Topic 9/10 – Cooperation II

Martin Kocher
University of Munich

Course in Behavioral and Experimental Economics

Preview of topic 10

Reward and punishment

+ Sefton et al. (2007)
+ Sutter et al. (2006)
+ Gürerk et al. (2006)

Leadership

+ Potters et al. (2005)
+ Güth et al. (2007)

The main questions treated in this section

- The relative performance of reward and punishment in sustaining cooperation.
- The endogenous choice of institutions in social dilemmas.
- The effects of leadership in social dilemmas.

Sefton et al. (2007) - procedure

4 treatments:

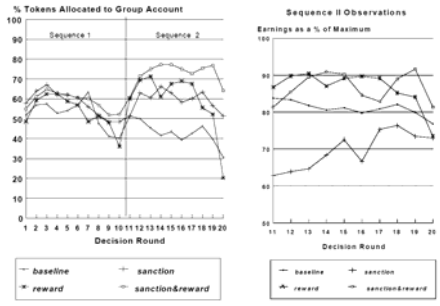
- VCM
- VCM plus punishment
- VCM plus reward
- VCM plus punishment and reward

- Partner design (4-person groups)
- Each session consisted of two sequences (I. VCM, II. See above); 20 rounds.

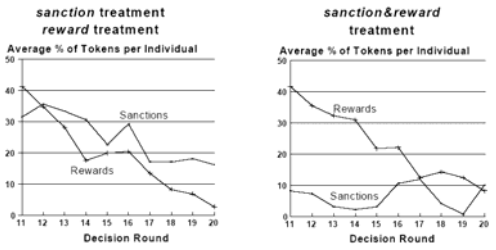
Sefton et al. (2007) - procedure

- Stage 1: 6 tokens per person to be allocated to the private account (10 cents per token) or the public account (5 cents per token)
- Stage 2 (when applicable): another 6 tokens to be kept (10 cents earnings per token) or to be used to punish/reward other group members (10 cents loss/10 cents gain).
- Introduction of punishment/reward effectiveness/costs (leverage).

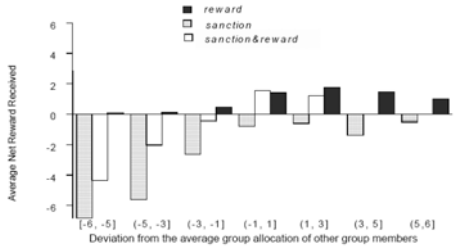
Sefton et al. (2007) - results



Sefton et al. (2007) - results



Sefton et al. (2007) - results



Sutter et al. (2006) – endogenous choice

- They examine the effects of endogenous institutional choice on behavior in social dilemma situations and address the following questions:
- Is there a marginal effect of endogenous institutional choice? I.e., does behavior depend upon endogenous or exogenous implementation of a rule?
- Which institutional rules are chosen endogenously (reward, punishment, neither)?
- Examples

Sutter et al. (2006) - design

- Groups with 4 subjects each (partner design)
- Endowment E = 20 tokens (= 0.8 €)
- Contribution to public good: $0 \leq c \leq 20$
- Payoff: $\pi_i = (20 - c_i) + 0.4\ \Sigma c_j$
- 10 rounds
- Payoff with punishment/reward:

  $\pi_i = (20 - c_i) + 0.4\Sigma c_j$ +/- $L\Sigma p_{ki} - \Sigma p_{ik}$

Sutter et al. (2006) - design

1. Control: Pure public goods game (no reward, no punishment) – only contribution phase (standard voluntary contribution mechanism - VCM)
2. Punishment: Additional punishment phase: subjects can punish each other (Yes or no)
3. Reward: Additional reward phase: subjects can reward each other (Yes or no)

Sutter et al. (2006) - design

1. Exogenous institutional choice: The institution is exogenously imposed (control/punishment/reward).
2. Endogenous institutional choice: Groups choose the institution endogenously by unanimous vote.
   a. Subjects choose whether to vote (one-time costs of 10 tokens).
   b. Voters can support any of the 3 institutions.
   c. If support is unanimous, institution is implemented.
   d. Otherwise, repeat steps b. and c.

