No. 48 october 2009

Gerald Eisenkopf
Sabrina Teyssier

Horizontal and Vertical Social Preferences in Tournaments

Research Paper Series
Thurgau Institute of Economics and Department of Economics
at the University of Konstanz

THURGAU INSTITUTE
OF ECONOMICS
at the University of Konstanz

Horizontal and Vertical Social Preferences in Tournaments

Gerald Eisenkopf* Sabrina Teyssier*

October, 08, 2009

First draft

Abstract

Most studies find no collusion in tournaments. This result suggests that social preferences are irrelevant in this context. We investigate the impact of social preferences in a tournament using data from a laboratory experiment with two treatments. In a conventional tournament, an agent receives either the full prize or no prize at all. The other tournament provides the same incentives but the actual payment of an agent equals her expected payment. In both treatments the principal chooses between a fair and an unfair contract. Standard economic theory predicts the same effort provision in all situations. Our results show instead that envy between agents and the fairness of the principal determine the effectiveness of tournaments. Moreover, we observe that collusion between the agents and reciprocity towards the principal are mutually exclusive.

JEL-Codes: M52; D03; C90

Keywords**:** Tournament, Collusion, Envy, Agency problem, Reciprocity

* Thurgau Institute of Economics, Hauptstrasse 90, 8280 Kreuzlingen, Switzerland, University of Konstanz Department of Economics, University of Konstanz, 78457 Konstanz, Germany; gerald.eisenkopf@uni-konstanz.de, teyssier@twi-kreuzlingen.ch.

Acknowledgments: We thank Urs Fischbacher,l Lisa Bruttel, Simeon Schudy, Verena Utikal, Kate Bendrick for very helpful contributions. The usual disclaimer applies.

1. Introduction

A tournament is an effective competitive mechanism to circumvent agency problems.[1] From a behavioral point of view, this observation implies a puzzle. In tournaments, increased effort of one participant implies a negative externality on her fellow participants. Similar to a public-good-game, such an externality should induce conditional cooperation. If one person does not compete, the other participants should restrain their behavior. Hence it is reasonable to expect some collusion if competitors have social preferences. Yet there is surprisingly little evidence on collusion in tournaments.[2] We investigate in this paper if social preferences in tournaments are either irrelevant or involved in a trade-off between different social motives.

Social preferences may play a role in tournaments even though we do not observe collusion between agents. We focus on two potential mechanisms a principal may use to benefit from social preferences. First, the strict separation between winners and losers can cause envy between the competitors, which in turn leads to highly competitive behavior (Grund and Sliwka, 2003, and Demougin and Fluet, 2003). Second, the fairness (unfairness) of the principal can cause positive (negative) reciprocity of the competitors. It is well known that fairness plays a role in the interaction between the principal and one agent[3] but it is not clear if this reciprocity 'survives' if agents compete against each other. Therefore, our experiment focuses on two aspects of tournaments which have been largely neglected in previous studies. We look at whether the large inequality in prizes deters collusion. We also investigate whether the kindness of the principal has an impact on collusion.

---

[1] For evidence in the field, see Bognanno (2001), Ehrenberg and Bognanno (1990), Eriksson (1999), Knoeber and Thurman (1994), Main, O'Reilly III and Wade, (1993). For laboratory experiments, see Bull, Schotter and Weigelt (1987), Harbring and Irlenbush (2003), Dohmen and Falk (2006), Eriksson, Teyssier and Villeval (2009), Orison, Schotter and Weigelt (2004), Schotter and Weigelt (1992).

[2] The only exception is provided by Bandiera, Barankay and Rasul (2005) who show that employees collude in a tournament only if they can monitor each other. We find few theoretical studies on collusion in tournament. Chen (2006) and Ishiguro (2004) investigate instruments to stop collusion when it is in place. Amegashie (2006) shows in a repeated setting that collusion should be easier when contestants are equal.

[3] Fehr and Gächter, 2002, and Güth, Schmittberger and Schwarze, 1982, focus on negative reciprocity; Fehr, Kirchsteiger and Riedl, 1998, focus on positive reciprocity; Gächter and Herrmann (2009) provide a survey on the topic.

Our paper contributes to the understanding of behavior in competitive environments and the efficiency aspects of tournaments. According to Lazear and Rosen (1981), it is the spread between wages but not the absolute value of the lowest possible wage that determines the effort of agents. A well-specified wage spread implements the efficient allocation. The absence of collusion suggests that this theory, based on the assumption of rational selfish decision makers, provides a sufficient explanation for the behavior in tournaments. Most relevant articles support this point of view (for example, Bull, Schotter and Weigelt, 1987, and Harbring and Irlenbush, 2003) but previous research provides insufficient information on the impact of social preferences. Since tournaments induce a large ex-post inequality between competitors they might lead to envy, defined as negative inequity aversion in the meaning of Fehr and Schmidt (2000). Envy should have an impact on effort provision as envious people should take precautions not to lose a tournament (Grund and Sliwka, 2003). If there argument is right, a tournament does not lead to an efficient outcome but to self-exploitation by the agents.

In our experiment, subjects are organized in groups of three: one principal and two agents. The experiment is repeated for twenty periods and the groups are identical in all periods. The principal chooses between a *fair* and an *unfair* contract. Each contract consists of a guaranteed payment and an effort-related prize. The prize is identical in the fair and the unfair contracts but the fair contract contains a higher guaranteed payment. In equilibrium, the fair contract leads to the same expected payoffs for the principal and each agent. The choice of the principal is not revealed. Via the strategy method, agents exert virtual, but costly, effort for both the fair and the unfair contract. The principal's payoff increases in the agents' effort.

Each subject participates in just one out of two treatments. In the *winner-takes-all* treatment, which resembles a conventional tournament, the prize goes to one person. The winner is determined by the highest performance which depends on the provided effort levels and independent but identically distributed random variables. In the *winner-takes-more* treatment, the prize is distributed among agents. For given effort choices, an agent's share in the winner-takes-more treatment is identical to the probability of winning in the winner-takes-all treatment. This type of competition is similar to a bonus scheme in a firm in which the sum of all bonuses is fixed. Since the winner-takes-more treatment implies a lower financial risk for the agents, we also elicit risk preferences at the beginning of the experiment.

Independent of the treatment and contract choice, a risk-neutral homo economicus always provides the same effort. Risk-averse agents play a lower effort in the winner-takes-all treatment than in the winner-takes-more treatment. Our results contradict these predictions. First we find that agents play, on average, a higher effort in the winner-takes-all treatment than in the winner-takes-more treatment even though most subjects are risk averse. Second, agents choose, on average, a higher effort in the fair than in the unfair contract. The situation leading to the highest effort provision is the fair contract in the winner-takes-all treatment while an unfair contract in the winner-takes-more treatment elicits the lowest effort. Therefore, our results show that both unfairness and insurance reduce the effort level in competition.

Furthermore we find that subjects who respond in kind to the principal's fairness do so in a similar way in both treatments. The subjects who do not reward the principal's fairness behave differently. In the winner-takes-all treatment, they provide predicted effort but they collude if the prize is shared among the agents. This result suggests that agents choose between collusion between agents and reciprocity towards the principal. They focus their social preferences only on one person.

Our results show that social preferences do play a role in tournaments. We do observe effort provisions which are similar to conventional predictions. However, this phenomenon occurs only because agents do not want to be worse off than their competitor and when principals are rather generous. Hence, we can reproduce the results from previous studies but falsify their underlying theory as explanations using the homo economicus cannot determine the variations in our results.

The paper is structured as follows: We present the experimental design and procedures in section 2. The theoretical predictions are shown in section 3 and experimental results in section 4. Section 5 concludes.

2. Experimental design and procedure

2.1. Design

We designed the experiment to identify two determinants of collusion between agents. The experiment tests whether the level of collusion depends on *(i)* the degree of fairness of the principal regarding the agents and *(ii)* the distribution of the prize between competitors. We investigate these questions with the main game. A further task elicits the risk preferences of the participants. Instructions of both tasks can be found in the appendix.

Main game

In the main game of the experiment, subjects are divided into groups of three persons: participants A, B and C. Participant A is the principal while participants B and C are in the role of the agents. The game is repeated for twenty periods with identical groups.

Each period consists of two stages. In the first stage, participant A (the principal) chooses between two different contracts. In the second stage, participants B and C (the agents) decide about their effort contribution for each contract. At the end of each period, the contract choice, the relevant effort levels and the resulting income are revealed to all group members. In both contracts the sum of performance related payments are identical but the fixed payments differ. The equilibrium predictions are identical in both contracts despite the differences in final income. We distinguish between a *fair* contract and an *unfair* contract.

