PUBLIC GOOD PROVISION - WHY PEOPLE DO (NOT) CONTRIBUTE?

AN EXPERIMENTAL EXPLORATION

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RESEARCH REPORT - DECEMBER 2003

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1. INTRODUCTION

In public good provision situations, individual members of a group have a choice of contributing or not contributing to the provision of a good from which all benefit, including those who chose not to do so. In such a context, theories of rational choice predict that individuals will try to "free ride" on the contribution of others – they will attempt to enjoy the good without contributing, leading thus to the under or no provision of the good.

However, contrary to rational choice theory or classical game theoretical predictions, people tend to voluntarily contribute to the provision of public goods. In fact, there is by now an impressive accumulation of empirical findings from experimental and field studies corroborating this conclusion[1].

The results obtained in experimental studies may be summarised by the following stylised facts: (a) experimental subjects contribute considerable amounts of their endowments in one-shot game situations; (b) in repeated games the level of contribution is high in the first round but contributions seem to unravel over time; (c) the levels of contribution heavily depend on the context in which the interaction takes place (namely, on the (im)possibility of face-to-face communication among experimental subjects).

Given the evidence gathered, the relevant research problem is no longer to determine whether the game-theoretical prediction is reliable or not. The issue is settled. People do tend to contribute. But, given that the levels of contribution seem to depend on a number of contextual factors, the relevant and interesting question is now the identification of those factors, and the understanding of their relation to the contributive behaviour of the agents. Along this line, the research reported in this paper aims at understanding and explaining the conditions (namely the institutional contexts) that may promote or hinder cooperation in public good provision situations. In particular, the research focuses on the effects of justice concerns on the contributive disposition of individuals.

Roth (1995: 22) identified three different types of motivations to run experiments: "Speaking to Theorists" - experiments designed to test predictions of well articulated formal theories -,

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"Searching for Facts" - experiments designed to study the effects of variables about which existing theory have little to say -, and "Whispering in the Ears of Princes" - related with the dialogue between experimenters and policy makers. The experiment reported in this paper would fit in the class "Searching for Facts". It is not aimed at testing any theory or hypothesis but rather at observing behaviour in conditions difficult to isolate in everyday life. The purpose is to suggest explanations that cannot be inferred from conventional economic principles or from intuition and introspection.

This does not mean, however, that the experiments were designed in a theoretical vacuum. Theories of cooperation and justice strongly suggest that there is a relationship between the levels of cooperation in groups and the (in)justice (as perceived by the members of the group) of the rules and/or of the decisions of empowered individuals. The design of the experimental study, as described in section 2, was thus guided by theory-induced conjectures on that relationship.

In section 3 a detailed description of the experimental study is given. The main results obtained are presented in section 4. In section 5 some exploratory interpretations are advanced, suggesting the need for new theoretical approaches that may give account of the observed results. Finally some provisional conclusions are drawn in section 6.

[1] See, for instance, surveys by Ledyard (1995), Ostrom (1998) and Camerer and Fehr (2002).

2. THE OVERALL CONCEPT BEHIND THE EXPERIMENTAL STUDY

In the process of conceiving this experimental study three main issues were addressed: (a) How to involve justice concerns in a public good provision setting; (b) How to deal with the important role played by communication; (c) How to capture the different dimensions of justice.

Starting with the first question. In pure public good provision experimental contexts each member of the group is free to decide how much to contribute to the provision of the good and, irrespective of each individual's decision, all members can enjoy the good in a non-rival way, even though some may obtain more "utility" than others from it. Nevertheless in many real life contexts the non-rivalry and the non-excludability clauses are questionable: public lightning may be unevenly distributed in different quarters of a city, security resources may privilege certain regions in detriment of others, public education and health services may differ in quality from place to place. In such real life contexts the rights to which citizens feel entitled to are not equally secured and we may wonder whether the sense of indignation of those excluded may not undermine their commitment to sharing the costs of producing those goods.

In fact in any collective action context the benefit of the joint effort is in general distributed in accordance with rules whose legitimacy may be questioned by any of the group members. Teamwork provides a good example: standard theory predicts that if the added value is apportioned in proportion to marginal contributions, the team will work efficiently. However, since individual contributions are generally difficult to monitor, measure, and evaluate, in practice the added value is distributed in accordance with a rule that may be judged and found fair or unfair by members of the team.

One way of introducing the justice dimension in public good experiments is to create a situation in which the good, after having been produced, is apportioned among the group members according to a distribution rule. Doing this amounts to create an impure public good situation – the good is no longer non-rival, but non- excludability remains, since all can enjoy it irrespective of their individual contributions to its production.

Let us now consider the issue of communication. There is a widely shared opinion among experimental economists that it is ill advised to allow communication in public good experiments since it only adds hard-to-control variables to the experiment.

While acknowledging the truth in this remark, the research team was persuaded by the counter-argument that although experimental settings must necessarily assume away many features of reality, it would be hardly acceptable that they exclude key features of that reality, such as communication in "small" groups of human beings involved in collective action. The research team concluded therefore that even though there is obviously a price to pay in terms of control, such a price would be acceptable in a study with exploratory purposes.

In spite of the possibility of communication, the decisions on how much to contribute to the collective good are most often private, and the actual contributions are hard to monitor by other group members. The experimental team tried to capture those features of reality by combining pre-play communication with private decision-making and anonymity in contributions.

The third problem addressed arose from the fact that justice is a multidimensional concept.

There is first of all a conventional dimension in justice – a rule is generally judged from the point of view of its appropriateness to the context it applies to. It is justified to assume, for instance (and in fact we did so) that among students participating in an experiment, the sharing of the public good in equal slices is generally taken to be the appropriate rule.

Secondly, the different ways of apportioning the public good refer to the distributive dimension of justice.

However, justice considerations are attached not only to the distribution rules themselves (in the arithmetical sense) but also to the procedures adopted to enact those rules. There is indeed a third dimension of justice which is the procedural one. A rule decided upon by members of the group may be judged fairer than a rule imposed upon the group, even if the rule is the same. Furthermore the same unequal distributive rule may be judged more unfair if it is perceived as the result of a decision made by a member of the group for his own benefit.

