From Commons Dilemmas to Social Solutions: A Common Pool Resource Experiment in Greece

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1 Introduction

The common pool resources (CPR) is a special category of goods with two main attributes: non-excludability, meaning that it is too difficult (i.e. too expensive) to exclude someone from using them, and rivalry, meaning that consumption by someone reduces availability to others (Ostrom 1990, 2003). These characteristics make possible overuse of the resource giving rise to conflicts of interest (Ghosh 2007); a situation in which users have to choose between overexploiting the common good to maximise their short-term personal returns, and refraining from doing so for the shake of the long-term, common benefit and the sustainability of the resource (Ostrom 2010a). A term which is commonly used to refer to

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such a situation is 'social dilemma' or 'social trap' in CPR (Kollock 1998; Ostrom 1998, 2010b; Van Lange et al. 2013).

Over the years, many scholars (e.g. Kollock 1998; Lichbach 1996; Vatn 2007) have discussed such social dilemmas arising in public goods and environmental resources, whereas others (e.g. Davis and Holt 1993; Isaac and Walker 1988; Isaac et al. 1994) have conducted experiments to explore precisely how individuals behave in such situations. In turn, Ostrom (2009, 2010a), among others, has used experiments and games to shed light on social dilemmas individuals face in CPR and to offer insights for dealing with them. In such games, conventional game theory proclaims that rational individuals have actually no choice but to maximize their personal returns, reaching appropriation levels at a Nash equilibrium that is above the social optimum (Cárdenas and Ostrom 2006; Ostrom 1998, 2010a). As such, the resource is overused and overexploited and so gradually depleted and led to degradation and destruction. This, rational choice models assert, is inevitable even in the case that some individuals decide to cooperate, opting for a sustainable use of the resource (Ostrom 2009). Others, theory predicts, will free-ride on the contributions of the cooperators leading eventually to 'the tragedy of the commons' (Hardin 1968). Therefore, what is required is an external mediation, where power to enforce the sustainable use of the resource is assigned either to a central authority or to a third party (Ostrom 1989).

However, extensive field and laboratory research has established that users enjoying good communication and feedback about the effect of their actions on a CPR would craft institutions that enable them to overcome commons dilemmas and to sustainably manage the resource (Carpenter 2000; Mason and Phillips 1997; Ostrom 2009). Key factors that increase cooperation in such situations is the existence of trust and reciprocity among involved parties, enable them to build a reputation for being trustworthy, as well as previous experience and engagement in collective action (Berg et al. 1995; Chaudhuri et al. 2002; Ortmann et al. 2000; Ostrom 1998, 2011; Putnam 1993). This is also the case in CPR dilemma experiments conducted in repeated games. Studies (e.g. Ahn et al. 2011; Cárdenas and Ostrom 2006; Ostrom and Walker 1991; Ostrom et al. 1994) have found that the possibility of encountering the same individuals in subsequent rounds is likely to increase cooperative behaviour, even under the condition of anonymity. This is because interaction with the same people allows participants to acquire information, to credibly signal their intentions to others (including readiness to punish defectors) and to build reputation and trust, all of which are crucial for reciprocal behaviour and the emergence of cooperative equilibria (Cárdenas and Ostrom 2006).

In addition, experimental findings on social dilemmas have revealed that face-to-face communication is not simply a 'cheap talk' (i.e. non-binding costless communication), but has an important effect in fostering cooperation among participants (Ahn et al. 2011; Cárdenas and Ostrom 2006; Kollock 1998; Ostrom 1998; Ostrom et al. 1992; Sally 1995). Face-to-face communication allows players to effectively exchange powerful signals, embodied even in body language, facial expressions and eye movements, which are beyond conscious manipulation and cannot be mimicked be free riders (Ahn et al. 2004; Poteete et al. 2010). These allow individuals to build trust amongst them, to mould a group identity and to establish informal arrangements and norms that make cooperation among players credible (Ahn et al. 2011; Janssen et al. 2011; Kollock 1998; Ostrom 1998; Ostrom and Nagendra 2007). As such, Sally (1995) concludes that face-to-face communication in repeated experiments significantly raises the cooperation rate by 40 percentage points, on average, as compared to no communication among subjects. However, as stakes increase or as the game closes to an end, the temptation to cheat on prior agreements increase and communication becomes less efficacious (Ostrom 1998).

