THE PEN MIGHT BE MIGHTIER THAN THE SWORD: HOW THIRD-PARTY ADVICE OR SANCTION IMPACTS ON PRO-ENVIRONMENTAL BEHAVIOR

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The pen might be mightier than the sword: How third-party advice or sanction impacts on pro-environmental behavior

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Abstract

It is recognized widely that incentives can influence the cooperation among individuals in the provision of public goods. The aim of this study is to adapt a public good game (PGG) to the environmental issue of waste management. We report an experiment where the players have to cooperate in order to reduce the cost of waste sorting treatment, modelled as a decrease in the tax rate. We consider a traditional PGG involving groups of four players. A fifth player representing the third-party is introduced in the incentivized treatments. The third-party can provide advice about the desired individual contribution (Advice Treatment), or can punish collectively non-cooperative behaviors by increasing the tax rate (Sanction Treatment). Participants are asked also to perform an effort task to increase their given initial endowments. A social preference measure is introduced in the form of a social value orientation (SVO) test. We find that initially, advice, sanction and the threat of sanction significantly increase the average individual contribution level. However, applying a sanction has a stronger disciplinary effect. Also, we find results in line with Becker (1974)'s altruism hypothesis that under both sanction and threat of a sanction, high income individuals contribute more in absolute value than low income individuals.

Keywords: Waste sorting, Laboratory experiment, Advice, Sanction, Pro-social behavior
JEL Code: Q53, C91, D03

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1 Introduction

In essence, pro-environmental behaviors are pro-social. Although their objectives and outcomes may be invisible in the present, their social benefit will become evident and be experienced in the future. Experimental economics as a branch of economics, studies environmental behavior as a social dilemma taking the form of a public good game (PGG) in which the first-best allocation of resources is unachievable because of potential conflict between the immediate interests of the individuals and societies in which they are embedded. This introduces the need for game-theoretic considerations (the well-known free-riding problem) whose resolution may not serve the collective good.

In this paper, we adapt a repeated PGG to the environmental issue of waste management. To simulate this issue at the municipality level, we design an experiment with groups that include four contributors and a third-party that has the possibility to design an incentive system in order to increase cooperation, and therefore, increase social welfare. We designed an environment where the well-being (payoff) of the third-party is correlated to the contributors' well-being or payoff, based on the idea that in the context of a pro-environmental project state (societal) welfare is reduced in the case of low levels of contributions from the population.

We investigate two types of incentives in two separate treatments with random introduction into each group of a third-party player. The first type of incentive is free advice given by the third-party in order to increase the average level of the group's contributions (advice treatment - AT). The second type is a costly punishment implemented by the third-party consisting of a group tax whose level depends on the average level of the group contributions (sanction treatment - ST). The punishment is costly to the third party since its payoff is linked directly to the group's average payoff. Comparison of the behavioral repercussions in the form of individual contributions to the common good[1] will reveal the most efficient incentive to foster individual cooperation. We investigate the wealth effects for contributors by including an effort task which provides increments to their initial given endowments which can be perceived as being earned 'fairly'. We control for participants' pro-social preferences by considering four individual profiles (individualistic, pro-social, competitor, and altruistic) provided by the social value orientation (SVO) measure (Murphy et al., 2011).

This experimental strategy is in line with the literature on the effect of incentive taxation, and advice on individual pro-environmental behaviors such as waste recycling.

[1] The instructions given to the players inform them that the common good consists of a shared waste management mechanism, and that sharing the good means sharing its tax.

There is a large body of work in economics on household recycling behaviors but it consists mainly of theoretical (Brekke et al., 2003; 2010) empirical studies (Viscusi et al., 2011; Cecere et al., 2014), or field experiments (Schultz, 1999). To our knowledge, there are no lab experiments investigating this question. The related environmental literature discusses how to encourage or influence households to sort waste *via* the use of non-monetary (communication, nudges) and monetary (incentive pricing) incentives. For instance, there is discussion in the literature about how to encourage or influence households to adopt pro-environmental behavior. On the one hand, several studies show that incentive pricing, acting like a Pigouvian tax, increases the quantity of recycled waste (Fullerton and Kinnaman, 1996; Dijkgraaf and Gradus, 2004; Ferrara and Missios, 2012). Fullerton and Kinnaman (1996) are interested in the effect of the introduction of unit pricing on the amount of waste recycled, and find it results in a 16% increase in the weight of recyclable materials. Dijkgraaf and Gradus (2004) compare multiple forms of unit pricing (based on waste weights, waste volumes, bag collection and collection frequency), and show that systems based on weight and frequency are respectively 21% and 10% more efficient.

Since we are drawing a parallel between effective pro-environmental behaviors and social dilemma environments, we focus on the experimental literature on social dilemmas in general, and PGG experiments in particular.

Since the beginning of the 1980s, PGG experiments have been aimed at investigating individual behaviors in diverse institutional settings. Ledyard (1995, p. 116) describes a very simple institution: the *voluntary contributions mechanism* (VCM) which has been tested. It involves each subject contributing (privately – i.e. without any information about others' contributions) an amount of a private good to a common good. In this context, the total amount of the common good equals that which is producible from the total private goods contributed. Many variants of this simple institutional setting can be investigated: e.g., introducing the possibility of *ex-ante* or *ex-post* communication between subjects, rendering the individual contributions public, or allowing punishment in order to enhance cooperation (see Fehr and Gächter (2000)).

As already mentioned, the present paper focuses on two specific variants: a communication mechanism based on advice vs. increased taxation under the contingency of the introduction of a third-party that is informed about the level of the contributions made by the members of its group. The experimental literature on PGGs draws attention in particular to the impact of information provision. For instance, Fischbacher et al. (2001) show that individuals contribute more to the public good if they are informed that their partners' contributions have increased. The information provided by communication in

the group has also been studied. For instance, Chaudhuri et al. (2006) investigate communication in a laboratory experiment where the effects of three different forms of advice (private, public and common knowledge) are compared. They demonstrate first that contributions are higher in the presence of common knowledge advice, and second that punishing non-contribution behavior is not the only way to increase contributions. The more recent economics literature is showing an interest in another form of communication by investigating what are commonly referred to as *nudges*. In their contribution to what is referred to as choice architecture, Thaler and Sunstein (2009) define nudges as costless tools aimed at improving decision making and correcting behaviors, and note that "to be considered a nudge an intervention must be easy and cheap to avoid". As a non-monetary incentive, nudges are considered by economists to be an interesting alternative to avoid the perverse effects of monetary incentives such as fiscal crowding out for instance. This type of intervention has been extended to the environmental economics literature resulting in several published studies on waste sorting behavior[2]. As already mentioned, its low cost advantage makes the nudge a popular and especially valued tool for policy makers implementing pro-environmental incentive policies to promote green behaviors.

