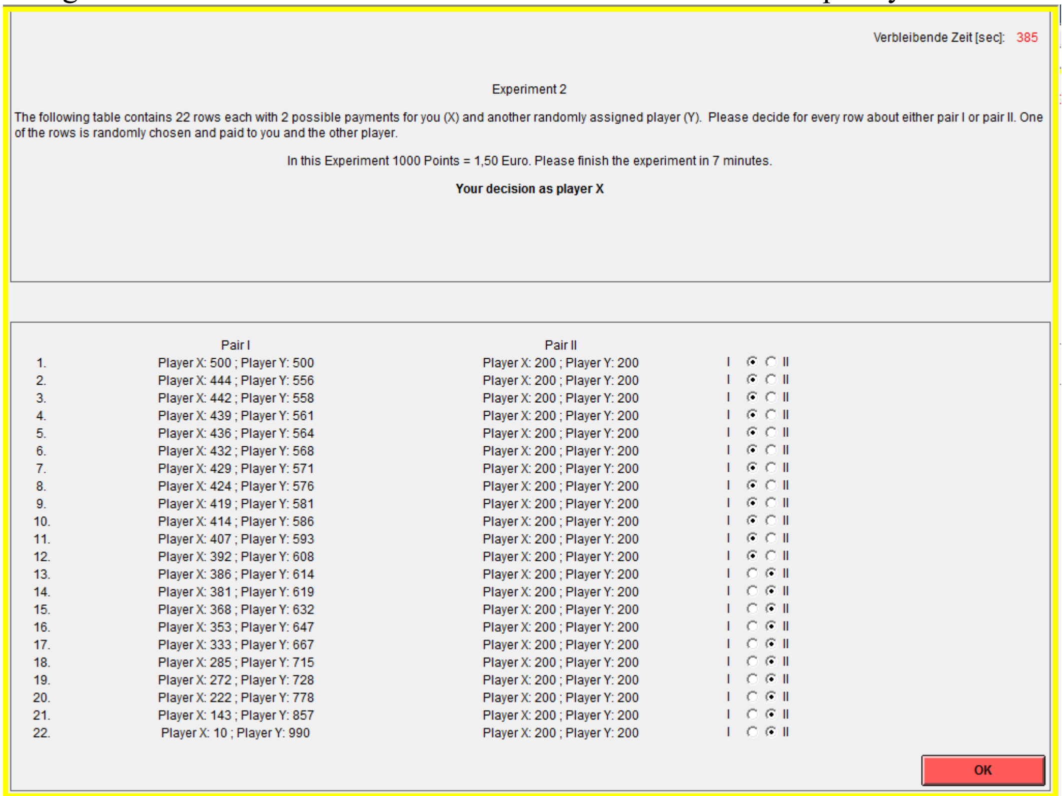
End of a period and further periods

After the investment decisions payoffs are calculated. The period ends. Your period payoff and your account balance are displayed to you. The next period starts according to the same rules.

Instructions for the additional Experiments (translated from German)

Experiment 2

Figure C1: Z-tree screenshot of Elicitation of unfavoured inequality aversion



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Experiment 2

The following table contains 22 rows each with 2 possible payments for you (X) and another randomly assigned player (Y). Please decide for every row about either pair I or pair II. One of the rows is randomly chosen and paid to you and the other player.

In this Experiment 1000 Points = 1,50 Euro. Please finish the experiment in 7 minutes.

