The Public Goods game revisited*

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Abstract Play in standard Public Goods games suggests that on average, humans are quite willing to cooperate in multi-person social dilemmas. Yet cooperation is largely absent in real world social dilemmas where the benefits of cooperation are highest, such as in environmental problems. We hypothesize that this discrepancy is due to the fact that in the Public Goods game the worst free riders can do is to not contribute to the common good, while in most real world environmental situations they can actually undo the good works of others. We construct a modified version of the standard Public Goods game that allows for negative contributions to the common good, and show that average behavior is not statistically different from the Nash equilibrium prediction in any of the periods the game lasts.

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1 Introduction

Standard game theory predicts a lack of cooperation in social dilemma situations. Yet economic experiments present evidence to the contrary – even if the experimental games are designed to stack the die against cooperation. The main workhorse of this literature is the finitely repeated Public Goods game (also known as the Voluntary Contribution Mechanism, VCM), which has been studied extensively over the past 30 years. Each subject receives an endowment that she can keep, or invest in a group project that benefits all members of her group. Aggregate payoffs are maximized if all subjects invest their entire endowment in the group project, but the dominant strategy in this game is to pocket one's endowment. Despite the standard game-theoretic prediction of zero contributions, subjects typically invest, on average, between 40 and 60% of their endowment in the first period of the interaction. Contributions decline over time, but only become (approximately) zero in the very last period (Ledyard 1995, Chaudhuri 2010) – even if the game lasts as long as 50 periods (Gächter et al. 2008). These observations (and results from other experimental games that measure pro-sociality in behavior, such as the Dictator game, see Forsythe et al. 1994 and Engle 2011) have inspired researchers to develop models incorporating other-regarding preferences such as altruism (Andreoni and Miller 2002), inequality aversion (Bolton and Ockenfels 1998, Fehr and Schmidt 1999), and preferences for conditional cooperation (Rabin 1993).

We dispute neither the fact that humans are endowed with other-regarding preferences nor that the amount of cooperation in the canonical VCM games is much greater than can be explained by standard game theory. However, we question the degree to which behavior in the VCM game in its canonical form, informs us about the propensity of humans to cooperate in real-world social dilemmas. The mean reason for this is that in the VCM game selfish individuals have a dominant strategy to contribute nothing to the common good, while in many real-world instances, including (virtually) all environmental problems, selfish individuals can actually undo some or all of the good works of others. Mitigating climate change has been labeled "the greatest externality good of all" (cf. Stern 2007), but the climate change game does not have a dominant strategy of "zero abatement". The more some agents invest in improving their energy efficiency or in utilizing renewable energy sources, the lower the price of fossil fuels, and the more attractive it becomes for other agents to actually increase their fossil fuel consumption (and the global net effect may even be an actual increase in total emissions, giving rise to the so-called "Green Paradox"; cf. Sinn 2008). And similar "leakage effects" play a role in many other social dilemmas –traffic congestion is another example in point.

In this paper, we present the results from a slightly modified version of the standard Public Good game, the "Claim game". This Claim game's mean feature is that cooperative actions of one agent can be undone by another. Subjects simultaneously choose how much to invest in a public fund, where contributions can be positive or negative. Negative contributions (or claims) increase the decision maker's payoffs at the expense of the size of the public good. If the total net contributions are still positive, the public fund pays a positive return to each member of the group; if the total net contributions are zero or negative, the returns from the public fund are zero. We compare the outcomes of a standard Public Good game with two different specifications of the Claim game, one that yields the same benefits of cooperation as in the PG game, and one in which the payoffs to defection are the same as in the PG game.