Designed to explore the factors that may hinder or foster cooperation in public good provision settings, and, in particular, the importance of justice concerns as a normative dimension

influencing contributive dispositions, the experimental study was guided by the following conjectures:

C_1: Pre-play communication is an important but not a sufficient pre-condition for cooperation in public good settings;

C_2: Justice concerns are crucial in explaining differences in overall contribution levels;

C_3: Deviations from the equal share principle may cause lower levels of cooperation;

C_4: The levels of cooperation tend to be even lower when the deviations from the equal share principle have been decided by an empowered group member in his benefit;

C_5: For the same equal share rule the contributive levels may be higher when the distribution rule is chosen by group members.

3. DESCRIPTION OF THE EXPERIMENTS

Although there is a remarkable diversity of public goods experiments, a standard one uses the following procedures: a group of n individuals (generally between four and ten, but sometimes more) is brought into a room (the lab); each of the participants is given a certain amount of token money (an endowment z_i), which he has to divide into a part, x_i, that he keeps to himself, and another part, $t_i = z_i - x_i$, which is "invested" in the production of the public good. The total amount invested, $T = \sum_{i=1}^{n} t_i$, is then used to produce the public good y, with $y = g(T)$ being the public good production function. The individual payoffs are then determined, depending on the choices x_i, and on the amount produced of the public good, y, by the function $U_i(x_i,y)$.

The particular feature in this experimental study was that the public good was apportioned among the group members in accordance with a distribution rule that varies in different experiments. This means that the individual's payoff function is given $U_i(x_i,\alpha_i y)$ with α_i, the individual share, depending on the distributive rule adopted. The production function adopted was $y = 2 \times T$.

In this study the above stated procedure is repeated 10 times in each experimental session, which involved different groups of 8 individuals $(n = 8)$. Each experimental session started with a ten-minute dialogue phase.

Four different experiments were designed and implemented:

- In experiment A each participant received an equal share of the public good (see annex 1);
- In experiment B a 30% share of the public good was assigned to a randomly selected subject; each one of the remaining subjects received 10% (see annex 2);
- In experiment C the distribution rule was to be decided by a randomly chosen subject who was faced with two alternatives: a) 30% to himself with the remaining individuals getting

each 10%; b) 44% to himself with 8% for the remaining[2]. The remaining subjects were not informed of the alternatives to which the selected subject was confronted, but only knew its actual decision (see annex 3);

- In experiment D individuals were informed that they had to define themselves a distribution rule for the public good during the dialogue phase[3] (see annex 4).

The experimental study took place at ISCTE, a business and social science university institute, in Lisbon during the month of April, 2003. Four sessions were held each day, during two weeks.

The common features in the four experiments were the following:

1. Group composition and recruitment

   Each session involved a group of 8 students and ten sessions were held for each experiment, totalling 40 sessions and 320 participants. The students were recruited by means of a public announcement distributed in several faculties of Lisbon. An effort was made to make sure that the students which participated in each session didn't know each other. Each student participated only in one session.

2. Characterisation of the experimental setting

   The experimental sessions took place in a room that contained a large table, where the students gathered in the instruction and communication phases of the experiment, and eight individual booths where they made their individual decisions. Everything was done to ensure anonymity and to prevent communication after the dialogue phase.

3. Learning the instructions

   Once arrived to the room the eight students sited around the large table. The instructions and the "decision and results" sheet (see annex 5) were distributed to each participant. In this phase one of the two experimenters present in the room read the instructions aloud. Afterwards the individuals were allowed to read the instructions by

[2] As the objective was to compare the results with experiment B, only the cases where the selected subject choose the 30-10 rule were considered (10 cases out of 13).
[3] In all cases the egalitarian distribution rule was unanimously chosen.

themselves and then they could pose questions. Both the questions and the answers were publicly made.

4. Dialogue phase

After having read and understood the instructions, subjects were allowed to talk with each other for ten minutes. This phase was the only opportunity that participants had to communicate with each other. After this dialogue phase the students were asked to move to their individual booths.

5. Comprehension Test

Once seated at their individual booths, the participants received a short test whose goal was to ensure that everyone had correctly understood the instructions. All questions at this phase were individually answered by the researchers.

6. Iterative Phase

After this exercise the series of 10 repetitions began. In each repetition the following procedures were undertaken:

- Each individual had to decide, from an amount of ten tokens, the part allocated to the common fund (invested in the public good) and the part kept to himself. The decisions were to be written on the "decisions and results" sheet (columns 2 and 3), which was then collected by the experimenter;

- After having collected the sheets, the experimenter wrote in each the total amount of the common fund and the part allocated to each individual, filling columns 4 and 5. The experimenter then delivered the sheets back to each participant who had to calculate his total earnings, filling column 6;

7. Final procedures

Before leaving the room the participants were asked to answer to a short questionnaire focusing on their evaluation of the distribution rule and of the results[4]. After the

[4] The most relevant question was the following:

questionnaire was answered one of the experimenters calculated the payoff of each subject (column 6) at a conversion rate of 75 cents for each 10 points. Three euros were added to this amount as participation fee[5]. After the total amount had been obtained the payment was privately made to each participant at her individual table. As this was being made the participants left the room.

Experiments B and C have particular features:

- In experiment B, after the dialogue, when the participants were already at their individual booths, each received a paper inside an envelope (see annex 7), which indicated whether she had been chosen as the receiver of 30% of the common fund during the ten repetitions.

- In experiment C, after the dialogue, when the participants were already at their individual booths, each received a paper inside an envelope (see annex 8), which indicated whether she had the role of deciding the distribution rule of the common fund. The decision-maker had to choose among two alternative distribution rules of the common fund. After that the experimenter publicly announced the decided distribution rule and wrote it in a board. This meant that the participants only came to know the distribution rule after the dialogue phase. It is worth noting that the remaining participants did not know the alternatives with which the decision-maker was faced.

Some final remarks on ill-controlled elements are worth making:

- One may wonder that the presence of the experimenters in the room, during the entire duration of each session, and their interaction with subjects, might, to a certain extent, have influenced behaviour in two different ways: by reinforcing the sense of group identity among the subjects in reference to an out-group (the experimenters); by

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How do you evaluate from the justice/injustice point of view the common fund's distribution rule adopted in this study. Tell us your opinion by using the following scale and by putting a X in the number that corresponds to your answer.