There is a large literature also on the impact of punishment opportunities as an incentive to maintain high levels of contribution to a public good. This body of work suggests that the opportunity to punish group members is usually helpful even when it is costly, or is implemented by a third-party (see Fehr and Fischbacher (2004) on dictator games or the prisoner's dilemma). Bowles et al. (2001) following Fehr and Gächter (2000) show that a considerable proportion of community members are willing to engage in a costly punishment in order to enforce a cooperative norm, even in the absence of any reasonable expectation of personal reward for their effort. This behavior is described as *strong reciprocity*, i.e., a predisposition to "co-operate with others and punish non-cooperators, even when this behavior cannot be justified in term of self-interest" Bowles et al. (2001, p. 425). These authors show also that a shirker's response to punishment by means of an increased level of contribution cannot be explained completely by the desire to avoid the reduced payoff caused by the punishment. Bowles et al. (2001) suggest that the behavior of shirkers is motivated also by the shame they experience when punished for violating a norm. Bochet et al. (2006) show that the willingness to impose costly punishments that affect other subjects' earnings applies mainly to low level contributors. In line with previous similar experiments, they conclude that punishment increases the level of contribution but if the cost of this punishment is taken into account, the net effect on efficiency is quite

[2]See Kirakozian (2016) for a review of behavioral and incentive policies for household waste management.

low. The implementation of punishments can also be delegated to third-parties. In a series of experiments, Fehr and Fischbacher (2004) examine the characteristics and relative strengths of second and third-party sanctions as well as the mechanisms of enforcement underlying social norms; they show that 60% of third-party punishments are directed to violation of cooperation norms. Almenberg et al. (2011) study costly punishment by a third-party, allowing the third-party to choose between punishing or rewarding players. Their results show a consistent and intuitive pattern: selfish behavior is punished, and generous behavior is rewarded, and costly rewards are at least as common as – if not slightly more common than – costly punishments. The preference for rewarding over punishing might be explained in part by fear of retaliation.

In this literature stream, the cost of punishment is fixed at an amount representing the cost of applying the punishment. Gürerk et al. (2006) investigate the advantages of a possible sanction applied by an institution with the sole objective of creating a contribution norm which will be adhered to by the contributors inside the group, and therefore, encourage low contributors. Gürerk et al. (2006) allow individuals to choose between operating in a sanction or a sanction free environment. Their results show that the contributions of individuals who switch from sanction free to sanction institution increase – going sometimes from extreme free riding to full contribution. In our experimental design, the third-party evaluates and decides about the need or not to punish the other players, knowing that its own payoff depends on that of its group members.

The paper is organized as follows. Section 2 describes the experimental design; section 3 presents the results, and section 4 concludes with a discussion.

2 The experiment

2.1 Experimental procedures

We conducted the computerized experiment in December 2015, at the LEEN laboratory in Nice Côte d'Azur University, France. The 252 participants were mainly undergraduate students recruited using ORSEE (Greiner et al., 2004). Depending on the availability of the participants, the sessions were conducted with three or four groups each. A total of 18 sessions were conducted in three different treatments.

The experimental procedure involved each subject on arrival at the LEEN Lab, drawing a number randomly which corresponded to the number on a computer in the room hosting the experiment. Once all the participants had been allocated to a computer, the

experimenter distributed written instructions[3], and also read them out loud and responded to any questions. No subject participated in more than one session, which allowed inter-group comparison of the recorded data. The experiment was conducted in French and computerized using the Z-tree software package (Fischbacher, 2007). The subjects were informed that the profits acquired in each step of the experiment would be measured in experimental currency units (ECU), and that their final payoff would be converted into euros at the rate of 1 euro per 10 ECU. Payments were made anonymously after the experiment. The average participant earned 13.6 euros, including a 5 euro show-up fee.

2.2 Treatments and parameters

Participants interact during 10 periods under a once-for-all random group matching protocol, for an average one hour duration. The experiment is based on a repeated PGG with n subjects, $n \geq 2$ ($n = 4$ for BT, $n = 5$ for AT and ST) and is composed of three treatments: baseline treatment (BT), advice treatment (AT) and sanction treatment (ST).

Table 1: Session composition (by treatment)

Treatment	Number of groups	Number of players by group	Total players
BT 'Baseline'	18	4 contributors	72
AT 'Advice'	18	4 contributors + 1 third-party	90
ST 'Sanction'	18	4 contributors + 1 third-party	90

Each session conducted for any of the treatments consisted of a series of 10 periods. We obtained a total of 720 observations for BT and 900 observations for the other two treatments (AT and ST).

All treatments include three stages: two preliminary common stages, and one specific stage. **The first stage** consisted of a personal social preferences measure based on "The ring measure of social values" (Murphy et al., 2011; Crosetto et al., 2012). This test, called the social value orientation (SVO) test, gives a magnitude measure of people's concern for others by studying the motivation underlying interdependent decision behavior, and assuming that people have different motivation levels when evaluating allocations between themselves and others. The SVO involves the subjects making 15 successive distributive decisions between themselves and an unknown other subject along a continuum of joint payoffs (see figure 6 in the appendix). A profile (altruistic, pro-social, competitor or individualist) was computed at the end of the task but not communicated to the subjects. The participants were told that one decision out of 15 would be selected randomly to

[3]English translation provided in the appendix 5

determine their payoff at the end of the first step, and that the ECUs earned at this stage would be added to those obtained in the other successive steps of the experiment.

In the second stage, the computer randomly assigns groups of four or five subjects depending on the treatment (see below). In the case of groups of five subjects, four are given an initial endowment of 5 ECUs, and the fifth participant is the third-party who does not participate directly in the PGG at this stage. A real effort task is implemented in order to increment the initial 5 ECU endowment of the four participants in the PGG up to a maximum of 10 ECUs depending on their performance. Building on Cherry et al. (2002)'s insights, we are mainly interested in the origin of endowments. This is the reason why we introduced this effortful marginal source of payoff. The rationale was that their endowments should consist of a mix of earned and windfall money which should increase their heterogeneity and induce stronger engagement of the participants in the experiment.[4]

A single screen was displayed with a number of "sliders" programmed in Z-tree (Fischbacher, 2007) (see 7 in the appendix). The screens were identical across runs and subjects. We chose this effort task because of its ease of understanding and lack of randomness and guessing which allowed us to identify the real effort invested by the subjects. The code implementing the slider task was based on that developed by Gill and Prowse (2012). It is presented as a screen of 20 sliders positioned at 0 and going from 0 to 100, where subjects can move the sliders to any integer location between and including 0 and 100, with the possibility to adjust and readjust these locations an unlimited number of periods during the allotted 60 seconds to reach exactly the value 50. The score points for the task are based on the level of effort exerted, with every four sliders correctly positioned being converted to 1 ECU which is added to the initial endowment.

In the third stage, one of the three treatments described below is allocated to different subjects (between-subject design).

