Social Capital or Economic Rents? An experimental study*

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Abstract

This paper provides experimental evidence to Crudeli's [10] theoretical conjejcture, according to which the distribution of Social Capital is determined by the set of available economic opportunities. We find evidence that, after accounting for natural cooperation (the level of cooperation simply determined by incentives), excess cooperation remains indeed influenced by the distribution of opportunities, becoming a more important determinant of cooperation the scarcer these opportunities are. On a general ground, when opportunities are fewer, people are more solidary to each other, more prone to reciprocate positive behaviours as well as more sensitive to betrayal. We also discuss our results on the background of the on-going debate on the measurability of Social Capital.

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1 Introduction

Over the last twenty years the concept of *Social Capital* (henceforth SC) has become very popular both in the academic debate and everyday talking.[1] The

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[1]Take, for example, [35]: "[...] *perhaps too much has been invested in the concept of social capital to help explain why nations become wealthy. As more economists pile into this fertile area, expect more deflation of the concept - and also more argument* ".

popularity of the term has been growing so suddenly and rapidly that there is yet no agreement on what SC precisely is. A plethora of definitions has instead been proposed in the literature. The term has been indistinctly used as synonym of "*generalized trust*", "*norms* ", "*networks*", "*reciprocity*", "*altruism*", and its use has been consequently applied in an increasing number of applications, from sociology to health economics, political science, business management, human resources and politics. In recent years, the concept has also been adopted by international organizations, such as the World Bank or the OECD, which have devoted entire issues of their respective annual reports to stress the importance of SC for human well being and development, making it become a reference concept in the debate for the development and the design of poverty reduction policies.[2]

The rapid development of the theory has been accompanied by a flourishing empirical literature as well. These studies have looked mainly in three directions. On the one side, digging from Coleman's [6] idea of *generalized trust,* authors have focused on a survey indicator of trust, obtained from the *World Values Survey,* an annual survey program under the auspices of the World Bank, upon which we based some questions of our questionnaire.[3] On the other hand, borrowing ideas from Putnam [28] , many works have been assessing the impact of some specific socio-economic characteristics, such has club membership, ethnic homogeneity or religious beliefs, on pro-social behavior.[4] Finally, SC has also been object of some recent experimental research. This happened in two ways. Firstly, many experimental researchers have tried to measure which conditions are necessary to develop reciprocity and pro-social behavior..[5] Reciprocity, both positive and negative, has also been provided as explanation for observed behavior that is inconsistent with "self-regarding preferences" typically assumed in standard economic modelling. Secondly, some researchers have used experimental techniques to measure SC in the field.[6] This approach has attracted not only economists, but also sociologists (such as [33], [23]), to the practice of field experiments.

In the realm of this ongoing debate, Crudeli [10] has recently proposed to restrain the meaning of SC to *a measure of the agents' willingness to share economic rents*, where the latter are defined, as in Kahn and Jomo [22], as *the difference between one's first and second-best opportunities.* The distribution of economic rents determines the opportunity cost of cooperation, and hence the "*natural level of cooperation*" that characterizes social interaction. Once the distribution of incentives is properly taken into account, Crudeli [10] claims that the residual willingness to share economic rents, thus the "*residual cooperation*",

[2]See, among others, [38], [26], [37].

[3]See, for example, [15], [16], [30], [36], [24], [25].

[4]See, among others, [3], [14], [18], [32], [20].

[5]This line of research is well represented in the works of [7], [8], [11], [5], [17].

[6]See, among others, [27], [4], [1], [2], [9], [21], [19]. For instance, Carpenter [4] makes the case that experiments among potential recipients of development assistance provide reliable information to assess the impact of various forms of SC. Overall, he claims, the information provided by social assessments or experiments can help to provide information on which villages will, *ceteris paribus*, have higher expected returns to public investments.

is a proxy for SC. The basis for this claim is the fact that residual cooperation does not directly respond to self-regarding preferences and rational motives, but is instead more deeply routed into social behaviors, habits and values. In synthesis, according to this approach, *residual cooperation is the measurable side of SC.*

The aim of this paper is to collect experimental evidence of the relationship between the distribution of economic rents and the level of cooperation. The experiment follows very closely Crudeli's [10] original model. Precisely, subjects in the lab had to decide whether to *cooperate* or *defect,* with defection implying an increased level of competition within the group, hence less opportunities for all members.

In explaining subjects' individual willingness to cooperate, we *a)* make appeal to the level of economic rents (i.e. we estimate the "natural" level of cooperation induced by the distribution of rents), as well as we *b)* explore which variables are relevant to explain cooperation outside pure rational motives. By doing so, we are able to distinguish between natural and "residual" cooperation, taking into account the background of what is discussed in the conventional literature on SC.

In analyzing our experimental evidence, we employ some simple (panel) logit regressions, in which the individual willingness to cooperate is regressed against both treatment condition and individual specific variables which describe subjects' behavior in the game, as well as their answers to a questionnaire built upon the three main strands of the empirical literature on SC.