Changing the rules of the game by using scarce resources to punish those who do not cooperate or keep agreements is not regarded as a viable option in CPR experiments. This is because participants face a kind of a second-order social dilemma (of equal or greater difficulty) in any effort to use costly sanctions to punish defectors (Heckathorn 1989; Oliver 1980), a situation which conventional rational choice theory predicts that would lead to failure. Yet, empirical evidences in many field settings and laboratory experiments reveal that participants do exactly this, that is, they make agreements and use monitoring mechanisms and graduated sanctions to enforce compliance (Fehr and Gächter 2000; Ostrom 1990, 1998; Ostrom et al. 1992; Sefton et al. 2007; Yamagishi 1986). Interestingly, scholars found that not only subjects are willing to pay a fee in order to fine noncooperators, but also that when sanctioning is combined with face-to-face communication outcomes improve substantially and defections are reduced (Ostrom et al. 1992).

Aiming to contribute to the above literature, the current paper uses an experimental setting to explore the ability of small groups of individuals by communicating with each other to cooperate and to form institutions that overcome commons dilemmas. For this purpose, three experiment sessions were undertaken with 77 final-year undergraduate students of Economics studying at the University of Thessaly in Greece. The game was played in eight rounds, where every two the rules were slightly changed. The study recorded the decisions of the subjects in each round examining whether, under different communication conditions, they would refrain from personal maximisation towards the sustainable use of the CPR. The purpose and design of the game was primarily pedagogical. However, from the beginning one of the goals was to conduct the sessions in such a manner that the results could be used for research purposes. To the best of our knowledge this is the first time that such a CPR dilemma experiment is reported using Greek subjects. Following this short introduction, the rest of the text is structured as follows. The next section outlines, respectively, the design of the game and the results of the experiment, whereas the final section concludes highlighting the key findings emerged.

2 The Game

Aiming to shed some preliminary light on how Greeks would behave in simple social dilemma situations we conducted a typical laboratory CPR experiment similar to that of Ahn et al. (2011) (for a more detailed discussion on such experiments see Anderies et al. 2011). However, in an attempt to explore further the role that sanctions play in enhancing cooperation and collective action, we extended the original game by allowing subjects to punish noncooperators (or individuals who do not keep agreements) at a cost to themselves.

Following many other experiment studies in public goods and CPR (inter alia: Carpenter 2000; Fischer et al. 2004; Isaac and Walker 1988; Isaac et al. 1994; Mason and Phillips 1997; Ostrom and Walker 1991; Ostrom et al. 1992) we used university students as subjects. These were final year undergraduates, studying at the Department of Economics at the University of Thessaly, Greece. Carrying out the recommendations of Anderies et al. (2011), data on the participants were collected through a questionnaire that was filled in by the subjects at the end of the experiment. The questionnaire recorded basic sociodemographic characteristics along with views, attitudes and aspects of their behaviour that the relevant literature (e.g. Anderies et al. 2011; Kollock 1998; Ostrom 1998) acknowledges as significant for facilitating cooperation in CPR dilemmas. All subjects were Greek nationals; their gender composition was 57.9%

male and 42.1% female and their average age was somewhat above 21 years, with the oldest student being 40 years old. Participants had met before in classes and in other occasions, and so they knew each other to an extent. Therefore, they had a history of trust, reciprocity and reputation that was not unknown to subjects at the time of the experiment. The experiment was conducted in three sessions; one took place in 2015 (S2015) and the other two in 2016 (S2016a and S2016b).