In the BT, and to comply with the usual PGG experiments, each subject i decides simultaneously and without communication, how much of her total endowment d_i to contribute to the public good. This amount constitutes the private individual contribution, and is denoted by c_i with $0 \leq c_i \leq d_i$. The total payoff of subject i is defined as the sum of her initial endowment net of the amount of the private individual contribution $(d_i - c_i)$, with $d_i \in (5, 10)$, $c_i \in (0, d_i)$plus a share of the total contributions (including hers) of the members of her group. The instructions given to subjects informed them that the common

[4]Keser et al. (2017) in a linear public good experiment investigate endowment asymmetry and fair-share norms. They find that public good provision is higher when highly endowed subjects face a higher minimum contribution relative to their endowment than a player with a low endowment. This effect is due to the expressive power of the mandatory minimum of the idea of a fair-share among players.

good is a shared device (a refuse bin) which must be funded by all the group members. They were told also that the higher their contribution, the lower would be the tax applied to this common good. The function form of the utility function for agent i (see equation (1) below) is adapted from Andreoni (1993) and given by the equation below.

$$u_i = (d_i - c_i + (1 - \frac{1}{n}e^{-\beta\sum c_i}))^{\alpha}(\sum c_i + e^{-\beta\sum c_i})^{1-\alpha} \quad (1)$$

In (1), n is the number in the group, and β is the tax parameter which 0.5 in the Baseline treatment (BT) and equals to 0.01 for the (ST) if a sanction is applied. Note that a smaller β equates to a higher tax burden. The term on the left hand side of the utility function corresponds to the utility of agent i's private consumption. It is equal to the difference between the agent's total endowment net of that agent's contribution to the public good plus the quota-part of the tax burden imposed by the municipality in order to manage household waste collection. Note that 1 is added in order to ensure that the left hand side term is strictly positive. The term on the right hand side of the utility function represents the public externality of the contributions of the group to which the agent i belongs. The parameters α and β are set so as to comply with several Nash equilibria outcomes.

The game is based on the above payoff function although subjects were not provided with this formula in the instructions. Instead, they were given a set of two-way tables corresponding to each possible level of performance in the real effort task k (from k=5 to k=10), where the level of the private contribution (from 0 to k) is the column variable and the sum of the contributions from the other three active members of the group (from 0 to a maximum of 30) is the row variable (see e.g. figure 1 where $k = 5$). For example, a subject with an endowment of 5 ECUs has to decide about the amount (between 0 and 5 ECUs) that she will contribute, depending on personal preferences and the aggregate amount obtained from her and the other subjects' contributions. In this case, the maximum payoff (13.42 ECUs) for that agent for that period is given by a null personal contribution $c_i = 0$ and the maximum contribution from the other members of the group $\sum c_i = 30$. This third stage is repeated 10 times for the same group of participants with heterogeneous individual endowments fixed once for all after the real effort task performed in the second stage.[5]

[5]Individual endowments remain private information throughout the whole third stage while the average level of endowments is common knowledge in all treatments.

Table 2: Payoffs matrix for 5 ECUs of Endowment in the Baseline Treatment (BT)

My Contribution

The sum of the contributions of the other members of my group	0	1	2	3	4	5
0	2,4	2,79	3,04	3,08	2,85	2,23
1	3,07	3,41	3,57	3,5	3,17	2,44
2	3,74	3,99	4,05	3,89	3,47	2,64
3	4,38	4,53	4,5	4,25	3,74	2,83
4	4,97	5,03	4,91	4,59	4	3
5	5,51	5,49	5,3	4,9	4,24	3,16
6	6,02	5,92	5,66	5,2	4,47	3,32
7	6,49	6,33	6	5,48	4,69	3,46
8	6,93	6,71	6,33	5,74	4,9	3,61
9	7,35	7,07	6,63	6	5,1	3,74
10	7,75	7,42	6,93	6,24	5,29	3,87
11	8,12	7,75	7,21	6,48	5,48	4
12	8,49	8,06	7,48	6,71	5,66	4,12
13	8,83	8,37	7,75	6,93	5,83	4,24
14	9,17	8,66	8	7,14	6	4,36
15	9,49	8,94	8,25	7,35	6,16	4,47
16	9,8	9,22	8,49	7,55	6,32	4,58
17	10,1	9,49	8,72	7,75	6,48	4,69
18	10,39	9,75	8,94	7,94	6,63	4,8
19	10,68	10	9,17	8,12	6,78	4,9
20	10,95	10,25	9,38	8,31	6,93	5
21	11,22	10,49	9,59	8,49	7,07	5,1
22	11,49	10,72	9,8	8,66	7,21	5,2
23	11,75	10,95	10	8,83	7,35	5,29
24	12	11,18	10,2	9	7,48	5,39
25	12,25	11,4	10,39	9,17	7,62	5,48
26	12,49	11,62	10,58	9,33	7,75	5,57
27	12,73	11,83	10,77	9,49	7,87	5,66
28	12,96	12,04	10,95	9,64	8	5,74
29	13,19	12,25	11,14	9,8	8,12	5,83
30	13,42	12,45	11,31	9,95	8,25	5,92

The AT is almost identical to the BT with the exception that the common knowledge possibility of receiving advice from a third-party is introduced. This additional subject is called the *advisor* and is now selected randomly within each group of five subjects. The advisor must wait until the other four group participants have finished the effort task. The advisor then is given information about the average endowment of the contributors in her group, following which and thanks to a nudge, the advisor suggests an optional desirable level of individual contribution. The advisor does not contribute to the public good but gets a payoff corresponding to the average earnings of her group. This infor-

mation is common knowledge. As in the BT, the third stage is repeated 10 times with each group of participants who have heterogeneous individual endowments between 0 and a maximum of 10 ECU. The third-party/advisor can adjust the suggested level of the individual contribution at the beginning of each subsequent round.

In the ST, the third-party can sanction (rather than advise) by increasing (decreasing the value of the parameter β) the tax rate if the average level of the group's contributions is considered too low. As in the AT, the third stage is repeated 10 times among the same group of participants with heterogeneous individual endowments. The third-party can adjust the level of the tax rate at the beginning of each subsequent round. Note that our setting implies a costly punishment mechanism since the third-party can sanction by deciding to raise the tax rate. The positive correlation between the contributors' and the third-party's wellbeing seems realistic judging by the reduction in State wellbeing implied by low levels of contributions in a pro-environmental collective project.

2.3 Behavioral hypotheses

Our analysis examines the following hypotheses about the behaviors of contributors and third-parties:

Hypothesis 1 Advice and punishment incentives lead to higher rates of individual contributions (Bowles et al., 2001; Sefton et al., 2007; Masclet et al., 2003; Nikiforakis, 2008).

Chaudhuri et al. (2006) predict that a communication mechanism designed as advice or a recommendation will lead to higher levels of cooperation, and especially if the advice is common knowledge. They argue also that punishing free riders is not the only incentive that is efficient to enhance cooperation.