1–Very Unfair; 2-Unfair; 3-Mildly Unfair; 4-Nor Fair, Nor Unfair; 5-Slightly Fair; 6- Fair; 7- Very Fair

[5] On average each participant in the experimental study received €16,45. The maximum amount received was €39 and the minimum €7,5.

leading subjects to make decisions in accordance to what they thought was expected of them by the experimenters;

- Since the experimental sessions were held sequentially in two weeks, involving a large

number of students that interact daily in the university campus, after the first sessions it was noticeable that some subjects had been in contact with previous participants. The extent to which a learning effect took place with influence on the results is unknown.

4. RESULTS

In its simplest description, the results of the experimental study are summarized in Figure 1 and Table 1.

In Figure 1 the series of the average contribution rates[6] along the ten repetitions in the 40 sessions can be observed (ten sessions in each experiment)[7].

Figure 1 – Average Contribution Rates

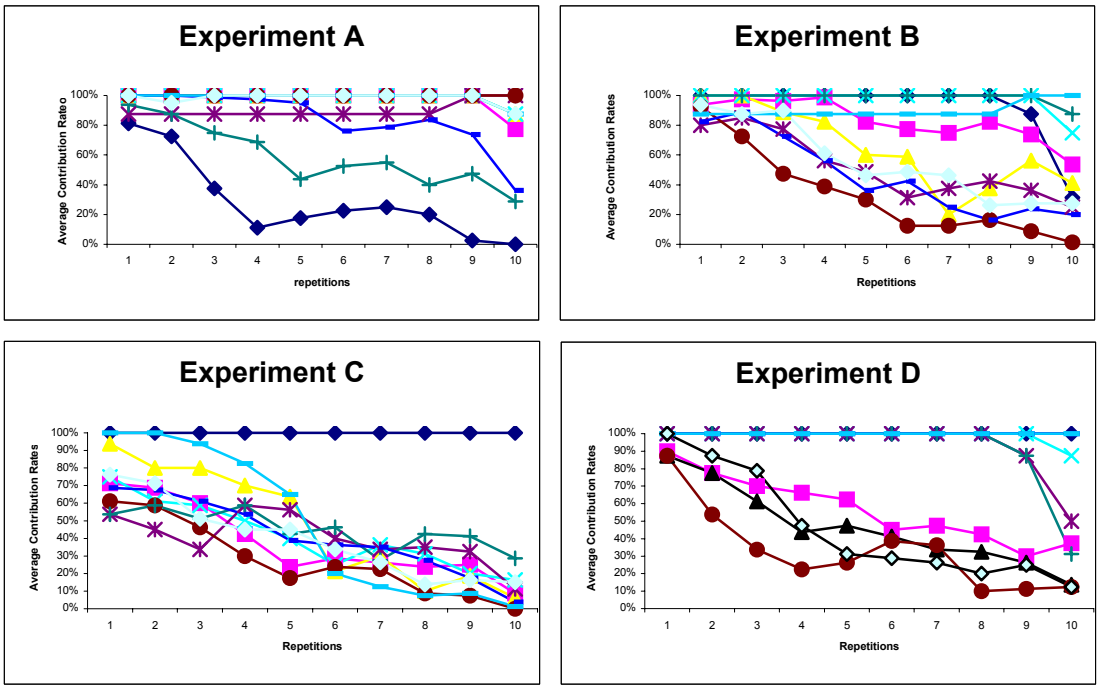


Table 1 – Average Contribution Rates to the Public Good

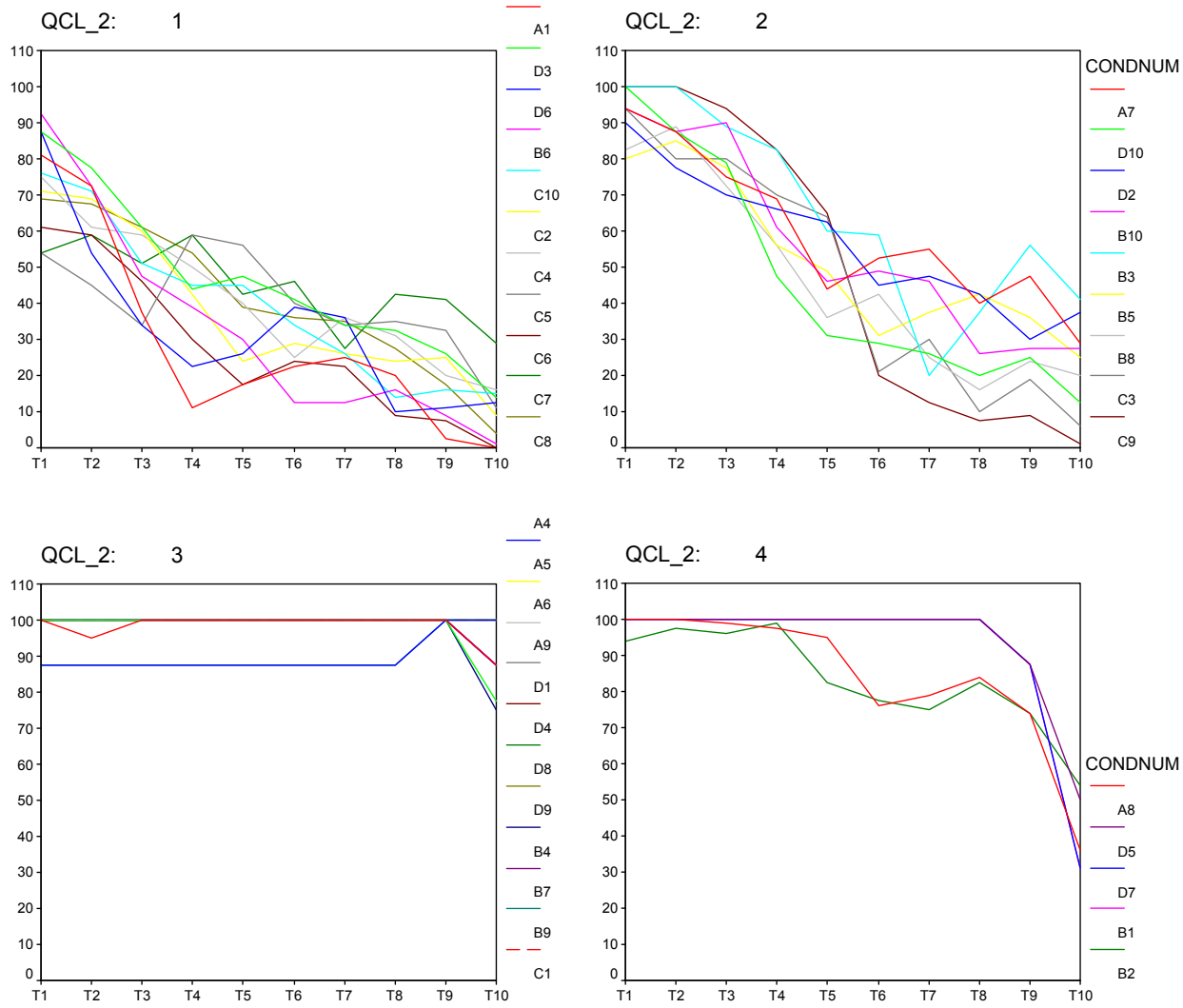
Experiment	A	B	C	D
Average Contribution Rates by Experiment	85%	71%	47%	77%
Average Contribution Rates by Experiment – 1st Repetition	96%	93%	75%	97%
Average Contribution Rates by Experiment – 10th Repetition	69%	46%	19%	55%

