Are incentives a must for biodiversity conservation? Experimental results on long-lasting cooperation

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Abstract: Permanence effect, sustained behaviour, persistence in effort or long-lasting cooperation are all concepts addressing the same question of cooperative behaviours in the long run and especially after the removal of incentives to contribute to a public good game. This question is central to efficient biodiversity conservation in payments for environmental services. This paper looks at the permanence effect of incentives by comparing non-monetary (NMI) and monetary incentives (MI) to contribute in public-good game experiments. We study if the type of incentives (monetary/non-monetary; rewards/punishments) affects long-lasting cooperation. The four incentives schemes we use show that both monetary and nonmonetary punishments and rewards significantly increase contributions compared to the baseline but monetary sanctions lead to the highest contributions while nonmonetary sanctions lead to the lowest contributions. The four treatments have long-lasting effects since contributions do not go back to baseline levels directly after the withdrawal of the incentives but rewards appear to have much stronger persistent effects than sanctions. Nonmonetary and monetary rewards have the same efficiency on contributions and produce some kind of delayed reciprocity since those who have been highly rewarded are those who contribute more once the rewards have been removed. These findings underline the importance to look both at the type of incentives and to better understand the changes in behavior in institutional arrangements between individuals when permanence is sought.

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1. Introduction

Long-lasting cooperation is motivated by very concrete cases. Practical applications of incentives like payments for ecosystem services (PES) tend to illustrate the lack of sustained behaviour at the end of the agreements: even after a long-period contract, permanence of actions is not, or rarely, observed and sometimes agents can implement some management practices that appear to be worse for environment (Sattler et al, 2013; Engel et al, 2008; Nsoh and Reid, 2013…). Yet ex post evaluation of payments for environmental services could

inform us on the effectiveness of conservation interventions. But some different conclusions exist on their efficiency in a long-term conservation benefit view because concerns about PES and their permanent effect are not always verified due to some lack of data. Few evaluations of PES exist due to the difficulties to collect data and to define some baseline or control groups. In addition, most of the PES programs tend to be defined with some perpetual payments especially those which aim to conserve land uses such as forests (Pagiola et al, 2014). Those last authors examined the long-term sustainability of environmentally-beneficial land use change induced by a short-term PES program in Colombia. They found that this question has not been treated in the literature[1]. They collected additional data on results several years after the project ended (four years after) to show that in these PES program land uses (especially silvopastoral practices) adopted under incentives were not abandoned once payments stopped.

Permanence effect, sustained behaviour, persistence in effort or long-lasting cooperation are all concepts addressing the same question of cooperative behaviours in the long run. In fact, the question is to know what we can expect once incentives have been totally removed at the end of a program. Permanence effect can also be studied in periods between a stop and a restart in incentives, or before a new design in incentives. In the case of contributions to public good, incentives are usually defined in some explicit contracts, involving individuals in some short-run program. Added to a costly implementation, one can really ask the long-run repercussions of using incentives in such short-run cases on behaviours: once incentives are stopped, if society does not accept the potential end of gains, will we need to sustain cooperation with permanent incentives? Or can we expect some modifications in behaviours, like adoption of new norms or learning the necessity of effort on a long-term issue? It seems particularly important to look at permanence effects also for other reasons, the main one being the sustainability of the funding possibilities and trust in institutions that encourage these environmental or social improvements. In fact, monetary incentives can be more costly for institutions asking for individual contributions to public good as they are difficult to quantify and often insufficient (i.e. not covering all the agent's real costs); furthermore, they can create some perverse effects (a positive contribution but a negative externality in another area), they are temporary (in a defined period) and finally they can be rejected. Two aspects appear

[1] Except in a stated preference study in which Grosjean and Kontoleon (2009) predict whether the program would prove sustainable, rather than observe actual behaviour post-program.

important to take into account: institutions that favour public good and the type of incentives

Incentives are most often monetary ones even if the use nonmonetary ones (or nudges) are increasing in the private and public areas (Thaler and Sustain, 2008). Furthermore, incentives can be positive ones like rewards or negative ones like punishments that can be costly to the bad contributors. A concrete reason to look at nonmonetary incentives in terms of is the crowding out effect of voluntary cooperation when using monetary incentives like in blood donation. Moreover, nonmonetary incentives seem sometimes more efficient than monetary ones, especially in case of rewards (Jin and Huan, 2014), which tend to show that some different behaviours can be obtained using less costly incentives.

The lack of data pushes toward the use of other sources of information to understand the social behaviour of individuals facing incentives to contribute to public goods. In the experimental literature, the contribution to public goods has been largely studied for years now. It provides an easy way to assess the contributing behaviour in different environments and facing different incentives. Especially it has been shown that there exist various preferences when we consider public goods, namely unconditional contributors, conditional contributors and free-riders (see Andreoni, 1990, 1995; Palfrey and Brisbey, 1997, Andreoni and Croson, 2008; Fischbacher et al., 2001; Fischbacher and Gachter, 2010). Furthermore experiments have documented that after an initial positive level of contributions to the public good, the contributions decline with repetitions when conditional contributors find out that there are free riders. In this respect it has been shown formal introducing monetary incentives, such as formal sanctioning, increases contributions and slowdown the decay observed with repetitions. Fehr and Gächter (2000, 2002) show that costly punishments raise contributions to levels above those attainable in the absence of such punishments. Sefton et al (2007) show also that monetary rewards can also increase contributions to the public good, although the effect is less strong than with punishments. Andreoni et al (2003) compare both types of incentives and conclude on the necessity to have rewards to improve cooperation, rejecting the equivalence of an absence of reward and a punishment. Interestingly it has also been shown that nonmonetary incentives can also sustain cooperation. Masclet et al. (2003), in a similar design to Fehr and Gächter (2000), introduce nonmonetary punishments such as expressions of disapproval. They show that both monetary and nonmonetary sanctions initially increase contributions. But over time, monetary sanctions are more effective and lead to higher contributions.