Sutter et al. (2006) - design

- Leverage = 1 ("*L*=1"):
  - Costs of punishment/reward: 1 token
  - Costs/benefits of being punished/rewarded: 1 token
- Leverage = 3 ("*L*=3"):
  - Costs of punishment/reward: 1 token
  - Costs/benefits of being punished/rewarded: 3 tokens
- In the endogenous treatments, the leverage is fixed.

Sutter et al. (2006) - design

Choice of institution	Leverage	Control	Reward	Punishment
Exogenous	L = 1	N = 10	N = 10	N = 10
	L = 3		N = 10	N = 10
Endogenous	L = 1	N = 40 overall		
	L = 3	N = 20 overall		

Sutter et al. (2006) - predictions

Assuming common knowledge of selfishness and payoff maximization a sub-game perfect equilibrium is where all members contribute $c_{i,t} = 0$ in each round.

This result applies also to the treatments with punishment or reward because these actions are costly.

Prediction 1: Subjects contribute zero all the time.

Prediction 2: No subject ever participates in the vote on the institution in the endogenous treatment (because voting is costly).

Sutter et al. (2006) - predictions

- They consider the social preferences-model of Fehr and Schmidt (1999) to derive alternative predictions.
- If $x = (x_1, \ldots, x_n)$ denotes the vector of monetary payoffs of the n subjects of a group, Fehr and Schmidt (1999) define subject i's utility U_i as follows:

$$U_i(x) = x_i - \alpha_i \frac{1}{n-1} \sum_{j \neq i} \max\{x_j - x_i, 0\} - \beta_i \frac{1}{n-1} \sum \max\{x_i - x_j, 0\}$$

  - It is assumed that $\beta_i \leq \alpha_i$ and $0 \leq \beta_i < 1$.

Sutter et al. (2006) - predictions

Contributions in the standard VCM:

If $\gamma + \beta_i < 1 \Rightarrow c_{i,t} = 0$

Let f denote the number of players with $\gamma + \beta_i < 1$

If $f/(n\text{-}1) > \gamma/2 \Rightarrow c_{i,t} = 0$ for all i

If $f/(n-1) < (\gamma + \beta_i - 1)/(\alpha_i + \beta_i)$

$(\gamma + \beta_i > 1)$- players contribute $c_{i,t} \in [0, E]$

$(\gamma + \beta_i < 1)$- players contribute $c_{i,t} = 0$

Sutter et al. (2006) - predictions

Punishment with $(n' < n)$:

enforcer: $\gamma + \beta_i > 1$ and n' denotes the number of enforcers

Intuition:

For contributing $c_{i,t} = c > 0 \ \forall \ i$ to be an equilibrium it would be necessary that:

(1) contributing c is rational for selfish-players and

(2) that the threat of punishment is credible in case $c_{i,t} < c$

Sutter et al. (2006) - predictions

Punishment with $(n' < n)$:

(1) $c \le \bar{c} = \frac{n'L}{(1-\gamma)}$

(2) Condition for punishment to be credible

$$-k - \frac{\alpha}{n-1}(n-n'-1)k - \frac{\alpha}{n-1}(\bar{c} - c + k - n'L) \ge$$

$$-\frac{\alpha}{n-1}(\bar{c} - c - (n'-1)L) - \frac{\beta}{n-1}(n'-1)k$$

$$\frac{L}{k} \ge (n-n') + \frac{1}{\alpha}[(n-1) - \beta(n'-1)]$$

$\Rightarrow$ Can only be fulfilled for L = 3 and $(n' > 1)$

Sutter et al. (2006) - predictions

Reward with $(n' < n)$:
enforcer : $\gamma + \beta_i > 1$ and n' denotes the number of enforcers

Intuition:

For contributing $c_{i,t} = c > 0 \ \forall \ i$ to be an equilibrium it would be necessary that:

(1) contributing c is rational for selfish-players and

(2) that the incentive to reward is credible in case $c_{i,t} = c$

Sutter et al. (2006) - predictions

Reward with $(n' < n)$:

