Promoting socially desirable behaviors through persuasion and commitment: experimental evidence*

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Abstract

Through a series of experiments, this paper tests the relative efficiency of persuasion and commitment schemes to increase and sustain contribution levels in a Voluntary Contribution Game. The design allows us to compare a baseline consisting of a repeated public good game to four treatments of the same game in which we successively introduce a persuasion message, commitment devices,

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and communication between subjects. Our results suggest that these non-monetary procedures significantly increase cooperation and reduce the decay of contributions across periods.

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1 Introduction

The vast literature in behavioural and experimental economics has long emphasized the question of contributions in social dilemmas. Indeed, in many contexts, individuals face a trade-off between self-interest and group interest, and so-called free-riding is a pervasive phenomenon of social life. Well-known examples of situations involving such trade-offs include biodiversity conservation, depletion of common resource pools, tax compliance, charitable giving or private provision of public goods. As pointed out by Drouvelis (2021), social preferences play an important role to understand the individual decision to contribute to a public good or donate to a charity. An important question is therefore how to promote contributions in these situations and there is now a large body of literature that shows how various incentives could achieve higher levels of cooperation[1]. However, these incentive programs are costly to implement and even sometimes backfire (Gneezy et al., 2011); this in turn has drawn attention to the modalities of non-financial devices. In particular, laboratory experiments on public good games have shown how non-monetary incentives can be effective in increasing voluntary contributions and inducing pro-social behavior across a number of situations, as we see, among others, in the effect of nudges (Altmann and Falk, 2009; Liu and Riyanto, 2017), social interactions (Rege and Telle, 2004) and awards and disapproval (Sefton et al., 2007; Dugar, 2013; Masclet et al., 2003).

Social psychology has long pointed out the effects of procedures that induce peo-

[1]See Drouvelis (2021) and the surveys by Ledyard (1995) and Chaudhuri (2011) on the effect of various type of incentives to increase contribution to public goods.

ple to willingly change their behavior. The Theory of Planned Behavior (Ajzen, 1991) has demonstrated that behavior is often a direct outcome of intention. Since this attitude is affected by social interaction through subjective norms[2], one may modify behavior by introducing normative statements or commitment devices that act on intentions (Simons, 1976; Kiesler, 1971; Joule et al., 2007b). These interventions can take various forms but the most common are persuasive messages such as communication and prevention campaigns, self-enforcing agreements, and binding communications. Examples of information and persuasion are religious and moral suasion, smoking prevention campaigns, and recommended contributions in fundraising campaigns. Well-known examples of commitments are self-enforcing international environmental agreements.

Although previous research has demonstrated that people's attitudes and behaviors can be altered via interventions such as those mentioned above (Girandola, 2003), so far little is known about their effects when the economic payoffs of some behaviors are involved, particularly when considering cooperation in social dilemmas (Drouvelis et al., 2015). Yet it appears to be important for economists to know whether persuasion messages and commitment devices can have significant impact on cooperative behaviors in situations in which free-riding is important. The frequency with which social dilemmas occur in economic and social life makes them an important object for empirical investigation. Furthermore, given present economic conditions and the strain on both public and private finances, there is a fairly urgent need to implement mechanisms to increase contributions that incur at either little

[2]Subjective norms rest on beliefs about the normative expectation of what behavior is important or appropriate for others.

or no cost.

In this paper we report on a series of lab experiments designed to measure and compare how persuasion and commitment schemes affect contributions in situations where we encounter social dilemmas. As noted by Chaudhuri et al. (2006), the linear public goods game is an excellent vehicle for understanding the inherent tension between cooperative and competitive behaviour in social dilemmas.[3] We therefore use a Voluntary Contribution Mechanism (VCM) played by groups of four subjects in a finitely repeated environment to see how the introduction of a persuasive message or a commitment device affects contributions to a public good. In a between-subjects design, we implemented five treatments: (i) a baseline treatment made of a Voluntary Contribution Mechanism (*Baseline* hereafter); (ii) an "information" treatment where the benefits gained by the members of the group for contributing is displayed to subjects (*Information*), prior to participating in the VCM; (iii) a "low commitment" treatment where subjects are asked to declare their personal opinion on the benefits of contributing (*Declaration*); (iv) a "high commitment" treatment in which subjects are asked to declare their personal opinion on the benefits of contributing and to sign this declaration (*Commitment*); (v) a "promise" treatment where they are asked to declare to their group members if they commit to contribute or not (*Promise*).

Our experimental design follows a natural path from persuasive information to binding communication. According to persuasion theories, one can generate a change in an individual's attitude toward a situation by introducing normative statements that act on attitudes and align intentions and behavior (Simons, 1976; Girandola,

[3]See also Alm and Jacobson (2007) for a survey of the use of lab experiments in public economics.

2003; Bromberg and Trognon, 2006). However, persuasive messages have been shown to have a limited effect in some situations (see e.g. Randall and Wolff, 1994). Informing and convincing may not be enough to change behavior. Thus the social psychology theory of commitment (Kiesler, 1971; Joule and Beauvois, 1998) introduces one further step. A commitment is defined as a "binding of individual to behavioral acts" (Kiesler, 1971, p.30). By introducing preparatory actions that freeze the system of possible choices, one can induce a predictable change in the resultant decision. More than with information, one can expect people to be consistent with their initial commitment[4]. This commitment is expected to enhance the power of cheap talk communication, thereby reducing strategic uncertainty and facilitating efficient coordination (Jacquemet et al., 2018). A commitment procedure can take various forms and be manipulated to increase its level; the important factors being the visibility of the act and the reasons for the act. This is why we vary the treatments, besides the baseline, from a weak commitment device with a simple declaration of opinion (*Declaration*) to a strong commitment procedure with a signed declaration (*Commitment*)[5]. Our last treatment (*Promise*) relies on binding communication and can be situated at the intersection between persuasion and commitment (Joule, 2000; Joule et al., 2007b). It associates the realization of a consistent preparatory act with a subsequent persuasive message and in addition to expressing a social norm it raises

[4]In the seminal low-ball experiment, Dialdini et al. (1978) showed that when subjects are asked for their willingness to perform a targeted behavior before knowing the full costs of that behavior, it increases compliance relative to cases in which people are asked to perform the targeted behavior directly.

[5]Signing a document has been found to affect behaviors even in cases in which violating the contract was legally and economically inconsequential (see i.e. Mazar et al., 2008; Kettle and Haubl, 2008).

reputational concerns and reinforces the moral cost of deviating. This is the preliminary declaration towards the others that act as a binding context. It then allows us to disentangle the effect from the simple commitment device.