However experiments looking at the long-lasting effect of incentive to contribute to common welfare is very recent. To our knowledge only one paper is concerned with this issue. In a recent paper, Bruttel and Friehe (2014) show that strong monetary incentives in the first rounds do not ensure long-lasting cooperation in the following rounds. Furthermore no studies tried to compare the incentives, either monetary or non-monetary, in terms of permanence effect. In areas different than public good games, absence of permanent behaviour has been observed as well in experimental studies: after the removal of incentives, team performance seems to be worse than before incentives for different reasons like the loss of intrinsic motivations (Falk and Kosfeld, 2006). In Attention-Deficit/Hyperactivity Disorder (ADHD) characterized by behavioural difficulties in the area of attention, behavioural strategies based on rewards and consequences also have a central role in the treatment. But it is not unlikely that these therapies must continue for life to obtain permanence of change, even if heterogeneity in the disorders must be taken into account as highly impulsive individuals are less likely to respond well to behaviour modification (Hersher, 1985).

The aim of our paper is to compare different types of incentives, monetary vs nonmonetary ones and rewards vs punishments in terms of permanent effect in a public good experiment. In our study, we compare treatments in which monetary and non-monetary incentives are available. After a fixed number of periods, these incentives are removed and we compare the long-lasting effect on contributions to the public good. What is the efficiency of non-monetary incentives on long-lasting cooperation? Are rewards better than punishments when looking at permanence or long-lasting cooperation? To our knowledge no papers try to assess the permanence effect of non-monetary incentives. Furthermore no papers compare the long-lasting effects of similar monetary and nonmonetary incentives in a similar design. As noted by Bruttel and Friehe (2014), three potential effects to the removal of incentives can be expected: 1) the contributions go back to their pre-incentive level (Hamman et al, 2007), 2) the contributions stay at the high level (Brandts and Cooper, 2006) and 3) the contributions go to a lower level than their pre-incentive level (Gneezy et al., 2011; Meier, 2007). Ariely et al (2009) insist of the image concern as a reason to maintain high average contributions even when strong material incentives have been removed. This means that incentives can have different long-lasting effect depending on their intrinsic nature. One can expect better sustainability with rewards than punishments and nonmonetary incentives, once they impact self-image, could work and stay efficient even after removal. This is what we assess in this paper

The next section will describe the experimental design as well as the predictions and procedures. Section 3 will present the results and a last section concludes.

2. Experimental design and procedures

2.1. Design

Our setting consists of a repeated Voluntary Contribution Mechanism (VCM) played by fixed groups of four subjects. It is played for 30 periods and at the start of each period, each subject receives an endowment of 20 tokens and has to decide simultaneously and without the possibility of communicating how many tokens she wants to keep for herself and how many tokens she wants to invest into a project. Each investment made into the project yields a payoff of 0.4 tokens to each of the four member of the group. Therefore the earnings of individual *i* who contributes c_i to the project in a period are given by:

$$\pi_i^B = 20 - c_i + 0.4 \sum_{k=1}^{4} c_k$$

We consider four treatment conditions in addition to the *Baseline* that has just been described: *Monetary Punishment (MP), Nonmonetary Punishment (NMP), Monetary Reward (MR), Nonmonetary Reward (NMR)* and a *Baseline.* In the four supplementary treatments, each subject participated in two sequences of 15 decision periods. Table 1 displays summary design information[2].

In Periods 1-15, each period consisted of a two-stage game. In stage 1, subjects plays a standard VCM in which he or she has to decide simultaneously and without the possibility of communicating how to allocate his or her 20 tokens endowment.

Table 1: Treatment conditions

	Subjects	Sequence I (Periods 1-15)	Sequence II (Periods 16-30)
Baseline	20	VCM	VCM
Monetary Punishment (MP)	20	VCM + Punishment	VCM
Nonmonetary Punishment (NMP)	20	VCM + Punishment	VCM
Monetary Reward (MR)	20	VCM + Reward	VCM
Nonmonetary Reward (NMR)	20	VCM + Reward	VCM

[2] Instructions for *MP* are presented in the appendix.

At the beginning of the second stage, subjects are informed of the contribution levels of each of the other members of their group[3]. Individual decisions are not linked to subject identifiers and contributions are presented in ascending order in each period such that subject-specific reputations could not develop across periods. Depending on the treatment condition, subjects can make a second decision in stage 2:

(i) In the *Monetary Punishment (MP)* treatment, they could assign zero to ten punishment points to each of the three other group members. Each point, p_{ij} assigned by subject *i* to subject *j* lowered subject j's income by one unit. There was also a cost of 0.25 token for the subject assigning the points associated with each point allocated[4]. This implies that payoffs at the end of Stage 2 and thus from any given period are given by

$$\Pi_i = \pi_i - \sum_{j \neq i} p_{ji} - 0.25 \sum_{j \neq i} p_{ij}$$

The choice of punishment points is restricted to the actual earnings from the first stage but the earnings at the end of a period can be negative depending on the number of punishments points distributed and received.