Your decision as player X

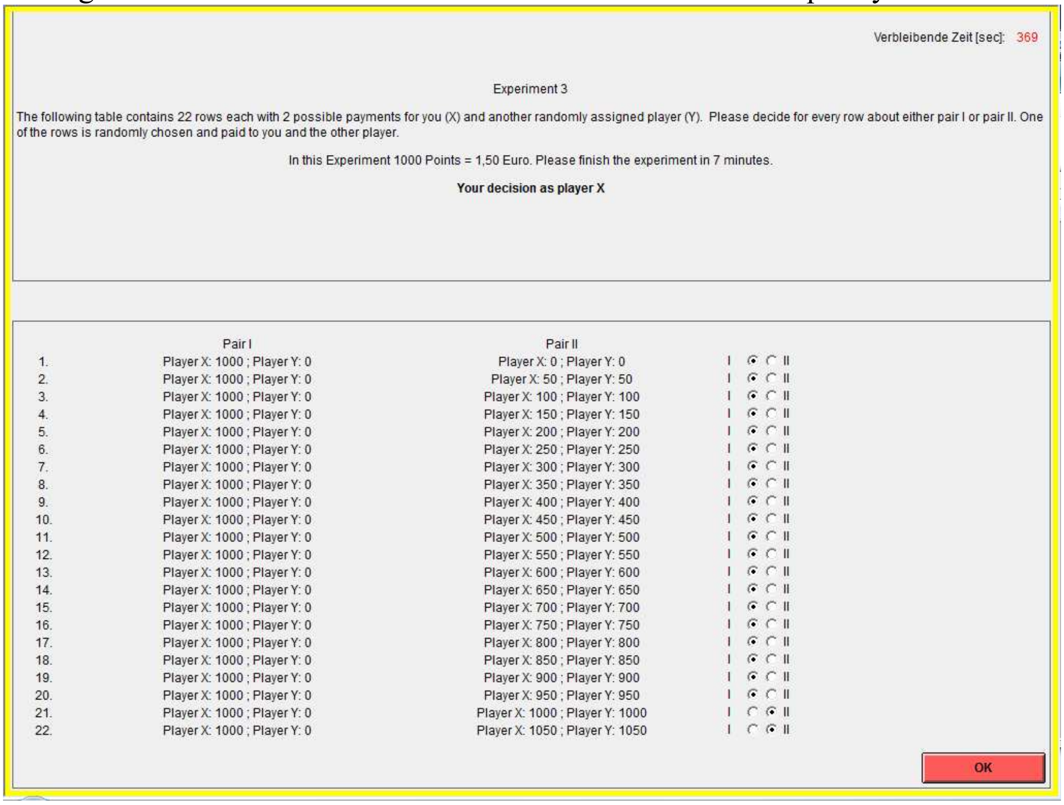
	Pair I	Pair II	
1.	Player X: 500 ; Player Y: 500	Player X: 200 ; Player Y: 200	I ◉ ○ II
2.	Player X: 444 ; Player Y: 556	Player X: 200 ; Player Y: 200	I ◉ ○ II
3.	Player X: 442 ; Player Y: 558	Player X: 200 ; Player Y: 200	I ◉ ○ II
4.	Player X: 439 ; Player Y: 561	Player X: 200 ; Player Y: 200	I ◉ ○ II
5.	Player X: 436 ; Player Y: 564	Player X: 200 ; Player Y: 200	I ◉ ○ II
6.	Player X: 432 ; Player Y: 568	Player X: 200 ; Player Y: 200	I ◉ ○ II
7.	Player X: 429 ; Player Y: 571	Player X: 200 ; Player Y: 200	I ◉ ○ II
8.	Player X: 424 ; Player Y: 576	Player X: 200 ; Player Y: 200	I ◉ ○ II
9.	Player X: 419 ; Player Y: 581	Player X: 200 ; Player Y: 200	I ◉ ○ II
10.	Player X: 414 ; Player Y: 586	Player X: 200 ; Player Y: 200	I ◉ ○ II
11.	Player X: 407 ; Player Y: 593	Player X: 200 ; Player Y: 200	I ◉ ○ II
12.	Player X: 392 ; Player Y: 608	Player X: 200 ; Player Y: 200	I ◉ ○ II
13.	Player X: 386 ; Player Y: 614	Player X: 200 ; Player Y: 200	I ○ ◉ II
14.	Player X: 381 ; Player Y: 619	Player X: 200 ; Player Y: 200	I ○ ◉ II
15.	Player X: 368 ; Player Y: 632	Player X: 200 ; Player Y: 200	I ○ ◉ II
16.	Player X: 353 ; Player Y: 647	Player X: 200 ; Player Y: 200	I ○ ◉ II
17.	Player X: 333 ; Player Y: 667	Player X: 200 ; Player Y: 200	I ○ ◉ II
18.	Player X: 285 ; Player Y: 715	Player X: 200 ; Player Y: 200	I ○ ◉ II
19.	Player X: 272 ; Player Y: 728	Player X: 200 ; Player Y: 200	I ○ ◉ II
20.	Player X: 222 ; Player Y: 778	Player X: 200 ; Player Y: 200	I ○ ◉ II
21.	Player X: 143 ; Player Y: 857	Player X: 200 ; Player Y: 200	I ○ ◉ II
22.	Player X: 10 ; Player Y: 990	Player X: 200 ; Player Y: 200	I ○ ◉ II

