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COMPETITION, INFORMATION AND COOPERATION

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Competition, Information and Cooperation

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Abstract

We inquire experimentally whether rivalry induced by competition has any impact on the individual voluntary contribution to a public good. Participants perform a task and are remunerated according to two schemes, a non-competitive and a competitive one, then they play a standard public goods game. In the first scheme participants earn a flat remuneration, in the latter they are ranked according to their performance and remunerated accordingly. Information about ranking and income, before the game is played, varies across three different treatments. We find that competition per se does not affect the amount of contribution. The time spent to choose how much to contribute is negatively correlated with the decision of cooperating fully. The main result is that full information about the relative performance in the competitive environment enhances cooperation, while partial information reduces it.

Keywords: competition; cooperation; information; public goods; experiments
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1. Introduction

The possible effects that a competitive environment may have on social interactions is the basis of this paper. On the one hand, "markets and other economic institutions do more than allocate goods and services: they also influence the evolution of values, tastes and personalities" (Bowles 1998, page 75), so that "social preferences and tastes may not be independent of the institutional environment" (Brandts et al 2009, page 1158). On the other, the hypothesis of selfishness as the sole determinant of human behaviour in economic activity is a reductive extension of behaviour in competitive markets to all aspects of economic interaction (for a similar point of view see, for instance, Fehr and Schmidt 2000).

Although the issue of how economic institutions - like markets - affect social preferences has been discussed broadly in the literature[1], few studies have analysed experimentally the effect of specific aspects usually associated with markets, like competition, on the disposition to cooperate. Brandts et al. (2009) study the effects of competitive rivalry on the disposition towards others in a social dilemma game without complete contracts. They find that rivalry increases neither efficiency nor the income of those on the short side of the exchange relation; in addition, it has a negative effect on the subjective well-being of those on the long side, and a positive one on those on the short side, therefore generating inequalities. More importantly, in analysing the derived consequences rivalry may have on well-being, they conclude that interacting under rivalry has a negative impact on people's behavioural disposition towards others, by decreasing "subsequent willingness to help" and potentially leading to the "obstruction of future cooperation" and "a deterioration of the social relations between interaction partners", in particular, towards those encountered in the interaction, and whom can be met again in the future. Significantly, they note that these effects cannot be explained only by differences in earnings due to interaction, but "are strongly related to experienced emotions" (page 1166).

Carpenter (2005) conducts an experiment to measure the effects of economic institutions on people's social preferences, with the intent to assess whether and how aspects traditionally associated with markets, in particular anonymity and competition, affects individuals' preferences for other people's well-being. Results show that reducing anonymity makes people "more social", as it reduces people's ability to engage in opportunist acts, and more importantly, that market competition "erodes social preferences", not only because it encourages

[1] For a discussion of theories concerning the role of markets in the formation of social preferences see for instance Carpenter (2005).

opportunistic behaviour, thus "creating a less friendly atmosphere", but also because the market institution itself - through a sort of framing effect - "decreases the other-regardingness" of participants (page 3).

A negative effect of competition on the propensity to cooperate has also been found by Canegallo et al. (2008), who study subjects' contribution to a public good in three different economic environments characterized by different degrees of competition.

Similar experimental findings are discussed in Hoffman et al (1994), who examine the effect of the framing of interactions as markets on ultimatum bargaining outcomes, and find that when interaction is framed as a market interaction the distribution of the surplus is significantly affected (sellers offer much less of the surplus to buyers). Markets appear to stimulate more egoistic behaviour, with a deterioration of social preferences. Schotter, Weiss and Zapater (1996) show that the introduction of competition reduces offers in the ultimatum game, providing evidence that competition seems to make participants more selfish.

Our experiment aims at inquiring into the effects of two aspects of competition. First, we ask whether competition has any effect on the willingness to give any positive amount to the voluntary provision of a public good. Second, whether the results of this competition in terms of both position in the ranking and wage premiums affect one's contribution to the public good.

In the following section the experimental design and procedure are described; in section 3 we introduce the experimental methodology; the descriptive and econometric results are given in sections 4 and 5, and section 6 concludes.

2. Experimental design and procedure

We designed an experiment with two steps and four treatments, and we implemented a repeated public goods game (PGG) with re-matching, so that each subject always played each round against subjects who were all different from those of the other rounds. A total of 160 subjects participated in the experiment, 40 for each treatment. All of them were students of the School of Economics of the University of Torino (Italy). We recruited them by advertising for the experiment on the webpage of the School, and they enrolled following an online procedure. No show up fee was given. Each experimental session involved 20 participants. Full anonymity was granted during and after the experiment.

The experiment was made of two parts. In the first the participants were asked to perform an administrative-type task consisting in recopying the enrolment numbers, the names and the scores of fictitious students, whose names were created by choosing at random a string of letters, on a form on the screen of their pc. A quadruplet made of enrolment number, surname, name and mark entered correctly in the form made a complete unit of the task. In case of mistakes, the program alerted the participant and did not allow him or her to continue before the mistake had been corrected.

