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Selfish-biased conditional cooperation: On the decline of contributions in repeated public goods experiments

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Abstract

The recent literature suggests that people have social preferences with a self-serving bias. Our data analysis reveals that the stylized fact of declining cooperation in repeated public goods experiments results from this bias and adaptation.

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Are People Selfish or Cooperative? Research on the voluntary provision of public goods must come to grips with this simple but still unanswered question about the fundamental nature of humankind. (Ledyard 1995, p.120)

1 Introduction

A consensus has emerged among researchers on voluntary provision of public goods that people are conditionally cooperative;[1] in experiments, participants contribute the more the more others contribute even if free-riding is a dominant strategy. However, social preferences seem to exhibit a selfish bias, as conditional contributions increase less than fully proportionally with those by others (Fischbacher et al. 2001).

It is a well-documented stylized fact that voluntary contributions decline with repetition (Ledyard 1995, p.121). Various theories have been advanced to explain this phenomenon. Traditional hypotheses include strategic play in early stages (Andreoni, 1988; Sonnemans et al, 1999) or errors that diminish over time (Andreoni, 1995; Palfrey and Prisbey, 1997). The aforementioned selfish bias in conditional cooperation could cause the decline, too, if it induces a downward spiral of contribution adjustments.[2]

The experiment reported in this article is designed to analyze the contribution decline in an interactive repeated public goods game.[3] Our setup, described in detail in section (2), elicits expectations on others' contributions. Our treatment variable is the information feedback on partners' contributions. In the control treatment, strategic play is impossible as no information is divulged.

[1] C.f. Croson, 1998; Sonnemans, Schram and Offerman, 1999; Ockenfels, 1999; Keser and van Winden, 2000; Fischbacher, Gächter and Fehr, 2001; Brandts and Schram, 2001; Levati and Neugebauer, 2004; and Croson, Fatas and Neugebauer, in press.
[2] Andreoni's (1988) observation of a restart effect renders an alternative learning hypothesis impossible.
[3] In contrast to the one-shot strategy method ('cold') applied by Fischbacher et al., we study conditional cooperation with spontaneous decisions ('hot'). Experimental evidence on different behavior in hot and cold experiments was reported by Brosig, Weimann and Yang, 2003.

The data, reported in section (3), favor the hypothesis that downward adaptation of contributions due to selfish-biased preferences causes declining contributions over the competing hypotheses. Section (4) concludes.

2 Experimental Design

The paper examines behavior in a 10-rounds 3-person voluntary contribution mechanism in a partners design. In every round, each subject was given an endowment (50 experimental currency units) which could voluntarily be contributed toward a public good, or be kept to be consumed as a private good. The marginal per-capita return from the public good was one half. Under standard assumptions, thus, free-riding is predicted. Subjects' expectations (guesses) about the sum of contributions of their partners were incentive-compatibly elicited in each round.[4] Contributions and guesses were submitted simultaneously.

We considered two treatments in a between-subjects setting, information feedback being the treatment variable. In the information treatment (hereafter INFO), subjects received information feedback about payoffs from the public goods game, broken up to the sum of partners' contributions, and from the guessing task after each round. In the control treatment (hereafter NoINFO), subjects received no information about payoffs and partners' contributions until the end of the experiment.

The experiment was computerized by Fischbacher's (1999) z-Tree. In total 36 inexperienced subjects participated (i.e., 18 subjects per treatment) who earned on average 18,300 Lira ≈ €9 ≈ $10.[5] At the beginning, instructions were read and subjects went through four exercises. The experiment did not start until subjects had

[4] Our scoring rule, which assumes symmetry of subjective distributions, induced payoffs equal to the square of 100 less the difference between the guess and partners' contribution divided by 400. Thus, payoffs were in the interval [0;25].

answered all questions correctly. Thus, we are confident that the game and the incentives were understood.