First stage: contract choice of the principal

The principal's (participant A) task is to make the payment to agents by choosing one of two contracts. Each contract consists of two payments, a guaranteed payment, m, and a performance-related prize, M. In theory the equilibrium effort level of risk-neutral agents depends on the distribution of the performance-related payments but not on the absolute value of the guaranteed payment. We kept this prize identical in both contracts such that $M = 16$ points. In the fair contract, we denote the guaranteed payment with $m_f = 17$ points, in the unfair contract, we use $m_u = 13$ points. The agents compete for the prize.

Second stage: effort choice of the agents

The agents (participants B and C) generate value by providing some virtual effort, e_i. The principal receives this generated output. Each agent chooses an effort level among integers between 0 and 20. It is costly for agents to provide effort. The cost function is convex ($c(e_i) = \frac{e_i^2}{20}$). The distribution of the prize $M = 16$ points differs across the treatments. In both treatments, an agent's expected benefit from the prize increases in her effort choice. However, this benefit is distorted by a random term, ε_i, which is identically and independently distributed according to the uniform function over the interval $[-8, +8]$ ($\varepsilon_i \sim U[-8, +8]$ witht $E(\varepsilon_i) = 0$).

Winner-takes-all treatment (Tournament)

In the winner-takes-all treatment, the prize is not shared between agents. The winner of the tournament receives all 16 additional points. Therefore, participant B wins the tournament against participant C if $e_B + \varepsilon_B > e_c + \varepsilon_c$. Vice versa, participant C wins if $e_B + \varepsilon_B < e_c +$

ε_c. The probability of winning is thus $\Pr(\varepsilon_B > e_c - e_B + \varepsilon_c)$ for participant B and $\Pr(\varepsilon_C > e_B - e_C + \varepsilon_B)$ for participant C.

The payoff of agent i in the tournament is:

$$\Pi_i = \begin{cases} m_k + M - c(e_i) & \text{if } e_i + \varepsilon_i > e_j + \varepsilon_j \\ m_k - c(e_i) & \text{if } e_i + \varepsilon_i < e_j + \varepsilon_j \end{cases} \quad i, j \in \{B, C\}, j \neq i \text{ and } k \in \{f, u\} \qquad (1)$$

Winner-takes-more treatment (Proportional payment)

This treatment differs from the winner-takes-all treatment only by the actual distribution of the prize. The 16 points are shared between the two agents. An agent's share equals her probability of winning if she had been assigned to the winner-takes-all treatment. We denote the share of the 16 points received by participant B with α ($1 - \alpha$ for participant C). We have $\alpha = \Pr(\varepsilon_B > e_c - e_B + \varepsilon_c)$ and $1 - \alpha = \Pr(\varepsilon_C > e_B - e_C + \varepsilon_B)$.

The payoff of participant B in the winner-takes-more treatment is:

$$\Pi_B = m_k + \alpha M - c(e_B) \qquad k \in \{f, u\} \qquad (2)$$

The payoff of participant C in the winner-takes-more treatment is:

$$\Pi_C = m_k + (1 - \alpha) M - c(e_C) \qquad k \in \{f, u\} \qquad (3)$$

It is important to note that the actual payoffs of agents in the winner-takes-more treatment are equal to their expected payoffs in the winner-takes-all treatment.

Benefit of the Principal

Under both treatments, we assume that the benefit of the principal from efforts of agents is linear. Therefore, the principal's payoff is such that:

$$\Pi_A = 50 + e_B + e_C - 2m_k - M \qquad k \in \{f, u\} \qquad (4)$$

The principal receives an endowment of 50 points plus the sum of agents' effort levels in his group minus the wages he pays to agents, depending on his contract choice. The principal's endowment and the guaranteed payments to the agents have been chosen to ensure that negative payoffs and concerns about limited liability are irrelevant. To summarize, Table 1 shows the earning functions of all the participants depending on the contract choice and the treatment group.

Table 1: Earning functions of the participants in the different contracts and treatments

	Winner-takes-all treatment (Tournament)	
	Fair Contract	*Unfair Contract*
The principal (A)	$50 + e_B + e_C - 2 * 17 - 16$	$50 + e_B + e_C - 2 * 13 - 16$
	When the winner of the tournament is agent B: $e_B + \varepsilon_B > e_c + \varepsilon_c$	
Agent B	$33 - \frac{1}{20} {e_B}^2$	$29 - \frac{1}{20} {e_B}^2$
Agent C	$17 - \frac{1}{20} {e_C}^2$	$13 - \frac{1}{20} {e_C}^2$
	When the winner of the tournament is agent C: $e_B + \varepsilon_B < e_c + \varepsilon_c$	
Agent B	$17 - \frac{1}{20} {e_B}^2$	$13 - \frac{1}{20} {e_B}^2$
Agent C	$33 - \frac{1}{20} {e_C}^2$	$29 - \frac{1}{20} {e_C}^2$
	Winner-takes-more treatment (Proportional payment**:** $\alpha = Pr\ (\varepsilon_B > e_c - e_B + \varepsilon_c)$)	
	Fair Contract	*Unfair Contract*
The principal (A)	$50 + e_B + e_C - 2 * 17 - 16$	$50 + e_B + e_C - 2 * 13 - 16$
Agent B	$17 + \alpha 16 - \frac{1}{20} {e_B}^2$	$13 + \alpha 16 - \frac{1}{20} {e_B}^2$
Agent C	$17 + (1 - \alpha)16 - \frac{1}{20} {e_C}^2$	$13 + (1 - \alpha)16 - \frac{1}{20} {e_C}^2$

Elicitation of risk aversion

Risk preferences have been measured for all subjects. We use the method suggested in Dohmen et al. (2009). The subjects had to make 20 decisions between an alternative *a* and an alternative *b*. In each of the 20 decisions, alternative *b* implied a payment of either 0 or 20 points to the subject (50% probability each). Alternative *a* implied a fixed payment between 0 points (decision 1) and 19 points (decision 20). We measure risk aversion among participants by counting the number of decisions in which a subject has chosen the safe option, alternative *a*. A subject who chooses the safe option more often is considered to be more risk averse than a subject with more risky choices.

2.2. Procedure

The experiment was computerized with the software “z-Tree” (Fischbacher, 2007). The recruitment was conducted with the software “ORSEE” (Greiner, 2004). Subjects were students from the University of Konstanz. Psychology students were not eligible to participate. All sessions took place at the University of Konstanz. 102 subjects participated in the experiment, 51 in each treatment.

The risk elicitation task was played before the main game task. At first all subjects received identical instructions regarding the risk elicitation task, including comprehension questions. Then all subjects made their decisions in this task. Afterwards the subjects received written instructions for the main game, including comprehension questions. Subjects had been randomly assigned a role as player A, B, or C upon arrival at the lab. All treatments were framed in a neutral manner.

For payment in the risk elicitation task, the computer randomly chose one of the 20 decisions subjects answered and we paid subjects according to their chosen alternative in this specific decision. In the main game task, at the end of the experiment, the computer randomly chose one of the twenty periods played and the decisions in the chosen period determined the payoffs for all members of the group. The payoffs in both tasks were revealed at the end of the entire experiment. The sessions lasted for about 100 minutes. Each experimental point was converted into 0.7 €. Additionally, each subject received a show up fee of 4 €.

3. Predictions

To derive theoretical predictions, we suppose that it is common knowledge that all participants in the experiment are rational and selfish. The utility function allows for constant absolute risk aversion of subjects. We note p the probability of agent B winning the tournament, $p = \Pr(\varepsilon_B > e_c - e_B + \varepsilon_c)$, and $(1-p)$ the probability of agent C of winning the tournament, $(1-p) = \Pr(\varepsilon_C > e_B - e_C + \varepsilon_B)$. Therefore, α, previously defined as the share of the prize received by agent B in the winner-takes-more treatment, is equal to her probability to win the prize in the winner-takes-all treatment, p. We have $\alpha = p$.