OK

Notes: Players have to decide upon one of each column in every row. The procedure is as proposed by Danneberg et al. 2007.

Experiment 3

Figure C2: Z-tree screenshot of Elicitation of favoured inequality aversion



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Experiment 3

The following table contains 22 rows each with 2 possible payments for you (X) and another randomly assigned player (Y). Please decide for every row about either pair I or pair II. One of the rows is randomly chosen and paid to you and the other player.

In this Experiment 1000 Points = 1,50 Euro. Please finish the experiment in 7 minutes.

Your decision as player X

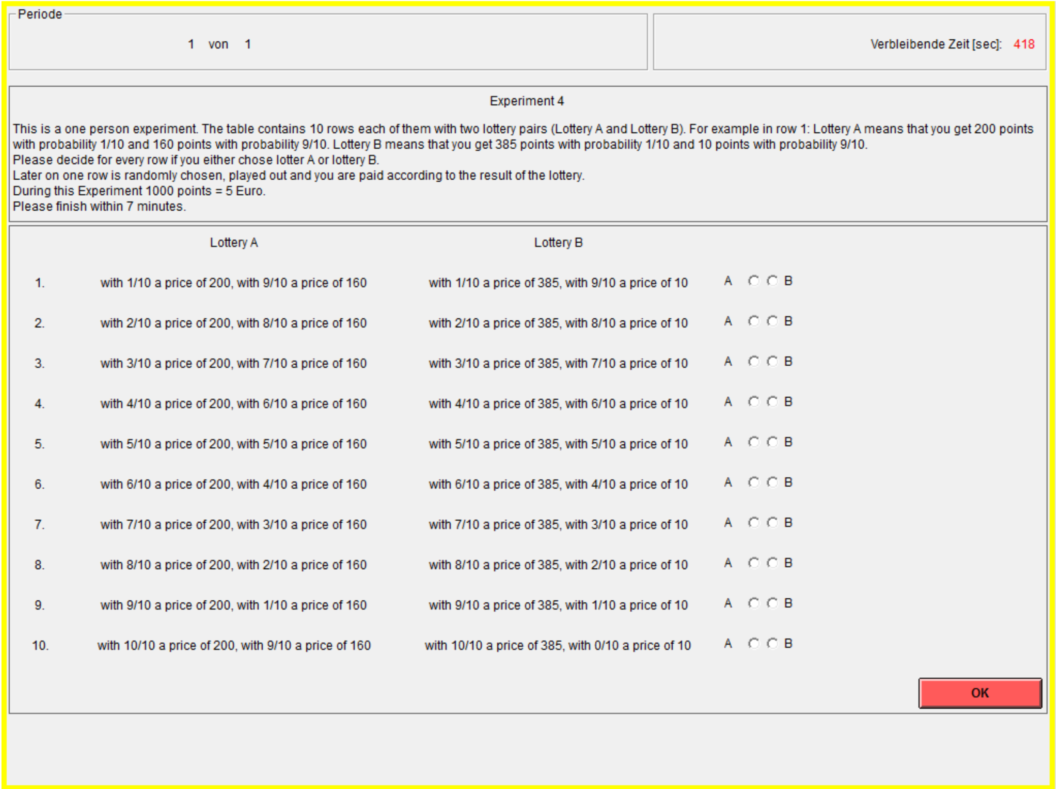
	Pair I	Pair II	
1.	Player X: 1000 ; Player Y: 0	Player X: 0 ; Player Y: 0	I ◉ ○ II
2.	Player X: 1000 ; Player Y: 0	Player X: 50 ; Player Y: 50	I ◉ ○ II
3.	Player X: 1000 ; Player Y: 0	Player X: 100 ; Player Y: 100	I ◉ ○ II
4.	Player X: 1000 ; Player Y: 0	Player X: 150 ; Player Y: 150	I ◉ ○ II
5.	Player X: 1000 ; Player Y: 0	Player X: 200 ; Player Y: 200	I ◉ ○ II
6.	Player X: 1000 ; Player Y: 0	Player X: 250 ; Player Y: 250	I ◉ ○ II
7.	Player X: 1000 ; Player Y: 0	Player X: 300 ; Player Y: 300	I ◉ ○ II
8.	Player X: 1000 ; Player Y: 0	Player X: 350 ; Player Y: 350	I ◉ ○ II
9.	Player X: 1000 ; Player Y: 0	Player X: 400 ; Player Y: 400	I ◉ ○ II
10.	Player X: 1000 ; Player Y: 0	Player X: 450 ; Player Y: 450	I ◉ ○ II
11.	Player X: 1000 ; Player Y: 0	Player X: 500 ; Player Y: 500	I ◉ ○ II
12.	Player X: 1000 ; Player Y: 0	Player X: 550 ; Player Y: 550	I ◉ ○ II