Many experiments show that high levels of public good provision are possible if participants' decisions are monitored, and their misbehaviors are punished by other participants (Fehr and Gächter, 2000; Bowles et al., 2001; Sefton et al., 2007). Bowles et al. (2001) expect that free riders who are punished respond by increasing their contributions in subsequent rounds. The authors develop an experiment in which team production is based on reciprocity which predicts punishment in equilibrium. They show that if some members violate the team contribution norm they are punished which increases the efficiency of team production. The authors provide empirical evidence that transferring residual clemency to the team increases the reciprocator's propensity to punish shirkers, and increases the productive efficiency of the team. Also, in the case of self-interested agents, we should expect costly sanctions to be more efficient compared to advice.

Hypothesis 2 Rich individuals contribute more than poor ones.

Under the altruism hypothesis, Becker (1974) predicts a higher contribution to the common good in absolute terms as individual incomes increase. However, some experimental studies challenge the assumption of altruism, and find no relationship between income and contribution. For instance, Buckley and Croson (2006) conducted linear public good experiments with endowment heterogeneity, and hypothesized that wealthier subjects would contribute more than poorer ones. However, they observed that less well-endowed subjects contributed the same in absolute amount as the more wealthy ones. The authors explain this result as an attempt by the former to compensate for the difference in incomes.

Hypothesis 3 Third-parties apply a constant level of punishment on free riders over time.

Following Fehr and Gächter (2000), we expect that allowing costly punishment prevents decreasing levels of cooperation. If it is assumed that advisors are self-interested, then punishment is not the best response because of its cost. In contrast, if the third party is a strong reciprocator as predicted by Bowles et al. (2001), punishing free riders for shirking should be constant over time, despite the consequences for payoffs. Fehr and Fischbacher (2004) hypothesize also that even if sanctioning is costly to the third-party and provides it with no economic benefit, third-parties may be willing to apply egalitarian distribution and cooperation norms.

3 Experimental results

In the first part of this section, we report the descriptive statistics of our data. We also provide non-parametric statistics based on STATA. The second part of the section presents the results of the regression analysis.

3.1 Descriptive statistics

3.1.1 *Main variables*

Table 3 summarizes the descriptive statistics of the contributions across the three experimental treatments. Considering the mean of the relative contributions (i.e., the absolute level of contributions over the 10 periods, divided by the level of the initial endowments), we observe subjects' average behavior in line with the findings in the literature. According to Ledyard et al. (1997) and Ostrom (2000), the typical level of efficiency of contributions in traditional PGG is between 40% and 60%.

Table 3: Statistics on relative contributions (by treatment)

Treatment	Observation	Mean	Standard deviation	Min	Max
BT 'Baseline'	720	0.39	0.27	0	1
AT 'Advice'	900	0.33	0.31	0	1
ST 'Sanction'	900	0.34	0.31	0	1

Table 4 synthesizes the general statistical characteristics of main individual variables in our analysis.

Table 4: Statistics descriptive

Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**
Endowment	6.49	0.98	5	9
Absolute Contribution	2.35	2	0	8
Relative Contribution	0.35	0.3	0	1
Average absolute contribution	3	1.1	0.25	6.67
Average endowment	7.19	0.81	6	9
Payoff	7.12	1.69	2.64	12.73
Pro-social	0.44	0.5	0	1
Individualistic	0.52	0.5	0	1
Competitor	0.04	0.19	0	1
Advice	1.53	2.63	0	10
Sanction	0.19	0.4	0	1

We see that the average amounts of the endowments and absolute contributions are relatively low. The sample is composed of individualists (52%), pro-socials (44%) and a small proportion of competitors (4%). We see also that the average amount of the advice is of 1.53 which is far below the average amount of endowment (6.5). We observe that on average, sanction by third-party subjects is imposed in only 19% of the periods.

3.1.2 *Evolution of the average absolute contribution over periods*

Figure 1 shows the average amount contributed to the public good in the three treatments, by period. We observe that the average contribution in the ST exceeds the average contributions for the other two treatments. The average contribution in the ST decreases from 3.6 ECU to 2.5 ECU in the BT. In the AT the average contribution is lower, starting at 3.4 ECU and decreasing in the last periods. The lowest average contribution which is observed in the BT shows a declining trend which is in line with the literature on PGGs. Figure 1 shows the endgame effects, from period 8 onwards.

Kruskal-Wallis equality of populations rank tests with means as observations, confirm

that the average contribution over the 10 periods differs significantly across the treatments compared. Therefore, we reject the null hypothesis that the contribution is the same for all three treatments ($X^2(3) = 41.492$, $p = 0.0001$). It seems that the possibility of a sanction from the third-party (ST) has a stronger effect than the provision of advice on participants' contributions. In sum, both advice and the threat of sanction enhance the average level of the contributions to the public good, with a stronger effect of threat of sanction.

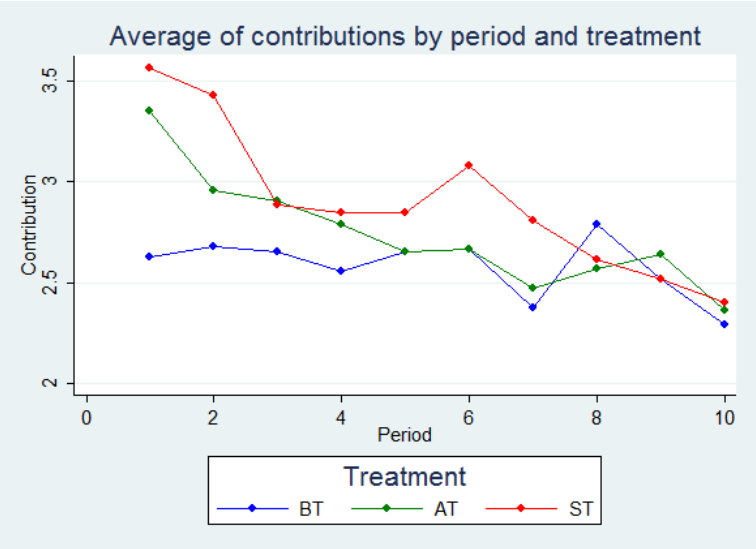

Figure 1: Mean of absolute contributions by periods

3.1.3 *Evolution of payoffs over periods*

Figure 2 shows the average payoffs for the three treatments and their trend over periods. It seems that the possibility of punishment has a significant impact on average payoffs, and that higher payoffs are observed in the case of the ST (Kruskal-Wallis test p-value = 0.0001). We have highlighted that the average contribution is higher for ST, and higher contributions lead to higher payoffs. However, in the case of the AT between the 5th and 9th periods, payoffs decrease to a lower level than in the BT.