(1) $c \le \bar{c} = n'L/(1-\gamma)$

(2) Condition for reward to be optimal

$$(n'-1)L - (n-1)k - \frac{\alpha}{n-1}[L + (n-1)k](n-n') \ge$$

$$(n'-1)L - \frac{\beta}{n-1}[L - (n'-1)k](n'-1)$$

$$(n-1)k + \frac{1}{n-1}(L + (n-1)k)[\alpha(n-n') - \beta(n'-1)] \le 0$$

$\Rightarrow$ Never fulfilled regardless of L

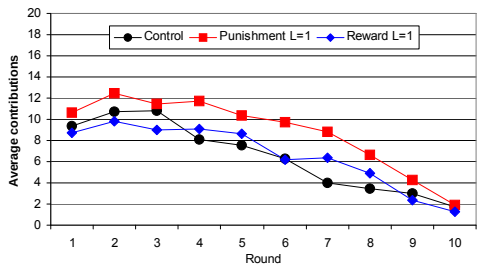
Sutter et al. (2006) - predictions

- Prediction 3: There is no difference between Control and Reward/Punishment with $L = 1$.
- Prediction 4: Subjects do not vote with $L = 1$.

Sutter et al. (2006) - predictions

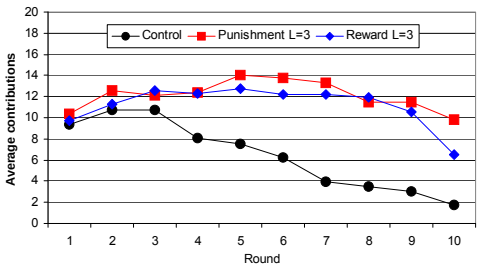
- Prediction 5: The contribution level $c^* = n'L / (1\text{-}0.4)$ can be enforced under punishment with $L = 3$, but not with reward.
  For $n' = 3$ we get $c^* = 15$.
- Prediction 6: Subjects should vote and should vote for punishment (for almost all possible parameter values of α_i and β_i (disregarding the coordination problem).
- Note: For $n' = n$: Every $c_i = c \in [0,E]$ is an equilibrium.

Sutter et al. (2006) – exo. results



No significant differences (see Predictions 1 and 3).

Sutter et al. (2006) – exo. results

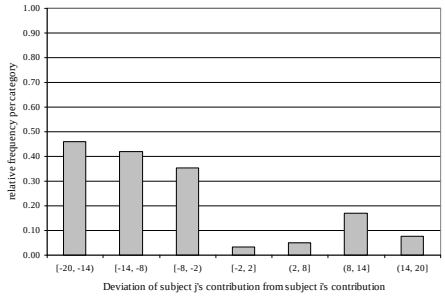


Punishment and Reward significantly larger than Control (see Predictions 1 and 5).

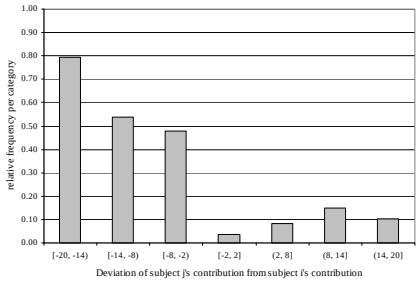
Sutter et al. (2006) – exo. results

	Contributions	Profits	Rel. freq. of reward/punishm.
Control	6.50	23.9	-
Punishment *L*=1	8.79	24.3	0.15
Reward *L*=1	6.62	24.0	0.10
Punishment *L*=3	12.11	24.8	0.20
Reward *L*=3	11.20	29.4	0.44

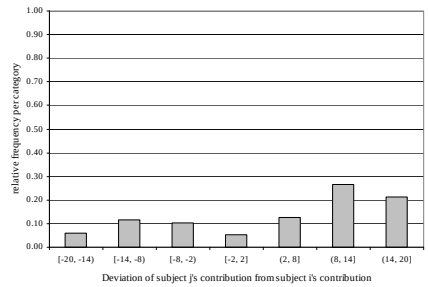
Sutter et al. (2006) – exo. results



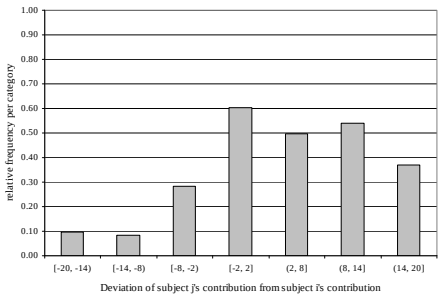
Sutter et al. (2006) – exo. results



Sutter et al. (2006) – exo. results



Sutter et al. (2006) – exo. results



Sutter et al. (2006) – results

Rel. frequency	*L* = 1	*L* = 3
Voters	0.44	0.60
Non-Voters	0.56	0.40
Participants (N)	160	80

Significantly higher voter turnout in *L* = 3 (see Predictions 2, 4 and 6).