Agents maximize their expected utility in the fair and the unfair contracts. In the winner-takes-all treatment, for contract $k, k \in \{f, u\}$, agents B and C solve the following problems, respectively:

$$\max_{e_B} EU_B = pU\left(m_k + M - \frac{{e_B}^2}{20}\right) + (1-p)U\left(m_k - \frac{{e_B}^2}{20}\right) \quad k \in \{f, u\} \tag{5}$$

$$\max_{e_C} EU_C = (1-p)U\left(m_k + M - \frac{{e_C}^2}{20}\right) + pU\left(m_k - \frac{{e_C}^2}{20}\right) \quad k \in \{f, u\} \tag{6}$$

As the random term follows a uniform distribution, the probability of winning the tournament for agent B is written:

$$p = \begin{cases} \frac{1}{2} + \frac{e_B - e_C}{2 \times 8} + \frac{(e_B - e_C)^2}{8 \times 8^2} & \text{if } e_B \leq e_C \\ \frac{1}{2} + \frac{e_B - e_C}{2 \times 8} - \frac{(e_B - e_C)^2}{8 \times 8^2} & \text{if } e_B \geq e_C \end{cases} \tag{7}$$

The probability of winning for agent C can be directly deduced from this expression as it is equal to $1 - p$.

Therefore, by maximizing the expected utility of agents and since cost functions are the same, equilibrium effort of agent B and equilibrium effort of agent C are identical:

$$e_i^* = \frac{5}{4} \frac{U\left(m_k + M - \frac{{e_i^*}^2}{20}\right) - U\left(m_k - \frac{{e_i^*}^2}{20}\right)}{U'\left(m_k + M - \frac{{e_i^*}^2}{20}\right) + U'\left(m_k - \frac{{e_i^*}^2}{20}\right)} \quad i \in \{B, C\} \text{ and } k \in \{f, u\} \tag{8}$$

For $U(\cdot)$ linear, agents are risk neutral. Therefore, the effort equilibrium of risk neutral agents is written:

$$e_i^* = \frac{5M}{8} = 10 \qquad i \in \{B, C\} \tag{9}$$

Risk neutral agents play an effort level equal to 10 in equilibrium.

Assuming constant absolute risk aversion, we note that the equilibrium effort of subjects is only affected by the additional payment. As this additional payment is identical between the fair and the unfair contract, the subjects should not be affected by the contract choice of the principal. Nevertheless, this effort provision decreases in risk aversion $\left(-\frac{U''}{U'}\right)$.

In the winner-takes-more treatment, as $\alpha = p$, subjects' utility is exactly equal to the utility of the expected gain in the winner-takes-all treatment. Recall that the subjects in the winner-takes-more treatment face no risk because they receive the expected payoff rather than either the guaranteed payment plus the prize or the guaranteed payment only. Therefore, the only difference between the two treatments is that in the winner-takes-more treatment subjects receive the average payoff in the winner-takes-all treatment. The equilibrium effort in the winner-takes-more treatment is then 10 regardless of the degree of agents' risk aversion.[4]

From the previous theoretical considerations we derive the following predictions:

1. Agents with constant absolute risk aversion should not react to the fairness of the principal. Agents should provide the same effort in both the fair and the unfair contracts.
2. Risk neutral agents should not be affected by the type of distribution of payments in competition. Risk-neutral agents should provide the same effort in both the winner-takes-all treatment and the winner-takes-more treatment. Due to the financial risk when one agent fully gets the prize, risk-averse agents should provide more effort in the winner-takes-more treatment.

[4] It is now clear why we called one contract fair and one contract unfair. Assuming risk neutrality of agents, their equilibrium payoff in the fair contract in equilibrium is equal to 20 and the payoff of the principal is also equal to 20. In the unfair contract, agents earn 16 in equilibrium while the principal gets 28.

3. As no effect of the principal's fairness on effort provision is predicted whatever the distribution of payments, the principal should always offer the unfair contract in both treatments .

Now we discuss these predictions from a behavioral point of view. Our expectations change if we assume that subjects have social preferences, i.e. if they take the external effects of their behavior into account.

Theories of social preferences predict that a positive fraction of individuals should be reciprocal toward others' action.[5] They say that an individual with social preferences should respond kindly (unkindly) to a kind (unkind) action of another person. Envy provides one motive for reciprocal behavior as unkind behavior can lead to a high inequality in outcomes. Grund and Sliwka (2003) show in a theory article how envy affects the effort provision in tournaments. We apply their argument to our game and assume that some subjects have social preferences. The consideration of social preferences affects our predictions in the following way:

1. Because of reciprocity we expect to observe more collusion in the unfair contract than in the fair contract. The average effort in the fair contract should be higher than in the unfair contract.
2. The winner-takes-all treatment leads to a larger inequity in outcomes than the winner-takes-more treatment. In the winner-take-all treatment envious people invest in precautionary effort in order to be better off than their competitor. Hence, we predict that the average effort is higher in such a conventional tournament.

---

[5] Some fairness models base reciprocity on the distributive consequences of an individual's action (Fehr and Schmidt, 1999, Bolton and Ockenfels, 2000) while other models focus on the intentions (Dufwenberg and Kirchsteiger, 2004, Rabin, 1993). According to Falk and Fischbacher (2006) both intentions and final outcome distributions influence reciprocity. Sobel (2005) proposes a survey of this literature.

3. The expectation of reciprocal behavior induces some principals to choose the fair contract.

Previous research does not provide a suggestion on how envy towards a peer and reciprocity towards a principal interact. The results of our experiment fill this gap. We can deduce whether agents who respond to the fairness of the principal condition their behavior on the inequality in outcomes between themselves and their competitor.

4. Results

In our empirical analysis we look at first at the behavior of the agents, in particular the effort provision. We then investigate the heterogeneity in social preferences among the agents. Finally we look at the behavior of the principal and the distribution of payoffs between the principal and the agents.

4.1. Effort level

Table 2 displays the mean and standard deviation of effort contributions for the different contracts (fair and unfair) and treatments (winner-takes-all and winner-takes-more).

Table 2. Average effort by contract and treatment (standard deviation in parentheses)

	Winner-takes-all (Tournament)	Winner-takes-more (Proportional Payment)
Fair contract	9.574 (5.154)	7.831 (5.098)
Unfair contract	8.393 (5.322)	6.609 (4.758)

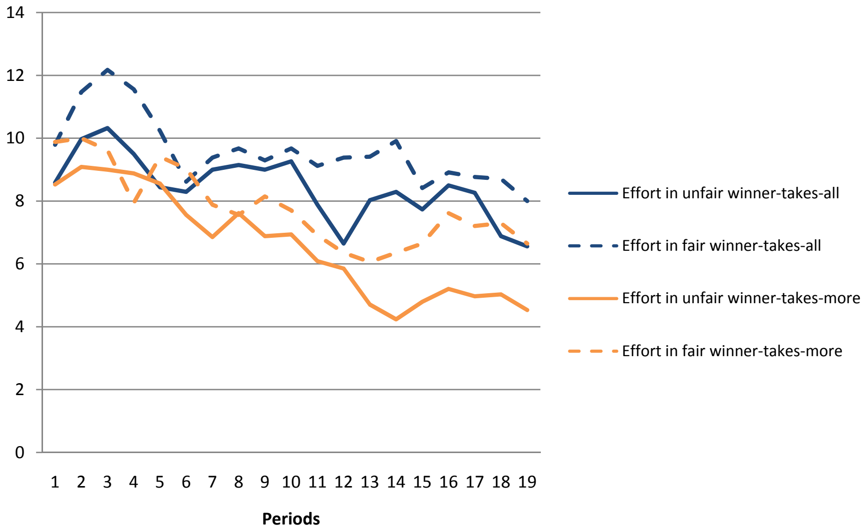
Predictions from standard economic theory are not verified in the data. First, the average effort across all periods is significantly higher in the fair contract than in the unfair contract (Wilcoxon signed rank test, $z=3.822$, $p<0.01$, $z= 3.800$, $p<0.01$, respectively for winner-takes-all and winner-takes-more treatments). This result supports our behavioural expectations saying that some agents are reciprocal to the principal's behavior and provide lower effort when he chooses the unfair contract instead of the fair contract. Choosing the unfair contract leads to higher collusion.

Second, the average effort across all periods in the winner-takes-all treatment is significantly higher than in the winner-takes-more treatment, independent of the contract (Mann-Whitney test, $z= 1.993$, $p<0.05$, $z= 1.742$, $p<0.10$, respectively for the unfair and the fair contracts). Again, this result goes in favour of our behavioural expectations. In a competition with one agent who fully gets the prize, agents produce higher effort. Collusion between agents is higher when the prize is shared between agents. This result is even stronger as we know that most agents are risk averse. On average, the agents chose the safe option around 10.9 times. We observe that 33.8% of the agents are risk neutral, 16.2% are risk loving and 50.0% are risk averse.[6] Therefore, fairness of the principal and inequality between ex-post payoffs prevent agents from colluding.