3.1.4 *Wealth effects on contributions*

In contrast to PGGs where all subjects are provided with the same initial endowment, in our experimental design, the relative proportions of windfall and earned money, and therefore the total amounts of initial endowments vary across subjects (Kroll et al., 2007). This creates the potential for wealth effects. Figure 3 displays the absolute contributions

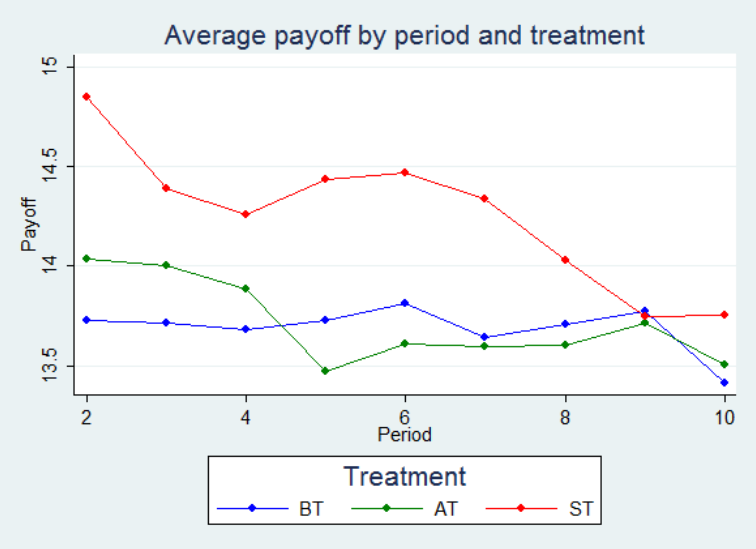

Figure 2: Payoff evolution by periods

depending on the wealth (endowment level), using a dummy variable *high wealth (low wealth)* for subjects with bigger (smaller) endowments than the average for their group. Individuals with relatively less wealth (compared to wealthier group members) contribute the same amount to the public good in the BT, contribute less in the ST, and contribute more in the AT. By splitting the sample between *high wealth* and *low wealth*, we can investigate whether the altruism hypothesis Becker (1974) holds. This hypothesis states that wealthier individuals contribute more in absolute value than poorer individuals. We test this hypothesis by comparing average contributions of the *high wealth* vs. the *low wealth*. Our results corroborate Becker's hypothesis in ST, thus contradicting the findings in Buckley and Croson (2006), according to which better-off individuals contribute the same as worse-off individuals. In a related work, Ledyard (1995) investigates the effect of heterogeneous endowments, and shows they have a negative effect on the group contribution. However, there is no consensus in the literature on this issue.

3.1.5 *Evolution of contributions depending on social preference profiles*

An interesting question to investigate is whether different SVO profiles impact differently on absolute and relative contributions. We hypothesize that pro-social individuals are likely to contribute a larger percentage of their income to the public good compared to individuals who are individualists or competitive. Figure 4 shows the average absolute and relative contributions for each social profile. It shows that competitive individuals contribute less in both absolute and relative terms than pro-socials and individualists.

Figure 3: Wealth effect on absolute contributions

The data indicate also that relative contributions levels do not differ significantly for individualistic and pro-social profiles. However, it appears that pro-socials tend to contribute more in absolute value.

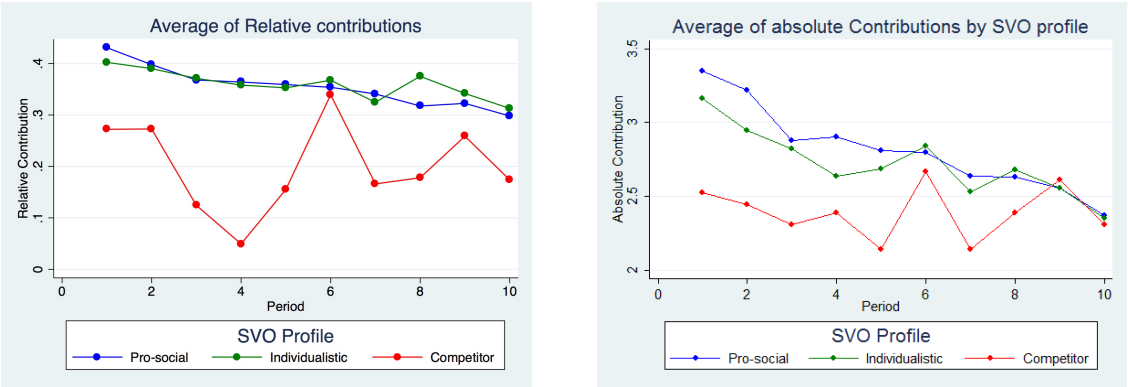

Figure 4: Absolute and relative contributions

In looking at SVO profiles across treatments (see figure 5), we observe that pro-socials contribute more than individualists and competitors in all three treatments. In the AT, competitors contribute slightly more than individualists but less than pro-socials. In the ST where there are no competitors, we find again that pro-socials contribute only slightly more than individualists.

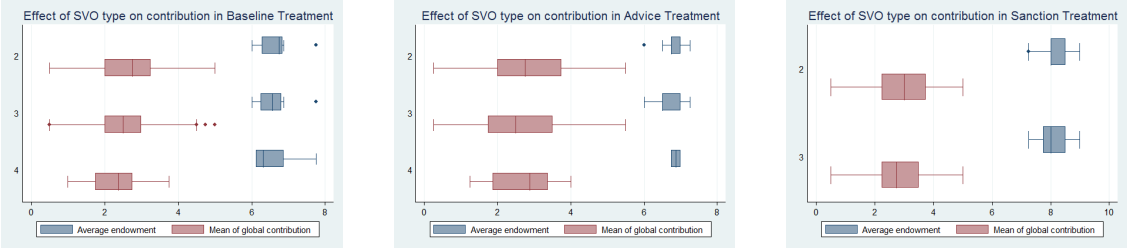

Figure 5: Social Value Orientation impact on contributions

3.2 Regression analysis

3.2.1 A negative binomial model of contributions

To confirm the interpretation in terms of aggregate numbers in the previous section, we conduct econometric analysis of individual decisions. Our experiment uses panel data for the decisions of participants over 10 periods. We want to estimate the impact of the AT and ST on individual contributions. We employ two estimations strategies. First, given the count nature of our dependent variable, we estimate a negative binomial model (NBM)[6], Second we conduct an ordinary least square (OLS) regression. In both models, we control for individual characteristics, and cluster the standard error around subjects[7]. Table 5 presents the variables used in the econometric analysis.

[6]The Poisson distribution has a few restrictive properties, one being that the mean and the variance of the process are equal. In our case $mean = 2.35$ and $variance = 4.02$. The NBM is a generalization of the Poisson model which allows for over-dispersion

[7]Given the qualitative nature of the variables in our estimation, the Hausman test cannot be used to choose between the fixed-effect (FE) and the random-effect (RE) methods for NBMs. If the Hausman test is rejected, this does not allow RE to be used (Baum, 2006). At the same time, the FE method is not appropriate because it drops important qualitative variables which are fixed along periods and among individuals.