To our knowledge this paper is the first to report a laboratory study of the comparative effects of those interventions in social dilemmas. While lab experiments have shown that priming is effective in increasing contributions to a public good (Drouvelis et al., 2015), moral messages or contribution recommendations in these experiments have displayed limited or no effects (Croson and Marks, 2001; Dale and Morgan, 2010; Dal Bo and Dal Bo, 2015; Chaudhuri and Paichayontvijit, 2017). However, the research cited never provides a message about the groups welfare[6], when in fact a social message might be more effective as a moral suasion technique in changing expectations and preferences (Joule et al., 2007a). We therefore introduce a direct link between the subjects contributions and the welfare of the groups members in the *Information* treatment. Recent literature has been interested in applying theories of commitment to economic issues (see i.e. Jacquemet et al., 2013, 2018; Hergueux et al., 2022). In particular Hergueux et al. (2022) find that a solemn honesty oath increases cooperation in a one-shot public good game. However, contrary to our experiment, their oath does not consist of stating any preferred behavior and does not therefore possess an expressive function designed to change social preferences. Finally, cheap talk between players has also been shown

[6]Dal Bo and Dal Bo (2015) included two messages with distinct moral content. One message stated that moral actions are those in which one treats others as one would like to be treated in turn. The other stated that actions are moral to the extent that they contribute to maximizing collective payoffs. Chaudhuri and Paichayontvijit (2017) exhort participants to contribute their entire endowment to the public good.

to improve cooperation and enforce desired behaviors (see Dawes et al., 1977; Isaac and Walker, 1988; Kerr and Kaufman-Gilliland, 1994; Bochet et al., 2006; Bochet and Putterman, 2009; Bhanot, 2017; Di Bartolomeo et al., 2017)[7]. But in particular, promises may enhance trustworthy behavior (Charness and Dufwenberg, 2006; Charness et al., 2013) and enhance the power of communication in the form of cheap talk. In a public good game, Oprea et al. (2014) find that chat communication may enhance cooperation but is dependent on the time being discrete or continuous. However, Denant-Boemont et al. (2011) show that requiring individuals to make a non-binding prior public announcement about their contribution level has no significant effect on average contributions.[8] Binding communication through a formal commitment procedure may thus be effective.

The scope of this paper is thus to present the first comparative results of these behavioral interventions in contribution in social dilemmas and provides insights into their effectiveness in achieving social objectives at a minimal cost and in a decentralized manner. Our results are twofold. First, we determine that the proposed procedures (except the commitment) on average significantly increase the level of contributions. The most effective devices are *Information* and *Promise*. This result is the outcome of an increase in the proportion of those contributing fully and a decrease in the proportion of free riders. Second, we show that in the four treatment conditions, the decay of contributions across periods is reduced in comparison with the *Baseline*. This is especially true of the two committed mechanisms: *Commitment*

[7]See also the meta-analysis by Balliet (2010) on communication and cooperation in social dilemmas.

[8]In a lab experiment on tax compliance, Koessler et al. (2019) also find that offering the possibility to make a promise does not lead to a change in compliance behavior.

and *Promise* in which the proportion of zero contributors is highly reduced.

The rest of this paper is organized as follows: section 2 outlines a detailed description of our experimental design; section 3 presents our main predictions for each treatment; the results are presented in Section 4; and a final section discusses and concludes the paper.

2 Experimental Design

The experiment consists of a repeated Voluntary Contribution Mechanism (VCM) played by fixed groups of four subjects for 30 periods. As outlined above, we consider five different treatment conditions: *Baseline*, *Information*, *Declaration*, *Commitment* and *Promise*. Subjects play the same VCM in all treatments. At the beginning of each period, subjects receive an endowment of 20 tokens each and each subject must decide, simultaneously and without the possibility of communicating with the other group members, how many tokens they want to keep for themselves and how many tokens they want to allocate to a group account. Each token contributed to the group account yields a payoff of 0.4 tokens to each of the four members of the group. Therefore the earnings of individual i who contributes c_i to the group account in a period are expressed as:

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

At the end of each period, subjects know from all group members including themselves. Given that the cost of contribution to the group account is one token and

the private return is 0.4 tokens, a subject that cares only about her monetary payoffs and is fully rational should not contribute and should only rely on the contribution of other group members.

2.1 Treatments

The *Baseline* treatment replicates this standard repeated VCM for 30 periods. In the four other treatments, we implemented four different information and commitment rules. Although each provided different kind of incentives, these four treatments were implemented in a similar way[9].

In the *Information* treatment, before the repeated VCM started, the subjects were provided information on an individual sheet of paper stating explicitly that "*In each period, contributing to the group project increases welfare of the group's members.*" Following this, the participants played 30 periods of the VCM as in the *Baseline*. Assuming that subjects care only about their monetary payoffs and are fully rational, they should not contribute to the public good. However the message is general and pushes forward the benefit for the group to contribute. The goal is to emphasize the public good dimension of the group project. This constitutes the simplest definition of persuasion. Subjects receive information on what is good for the group while they know that it is not in their interest to contribute.[10]

[9]Detailed instructions and the specific procedures for each treatment are presented in the appendix.

[10]It is important to note that if the subjects do not understand all the rules of the game, they could be wrongly influenced by the message because it is in their own sake not to contribute when the others do. To ensure that everybody understand the public good game, participants had to answer a set of control questions and the game could only start after all had answered correctly to all questions. Some questions were specifically dedicated to the payoffs calculation and group contributions (these control questions are available upon request).

In the *Declaration* treatment, every subject was asked to make a simple statement. They received a sheet of paper on which they had to make a choice before returning the sheet to the experimenter. The choice was: "*In each period, I consider that contribution to the group project is important in order to increase welfare of the group's members: yes/no*". This declaration was gathered by the experimenter and the answer was kept from the other participants. It was also made clear that this information was not kept by the experimenter after the experiment. Thus in this treatment, a low commitment strategy is applied with a simple expression of an opinion.

In the *Commitment* treatment, the process was similar to that of the Information treatment except that the subjects had to formally sign a statement whereby they would commit (or not commit) to contribute to the group project. The statement read: "*In each period, I commit to contribute to the group project in order to increase welfare of the group's members: yes/no + signature*". As for the declaration, they are gathered by the experimenter and their content was kept secret from the other participants. Here the commitment is strong and requires a signature, a device that has been found to be effective.

Finally, in the *Promise* treatment, the procedure is the same as for the commitment except that the commitment is transmitted to each member of the group and only to the members of the group. This information remains anonymous and the members of the group cannot identify the individual promising to contribute. They know, however, how many members of the group have promised to contribute. This

last treatment, introduces visibility to the act of commitment[11].