Sutter et al. (2006) – results

Groups with institution	Control	Punishment	Reward
L = 1	25	5	10
L = 3	3	0	17

Institutional choice is far from random. Under *L* = 1 the majority of groups opt for Control, whereas under *L* = 3 the reward institution is predominant (see Prediction 6).

Sutter et al. (2006) – results

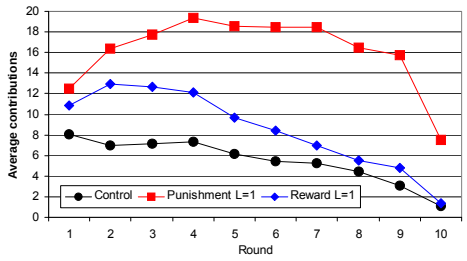
L = 1 (*N* = 40)

Wähler	R 1	R 2	R 4	R 7	R 9	R 10	R 11	R 13	R 26
1 (15)	15								
2 (13)	9	1		1		1		1	
3 (6)	3	1					1		1
4 (3)		1	1		1				

L = 3 (*N* = 20)

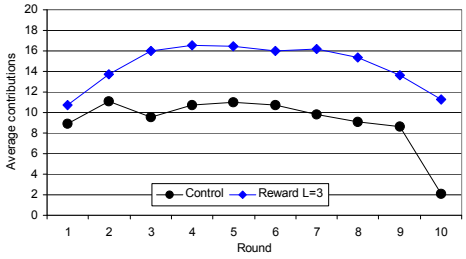
Wähler	R 1	R 2	R 3	R 11	R 13	R 51	R 61	R 103
1 (5)	5							
2 (6)	5		1					
3 (5)	2	1			1		1	
4 (4)			1	1		1		1

Sutter et al. (2006) – endo. results



Punishment > Reward > Control (significantly).

Sutter et al. (2006) – endo. results

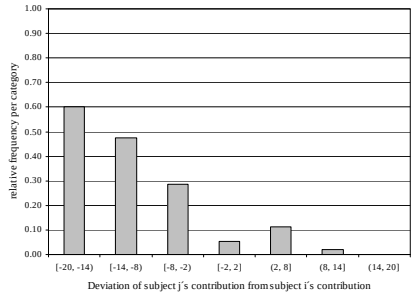


Reward > Control (significantly).

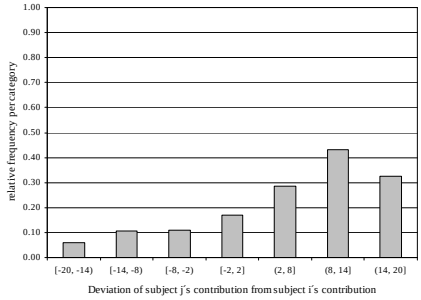
Sutter et al. (2006) – endo. results

	Contributions	Profits	Rel. freq. of reward/punishm.
Control "*L*1" (*N*=25)	5.48	23.3	-
Reward "*L*1" (*N*=10)	8.53	25.1	0.17
Punishment "*L*1" (*N*=5)	16.13	29.3	0.10
Control "*L*3" (*N*=3)	9.17	25.5	-
Reward "*L*3" (*N*=17)	14.59	32.1	0.55

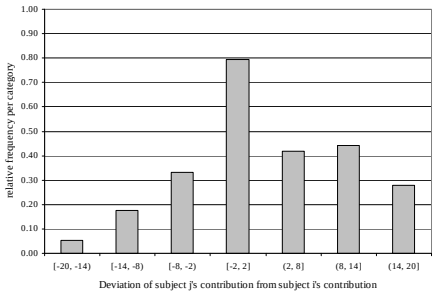
Sutter et al. (2006) – endo. results



Sutter et al. (2006) – endo. results



Sutter et al. (2006) – endo. results



Sutter et al. (2006) – results

$L = 1$	Control	Reward	Punishment
Exogenous	6.50	6.62	8.79
Endogenous	5.48	8.53	16.13
p (U-test)	n.s.	$p = 0.10$	$p < 0.01$

$L = 3$	Control	Reward	Punishment
Exogenous	6.50	11.20	12.11
Endogenous	9.17	14.59	-
p (U-test)	n.s.	$p = 0.09$	-

Endogenous choice of Reward or Punishment raises contributions.