Although the unfairness of the principal favours collusion, agents provide a higher effort in the unfair winner-takes-all than in the fair winner-takes-more (Mann-Whitney test, $z= 2.110$, $p=0.0348$). The highest collusion is observed in the unfair winner-takes-more and the lowest collusion in the fair winner-takes-all. The standard deviation of efforts being not different between contracts and treatments, the only relevant measure to classify the efficiency of contracts and treatments is the average effort. Figure 1 shows the evolution over periods of effort levels.

[6] In total, i.e. including subjects playing as a principal in the main game, the subjects chose around 10.6 times the safe option. 33.3% of the subjects are risk neutral, 19.6% are risk lover and 47.1% are risk averse. The distribution of subjects for each decision is represented in the appendix.

Figure 1: Evolution of average effort by contract and treatment



Across the twenty periods we observe a significant decline in effort contributions. The decrease of effort level concerns both treatments and both contracts. This decline does not affect the qualitative results previously described: The average effort is higher in the winner-takes-all treatment than in the winner-takes-more treatment and higher in the fair than in the unfair contract at each period.

Tobit regressions in Table 3 confirm our results. Model (1) gives the effect of periods and of both interest variables, which are the fairness of the contract and the treatment. Model (2) controls for the observed behavior of the partner and the choice of the principal in the previous period. Model (3) takes the observed behavior of the partner and the choices of the principal in the two previous periods and risk preferences of the subjects into account. Risk preferences are measured through the number of safe choices in the risk elicitation task.

Table 3: Tobit estimations of effort provision across contracts and treatments

Dependant variable: Effort level				
Independent Variables	Description	Model (1)	Model (2)	Model (3)
Period	1 to 20	-.186*** (.034)	-.109*** (.030)	-.060* (.030)
Unfair	1 = unfair; 0 = fair	-1.265** (.536)	-1.805*** (.568)	-1.953*** (.619)
Winner-takes-all	1 = Winner-takes-all treatment; 0 = winner-takes-more treatment	1.691* (.928)	3.168** (1.322)	3.378** (1.403)
Interaction	*Unfair × Winner-takes-all*	-.121 (.681)	-.224 (.730)	-.230 (.761)
$Contract_{t-1}$	Contract choice of the principal in the previous period: 1 = unfair; 0 = fair		-.507 (.525)	-.590 (.487)
$Effort_{t-1}$	Observed effort of the partner in the previous period (0 – 20)		.507*** (.087)	.349*** (.054)
$Efftreat_{t-1}$	*Effort-1 × Winner-takes-all*		-.244** (.123)	-.183** (.089)
$Efffair_{t-1}$	*Effort-1 × Unfair*		.073 (.051)	.055 (.042)
$Contract_{t-2}$	Contract choice of the principal two periods earlier: 1 = unfair; 0 = fair			-.752 (.560)
$Effort_{t-2}$	Observed effort of the partner two periods earlier (0 – 20)			.318*** (.051)
$Efftreat_{t-2}$	*Effort-2 × Winner-takes-all*			-.109 (.067)*
$Efffair_{t-2}$	*Effort-2 × Unfair*			.035 (.042)
stablechoice	*Choice-1 = Choice-2*			-.824 (.504)
riskpref	# of safe choices in task 1 in the experiment	-.230 (.173)	-.159 (.138)	-.146 (.135)
Constant		12.104*** (2.062)	6.922*** (1.844)	4.052*** (1.060)
Observations		2720	2584	2448
Left-censored		298	292	290
Right-censored		32	30	29
Prob > F		.000	.000	.000
Pseudo R^2		.014	.038	.048

Significance levels: * p < .1; ** p < .05; *** p < .01; in parenthesis standard errors adjusted for 68 clusters in subject.

The descriptive results on the effect of the principal's fairness and of the distribution of payments in competition are reinforced by this econometric analysis. Both effects are strong and significant at 5%. According to model (1), the effort exerted by agents is lower in the unfair contract by 1.3 compared to the fair contract. In the winner-takes-all treatment, the effort is higher by 1.9 compared to the winner-takes-more treatment. We observe no significant interaction effect of the principal's fairness and the treatment. This means that the effect of the principal's fairness is not significantly different between the winner-takes-all treatment and the winner-takes-more treatment. Regarding the evolution of effort over time, we find that the effort level is decreasing.

When adding observed behavior of others at the previous period, we observe a significant and positive effect of the partner's observed effort in the previous period. Model (2) shows that for an increase of 1 of the partner's effort in the previous period, the agent increases his effort by 0.5. This result underlines that collusion needs coordination between subjects. Moreover, the significant and negative effect of the interaction between the partner's observed effort at the previous period and the winner-takes-all treatment reveals that the effect of the partner's observed effort is lower in the winner-takes-all treatment than in the winner-takes-more treatment. Coordination between agents is less effective in the winner-takes-all treatment than in the winner-takes-more treatment.

Finally, model (3) includes behavior in period -2. The effect of the behavior of the partner and the principal at period -2 are not qualitatively different from the effect of their behavior at period -1. All regressions also show that risk aversion does not significantly affect the effort decision of agents.[7] From the analysis of agents' effort, we conclude that collusion is easier to reach when the principal is unfair and when the prize is shared between agents in function of their effort provision, i.e. in the winner-takes-more treatment.

[7] We added the cross variable treatment and risk aversion in the regressions but its effect is not significant suggesting that the effect of risk aversion is not more significant in one treatment than in the other one. Moreover, we ran separated regressions for the winner-takes-all and the winner-takes-more treatments and the effect of risk aversion is not significant in both cases.

4.2. Heterogeneity of agents

We investigate now whether envy between agents also predicts reciprocity towards the principal. We classify agents to identify types. We base the classification of agents on the average of the difference between their effort in the fair contract and their effort in the unfair contract and on its standard deviation, i.e. on the reaction of agents to the principal's fairness. We use the hierarchical Wald method. This method is based on the minimization of the intra-group variance. We identify three types of subjects. Subjects from the first type do not react to the principal's fairness, we call them "Not reciprocal". Subjects from the second type react to the principal's fairness and are stable over time while subjects from the third type react to the principal's fairness but are unstable over time; they are called "Stable reciprocal" and "Unstable reciprocal" respectively.[8]

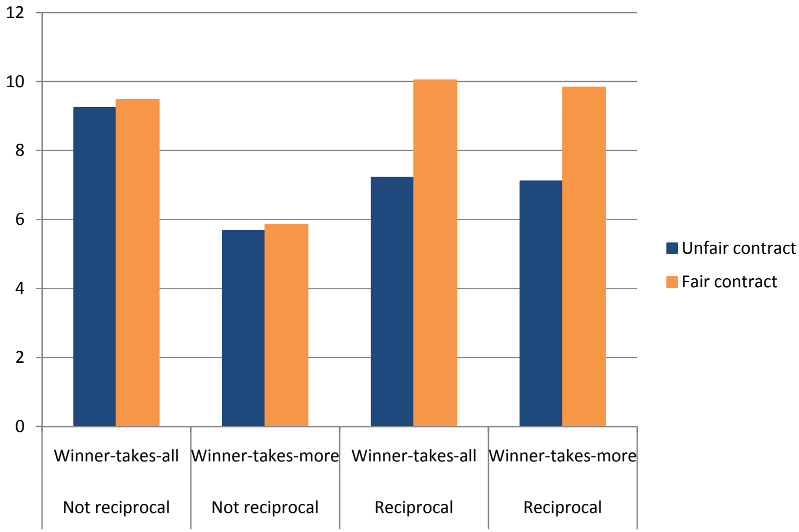
Table 4. Classification of agents according to their reaction to the principal's fairness

	Share in the population	Average effort difference fair/unfair	Within SD effort difference fair/unfair	Between SD effort difference fair/unfair	Effort in unfair contract	Effort in fair contract
Winner-takes-all tr.						
Not reciprocal	54.55%	0.23	1.62	0.51	9.24	9.47
Stable reciprocal	24.24%	3.31	1.46	1.35	6.99	10.30
Unstable reciprocal	21.21%	2.26	6.15	0.89	7.49	9.75
Winner-takes-more tr.						
Not reciprocal	45.45%	0.18	1.11	0.53	5.67	5.85
Stable reciprocal	21.21%	2.61	1.77	0.59	8.05	10.66
Unstable reciprocal	33.34%	2.79	5.20	2.34	6.52	9.31

Regarding the distribution of subjects, we observe that around half of agents are reciprocal and half are not. Nevertheless, the proportion of non-reciprocal agents is higher in the winner-takes-all treatment than in the winner-takes-more treatment. Figure 2 shows the average effort for not-reciprocal and reciprocal agents in both contracts and treatments.