Given our design we may face issues related to an experimenter's demand effect on two levels. First, as Zizzo (2010) and De Quidt et al. (2019) have shown, interaction between the experimenter and the participants can result in deviations from the choice the participants would select in the absence of the experimenter. In order to avoid facial expressions or gestures that might subconsciously convey desired behavior to participants, the instructions were read aloud by a person external to the research project[12]. Then all interactions related to the distribution of instructions and messages were also delivered by research assistants that left the room directly after the start of the experiment. All participants decisions remained anonymous once the experiment had begun. Second, asking subjects to sign a statement saying that they commit to contribute may also introduce a bias if the experimenter is seen by subjects as an authority whose instructions should be followed. Indeed, Karakostas and Zizzo (2016) points out that subjects often view the experimenter as being in a position of authority due to its legitimacy and expertise about the experimental environment. In the context of our experiment, it can be a problem if participants felt obliged to sign because they think this is what the experimenter expects. As Joule et al. (2007b) explained, the commitment is created through a volitional action. That is the initial task (filling the form) and subsequent behaviors are done

[11]This is also why we have implemented a partner design in all treatment conditions. In Promise, a subject makes a promise to the members of her group that has the same composition all along the periods. To keep comparability between treatments, we consider a partner design in all conditions

[12]In actual fact, the lab manager at the experimental Economics Laboratory of Strasbourg usually read the instructions, thus avoiding interaction between subjects (mostly students) and professors who were possibly known to them. De Quidt et al. (2019) note, however, that there is little evidence that gestures and pitch can alter behavior.

freely by the subject (Kiesler, 1971; Joule and Beauvois, 1998); the so-called free will compliance. In order to control for that, when distributing the forms, research assistants explicitly pointed out to the subjects that they were free to declare and/or sign or not, and that participation was not conditional on declaring or signing the form. Furthermore, when they filled the form they could always choose between the "yes" or "no" answer. In our experiment, everybody agreed to fill the form and a majority answered "yes" (see below). This allowed us to investigate the effect of the treatment rather than its combined effect with potential self-selection.

2.2 Procedures

All sessions were conducted at the University of Strasbourg and in total 200 subjects participated in ten sessions (two for each treatment condition). The subjects were recruited from a list of experimental subjects maintained at the Experimental Economics Laboratory of Strasbourg using the ORSEE software (Greiner, 2015).

The experiment was computerized. Upon arrival, each subject was assigned a computer at random. The instructions were read aloud and, before starting, a comprehension questionnaire was administered to ensure that the rules were well understood. All questions were answered in private. Once the 30 periods had been completed, the screens displayed the total cumulative gains for the experiment and the subjects answered a post-experiment questionnaire. In the questionnaire we asked for some usual information such as sex, age, country of origin, field of study as well as some questions on their risk preferences and trust in others[13]. At the end of the

[13]The list of questions is presented in the appendix.

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 €24.9 (standard deviation = 4.4).

Table 1 presents some demographics of our sample by treatment. In total, 54.5% of the subjects are female and there are no significant differences between treatments (according to a two-sample test of proportions). The average age is 22 years old and we observe a significant difference (according to a Two-sample Wilcoxon test) in age between *Baseline* and *Information* (p=0.0150), between *Baseline* and *Commitment* (p=0.0052), between *Baseline* and *Promise* (p=0.0005) and between *Declaration* and *Promise* (p=0.0024). The proportion of students in economics is also different (according to a two-sample test of proportions) between *Baseline* and *Information* (p=0.0125), between *Baseline* and *Declaration* (p=0.0237) and between *Baseline* and *Promise* (p=0.0247). There are no significant differences among treatment for the proportion of subjects who declare to take part into volunteering activity, trusting the others or for the average level of declared risk preference. However some of these significant differences justify that we control for these observables in our econometric analysis in order to avoid selection bias (see the results section).

3 Behavioral hypotheses

Assuming that subjects care only about monetary payoffs and are fully rational, they should not contribute in the *Baseline* since free-riding is a dominant strategy. However we know that we can expect positive contributions in the *Baseline* followed

Table 1: Treatment information

	Baseline	Information	Declaration	Commitment	Promise
Nb groups	10	10	10	10	10
Nb subjects	40	40	40	40	40
% Female	55.0	62.5	52.5	52.5	50.0
Avg. Age	22.6	21.45	22.83	21.63	21.03
% Volunteer	37.5	42.5	30.0	37.5	41.0
% Economics	55.0	27.5	30.0	37.5	30.0
% Trust	65.0	50.0	52.5	60.0	54.0
Risk aversion	5.75	5.525	4.8	4.925	4.975

Note: % Volunteer is the % of subjects who declare to take part to volunteering activities. % Economics is the % of students studying economics or management. % Trust is the % of subjects who declare to easily trust others. Risk aversion is the average value of the individual answers to a question about risk aversion on a scale that goes from from 1 (no risk at all) to 10 (loving risk).

by a continuous decay until the last period due to the presence of conditional cooperators (Chaudhuri, 2011). This unstable cooperation may be fixed in the four other treatment conditions in which we introduce persuasion and commitment devices but to varying degrees.

There is evidence to suggest that persuasive messages are successful in enhancing cooperation. A message exhorting contribution may affect participants preferences by raising the level of contributions they deem to be appropriate and thus raising the utility weight on meeting that level (Dal Bo and Dal Bo, 2015). The message may also change participants expectations about others by raising optimism about how their fellow subjects might contribute (Fischbacher et al., 2001). However, this effect has been shown to be dependent on how participants value the public good and on the specific content of the message (Croson and Marks, 2001; Dale and Morgan, 2010; Chaudhuri and Paichayontvijit, 2017). In particular, in a linear public good game Dale and Morgan (2010) show that recommendations favoring the social

optimal contribution worked less well than recommendations favoring intermediate contributions.

Prediction 1 *In* Information*, our neutral suggestion is expected to a) increase contribution and thus b) lead to higher group contributions than in* Baseline*.*

Joule and Beauvois (1998) have pointed out that, by binding individuals to behavioral acts, commitment procedures should be more effective than information in inducing specific behavior. Through the introduction of a prior action that freezes the system of possible choices, the individual is focused on the behavior directly related to her decision. This makes the effect much stronger than simple persuasive messages (Joule et al., 2007b). We thus expect the prior action to induce people to be consistent with their initial commitment to contribute in subsequent periods of the game. As indicated by Jacquemet et al. (2013), we would expect this commitment to enhance the power of cheap talk, thereby reducing strategic uncertainty and facilitating efficient coordination. Both *Declaration* and *Commitment* should lead to higher contributions than *Information*. But Jacquemet et al. (2013) also emphasize that the magnitude of the behavioral effects of committing oneself to a particular task depends on a subjects degree of commitment. Since commitment is a continuous rather than a dichotomous variable Kiesler (1971), *Commitment* should be more effective than *Declaration*.