Sutter et al. (2006) – results

	Dependent variable: Contributions in …		
Independent variables	1st period	2nd period	Overall (Perio. 1-10)
Voter (= 1)	4.01*	2.67	0.95
Punishment institution (= 1)	5.98**	15.44**	11.91**
Reward institution (= 1)	5.35*	10.98**	4.15**
Leverage (= 1 if $\|L\| = 3$)	-2.09	0.35	5.79**
Number of voters in group	0.94	0.15	-0.12
Intercept	3.84*	1.30	4.73*

** significant at 1% level; * significant at 5% level

Sutter et al. (2006) – results

	Dependent variable: Decision to…		
Independent variables	*punish with* $\|L\| = 1$	*reward with* $\|L\| = 1$	*reward with* $\|L\| = 3$
Voter (= 1)	-0.020	0.051*	0.134**
Number of voters in group	0.027*	0.060**	-0.021
Group contribution	-0.001**	0.001**	0.005**
Difference between other member's and own contribution	-0.011**	0.008**	0.009**
Observations	600	1200	2040

** significant at 1% level; * significant at 5% level

Sutter et al. (2006) – conclusion

- Reward and punishment enhance cooperation in public goods games, but only when the leverage of these institutions is high or when they are chosen endogenously. Hence, endogenous choice is a substitute for higher leverage of reward or punishment – and can, therefore, avoid the inefficiencies associated with punishment (cf. Nikiforakis and Normann, 2005).

Sutter et al. (2006) – conclusion

- If given the choice, subjects opt for reward when it has a high leverage (L = 3), but mostly prefer the standard public goods game when the leverage of reward or punishment is low (L = 1). Punishment is an unattractive institution (cf. Botelho et al., 2005), but very effective, if chosen endogenously.
- Endogenous choice of punishment might make the threat of punishing free-riders more credible.

Sutter et al. (2006) – conclusion

- In sum, endogenous institutional choice adds a "democratic participation rights"-premium to contributions under reward or punishment.
- This cooperation-increasing effect of endogenous choice is independent of the number of voters in a group.
- A subject's decision to vote on the institution is a good indicator of her (higher) level of cooperation (in the beginning).
- Theoretical implications.

Gürerk et al. (2006) – endogenous choice

- They study the competitive advantage of sanctioning institutions by analyzing self-selection (voting by feet) of individuals into groups with a given institution.

- Differences to Sutter et al.:

  One-time institutional choice vs. multiple switching

  Costly voting vs. costless switching

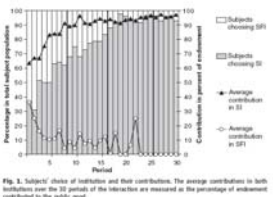
  Effectiveness of reward and punishment

Gürerk et al. (2006) – endogenous choice (design)

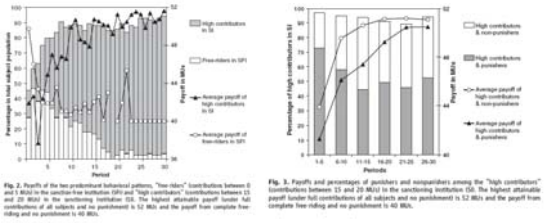
- 3-stage game: institutional stage, contribution stage and sanctioning stage (S0-S2)
- In S0: Independent choice between sanctioning environment or sanction-free environment.
- In S1: Contributions to a public good with all participants, who have chosen the same institution in S0.
- In S2: Players in the sanctioning environment can punish (1:3) or reward (1:1) other players (20 sanctioning tokens available).

Gürerk et al. (2006) – endogenous choice (design and results)

- 30 periods.
- Detailed information about the results in both environments to all players at the end of each period.