The first difference between the treatments concerns the remuneration of this part of the experiment. We implemented two schemes, a non-competitive and a competitive one; the first provides the baseline for assessing the effect of competition and henceforth will be called "baseline treatment"(BL). In the non-competitive scheme 20 subjects received a remuneration of 8.5€ if they recopied correctly 40 quadruplets in 30 minutes and 4 € if they did not. The program announced the end of this part of the experiment either when the 40th quadruplets had been filled, or when 30 minutes are over[2]. In the competitive scheme the number of lines to be recopied was not limited, and at the end of the task, i.e. after 30 minutes, those subjects were ranked according to their performance, and the payments were differentiated. The players in the best group of 5 (that is, those who completed the highest number of quadruplets) obtained 15€, those in the second best group 10€, those in the third 6€ and those in the last 3€. The payment in the baseline treatment (i.e. 8.5€) corresponds to the expected payment under the competitive treatment[3]. The players recopied on average 80.08 quadruplets under the competitive scheme, i.e. double the goal assigned in the non-competitive framework. This proves that the requirement under the non-competitive treatment was easy to accomplish and arguably did not entail competition among the subjects. Before starting the session, the experimenters informed the subjects about the rules. In particular the subjects in the competitive environment knew that they would have been divided in four groups according to their performance and that the payments were to be scaled across the groups, with the highest for the best performing group. In contrast, the information about the exact amounts paid to each group and about the actual ranking was provided in different ways across the treatments, as will be explained in detail below.

After performing the described task, the subjects played five rounds of a classical PGG in groups of four anonymous individuals. In order to maximise the number of observations, we re-matched the players after each round, following two rules. The first was *random matching* (see

[2] It never occurred that a subject did not complete the task in the 30 minutes allocated.
[3] This allows to compare average performances and average choices across the treatments.

Andreoni, 1988 and Botelho et al., 2009), which means that at each round the players were matched with three others who were not members of the same group in the previous or subsequent rounds[4]. In other words, each player faced three new opponents in each round. The second rule, relevant for competitive treatments, further constrained this re-matching procedure to form the groups so as to always include one player from each of the quartiles in which the players were ranked after the initial task. This procedure was envisaged to avoid any possible effect due to the average amount gained in the first part of the experiment. Assume that contributions increase with initial income. If three subjects with low initial income and a subject with high initial income compose a group, the latter will possibly contribute more than the former (the three subjects with the low initial income) in the first round. At the end of the round, when the high-income individual looks at the sum of all the contributions, s/he could get disappointed by the fact that the other three members contributed less than her/him, and this could affect her/his subsequent behaviour (see Cherry et al., 2005 and Buckley and Croson, 2006). The composition of the groups described above excludes this effect. However, given the capacity of the lab (20 seats), the described procedure allowed for a maximum of five rounds of the PGG.

The players who worked in the competitive environment played the PGG under three different treatments. The difference concerned the information about their position in the ranking and the income they received in the first part. In the first treatment (Full ignorance treatment, IG) neither the position in the ranking nor the remuneration from the first part was disclosed before the PGG; this information was given them only at the very end of the experiment, i.e. after playing the PGG. In the second treatment (Partial information treatment, PI) the information about the income obtained in the first part, but not the ranking, was disclosed before playing the PGG; the subjects knew their position in the ranking only *after* the PGG. In the third treatment (Full information treatment, FI) the complete information about placement and income from the first part was disclosed before the PGG. To sum up, the participants played the PGG: 1) knowing neither their ranking nor their income, 2) knowing only the income, but not the ranking, and 3) knowing both. The difference between these three treatments aims at disentangling the effects of competition. The comparison of the blind treatment with the baseline treatment (where there was no competition) isolates the effect of working under competitive pressure, separated from the effect of income or pride (or frustration) arising from knowing one's position in the rank. The comparison between the blind

[4] Of course, all players were informed about this.

treatment and that with partial information aims at identifying the effect of the initial endowment on the contributions to the PGG. Finally, the treatment with full information isolates the effect of knowing the position in the ranking due to the comparison between this treatment and the others.

A summary of the characteristics of the design is given in Table A1 in the appendix.

At the beginning of each of the five rounds of the PGG the participants received a fresh endowment of 60 experimental coins, each worth 0.01€. The subjects then had to decide whether to keep them for themselves or to allocate all or part of them to a common fund, knowing that the total amount contributed would be doubled and then would be redistributed in equal shares among the members of the group at the end of each round. The coins kept by the subject remained as his/her earning. The subjects also knew that they would always be matched with strangers at the beginning of each round. Between one round and the following the subjects viewed the total amount contributed and their gain in that round. At the end of the PGG the total payoff (the sum of what was earned in each of the five rounds of the PGG plus the gain of the first part of the experiment) was displayed.

As we know, in this kind of PGG the unique subgame perfect equilibrium predicts always to contribute nothing to the common fund (complete free-riding), while the Pareto-efficient solution (full cooperation) predicts allocation to the fund of the whole endowment.

At the beginning of each session the subjects were sat at 20 different isolated computer terminals, so that no communication was possible among them. The instructions appeared sequentially on each participant's computer screen and would proceed to the following page only when all the participants had clicked on the 'Continue' button on the screen, while they were read aloud by an experimenter at the same pace. When the instructions on the first part of the experiment were over, the time for the completion of the task started running. The list with the data to be copied as well as the rows with the empty fields appeared sequentially on each participant's screen. In the treatments with competition the countdown in seconds of the time remaining was being displayed on the top right hand-side of the screen. When the time was over the information about the ranking and/or income was given according to the treatment. Then, the second part of the experiment started. The PGG was illustrated to the subjects, both on the screen and by the same experimenter. It was made clear that the game would be played in groups of 4 participants unknown to each other and that the composition of the group would change at each round, with no re-encounters, that all the initial sum would be kept as earnings in case no coin was allocated to the common fund, that the total earnings in case all participants

allocated all the sum to the fund would be twice of the initial endowment, and that no amount could be transferred from one round to the following one.