2.1 Design

The experiment was explained as a game of harvesting a renewable CPR. In particular, participants were asked to imagine themselves as fishermen, fishing for fish in a local lake. The game was played for 8 rounds keeping a fixed match protocol in which each student was assigned randomly to a group of seven. The group composition was initially (up to round 5) unknown to participants. In rounds 1 and 2 subjects were sitting in the same seminar room but they made their decisions in private, having no discussion at all. In rounds 3 and 4, subjects were allowed to communicate as a large group for ten minutes. The communication in these rounds was among all participants of the current session, but subjects did not know the exact composition of their groups. In round 5 and onwards subjects were informed of their fellow group mates, and groups were instructed to move to separate rooms where members could communicate in private, again for ten minutes. As in previous studies using face-to-face communication, subjects were explicitly told that they could not threaten others or make offers of side payments. Finally, in rounds 7 and 8, being informed of the total (group) as well as the individual (each members') harvesting levels in their group, subjects were given the opportunity to punish (at a cost) any group member they reckoned it did not comply with the strategy (rule) of the group.

In each round participants made their decisions in private, marking on a paper form (given to them) the units of the resource willing to extract. These papers were collected by the experimenters (in each round), who calculated the total harvesting level and average cost of the group. The papers were, then, given back to subjects who, on the basis of the reported group aggregate and their own harvesting level, were asked to calculate their individual earnings according to a payoff function.[1] This payoff

[1] Note, that during the first six rounds, subjects did not know the individual decisions of the others in the group; they were informed only of the total aggregate extraction of their group.

function was the same as that used in Ahn et al. (2011), replicating Walker et al. (2000), in which the marginal cost of appropriation from the CPR increases with the aggregate level of harvesting. Specifically, the per-round pay-off function for player *i* was:

$$\pi_i = \left[0.761x_i - 0.007x_i^2\right] - \left[x_i\left(\frac{0.01(X+1)}{2}\right)\right],$$

where x_i denotes the harvesting units of individual *i* and *X* denotes total number of units extracted by the group (of seven people). According to the payoff function, and as is typical in CPR experiment settings, increasing harvesting units yields higher individual earnings while aggregate extraction reduces them.

Walker et al. (2000) provided the one-shot game Nash equilibrium and social optimum of this setting. If the sum of units extracted by the six other members of a group is Y, then the payer i's best respond function is $32.5–0.208Y$. Assuming the monetary payoff function as the utility function of the game, the unique symmetric Nash equilibrium of the one-shot game involves each individual in a group harvesting 14 units. This outcome gives to each player a per-round monetary payoff of €2.35. In turn, the socially optimal outcome involves each subject harvesting 9 units with a corresponding per-person payoff of €3.40. However, if all team members decide to harvest 9 units, a player maximise her monetary payoff by extracting 20 units.

The game and the cost and benefit functions were explained orally to the subjects and handed out to them in a form of written instructions. This included a table showing the gross benefits of each harvesting unit from 1 to 60 (provided in Appendix). The benefits were the same to all participants (for the same extraction units) but the average costs were increasing as the total appropriation units were accumulating. Subjects undertook a number of handwritten exercises to ensure that they understood the game.

2.2 Results

This section discusses the results of the game. Following Ahn et al. (2011) the presentation focuses on individual decisions, organized around experiment sessions, instead of seven-person groups. This allows certain comparisons to be made between our Greek subjects and those participated in Ahn's et al. experiment sessions (coming from 41 countries). Harvesting levels and earnings at the Nash equilibrium and the social optimum are used as behavioural benchmarks.