(ii) In the *Nonmonetary Punishment (NMP)* treatment, the rules were similar to those of *MP*, except that each point awarded to a subject had no effect on her final earnings and was costless to assign. As in *MP*, each subject had the opportunity to assign between 0 and 10 points to each member of the group. In a similar framework to Masclet et al (2003), these points correspond to level of disapproval of the subject's contributions in the first stage. Ten points were to be assigned for the highest level of disapproval and zero points for the lowest level of disapproval.

(iii) In the *Monetary Reward (MR)* treatment, the mechanism was identical to the *MP* treatment, except instead of assigning points to sanction other group members, subjects could use points to rewards other group members. Subjects could assign 0

[3] One alternative would have been to present each member's individual income. However Nikiforadis (2010) has shown that giving the individual income instead of the individual contribution reduce the effectiveness of the punishment mechanism.

[4] The effectiveness of the punishment mechanism has been shown to be related to the mix of cost-impact of the punishment. Egas and Riedl (2008) show that a low cost-high impact punishment is the most effective mechanism. We opted for a 1 to 4 ratio.

to 10 points. Each point, p_{ij} assigned by subject *i* to subject *j* increased subject j's income by one unit. As in *MP*, there was a cost of 0.25 token for the subject assigning the points associated with each point allocated[5]. This implies that payoffs at the end of Stage 2 are given by

$$\Pi_i = \pi_i + \sum_{j \neq i} p_{ji} - 0.25 \sum_{j \neq i} p_{ij}$$

(iv) In the *Nonmonetary Reward (NMR)* treatment, the rules were similar to those of *MR*, except that, as in *NMP*, each point awarded to a subject had no effect on her final earnings and was costless to assign. Each subjects had the only opportunity to express her approval of the group's member contributions by assigning 0 to 10 reward points.

In each of these four treatments, after having assigned points (either sanctions or rewards), each subject was informed of their earnings, including any punishment (reward) they imposed or received. Subjects were also informed of the total number of punishment (reward) points they received, but could not identify which of the other subjects imposed the punishment (rewards). Further, subjects were not informed of the number of punishment (reward) points other group members received.

In Periods 16-30, each period was identical except that there was no stage 2; that is no more opportunities for rewards or sanctions. Each period consist of a standard VCM. This was clearly stated in the instructions from the very beginning of the experiment and in all treatment conditions, subjects know they play a finitely repeated game with a final period.

2.2. Predictions

Assuming that subjects care only for their monetary payoffs and are fully rationale and it is common knowledge, they should not contribute in the Baseline. They should also abstain from costly punishment or reward (Fehr and Gachter, 2000; Kocher et al, 2009). Free riding is a dominant strategy. However we know that we can expect positive contributions in the *Baseline* followed by a continuous decay until the last period due to the presence of conditional cooperators (Chaudhuri, 2011). This unstable cooperation has been shown to be fixed by the introduction of sanctions or rewards. This means that one can expect that there

[5] Thus, rewards constituted a pure redistribution of earnings.

are conditional cooperators that are willing to engage in the punishment of free riders as well as in the rewarding of good contributors. Given previous results, punishments should lead to higher contributions than rewards and monetary incentives should lead to higher contributions than nonmonetary ones (Masclet et al, 2003; Sefton et al, 2007).

Whether we observe positive contributions during period 1-15, predictions for periods 16-30 are not clear-cut. As pointed by Bruttel and Friehe (2014), after the removal of incentives, predictions on contribution level depends on the hypothesis retained. If we assume that it is the incentives that primarily influence contributing behavior, contribution should goes down to the *Baseline*. If we assume that the incentives improved coordination and may be create trust and self-image, that should influence later interactions and we should not observe much change from what we obtain in periods 1-15. Finally it might be that the levels of contribution worsen to a level below the *Baseline*. But this would happen mostly with monetary incentives that have been shown to backfire in some cases. In any ways, it is difficult to predict the difference between monetary and nonmonetary incentive effects. The effect of showing disapproval or approval has been shown to be strong but the long-lasting effect is somewhat unknown.

2.3. Procedures

In total, 100 subjects participated to five sessions (one for each treatment condition). All subjects were recruited from a list of experimental subjects maintained at BETA, University of Strasbourg, France, using the ORSEE software (Greiner, 2004). Subjects had an average age of 21 years, and 44% of subjects were female. They were from very different fields but among them 33% were studying economics or business management.

The experiment was computerized. Upon arrival, each subject was assigned a computer randomly. The instructions were read aloud by the experimenter and before starting a comprehension questionnaire was administered to check that the rules were well understood. All questions were answered in private. Once the 30 periods were completed, the screens displayed the total cumulative gains for the experiment and the subjects answered a post-experimental questionnaire. Then, at the end of the session, subjects were paid their earnings in a separate room and in private. There was a conversion rate of 30 tokens to €1. Average earnings were €26.4 (standard deviation = 4.3).