[6] The contribution rate is the ratio $\frac{contribution}{endowment}$ in percent terms.

[7] Due to overlapping some of the series are not visible.

The average contribution rate by repetition in a single session gives the average value of all participants' contribution rates in that repetition and session. The average contribution rate by experiment stands for the average value of all participants' contribution rates over all repetitions and sessions in each experiment (average of 800 values). The average contribution rate in a given repetition by experiment gives the average value of all participants' contribution rates for this given repetition over the ten sessions in each experiment (average of 80 values).

Figure 2: Clusters of Contributive Patterns



As was shown in Figure 1 a wide range of contributive dynamics was observed in the four experiments. In order to identify the main patterns in these contributive dynamics, the different outcomes have been grouped into four categories using the k-means clustering algorithm[8].

Figure 2 suggests four different types of contributive dynamics: (1) strongly non-cooperative; (2) non-cooperative; (3) strongly cooperative; (4) cooperative. These four patterns are unevenly distributed across the experiments, with the strongly non-cooperative pattern over-represented in experiment C and the strongly cooperative pattern over-represented in experiment A.

Table 2: Frequency of Contributive Patterns per Experiment

	Exp. A	**Exp. B**	**Exp. C**	**Exp. D**
Strongly Non-Cooperative	1	1	**7**	2
Non-Cooperative	1	4	2	2
Strongly Cooperative	**7**	3	1	4
Cooperative	1	2	0	2

In order to identify whether there were significant differences between the average contribution levels of the four experiments, statistical tests were undertaken that used the medians of the average contribution rates of the session per experiment (Med_T). The main results are summarized in Table 3.

Table 3 - Comparing Experiments: Medians of the Average Contributions to the Public Good

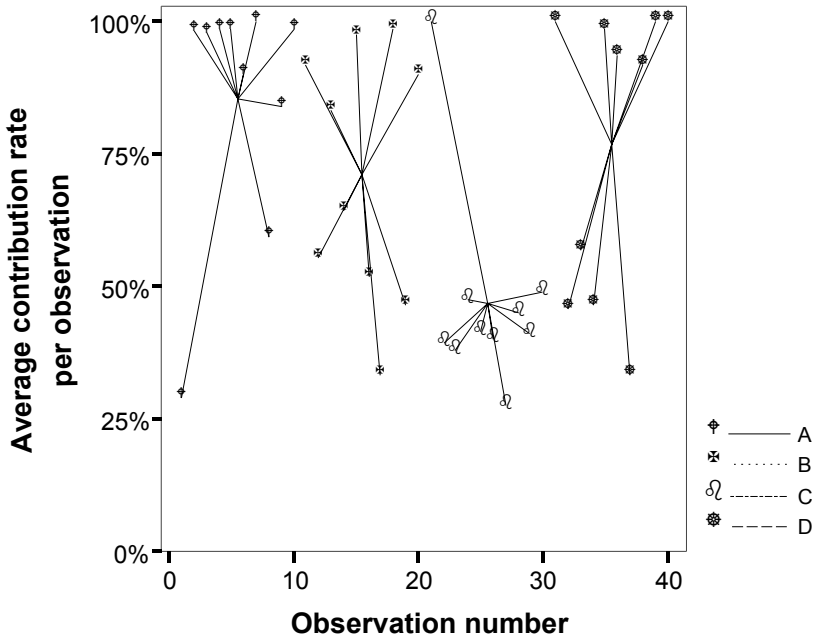
Variable in test	Grouped by	Test	p-value	Significant at the 5% level
Med_T	A, B, C, D	Kruskall-Wallis	0,02	Yes
Med_T	{C} vs. {A,B,D}	Mann-Whitney	0,003	Yes
Med_T	A, B, D	Kruskall-Wallis	0,273	No
Med_T	{A} vs. {C}	Mann-Whitney	0,014	Yes
Med_T	{B} vs. {C}	Mann-Whitney	0,023	Yes
Med_T	{D} vs. {C}	Mann-Whitney	0,025	Yes
Med_T	{A} vs. {B}	Mann-Whitney	0,081	No
Med_T	{A} vs. {D}	Mann-Whitney	0,879	No

[8] Given that the k-mean is sensitive to the initial centres (departure conditions), we used the centres given by a partition in four groups based on a hierarchical clustering method (Ward's method; squared Euclidean distance).

A difference was identified between the four experiments in that the medians of the average contribution rates of the sessions in each experiment are significantly different at the 5% level (first line of Table 2). Further comparisons reveal that the sharpest difference is between experiment C and the other three experiments. This is shown by the comparisons {C} vs. {A, B, D}, {A} vs. {C}, {B} vs. {C} and {D} vs. {C}. Furthermore, no significant differences were identified when simultaneously comparing A, B, D or {A} vs. {B} and {A} vs. {D}.

Figure 3 displays the average contributions for the ten sessions of each experiment with their respective averages represented as gravity centres.

Figure 3 –Average Contributions per Session and Experiment



The same results hold for tests using the median of the average contribution rates of the ten sessions in the first repetition (Table 4) and in the last one.