We find that in the Claim games group investments in the public good are not significantly different from zero – not when averaged over all periods, and also not when just analyzing contributions in the first period. We thus find that standard game theory is a good predictor of *aggregate* play in the Claim game even in the early periods of each session. Moreover, we also observe that "pro-social individuals" (as classified on the basis of the positive contributions they make in the first period of the interaction) very rapidly revert to Nash behavior – much faster than in the standard VCM game. While we do not dispute that a large share of humans has other-regarding preferences (cf. Fischbacher et al. 2001), our results indicate that these preferences may not always translate into pro-social behavior in the real world. Indeed, our results echo the discussion whether a model's worth should be evaluated on the basis of whether the assumptions are realistic, or whether its predictive power is the key criterion for evaluation. If a model's predictive power is most important (as argued by Milton Friedman in his 1954 paper), our results suggest that at least in some social dilemma contexts, it is sufficient to use simple models based on 'homo economicus'. A substantial share of mankind cares about more than just their own private welfare, but in those contexts the strategic environment is such that we can assume *as if* they are all selfish, and still predict their behavior well.

Within the VCM literature, the papers by Khadjavi and Lange (2011), McCarter et al. (2011), and Cox et al. (2013) are closest to ours. Khadjavi and Lange (2011) analyze the impact of framing on subjects' contributions to the public good. The three key treatments differ in both the action set (whether subjects can only give, only take, or can both give or take) and the initial endowment in the public account (empty, some share of the group's total budget, or all of the group's budget). Khadjavi and Lange find that average contributions to the public good are significantly smaller when subjects can only take (a 'taking game') than when they can only give (the VCM game); cf. Andreoni (1995). But they find no significant differences between play in the standard VCM game and the game in which they can give or take (in the treatment in which some -but not all- of the budget has already been allocated to the public good). Our design complements that by Khadjavi and Lange (2011) as "taking" does not just reduce one's own contributions to the public good, but actually decreases those of others. In our experiment, a subject contributing her entire endowment to the public account may discover that ultimately the public account contains fewer points than she contributed – if all other subjects decided to take rather than to give. While the experiment by Khadjavi and Lange yields valuable insights into the preferences of humans and how the benchmarks of "good" and "bad" behavior depend on the available action space (as in List 2007 and Bardsly 2008), our experiments complement these insights by exploring the impact of changing the strategic environment. McCarter et al. (2011) explore the impact of allowing subjects to give or take in a threshold Public Goods game, and find that the option to take results show less cooperation than in the standard setup, where taking is not an option. Nevertheless, they still report cooperation levels that are still far removed from the Nash equilibrium. The paper by Cox et al. (2013) is closest to ours. They conduct a sequential public goods game in which three group members simultaneously decide how much of their tokens to contribute to the public account, while the fourth can then either contribute donate to the public good, or take from it (all, or none). They find that contributions are much smaller in this treatment than in the standard public goods game; our experiment complements these insights by showing that the strategic effect can result in all subjects playing the Nash equilibrium strategy even when play is simultaneous rather than sequential.

This paper is organized as follows. Section 2 gives the experimental design, and section 3 presents the data. Finally, section 4 concludes.

2 The experimental games, treatments and procedures

2.1 The experimental games

The game we study is very similar to the standard public good game (Fehr and Gächter 2000). At the beginning of the experiment, subjects are placed in groups of n subjects. They remain in the same group in all $T > 0$ periods of the experiment. Each subject is assigned an identification number at the start of the experiment, and this number remains the same throughout the entire session. Financial returns are expressed in points, which are converted to Euros at the end of the experiment.