Table 5: Variables of the econometrics models

Symbol	Definition
Dependant variables	
Contribution [1]	The amount of individual contribution to public good, from 0 to 10
Advice [2]	The amount of advice, from 0 to 10
Sanction [3]	1 if sanction, 0 otherwise
Independant variables	
Average contribution in $t-1$ [123]	The amount of group's contribution in the previous period
Average endowment in $_{t-1}$ [123]	The amount of group's endowment in the previous period
High Wealth	1 if the endowment is greater than the average group endowment, 0 otherwise
Pro-social [123]	1 for pro-social, 0 otherwise
Individualistic [123]	1 for individualistic, 0 otherwise
Competitor [123]	1 for competitor, 0 otherwise
Payoff in $_{t-1}$ [123]	The amount of individual's payoff in previous period
Advice [1]	The third-party amount of advice, from 0 to 10
Sanction [1]	1 if the third-party punishes, 0 otherwise
No sanction in T_2 [1]	1 if the third-party do not punish in treatment 2, 0 otherwise
No advice in T_1 [1]	1 if the third-party advice of zero in treatment 1, 0 otherwise

[1]see table 6, [2]see table 7, [3]see table 7

3.2.2 *Contributors' behavior*

Table 6 reports the results of the two estimations. Column 1 (NBM) shows that the average level of the contribution in $t-1$ has a significant effect on the amount of the individual contribution: An increase of 1 point in the level of the group contribution at period $t-1$ is associated with an increase of 19% in the individual contribution to the public good. The payoff at period $t-1$ is also significant. However, the sign is negative which means that an increase of 1 point in the individual's payoff at period $t-1$ decreases the individual contribution by 13%. As already emphasized, a novel contribution of the present paper is that it introduces a measure of individual SVO in order to investigate its impact on the individual contribution to the public good. Our results show that a pro-social and an individualist orientation make it respectively 71% and 63% higher compared to a competitive orientation if the individual contribution increase by one point. We highlight also that individuals with greater wealth endowments ($highwealth = 1$) contribute more than less well-endowed individuals: an increase of 1 point in the average individual contribution level is associated to a 52% increase in the level of wealth. In the case of advice, the models report a significant positive correlation: in other words, an increase of 1 point in the average individual contribution leads to a 4% rise in the level of third-party advice.

Economists generally advocate use of monetary sanctions to enforce cooperation. They argue that punishment, by reducing the expected payoffs of non-cooperative individuals, makes cooperation more profitable. However, experimental findings highlight the effect of motivation crowding out (Frey and Jegen, 2001) due to a non-monotonic relation between incentives and motivation (Gneezy and Rustichini, 2000; Fehr and Falk, 2002; Festré and Garrouste, 2015). Our experimental results show that both the effects of sanctions and its threat are positively significant since sanctioned subjects contribute 26 % more while non-sanctioned ones contribute 20 % more. These results run counter to the economic literature which assumes monotonicity of the relation between monetary incentives and efforts, and therefore, highlights the benefits of mainly tax policies (Masclet et al., 2003). In our case, by contrast, we do not rule out the crowding-out effect of monetary incentives(Andreoni, 1993).

Even more convincing, our results indicate that the threat of sanction exerts a disciplinary effect. The effect of the 'No sanction'[8] variable shows that the threat of being sanctioned while not being punished induces participants in the BT to contribute significantly more (20% more than non-threatened individuals). In their PGG experiment, Galbiati and Vertova (2008) argue for the power of punishment for enhancing cooperation, independent of the incentive mechanism. Similar to Masclet et al. (2013), we assume that the threat of sanction on its own, has a positive effect on contributions. In other words, *The pen might be mightier than the sword.*

3.2.3 *Third-party behavior*

Table 7 reports the results of two estimated regressions - NBM and marginal effects Probit models - to explain respectively the *advice* (in the AT) and the *sanction* (in the ST) issued by the third-party introduced into each group of participants in the PGG.

The results show that the individual profile does not affect the behavior of the third-party. However, the level of the advice is significantly affected by the average level of endowment of group members at period $t-1$. This means that an increase of 1 point in the average level of contributions and endowments translates into increases in the level of advice by 82%. In the case of sanctions (ST), there is no significant effect on the decision to sanction.

[8] variables Sanction and No sanction in ST considered at period t-1.

Table 6: Estimated models of the contributions

	NBM	OLS Model
Avg. group contribution in $t-1$	0.192***	0.586***
Avg. group endowment in $t-1$	0.0583	0.193
Avg. group payoff in $t-1$	-0.136***	-0.406***
Advice in t	0.0394***	0.121***
Null advice	-0.113	-0.228
Sanction $t-1$	0.265***	0.734***
No sanction	0.209**	0.565**
Baseline Treatment	*ref*	*ref*
High Wealth	0.224***	0.607***
Pro-social	0.717***	1.203***
Individualistic	0.635***	0.981***
Competitor	*ref*	*ref*
Constant	0.0137	0.674
R-squared		0.20
Number of observation	1944	1944

Legend: *$p < .1$; **$p < .05$; ***$p < .01$

Table 7: Estimated models of Advice and Sanction

	Advice		**Sanction**	
	NBM	OLS	Probit (ME)	OLS
Avg. group contribution in $t-1$	-0.148	-0.589	-1.349	-0.531
Avg. group endowment	0.824***	3.418***	-0.096	-0.0361
Avg. group payoff in $t-1$	0.136	0.588	0.903	0.355
Pro-social	0.213	0.824	-0.206	-0.0814
Individualistic	*ref*	*ref*	*ref*	*ref*
Constant	-4.949***	-22.36**	-2.740	-0.594
R-squared		0.129		0.024
Number of observation	162	162	162	162

Legend: *$p < .1$; **$p < .05$; ***$p < .01$

4 Discussion and conclusion

This paper set out to explore the relative efficiency of third party or advisor advice and sanction to promote public good contributions in an artificially constructed environmental context.

We designed an experiment that included three treatments in which the adviser's payoff is correlated to the payoff of the members of his or her group assigned randomly. The BT is a classical PGG. The AT includes the advisor who based on observation of the average level of endowments and the previous contributions of her group's members, provides a recommendation about the desired level of individual contributions. In the ST, the advisor can impose a collective sanction by imposing an increase in the tax rate.

The four main results of our experiment are summarized below. First, in line with the experimental literature on public good provision, we observe that individuals contribute more than predicted by theoretic models based on a pure self-interest paradigm. This divergence from the theoretical predictions is observed in a population with heterogeneous social preferences. We observed this tendency for the three social preference profiles reported. The experiment's pool of subjects included a larger proportion of individualist and pro-social individuals and a decreasing level of contributions along the periods, with the minority competitive subjects contributing significantly less than the other two types.