Prediction 2 *Both* Declaration *and* Commitment *are expected to a) reduce the level of free-riding compared to* Information *and thus b) lead to higher group contributions*

Cheap talk and non-binding communication have often been found to be effective in increasing contributions in public good games (Isaac and Walker, 1988; Palfrey and Rosenthal, 1991; Bochet et al., 2006; Palfrey et al., 2017). In our *Promise* treatment, the declared intentions that we considered as promises are cheap talk since the introduction of promises does not affect the gains. However, this information becomes common knowledge before the beginning of the game and thus, as pointed out by Joule (2001), makes the context "binding" because of the public character of the act. This should make the effect of the commitment procedure stronger as subjects strive to live up to the expectations of others so as to avoid feeling guilt (Charness and Dufwenberg, 2006).

Prediction 3 Promise *is expected to reduce the level of free riding compared to* Commitment *and thus b) lead to higher group contributions*

Finally these four mechanisms induce the subjects to change their behavior by affecting their subjective norms. This means that they tend to change individuals' attitude toward some situation. Communication policies as non-monetary incentives are less affected by crowding out of intrinsic motivations or a potential change in behavior determinants (Frey and Jegen, 2001; Lefebvre and Stenger, 2020). Commitment procedures have also been shown to affect future behaviors (Girandola and Roussiau, 2003). Commitments make the act more stable by freezing and priming effects (Joule and Beauvois, 1998). Thus we expect the four treatment conditions should have some long-lasting effects such that they should reduce the decay of contributions through time compared to the baseline.

Prediction 4 *All four treatments are expected to reduce the decay of contributions in comparison to the baseline.*

4 Results

We present the results in two steps. in a first step, we present results pertaining to contribution at the group level. This is to account for interdependence of outcomes for members of a given group. In a second step, we illustrate the individual choices of contributing to the public good to identify the effects of the treatments on free-riding behavior and full contribution.

4.1 Group contributions

Table 2 presents the average contributions by group in each treatment with the standard deviation. The lowest average contribution is observed in the *Baseline*. Table 2 also shows that on average the highest contribution is observed in the *Information* treatment. The second highest level is observed in the *Promise* treatment and the lowest level of contributions is to be found in the *Commitment* treatment [14].

We test first for significant differences with the *Baseline*. Unless specifically noted, we report the significance levels of a two-sided Mann-Whitney rank-sum test taking group averages as the unit of observation (so that there are ten observations for each treatment). The contributions are considerably higher in *Information* (p=0.0032), *Promise* (p=0.0025) and *Declaration* (p=0.0413) than in the *Baseline*.

[14] Table A.1 in the appendix also presents the average contribution of each group in each treatment separately. It shows heterogeneity among groups but still displays similar ordering of the treatments.

Contributions in *Commitment*, however, are not significantly different from the Baseline[15]. The effectiveness of *Information* confirms *Prediction 1.* However *Declaration* and *Commitment* are not significantly different than *Information* (p=0.4497 and p= 0.1124 respectively) which contradicts *Prediction 2.* Moreover contributions in *Promise* are not significantly different than in the three other treatment conditions. This contradicts *Prediction 3.*

The results point out the effectiveness of two different devices, *Promise* and *Information*, in improving cooperation in social dilemmas as already demonstrated in research to date (Burger, 1999; Ellingsen and Johannesson, 2004; Charness and Dufwenberg, 2006; Dal Bo and Dal Bo, 2015). Surprisingly, *Commitment* appears to be insignificant.

Result 1: All treatments, except Commitment, significantly increase the level of contributions compared to the Baseline. The highest levels are observed in Information and Promise, followed by Declaration.

Table 2: Average group contribution by treatment

	Obs.	Subjects	Mean	Sdt. Dev.
Baseline	10	40	20.6	16.6
Information	10	40	42.3	22.3
Declaration	10	40	35.7	23.3
Commitment	10	40	30.6	20.1
Promise	10	40	40.0	19.3

[15]We also performed tests for different distributions using an Epps-Singleton Two-Sample Empirical Characteristic Function test and obtained results indicating significant differences between the *Baseline* and *Promise* as well as *Baseline* and *Information.*

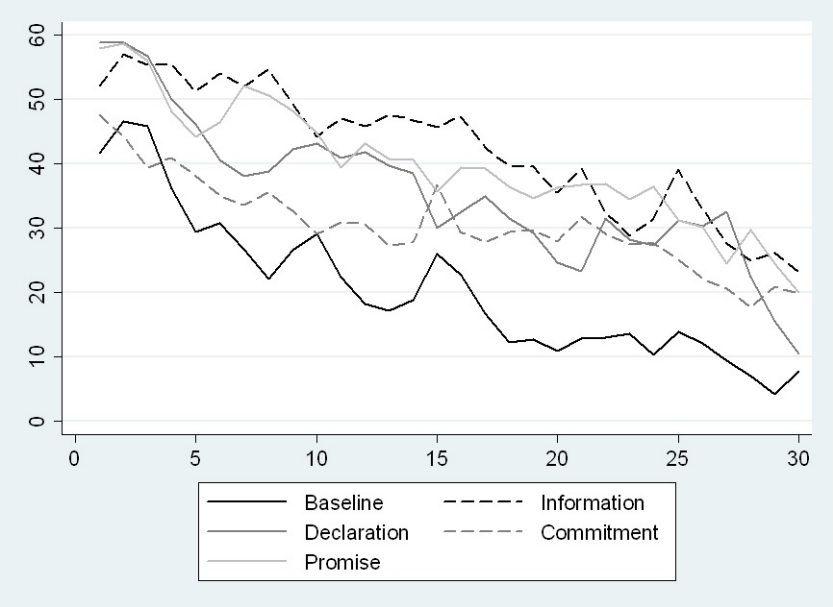
Figure 1 illustrates the mean contribution by period in each of the five treatments. The pattern of contributions in the *Baseline* is consistent with that observed in previous studies (see Ledyard, 1995 and Chaudhuri, 2011). Contributions start from about 50% of the endowment and then continuously decrease until period 30. In the *Declaration*, *Information* and *Promise* treatments, the contributions are much higher in the initial period than in the *Baseline*. On the contrary, the contributions in the *Commitment* treatment are not much different than in the *Baseline* during the first ten periods but are well above in the rest of the game.