3 Experimental Results

Table 1 records the voluntary contributions in percentages of the endowment and the guesses of the sum of partner's contributions. Average contributions and guesses were significantly greater in NoINFO than in INFO.[6] Initial contributions were the same in both treatments rejecting the hypothesis of strategic play by the participants, as that would likely involve higher contributions at the beginning to induce others to do the same. The main results follow, organized into six observations.

Table 1. Average guesses and contributions[c]

		Round										All
		1	2	3	4	5	6	7	8	9	10	Rounds
Contribution[c]	NoINFO	39.2	45.0	44.1	48.2	45.6	37.3	37.1	43.6	27.1	46.7	41.4
	INFO	35.2	33.9	28.3	24.0	15.8	32.8	20.2	21.4	18.2	14.1	24.4
	Difference[a]	4.0	11.1	15.8	24.2	29.8*	4.6**	16.9	22.1	8.9	32.6**	17.0*
Guess	NoINFO	47.3	51.8	48.8	54.3	57.2	49.6	53.6	41.2	48.2	58.1	51.0
	INFO	43.4	40.6	37.1	34.7	28.0	39.4	29.2	25.1	27.6	21.3	32.6
	Difference[a]	3.9	11.3	11.8	19.7	29.2*	10.2	24.4	16.1	20.6	36.8**	18.4*
Guess –	NoINFO[b]	7.4	7.0	4.7	6.3	11.2*	12.3	15.8*	-3.5	21.0*	11.9	9.4*
Contribution[c]	INFO [b]	8.1*	6.2	7.9	9.9	11.6*	6.1	8.6	2.9	9.7	7.9*	7.9*
	Difference[a]	-0.7	0.8	-3.2	-3.6	-0.3	6.1	7.2	-6.3	11.4	4.0	1.4

a. Two-tailed Mann-Whitney exact test (NoINFO #18; INFO #6); H_0: λ(NoINFO)=λ(INFO).
b. Two-tailed Wilcoxon signed ranks test (NoINFO #18; INFO #6); H_0: Guess=Contribution[c].
c. Percentage-contribution relative to endowment.
$^{*}p<0.05$, $^{**}p<0.01$

Observation 1. We observe a self-serving bias, in that the great majority of subjects (77.8%) contribute less than they expect their partners to contribute, with one's contribution averaging 9.1% (INFO) and 7.7% (NoINFO) less than one's guess. This evidence supports the conjecture of Fischbacher et al (2001) that people are

[5] A session took 70 minutes.

motivated to avoid being a person who gives more than others. As the difference of contributions and guesses is a proxy for participants' estimation error, it seems remarkable that there is no discernible downward trend.

We propose four regression models to explain contributions and revealed expectations before we turn to a more in-depth analysis of round-to-round behavior. Let subject *i*'s contribution and the guess of the partners' contributions in round *t* be denoted by $cont_{it}$ and $guess_{it}$. Models (1) and (2) involve regressions of contributions and of guesses on time.[7] The outcomes are recorded in Table 2.

Observation 2. While contributions and guesses decline when feedback is given about the partners' contributions (INFO), contributions and guesses do not decline when no feedback is given (NoINFO).[8] This follows from the recorded time coefficients and standard errors.

Models (3) and (4) represent two alternative random effects regression models that provide a reasonable fit for both treatments, respectively. One's guess and contribution, both the current and with a lag of one round, and the lagged average contribution of the other two group members (denoted by –i) are introduced as additional explicatory variables. Time becomes insignificant in these models. As the lagged average contribution was no available information in NoINFO, it is no surprise that the corresponding coefficient is also insignificant (see Table 2). In

[6] Croson (2000) reported similar contributions in a treatment comparable to INFO.
[7] We use the random effects model as applied in Croson (1998) and Croson et al (in press). We stratify by group in INFO and by individual *i* in NoINFO.
[8] The observation of no significant decline confirms Sell and Wilson (1991) who studied a no feedback setting without expectation elicitation.

