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Supporting Online Material for

The Competitive Advantage of Sanctioning Institutions

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The Competitive Advantage of Sanctioning Institutions

Supporting Online Material

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SUPPORTING ONLINE MATERIAL

Materials and Methods

Methods

84 undergraduate students from the University of Erfurt voluntarily participated in the experiments. Special care was exerted to recruit students from many different disciplines to increase the likelihood that the subjects had never met before. Each participant was allowed to take part in one session only. In total 7 experimental sessions each involving 12 subjects took place. These sessions constituted the independent observations for the non-parametric statistical analysis. Most of the sessions were run in pairs, i.e. 24 subjects were gathered in the lab.

The game is repeated over 30 periods and participants are not restricted by choices performed in previous periods. Each period consists of three stages: An institution choice stage (S0), a voluntary contribution stage (S1), and a sanctioning stage (S2). In stage S0 the participants simultaneously and independently choose between a sanctioning institution (SI) and a sanction-free institution (SFI) in which neither positive sanctioning (rewards) nor negative sanctioning (punishment) is possible. In stage S1, each participant is informed about the number of participants in each institution and in case the institution is occupied by at least two participants a public goods game is played with all participants who have chosen the same institution in S0. If only one subject joins an institution the subject's total endowment is automatically transferred to her/his private account. The public good's game constitutes a prototypical social dilemma in which each player is endowed with 20 money units (MUs) and may contribute between 0 and 20 MUs to a project which benefits the entire group. Each MU contributed to the public good is deducted from the contributor's private account and creates a benefit of 1.6 MUs for the entire group. This group benefit is equally distributed among the group members, i.e. if a group consists of n members each member profits by $1.6/n$ MUs from

each 1 MU contributed ($1.6/n$ is the marginal per capita return MPCR). If, for example, only one group member contributes the total endowment of 20 and the other n–1 group members contribute nothing, the public good amounts to $20 \cdot 1.6$ and the contributor's profit is $20 \cdot 1.6/n$ while each free-riders' profit is $20+20 \cdot 1.6/n$. If, however, all n group members contribute an identical amount of x, with $0 \leq x \leq 20$, the public good is $n \cdot x \cdot 1.6$ and each member achieves a profit of $20-x+1.6 \cdot x = 20+0.6 \cdot x$. Hence for an identical contribution x of all group members the net benefit of each group member is $0.6 \cdot x$ independent from the group size n. The MUs not contributed to the public good are transferred to the participant's private account. Thus, the provider's return from one additional MU is less than 1 but the group's return exceeds 1. Since the cost of providing is higher than the individual return, it is always in the material self-interest of any subject to free-ride on the contributions of the others and to keep all MUs for the private account. If all participants follow their material self-interest, nobody contributes to the public good and each participant achieves a payoff of 20 MUs. Because the group's return of each MU invested is greater than 1, it is in the collective interest that all group members contribute their entire endowment to the group project. These diametrically opposed individual and collective interests constitute the social dilemma in public good provision. After the players have simultaneously made their contribution decisions, they are informed about the contributions of each member in the own group.

At the beginning of stage S2 each player receives additional 20 tokens independent of the affiliation choice in S0. In SFI these tokens are directly transferred to the player's private account without any decisions required, i.e. sanctioning was not possible. In SI these tokens may be used to positively or negatively sanction other members of SI by assigning between zero and 20 tokens to other members. Each player is free to choose which of the other members of SI she/he wants to positively and/or negatively sanction and to determine the amount of allocated sanctioning tokens to each of those players. She/he is free to allocate different numbers of sanctioning tokens to different individuals with the only restriction that

the sum of allocated tokens is limited to at most 20. Tokens not used for sanctioning are transferred to the player's private account. Each token employed as a negative sanction costs the punished member 3 MUs and the punishing member 1 MU. Each token employed as a positive sanction yields the receiving member 1 MU and costs the employing member 1 MU. The leverage in the negative sanctioning mechanism is motivated by the understanding that punishment is more costly for the punished individual than for the punisher. We assume that the leverage in positive sanctioning is smaller and does not create any efficiency gains. The efficiency loss of negative sanctioning as well as the efficiency neutrality of positive sanctioning excludes efficiency gains solely by applying these instruments.