[8] One subject in the tournament and one subject in the proportional payment have been excluded as they do not fit into any category.

Figure 2. Average effort of non-reciprocal and reciprocal agents by contract and treatment



Not reciprocal agents, i.e. agents who do not react to the fairness of the principal, in the winner-takes-all treatment have different behavior from non-reciprocal agents in the winner-takes-more treatment. In the winner-takes-all treatment, non-reciprocal agents exert an average effort of 9.3 while in the winner-takes-more treatment, non-reciprocal agents exert in average only 5.7 (Mann-Whitney test, $z=8.696, p<0.0001$ in the unfair contract and $z=8.695, p<0.0001$ in the fair contract). Hence, non-reciprocal agents collude in the winner-takes-more while they play the equilibrium (no collusion) in the winner-takes-all. Non-reciprocal agents provide a significantly higher effort if the prize is fully rewarded to one person rather than if it is shared between the agents. This behavior corresponds to the envious type. Therefore, at the aggregate level, we conclude that non-reciprocal agents are envious.

In contrary, stable or unstable reciprocal agents, i.e. agents who react to the principal's fairness, exert on average the same effort in both treatments (Mann-Whitney test, $z=0.540, p<0.5892$ in the unfair contract and $z=0.221, p<0.8247$ in the fair contract). Reciprocal agents do not behave differently depending on the distribution of payments in the competition. Reciprocal agents are not envious.

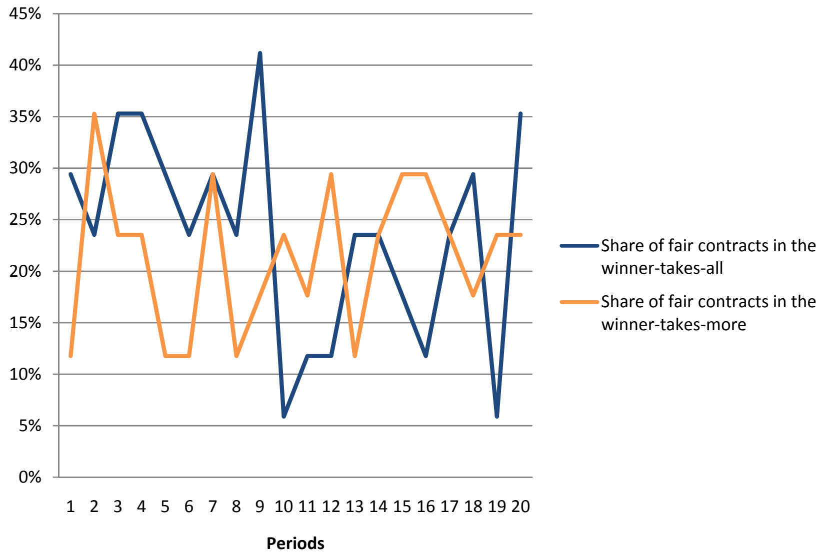
To summarize, the data show that agents who do not react to the principal's fairness react to the distribution of payments in competition and agents who react to the principal's fairness do not react to this distribution. This analysis shows that subjects focus their social preferences on one person. Either they are reciprocal towards the principal or they are envious towards their competitor.

4.3. Principal's behavior and profits

Principal's contract choice

Although agents respond in kind to a fair principal, most principals prefer the unfair contract to the fair contract. The fair contract is chosen by the principal in only 24% of cases in the winner-takes-all treatment and in 21% of cases in the winner-takes-more treatment. There is no systematic variation in the provision of fair contracts over time (see Figure 3).

Figure 3: Share of the fair contracts in each of the 20 periods



We conducted a probit regression to understand what explains the principal's choice of contract, fair or unfair. As the principal observes only the effort level of agents under the contract he has chosen, we separated the analysis for principals who have chosen the fair contract at the previous period from principals who have chosen the unfair contract at the previous period. Table 4 shows the marginal coefficients of the probit regressions clustered on groups.

Profits of principals and agents

Table 5 shows the potential profit of principals and agents depending on the contract and the treatment.

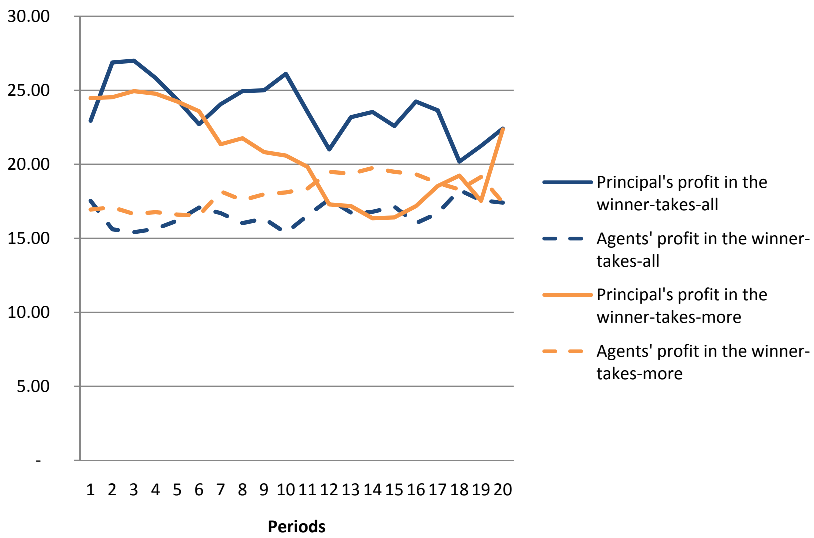
Table 5. Average profits by contract and treatment

		Winner-takes-all (Tournament)	Winner-takes-more (Proportional Payment)
Principals	Fair contract	19.15	15.66
	Unfair contract	24.79	21.22
Agents	Fair contract	19.09	20.64
	Unfair contract	16.06	17.69

The average profits reflect the effort level decisions of agents. Nevertheless, although agents always provide a higher effort in the fair contract, the principal earns lower profits: The sum of payments paid by the principal to the agents in the fair contract is higher than the benefit from a higher effort provision by the agents. Agents are better off in the fair contract. Moreover, we observe that, in both contracts, the profits of the principal are always higher in the winner-takes-all treatment than in the winner-takes-more treatment. Therefore, the principal benefits from the inequality in outcomes instituted between agents in the winner-takes-all treatment. The difference between agents' profits in the two treatments is small.

Figure 4 represents the actual profit of principals and agents over time. We observe that, over time, in the winner-takes-more treatment the agents are able to eliminate the difference in income between them and the principal. This does not occur in the winner-takes-all treatment. The profit of the principal and the average profit of agents are not significantly different on average over periods 7 to 20 (Mann-Whitney test, $z = 0.280, p=0.7793$). In the winner-takes-all treatment, the profit of the principal is significantly higher than the profit of agents (Mann-Whitney test, $z = 7.879, p<0.0001$).

Figure 4. Evolution of real profits by treatment



This analysis emphasizes again that fully distribution the prize to one person prevents agents from colluding. Under high inequality between ex-post payoffs, agents do not manage to coordinate to get higher profits. Thus, the principal gains from this behavior in the winner-takes-all treatment.

5. Conclusion

We examined the effect of the principal's fairness and of inequality in payments on effort provision in tournaments. We conducted our study because previous studies seemed to imply that social preferences do not play a role in tournaments. Since tournaments share key characteristics with public good games we devised an experiment which properly controls for the impact of social preferences in tournaments.

Our results show that social preferences matter in tournaments. We observe collusion which depends on the principal's fairness and inequity in outcomes between agents. Unfairness of the principal favors collusion. A lower inequality in ex-post payoffs, i.e. if the prize is shared between the agents, has the same effect. Principals who use tournaments with high inequality in ex-post payoffs benefit from the envy of their agents. Our results provide a clear contradiction to standard theory.

Additionally, we find that agents make a choice between collusion between agents and reciprocity towards the principal. On the one hand, agents who react to the principal's fairness do not bother about the distribution of payments. These reciprocal agents provide the same effort when one person fully gets the prize and when the prize is shared between the agents. On the other hand, envious agents provide significantly less effort if the inequality in payments is low but they do not react to the principal's fairness.