INFO, others' lagged contributions are highly significant for the determination of guesses, but not, in model (3), for contributions.[9]

Observation 3. Guesses depend significantly on the lagged partners' contributions. This implies that expectations in the feedback treatment are adapted from observed partners' contributions.

Observation 4. Individual contributions and guesses display path-dependence as they highly correlate with the individual contributions in the previous round, suggesting constant preferences over time.

Observation 5. Contributions are strongly correlated with one's guess in both treatments, clearly supporting the hypothesis of conditional contribution in the repeated public goods game.[10]

Table 2. Random effects model results

	NoINFO				INFO			
	$Cont_{it}$		$Guess_{it}$		$Cont_{it}$		$Guess_{it}$	
Model	(1)	(3)	(2)	(4)	(1)	(3)	(2)	(4)
R^2	0.004	0.355	0.000	0.374	0.050	0.617	0.072	0.640
Const	22.404**	7.563	50.237**	17.802*	17.674**	0.482	-.995**	7.702*
	(2.624)	(4.066)	(6.019)	(7.114)	(2.931)	(2.251)	(.295)	(3.863)
Round *t*	-0.311	-0.355	0.143	0.388	0.995**	-.100	-2.149**	-.248
	(.352)	(.362)	(.590)	(.640)	(.295)	(.254)	(.488)	(.573)
$Cont_{it}$		-		0.576**		-		1.099**
				(.134)				(.108)
$Guess_{it}$		0.185**		-		0.364**		-
		(.043)				(.035)		
$Cont_{i,t-1}$		0.310**		0.177		.391**		-0.161
		(.079)		(.145)		(.074)		(.139)
$Guess_{i,t-1}$		0.037		0.343**		-0.103*		0.250**
		(.046)		(.077)		(.042)		(.072)
Av. $Cont_{-i,t-1}$		-0.113		-0.075		-0.049		0.474**
		(.096)		(.169)		(.035)		(.115)

* p<5%; ** p<1%. Standard errors are in parenthesis.

[9] Others' lagged contributions are highly correlated to contributions. However, if one's guess on others' contributions is included in the regression they become insignificant.

[10] Also, subjects contribute significantly more the more they overestimate the others' contributions.

Adopting the qualitative approach recently proposed by Keser and van Winden (2000), we expect subjects to weakly adapt their contribution by increasing or decreasing it when they observe that it was below or above the average contribution of their partners in the previous round, respectively. Table 3 records the frequencies of upward and downward adaptation of individual contributions. There is no discernible difference in adjustment behavior between INFO and NoINFO for the sample as a whole or restricted to below-average contributions.[11]

Observation 6: A contribution decrease after an above-average contribution is significantly more likely when information feedback is given (INFO) than when it is not (NoINFO). This suggests a causal relationship between changes and the average contribution of the other group members, in line with the downward spiral explanation of contributions decrease over time.

Table 3. Contribution changes between rounds t-1 and t

		Subject's contribution in t-1		
		below average	above average	Average
	Adaptation in t			
NoINFO	# decrease (relative)	32 (36.0%)	36 (52.2%) [a]	2 (50.0%)
	# increase (relative)	43 (48.3%) [a]	20 (29.0%)	0 (0.0%)
	# unchanged	14	13	2
	# total	90	68	4
INFO	# decrease (relative)	18 (22.5%)	47 (72.3%) [a]	1 (5.9%)
	# increase (relative)	34 (42.5%) [a]	12 (18.5%)	4 (23.5%)
	# unchanged	28	6	12
	# total	80	65	17

a. Contribution change proposed by Keser and van Winden (2000).

[11] We ran tests on the surpluses of the number of predicted contribution changes over the non-predicted ones within and between treatments (INFO #6; NoINFO #18). The two-tailed Wilcoxon signed ranks test favors Keser and van Winden's hypothesis over random behavior in both treatments ($p<.05$). Between treatments, the two-tailed Mann Whitney exact test suggests significant [no significant] differences conditional on [below-average] above-average contributions in the previous round ([$p=.673$] $p=.066$) and no differences overall ($p=.197$), respectively.