At the end of the period each participant receives detailed (but anonymous) information about each individual other participant from both institutions: the contribution, the sum of allocated positive sanctioning and negative sanctioning tokens to others, the sum of received positive sanctioning tokens from others, the sum of received negative sanctioning tokens from others, and the period profit. Players are neither informed about the identities of the other players nor are they able to track the identities over periods, because the order in which the players' details are displayed is known to be randomized in each period. In particular players could not identify the other players who allocated sanctioning tokens to them.

At the beginning of the experiment subjects received written instructions (see the section "Experimental instructions" below). At the end of the experiment subjects privately received their experimental earnings in cash. One experimental session typically lasted for 2.5 hours, and on average subjects earned 24 € per session. All experimental decisions were made on a computer screen using the experimental software z-Tree (*S1*). Each of the 24 computers was located in a booth such that subjects could not see or communicate with each other.

The Effect of the Group Size on the Marginal per Capita Return (MPCR)

The marginal per capita return (MPCR) denotes the individual return a recipient obtains from each token contributed. In a public goods game of n players the MPCR is lower than 1 and exceeds $1/n$. The MPCR being lower than 1 implies that it is individually rational to refrain from contributing since the individual return is lower than the investment. The fact that the MPCR exceeds $1/n$ implies that contributing is collectively rational because the groups' return on each token invested is greater than one. The endogenous group choice in each period of our experiment allows varying group sizes in each period. We constructed the MPCR such that it changes with the group size n, i.e. MPCR = $1.6/n$. Hence, smaller groups have a higher MPCR than larger groups. Thus, the more members choose an institution the lower is the individual return on investment for one contributed token. As a consequence, however, the total "productivity" $n \cdot$MPCR from the perspective of the group is constant, i.e. equal to 1.6. This means that all groups consisting of full cooperators achieve the same individual payoffs (i.e. $20 \cdot 1.6$), no matter how large the groups are. Hence, in the Nash-equilibrium of complete free-riding as well as under full cooperation the individual payoffs do not depend on the group size. From what is known on the interplay of the group size and the MPCR (*S2*) our design favors cooperation in small groups and disfavors cooperation in large groups.

Experimental Instructions

The next pages show a translation of the written experimental instructions. They describe the sequence of events during the experiment and the payoff rules. Subjects received the instructions in German.

Instructions to the Experiment

General Information: At the beginning of the experiment you will be randomly assigned to one of **2 subpopulations each consisting of 12 participants**. During the whole experiment you will interact only with the members of your subpopulation. At the beginning of the experiment, **1,000 experimental tokens** will be assigned to the experimental account of each participant.

Course of Action: The experiment consists of **30 rounds**. Each round consists of 2 stages. In Stage 1, the group choice and the decision regarding the contribution to the project take place. In Stage 2, participants may influence the earnings of the other group members.

Stage 1

(i) The Group Choice: In Stage 1, each participant decides which group she wants to join. There are two different groups that can be joined:

		Influence on the earnings of other group members
Group	A:	No
	B:	Yes, by assigning positive and negative tokens

(ii) Contribution to the Project: In stage 1 of each round, each group member is endowed with 20 tokens. You have to decide how many of the 20 tokens you are going to contribute to the project. The remaining tokens will be kept in your private account.

Calculation of your payoff in stage 1: Your payoff in stage 1 consists of two components:

- **tokens you have kept** = endowment – your contribution to the project
- **earnings from the project** = 1.6 x sum of the contributions of all group members / number of group members

Thus, **your payoff in Stage 1** amounts to:

20 – your contribution to the project

+ 1.6 x sum of the contributions of all group members / number of group members

The earnings from the project are calculated according to this formula for each group member. **Please note:** Each group member receives the same earnings from the project, i.e. each group member benefits from **all** contributions to the project.