An important effect of the treatments is how they affect the decay of contributions. Although *Commitment* appears to have, on average, a lower effect than the other treatments, Figure 1 shows that this result is mixed once we consider the evolution of contributions. Looking at period 10 to 30, the average contributions in *Commitment* and in the *Baseline* are 27.1 and 14.9 respectively; and the difference is significant (p=0.034). Graphically, *Declaration* and *Promise* seem to reduce the decay of contributions. Notably, when we consider only the last twenty periods of the game, all treatment conditions have a higher average level of contribution than in the *Baseline* (p<0.001).[16] Looking at the per period average difference between each treatment and the *Baseline*, we observe that it increases in *Declaration*, *Commitment* and *Promise*; which tend to indicate a slowdown of the decay (see Table A.2 in the appendix). Thus these treatments ensure some degree of persistence in the level of cooperation as proposed by *Prediction 4*. A result that is also confirmed

[16]This is also true when we consider only the last five periods but when we consider the last period alone, only *Information* bears a marginal significant difference to the *Baseline* (p=0.0209). However, these last period contributions are also affected by an end-of-the-game effect.

by the econometric analysis of individual contributions in Table 5 below but only for *Commitment* and *Promise*. Indeed, when we look at individual decisions and control for a series of covariates, it is only in *Commitment* and *Promise* that contributions decline more slowly than in the Baseline. We discuss this result in Section 4.2.

Figure 1: Average group contributions overs periods



Result 2: In all treatments, the contributions are well above the Baseline in almost all periods. But the decay is only reduced in the* Declaration, Commitment *and* Promise *treatments.

4.2 Individual contributions

We now turn to individual contributions in order to explain the differences between treatments. The higher effectiveness of our four conditions can be explained by how

these type of incentives reduce free-riding.

Figure 2: Distribution of individual contributions

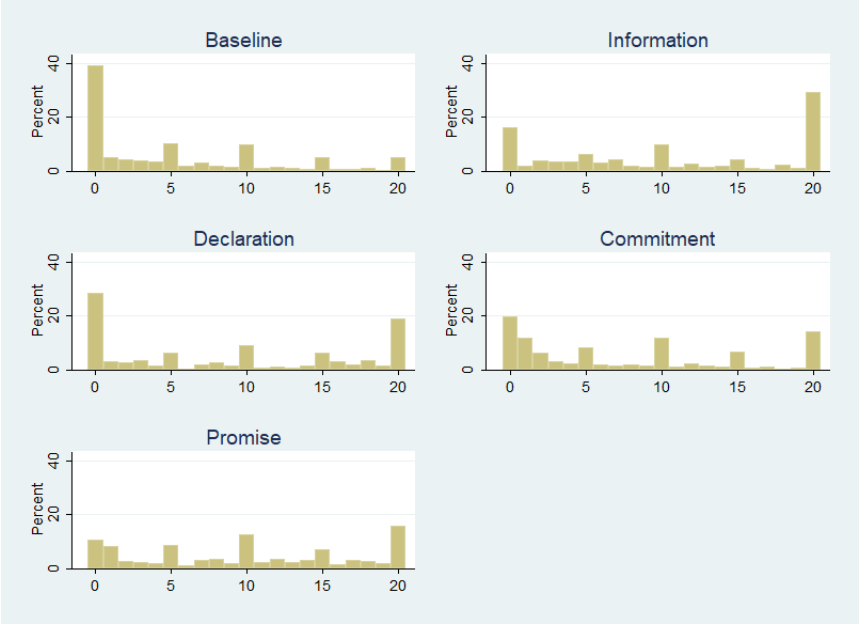


Figure 2 presents the distribution of individual level of contributions across periods according to treatments. The distributions appear to be different among treatments, which is confirmed by a Kruskal-Wallis test ($Chi^2 = 416.703$, p=0.0001)[17]. In the *Baseline*, we observe 40% of zero contributions in total. This figure is greatly reduced in the four other treatment conditions where the percentage falls to 16% in *Information*, 28% in *Declaration*, 20% in *Commitment* and 10% in *Promise*. These proportions are significantly lower than in the *Baseline* at 5% level (Two-sample sample proportion test, see Table 3). Yet it is notable that the proportion of full contributors is also significantly increased in all other treatment conditions compared

[17]Figure A.1. in the appendix presents the evolution of individual contributions along periods in the five treatments. Similarly to Figure 1, we observe a pattern of decreasing contributions with different decays between treatments. We will discuss this later in the econometric analysis.

to the *Baseline*. Here again, in the four other treatments with persuasion or commitment devices the proportion of full contributors differs considerably from *Baseline* (Two-sample sample proportion test, see Table 4).

Table 3: Two-sample proportion test of zero contributions between Treatments

	Information	Declaration	Commitment	Promise
Baseline	$z = 12.46$	$z = 5.57$	$z = 10.30$	$z = 16.12$
	$p < 0.01$	$p < 0.01$	$p < 0.01$	$p < 0.01$
Information		$z = -7.07$	$z = -2.28$	$z = 4.07$
		$p < 0.01$	$p = 0.0225$	$p < 0.01$
Declaration			$z = 4.82$	$z = 10.94$
			$p < 0.01$	$p < 0.01$
Commitment				$z = 6.31$
				$p < 0.01$

Table 4: Two-sample proportion test of full contributions between Treatments

	Information	Declaration	Commitment	Promise
Baseline	$z = -15.66$	$z = -10.52$	$z = -7.60$	$z = -8.50$
	$p < 0.01$	$p < 0.01$	$p < 0.01$	$p < 0.01$
Information		$z = 5.77$	$z = 8.86$	$z = 7.93$
		$p < 0.01$	$p < 0.01$	$p < 0.01$
Declaration			$z = 3.18$	$z = 2.21$
			$p < 0.01$	$p = 0.0272$
Commitment				$z = -0.97$
				$p = 0.3306$

All treatments reduce the level of zero contributions compared to the Baseline[18]. Among these treatments, the highest increase of full-contributors is observed in *Information* and the lowest level of free-riding is observed in *Promise*. These results contrast with the previous findings by Hergueux et al. (2022) that show that an

[18]Our design goes one step further in explicitly indicating what is the social optimum in the public good game.

oath of honesty increases average contributions and especially high-level contributions. Although *Commitment* and *Promise* appear to be less efficient in increasing the proportion of full-contributors in our findings, they succeed in reducing the number of free-riders. This may explain that *Commitment* displays low average but persistent contributions along the periods. In this treatment, no target of contributions is specified but subjects are asked to commit to contribute non-zero levels. As a result, subjects do not contribute at high levels but contribute constantly. By changing the commitment and specifying a given amount of contribution, one could maybe achieve higher levels. It may also be the case that by asking subjects to commit, we crowd out their true willingness to contribute. Consequently they fix their contributions to some acceptable but lower levels. Similar threshold effects have been found in gift-exchange game when a minimum wage is imposed for example (see i.e. Brandts and Charness, 2004; Kosfeld and Falk, 2006). Subjects lower their effort.

Result 3: Compared to the Baseline, the four treatment conditions reduce the level of free-riding and increase that of full-contribution.