Divide and Rule (*Divide et impera*) is a popular maxim to summarize a strategy of gaining and maintaining power against large hostile forces. Our results show that tournaments with rigid prize spreads induce envy between agents. This envy induces more activities that are harmful for the agents but beneficial for the principal. Nevertheless, the benefits from exploiting envy can outweigh their costs, in particular if the resulting revenue is equally shared between principal and agents. Our findings therefore support James Madison. In the Federalist Paper No. 10, he argued that "*Divide et impera, the reprobated axiom of tyranny, is under certain qualifications, the only policy, by which a republic can be administered on just principles"*.

References

Amegashie, J. A. (2006). "Asymmetry and Collusion in Infinitely Repeated Contests." *Mimeo*.

Bandiera, O., I. Barankay, and I. Rasul (2005). "Social Preferences and the Response to Incentives: Evidence from Personnel Data." *Quarterly Journal of Economics, 120* (3), pp. 917-62.

Bognanno, M. L. (2001). "Corporate Tournaments." *Journal of Labor Economics, 19* (2), pp. 290-315.

Bolton, G. E., and A. Ockenfels (2000). "ERC - A Theory of Equity, Reciprocity and Competition." *American Economic Review, 90* (1), pp. 166-93.

Bull, C., A. Schotter, and K.Weigelt (1987). "Tournaments and Piece-Rates: An Experimental Study." *Journal of Political Economy, 95* (1), pp. 1-33.

Chen, Z. (2006). "Fighting Collusion in Tournaments." *MPRA Paper*, n° 872.

Demougin, D. and Fluet, C. (2003) "Inequity Aversion in Tournaments," CIRPEE Working Paper 03-22.

Dohmen, T., and A. Falk (2006). "Performance Pay and Multi-Dimensional Sorting: Productivity, Preferences and Gender." *IZA Discussion Paper*, n° 2001.

Dohmen, T., A. Falk, D. Huffman, U. Sunde, J. Schupp, and G. G. Wagner (2009). "Individual Risk Attitudes: Measurement, Determinants and Behavioral Consequences." *Journal of the European Economic Association*, forthcoming.

Dufwenberg, M., and G. Kirchsteiger (2004). "A theory of sequential reciprocity." *Games and Economic Behavior, 47* (2), pp. 268-98.

Ehrenberg, R. G., and M. L. Bognanno (1990a). "Do Tournaments Have Incentive Effects?" *Journal of Political Economy, 98* (6), pp. 1307-24.

Eriksson, T. (1999). "Executive Compensation and Tournament Theory: Empirical Tests on Danish Data." *Journal of Labor Economics, 17* (2), pp. 262-80.

Eriksson, T., S. Teyssier, and M.C. Villeval (2009). "Self-Selection and the Efficiency of Tournaments." *Economic Inquiry, 47* (3), pp. 530-48.

Falk, A., and U. Fischbacher (2006). "A theory of reciprocity." *Games and Economic Behavior, 54* (2), pp. 293-315.

Fehr, E., and S. Gächter (2002). "Altruistic Punishment in Humans." *Nature, 415*, pp. 137-40.

Fehr, E., G. Kirchsteiger, and A. Riedl (1998). "Gift Exchange and Reciprocity in Competitive Experimental Markets." *European Economic Review, 42*, pp. 1-34.

Fehr, E., and K. M. Schmidt (1999). "A Theory of Fairness, Competition, and Cooperation." *Quarterly Journal of Economics, 114* (3), pp. 817-68.

Fischbacher, U. (2007). "Z-Tree: Zürich Toolbox for Ready-Made Economic Experiments." *Experimental economics, 10* (2), pp. 171-78.

Gächter, S. and Herrmann, B. (2009) "Reciprocity, Culture and Human Cooperation: Previous Insights and a New Cross-Cultural Experiment." *Philosophical Transactions B*, *364*(1518), pp. 791.

Greiner, B. (2004). "An Online Recruitment System for Economic Experiments." In Kurt Kremer, Volker Macho (eds.). *Forschung und wissenschaftliches Rechnen*, GWDG Bericht 63, Gttingen : Ges. fr Wiss. Datenverarbeitung, 2003, pp. 79-93.

Grund, C. and Sliwka, D. (2005) "Envy and Compassion in Tournaments." *Journal of Economics and Management Strategy*, *14*(1), pp. 187-207.

Güth, W., R. Schmittberger, and B. Schwarze (1982). “An Experimental Analysis of Ultimatum Bargaining.” *Journal of Economic Behavior and Organization, 3*, pp. 367-88.

Harbring, C. and B. Irlenbusch (2003). “An Experimental Study on Tournament Design.” *Labour Economics, 10* (4), pp. 443-64.

Ishiguro, S (2004) “Collusion and Discrimination in Organizations” *Journal of Economic Theory, 116,* pp. 357-69.

Knoeber, C. R., and W. N. Thurman (1994). “Testing the Theory of Tournaments: An Empirical Analysis of Broiler Production.” *Journal of Labor Economics, 12* (2), pp. 155-79.

Main, B. G.M., C. O’Reilly III, and J. Wade (1993). “Top Executive Pay: Tournament or Teamwork?” *Journal of Labor Economics, 11* (4), pp. 606-28.

Orrison, A., A. Schotter, and K. Weigelt (2004). “Multiperson Tournaments: An Experimental Examination.” *Management Science, 50* (2), pp. 268-79.

Rabin, M. (1993). “Incorporating Fairness into Game Theory and Economics”. *American Economic Review, 83* (5), pp. 1281-302.

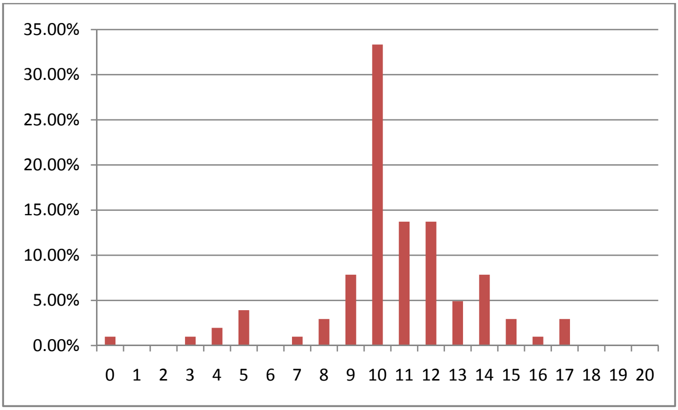
Schotter, A., and K. Weigelt (1992). “Asymmetric Tournaments, Equal Opportunity Laws, and Affirmative Action: Some Experimental Results.” *Quarterly Journal of Economics, 107* (2), pp. 511-39.

Sobel, J. (2005). “Interdependent Preferences and Reciprocity.” Journal *of Economic Literature, XLIII*, pp. 392-436.

Appendix

Instructions

Distribution of risk preferences across subjects (on the x-axis: the number of safe choices, on the y-axis: the share of subjects who made the specific amount of safe choices)


35.00%
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Instructions for Winner-Takes more-Treatment

(*In Italics: differences in the winner-takes-all-treatment*)

Instructions for Participants in the Winner-takes-More-Treatment

(*Text in italics shows the different instructions for participants in the Winner-Takes-All-Treatments*)

This experiment has two parts. These are the instructions for the second part. Depending on the decisions of you and the other participants in this experiment, you may receive additional payments.

Therefore we recommend to study these instructions in detail. If you have any question, please contact us **before** the experiment starts. All participants receive the same instructions.

You must not talk with other participants during the experiment. Otherwise you are excluded from the experiment and receive no payments at all.

During the experiment we talk about points instead of Euros. At first, all your revenues are calculated in points. We exchange the final score into Euros at the end of the experiment. The exchange rate is

1 Point = 70 Eurocents.

At the end of this experiment, you receive payments for all your received points in both parts of the experiment **and** the 4 Euros for participation in **cash**.

Now we explain the procedure of the experiment on the following pages in detail.

Part 2 of the Experiment

1. Design of the experiment

In this part of the experiment you and two other persons form a group. Each group contains a participant A, a participant B and a participant C. The assignment to the groups is random and anonymous, You will see on the screen if you are a participant A, B or C.

This part of the experiment continues for 20 periods. During all periods you remain in the same group and in the same role (A, B, or C). In each period you make a decision which can influence your payoff. At the end of the experiment, the computer chooses randomly one period. We will pay you for this randomly selected period. All other periods are payoff irrelevant.

Each period is divided into two phases:

1. Participant A chooses between two payments, 1 or 2, for participants B and C. In return, A receives contributions of B and C which are conditioned for each payment. At the end of the period, B and C will learn which payment has been chosen by A.
2. Now, participants B and C make their decisions for each possible payment.
   - At first, B and C choose simultaneously a contribution in case that A has opted for payment 1.
   - Then B and C choose simultaneously a contribution in case that A has opted for payment 2.