Stage 2

Assignment of Tokens: In stage 2 it will be displayed how many tokens each group member contributed to the project. (**Please note: In each round the order of displaying the members' actions will randomly be determined.** Thus, it is not possible to identify any group member by her position on the displayed list throughout different rounds.) By the assignment of tokens in stage 2 you can increase or reduce the payoff of a group member or keep it unchanged.

In each round each participant receives additional 20 tokens in stage 2. You have to decide how many of these 20 tokens you are going to assign to other group members. The remaining tokens are kept in your private account. You can check the costs of your token assignment by pressing the button "Calculation of Tokens".

- Each **positive token** that you assign to a group member **increases her payoff by 1 token**.
- Each **negative token** that you assign to a group member **reduces her payoff by 3 tokens**.
- If you assign **0 tokens** to a group member her **payoff won't change**.

Calculation of your payoff in stage 2: Your payoff in stage 2 consists of three components:

- **tokens you kept in your private account** = 20 – sum of the tokens that you have assigned to the other group members
- **increased by the number of positive tokens** you have received from other group members
- **diminished by the threefold number of negative tokens** you have received from other group members

Thus, **your payoff in Stage 2** amounts to:

20 – sum of the tokens that you assigned to other group members

+ the number of positive tokens you received from other group members

– 3x (the number of negative tokens you received from other group members)

Calculation of your round payoff: Your round payoff is composed of

	Your payoff from Stage 1	20 – your contribution to the project + 1.6 x sum of the contributions of all group members / number of group members
+	Your payoff from Stage 2	20 – sum of the tokens that you have assigned to other group members + number of positive tokens you have received from other members – 3 x (the number of tokens you have received from other members)
=	Your round payoff	

Special case: a single group member: If it happens that you are the only member in your group you receive 20 tokens in Stage 1 and 20 tokens in Stage 2, i.e. your round payoff sums up to 40. You do not have to take any action neither on Stage 1 nor on Stage 2.

Information at the end of the round: At the end of the round you receive a detailed overview of the results obtained in all groups. For every group member you are informed about her: Contribution to the project, payoff from the Stage 1, assigned tokens (if possible), received positive tokens (if possible), received negative tokens (if possible), payoff from Stage 2, round payoff.

History: Starting from the 2nd round, in the beginning of a new round you receive an overview of the average results (as above) of all previous rounds.

Total Payoff: The total payoff from the experiment is composed of the initial endowment of 1,000 tokens plus the sum of round payoffs from all 30 rounds. At the end of the experiment your total payoff will be converted into Euro with an exchange rate of 1 € per 100 tokens.

Please notice: Communication is not allowed during the whole experiment. If you have a question please raise your hand out of the cabin. All decisions are made anonymously, i.e. no other participant is informed about the identity of someone who made a certain decision. The payment is anonymous too, i.e. no participant learns what the payoff of another participant is.

We wish you success!