After the above description a written summary of the instructions was distributed to the participants and this part of the experiment started. In each repetition the subjects faced a screen with an empty box where they had to enter the amount of coins they wanted to allocate to the common fund. Once each subject had taken the decision or the time allocated had passed, a new screen for a new round appeared. In every repetition each subject could see summarized in a table on the screen the total amount of the common fund, her/his earnings for that round, the amount of coins kept by him/her, and the division of the common fund and her/his total profit up to that round. At the end of the 5 rounds, the total earnings from the experiment (first and second part) appeared on the screen. Once the experiment was over, the subjects were asked to fill in a questionnaire which appeared on the screen, then they were asked to leave the room and come back individually to fill in their receipts and be paid in full anonymity.

3. Experimental strategy and empirical methodology

Two figures were of interest: the contribution to the PGG and the share of extreme behaviours, that is *full free riding* (contributing 0 to the PGG) and *full cooperation* (contributing the entire endowment of 60 experimental coins). At each round, the contribution to the PGG is bounded between 0 and 60. We, therefore, treat this variable as a truncated continuous variable, and analyse the effects of the treatments on it with tobit regressions. We specify three different models to check whether the effects of the treatments are robust to different specifications. In particular, in the first specification we include: the dummies for the different treatments, the time spent by the subject to decide how much to contribute, the time spent in looking at the results of the previous round, a variable that captures the round, and two one-period-lagged dummies for the extreme behaviours (free riding and full contribution). In the second we replace these extreme choices with the value of the fund (i.e. the sum of all the four contributions) and the average contributions of the other three members of the group[5]. Both these last controls are presented lagged by one and two rounds to capture their persistence on the individual choices[6]. The extreme choices are, instead, modelled separately: we constructed dummy variables for

[5] This is calculated as follows: $c_{-i,j,t} = \frac{1}{3}\left(F_{j,t} - c_{i,j,t}\right)$ where $c_{-i,j,t}$ is the average contribution to the PGG of the subjects other than subject "i" who belong to group j at time t; $F_{j,t}$ is the amount of the fund of group j at time t, and $c_{i,j,t}$ is the contribution of subject i who belongs to group j at time t.

[6] The dummies for extreme behaviours and the lagged value $c_{-i,j,t}$ are not introduced in the same model, to minimise multicollinearity.

free-riding or contributing the full endowment at each round. In this case we analyse the data using probit regressions. With respect to the first specification the third model removes the extreme choices (and the time-to-see-results variable) and introduces the difference from the average contribution, without much difference in results.

Whereas we designed the experiment in order to render the observations independent of each other at every round, gains and the others' contributions in a round may affect a subject's choice in the subsequent ones. Therefore, we ran panel regressions and, for each individual, we controlled for both the lagged value of her/his contribution to the PGG and of the average contributions of the other three members of the group. In this way we capture the "learning" effect, i.e. the effect that playing in a group of co-operators (non-co-operators) in round t-1 (and t-2 in a second estimated model) may have on one's decisions in round t. We capture the well-known decreasing trend of contributions to the PGG (Laury and Holt, 2000 and Lotito et al., 2015) controlling for the round. Moreover, we control for the time spent in choosing the contribution and for the time spent in looking at the results in the previous round. There is indeed evidence that these proxy for the subject's degree of instinctiveness used in the decision process (Rubinstein 2007, 2013; Piovesan and Wengström 2009 and Lotito et al. 2013). This will, therefore, clean the results from the "instinctiveness" component. We also control for the participant's gender (1 if male, 0 if female), and – in one of the three estimated models – for a couple of dummies that capture whether the subject had fully cooperated (i.e. contributed 60 experimental coins) or free-rode in the previous round. This helps to clean the results from the possibility that someone had a pre-conceived strategy of pure contribution or pure free-riding. We control also for the voluntary social activities conducted by the subjects (as detected from the questionnaire), in order to capture the possible effect of pro-social attitudes. In the econometric analysis presented below we do not control for the income gained in the first part of the experiment, as we have introduced it in several estimations, but it had never shown any statistically significant effect[7].

In addition, we present an analysis of the response times to understand the degree of instinctiveness behind the subjects' decisions (Rubinstein 2007 and 2013) in order to assess whether the presence of competition and the information about one's position in the competitive ranking render the decision more or less instinctive. The reason is that people whose labour income is high (low) may think less (more) about how much to contribute to the production of a PGG.

[7] Income is not statistically significant even in the treatment where only the wage gained in the first part of the experiment is disclosed before the PGG.

4. Results: descriptive and graphical analysis

The performance in the three treatments with competition in the first part of the experiment is statistically the same (see Table 1), which suggests that the subjects involved in these treatments had statistically the same ability, and therefore the differences on the other outcomes cannot be attributed to heterogeneity in abilities. Male subjects recopied correctly more quadruplets than their female peers, which might reflect the fact that competition has different effects on the two genders, with males more responsive than females to competition (Niederle and Vesterlud, 2007 and Migheli, 2015). This gender effect might affect the results as follows: if males are more competitive and they work harder than females, then we will end with more males than females receiving a high income from performing the task. Indeed there is an average difference of 0.89€ in the sub-sample of subjects who recopied the quadruplets in a competitive setting. This difference is statistically significant (at 1% level), but is small both in value and in relative terms (it amounts to 10.5% of the average income from the first part). Finally, we note that the time needed by the subjects to choose how much to contribute to the PGG is decreasing with the level of information disclosed before the PGG. We will return on this result later.