Table 4 – Comparing Experiments: Medians of the Average Contributions in the 1st Repetition to the Public Good

Variable in test	Grouped by	Test	p-value	Significant at the 5% level
Med_T1	{A, B, C, D}	Kruskall-Wallis	0,008	Yes
Med_T1	{C} vs. {A,B,D}	Mann-Whitney	0,001	Yes
Med_T1	A, B, D	Kruskall-Wallis	0,366	No
Med_T1	{A} vs. {B}	Mann-Whitney	0,229	No
Med_T1	{A} vs. {D}	Mann-Whitney	0,963	No
Med_T1	{B} vs. {C}	Mann-Whitney	0,026	Yes
Med_T1	{C} vs. {D}	Mann-Whitney	0,023	Yes

The difference existing in experiment C in respect to the other three is also apparent in the contributive patterns in the first and last repetitions. While in experiments {A, B, D} in the first repetition the mass of contributions is concentrated in level 10, in experiment C the dispersion of initial contribution is much greater (Figure 4).

Figure 4 – Absolute Frequency of Contributions in the 1st Repetition

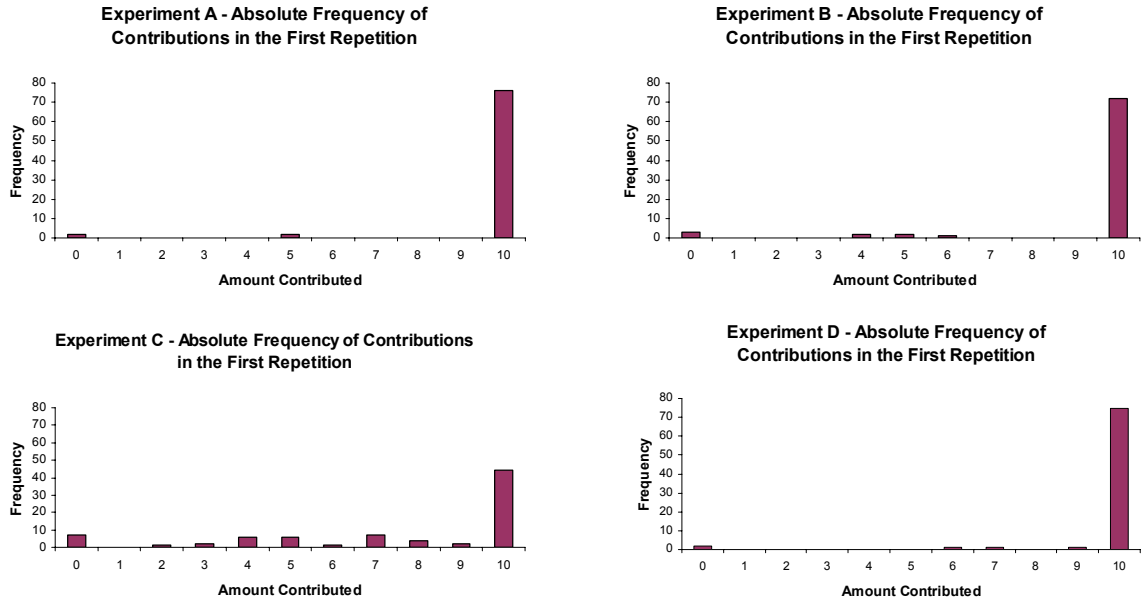
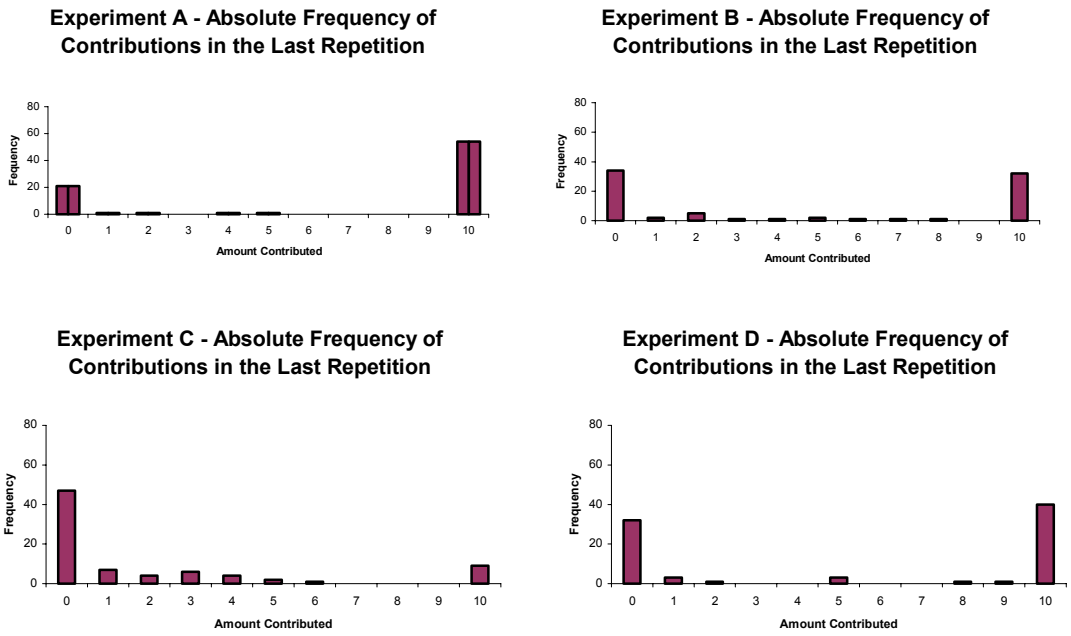


Figure 5 – Absolute Frequency of Contributions in the Last Repetition



In the last repetition, as can be seen in Figure 5, in experiments A, B and D the contributions are more or less evenly divided between the full contributive level and 0, in experiment C a clear majority of the participants did not contribute.

The experimental study also involved a small questionnaire whose objective was to assess the participants' perceptions regarding the justice of the distributive rule. The results obtained showed that the distributive rule scored higher in respect to fairness in experiment D, followed by A, B and C.

Table 5 – Evaluation of the Distributive Rule

	Average	Minimum	Maximum	Std. Deviation
Exp. A	5,08	1	7	1,59
Exp. B	3,57	1	7	1,62
Exp. C	3,23	1	6	1,31
Exp. D	6,26	3	7	1,20

The pairwise comparison between the participant's responses in the different experiments reveals that these differences are statistically significant except for experiments B and C (Table 6).