Subjects can invest points in a public account, but also in a private account. Investments in the public account benefit all members of one's group, unless they are undone by other subjects in the group. All points in a subject's private account are hers to keep. Individual contributions to the public good are denoted by $c_i \in [a, e]$, with *a* £ 0 and *e* > 0. If a subject decides to make a positive contribution to the public good, we refer to him/her as an investor, and the positive amount contributed is referred to as the investment. When *a* < 0, subjects can also decide to contribute a negative amount, which implies that they increase the number of points in their private account at the expense of the number of points in the public account. Negative contributions will be referred to as 'claims' rather than, for example, 'takings', because negative contributions can only be realized in full if the amount of positive contributions is sufficiently large. In a group, the net aggregate number of points contributed to the public account is equal to $C \equiv \sum_{i=1}^{n} c_i$. Claimants and investors are identified by indicator function $\varphi_i = \varphi(c_i)$, where $\varphi_i = 1$ if $c_i < 0$, and zero otherwise. The total amount invested in the public account is thus equal to $C^{Inv} \equiv \sum_{i=1}^{n} (1 - \varphi_i) c_i \quad 0$, and the number of points claimed is $C^{Cl} \equiv \sum_{i=1}^{n} \varphi_i c_i \quad 0$. Negative contributions are claims to the points invested by others, and these claims may or may not be successful. If $C = C^{Inv} - C^{Cl} \geq 0$, all claims are satisfied, and the net contribution to the public good, C, is multiplied by α and then divided equally among all n group members. If $C = C^{Inv} - C^{Cl} < 0$, all contributions by the investors are undone by the negative contributions of the claimants. The public good is then not produced (implying that it yields a zero payoff) and claims are rationed according to a claimant's share in the total claims made by all claimants $(\varphi_i c_i / C^{Cl})$.

Subjects thus choose their contribution levels c_i from the range $[a, e]$, and we implement three different treatments using different combinations of *a* and *e*. The standard VCM game is implemented using (*a*,*e*) = (0,20), and two versions of the "Claim" game are obtained setting (*a*,*e*) = (-10,10) and (*a*,*e*) = (-20,20), implying that an individual's contribution is not restricted to the non-negative domain. The payoffs of every subject *i* in any of these three treatments can be represented as follows.

$$\text{If } C \geq 0, \quad \pi_i = e - c_i + \alpha C / n \quad \forall \varphi_i \in \{0, 1\} \tag{1a}$$

$$\text{If } C < 0, \quad \pi_i = \begin{cases} e - c_i & \text{if } \varphi_i = 0 \quad (1b) \\ e + \left(\frac{c_i}{C^{Cl}} C^{Inv} \right) & \text{if } \varphi_i = 1 \quad (1c) \end{cases}$$

In the treatment where (*a*,*e*) = (0,20), (individual) contributions cannot be negative and hence we have $\varphi_i = 0$ for all i and also $C = C^{Inv} \geq 0$. Each subject's payoff structure is thus given by (1a). The maximum number of points a subject can invest in the public good is equal to *e*. Any point not invested $(e - c_i)$ is put in subject *i*'s private account, and all subjects in a group receive $\alpha C/n$ $\left(=\alpha C^{Inv}/n\right)$ points from the public good – independent of whether they themselves made a positive contribution to the public fund, or not. Equation (1a) is the payoff function typically used in the literature on VCM (or Public Good) games, and we impose that $\alpha/n<1$ to have social dilemma.

In the treatments where (net) contributions can be negative (i.e., (*a*,*e*) = {(-20,20), (-10,10)}), payoff function (1a) may still apply, but only if the total number of points invested is at least as large as the total number of points claimed (that is, if $C=C^{Inv}+C^{Cl}\geq 0$, where C^{Cl} may be smaller than zero). In that case, each subject receives $\left(\alpha\left(C^{Inv}+C^{Cl}\right)/n=\alpha C/n\right)\geq 0$ points from the returns from the net contributions to the public account, and all claims are satisfied. The number of points in a subject's private account is thus equal to $e-c_i$, and whether this amount is larger or smaller than *e* depends on whether subject *i* is a claimant ($\varphi_i=1$), or an investor ($\varphi_i=0$). If the number of points invested $\left(C^{Inv}\right)$ is smaller than the absolute number of points claimed $\left(\left|C^{Cl}\right|\right)$, we have $C<0$ and the public good fails to be produced – implying that all subjects receive a zero return from the public account. Those who invested points in the public good ($\varphi_i=0$) only receive the number of points they put in their private account ($e-c_i\leq e$; see (1b)). Claimants ($\varphi_i=1$) still have their endowment, *e*, and in addition they receive a share $0<c_i/C^{Cl}\leq 1$ of the positive contributions by the others $\left(C^{Inv}\right)$; see (1c).