Table 2 presents the descriptive statistics for the variables used in the subsequent analyses. We may observe a certain variability between the contributions in the different treatments. Most noticeably, full information about both the ranking and the income from the first part enhances considerably the contributions to the PGG with respect to all other cases.

Figure 1 presents the average contributions by treatment and by round for the full game.

Here we can observe some interesting outcomes. First, while for the treatment with full information we observe almost no decline in the average contribution to the PGG, in the other treatments we observe a decline. In particular, people who played with no or with partial information reduce their average contributions more than the subjects in the baseline treatment. These outcomes suggest that competition *per se* has a negative effect on cooperation. In addition, the lines in the graph suggest that information plays a key role in sustaining cooperation. Indeed, all the subjects start from average levels of contribution that are similar and statistically not different from each other. However, as the subjects interact, cooperation decreases, as it happens in the baseline treatment (consistent with what usually is found in the literature). In other words, competition seems to have a negative effect on the conservation of cooperation, rather than on cooperation itself. Instead, full information sustains cooperation, and generates increasing and statistically significant differences between average contributions under full information and under other conditions. In addition, statistical tests on these

differences reveal that in the full-information setting the average contributions are not statistically different over the five rounds. The comparison between the contribution in the first round and those in the other rounds is informative about how long cooperation lasts in time. Indeed, in the first round, players have no information about the average level of cooperation of their game mates; this is no longer true from the second round on, when players choose, after observing the average contribution of the other players who are in the same group as the observer. In other words, the contribution in the first round represents the unconditional level of cooperation of the player, while in the subsequent rounds, we observe individual cooperation conditioned to what happened in the past. For this reason, it is common in the literature (Andreoni, 1988; Cadsby and Maynesb, 1998; Milinski et al., 2002; Croson et al., 2005) to compare the average contributions in the rounds from the second to le the last with the average contribution in the first round. In particular, we aim at capturing the first round in which the average contributed sum is statistically different from that in the first round. Figure 1, indeed, shows that the average contributions decrease monotonically in all the treatments, but that with full information. Therefore, the first round, in which the average contribution if statistically different from the average contribution in round n.1, captures the round since which we can assess, with statistical support, that contributions have started to decrease. Using this strategy, we observe that in all the treatments, but that with full information, the decrease between the first and the fifth round is always statistically significant at 5% or even at 1%. In the baseline treatment the decrease of the contribution with respect to the first round is statistically significant from the fourth round (38.95 coins in the first against 29.62 in the fourth – p-value = 0.034 – and 29.30 in the fifth – p-value[8] = 0.029). In the competitive treatment with no information about the ranking or about the income, the decrease with respect to the first round gets statistically significant from the third round (39.57 coins in the first, against 31.02 in the third – p-value = 0.041 – 27.05 in the fourth – p-value = 0.001 – and 19.30 in the fifth – p-value < 0.001). In the setting with partial information, the decrease with respect to the first round also becomes statistically significant from the third round (from 35.35 coins in the first to 26.95 coins in the third – p-value = 0.057 – to 19.32 in the fourth – p-value = 0.0001 – to 20.20 in the fifth – p-value = 0.002). All this is important. It suggests that competition disrupts cooperation when there is full or partial ignorance, while it enhances both the level of the contribution and the maintenance of a high level over time (rounds) when there is full knowledge. Also, the data show that partial ignorance (i.e. when only the information on the income earned is disclosed)

[8] Here and below the p-value refers to the statistical significance of the difference between the average contribution in round t (for t = 3, 4, 5) and the average contribution in round 1.

hinders cooperation more than full ignorance. The relevance of knowledge was unexpected; data do not provide an indication about its cause. We will suggest a possible explanation in the last section.

Figure 2 presents the densities of the contributions in the four treatments. We can observe that in the baseline and in the treatments with no or only partial information the density of free-riders and of subjects with low contributions is much larger than in the treatment with full information. In addition the share of contributions equal to the whole endowment (60 experimental coins) is much higher in this last treatment than in all the others. This result is both unexpected and relevant; we will return to it.

Table 3 completes the picture reporting the percentage of times in which a subject made an extreme choice (either free-riding or contributing the entire initial endowment). These percentages are calculated on the total number of choices made (this renders the number of observations equal to 800: 160 subjects multiplied by the 5 rounds). The subjects free-rode much less and contributed the full amount much more frequently in the treatment with full information than in the other treatments. In particular, the effect is much stronger for the cases in which the subjects contributed the full amount. Indeed, the share of free-riding decisions is similar in the baseline treatment and in the full-information one, with no significant difference, while the difference is very strong in the case of full cooperation. Apparently, the effect of knowing one's own position in the ranking is more effective in enhancing cooperation than discouraging free-riding. The bottom of the Table shows pairwise comparison for average contributions to the public good, by treatment. Given the presence of multiple choices, the standard deviations have been corrected using the Bonferroni and the Scheffe methods; we have chosen this last, as it is one of the most general available. The table reports the levels of statistical significance based on this second correction method. The picture is very similar to what emerges from the central panel of the table: in the full-information treatment, the average contribution is much higher than in the other treatments, and the differences are always statistically highly significant. The lowest average contribution (26.41 experimental coins) corresponds to the treatment with partial information: this figure is statistically different from those of the baseline and the full-information treatments. The average contribution in the treatment with ignorance is not statistically different from that in the baseline treatment. Information seems to play a role: when full information about both the remuneration of the work and the subject's relative position in the rank is disclosed, the average contribution is maximised. When only information about the remuneration of the first part of the experiment is

disclosed, the average contribution is minimised. This non-monotonic path followed by the average contributions suggests that the effect of information on cooperation depends on which piece of information is released.