Table 6 – Comparing Experiments: Medians of the Evaluation of the Distributive Rule

Variable in test	Grouped by	Test	p-value	Significant at the 5% level
Evaluation of the Rule	{A} vs. {B}	Mann-Whitney	0,000	Yes
Evaluation of the Rule	{A} vs. {C}	Mann-Whitney	0,000	Yes
Evaluation of the Rule	{A} vs. {D}	Mann-Whitney	0,000	Yes
Evaluation of the Rule	{B} vs. {C}	Mann-Whitney	0,177	No

There is a higher degree of unanimity in participants' perceptions regarding the justice of the distributive rule in experiments C and D and a higher degree of disagreement in experiments A and B (Table 7). From a statistical point of view this can be seen by comparing the variances of subject's evaluation of the distributive rule in the different conditions.

Table 7 - Comparing Experiments: Variances of the Evaluation of the Distributive Rule

Variable in test	Grouped by	Test	p-value	Significant at the 5% level
Evaluation of the Rule	{A} vs. {B}	Levene's Test for Equality of Variances	0,410	No
Evaluation of the Rule	{A} vs. {C}	Levene's Test for Equality of Variances	0,001	Yes
Evaluation of the Rule	{A} vs. {D}	Levene's Test for Equality of Variances	0,000	Yes
Evaluation of the Rule	{B} vs. {C}	Levene's Test for Equality of Variances	0,037	Yes
Evaluation of the Rule	{B} vs. {D}	Levene's Test for Equality of Variances	0,008	Yes
Evaluation of the Rule	{C} vs. {D}	Levene's Test for Equality of Variances	0,611	No

The results of Table 7 allow the identification of two groups of experiments - A, B – the high variance group and C, D – the low variance group[9].

Finally, we investigated if the evaluation of the distribution rule was in anyway influenced by the participation in an experiment where high levels of cooperation were achieved. In order to detect this effect we divided the different observations in two groups: cooperative and non-

[9] When one compares pairs of variances no significant differences are detected between elements of the same group (A, B or C, D) and all pairs formed between elements belonging to different groups do show significant differences.

cooperative. The cooperative group was formed by aggregating the cooperative and the strongly cooperative patterns of Figure 2 and the non-cooperative group was formed by aggregating the non-cooperative and the strongly non-cooperative patterns of Figure 2. The differences in the evaluation of the distribution rule are presented in Table 8.

Table 8 - Differences in the Evaluation of the Distributive Rule Between Cooperative and Non Cooperative Groups

		Average	Minimum	Maximum	Std. Deviation	Number of Participants
Non-Cooperative	Exp. A	4,25	2	7	1,65	16
	Exp. B	3,48	1	7	1,48	40
	Exp. C	3,18	1	6	1,35	72
	Exp. D	5,91	3	7	1,40	32
Cooperative	Exp. A	5,28	1	7	1,52	64
	Exp. B	3,67	1	7	1,77	40
	Exp. C	3,63	2	5	0,92	8
	Exp. D	6,50	3	7	0,99	48

In Table 9 one can see that in experiments A and D there is a significant difference in the medians of the average evaluation of the distributive rule between the cooperative and the non-cooperative groups.

Table 9 – Comparing Groups: Evaluation of the Distributive Rule

Condition	Grouped by	Number	Test	p-value	Significant at the 5% level
A	Cooperative	64	Mann-Whitney	0,031	Yes
	Non Cooperative	16			
B	Cooperative	39	Mann-Whitney	0,748	No
	Non Cooperative	40			
C	Cooperative	8	Mann-Whitney	0,156	No
	Non Cooperative	72			
D	Cooperative	48	Mann-Whitney	0,028	Yes
	Non Cooperative	32			

5. FINDINGS

Finding 1: There was a high level of contribution in the first repetition and in the average contribution rate over the 10 repetitions in experiments A, B and D.

As mentioned in the introduction, classical game theory predicts that in repeated standard public good games subjects' contributions would be zero from the outset[10]. Nevertheless, there is a host of evidence which clearly contradicts these predictions. In a wide variety of conditions, individuals contribute 40 to 60% of their endowments to the public good in the first repetitions, and contributions decline over time with approximately 60 to 80 percent of all subjects contributing nothing in the final period (Ledyard, 1995; Ostrom, 1998)[11].

Previous results also show that the unravelling of cooperation is stronger when opportunities for communication are totally absent. This is contrary to the predictions of currently accepted models according to which players are assumed to be unable to commit to agreements. Indeed, communication is viewed as "cheap talk".

As can be seen in Table 1, the average contribution rate in the first period ranged from 93 to 97% in experiments A, B and D and the average contribution rate over the 10 repetitions ranged from 71 to 85%. These results thus replicate previous ones that showed that, contrary to rational choice theory, communication is not mere "cheap talk" (Ledyard, 1995). It is important to note that these results are observed in social dilemmas experiments that allow *face-to-face* communication (Dawes *et al*, 1998). When indirect forms of communication are devised, such as communication through computer terminals, the increase in cooperation is far lower (Ostrom, 1998).

The high contribution levels observed can be attributed to the existence of pre-play face-to-face communication. However several explanations of the effects of communication are

[10] The same prediction would apply to any of the four experiments in this study.
[11] An explanation given for this behaviour was that subjects needed repetition to fully understand the game and only learned that free riding was dominant over time (Isaac *et al.*, 1985). Andreoni's (1988) and Cookson's (2000) experiments, however, dismissed the hypothesis that this decline in contributions was due to some kind of learning effect, since they found that if the game was re-started, contributions were restored at the initial higher level.

plausible. Exchanging mutual commitments, creating trust, creating and reinforcing norms and developing a group identity are among the most commonly put forward in the relevant literature. These explanations come from very diverse (and sometimes antagonistic) traditions of thought in philosophy and social sciences which will not be explored here. Let's simply refer that face-to-face communication allows the making of promises and the expression of contributive intentions that people subsequently feel committed to comply with. It is important to note that the compliance to previously expressed commitments is conditional on the contributions of others. Face-to-face communication allows the establishing of mutual beliefs and/or expectations that others will contribute. In short, mutual commitments are created and/or reciprocal attitudes are shared by subjects that constitute reasons for subsequent cooperation.

Extensive promise making was indeed observed in the pre-play communication phase (Box 1).