Table 1 displays summary information on the harvesting levels aggregating across the three sessions, whereas Table 2 provides information for each individual session, i.e. S2015, S2016a and S2016b. As becomes evident from Table 1, in round 1 the individual harvesting averaged at 17.92 units, well above the social optimum of 9, as well as above the Nash equilibrium prediction of 14. As the game progressed and experience accumulated, the average extraction level fell from 17.92 units in round 1, to 14.82 units in round 2, and to 14.78 in round 3, in which large-group communication was allowed. Both figures are very close to the Nash equilibrium. The average extraction level rose somewhat in round 4 (as some participants attempted to capitalise the information obtained through large-group communication for their own benefit) and fell immediately after small-group

Table 1 Summary of harvesting levels

	Round	N	*Mean*	*Standard deviation*	*Median*	*Percentiles*			*Min*	*Max*
						25	*50*	*75*		
No communication	1	77	17.92	14.35	15	8.0	15.0	23	1	54
No communication	2	77	14.82	12.33	11	8.0	11.0	17.5	1	60
Large-group communication	3	77	14.78	10.60	12	8.0	12.0	17.5	2	54
Large-group communication	4	77	15.90	9.53	13	10.0	13.0	20.0	2	54
Small-group communication	5	77	11.10	3.49	10	9.0	10.0	12.0	5	26
Small-group communication	6	77	10.73	3.69	9	9.0	9.0	12.0	8	30
Small-group communication & sanctioning	7	77	11.07	2.70	10	9.0	10.0	13.0	5	20
Small-group communication & sanctioning	8	77	10.17	2.02	9	9.0	9.0	10.0	6	17

Note: Nash equilibrium = 14; Social optimum = 9

Source: Own construction

Table 2 Average level of extraction by session

	Round	*S2015*	*S2016a*	*S2016b*	*All sessions*
No communication	1	18.18	15.64	20.62	17.92
No communication	2	12.04	12.68	21.24	14.82
Large-group communication	3	15.39	13.04	16.43	14.78
Large-group communication	4	15.89	15.25	16.76	15.90
Small-group communication	5	10.82	11.29	11.24	11.10
Small-group communication	6	9.75	9.79	13.29	10.73
Small-group communication & sanctioning	7	10.93	11.71	10.38	11.07
Small-group communication & sanctioning	8	9.61	10.39	10.62	10.17

Note: Nash equilibrium = 14; Social optimum = 9

Source: Own construction

communication was allowed, from 15.90 in round 4 to just above 11 in round 5. Introduction of sanctioning (along with face-to-face communication in small groups) further improved outcomes bringing the mean harvesting level in round 8 down to slightly over 10 units. As can be noticed, the average extraction levels in rounds 5 to 8 are very close to the social optimum of 9 units. As regards the dispersion of the decisions, we observe that, as communication was improving and players gained more experience in rounds, the standard deviation decreased sharply, from 14.4 units in round 1, to 3.69 units in round 6. Similarly, when sanctioning was combined with face-to-face communication standard deviation dropped further, to just above 2 in round 8, indicating reduction of non-cooperation or defection among the players. Interestingly, similar findings are reported in Ahn et al. (2011), as well as elsewhere in the literature (e.g. Ostrom et al. 1992).

As regards the variation in the levels of appropriation, information is also provided by the minimum and maximum values (Table 1). Interestingly, similar to Ahn et al. (2011), we see that at the beginning of the game in rounds 1 and 2, there were subjects who extracted 54 or even 60 units. These were no single cases; in fact, there were five participants who decided to harvest 54 units in round 1, one of whom continued with the same strategy in round 2. In rounds 3 and 4, average extraction levels dropped, but again one player persisted in extracting the high amount of 54 units. Obviously, harvesting a very high (or a very low) amount of CPR units suggests confusion or misunderstanding over the payoff properties of the game; a situation which was improved substantially as the game progressed. Indeed, the subjects who extracted a very high number of resource units in rounds 1 and 2 immediately reduced their harvesting close to the social optimum in the rounds that followed.

Now let us move to the results of each session, described in Table 2. We observe that in round 1 average harvesting levels in all sessions lay well above the Nash equilibrium prediction, ranging from 18.18 units (in S2015) to 20.62 (in S2016b). In round 2, where still no communication was allowed among participants, appropriation was reduced but remained high and close to the Nash equilibrium benchmark, showing a trend that is consistent with the pattern found in Ahn et al. (2011) as well as in other experiments (e.g. Herr et al. 1997). In particular, the average extraction volumes in sessions S2015 and S2016a fell below the Nash equilibrium prediction, but stayed closer to it rather than getting near to the social optimum benchmark.