4 Conclusions

The present paper has intended to solve the puzzle of declining contributions in repeated public goods experiments. Our data encourage the suggestion of Fischbacher et al. (2001) that subjects do not want to contribute more to the public good than their partners, and that contributions appear to "spiral downwards" in the repeated setting (p. 403). Participants' contributions are highly significantly correlated to their expectations (though 8-9 percentage points lower), and contributions are significantly more frequently adapted when they exceed the contributions of others.[12] Our observations suggest that one's expectations about the contribution of others and one's contributions are mutually correlated and the expectations are adapted by hindsight on the basis of feedback on partners' contributions.

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[12] If subjects take a reference point in the average, the observed adaptation might lead to an analogy of loss aversion in decision making experiments (Schmidt and Traub, 2002).

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Table A0. Individual guesses and contributions[a)]

	Round NoINFO										Round INFO									
ID	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
GUESS1	45	40	65	45	80	50	45	50	35	75	10	40	30	20	30	0	30	40	45	20
CONT1	40	40	60	80	80	20	50	40	20	80	20	40	30	10	20	24	30	20	40	20
GUESS2	30	30	50	40	60	35	45	65	70	50	30	20	35	50	20	15	25	40	48	49
CONT2	30	10	30	20	40	30	20	60	40	50	20	16	20	30	14	16	20	30	24	24
GUESS3	80	80	85	60	75	85	85	80	60	85	50	40	30	20	10	100	50	40	30	20
CONT3	30	40	70	40	50	56	56	36	20	48	50	40	30	20	10	100	100	80	60	40
GUESS4	20	20	20	20	20	20	20	20	20	20	30	45	60	80	85	45	50	35	55	35
CONT4	20	20	20	20	20	20	20	20	20	20	50	60	100	80	40	20	20	40	10	10
GUESS5	65	80	75	85	65	95	75	80	86	69	20	30	28	40	10	29	38	20	40	20
CONT5	60	70	40	70	60	70	80	70	86	60	10	20	0	40	0	30	10	10	0	20
GUESS6	50	80	50	25	50	50	50	50	50	50	75	75	75	100	50	90	30	75	75	40
CONT6	50	50	50	100	50	50	50	50	50	50	50	50	100	100	60	60	20	80	50	20
GUESS7	43	60	39	80	38	59	68	0	80	96	75	60	50	65	80	100	75	60	28	28
CONT7	46	98	70	60	68	52	100	94	68	30	50	30	20	40	60	100	50	30	0	0
GUESS8	50	75	80	70	50	40	35	20	25	20	30	75	35	28	60	55	50	35	55	20
CONT8	0	60	60	30	20	0	10	0	20	20	10	84	16	4	20	70	40	60	30	0
GUESS9	50	70	25	50	80	40	100	30	20	50	50	50	50	50	29	33	50	35	35	30
CONT9	40	0	20	0	14	10	0	20	12	16	50	50	50	0	14	20	40	20	22	20
GUESS10	50	45	55	100	75	50	50	40	40	50	20	40	40	15	20	0	0	0	0	0
CONT10	50	50	30	100	70	20	30	20	20	50	4	0	0	0	0	0	0	0	0	0
GUESS11	50	15	45	62	40	29	56	10	30	60	100	50	25	19	25	25	25	25	23	0
CONT11	40	30	46	26	52	60	44	30	10	6	100	50	0	0	0	0	0	0	0	0
GUESS12	60	75	40	80	75	50	65	57	80	78	50	50	25	25	0	50	0	0	0	0
CONT12	60	80	70	40	0	66	50	80	68	40	50	50	40	50	0	50	0	0	0	0
GUESS13	50	60	50	0	100	80	10	50	100	100	20	20	16	30	25	25	10	0	31	3
CONT13	60	60	80	50	100	80	20	100	0	64	20	20	16	30	26	24	2	0	2	2
GUESS14	50	40	50	60	20	30	50	20	25	50	45	30	30	20	18	18	18	15	10	8
CONT14	20	40	20	30	40	60	0	0	10	100	40	20	40	2	10	6	0	10	10	8
GUESS15	95	80	80	94	89	88	91	66	94	75	45	35	25	35	25	20	20	15	13	6
CONT15	96	80	60	96	96	70	100	90	24	90	10	10	20	10	10	10	0	0	0	0
GUESS16	4	3	10	7	17	12	20	9	2	3	60	40	25	17	7	50	5	7	3	25
CONT16	4	2	8	6	0	8	8	4	0	6	40	50	4	6	0	40	2	6	0	20
GUESS17	40	50	20	60	45	30	50	40	20	80	60	30	28	10	5	5	30	5	5	30
CONT17	30	50	20	60	40	0	10	40	0	60	60	20	24	10	0	20	30	0	40	20
GUESS18	20	30	40	40	50	50	50	55	30	35	12	0	60	0	5	50	20	5	0	50
CONT18	30	30	40	40	20	0	20	30	20	50	0	0	0	0	0	0	0	0	40	50