Box 1 – Quotes from the pre-play communication phase

"If everyone contributes, so will I"

"We should all contribute with all our endowment to the common fund"

Of course, making a promise or committing to a specific behaviour does not mean that people will actually behave accordingly. Communication does not give the assurance of cooperative behaviour but our results and previous ones show that the effects of communication are far more effective than predicted by standard game theory.

Finding 2: There was no statistically significant difference between the average contribution rates in experiments A, B and D.

Despite some differences between the contribution rates and the contributive patterns in experiments A and B (especially apparent in Figure 1 and Table 1), there was no statistically

significant difference between them, as shown in Table 3 (see lines 3 and 4). As there was a different distribution rule in these two experiments (equal rule in A and unequal in B), this is an unexpected result.

In experiment A as in experiment B the rule was given by the experimenter and therefore was not subject to choice. In both experiments the group members discussed about the best courses of action on the basis of a distribution rule which was known to them. They acknowledged that each and every element of the group would benefit if all cooperate, and they were able to make the corresponding promises and commitments. The fact that only one member of the group benefited from the inequality did not seem to have a predominant role at this stage because the beneficiary was randomly selected. This may explain the high and very similar contribution rates in the first repetition of both experiments (Table 1).

This does not mean, however, that the individuals perceived the distribution rules equally. As the questionnaire revealed (Table 5 and 6) there were significant differences regarding the evaluation of these rules with the rule of experiment A judged fairer than the rule of experiment B. This in turn suggests a lower degree of commitment to cooperation which is reflected in slightly less frequent full individual contributions in the first repetition and more frequent non-cooperative outcomes in experiment B (Table 2 and Figure 3).

It should be highlighted that the different incentive structure in A and B did not significantly affect the subjects' contributive behaviour. Recall that the public good was unequally distributed, which means that the marginal return rate of the investment in the public good in experiment B was different from the marginal return in experiment A. In the same way, the marginal return rate of the subject who received 30% of the public good was substantially higher. However, his contributive behaviour did not differ from those of the other 7 subjects in each group[12].

In experiment D, the group members chose themselves the equal distributive rule. Despite the fact that the procedure of choice was considered fairer than the one used in experiment A (Tables 5 and 6), there was no statistically significant difference between the contribution levels in both experiments (Table 3, lines 3 and 6), and the existing difference is on average

[12] There are no significant statistical differences in the average contribution rates between the subjects who received 10% of the public good and the subject who received 30%. There is thus no difference in the tests whether the subject who received 30% is included or not.

contrary to the one expected. So, the difference in the decision process of the distributive rule did not affect the subjects' contributive behaviour. The comparison is difficult because in both experiments the contributive level is close to its maximum thus giving no room for discrimination (at least in the first repetition).

Finding 3: The average contribution rate in experiment C was significantly lower than in experiments A, B and D.

The average contribution rates in experiment C were lower in the first repetition (75%), the last repetition (19%) and on the average of repetitions (Table 1). The difference is statistically significant, as shown in Table 3 (see lines 2, 5 and 7). The results also suggest an over-representation of the non-cooperative patterns in experiment C (Table 2). In fact, the contributive levels were very close to those reported in the literature of public good experiments without communication. We must note that these lower contributive levels are not to be explained by the inequality of the rule itself, because on the one hand, as mentioned above, the difference in the incentive structure did not affect significantly the contributive behaviour when experiments A and B are compared. On the other hand, when comparing experiment B with experiment C, one can conclude that the same incentive structure gave rise to significantly different contributive behaviours.

In contrast to the other experiments, in experiment C one of the subjects chose the distributive rule to be applied. The other seven subjects, however, did not know which were the alternatives the chooser was confronted with. Moreover, this decision was taken after the pre-play communication phase.

This means that:

1. The pre-play face-to-face communication phase did not allow the exchange of mutual promises and contributive intentions. Indeed, during the communication phase the subjects used the available time to talk about the decision which was to be taken by the empowered individual rather than focusing on their future behaviour (Box 2).

2. When all subjects were informed about the rule chosen by the empowered individual, they didn't have any clear-cut basis to form any judgement about the decision-makers'

intentions: while some may have guessed that the available alternatives did not include the equal distribution rule, others may have suspected that the chooser selected an unequal rule for his own benefit.

Box 2 – Quote from the pre-play communication phase

"The "chooser" must decide an equal distributive rule"

"But we don't know what rules he can choose"

"He must decide the most equal of all available rules"

In face of this result the following plausible explanation emerges. The lower level of contribution in experiment C may be explained by uncertainty. In this context, uncertainty manifests itself at two different levels. Firstly, uncertainty may refer to the intention of the empowered individual who chooses the rule, in that the other group members are not aware of the alternatives available to him. Secondly, uncertainty may concern the contributive intentions of the other members of the group, in that the individual does not know how the others judge the decision of the empowered individual, nor had he the opportunity to receive signals about their contributive intentions.

Uncertainty in this context has a normative content which is related to justice concerns. Every individual has doubts on whether to approve or disapprove, on justice grounds, the empowered individual's decision, and he has doubts regarding the same evaluation made by others.

Uncertainty may explain the lower contributive levels observed in the first repetition (Figure 4) because the shared belief exists that justice concerns may have an influence on cooperative dispositions, leading individuals who interpret the decision-maker's choice as unjust to refrain from contributing. The lower levels of contribution in the first repetition and the unravelling of contributions that follows may therefore be understood as a result of the combination of two different types of motivations: (a) *indignation*, in result of disapproving the empowered individual's intentions; and/or (b) *fear* (of playing the sucker), in result of the belief that the

disapproval of the empowered individual's intentions by others may trigger their indignation leading them to refrain from contributing.

Finding 4: The contributive dynamics in experiments A, B, D, were highly heterogeneous.

Two main contributive dynamics can be distinguished in Figures 1 and 2:

1. A first type in which there are high contributive rates from the 1st until the last or until the 8/9th repetition – these are sustained cooperative dynamics or positive reciprocity dynamics;

2. A second type in which the non-contribution of one or several subjects leads to a rapid decreasing of the contributive levels – these are non-cooperative dynamics or negative reciprocity spirals.

As reported in the vast majority of experimental and empirical studies, cooperative behaviour is highly conditional – a behavioural pattern called reciprocity. Individuals "tend to react to the positive actions of others with positive reactions and to the negative action of others with negative responses" (Ostrom, 1998:10). According to most authors, reciprocity is a double-edged sword in the sense that it can be responsible, under proper institutional circumstances, for the sustainability of high levels of individual contributions to the provision of public goods while in some cases it can explain its decay.