In all three treatments, (*a*,*e*) = {(0,20),(-10,10), (-20,20)}, we set $\alpha=1.6$, $n=4$, and $T=25$. Given these parameterizations, the standard game-theoretic prediction are that $\pi_i=e$ for all *i* in all three treatments. Backward induction implies that all n-player vectors containing only non-positive contributions (that is, $c_i\in[a,0]$) are Nash equilibria: all subjects put *e* points in their private accounts, and because $C^{Inv}=0$, any point claimed cannot be satisfied. In every period there is a dominant strategy of investing zero when *a* = 0, and a weakly dominant strategy of claiming *a* in every period in the treatments with *a* < 0.

2.2 The experimental treatments

For ease of reference, we label the three treatments (*a*,*e*) = {(0,20),(-10,10), (-20,20)} as VCM[0,20], Claim[-10,10], and Claim[-20,20], respectively. The socially optimal payoffs in VCM[0,20], the standard Public Good game, and Claim[-20,20] are the same and equal to 32. The main impact of allowing subjects to undo the good works of others can be gauged from comparing play in these two treatments as the benefits to cooperation, defined as the socially optimal payoff minus the Nash equilibrium payoff, are the same. The two treatments differ, however, in the (maximum) "temptation to defect" – the difference in payoffs when choosing to defect rather than to cooperate while all other group members fully cooperate. In VCM[0,20] the maximum temptation payoff is 12 points, but in Claim[–20,20] it is 24 points. To control for that, we also implemented Claim[-10,10]. In this treatment the socially optimal payoffs are 16 and hence smaller than in VCM[0,20] but the maximum temptation payoff is 12 – as is the case in VCM[0,20]. Table 1 gives an overview of the treatments.

Table 1 Overview of the experiments

Treatment	Socially optimal payoff	Maximum defection payoff	Groups	Individual earnings
VCM[0,20]	32	12	9	€10.09
Claim[-20,20]	32	24	9	€9.22
Claim[-10,10]	16	12	8	€6.74

2.3 The experimental procedure

The experiments were all conducted at the CentER laboratory at Tilburg University in the Fall of 2011. Subjects were students with different nationalities and with backgrounds in business, economics, law, or social sciences. No subject participated in more than one session. Each session lasted roughly forty five minutes. All decisions were mediated via z-Tree (Fischbacher 2007).

The instructions of the experiment were neutral, using phrases like "contributions to a project that may benefit all participants in your group", and "you can make claims to take out points from the project". The instructions presented the payoff function as well as some examples of how the payoffs are calculated. We did not inform subjects about the Nash equilibrium or social optimal play in the games. Before each session began, all subjects had to complete test questions. Once all subjects correctly answered all questions, the experiment began. All participants were able to answer all questions without much difficulty.

3 Data analysis

Figure 1 presents the aggregate net contributions, averaged over all groups, for each of the three treatments. The pattern in VCM[0,20] is a replication of what is typically found in standard public good experiments. Initial contributions are roughly forty percent of the total endowment, and the contributions decline as the game progresses. Strikingly, in the two Claim games the net aggregate contributions are very close to zero in the first few periods, and roughly remain negative throughout the rest of the interaction. In Appendix A, we show the net aggregate contribution levels for each treatment per group, and in Table 2 we present average net contributions (expressed as the share of the maximum possible contributions in the treatment) in the three different treatments along with the relevant test statistics.