3. Results

We first present the contributions to the public good in order to assess the possible long-lasting effect of incentives. In a second step we present the individual choices of punishing or rewarding other group members as well as the determinant of being sanctioned or rewarded.

3.1. Contributions

Table 2 presents the average contributions in each treatment by comparing the initial 15 periods with the last 15 periods. In each part, test of significant difference with the *Baseline* is performed. Table 2 shows that on average the individual contributions are significantly much higher in *MP*, *NMP*, *MR* and *NMR* than in the *Baseline* for periods 1-15. This confirms previous results on the effectiveness of punishments and rewards in public good games (Fehr and Gachter, 2000; Masclet et al, 2003 and Sefton et al, 2007). Moreover monetary sanctions lead to higher contributions than nonmonetary sanctions and rewards (Mann-Whitney rank-sum test, $p<0.000$). Interestingly, rewards lead to higher contributions than nonmonetary punishments ($p<0.000$) and Monetary rewards lead to higher contributions than Nonmonetary rewards ($p<0.000$).

> *Result 1: a) Both monetary and nonmonetary punishments and rewards significantly increase contributions compared to the baseline but b) monetary sanctions lead to the highest contributions while nonmonetary sanctions lead to the lowest contributions.*

Table 2 : Mean contribution

	Periods 1-15		Periods 16-30	
	Mean	Std. Dev	Mean	Std. Dev
Baseline	8.5	6.1	4.0	4.6
Monetary Punishment (MP)	17.2***	6.4	8.0***	8.4
Nonmonetary Punishment (NMP)	11.8***	7.5	5.9	7.0
Monetary Reward (MR)	14.6***	7.6	9.2***	8.4
Nonmonetary Reward (NMR)	14.4***	5.9	8.8***	7.7

***, **, * stand for significance difference at the 1%, 5% and 10% respectively according to a two-side Mann-Whitney test of difference with the *Baseline*.

From period 16 onwards, opportunities to punish or to reward are withdrawn from every treatment. Table 2 shows that during periods 16 to 30 the contributions are still significantly

higher, on average, than the *Baseline* for all treatments except in *NMP*. This tends to confirm some long-lasting effects of incentive introduced in the initial periods.

Figures 1 and 2 show the time series of individual contributions by period in the *Punishment* and the *Reward* treatments compared to the *Baseline*[6]. The bold line indicates the *Baseline* contribution. The pattern of contribution in the *Baseline* is consistent with that observed in previous studies (see Ledyard, 1995; Chaudhuri, 2011). Contributions start from about 50% of the endowment and then continuously decrease until period 30. In the *Punishment* and the *Reward* treatments (both *monetary* and *nonmonetary*), as noted in Table 2, the contributions are much higher during the 15 first periods. In the four treatments, the contributions are well above the *Baseline* and do not display the same decay; they appear more stable than in the *Baseline*, also in line with previous studies (see i.e. Nikiforakis and Normann, 2008).

In period 16, contributions in the four incentivized treatments do not fall down immediately to the *Baseline* level. In *MP* and *MR*, we observe a drop of about 25% after the stop of the opportunity to punish or reward but still higher than the *Baseline*. We do not observe such a drop in the *nonmonetary* treatments: *NMP* and *NMR*. The positive difference with the *Baseline* tends to reduce faster for sanctions than rewards but except for the last periods, contributions stay at high level for several periods after the withdraw of the incentive[7]. In repeated settings, rewards are better in producing long-lasting contributions. These results tend to be in line with previous ones showing that rewards produce better outcomes than punishments (Rand et al, 2009).

> *Result 2: a) MP, NMP, MR and NMR have long-lasting effects since contributions do not go back to baseline levels directly after the withdrawal of the incentives but b) rewards appear to have much stronger persistent effects than sanctions. c) Nonmonetary and monetary rewards have the same efficiency on contributions.*

[6] Contributions at the group levels display similar results and are available upon request.
[7] Table A1 in the appendix shows that the difference with the Baseline is significant until period 20-21 for sanctions and until period 25 for rewards.

Figure 1: Average contribution - Punishment vs Baseline

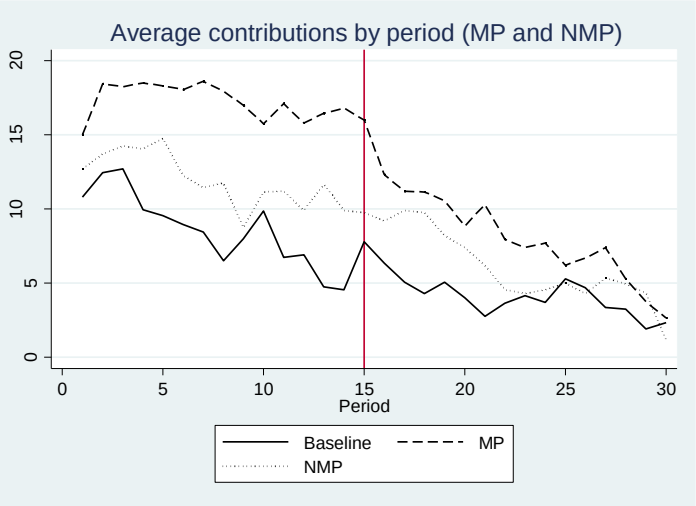
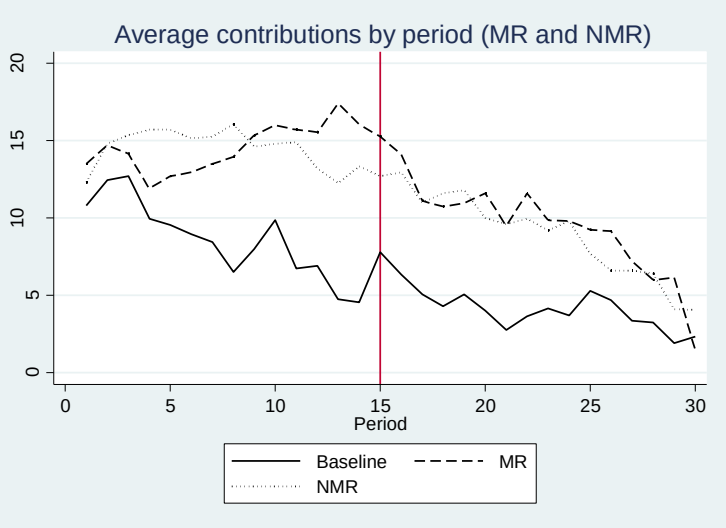