a) Percentage-contributions relative to endowment

Instructions (Translated from Italian)

1) You will participate in 10 Rounds of a Group Decision-Making Experiment, in which you will interact with (always the same) two partners, whose identity will not be revealed to you at any time.

2) In every Round you (as well as your partners) will receive an initial endowment of 50 ECU (1 ECU = 25 Lire), and you have to decide how much of this amount to contribute to a Group Project and a remainder to an Individual Project. Any ECU contributed to the Group Project will generate Payoff for you as well as for each of your partners. The remainder of your endowment that you do not contribute to the Group Project will be saved in your Individual Project, which generates payoff only to you.

3) Your PAYOFF FROM THE GROUP DECISION in a Round will be determined as follows:

0.5 x Group Project + your Individual Project.

4) During the entire experiment you will not receive any information about the other group members' contribution to the Group Project.

5) However, you will be asked to guess the sum of the partners' contribution. In each Round you have to enter your Guess about this sum, i.e., a number between 0 and 100. Your PAYOFF FROM GUESSING will be determined as follows (in ECU):

$$\frac{1}{400}(100 - |\text{your guess} - \text{the actual sum of contributions of your partners}|)^2$$

Note: the closer your Guess is to the sum of contributions of your partners the higher is your payoff. To calculate proceed as follows:

Calculate first the difference between your Guess and the sum of your partners' contributions. If this sum is

1. positive calculate the difference between 100 and this result.
2. negative calculate the sum between 100 and this result.

Then calculate the square of this difference and divide it by 400.

At the end of the experiment you will be told and paid the sum of payoffs (converted into Lire) you received during the experiment. This includes the payoffs from the Group Decision as well as from Guessing.

Exercises (translated from Italian)

Exercise 1: a) How much Payoff does every group member receive from the Group Decision in a Round in which none of them contributes anything to the Group Project?

b) How much Payoff does a group member receive if she or he submits a guess of 0, 50 or 100?

Exercise 2: a) How much Payoff does every group member receive from the Group Decision in a Round in which every member contributes the entire endowment (50ECU) to the Group Project? b) How much Payoff does a group member receive if she or he submits a guess of 0, 50 or 100?

Exercise 3: a) How much Payoff does every group member receive from the Group Decision in a Round in which the lowest contribution to the Group Project is 0 ECU, the median-contribution is 25ECU and the highest-contribution is 50 ECU?

Exercise 4: a) How much Payoff does every group member receive from the Group Decision in a Round in which the lowest contribution to the Group Project is 0, the median contribution is 1 ECU and the highest contribution is 2 ECU?

Please make your calculation on this sheet. (Hint: calculate first the Group Project, than the Individual Project for each member. Next calculate the absolute value of the difference between your Guess and the sum of the others' contribution)