At the end of the experiment the choice of A and the relevant contributions of B and C are revealed to all participants.

Now, we will explain the relationship between payment, contributions and the resulting earnings at the end of the period in detail.

2. The decision of participant A

Participant A has an endowment of 50 points and chooses between payments 1 and 2.

- Payment 1:
  - B and C receive 13 points each
  - 16 additional points will be distributed between B and C. *16 additional points will be given either to B or C. The other participant does not receive any additional points.*
  - Participants B and C increase their share in these 16 points by increasing their contribution to A. If, for example, B contributes more than C she will also earn more points. Note that a higher contribution also implies higher costs. *Participants B and C increase their probability of getting these 16 points by increasing their contribution to A. If, for example, B contributes more than C she is more likely to get these points. Note that a higher contribution also implies higher costs.*

- Payment 2:
  - B and C receive 13 points each.
  - 24 additional points will be distributed between B and C. Out of these 24 points each participant receives at least 4 points. *24 additional points will be given to B and C. One participant receives 20 additional points, the other participant receives 4 additional points.*
  - Participants B and C increase their share in these 24 points by increasing their contribution to A. If, for example, C contributes more than B she will also earn more points. Note that a higher contribution also implies higher costs. *Participants B and C increase their probability of getting 16 points more by increasing their contribution to A. If, for example, B contributes more than C she is more likely to get these points. Note that a higher contribution also implies higher costs.*

The costs of a contribution and the sharing rules for *(probabilities of receiving)* the 16 points are identical for both payments (see below). When making her decision, participant A will see the following screen. Participant A chooses between payments 1 and 2 by typing the relevant number in the field. The decision is irreversible once A has clicked the OK button.

3. The decisions of participants B and C

In phase 2, participants B and C make two decisions each. These decisions differ only with respect to the subsequent payments. Otherwise the following explanation hold for both decisions in the same way. In the end earnings and costs will be realized only for the payment chosen by participant A.

- Participants B und C choose an individual contribution between 0 and 20 (only integers are possible).
- These contributions are transferred to participant A.
- A contribution implies a cost which has to be borne by the contributing participant. For example, a contribution of 8 points costs 3.20 points. A contribution of 12 points costs 7.20 points. Table 1 provides an overview over the contribution and their associated costs.

Instructions for Winner-Takes more-Treatment

(*In Italics: differences in the winner-takes-all-treatment*)

Table 1: The costs of contribution to A for the contributing participant (B or C)

Contribution	**Cost**	**Contribution**	**Cost**
0	0.00	10	5.00
1	0.05	11	6.05
2	0.20	12	7.20
3	0.45	13	8.45
4	0.80	14	9.80
5	1.25	15	11.25
6	1.80	16	12.80
7	2.45	17	14.45
8	3.20	18	16.20
9	4.05	19	18.05
		20	20.00

- Via a higher contribution, a participant can increase her share in the 16 points. *Via a higher contribution, a participant can increase her probability of getting the 16 points.* Table 2 shows the shares.

  Example 1: Participant C contributes 5 points more than participant B (In table 2: Contribution B – Contribution C = -5).In this case, B's share is 23.63%. The share of C is 76.37% or 12.22 points. *In this case, B's probability is 23.63%. The probability of C is 76.37%.*

  Example 1: Participant B contributes 3 points more than participant C (In table 2: Contribution B – Contribution C = -5).In this case, B's share is 66.99% or 10.72 points. The share of C is 33.01% or 5.28 points. *In this case, B's probability is 66.99%. The probability of C is 33.01%.*

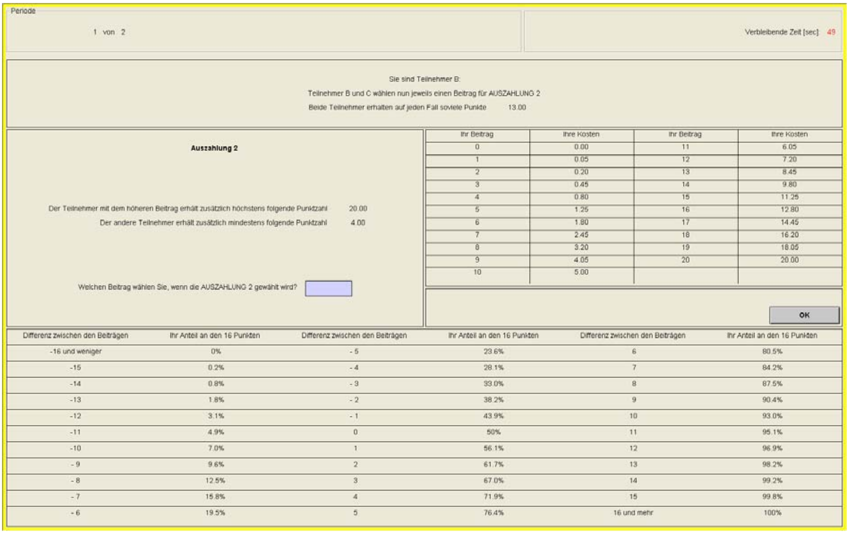
Table 2: The difference in contributions between participants B and C and the resulting share of the distributed 16 points.

Table 2: The difference in contributions between participants B and C and the resulting probability of getting 16 points.

Differences in the contributions	**Share of the 16 points** ***Probability of getting 16 points***		**Differences in the contributions**	**Share of the 16 points** ***Probability of getting 16 points***	
Contribution B – Contribution C	*Participant B*	*Participant C*	*Contribution B – Contribution C*	*Participant B*	*Participant C*
-16 and less	0.00%	100.00%	0	50.00%	50.00%
-15	0.20%	99.80%	1	56.05%	43.95%
-14	0.78%	99.22%	2	61.72%	38.28%
-13	1.76%	98.24%	3	66.99%	33.01%
-12	3.13%	96.88%	4	71.88%	28.13%
-11	4.88%	95.12%	5	76.37%	23.63%
-10	7.03%	92.97%	6	80.47%	19.53%
-9	9.57%	90.43%	7	84.18%	15.82%
-8	12.50%	87.50%	8	87.50%	12.50%
-7	15.82%	84.18%	9	90.43%	9.57%
-6	19.53%	80.47%	10	92.97%	7.03%
-5	23.63%	76.37%	11	95.12%	4.88%
-4	28.13%	71.88%	12	96.88%	3.13%
-3	33.01%	66.99%	13	98.24%	1.76%
-2	38.28%	61.72%	14	99.22%	0.78%
-1	43.95%	56.05%	15	99.80%	0.20%
			16 and more	100.00%	0.00%

- On the computer screen the decision situation looks like this for B and C. At first, each participant decides about a contribution for payment 1. On the next screen each of them decides about a contribution for payment 2. B and C make each decision simultaneously.

The following screenshot shows the decision situation of B and C for payment 2. On top to the left, you will find the field in which you state your contribution. To the right, you see how much a contribution costs. The lower half of the screen shows the shares of the 16 points *(the probabilities of getting 16 points)*, depending on how much the contributions differ between the two participants.



Periode

1 von 2

Verbleibende Zeit [sec] 49

Sie sind Teilnehmer B:

Teilnehmer B und C wählen nun jeweils einen Beitrag für AUSZAHLUNG 2

Beide Teilnehmer erhalten auf jeden Fall soviele Punkte 13.00

Auszahlung 2

Der Teilnehmer mit dem höheren Beitrag erhält zusätzlich höchstens folgende Punktzahl 20.00

Der andere Teilnehmer erhält zusätzlich mindestens folgende Punktzahl 4.00

Welchen Beitrag wählen Sie, wenn die AUSZAHLUNG 2 gewählt wird?

Ihr Beitrag	Ihre Kosten	Ihr Beitrag	Ihre Kosten
0	0.00	11	6.05
1	0.05	12	7.20
2	0.20	13	8.45
3	0.45	14	9.80
4	0.80	15	11.25
5	1.25	16	12.80
6	1.80	17	14.45
7	2.45	18	16.20
8	3.20	19	18.05
9	4.05	20	20.00
10	5.00		

OK

Differenz zwischen den Beiträgen	Ihr Anteil an den 16 Punkten	Differenz zwischen den Beiträgen	Ihr Anteil an den 16 Punkten	Differenz zwischen den Beiträgen	Ihr Anteil an den 16 Punkten
-16 und weniger	0%	- 5	23.6%	6	80.5%
-15	0.2%	- 4	28.1%	7	84.2%
-14	0.8%	- 3	33.0%	8	87.5%
-13	1.8%	- 2	38.2%	9	90.4%
-12	3.1%	- 1	43.9%	10	93.0%
-11	4.9%	0	50%	11	95.1%
-10	7.0%	1	56.1%	12	96.9%
- 9	9.6%	2	61.7%	13	98.2%
- 8	12.5%	3	67.0%	14	99.2%
- 7	15.8%	4	71.9%	15	99.8%
- 6	19.5%	5	76.4%	16 und mehr	100%

4. <u>The determination of revenues and costs for each participant.</u>

This experiment has 20 periods. Only one randomly chosen period will be paid. In this period the following aspects are relevant for the final payments,

- The payment chosen by participant A (1 or 2)
- The contributions of B and C for this payment.
- The costs of these contributions.