Figure 2 : Average contribution - Reward vs Baseline



These results are confirmed by regressions in Table 3. The first columns present Tobit estimations for the individual contributions during Periods 1-30 and 1-15. The specification includes control for age, gender and if the subject is a student in economics or management. In addition to treatment variables, we also introduce a period variable as well as the relative contribution to the group in the preceding period. The reference is the *Baseline* treatment. The results confirm the strong effect of our four incentivized treatments on the individual contribution. *Monetary sanctions* have the strongest effect, followed by *Monetary rewards* and *Nonmonetary rewards*. *Nonmonetary punishments* have a smaller but significant effect on contributions. Those who were positively far from the group contribution in the preceding period contribute more. Along time we observe a decline in the level of contribution.

The third column presents the same estimation as in specification (1) and (2) but for the periods 16-30. The results confirm previous findings. Whereas punishments and rewards can no longer be applied, we still observe significant deviations from the *Baseline* treatment. Interestingly the rewards have a stronger impact than the punishments. One interesting question in our study is the long-lasting effect of the incentives introduced in periods 1-15. In order to identify diverging behavior among treatments and across time, specification (4) introduces interaction effects between treatment variables and time. As noticed in the previous results, one observe an initial higher level of contribution in incentivized treatments than in the Baseline but a stronger decreasing pattern than in the Baseline. This tends to confirm the convergence operating through time. In the last column, results show that after the first 15 periods, subjects in each of the four treatments with incentives contribute more than in the *Baseline* but the interaction of treatment variables with time show that the contributions decrease more rapidly than in the *Baseline*. This is not surprising since we observe a kind of convergence at the end of the 30 period between all treatments, revealing an effect of a known end of game.

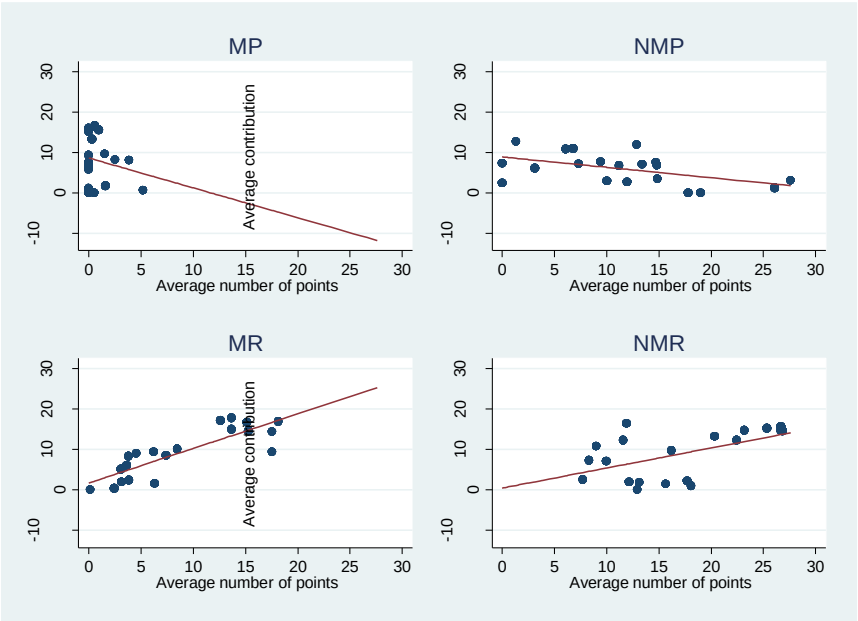
Table 3 : Determinants of individual contributions, Tobit estimation

	(1) Periods 1-30	(2) Periods 1-15	(3) Periods 16-30	(4) Periods 16-30
MP	12.009***	20.175***	4.333***	23.186***
	(0.845)	(1.313)	(0.673)	(6.790)
NMP	3.805***	5.186***	1.869***	15.270**
	(0.800)	(1.088)	(0.670)	(6.761)
RM	9.522***	11.099***	6.018***	26.459***
	(0.810)	(1.126)	(0.664)	(6.808)
NMR	8.149***	9.332***	5.042***	22.598***
	(0.790)	(1.079)	(0.660)	(6.689)
Relative contribution in t-1	0.497***	0.553***	0.274***	0.382***
	(0.056)	(0.078)	(0.047)	(0.080)
Period	-0.791***	-0.333***	-0.534***	-0.390**
	(0.078)	(0.106)	(0.067)	(0.189)
MP * Period				-0.795***
				(0.287)
NMP * Period				-0.594**
				(0.286)
MR * Period				-0.812***
				(0.288)
NMR * Period				-0.694**
				(0.283)
Constant	16.133***	10.687***	25.105***	30.449***
	(0.803)	(1.153)	(2.644)	(6.608)
N	2900	1400	1400	1400