5. Results: econometric analysis

Table 4 reports the coefficients of tobit regressions for three different specifications. The results confirm what has already been suggested by the previous analysis. The baseline treatment is taken as reference; this implies that the coefficients for the three treatments introduced in the regressions are to be interpreted as effects relative to the baseline. The contributions under full information are always significantly larger than those in the baseline, and people contributed significantly less in the partial-information treatment than in the baseline. Moreover, a simple t-test highlights that the coefficients for the full-information treatment are statistically different from the coefficient for the partial-information treatment. This also confirms the previous results. People playing the PGG under the no-information treatment contribute less than people playing the baseline, but the difference is not statistically robust to different specifications of the model.

The figures in the table also suggest other interesting results. First, in spite of the matching procedure that always generates groups of strangers (i.e. of people who had never played in the same group in any of the previous rounds), the contributions are strongly path-dependent. The coefficients for the lagged values of the contribution (i.e. the sum contributed by individual *i* in the previous round) and the coefficients for the lagged values of the others' average contribution are statistically very significant. In particular, the value of the contribution at times t-2 (L2) and t-1 (L1) affects the individual contribution at time t positively, while the average amount of the others' contribution has the opposite (i.e. negative) effect. Moreover the magnitude of the first and second lag coefficients is almost the same, suggesting that the subject discounts the past at a very low rate.

The inclusion of these variables in the regression decreases the coefficients for the partial and the full-information dummies and the associated levels of significance. Arguably, is reflects the persistence over time of the effect of the past experience on the present decision. This suggests that, while the observations in our sample are independent of each other because of the way in which the groups are formed at each round, the individuals anyway internalise the behaviour of the others in the previous rounds, and they discount these behaviours at a very low rate (the

coefficients are very close to each other over time). Last but not least, the dummy that captures whether the distance from one's contribution and the average contribution at t-1 is positive has a positive coefficient. This suggests that people who tend to be cooperative in a round remain more cooperative than the average in the subsequent rounds. Gender does not appear to be significantly related to the level of contributions.

Additionally, it can be noted that the amount of time people take to decide how much to contribute is positively and significantly related to the level of the contribution, while the longer they take to see the results from the previous round, the less they contribute.

Table 5 presents the results of the panel probit estimates for the extreme behaviours. These are defined as perfect free-riding (i.e. contributing 0 experimental coins in a round) and as complete cooperation (i.e. contributing 60 experimental coins, the whole endowment, at each round). The figures in the table confirm what the other analyses have already highlighted. The treatments have no effect on the probability of full free-riding: this behaviour is distributed more or less homogeneously across treatments, although when full information is provided, the share of free riding episodes in the total number of decisions is slightly lower than in the other cases (but this difference is not statistically significant). Only the average contribution of the other players in round t-1 seems to slightly decrease the probability of free-riding in round t, but this result is not robust to different specifications (compare columns 1 and 2 of Table 5). The treatment variables are, in contrast, effective in promoting cooperation: in the setting with full information, the probability of contributing all the 60 experimental coins in a round is between 73 and 83 percent higher than in the baseline treatment. This is an impressive figure; we will discuss it in the following section. There is also no significant difference between the baseline and the other two treatments without full information. Also, the individual contribution in round t-1 increases the probability of contributing the full endowment in round t, while the opposite happens for the average contribution of the others. This is in line with the results presented in Table 4. Subjects display a path-dependent behaviour, in the sense that at each round they behave consistently with their past decisions, but apparently try to benefit from the others' high contributions. This appears as a contradiction; but at the end of each round subjects see the total value of the fund, but they do not see the others' average contribution nor the others' individual contributions. Since we do not know whether they mentally calculate the others' average contribution, we might suggest that they respond more to the total value of the fund than to the average contribution of the others. From a quantitative perspective, this distinction is irrelevant, but from an economic and psychological point of view this is a relevant clarification. There may

be two possible interpretations. First, there is some degree of constancy in the subject's behaviour, so that people who start contributing large stakes continue doing so. Second, the individual responds to the total value of the fund by increasing one's own level of cooperation, but s/he does not disentangle her/his own from the others' contributions and her/his behaviour is unconsciously driven by her/his past decisions.

Interestingly, the time spent by a subject in looking at the results increases the probability of free-riding (column 1), and decreases that of contributing the whole endowment (column 3). However, these results are not robust to different specifications. The time spent to choose how much to contribute is not relevant in the case of free-riding, but it is positively correlated with the decision to cooperate fully. The overall effect is entirely due to the competitive settings[9].