We shall here summarize our main results by remarking that cooperation is a complex phenomenon influenced by different co-existing aspects, such as the distribution of economic rents, and the development of reciprocal behavioral patterns. We also see that our subjects' pool heterogeneity plays a crucial role in determining the cooperation patterns. In particular, we are able to partition our sample in two groups according to their relative willingness to act in response to direct economic incentives, as opposed to more socially and behaviorally routed motives. While in the first subsample cooperation is basically explained as rational response to monetary incentives (i.e. distribution of rents), for the latter subsample cooperation is also explained by trust, reciprocity and concerns for inequality. By contrast, for both subsamples, socio-economic characteristics seem to have marginal impact on cooperation patterns

The remainder of the paper is arranged as follows. The theoretical properties of the model is what we investigate first, in Section 2. Experimental conditions are described in Section 3. Section 4, devoted to experimental results, is divided in two parts. Descriptive statistics are presented first, followed by some panel data regressions in which we test, in the realm of Crudeli's [10] model, the explanatory power of the different approaches to SC proposed by the literature and check the robustness of equilibrium predictions. Conclusions and guidelines for future research are listed in Section 5, followed by an Appendix containing the experimental instructions, the questionnaire, and some additional statistical information on our experimental evidence.

2 The model

Our stylized economy is modeleld as a sequence of n economic opportunities (*projects* henceforth). The number of agents in the economy is also set to n, hence the number of agents equals the number of available projects. The model imposes that one and one only agent needs to be involved to realize each project.

As projects yield different potential benefits, they can be ordered by their *value*. More precisely, we assume that project k has a value $v^k = (1-\gamma)^{k-1}$, with $k = 1, ..., n$ and $\gamma \in (0,1)$. In order to produce its potential benefit v^k, a project requires the full commitment of the agent that is involved in it, who, as a consequence, bears the attached opportunity cost of not getting involved in any other project. The choice of committing to a single project will be defined as "cooperation". Our simple model also admits an alternative behavior, defined as "defection". A defector does not commit to a specific project, but tries to get involved in as many projects as she can. This alternative conduct has its costs and benefits. First, the value of all projects assigned to a defector are discounted by a fixed parameter $\delta \in (0,1)$, to take into account the fact that part of the defector's effort is devoted to the search of multiple projects. On the other hand, a defector can possibly be assigned to more than one project, the probability of this event depending on the matching technology that characterizes our stylized market. In this respect, we shall assume that projects are assigned in a random fashion, starting from the highest to the lowest valuable. In other words, project 1 is assigned first, with $\frac{1}{n}$ being the probability that any of the agents (regardless of whether they are cooperators or defectors) can get it. If project 1 is assigned to a cooperator, she enjoys its full value v^1 =1 and leaves the market, leaving the remaining $n-1$ agents to compete for the remaining $n-1$ projects. If instead project 1 is assigned to a defector, she can benefit only its discounted value $\delta v^1 = \delta$, although she may remain in the market pool with some probability $\alpha \in (0,1)$ to compete for project 2, and the following ones, until all n projects are assigned. This design of technology is justified by the assumption that agents will preferably compete first for the larger project, and subsequently for the smaller ones. This, in turn, implies that the presence of defectors in the population gives positive probability to the event that a defector gets more than one project (with other agents not getting any project at all).

By our matching assignment, if $n_c(k-1)$ ($n_d(k-1)$) is the number of cooperators (defectors) still in the market at the time project $k-1$ is assigned, the (expected) number of cooperators and defectors competing for project k is uniquely defined by the following system of difference equations:

$$\begin{aligned} n_c(k) - n_c(k-1) &= -\frac{n_c(k-1)}{n_c(k-1) + n_d(k-1)}; \qquad (1) \\ n_d(k) - n_d(k-1) &= -\frac{n_d(k-1)(1-\alpha)}{n_c(k-1) + n_d(k-1)}. \end{aligned}$$

with initial conditions $n_c(1) = \nu$ and $x_d(1) = n-\nu$. For any given population state ν, let $p^k(\nu) \equiv \frac{n_c(k)}{n_c(k)+n_d(k)}$ be the probability that a cooperator is assigned to project k when the total number of cooperators in the population is ν and $n_c(k)$ and $n_d(k)$ solve (1). By (1), for all ν, $p^k(\nu)$ is decreasing in k. This is because cooperators leave the matching market at a higher rate. We are now in the position to specify the (symmetric expected) payoff functions for cooperators (π_c) and defectors (π_d) when the number of cooperators is ν, with $0< \nu < n$:

$$\pi_c(\nu) = \frac{1}{\nu}\sum_{k=1}^{n} v^k p^k(\nu) = \frac{1}{\nu}\sum_{k=1}^{n}(1-\gamma)^{k-1}p^k(\nu) \tag{2}$$

and

$$\pi_d(\nu) = \frac{\delta}{n-\nu}\sum_{k=1}^{n}(1-\gamma)^{k-1}(1-p^k(\nu)). \tag{3}$$

Let $\psi(\nu) \equiv \pi_c(\nu) - \pi_d(\nu-1)$, $\nu \in \{1, ..., n\}$ measure the opportunity cost of defecting for any given (interior) population state ν. Following our experimental protocol, Figure 1 traces the payoff difference $\psi(\nu)$ corresponding to our four treatment conditions, T_1 to T_4.[7]

Put Figure 1 about here

In our experiment, we only varied the level of γ (that is, the size of rents), with the values of $\alpha = .85$, $\delta = .8$ and $n = 6$ being constant across treatments.