Table 5 presents Tobit estimations of the determinants of individual contributions[19]. The dependent variable is the individual contribution per period. Each specification includes control for age, gender, if the subject studies economics, if he or she volunteers, the trust in other and the self-declared risk aversion. In ad-

[19]We use a panel Tobit random-effect model since our dependent variable is the number of tokens contributed to the group account and is censored by a lower (0) and an upper bound (20). However all the results are robust to the use of other specifications such as OLS, group clustered and individual clustered standard errors.

dition to treatment variables, we also introduce a period variable. The reference is the *Baseline*. The results confirm that our four treatments exert a considerable influence on individual contribution. *Information* has the greatest effect, followed by *Promise*; *Declaration* and *Commitment* that are less effective, while still being significant. Along time we observe a decline in the level of contribution. As for the group contributions, we consider how our treatments affect contributions over time. In the second column of results, we introduce interactions between the treatment dummy variables and the period. We find that participants in the *Information*, *Declaration* and *Promise* treatments initially contribute more. There is no initial difference in contributions between *Commitment* and the *Baseline* but we observe that in *Commitment* and in *Promise*, the participants decrease their contributions less than in the *Baseline*. It confirms partially *Result* 2 that showed that group contributions in Declaration, Commitment and Promise were declining more slowly than in the Baseline. These results are consistent with the possibility that our simple commitment process (in both *Commitment* and *Promise* treatments) can in fact ensure some degree of persistence in the level of cooperation.

In the last two columns, we explain the decision to contribute zero tokens or the total amount of the endowment. The dependent variable *Zero contr.* equals to 1 if the subject did not contribute at all in the period and equals zero otherwise. The dependent variable *Full contr.* equals to 1 if the subject contribute the total endowment in the period and equals zero otherwise. Since these two dependent variables are dummy variable, we estimate a random-effect Logit model[20]. As observed previously,

[20]A Hausmann test confirms the choice of a Logit model instead of a Probit model.

Table 5: Determinants of individual contributions - Random-effects models

	Tobit		Logit	
	Contribution	Contribution	Zero contr.	Full contr.
Information	10.363***	9.733***	-2.083***	2.954***
	(1.875)	(1.963)	(0.571)	(0.669)
Declaration	6.366***	5.993***	-0.914	2.021***
	(1.863)	(1.946)	(0.560)	(0.664)
Commitment	5.422***	1.887	-2.554***	1.540**
	(1.858)	(1.938)	(0.584)	(0.673)
Promise	9.078***	7.458***	-3.147***	1.863***
	(1.902)	(1.982)	(0.600)	(0.685)
Period	-0.407***	-0.494***	0.108***	-0.127***
	(0.012)	(0.028)	(0.006)	(0.007)
Age	0.381	0.384	-0.069	0.212**
	(0.245)	(0.245)	(0.076)	(0.084)
Female	-0.258	-0.261	-0.579	-1.032**
	(1.173)	(1.172)	(0.366)	(0.412)
Volunteer	1.379	1.361	0.037	0.893**
	(1.212)	(1.211)	(0.377)	(0.423)
Economics	0.073	0.059	-0.076	-0.206
	(1.224)	(1.223)	(0.381)	(0.433)
Trust	0.789	0.785	0.596	0.948**
	(1.198)	(1.198)	(0.374)	(0.425)
Risk aversion	0.390	0.397	-0.020	0.166*
	(0.254)	(0.254)	(0.078)	(0.089)
Period*Information		0.048		
		(0.038)		
Period*Declaration		0.030		
		(0.038)		
Period*Commitment		0.237***		
		(0.038)		
Period*Promise		0.111***		
		(0.038)		
Constant	-3.283	-2.113	-0.690	-8.953***
	(6.001)	(6.016)	(1.870)	(2.113)
N	5970	5970	5970	5970
# censored obs.	2362	2362		

Notes: Random-effects panel estimations. *Information*, *Declaration*, *Commitment* and *Promise* are dummy variables for each treatment. The reference is the *Baseline*. Period is a continuous variable giving the period of observation. Female is a dummy equal to one if the subject is a female. Volunteer is a dummy equal to one if the subject declare taking part to volunteering activities. Economics is a dummy equal to one if the participant is a student in economics or management. Trust is a dummy variable equal to one if the participant has declared to easily trust others. Risk aversion is a variable from 1 (no risk at all) to 10 (loving risk). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses.

the four treatment conditions decrease free-riding while increasing full contribution (although *Commitment* is only marginally significant). This data presents strong evidence that all four processes increase contributions by restraining free-riding behavior and by encouraging virtuous contributions. However the effect of *Declaration* is only marginally significantly different to the *Baseline*. According to the theory of planned behavior, the effects of procedures on subjects willingness to contribute are the biggest the more committing is the intervention. Thus in *Commitment* and *Promise*, one can expect a reduction of free-riding compared to *Declaration*. However the case of *Information* is interesting and we conjecture that by giving advice to subjects on how to contribute, we discipline them to not contribute zero; which goes in the way of what previous persuasion scheme has shown (see i.e. Dal bo and Dal bo, 2015).

A last noteworthy result concerns the decision to answer *Yes* or *No* when asked whether to contribute in the three decision treatments. Table A.3 in the appendix presents average individual contributions by treatment and by answer *Yes* or *No*. We observe that 85%, 75%, and 100% of participants answered *Yes* to the question in the in the Declaration, Commitment and Promise treatments respectively. Notably, we observe a particularly high level of willingness to declare forthcoming contributions when this information is directly transmitted to the other members of the group. We also observe that among those who declared forthcoming contributions, they contributed on average zero tokens in about 24% of the decisions but this rate falls to 7% and 10% in the *Commitment* and *Promise* treatments. Figure A.1 in the appendix shows no deviation from the *Baseline* for those who did not declare that

they will contribute. This further confirms the effectiveness of the two treatments in which participants were engaged compared to the others. Once engaged, either through a *Commitment* or a *Promise*, subjects contribute to the public good.

4.3 Group payoffs

Lastly we now turn our attention to subject payoffs. It is interesting to see how the effectiveness of some of the treatments influences the welfare of the groups[21]. To examine this we computed the average group payoff in each treatment. Table 4 presents the results.

We observe the highest payoffs in *Information* and *Promise* followed by *Declaration* and *Commitment*. The *Baseline* presents the lowest level of payoffs. Mann-Whitney rank-sum tests of the difference between the *Baseline* and the other treatments show that the payoffs are significantly higher in *Information* ($p < 0.01$), *Declaration* ($p < 0.01$) and *Promise* ($p < 0.01$) but not in *Commitment* ($p=0.126$). In relative terms, the payoffs in *Information* and *Promise* are almost 10% higher than in the *Baseline*. Moreover when we look at the payoffs per period, they are above the *Baseline* in all treatments in all periods, with the exception of the very first periods in *Commitment*.