Gürerk et al. (2006) – endogenous choice (design and results)



Potters et al. (2005) – endogenous sequencing

- They are interested in public good (fund-raising) situations with asymmetric information.
- The design is very straightforward but allows some interesting insights: two-players (1 and 2), and a binary public good (contributing means $x_i = 1$).
- The source of uncertainty is the marginal per capita return m that is drawn from a commonly known distribution.
- $\Pi_i = 1 - x_i + m(x_1 + x_2)$
- $E[m]<1$ und $E[m|m>1/2]>1$.

Potters et al. (2005) – endogenous sequencing

- Two stages: Voting stage (whether contribution of player 1 will be announced or not, i.e. whether the simultaneous game becomes a sequential one or not) – requires unanimity – and the contribution stage.
- Player 1 always knows m.
- Equilibrium analysis: two subgames (1. non-unanimity, 2. unanimity); two perfect Bayesian equilibria.
- 18 rounds.
- $m = 0$, 0.75 or 1.5
- 3 treatments: simult. exo, seq. exo, endo

Potters et al. (2005) – endogenous sequencing

Do contributors endogenously choose a sequential order?

- 81% do.
- Stable across rounds.
- 82% of leaders, 99% of followers

Potters et al. (2005) – endogenous sequencing

Do announcements increase contributions?

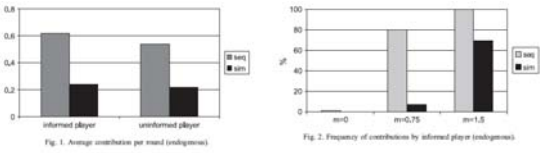


Fig. 1. Average contribution per round (endogenous).

Fig. 2. Frequency of contributions by informed player (endogenous).

Potters et al. (2005) – endogenous sequencing

How do contributions with endogenous choice compare to exogenous choice?

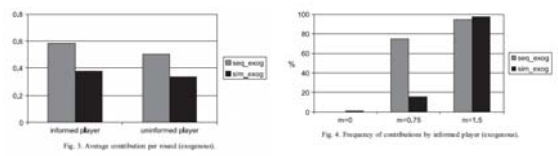


Fig. 3. Average contribution per round (exogenous).

Fig. 4. Frequency of contributions by informed player (exogenous).

Güth et al. (2007) - Motivation

- „Example is leadership.“ (Albert Schweitzer)
- „We must be the change we wish to see in the world.“ (Mahatma Gandhi)

- Leadership is important in economic as well as political organizations.
- It provides a means to influence the behavior of others in a desired direction through leading by example.

Güth et al. (2007) – Existing literature

- Leadership implemented as a sequential public good/bad game with one leader and several followers.

- Typically, contributions with leadership are higher than in the standard simultaneous framework [Gächter and Renner, 2004 (insignificant); Moxnes and van der Heijden, 2003; van der Heijden and Moxnes, 2003; Potters et al., 2005].

Güth et al. (2007) – Contribution

They report a public goods experiment with leadership to examine …

(1) … whether leadership works (re-examination of previous literature),

(2) … whether leadership with ostracism power is more efficient than leadership without such power,

(3) … whether the way in which a leader is appointed makes a difference,

(4) … whether groups want to have a leader when given the choice.

Güth et al. (2007) – design

- Standard public goods game.
- Each of 4 subjects in a group is endowed with 25 tokens.
- Tokens can be invested in private or public good.
- Payoffs are: $\pi_i = 25 - c_i + 0.4\Sigma c_j$. (where c_i is subject i's contribution to the public good).
- The game is played for 24 periods.

Güth et al. (2007) – design

Does leadership work?

- Control-treatment (C): No leadership and simultaneous contributions of all group members.
- Leadership-treatment (L): One group member is assigned the role of leader.
  - Stage 1: The leader decides on his contribution.
  - Stage 2: Followers decide simultaneously on their contribution, knowing the leader's contribution.

Güth et al. (2007) – design

Are strong leaders better than weak leaders?

- Leadership-treatment (L): As introduced above.
- Strong-leadership-treatment (SL): The leader has ostracism power.
  - Stage 3: The leader can exclude one of the followers from the group in the next period. The excluded member earns 25. The others interact in a smaller group (efficiency losses).

Güth et al. (2007) – design

Does it make a difference how a leader is appointed?