Second, for the relative impact of advice and sanction for promoting cooperation within groups, we found that advice has a positive impact on increasing cooperation but this effect fades over time. In fact, after a certain period, the advice incentive provides no added value compared to a no incentive situation. These results are in line with the findings in My et al. (2017) which uses a PGG to study the impact of nudges on environmental behavior. It shows a positive effect of nudges on individual cooperation. This increased cooperation is dependent originally on the individual's environmental sensitivity but fades over time.

Chaudhuri et al. (2006) explain that if the majority of subjects display conditional cooperation, this produces a social norm within the group which leads to high levels of contributions without the threat of sanction. However, we observed that pro-socials that benefited from advice (in the AT) contributed significantly less than pro-socials in the BT. This result can be interpreted as a crowding-out effect of advice on pro-social individuals' motivation either as a "looking-glass self" effect (Bénabou and Tirole, 2003), or as a denial of autonomy in self-determination theory (Ryan and Deci, 2000).

There is a large literature which shows mixed effects of sanctions such as taxation on cooperation in a public good. Our experiment results suggest that sanctions are efficient.

Moreover, they show that the threat of sanction is more efficient than advice (and more efficient than the situation without either advice or sanction) for promoting significantly higher levels of contributions in both the short and long run. This echoes the results of previous PGG experiments such as those where cooperation is increased without use of sanction as in Masclet et al. (2013) but where the threat alone (i.e., without its being applied) pushes individuals to increase the average level of their contributions significantly. The literature suggests also that the presence of an institution (such as our third-party) that can express disapproval of non-cooperative behaviors induces the minority of free riders to adjust to the behavior of the majority by increasing their contribution (Gürerk et al., 2006). Our data suggest that individuals punished in the ST increase their contributions. In line with results in Bowles et al. (2001), free-riders seem to be constrained by the shame of being sanctioned, and are influenced by the behavior of the majority of contributing partners.

Third, to estimate the impact of wealth heterogeneity on individual behavior, we analyzed absolute contributions as a function of participants' endowments. Our setting allows us to test the altruism hypothesis that wealthy individuals contribute more in absolute value than poorer ones (Becker, 1974). We observed that the population defined as *high wealth* contributed more in absolute value which confirms the altruism hypothesis but only in ST. However, in relative terms the contributions are not significantly different. It has been argued that wealthy individuals do not necessarily contribute more than less well-endowed ones because of an anticipated reciprocity effect (Cherry et al., 2005) where people expect reciprocation from their contributions. They are likely to contribute more if they believe that the other members of the group will also contribute more. Cherry et al. (2005) links this anticipation effect to the concept of conditional cooperation proposed in Fischbacher et al. (2001) who explain that an individual's contribution will be higher if she is optimistic about how much others will contribute. In our experiment, the *high wealth* subjects can infer information about the average endowments of group members, and thus, can appreciate that their partners cannot afford high levels of contribution, or at least not as high as they can contribute. Combined with the impact of incentives, these results show the importance of considering income heterogeneity when looking at the fairness of environmental policies and rules that impose the same contribution on all communities.

We analyzed the behavior of the third-party by looking at what determines the amount of advice offered, and the decision to impose a sanction. Table 7 shows that the amount of advice is a function of the level of the wealth (endowment) and the contributions of the subjects.

Fourth, in addition to interpreting the data from our experiment, we can highlight some policy implications of our behavioral findings. Our results could help to mitigate the detrimental impacts of State policy from the unanticipated individual reactions to incentives.

Our experiment suggests some ways to limit the welfare losses associated to the management of waste sorting framed as a typical social dilemma. The modified PGG experiment we designed shows that the threat of sanction from the advisor – here substituting for the State, is more efficient for promoting cooperation than mere advice. It would seem also that in contrast to what some believe, wealthy people do not systematically cooperate more (in relative terms). Similar behavioral results can be found in the empirical literature on waste sorting management.

For instance, Van den Bergh (2008) highlights studies that show that people are not motivated solely by monetary compensation and notes that non-monetary instruments are also effective inducing desired behavior. Therefore, by focusing on social factors such as social norms, peer pressure and intrinsic or extrinsic motivation we can change individual behaviors. It is for this reason that behavioral non-monetary incentives such as provision of *advice* are used by public authorities to encourage individuals to adopt socially desirable behaviors. Our experimental results show that non-monetary types of incentive in the form of free advice are as successful for increasing group members' cooperation although the effect is not persistent over time.

On the other hand, the study by Fullerton and Kinnaman (1996) shows that following the introduction of an incentive pricing mechanism, the weight of waste collected reduced by 14% while the volume and weight of recycled material increased by respectively 37% and 16%. As in our experimental setting, a tax incentive can be efficient for enhancing cooperation, and thus promoting pro-social behaviors. However, Fullerton and Kinnaman (1996) show also that after controlling for estimated illegal waste diversion, the decrease in collected waste weight was only 10%. This can be likened to what we describe as free riding behavior in our experimental study. Although the effect of incentive pricing mechanisms remains positive, Fullerton and Kinnaman (1996) propose several arguments against this type of incentive. First, the administrative and implementation costs are too high; and second, 28% to 43% of total waste is diverted away from legal waste flows (illegal dumping, depositing waste in the workplace or in neighbors' bins, and burning of waste). The low proportion of sanctions applied in our experimental setting (only 19% of the total rounds in the ST) can be interpreted as exemplifying the first limitation (the high cost of implementing a tax). Other studies have examined the impact of various incentive pricing

systems (based on waste weight, waste volume, bags and collection frequency) on the production of total, unsorted, compostable and recyclable waste (Nestor and Podolsky, 1998; Dijkgraaf and Gradus, 2004; Kinnaman and Fullerton, 2000; Ferrara and Missios, 2012). All these works shows the positive impact of various levels of monetary incentives in the form of taxes. Our experimental findings are in line with their results.

Policy makers could consider alternatives to monetary incentives such as advice which seems to have a degree of efficiency in driving behaviors in the desired direction - at least in the short term. However, much work is needed on the design of non-monetary incentive policy tools able to achieve long term sustainable behavioral change. From this perspective, our experimental results suggest use of sanctions in the form of the threat of an increase in the tax rate. They underline the complementarity of experimental studies to investigate individuals' behavioral responses to various types of waste sorting incentives.