In rounds 3 and 4, where open discussion among all participants was allowed, decisions on levels of appropriation in all three sessions converged closer to the Nash equilibrium benchmark. In particular, in round 3, S2015 and S2016a, which in the previous round exhibited an average extraction level below the Nash equilibrium, raised their harvesting level to get closer to it, whereas S2016b (which in round 2 had an extraction level above the Nash equilibrium) lowered it. This stands in contrast to the findings of Ahn et al. (2011). We argue that possible explanations of this behaviour should be sought in relation to the profile of the players. Their cultural/national background or rather the fact that they are all well trained economists should play a role, since the strategy the subjects seem to follow was to use the information and knowledge gained from the group discussions in order to maximise their personal utility. This behaviour is also apparent in round 4.

The picture changed when small group face-to-face communication was at play (rounds 5 and 6). Knowing personally the others in the group and having private discussions with each other led players to reduce their harvesting units to levels that lie closer to the social optimum, in all sessions. Similar findings are reported in Ahn et al. (2011), who argue that small groups and face-to-face contact among members enhance cooperation and make easier optimal decisions to be reached. This trend repeated even when sanctioning was also allowed, reaching harvesting levels in round 8 which were the closest possible to the social optimum benchmark

(9.61 units in S2015, 10.39 in S2016a and 10.62 in S2016b). Interestingly, in round 7, when sanctioning was introduced, participants increased their harvesting as compared to this of the previous round (in S2015 and S2016a). We argue that the fact that many students not only knew each other in their group prior to the game, but some were also friends, led them to believe that no fine will be imposed on them by their group mates, and as such they could not resist the temptation to take advantage of others' cooperativeness by increasing somewhat their harvesting levels. This was also verified at the private discussions the experimenters had with the subjects right at the end of the game and afterwards.

Further conclusions on the behaviour of the subjects can be drawn from the average returns, presented in Tables 3, 4, and 5. Table 3 summarizes the results related to absolute earnings per round. As can be seen, due to the large harvesting levels both in rounds 1 and 2 (without communication) and 3 and 4 (large-group communication), the average payoffs to individuals were either negative or very low and variation was high. In particular, in round 1 the mean payoff was negative (−€2.14) and standard deviation the

Table 3 Average earnings (in €)

	Round	N	*Mean*	*Standard deviation*	*Median*	*Percentiles*		
						25	*50*	*75*
No communication	1	77	−2.14	6.54	0.05	−2.13	0.05	0.92
No communication	2	77	0.09	5.29	1.69	−0.31	1.69	3.00
Large-group communication	3	77	0.87	3.82	1.76	0.83	1.76	2.51
Large-group communication	4	77	0.55	2.74	1.21	0.34	1.21	1.92
Small-group communication	5	77	2.93	0.68	3.22	2.57	3.22	3.40
Small-group communication	6	77	2.96	1.03	3.12	2.91	3.12	3.40
Small-group communication & sanctioning	7	77	3.25	0.77	3.40	2.98	3.40	3.40
Small-group communication & sanctioning	8	77	3.23	0.36	3.40	3.31	3.40	3.40

Note: Nash equilibrium earnings = 2.35; Social optimum earnings = 3.40

Source: Own construction

Table 4 Average earnings (in €) and as a percentage of benchmarks

	Round	N	*Mean*	*Percentage earnings of Nash*	*Percentage earnings of optimum*
No communication	1	77	−2.14	−91.06	−62.94
No communication	2	77	0.09	3.83	2.65
Large-group communication	3	77	0.87	37.02	25.59
Large-group communication	4	77	0.55	23.40	16.18
Small-group communication	5	77	2.93	124.68	86.18
Small-group communication	6	77	2.96	125.96	87.06
Small-group communication & sanctioning	7	77	3.25	138.30	95.59
Small-group communication & sanctioning	8	77	3.23	137.45	95.00