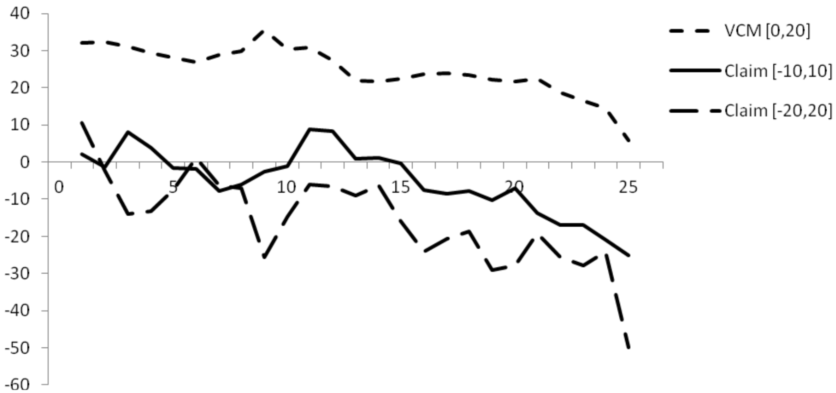

Figure 1 Net aggregate number of points contributed in the VCM[0,20], Claim[-10,10] and Claim[-20,20] treatments in each of the 25 periods, averaged over all groups in the treatment.

Table 2 Net aggregate contributions as a share of the maximum possible group contribution (averaged over all groups within a treatment); standard deviations in parentheses.

	Average net contribution share			Differences in average net contribution shares		
	Claim [-20,20]	Claim [-10,10]	VCM [0,20]	Claim[-20,20] – VCM[0,20]	Claim[-10,10] – VCM[0,20]	Claim[-20,20] – Claim[-10,10]
Averaged over all rounds	-0.195 (0.241)	-0.124 (0.264)	0.311*** (0.309)	-0.506*** (0.131)	-0.435*** (0.141)	-0.071 (0.122)
Average first round	0.132 (0.241)	0.053 (0.276)	0.401*** (0.137)	-0.269*** (0.093)	-0.348*** (0.104)	0.079 (0.125)

*,**,*** indicate significant differences at the 0.10, 0.05, 0.01 levels, respectively, based on standard *t*-tests.

The results of the *t*-tests presented in the first three columns Table 2 indicate that averaged over all periods, net group contributions are only positive and significant in the VCM[0,20] treatment, and not in the two Claim treatments. Not surprisingly, the differences in average contribution shares between the claim treatments on the one hand and the VCM treatment on the other hand, are negative, and highly significant – see the last three columns of Table 2. This table also shows that these differences already manifest themselves in the first period of the interaction. In that period, average contribution shares in Claim[-10,10] and Claim[-20,20] are already smaller than in VCM[0,20], and standard *t*-tests do not allow us to reject the null hypothesis that the average contributions are zero in the two Claim games. This gives rise to our first result.

Result 1 Throughout the interaction average contribution shares are much lower in the Claim[-10,10] and Claim[-20,20] than in VCM[0,20], and fail to be significantly positive even in the first period.

Result 1 states that patterns of net contributions are in line with the predictions provided by standard game theory – whether it also holds for individual play, will be addressed later. These results complement the insights obtained by Khadjavi and Lange (2011). While contributions are significantly different from zero even in their taking game (with average contributions equal to 43% of the maximum in period 1 and 22% averaged over all periods), average net contributions in both our claim games are in line with the Nash equilibrium prediction of zero net contributions even in the early periods of the interaction. Moreover, while Khadjavi and Lange find that the net contributions in the treatment that allows for both giving and taking do not differ from those in their VCM treatment (as the respective average contributions are 58% and 59% of the maximum in the first period, and 36% and 38% averaged over all periods), the initial contributions in our claim games are significantly lower than in the VCM game even in the very first period. Khadjavi and Lange thus find that changing the action space from just giving to (also allowing for) taking makes subjects less cooperative on average, but the Nash equilibrium prediction of zero cooperation is rejected in all instances. Our experiments show that if the good works of some can actually be undone by others – as is the case in CO2 emission reductions – aggregate play is in line with the standard neoclassical predictions. Predicting individual behavior may require modeling each agent's utility function, but if policy makers only care about the aggregate outcomes, they can safely assume that all agents behave *as if* they are purely self-interested in some circumstances (when some can undo the good works of others) – but not in all (in those circumstances in which contributions cannot be negative).