Notes: All regressions contain a control for the periods and a dummy for gender as well as a dummy if the subject studies economics or management. Standard errors are in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

However it still remains that contributions are higher than in the *Baseline* in the four other treatments even after that the opportunity to punish or reward has been removed but that in punishment treatments, contributions decrease more rapidly than in rewards treatments. Thus having received punishment or rewards points, either monetary or nonmonetary appears to have diverging long-term effect on the contributions. Figure 3 presents the average contribution in period 16-30 according to the number of points received during the periods 1-15, by treatment. We will come back below to the drivers of assigning or receiving points during the first part of the experiment but we see from Figure 3 that the effect of the points on the later contributions is different according to the treatment and following to the meaning of the points. On average those who have been punished a lot tend to contribute less afterwards whereas those who have been awarded a lot contribute more. These surprising results show that in the punishment treatments a part of the free riders are likely to keep on their initial behavior all along the experiment. They do not contribute during the first 15 periods and are then sanctioned (see the determinants of being sanctioned in the next section below) and they continue not contributing the last 15 periods. It may also be that they contribute even less in the last periods to gain back what they lose because of punishment points in *MP*. On the contrary, in the rewards treatments, we observe some kind of delayed reciprocity behavior since those who have been highly rewarded are those who contribute more once rewards opportunities have been removed.

Figure 3 : Average contributions in periods 16-30 according to average number of points received in periods 1-15



Result 3: a) in MP those who contributed less during the first periods and have been highly sanctioned are also those who contribute less once the sanction opportunity has been removed. b) In MR and NMR, we observe some kind of delayed reciprocity since those who have been highly rewarded are those who contribute more once the rewards have been removed.

Table 4 confirm these results by presenting regressions by treatment for periods 16-30 when we introduce the total number of points received during periods 1-15 as an explanatory variable[8]. The number of points obtained during the first periods displays a different effect depending on the context. Those who have received rewards points, either monetary or nonmonetary, contribute more during the last 15 periods than those who have received fewer points. On the contrary, those who have been assigned with a lot of punishment points decrease their contributions. In both case, monetary points appear to have a stronger effect than nonmonetary. These results also explain why we observe a more long-lasting impact in the rewards treatments. Indeed those who have been deeply punished during the first part of the experiment contribute less in the second part. In comparison to the *rewards* treatments, the contamination of cooperator (likely conditional) is much more rapid and important due to those free-riders. This explains that we observe a lower long-lasting effect in *punishments* treatments.

Table 4 : Determinants of contributions by treatment in periods 16-30

	(1) *MP*	(2) *NMP*	(3) *MR*	(4) *NMR*
Relative contribution in t-1	-1.262**	-0.862***	-0.178	-0.985***
	(0.496)	(0.270)	(0.284)	(0.281)
N points received	-0.365**	-0.050***	0.132***	0.049***
	(0.178)	(0.016)	(0.020)	(0.014)
Deviation from part 1	1.952***	0.883***	0.303	1.467***
	(0.479)	(0.196)	(0.251)	(0.200)
Period	-0.282	-0.550***	-1.304***	-0.138
	(0.269)	(0.171)	(0.385)	(0.142)
Constant	18.506	40.079*	32.530	-8.611
	(22.967)	(23.908)	(31.483)	(18.421)
N	280	280	280	280

Notes: All regressions contain a control for the periods and a dummy for gender as well as a dummy if the subject studies economics or management. Standard errors are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

[8] We also tried with the average number of points received and it does not change the conclusions. Results are available upon request.

3.2. Punishments and rewards

Our data also allows us to look at the determinants of assigning and receiving points in each of the four treatments for periods 1-15. In the following we study both the determinants of receiving and assigning points. Our previous results show that all four incentivized treatment significantly increase contributions in the first periods. Figure 4 depicts the average number of points received as a function of deviations from the others' average contribution in the group. Figure 4 shows that in both *punishment* treatments negative deviations from the average are strongly punished. The number of points drop to almost 0 when the deviation is positive. On the contrary, the number of rewarding points is an increasing function of the deviation from the average. Surprisingly the average number of points appears to be almost constant once the deviation is positive. In both treatment conditions, *punishment* and *reward*, many more points are received in the nonmonetary treatments.