6. Conclusions

In the last section we considered some ancillary results. Here we discuss the main ones. Our experiment aimed at assessing the effect of competition on cooperation. The hypothesis was that exposure to competition reduces people's propensity to cooperate, arguably due to the enhancement of a selfish mood stimulated by the competition. We found mixed support for this hypothesis. In absence of information about the effect of the competition the propensity to cooperate was unaffected (Table 4, line 1). Note that this result is not conclusive: it is possible that the competition was too feeble to actually induce a selfish mood, or that the "they came to play" effect (see Carpenter *et al.*, 2010) prevailed. All what we can infer is that the effect of competition, if existent, is too small to appear in the setting of our experiment. Instead, we found that competition has a significant effect if the information that accompanies it is varied. Partial information reduces the propensity to cooperate (Table 4, line 2), but *full* information strongly enhances it (Table 4, line 3). We cannot provide any explanation; we can only suggest some. The first has to do with the notion of *overall security*[10]. A person feels more secure the more s/he knows all the relevant features of the environment that surrounds her/him; and a secure person, arguably, is more prone to help. In our setting the full knowledge of one's own

[9] Lotito, Migheli and Ortona (2013) obtained, in a setting devoid of rivalry, that the decision time is *inversely* correlated with the degree of cooperation. The double evidence suggests that cooperation is spontaneous in non-competitive settings, while it requests some thinking when the possibility of strategic behavior by other subjects may be more relevant, thus displacing the instinctive behavior. However, data are (still) too limited to establish this conclusion.

[10] Garrone and Ortona (2013) found that overall security, as self-assessed following the economics of happiness approach, strongly correlates with several relational and economic items. The definition adopted by the authors (p.275) is "the feeling that a weighted average of what is important for life is not bound to worsen".

position in the game produces a feeling of security, while a partial knowledge adds an element of uncertainty to the environment, and hence reduces security, and a total absence of information de-emphasizes the security concern. However, the study of security as such is in its infancy (see Garrone and Ortona, 2013), also for a discussion of the meaning of the notion, hence what has been stated above is highly speculative. The second possible interpretation is that people who are shown that their remuneration is fair compared to that of their competitors, as it reflects their relative performance, are more willing to contribute to the common good. This is because if the payment for a work is perceived as fair, negative sentiments such as envy and resentment are minimised. This could be an extension of the idea of conditional cooperation (see Fischbacher et al., 2001). Indeed, people evaluate fairness not only looking at the results of some behaviour, but also at the intentions behind that behaviour (Falk and Fischbacher, 2006). In this sense, the subjects who are informed both about their position in the ranking and about their payment may feel that their remunerations are intentionally fair and ,therefore, they show a high level of cooperation (conditional on how they have been previously treated). Note that the two explanations are not mutually exclusive, and that both require further evidence to be assessed.

In any case, it must be noted that the literature on the effect of the variation of information on the behaviour in the laboratory ranges from poor to inexistent. Fatas et al. (2011) find that, in a team production game, as the experimenters disclose information about the others' contributions to the production of the good the effort put by each subject increases, with respect to when no information is provided. Hartner et al. (2008) had already showed that tax-compliance is self-reinforcing, in the sense that people tend to comply more with tax duties if they know that the share of evaders decreases. Yang and Yue (2010) find that – in a contribution game – informing subjects about the (non-uniform) distribution of their incomes increases the individual contributions with respect to the case, where no such information is revealed. These few results suggest that, in general, information fosters cooperation, as it happens in our experiment. Nevertheless, the extant literature does not shed light on the psychological mechanisms behind this phenomenon; nor it provides any hint with regard to the opposite effect of *partial* information that we found. Further research is strongly advisable.

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Tables

Table 1. Recopied quadruplets and treatments. OLS estimates (s.e. in brackets)	
Male	4.669
	(1.560)***
Competition with partial information (wage only)	0.643
	(1.187)
Competition with full information	-1.680
	(1.877)
Constant	77.657
	(1.578)***
Observations	160
R-squared	0.017
Root-MSE	18.73

Table 2. Descriptive statistics: average values and their standard deviations (in brackets)	
Average contribution (experimental coins)	
Full sample	32.94
	(23.33)
Baseline treatment	33.31
	(22.58)
Competition with full ignorance	30.31
	(22.76)
Competition with partial information (wage only)	26.41
	(23.08)
Competition with full information	41.70
	(22.31)
Performance in the task (average number of triplets correctly recopied by the subjects)	
Full sample	70.05
	(23.85)
Baseline treatment	39.95
	(0.33)
Competition with full ignorance	80.22
	(19.26)
Competition with partial information (wage only)	81.12
	(16.38)
Competition with full information	78.89
	(20.69)
Individual characteristics	
Subjects who volunteer (%)	15.62
	(36.33)
Males (%)	56.50
	(49.61)
Average choice times (in seconds)	
Full sample	27.62
	(26.60)
Baseline treatment	29.40
	(27.52)
Competition with full ignorance	33.00
	(29.32)
Competition with partial information (wage only)	24.98
	(22.93)
Competition with full information	23.49
	(25.42)
Percentage of free-riding episodes[1]	16.75
	(37.37)
Percentage of full co-operation episodes[1]	30.87
	(42.23)

1) Calculated on the total number of observations (number of subjects x rounds)

Table 3. Pair-wise comparisons of extreme behaviours and of average contributions by treatment (standard errors in brackets)