13.	Player X: 1000 ; Player Y: 0	Player X: 600 ; Player Y: 600	I ◉ ○ II
14.	Player X: 1000 ; Player Y: 0	Player X: 650 ; Player Y: 650	I ◉ ○ II
15.	Player X: 1000 ; Player Y: 0	Player X: 700 ; Player Y: 700	I ◉ ○ II
16.	Player X: 1000 ; Player Y: 0	Player X: 750 ; Player Y: 750	I ◉ ○ II
17.	Player X: 1000 ; Player Y: 0	Player X: 800 ; Player Y: 800	I ◉ ○ II
18.	Player X: 1000 ; Player Y: 0	Player X: 850 ; Player Y: 850	I ◉ ○ II
19.	Player X: 1000 ; Player Y: 0	Player X: 900 ; Player Y: 900	I ◉ ○ II
20.	Player X: 1000 ; Player Y: 0	Player X: 950 ; Player Y: 950	I ◉ ○ II
21.	Player X: 1000 ; Player Y: 0	Player X: 1000 ; Player Y: 1000	I ○ ◉ II
22.	Player X: 1000 ; Player Y: 0	Player X: 1050 ; Player Y: 1050	I ○ ◉ II

OK

Notes: Players have to decide upon one of each column in every row. The procedure is as proposed by Danneberg et al. 2007.

Experiment 4

Figure C3: Z-tree screenshot of Elicitation of Risk Preferences



Periode

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Experiment 4

This is a one person experiment. The table contains 10 rows each of them with two lottery pairs (Lottery A and Lottery B). For example in row 1: Lottery A means that you get 200 points with probability 1/10 and 160 points with probability 9/10. Lottery B means that you get 385 points with probability 1/10 and 10 points with probability 9/10.
Please decide for every row if you either chose lotter A or lottery B.
Later on one row is randomly chosen, played out and you are paid according to the result of the lottery.
During this Experiment 1000 points = 5 Euro.
Please finish within 7 minutes.