Figure 4 : Received points for deviations from others' average contributions

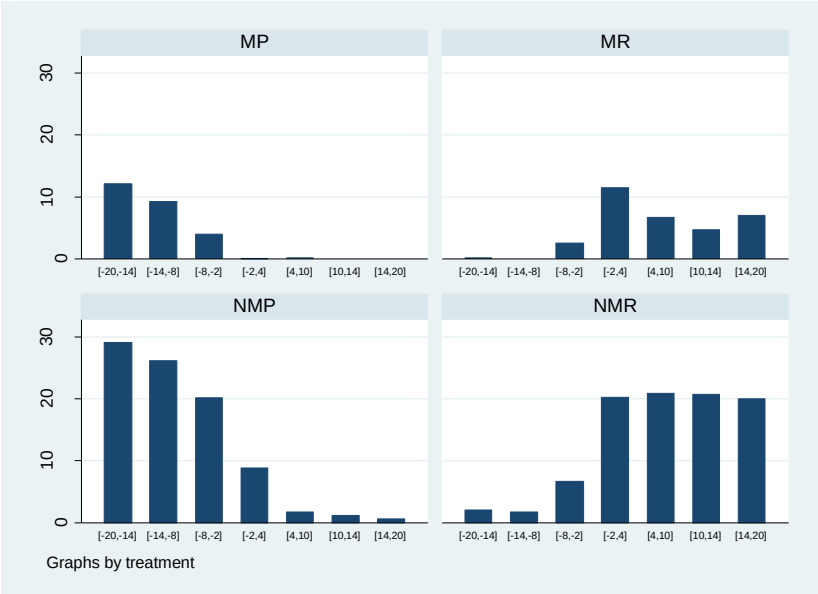


Table 5 presents Tobit regressions separately for the four treatments. The dependent variable is the total number of points received in each period by a subject and we introduce the others contributions and the deviation from these as explaining variables. As in Fehr and Gachter (2000), we consider positive and negative deviations. Indeed Figure 4 suggests that positive and negative deviations from the others' average contribution elicit different responses. The positive deviation is the actual deviation of a subject's contribution from the others' average in case that his or her own contribution is above the average. It is zero if the subject's own

contribution is equal to or below the others' average. The negative deviation is constructed analogously. In all four treatments, the absolute negative deviation is highly significant and the effect is negative for punishments and positive for rewards. Which means that, in *MP* and *NMP*, the more a subject's contribution falls short of the average the more that subject gets punished. On the contrary, in *MR* and *NMR*, the more a subject's contribution falls short of the average the less that subject gets rewarded. Results are similar with the positive deviation except that the coefficient for *MP* is not significant. The same applied for the others contribution variable. This tends to show that in the case of monetary punishment, it is only the negative deviation from the average that pushes to get punished.

Result 4: a) In MP and NMP, negative deviations from the others average contribution are sanctioned and b) in MR and NMR positive deviation from the others average contribution are rewarded.

Table 5 : Determinants of receiving points -Periods 1-15 – Tobit regressions

	(1) *MP*	(2) *NMP*	(3) *MR*	(4) *NMR*
Others total contribution	-0.049	-0.556***	0.233***	0.303***
	(0.049)	(0.130)	(0.034)	(0.055)
Positive deviation	-0.318	-2.199***	0.242**	1.832***
	(0.227)	(0.491)	(0.098)	(0.445)
Negative deviation	-1.508***	-4.292***	1.100***	1.330***
	(0.522)	(0.963)	(0.180)	(0.263)
Period	-0.496**	0.271	-0.106	-0.152
	(0.218)	(0.174)	(0.099)	(0.105)
Constant	-18.664*	11.874	15.496**	14.500*
	(10.813)	(21.160)	(6.712)	(8.784)
N	300	300	300	300

Notes: All regressions contain a control for the age, a dummy for gender as well as a dummy if the subject studies economics or management. Standard errors, clustered at the individual level, are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Finally, we can also look at the determinants of assigning points to the others. Figure 5 displays the average number of points given by periods in the four treatments. Not surprisingly subjects assign much more points when they do not cost anything. Also they assign much more points on average in the rewards treatments than in the punishments treatments. Remember than in *MR*, assigning points corresponds to a transfer of resources whereas in *MP*, assigning points cost to both subjects. Also it appears that there is a decrease

of monetary punishment overtime but an increase of nonmonetary punishment. Except of the last period, rewarding appears to be almost constant overtime.