Let us now turn to analyzing individual behavior. Economic theory predicts that not only the aggregate amount contributed is non-positive, but also that each individual's contributions are non-positive as well. As is well known by now this prediction is violated in VCM games, but the question is whether this prediction is also violated if one's good work can be undone by others as is the case in the Claim games. Table 3 presents the shares of subjects choosing positive contribution levels in the three treatments in all periods, in period 1, and, arbitrarily, also in period 20. Averaged over all periods, subjects in VCM[0,20] chose positive contribution levels (as opposed to contributing zero) in almost 60% of the cases, while subjects chose positive levels (as opposed to zero or negative contributions) in 24% and 35% of the instances in the Claim[-20,20] and Claim[-10,10] treatments, respectively. These percentages are all significantly different from each other according to standard Fisher exact tests. Moreover, the drop in investor shares from period 1 to period 20 is much more pronounced in the two Claim games than in VCM[0,20].

Table 3 Share of subjects choosing positive contribution levels in the three treatments, in periods 1, 20 and in all periods, and the associated Fisher exact tests.

	Share of subjects contributing a positive amount to the public account			Significance of the differences in shares of subjects contributing positive amounts in the three treatments[a]		
	Claim [-20,20]	Claim [-10,10]	VCM [0,20]	Claim[-20,20] vs VCM[0,20]	Claim[-10,10] vs VCM[0,20]	Claim[-20,20] vs Claim[-10,10]
All periods	217 / 900	279 / 800	535 / 900	$p= 0.000$	$p = 0.000$	$p = 0.000$
Period 1	21 / 36	18 / 32	31 / 36	$p = 0.017$	$p = 0.008$	$p = 1.000$
Period 20	2 / 36	7 / 32	19 /36	$p = 0.000$	$p = 0.012$	$p = 0.073$

[a] *p*-values obtained using standard (2-sided) Fisher exact tests.

We summarize these results as follows.

Result 2 The frequency with which positive contribution levels are chosen in the first period is higher in VCM[0,20] than in the two Claim games, and the difference in frequency distributions is even larger in the later periods.

Result 2 indicates that the rate at which subjects cease to invest positive amounts in the public account, falls faster in the Claim games than in the VCM game. Comparing play in Claim[-20,20] and in Claim[-10,10], Table 3 also indicates that sustaining cooperation is more difficult when the temptation to defect is stronger. This is interesting because the average contribution levels were not found to significantly differ between the two Claim games; see Table 2. We explore the impacts of (i) higher defection payoffs and (ii) lower cooperation benefits in two steps. First, we analyze the impacts on the extent to which subjects who started the game with the intention to cooperate (by contributing a substantial share of their endowment in the first period), are willing to continue cooperating. Second, we use regression analysis to disentangle the two effects for all subjects involved.

In Table 4 we present the average contributions shares in periods 5-20 of those subjects who contributed 40% or more of the maximum contribution level in period 1. Let us refer to these subjects as "prosocial individuals". Table 4 shows that on average, the contributions of these individuals are positive in both Claim[-10,10] and Claim[-20,20], but not significantly so. Also, the average contribution share of these prosocial subjects is much greater in Claim[-10,10] than in Claim[-20,20], but this difference is not significant either (p = 0.40 according to the Mann-Whitney U test). This gives rise to the following result:

Result 3 Those subjects who invested substantially in the first period of the two Claim games, are not found to do so in the later periods; their average contribution shares are positive but not significantly different from zero. In addition, the average contributions of these subjects are smaller when the temptation to defect is higher, but not significantly so.