Note: Nash equilibrium earnings = 2.35; Social optimum earnings = 3.40

Source: Own construction

Table 5 Average earnings by session (in €)

	Round	*S2015*	*S2016a*	*S2016b*	*All sessions*
No communication	1	−2.06	−0.96	−3.83	−2.14
No communication	2	1.92	2.10	−5.04	0.09
Large-group communication	3	0.53	2.26	−0.53	0.87
Large-group communication	4	0.53	0.94	0.04	0.55
Small-group communication	5	3.16	2.80	2.78	2.93
Small-group communication	6	3.21	3.34	2.11	2.96
Small-group communication & sanctioning	7	3.67	2.83	3.25	3.25
Small-group communication & sanctioning	8	3.32	3.18	3.18	3.23

Note: Nash equilibrium earnings = 2.35; Social optimum earnings = 3.40

Source: Own construction

highest (€6.54), owing to the costly externality created by some players who opted for a very high level of resource appropriation. The average earnings in rounds 2 to 4 were higher (and standard deviation dropped) but again below the Nash equilibrium prediction of €2.35 (and, of course, much below the social optimum). In turn, rounds 5 to 8 showed increasing average earnings (and low variation), getting much closer to the social optimum benchmark and above this predicted by the Nash equilibrium.

Table 4 summarizes the results related to absolute earnings and earnings relative (as percentage) to the two theoretical benchmarks. As becomes evident, in rounds 1 and 2 (without communication) the average payoffs to individuals were negative or very low due to the large average level of extraction. In rounds 3 and 4 average earnings improve, but not enough in order to get closer to the theoretical benchmarks. This, again, was a result of the decision of some participants to harvest a high volume of resource units, increasing substantially the social costs. Only in round 5 and onwards (where face-to-face communication was made possible) the average earnings were multiplied, getting very close to those at the social optimum (ranging from 86.18% in round 5, to 95.00% in round 8), and above those at the Nash equilibrium (ranging from 124.68% in round 5, to 137.45% in round 8). These results are similar to those of Ahn et al. (2011), verifying that personal discussions and agreements among participants in small groups improve outcomes to a great degree.

Finally, Table 5 provides the average earnings at a session level. We observe that the average earnings in the first two rounds (no-communication) showed substantial variability, with a high of €2.10 (round 2 of S2016a) and a low of −€5.04 (round 2 of S2016b). The highest average is still closer to that predicted by the Nash equilibrium than it is to the social optimum. Of the 6 reported averages in these rounds, only 2 were positive. Low average earnings were evident in the next 2 rounds, in which large-group communication was allowed, but negative earnings were apparent only once (round 3 of S2016b). As the game progressed all sessions improved the average earnings, getting closer to these prescribed by the social optimum. Similar results are also reported in Ahn et al. (2011). As was expected, the imposition of fines at a cost to participants (in rounds 7 and 8) reduced the average returns (round 8 in S2015, round 7 in S2016a, and round 8 in S2016b) as compared to those gained at the previous state (since sanctioning costs were subtracted from earnings); a finding that has been reported by others as well (e.g. Ostrom et al. 1992).

3 Conclusions

The current study employed an experimental setting to explore the ability of small groups of individuals by communicating with each other to cooperate and to fashion institutions that overcome CPR dilemmas. For this purpose, three experiment sessions were undertaken with final year undergraduates in Economics studying at the University of Thessaly in Greece. The game was played in eight rounds, where every two the rules and communication conditions were changed. The study recorded the decisions of the subjects in each round (in terms of appropriation levels and payoffs), examining whether, under different conditions, they would refrain from personal maximisation towards the sustainable use of the resource. To the best of our knowledge this is the first time that such a CPR experiment is reported using Greek subjects. A number of points that have emerged are highlighted next. These are important not only for our scientific understanding but also for the design of institutions to facilitate individuals' achieving higher levels of productive outcomes in CPR dilemmas.