As mentioned above, communication may favour reciprocity in that it allows the expression of mutual commitments and of the intentions to comply with them. These promises and intentions possess a mutually reinforcing character, which means that when someone does not behave as expected, withdrawal from cooperation becomes very likely, as acknowledged by the subjects in the dialogue phase (Box 3).

Box 3 – Sentences from the pre-play communication phase

"If someone does not contribute, there will be a tendency for others not to contribute".

"Let's see what happens in the first round".

Our conjectural explanation for both types of observed dynamics is that expressing promises and contributive intentions imposes obligations on individuals' future behaviour. These obligations are not just expected to be binding but to be embraced by all individuals as being so.

If someone does not behave accordingly, reciprocity gives rise to the unravelling of cooperation (negative reciprocity). This behavioural pattern and the motives that lay behind it explain the two contributive dynamic cases: when promises were complied with by a vast majority of members, sustained cooperative dynamics were observed; but whenever one or more subjects defected or were perceived to defect, thus defrauding the established expectations, the other members ceased to contribute. Reciprocity involves justice concerns. When one responds with defection to defection, one may not only be motivated by fear, but also, or mainly, by indignation in face of the intention revealed of obtaining an undue benefit at others' cost.

Finding 5: The frequency of full individual contributions in the last repetition in experiments A, B and D is high.

Out of 240 individuals that participated in these three experiments there were 118 who fully contributed in all repetitions, regardless of the contributive dynamics of the session considered.

Out of the 152 subjects that participated in the strongly cooperative and cooperative instances (Figure 2) 111 contributed all the way through the ten repetitions and of the 88 who participated in the strongly non-cooperative and non-cooperative instances 7 always contributed the full amount.

These results show that, when given the opportunity to express contributive commitments, individuals tend to abide by them. In spite of the fact that abidance is in general conditional on overall compliance, there remains an important residual of unconditional cooperation.

6. CONCLUDING REMARKS

Our aim was to better understand and explain the institutional pre-conditions for cooperation in public good provision situations, and in particular the effects of justice concerns on the contributive disposition of individuals.

In order to achieve this we devised an experimental study which incorporated:

- Pre-play face-to-face communication;
- Different distributive rules: an equal (experiments A and D) and an unequal rule (experiments B and C);
- Different procedures to choose the distributive rule: the rule was chosen by the experimenters (A and B), by an empowered individual belonging to the group (C) and through a choice by the group itself (D).

With all the qualifications that generalizations from experimental studies recommend, some tentative conclusions may nevertheless be advanced.

Pre-play communication, as conjectured, *is an important pre-condition for cooperation in public good settings*. The experimental results suggest that in clear-cut situations, that is, when uncertainty is low in respect to the justice of the distributive rule and/or others' intentions – as in experiments A, B and D - communication allows the group members to build a shared interpretation and understanding of the situation they are facing. They exchange promises and express contributive intentions. Beliefs and/or expectations of high contributions are thus established. The mutual commitments are expected to give rise to the corresponding reciprocal attitudes, and thus constitute reasons for subsequent cooperation.

Pre-play communication, as also conjectured, *is not a sufficient pre-condition for cooperation - justice concerns are crucial in explaining differences in aggregated contribution levels*. In spite of communication, twenty out of forty sessions led to non-cooperative, or to strongly non-cooperative outcomes. In experiments A, B and D the non-cooperative and strongly non-cooperative outcomes were always triggered by deviations from full contributions by only one

or two individuals – a grain of sand in the mechanism was enough to cause a spiral of negative reciprocity. Such dynamics are related to justice concerns in the sense that those deviations may be interpreted as non-compliance with former commitments and as attempts to obtain an advantage at the cost of others. Since the only mean available to express disapproval in face of commitment failure was for individuals to withdraw from cooperation, initial deviations tended to give rise to non-cooperative outcomes.

In respect to the difference in outcomes in experiment C (significant lower levels of average contribution in the first and last rounds, and high frequency of non-cooperative outcomes) justice concerns are involved in the uncertainty that prevailed. Subjects were uncertain about the intention of the empowered rule chooser, and they were uncertain about the interpretations given by others to that intention. Those disapproving the rule choice might feel prone to express that disapproval by not contributing, those believing that others might disapprove the rule choice, feared that contribution levels might be low at the outset. The mix in levels of uncertainty combined with the absence of opportunity to clearly express commitments may explain the observed result.

Some of the initial conjectures were not corroborated. The absence of significant differences (in fact the inversion of the expected difference) between experiments A and D is a surprising but inconclusive result. On the other hand, the absence of a significant difference between experiments A and B and the existence of a significant one between experiments B and C are instructive. Subjects tended to consider the unequal share rule as more acceptable when the benefited subject was randomly chosen than when the rule benefited the one who had the power to enact it. This result suggests that inequality seems to be more acceptable when the distributive rule is due to nature (or to a random draw) than when it is deemed to be the result of an intentional discriminating decision by a pear. Overall, the perception by the individual of the (in)justice of others' behaviour had a more important effect on her contributive behaviour than the evaluation of the institutional settings' justice.

The results suggest that neither pre-play communication nor distributive equality by themselves, or even taken together, are sufficient pre-conditions for cooperation. On a speculative vein, it may be conjectured that the sustained observance of the contributive norm requires both communication and justice, but distributive justice can only prevail if a minimum level of monitoring and of sanctioning are allowed. However, the levels of

monitoring and sanctioning do not have to be those that correspond to incentives that dissolve the dilemma situation. Sanctions may be operative not mainly because they change the cost-benefit balance of selfishness, but because they prevent justice motivations from manifesting themselves by the withdrawal of contributions. The reason that those committed to cooperation need for continuing to do so is that *enough* others cooperate (Hollis, 1998), and the reason that they need to abstain from expressing disapproval through withdrawal is that an institutional mechanism exists to sanction non-compliance. As long as withdrawals from cooperation due to justice concerns do not get mixed up with pure defection, feeding the spiral of negative reciprocity, a situation may exist where *sufficient* levels of cooperation are sustained, in spite of occasional defections and even in the absence of an ever-present and perfectly efficient Leviathan.

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