Supporting Figures

Figure S1

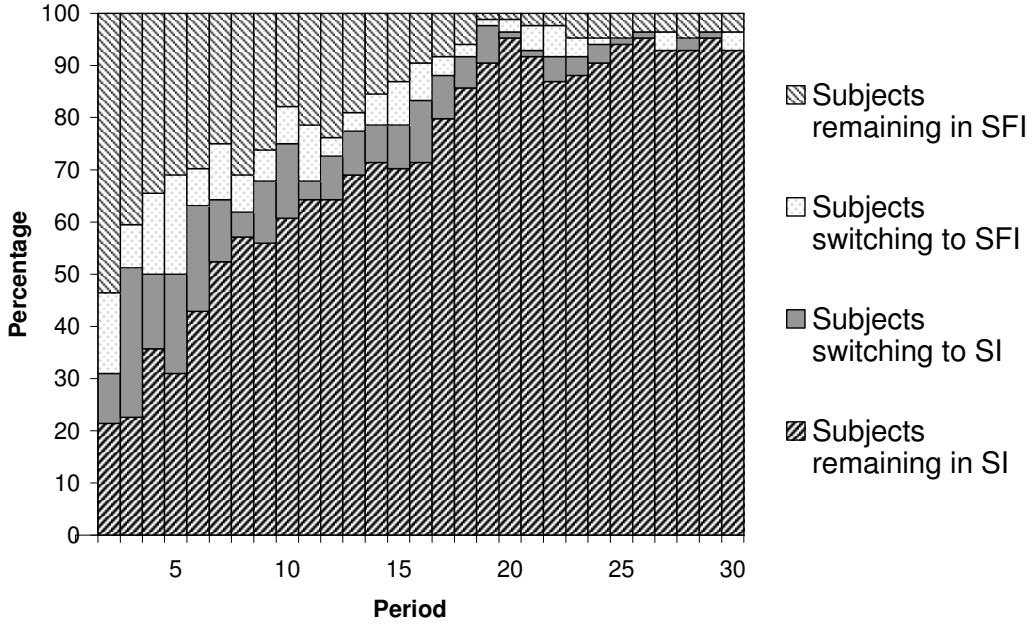

Fig. S1. Subjects' choices of institutions and their switching behavior in both directions.

Figure S1 displays the percentage of subjects who remain in the institutions or switch between the institutions.

Figure S2

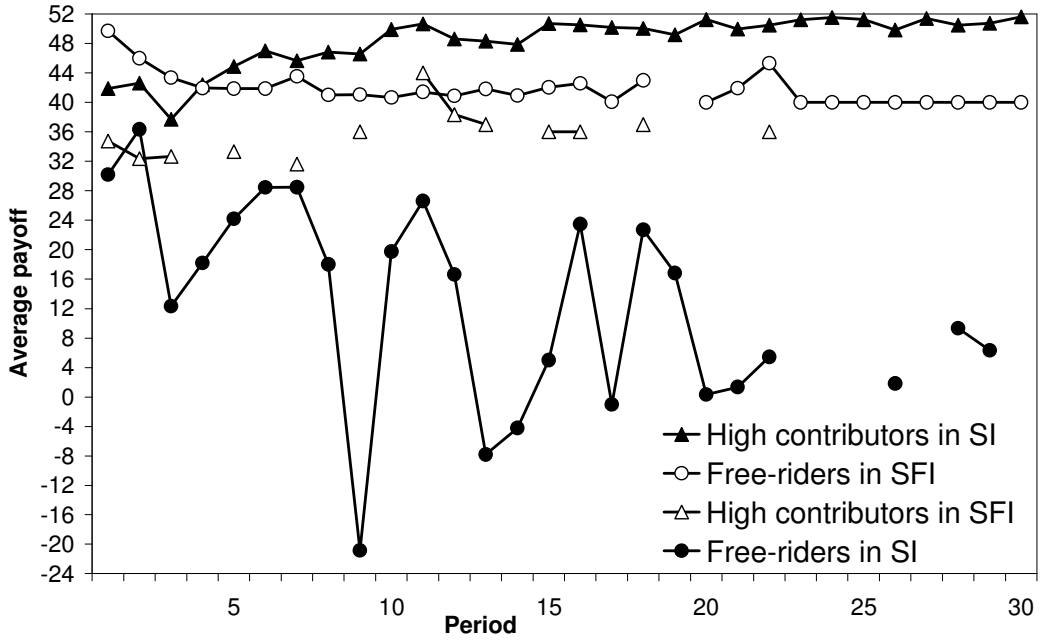

Fig. S2. Subjects' average payoffs dependent on their contribution behavior.

Supporting Tables

Table S1. Logit analysis of the punishment probability dependent on the experience in SI (using individual dummies for subjects, 778 observations in total)

	Coefficient		*Z* value
Number of periods in SI when punishing	-.074	(.026)	- 2.82***
Constant	.798	(.278)	2.87***

*** denotes significance at 1%. The values in parentheses denote the standard errors.

Supporting References and Notes

S1. U. Fischbacher, Working Paper No. 21, *Institute for Empirical Research in Economics*, University of Zurich (1999).

S2. R. M. Isaac, J. Walker, S. Thomas, *Public Choice* 43, 113 (1984).