Table 4 Contribution shares, averaged over periods 5 to 20, of the prosocial individuals in the three treatments; standard deviations in parentheses.

Average contribution share over periods 5-20			Differences in net average contribution shares [a]		
Claim [-20,20]	Claim [-10,10]	VCM [0,20]	Claim[-20,20] – VCM[0,20]	Claim[-10,10] – VCM[0,20]	Claim[-20,20] – Claim[-10,10]
0.023 (0.431)	0.193 (0.448)	0.437*** (0.363)	-0.415** (0.153)	-0.245** (0.165)	-0.170 (0.197)

[a] p-values based on standard Mann-Whitney U test. *,**,*** indicate significant differences at the 0.10, 0.05, 0.01 levels, respectively.

Hence, subjects displaying the intention to cooperate by contributing a substantial share of their endowment in the first period, tend to behave prosocially in the remainder of the experiment too in the sense that they, on average, do not choose negative contribution levels. But they still act more or less in line with the game-theoretic prediction in that their contribution levels are not significantly positive either. Comparing Tables 2 and 4 suggests that the non-prosocial individuals tend to choose negative contribution levels, and possibly more so when the temptation to defect is larger, thus inducing pro-social individuals to choose contribution levels that are, on average, not significantly different from zero. In Table 5 we show the regression results trying to parse out the impact, on average play, from (i) participating in a treatment with higher or lower benefits of cooperation, and (ii) facing a higher or lower temptation to defect. We construct a dummy variable "HiBenfsCoop" which has value 0 for treatment Claim[-10,10] and 1 otherwise, and a dummy variable "HiTemptDefect" which has value 1 for treatment Claim[-20,20], and zero otherwise.

Table 5 disentangles the impact of the two factors on the actual contribution level.

The intercept reflects the average contribution level when the benefits of cooperation and the temptation to defect are both small. Higher benefits of cooperation raise the average subject's contribution share by 26 percentage points, while a stronger temptation to defect reduces it by 42 percentage points. Over time, contributions fall, but they fall slower (faster) when the benefits to cooperation (temptation to defect) are higher. This gives rise to result 4.

Result 4 Averaged over all subjects, contributions tend to be greater the greater the benefits of cooperation, and smaller the stronger is the temptation to defect. Over time, contributions tend to fall, and the decline is fastest when the temptation to defect is large and the benefits of cooperation are small.

Table 5 The effects of higher cooperation benefits and stronger defection incentives on absolute and relative contribution levels.[a]

	Contribution as a share of the maximum possible contribution
Constant	0.178*
	(0.0975)
HiBenfsCoop	0.259**
	(0.108)
HiTemptDefect	-0.415***
	(0.0963)
Period	-0.0232***
	(0.00427)
HiBenfsCoop interacted with Period	0.0136*** (0.00461)
HiTemptDefect interacted with Period	-0.00700* (0.00411)
N	2600
Adjusted R2	0.194
F	41.30

[a] Results of a standard OLS regression. Robust standard errors, clustered at the subject level, in parentheses.
*,**,*** indicate that coefficients are significantly different from zero at the 0.10, 0.05, 0.01 levels, respectively.

4 Conclusions

In this paper, we test the effects of giving subjects the option to choose negative contributions in a game that is otherwise identical to the standard Public Goods game. Subjects have the possibility to make positive contributions, but they can also make negative contributions –

increasing their own private payoffs at the expense of the size of the public good. We compare play in the standard Public Goods game, VCM[0,20], to two versions of our Claim game. In Claim[-20,20] the benefits of cooperation are equally high as in the standard VCM[0,20] game, but the temptation to defect (defined as the maximum defection payoffs) are twice as large. In Claim[-10,10], the temptation to defect is equally large as in the VCM[0,20] treatment, but the benefits from cooperation are half as large. Allowing subjects to undo the contributions of others results in aggregate contributions that are not significantly different from zero from the first period onward – as predicted by standard game theory. But also individual play is roughly as predicted by game theory – even subjects who started the game with the intention to cooperate (by contributing a substantial share of their endowment in the first period), choose effort levels that are, on average, not significantly positive.