	Lottery A	Lottery B	
1.	with 1/10 a price of 200, with 9/10 a price of 160	with 1/10 a price of 385, with 9/10 a price of 10	A ◌ ◌ B
2.	with 2/10 a price of 200, with 8/10 a price of 160	with 2/10 a price of 385, with 8/10 a price of 10	A ◌ ◌ B
3.	with 3/10 a price of 200, with 7/10 a price of 160	with 3/10 a price of 385, with 7/10 a price of 10	A ◌ ◌ B
4.	with 4/10 a price of 200, with 6/10 a price of 160	with 4/10 a price of 385, with 6/10 a price of 10	A ◌ ◌ B
5.	with 5/10 a price of 200, with 5/10 a price of 160	with 5/10 a price of 385, with 5/10 a price of 10	A ◌ ◌ B
6.	with 6/10 a price of 200, with 4/10 a price of 160	with 6/10 a price of 385, with 4/10 a price of 10	A ◌ ◌ B
7.	with 7/10 a price of 200, with 3/10 a price of 160	with 7/10 a price of 385, with 3/10 a price of 10	A ◌ ◌ B
8.	with 8/10 a price of 200, with 2/10 a price of 160	with 8/10 a price of 385, with 2/10 a price of 10	A ◌ ◌ B
9.	with 9/10 a price of 200, with 1/10 a price of 160	with 9/10 a price of 385, with 1/10 a price of 10	A ◌ ◌ B
10.	with 10/10 a price of 200, with 9/10 a price of 160	with 10/10 a price of 385, with 0/10 a price of 10	A ◌ ◌ B

OK

Notes: Players have to decide upon one of two lotteries in every row. The procedure is as proposed by Holt and Laury (2002).

Appendix B – Regression Tables of Chapter 3

Table B1: Regression Results of Regression on Effort in *GT*

Variable	*Coefficient*	*Robust Std. Error*	*P-Value*
*Asymmetric Team * Fix-GT*	0.323	0.141	0.023
*Asymmetric Team * Share GT*	0.050	0.008	0.000
*Asymmetric Team * Average Team Productivity*	0.071	0.028	0.012
Asymmetric Team	-7.779	1.167	0.000
Low Team Productivity	-3.555	1.210	0.012
Period	-0.262	0.057	0.000
Constant	8.530	0.659	0.000
Model Statistics:	N = 800 P-Value: 0.000 Pseudo R2: 0.032		
Dependent Variable:	Effort in *GT*		
Method:	Tobit Regression		

Notes: Base category is symmetric team with productivity 7.5.

Table B2: Regression Results of Regression on Tasks Selection

Choice of Tasks, multinomial logistic regression			
	GT versus IT		
Variable	*Coefficient*	*Robust Std. Error*	*P-Value*
Share in GT	0.030	0.005	0.000
Fix in GT	0.112	0.019	0.000
Share in IT	-0.025	0.006	0.000
Fix in IT	-0.148	0.022	0.000
*Share in GT * HT*	0.014	0.008	0.073
*Fix in GT * HT*	0.051	0.032	0.119
*Share in IT * HT*	-0.018	0.009	0.046
*Fix in IT * HT*	-0.070	0.039	0.077
HT	0.804	0.785	0.306
Alpha-high	0.504	0.193	0.009
Alpha-missing	0.269	0.233	0.247
Beta-high	0.287	0.176	0.102
Beta-missing	-0.364	0.284	0.200
Period	0.237	0.097	0.014
$Period^2$	-0.016	0.008	0.052
Constant	-0.630	0.647	0.330
	Exit Option versus IT		
Variable	*Coefficient*	*Std. Error*	*P-Value*
Share in GT	0.005	0.008	0.547
Fix in GT	-0.085	0.027	0.002
Share in IT	-0.024	0.011	0.028
Fix in IT	-0.245	0.040	0.000
*Share in GT * HT*	-0.014	0.011	0.175
*Fix in GT * HT*	-0.022	0.040	0.587
*Share in IT * HT*	0.004	0.016	0.790
*Fix in IT * HT*	-0.042	0.061	0.494
HT	0.662	1.137	0.561
Alpha-high	0.856	0.400	0.032
Alpha-missing	-0.132	0.590	0.824
Beta-high	0.386	0.350	0.270
Beta-missing	-1.376	0.599	0.022
Period	0.380	0.231	0.100
$Period^2$	-0.018	0.017	0.284
Constant	-3.119	1.099	0.005
Model Statistics:	N = 1440 P-Value: 0.000 Pseudo R^2: 0.2523		