First, in cases of both no communication among subjects and communication in one large group, outcomes were suboptimal, that is, closer to the Nash equilibrium benchmark rather than to the social optimum. In contrast, when small-group, face-to-face, communication was allowed decisions converged to achieve social optimal (or near optimal) outcomes. This suggests that both direct, personal contact among individuals and association in small groups are important factors in achieving and maintaining a cooperative outcome that enable sustainable use of CPR. Similar findings are reported by Ahn et al. (2011) and Herr et al. (1997), amongst others.

Second, our research indicated that individuals (if given the possibility of sanctioning each other) are willing to assume material costs in order to enforce agreed rules and to punish violations of social norms in general. This mechanism (and especially the threat of sanctioning) deters noncooperation and aligns individuals' behaviour along collective interests, as other scholars have also pointed out (inter alia: Anderies et al. 2011; Cárdenas and Ostrom 2006; Fehr and Gächter 2000; Ostrom 1998; Stout 2006). Moreover, our experiment also revealed that the number of actual punishment events was quite small, enabling us to conjecture that in small groups of known individuals, costly punishment can be employed but remains rather low.

Third, related studies (e.g. Ahn et al. 2011; Ostrom 1998) have reported that in finitely repeated CPR experiments subjects appear to be learning how to cooperate as the game progresses, but cooperation rates drop in the last round (whenever this occurs) and participants revert to maximising behaviour. This does not seem to be the case in our experiment. Instead, we observed instances of personal maximisation in progressive rounds of the game (when communication as a large group was allowed) and high degrees of cooperation and rule compliance in the last round. We assert that possible explanations of this should be sought in the profile of the subjects. The fact that they are all final year undergraduates in Economics should play a role in the strategy they followed in early stages of the game to capitalise the information provided for their own benefit, attempting to maximise their individual utility. In turn, in the last round it seems that personal acquaintance and friendly relations among participants (prior the experiment and onwards), in addition to the threat of sanctioning, forged a group identity and a reputation for being trustworthy that remained in force to sustain cooperative behaviour despite the increased temptation to cheat and to maximize personal returns.

Fourth, the differences between outcomes in successive rounds with no rule change (e.g. between rounds 3 and 4, 5 and 6, etc.) were relatively small, suggesting that single repetition of a round without variation in the conditions might not have a significant effect in altering the results of the game. This also corroborates the finding that direct contact in small groups is a powerful condition for efficient communication and increased cooperation towards the sustainable management of CPR.

Finally, although norms are developed in a social milieu and can vary noticeably across cultures (or given settings) we found no particular differences in behaviour between our Greek subjects and those of other countries, reported in Ahn et al. (2011). This certifies the generalization of the discussed behavioural traits, affirming that individuals in commons dilemmas are inclined, under certain conditions, to articulate cooperation-facilitating institutions that help avoid social dilemmas as much as possible.

Appendix

Table 6 Benefits per harvesting unit (in €)

Harvesting units	*Benefits*	*Harvesting units*	*Benefits*	*Harvesting units*	*Benefits*	*Harvesting units*	*Benefits*	*Harvesting units*	*Benefits*
1	0.75	13	8.71	25	14.65	37	18.57	49	20.48
2	1.49	14	9.28	26	15.05	38	18.81	50	20.55
3	2.22	15	9.84	27	15.44	39	19.03	51	20.60
4	2.93	16	10.38	28	15.82	40	19.24	52	20.64
5	3.63	17	10.91	29	16.18	41	19.43	53	20.67
6	4.31	18	11.43	30	16.53	42	19.61	54	20.68
7	4.98	19	11.93	31	16.86	43	19.78	55	20.68
8	5.64	20	12.42	32	17.18	44	19.93	56	20.66
9	6.28	21	12.89	33	17.49	45	20.07	57	20.63
10	6.91	22	13.35	34	17.78	46	20.19	58	20.59
11	7.52	23	13.80	35	18.06	47	20.30	59	20.53
12	8.12	24	14.23	36	18.32	48	20.40	60	20.46

Source: Adapted from Ahn et al. (2011, 1587)

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