Figure 5 : Average points given by treatment conditions

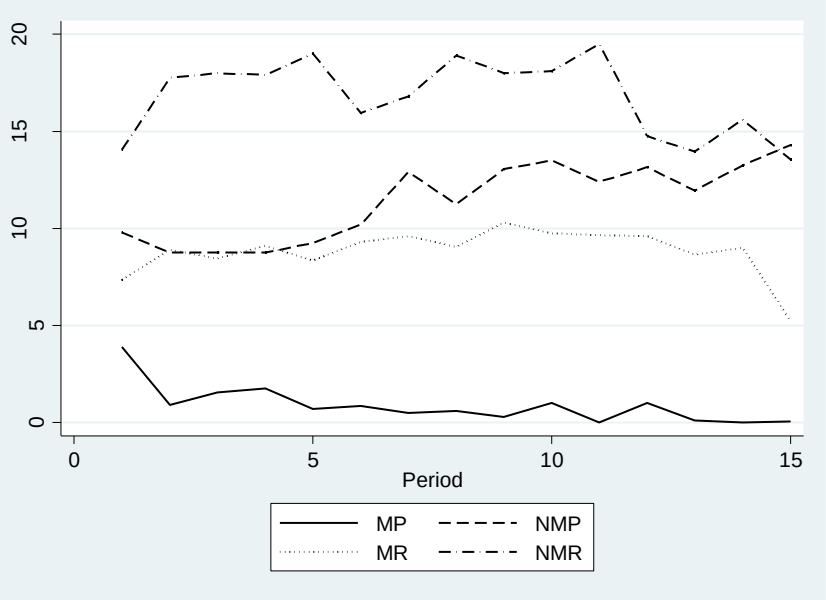


Table 6 explores the potential differences between treatments through a Tobit regression performed on individual decision to assign points. As in Table 5, we estimate one regression for each treatment condition. The dependent variable is the number of points assigned to each partner, going from 0 to 10, which explains the large number of observations by treatment. The main explaining variables are the deviation of the group's member contribution from the subject's own contribution and from the group's average. We also control for the total group contribution. In both *MP* and *MR*, when the other group's member is above the subject's own contribution, the number of points decreases. While it is trivial in the case of a punishment, it is surprising in the case of rewards. An explanation to this result may be that rewards are used as a cheering device so that those who are already high contributors do not need to rewarded and subjects prefer to reward positive but lower contributors. But what seems also important in the case of monetary rewards is the deviation from the group's average. When the group's member contribution is above the average, rewarding increases. On the contrary, in this case, punishment decreases. There is no significant impact of individual deviation in the case of *nonmonetary* points but we observe expected effects for the deviation from the average. The total group contribution positively impact the number of points assigned in *MR* and *NMR* and negatively in *NMP*; it is not significant in *MP*.

Table 6 : Determinants of sanctioning or rewarding behavior – Periods 1-15 - Tobit regressions

	(1) *MP*	(2) *NMP*	(3) *MR*	(4) *NMR*
Deviation from its own cont.	-0.358***	-0.078	-0.198***	-0.098
	(0.131)	(0.107)	(0.068)	(0.196)
Deviation from the average	-0.607*	-1.224***	0.638***	1.170***
	(0.317)	(0.161)	(0.116)	(0.290)
Group contribution	-0.005	-0.146***	0.126***	0.211***
	(0.021)	(0.041)	(0.024)	(0.050)
Period	-0.297**	0.165*	-0.093	-0.082
	(0.116)	(0.086)	(0.065)	(0.097)
Constant	-16.746**	0.247	5.475	-1.847
	(7.734)	(23.038)	(6.676)	(11.973)
N	900	900	900	900

Notes: All regressions contain a control for the age, a dummy for gender as well as a dummy if the subject studies economics or management. Standard errors, clustered at the individual level, are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Result 5: a) Subjects assign less sanction to those who contribute more than their own contribution or the group's average contribution but b) Subjects assign less reward to those who contribute more than their own contribution but assign more rewards when the contribution is above the group's average.

4. Conclusion

This paper investigates the long-lasting effects of various incentives in public good games. More specifically, it aims at comparing the effects of monetary and nonmonetary punishments and rewards. These incentives are shown to be effective in increasing contributions while they are applied. Once they are removed, we observe diverging results. In all treatments, the stop of the possibility to punish or rewards free riders do not lead to a direct dramatic drop in contributions but the duration of the effect is different among treatments. Especially rewards appear to have much longer effect than punishments and monetary incentives are more effective than nonmonetary ones. However we observe in all four treatments a kind of convergence to the baseline in the last period.

Our results show that having heavily punished lead some kind of revenge behavior, that in order to gain back what has been lost in the first periods. On the contrary, having been rewarded lead to some kind of delayed reciprocity which explains that we have longer lasting

cooperation in the rewards treatments. Then the importance of conditional cooperation explains that we have a faster decay in punishment treatments than rewards'.

The lessons from this experience reinforce the idea that some permanence effects can be expected in PES case studies and notably confirm Pagiola et al's results on long-term sustainability on changes induced by the contracts. Moreover, our results showing how reward (monetary but also non-monetary ones) can positively impact contributions to a public good, give some higher expectancy that biodiversity conservation can be done on a long-term period even when the payments have been stopped. Delayed reciprocity (or revenge behavior) can be compared to some learning or implementation of social norms at the neighborhood level that impact the decision to continue in the participation of biodiversity conservation (Chen et al, 2009).

Our finding leaves wide rooms for further research and new experiments. Given the important of reciprocity, it seems interesting to investigate the case of identifiable subjects within groups. The total convergence to the baseline in the last period is somehow striking and may be overcome by introducing a variable end that is not common knowledge.

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Appendix

Table A1 : Comparison of contributions: p-values from two-sided Wilcoxon rank sum test.

	MP	*NMP*	*MR*	*NMR*
Period 16	0.041	0.229	0.003	0.002
Period 17	0.068	0.040	0.052	0.027
Period 18	0.013	0.045	0.063	0.002
Period 19	0.059	0.395	0.036	0.007
Period 20	0.210	0.164	0.008	0.042
Period 21	0.009	0.187	0.005	0.012
Period 22	0.275	0.803	0.007	0.014
Period 23	0.709	0.488	0.029	0.095
Period 24	0.667	0.945	0.027	0.028
Period 25	0.487	0.738	0.159	0.446
Period 26	0.595	0.142	0.310	0.762
Period 27	0.361	0.878	0.966	0.253
Period 28	0.566	0.758	0.785	0.809
Period 29	0.510	0.358	0.189	0.489
Period 30	0.330	0.362	0.144	0.452

Note: Each cell displays the p-value of a comparison of average contributions in the Baseline and the treatment condition given in the top of the column.