5 Appendix

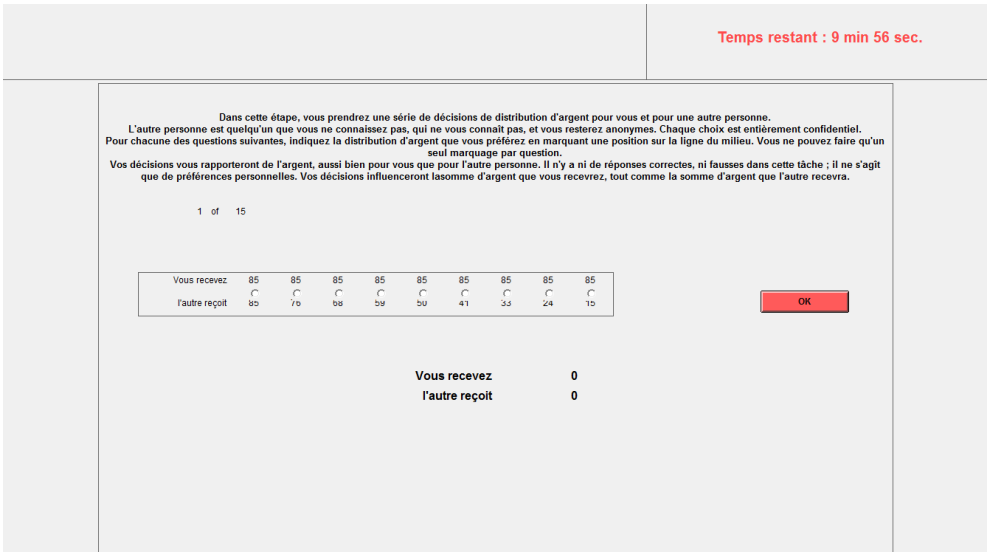

Figure 6: Social Value Orientation Test

English instruction: In this stage, you will take a couple of decisions about the distribution of ECUs to yourself and another person. For each of the following questions, please indicate the ECU distribution you prefer marking a position on the middle line. You are allowed to make only one decision. Your decision will earn ECU for you and for the other person. There are no right or wrong answers; it is a matter of personal preference.

Figure 7: Slider effort task (Gill and Prowse, 2012)

Instructions ***The following is the English translation of the instructions related to the baseline treatment (BT). The parts related to the advice and sanction treatments are in parentheses***

Welcome to the Nice Laboratory of Experimental Economics (LEEN - Nice Lab). You are going to participate in an experiment where your decisions will be anonymous, and in part will determine your final payment. Please read the following instructions carefully. In addition to the earnings accrued in the experiment, and depending on your decisions, you will be given a fixed sum of 50 ECU to cover your travel expenses. A variable amount will be added depending on the decisions made during the experiment. The total amount of your payoff will be paid to you at the end of the experiment and after you have completed a questionnaire. Payments are confidential in relation to the other participants and to ourselves. The currency used in this experiment is the experimental currency unit (ECU). However, at the end of the experiment you will be paid in euros according to the exchange rate: 10 ECU = 1 EURO. We ask you not to talk to one another for the duration of the experiment and to turn off your cellphones. Infringement of the rules means that the experiment will be interrupted and all payments canceled. If you encounter a technical problem, please raise your hand and wait for the experimenter to come to you. Everyone on the room has been given the same instructions and will participate in the same experiment.

The experiment consists of 3 steps.

Step 1: We propose an exercise in which you must decide anonymously about the distribution of payment for you and another person in the room but without knowing who this person is. You will be asked to indicate your preferred distribution of the money by marking a position on the middle line. There is no right or wrong answer; it is a matter of personal preference. In the example, one person chose to distribute the money so that he or she receives 85 units and the other person receives 33 units (see 6). You are allowed only one choice per question. You must answer 15 questions in total. Your decisions will earn you and the other person money. A period among the 15 will be drawn at random and this will define your payoff for that first part of the experiment. The conversion of points earned in this part of the experiment will be at a rate of 10 units = 1 ECU and added to the ECUs accumulated during the subsequent stages and converted into euros at the end of the experiment.

End of the first stage of the experiment

Step 2: You will be grouped randomly and anonymously with 3 other participants. The results and information gathered during the experiment will respect your anonymity. Each of you has an initial allocation of 5 ECU. During this stage of the game, you will be

invited to participate in a game that will allow you to increase this initial endowment. The amount of your total endowment will be between a minimum of 5 ECU and a maximum of 10 ECU depending on your performance during the next game.

[In the Advice Treatment participants in the PGG are told: You will be grouped randomly into groups of 5 players. Each group will consist of 4 contributors and 1 observer. The results and information gathered during the experiment will respect your anonymity; the third-party (the observer) is told: Your role is to observe the behavior of the contributors in your group. You will be informed of the average endowment of the contributors in your group. You then will advise them about the amount of their contribution to a common good. Contributors can choose whether to follow your advice or ignore it.]

[In the Sanction Treatment, after the random groups have been formed, participants in the PGG are told: You need to wait for the contributors in your group to complete a slider game. This will provide you with information on the average endowment of the contributors in your group.]

How to increase your endowment The game requires you to use the computer mouse to place a maximum number of the sliders at the center of each slide (see figure 7) to point to the number 50, in a maximum of 60 seconds. At the end of the allotted time, the number of best positioned cursors will be converted into ECU, at the rate of: 4 well positioned cursors = 1 ECU. In this example, the participant has managed to position 4 sliders on the slides, earning him 1 extra ECU. You can see that the cursors placed on the digits 49 and 51 have not been validated. The task is to set the value at 50 exactly! In this example, the endowment of this participant for the rest of the experiment will be equal to: 5 ECU + 1 ECU = 6 ECU, i.e., the amount in ECU allocated at the start of the experiment + the additional amount in ECU earned through play slides equaling the total amount in ECU to be used during the rest of the experiment.
End of the second stage of the experiment

Step 3: Now that your endowment has been increased, you have the opportunity to transfer a portion of it to contribute to a common good (e.g. a device to better manage household waste). The proportion that you decide to allocate to the common good potentially will reduce the total cost of waste management for your group. The greater the collective contribution, the greater the cost reduction. The experiment will be repeated ten times in succession (10 periods) within the same group.

Computation of earnings: To help you make decisions, please refer to the table for the amounts of your endowment. The following tables present a simulation of your earnings based on the amount of your endowment, the amount of your contribution and the total amount contributed by your group members. (see example in Table 2 for a total endowment of 5 in the baseline treatment)

[In the advice treatment, the third-party (the observer)is given the following information about her payoff: Your payoff is equal to the average earnings of the contributors in your group.]

[In the sanction treatment, the third-party (the observer) is told: Your role is to observe the behavior of contributors in your group. You will be able to sanction them collectively if you consider that the average contribution of the group to the common good is not sufficient. This penalty is costly to you since your payoff is related to the average contributor payoffs in your group. At the end of each round, you will be informed of the average contributions within your group. You will then be able to maintain earnings as they are, or apply the penalty of a higher tax rate. The experience will be repeated ten times in ten successive rounds with the same groups and the same roles in each group. *The contributors* are given the following information: To help you make decisions, please see the table for the amount of your endowment. The following tables present a simulation of your payoff according to: The amount of your endowment; The amount of your contribution; The amount of the total contribution of the members of your group. In summary: your total payoff will depend on: 1) the decision of the observer to exert or not the sanction, 2) the share of private gain linked to private consumption, and 3) the part of the individual gain resulting from the collective behavior of your group. It might be that this latter share outweighs the share associated to private consumption.]

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