[21]The sum of payoffs in the group is equal to social welfare here.

Table 6: Average individual payoffs by treatment

	Obs.	Mean	Sdt. Dev.
Baseline	40	24.09	2.48
Information	40	26.35	3.99
Declaration	40	25.36	3.78
Commitment	40	24.59	4.05
Promise	40	25.99	4.02

5 Conclusion

An important question in economics is how to promote contribution in social dilemmas where there is a conflict between cooperating, which is socially optimal and free-riding, which promotes individual self-interest. Although the voluminous literature on repeated voluntary contributions games has shown that in these situations some individuals initially contribute, the presence of free-riding inevitably leads to a decay of contributions as the game is repeated.

The aim of this paper was to test alternative non-monetary institutions that foster cooperation in social dilemma without affecting the social benefits of the situation. To that end, we assessed whether persuasive and commitment devices can increase contributions to a public good in a repeated setting. Starting from providing social information on the goal of contribution, we introduced three alternative commitment devices with an increasing level of pressure on subjects. Following the results of the social psychology literature, we test first a light commitment scheme (declaration of intention), then a more binding one (action) and finally we tested, due to the very nature of social dilemmas, a binding communication scheme that activates the existing social link.

We find that all four mechanisms increase contributions to the public good; although persuasive information and commitment to the group are the most efficient. In the *Declaration*, *Information* and *Promise* treatments, the contributions start off at a higher level in the initial period than in the *Baseline*. On the contrary, the contributions in the *Commitment* treatment are not much different than the *Baseline* in the first periods of the experiment. Looking at individual decisions to contribute, we observe that the decay of contributions is reduced when we introduce a commitment device (in both *Commitment* and *Promise* treatments). This is not the case in *Declaration* and *Information*. One important result is that the four lastc treatments significantly reduce the number of zero contributors and increase the number of full contributors.

These results provide support for creative communication from public bodies to contributors, especially when traditional public policies of control are expensive, backfiring and rejected. Furthermore, these mechanisms can be useful when identification of free-riders or small contributors is difficult. This is particularly the case of global public good like environment protection or State funding contribution in which there is potentially a large number of small contributors.

Our findings give insights to what can be expected from some policy trials that have been recently implemented. In Netherlands for instance the tax administration now contact taxpayers before or in their first contribution year either by mail or physically, to discuss with them the necessity to contribute. They also propose a more bidding scheme as they open the opportunity for firms to engage in a contract with them implying the payment of due taxes. In France, a large communication

campaign has recently advertised on the necessity to implement small changes for environmental matters such as switching off lights, recycling or be vigilant in terms of consumption (food, water, energies).

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A Appendix

A.1 Additional analysis

Table A.1: Average contribution by group by treatment

Groups	Baseline	Information	Declaration	Commitment	Promise
1	2.27	19.3	13	8.37	25.37
2	13.97	23.10	13.4	16.33	25.77
3	14.77	29.87	25.5	16.8	28.73
4	17.93	35.7	28.7	23.23	30.27
5	21.07	37.37	31.73	28.7	31.87
6	21.93	38.57	37.4	28.73	36
7	25.4	45.5	37.5	35.57	36.27
8	25.47	54	42.57	36.73	60.43
9	28.83	63.87	59.13	45.77	61
10	34.47	76.07	68.1	65.47	63.77

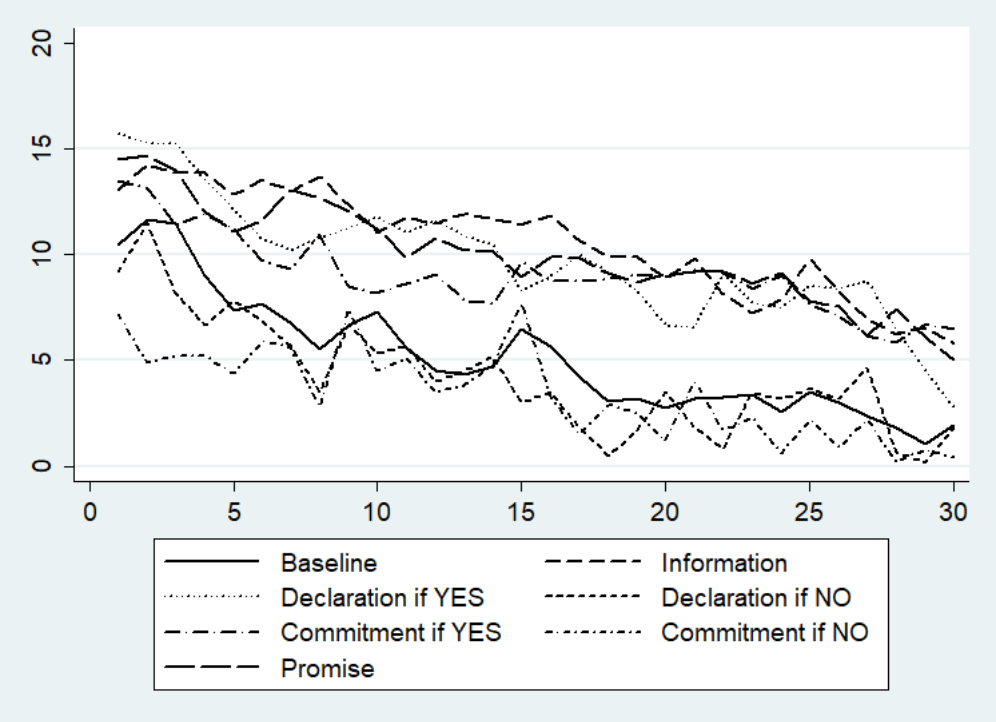
Table A.2: Average difference with the Baseline by periods

Periods	Information	Declaration	Commitment	Promise
1-5	14.31	14.2	2.1	13.1
6-10	23.8	13.5	6.1	21.4
11-15	26.1	17.7	10.1	19.4
16-20	25.9	15.5	13.8	22.1
21-25	21.5	15.6	15.5	22.4
26-30	18.9	14.2	12.1	17.6

Table A.3: Average individual contribution by treatment and by decision to answer YES or NO

	Commit	Obs.	Mean	Sdt. Dev.
Baseline	-	1200	5.15	6.04
Information	-	1200	10.58	7.66
Declaration	All	1200	8.93	7.88
	Yes	1020	9.75	7.88
	No	180	4.27	6.05
Commitment	All	1200	7.64	7.11
	Yes	900	9.03	7.00
	No	300	3.49	5.72
Promise	All	1200	9.99	6.88
	Yes	1200	9.99	6.88
	No	-	-	-

Figure A.1: Average individual contributions overs periods



A.2 Instructions

Thank you for participating in this experiment on decision making. In this experiment, your earnings depend on both your decisions and those of the other participants. We ask you to read these instructions carefully; they should enable you to understand the experiment. All your decisions are anonymous. You will never enter your name on the computer. Indicate your choice on the computer at which you are sitting.