	% of free-riding episodes	Significance with respect to treatment				Observations
		BL	IG	PI	FI	
Baseline	16.00 (36.75)		-	*	-	200
Competition with ignorance	17.00 (36.66)	-		*	*	200
Competition with partial information (wage only)	22.00 (41.53)	*	*		***	200
Competition with full information	12.00 (32.58)	-	*	***		200
	% of full co-operation episodes	BL	IG	PI	FI	
Baseline	29.50 (3.23)		-	**	***	200
Competition with ignorance	24.50 (3.05)	-		-	***	200
Competition with partial information (wage only)	20.50 (2.86)	**	-		***	200
Competition with full information	49.00 (3.54)	***	***	***		200
	Average contribution	Significance with respect to treatment				Observations
		BL	IG	PI	FI	
Baseline	33,31 (1.596)		-	***	***	200
Competition with ignorance	30.31 (1.610)	-		-	***	200
Competition with partial information (wage only)	26.41 (1.632)	***	-		***	200
Competition with full information	41.70 (1.579)	***	***	***		200

Legenda: BL = baseline; IG = with ignorance; PI = with partial information (wage only); FI = with full information
Significance levels: *** 1%; ** 5%; * 10%; - not significant at conventional levels

Table 4. Tobit analysis of the individual contributions (measured in experimental coins) to the public good (standard errors in brackets)

VARIABLES	(1) Contribution	(2) Contribution	(3) Contribution
No information	-5.534	-6.648	-6.409
	(5.599)	(4.460)	(7.687)
Partial information (wage only)	-11.12**	-7.689*	-14.58*
	(5.633)	(4.632)	(7.698)
Full information	16.08***	8.852*	21.85***
	(5.901)	(4.608)	(7.967)
Round	-3.320***	-0.958	-5.824***
	(1.262)	(1.974)	(1.040)
Mean of the others' contributions (L1)		-1.706***	
		(0.262)	
Contribution (L1)		0.605***	
		(0.0816)	
Mean of the others' contributions (L2)		-1.657***	
		(0.261)	
Contribution (L2)		0.535***	
		(0.0828)	
Time to choose	0.199***	0.152**	0.200***
	(0.0640)	(0.0638)	(0.066)
Time to see results (L1)	-0.186*	-0.329***	
	(0.110)	(0.123)	
Full cooperation (L1)	21.95***		
	(4.833)		
Free riding (L1)	-13.94**		
	(6.456)		
Male			-5.739
			(5.477)
Difference from the average contribution (L1)			0.044
			(0.080)
Constant	37.29***	8.182	63.76***
	(9.524)	(14.17)	(7.407)
Observations	640	480	640
Number of subjects	160	160	160

Significance levels: *** p<0.01, ** p<0.05, * p<0.1

Table 5. Analysis of extreme contributions. Panel probit estimates (s.e. in brackets)

VARIABLES	(1) Free rider	(2) Free rider	(3) Cooperator	(4) Cooperator
Male	0.687**	0.742**	0.118	0.121
	(0.295)	(0.336)	(0.225)	(0.247)
With no information	-0.0837	-0.0215	-0.152	-0.194
	(0.407)	(0.460)	(0.323)	(0.352)
With partial information (only about wage)	0.189	0.356	-0.178	-0.248
	(0.392)	(0.452)	(0.323)	(0.354)
With full information	-0.358	-0.415	0.730**	0.827**
	(0.416)	(0.471)	(0.329)	(0.363)
Round		0.213**		-0.171**
		(0.0976)		(0.0795)
Contribution (L1)	-0.00780*	-0.00295	0.0243***	0.0214***
	(0.00437)	(0.00518)	(0.00468)	(0.00514)
Average others' contribution (L1)	0.0162	0.00471	-0.0669***	-0.0597***
	(0.0144)	(0.0163)	(0.0152)	(0.0163)
Time to look at the results of the previous	0.0170**	0.00910	-0.0142**	-0.0101
	(0.00793)	(0.00901)	(0.00630)	(0.00682)
Time to make the choice	-0.00493	-0.00468	0.0184***	0.0190***
	(0.00443)	(0.00464)	(0.00431)	(0.00459)
Income from the initial task		0.0142		0.00481
		(0.0406)		(0.0312)
Volunteer (yes = 1)	-0.581		0.291	
	(0.435)		(0.307)	
Constant	-2.498***	-3.320***	-0.701	-0.304
	(0.813)	(0.951)	(0.631)	(0.720)
Observations	640	640	640	640
Number of subjects	160	160	160	160