The contributions for the payment which has not been selected are irrelevant.

Costs and revenues of participant A:

Participant A has an endowment of 50 points at the beginning of the period. Additionally she receives the contributions of B and C. Participant A has to make the assigned payments to B and C.

Costs and revenues of participant B and C:

Participants B and C each receive a payment from A. In payment 1, 16 points are distributed between B and C. In payment 2, 24 points are distributed between B and C, but each participant receives at least 4 of these 24 points. The size of the additional payment depends on the difference in the contributions. The costs of the contribution are withdrawn from these revenues.

Participants B and C each receive a payment from A.In payment 1, either B or C get 16 points. In payment 2, one participant gets 24 points and the other gets 4 points. The probability of getting the higher payment depends on the difference in the contributions. The costs of the contribution are withdrawn from these revenues.

Example 3 for a random period:

Participant A selects payment 1. Participant B chooses a contribution of 11 points for payment 1 and 9 points for payment 2. Participant C chooses a contribution of 10 points for payment 1 and 13 points for payment 2. The contributions for payment 2 are irrelevant.

In payment 1, B contributes 1 point more than C. Her share is therefore 56.05% (8.97 points). The share of C is 43.95% (7.03 points, see Table 2). The resulting revenues for A are:

In payment 1, B contributes 1 point more than C. Her probability of getting 16 points is therefore 56.05%. The probability of C is 43.95% (see Table 2). The resulting revenues for A are:

Endowment	50 points
Contribution B	11 points
Contribution C	10 points
Sum	71 points

The costs of A for payment 1 are:

Guaranteed Payment to B	13 points
Guaranteed Payment to C	13 points
Additional Payment to B	8,97 points
	16 or 0 points
Additional Payment to C	7,03 points
	16 or 0 points
Sum	42 points

Therefore the final profit of participant A is 29 points (71-42).

The revenues for B are:

Guaranteed Payment from A	13 points
Additional Payment (56,05% from 16 points)	8.97 points
Sum	21.97 points

Guaranteed Payment from A	*13 points*
Additional Payment of 16 points (56,05% probability)	*16 points*
Sum	*Either 13 points or 29 points*

The costs of participant B are the costs of her own contribution (11), i.e. 6.05 points (see table 1)

Therefore the final profit of participant B is 15.92 points (21.97-6,05)
Therefore the final profit of participant B is either 6.95 points (13-6.05, with a probability of 43.95%) or 22.95 points (29-6.05, with a probability of 56.05%)

The revenues for C are:

Guaranteed Payment from A	13 points
Additional Payment (43.95% from 16 points)	7.03 points
Sum	21,97 points

Guaranteed Payment from A	*13 points*
Additional Payment of 16 points (43.95% probability)	*16 points*
Sum	*Either 13 points or 29 points*

The costs of participant B are the costs of her own contribution (10), i.e. 5 points (see table 1)

Therefore the final profit of participant C is 15.03 points (20.03-5)
Therefore the final profit of participant B is either 8 points (13-5, with a probability of 56.05%) or 24 points (29-5, with a probability of 43.95%)

Example 4 for a random period:

Participant A selects payment 2. Participant B chooses a contribution of 8 points for payment 1 and 5 points for payment 2. Participant C chooses a contribution of 7 points for payment 1 and 7 points for payment 2. The contributions for payment 2 are irrelevant.
In payment 1, B contributes 2 point less than C. Her share is therefore 38.28% (6.12 points). The share of C is 61.72% (9.88 points, see Table 2). The resulting revenues for A are:
In payment 1, B contributes 2 points less than C. Her probability of getting 16 points is therefore 38.28%. The probability of C is 61.72% (see Table 2). The resulting revenues for A are:

Endowment	50 points
Contribution B	5 points
Contribution C	7 points
Sum	62 points

The costs of A for payment 2 are:

Guaranteed Payment to B	13 points
Guaranteed Payment to C	13 points
Additional Guaranteed Payment to B	4 points
Additional Guaranteed Payment to C	4 points
Additional Payment to B	6.12 points
	16 or 0 points
Additional Payment to C	9.88 points
	16 or 0 points
Sum	50 points

Therefore the final profit of participant A is 12 points (62-50).

The revenues for B are:

Guaranteed Payment from A	13 points
Additional Guaranteed Payment from A	4 points
Additional Payment (38.28% from 16 points)	6.12 points
Sum	23.12 points

Guaranteed Payment from A	*13 points*
Additional Guaranteed Payment from A	*4 points*
Additional Payment of 16 points (38.28% probability)	*16 points*
Sum	*Either 17 or 33 points*

The costs of participant B are the costs of her own contribution (5), i.e. 1.25 points (see table 1)

Therefore the final profit of participant B is 21.87 points (23.12-1.25)

Therefore the final profit of participant B is either 15.75 points (17-1.25, with a probability of 38.28%) or 31.75 points (33-1.25, with a probability of 61.72%)

The revenues for C are:

Additional Guaranteed Payment from A	4 points
Guaranteed Payment from A	13 points
Additional Payment (61.72% from 16 points)	9.88 points
Sum	26,88 points

Guaranteed Payment from A	*13 points*
Additional Guaranteed Payment from A	*4 points*
Additional Payment of 16 points (61.72% probability)	*16 points*
Sum	*Either 17 or 33 points*

The costs of participant C are the costs of her own contribution (7), i.e. 2.45 points (see table 1)

Therefore the final profit of participant C is 24.43 points (26.88-2.45)
Therefore the final profit of participant B is either 14.55 points (17-2.45, with a probability of 38.28%) or 30.55 points (33-2.45, with a probability of 61.72%)

Questionnaire

Please answer the questions carefully and raise your finger if you have a question or you have answered all questions. We use these questions to ensure that all participants understand the experiment in the same way.

Question 1:

Please mark if the following statements are correct or not

	Ja	Nein
Participant A chooses the payments for B and C.		
In each period the composition of a group changes.		
If Participant B chooses a higher contribution than C she will always get more points from A.		
Each participant receives the average of her earnings from all periods.		
The revenues of A increase in the contributions of B and C		
The payments of A and B remain the same, if B and C both choose a contribution of 8 points or if both of them choose a contribution of 12.		
Participant B chooses a contribution of 12. His costs for this contribution are 7.33 points.		
Participant B chooses a contribution of 11, C a contribution of 19. The share of B from the 16 points is 12.50%. *In the winner takes all treatment: B's probability of winning the 16 points is 12.50%*		
The experiment has 20 periods		

Question 2:

Participant B chooses a contribution of 8 points for payment 1 and a contribution of 8 points for payment 2. Participant C chooses a contribution of 14 points for payment 1 and a contribution of 14 points for payment 2.

Determine B's share from the 16 points. *In the winner takes all treatment: Determine B's probability of winning the 16 points.*

Determine the costs for B and C (see table 1)

Determine the final profit for all three participants,

- If A has chosen payment 1;
- If A has chosen payment 2.

Aufgabe 3:

Participant B chooses a contribution of 10 points for payment 1 and a contribution of 4 points for payment 2. Participant C chooses a contribution of 6 points for payment 1 and a contribution of 8 points for payment 2.

Determine C's share from the 16 points for payment 1 (Table 2).

In the winner takes all treatment: Determine C's probability of winning the 16 points for payment 1.

Determine B's share from the 16 points for payment 2 (Table 2).

In the winner takes all treatment: Determine B's probability of winning the 16 points for payment 2.

Participant A has chosen payment 1. Determine the final profit for all three participants.

THURGAU INSTITUTE
OF ECONOMICS
at the University of Konstanz

Hauptstr. 90
CH-8280 Kreuzlingen 2

Telefon: +41 (0)71 677 05 10
Telefax: +41 (0)71 677 05 11

info@twi-kreuzlingen.ch
www.twi-kreuzlingen.ch