From now on we ask you not to talk. If you have a question, please raise your hand and an experimenter will meet you in private. It is forbidden to communicate with another participant during the experiment. If you violate this rule you will be disqualified from this experiment and from any potential payment.

The 20 participants in the experiment are divided into groups of four. You are therefore in a group with three other participants. You cannot know the identity of other members of your group. Likewise, no member can know your identity. You do not know the constitution of other groups. Your group will remain the same throughout the experiment. Your earnings will depend on your decisions and the decisions of other members of your group.

This experiment consists of 30 successive periods. In each period, you will earn gains calculated in tokens. At the end of the experiment your total earnings in tokens accumulated over the 30 periods will be exchanged at the following rate: 30 tokens = 1 euro. Gains in euros that you have made will then be paid in cash.

At the beginning of each period you will receive 20 tokens. These 20 tokens constitute your initial endowment for this period. You must decide how to use this

endowment. More precisely, you must decide how many tokens you wish to invest in a common project to the group to which you belong and how many tokens you want to keep for yourself.

At the beginning of each period you will decide the number of tokens be- tween 0 and 20 you wish to invest in the common project. Choosing your investment in the project automatically determines the number of tokens you keep for yourself (20 minus your investment fees). *For example, if you decide to invest 15 tokens in the project, you keep 5 tokens for you.*

After each member of your group has made his or her investment choices, you are informed of the total amount invested in the project (that is, your contribution combined with the contribution of your group members). You are also informed of your earnings for that period.

Your earnings for this period are the sum of two amounts:

1. The number of tokens you have not invested in the joint project and have kept for yourself; and

2. The income obtained through your investment in the joint project.

The investment in the joint project entitles you to an income. The income of the joint project is 40% of total contributions to the project of the four members of the group (including your contribution).

Your gain for the period = (20 - your invested amount) + 0.4 * (the total of the invested amounts)

The income from the project is calculated in the same way for all members of your group. Therefore each member of the group receives the same project income.

- *For example, if the total amount invested by the four members of the group is 60 tokens, each group member receives an income of 0.4 * 60 = 24 tokens. If the total investment is 9 tokens, each group member receives an income of 0.4 * 3.6 = 9 tokens from the project.*

All of the tokens that you do not invest in the joint project are for you. However, each token you spend for the joint project increases the total contribution of 1 token and therefore increases your income from the proposed 0.4 * 1 = 0.4 tokens. The income of other group members is also increased by 0.4 tokens in this case. Your investment in the joint project thus increases the income of other group members. Similarly, any investment in the joint project by another member of the group increases your own income and that of other group members.

- *For example, if all group members keep their initial endowment of 20 tokens and do not contribute to the joint project, each group member receives 20 tokens he or she kept and receives nothing from the project. The total gain for each member is 20 tokens.*

- *If all group members invest their entire initial allocation of 20 tokens in the project, the sum of contributions is 80 tokens. Each group member will therefore receive an income of 32 tokens for the project and kept 0 token. The total gain for each member is 32 tokens.*

A.3 Experimental treatments

The experiment consists of one Baseline in which subjects play the repeated VCM outlined in the instructions, along with four additional treatments. In each of these four treatments, we introduce different rules just before the subjects start the VCM. Here are the detailed procedures for each one:

- Information treatment
  - After reading the instructions, the experimenter says aloud: "We would like you to read carefully the following information (sheets of paper are distributed). Once all participants have read this information, we will collect the sheets from you".
  - On the sheet, the subject reads: "In each period, contributing to the group project increases welfare of the group's members".
  - Once the papers have been collected, the subjects start the VCM for 30 periods.
- Declaration treatment
  - After reading the instructions, the experimenter says aloud: "We would like you to answer the following question (sheets of paper are distributed). On this sheet we ask you to make a choice. Once all participants have answered this question, we will collect the sheets from you. This information will remain anonymous".

  - On the sheet, the subject reads: "In each period, I consider that contribution to the group project is important in order to increase welfare of the group's members: yes/no".
  - Subjects make their decisions, the papers are collected, and the VCM starts for 30 periods.

- Commitment treatment
  - After reading the instructions, the experimenter says aloud: "We would like you to answer the following question (sheets of paper are distributed) On this sheet we ask you to make a choice. Once all participants have answered this question and signed the document, we will collect the sheets from you. This information will remain anonymous".
  - On the sheet, the subject reads: "In each period, I commit to contribute to the group project in order to increase welfare of the group's members: yes/no + signature".
  - Subjects make their decision, the papers are collected and the VCM starts for 30 periods.

- Promise treatment
  - After reading the instructions, the experimenter says aloud: "We would like you to answer the following question (sheets of paper are distributed). We are going to distribute to you three answer sheets, three small white envelopes, and a large brown envelope. We will ask you to make a choice

and to indicate it identically on the three sheets of answers. Once this choice has been made, please sign at the bottom of each of the three sheets. Then please place each answer sheet in a white envelope and seal it without writing anything on it. Place the three white envelopes in the large brown envelope and seal it. Then indicate the number of the position at which you are on and only on the large brown envelope. Once all participants have made their choice, we will collect the sheets from you and distribute them to the members of your group and only to the members of your group. This information remains anonymous and the members of your group cannot identify you".

- On the sheets, the subject can read: "In each period, I commit to contribute to the group project in order to increase welfare of the group's members: yes/no +signature".
- Subjects make their decisions, the papers are collected, and distributed to the members of the group. Then the VCM starts for 30 periods.

A.4 End-of-experiment questionnaire

At the end of the experiment, we collected some demographic information and we ask some questions about preferences:

- What is your age
- What is your sex
- What is your field of study

- Are you originally from France?
- If not, which country are you from originally?
- Please indicate how many older siblings you have
- Please indicate how many younger siblings you have
- Are you married?
- How do you see yourself? Are you generally a person who is fully willing to take risks or do you try to avoid taking risks? Please tick a box on the scale below, where 0 means risk averse and 10 means fully prepared to take risks.
- How happy would you say that you are at the moment of your life? Please indicate your happiness on the following scale, with 0 indicating not happy at all and 10 indicating extremely happy
- How do you see yourself? Are you generally a person who trust the others?P lease tick a box on the scale below, where 0 means no trust at all and 10 means fully trust.
- Do you take part in volunteering activities?