The possibility that each subject can (partly) undo the good work by others, results in behavior that we typically refer to as selfish – contributing zero to the public good. This is not because humans only care about their own welfare – play in VCM[0,20] proves the contrary – but because the strategic environment is such that it does not increase group welfare to be generous. In those environmental problems where the good works by some can be undone by others, modeling the ecological-economic system assuming other-regarding preferences may complicate the models without improving their predictive power.

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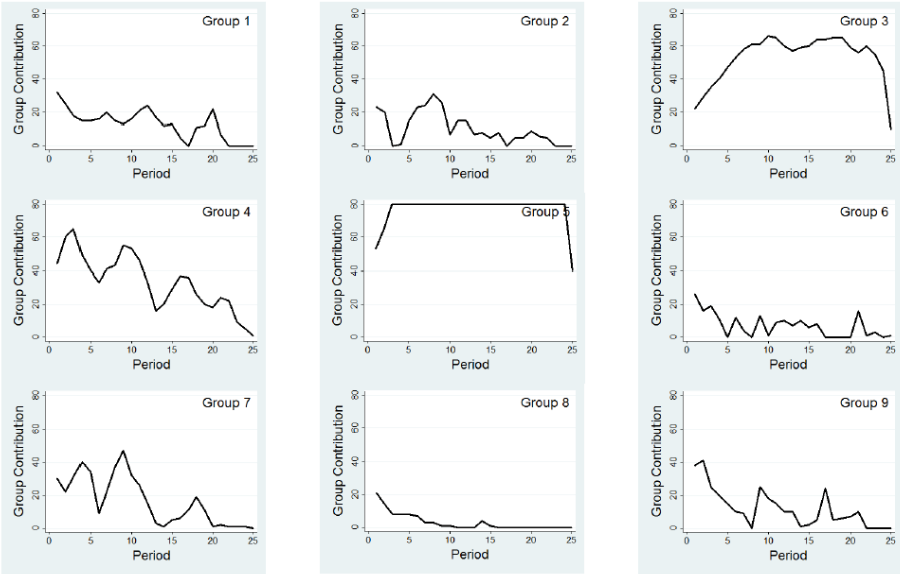
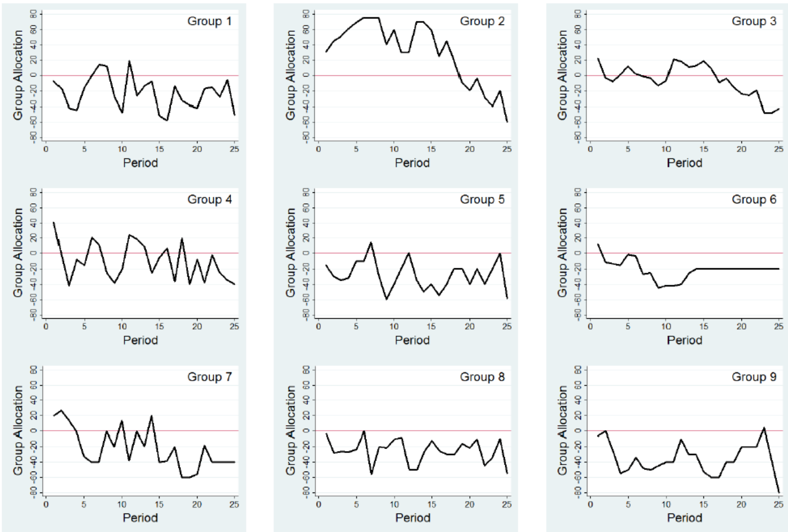
Appendix A:

In this appendix, we show the contribution levels per group.

Contributions per group in VCM[0,20]



Contributions per group in Claim[-20,20]



Contributions per group in Claim[-10,10]