- Fixed (strong) leader-treatment (f): One group member is randomly selected as leader and remains in charge throughout the experiment.
- Rotating (strong) leader-treatment (r): Leadership rotates among the four group members in a predetermined and commonly known order. Each member is leader for 4 periods.
  (Strong leaders cannot exclude anyone in the fourth round of their leadership.)

Güth et al. (2007) – design

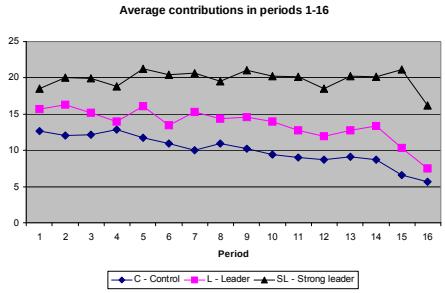
Do groups want to have a leader?

- Periods 1-16: Exogenously determined leaders.
- Periods 17-24: Endogenously determined leaders for periods 17-20 and periods 21-24.
  - In the fixed (strong) leader-treatment, subjects must decide whether to keep their leader or not.
  - In the rotating (strong) leader-treatment, subjects indicate for each member whether they accept him as leader or not (unanimity).

Güth et al. (2007) – design

Treatment	Leader	Ostracism power	Assignment
C – Control	No	-	-
Lf – Leader fixed	Yes	No	Fixed
Lr – Leader rotating	Yes	No	Rotating
SLf – Strong leader fixed	Yes	Yes	Fixed
SLf – Strong leader rotating	Yes	Yes	Rotating

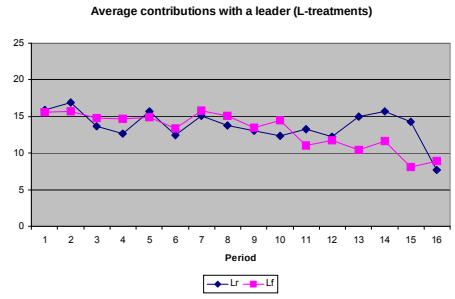
Güth et al. (2007) – results



Result 1: Leadership works. L > C ($p < 0.08$)

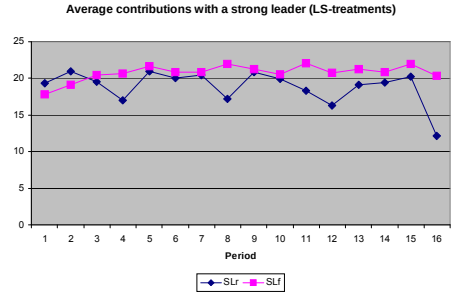
Result 2: A strong leader is even better. SL > L ($p < 0.01$).

Güth et al. (2007) – results



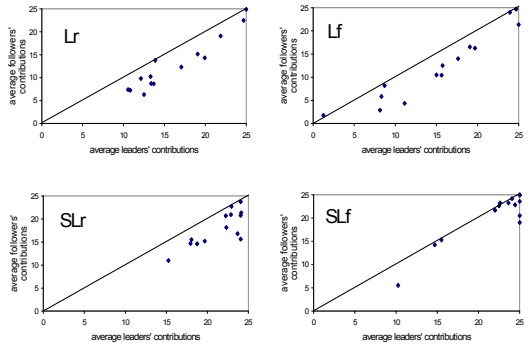
Result 3a: The way how the leader is appointed has no significant influence in the L-treatments.

Güth et al. (2007) – results



Result 3b: Fixed leadership produces weakly significantly higher contributions. However, this is due to the design.

Güth et al. (2007) – results



Güth et al. (2007) – results

Treatment	Leader appointed (rel. frequency)	Contributions with leader	Contributions without leader
Lf – Leader fixed	0.36	15.6	3.6
Lr – Leader rotating	0.29	11.4	9.5
SLf – Strong leader fixed	0.61	21.5	9.3
SLr – Strong leader rotating	0.43	18.8	10.7

Result 4: About 40% of groups appoint a leader, and that pays off significantly ($p < 0.05$).

Güth et al. (2007) – conclusion

- Contributions in a public goods game are higher if
  - … leaders commit to a high contribution, and
  - … if free-riders can be ostracized by cutting social ties and isolating them.
- The way how leadership is appointed has no significant influence.
- Groups with higher cooperation levels in the exogenous part are more likely to endogenously appoint a leader which is clearly beneficial for groups.