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figures

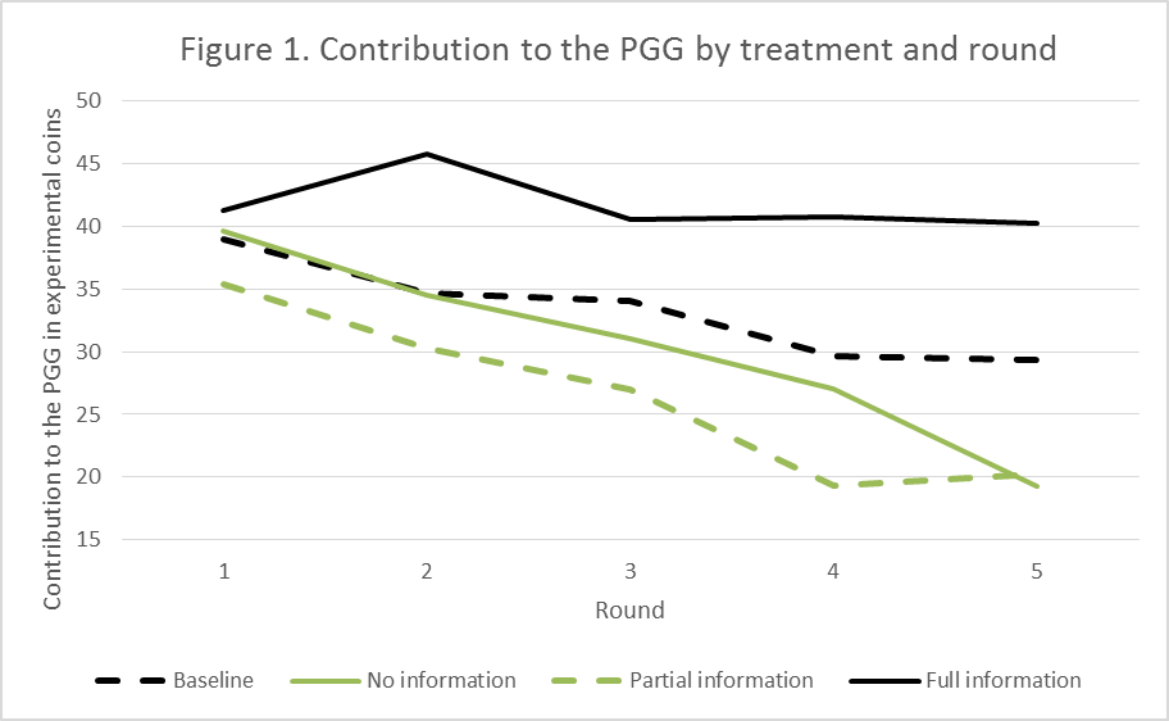
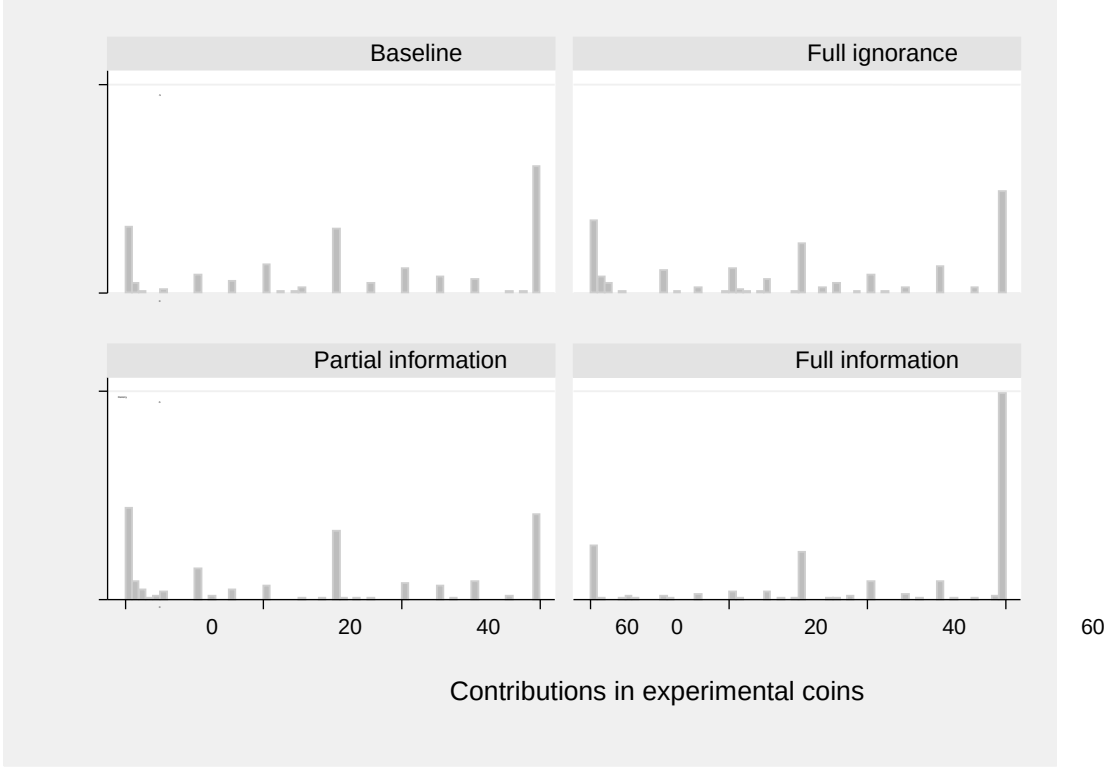


Figure 1. Contribution to the PGG by treatment and round
Contribution to the PGG in experimental coins
50
45
40
35
30
25
20
15
1
2
3
4
5
Round
Baseline
No information
Partial information
Full information

Figure 2. Densities of individual contributions to the PGG (experimental coins) per treatment over all the rounds.



Appendix 1. Table reporting the main characteristics of the treatments

Table A1. Summary of the characteristics of each treatment.

	Competition	Information on payment first part	Information on position in the rank
Baseline treatement (BL)	no	no	no
Full ignorance treatment (IG)	yes	no	no
Partial information treatment (PI)	yes	yes	no
Full information treatment (FI)	yes	yes	yes