- *Treatment* T_1 : $\gamma = .1$. In the first treatment, the difference between the projects' potential value (i.e. the size of rents, γ) was set to 10%. As the projects' potential values were not too different, defection (action B) was the strictly dominant strategy in the framework (in this sense, the induced 6-player game is analogous to *prisoners' dilemma,* that is, a game of "type 1", according to Proposition 1's terminology). In consequence, as Figure 1 shows, $\psi(\nu) < 0, \forall \nu$.

- *Treatment* T_2 : $\gamma = .31$. In treatment T_2 , rents were set at 31%. In consequence, the game has a unique equilibrium in pure strategies by which cooperators and defectors are in equal number (equilibrium of type 2). In this case, $\psi(\nu) < 0$ ($\psi(\nu) > 0$) for $\nu > 3$ ($\nu < 4$), making $x_c^* = 3$ the unique equilibrium.

- *Treatment* T_3 : $\gamma = .33$. In treatment T_3 , rents were set at 33%. In consequence, the difference between the projects' values was such to produce a game where no strictly dominant strategy was defined. The game has instead two equilibria in pure strategies, each of which characterized

[7]Notice that payoff functions $\pi_c(\nu)$ and $\pi_d(\nu)$ are not defined for $\nu = 0$ and $\nu = n$, respectively. In Figure 1, the four diagrams are drawn under the ssumption $\pi_c(0)=\pi_d(n) = 0$.

by 4 (2) and 3 (3) cooperators (defectors). This situation corresponds, again, to a Chicken game (equilibria of type 2). The presence of multiple equilibria however, is aimed to create some coordination problems for the players. As Figure 1 shows, $\psi(\nu)$ behaves very similar to T_2, except for the presence of multiple equilibria.

- *Treatment* T_4 : $\gamma = .5$. In this last treatment, rents are so high to make cooperation (action A) the unique dominant strategy (game of type 3). As a consequence, $\psi(\nu) > 0, \forall \nu$.

Notice that the strategic properties of the four experimental conditions crucially depends on the fact that, as Figure 1 shows, $\psi(\nu)$ *is monotonically decreasing in* ν. This property is not peculiar of our experimental conditions, but a much more general characteristic of the economic environment under consideration. However, a direct proof of this claim is not available, since the system of difference equations (1) does not admit a closed-form solution for any arbitrary population size n. To substantiate our claim, we then simplify the model by letting n (i.e. the number of agents and projects in the economy) going to infinity and by substituting the induced system of differential equations (which, again, does not admit a closed-form solution) with its first-order approximation, as follows:

$$\begin{aligned} x_c(k) &= x - xk; \\ x_d(k) &= (1-x) - (1-x)(1-\alpha)k. \end{aligned} \tag{4}$$

where, by analogy with (1), $k \in [0, 1]$ now orders the infinite number of projects of total mass 1.[8] Fix a given value for α and γ and let $p^k(x)$ denote the probability for a cooperator to be assigned to project k if the total mass of cooperators in the population is $x \in [0, 1]$. By (4), we have

$$p^k(x) = \frac{x(1-k)}{1 + k(\alpha(1-x)^2 + x(1-x) - 1)}.$$

With another slight abuse in notation, let $\pi_c(x, \delta)$ and $\pi_d(x, \delta)$ denote the (symmetric expected) payoff functions for cooperators and defectors when the total mass of cooperators is $x \in (0, 1)$,that is

$$\begin{aligned} \pi_c(x,\delta) &= \frac{1}{x}\int_{k=0}^{1}(1-\gamma)^k p^k(x)dk = \int_{k=0}^{1}(1-\gamma)^k \frac{1-k}{1+k(\alpha(1-x)^2+x(1-x)-1)}dk, \\ \pi_d(x,\delta) &= \frac{1}{1-x}\int_{k=0}^{1}\delta(1-\gamma)^k(1-p^k(x))dk = \delta\int_{k=0}^{1}(1-\gamma)^k \frac{1+k(\alpha+x(1-\alpha)-1)}{1+k(\alpha(1-x)^2+x(1-x)-1)}dk \end{aligned}$$

[8]Clearly, our first-order approximation looses in accuracy as k grows. This consideration notwithstanding, since we are already working with a continuous-time approximation of our original model, we found this solution a parsimonious way to preserve a key property of the model (that is, $p^k(x)$ decreasing in k).

where, by analogy with (2-3), $\psi(x,\delta) \equiv \pi_c(x,\delta) - \pi_d(x,\delta)$ is the corresponding difference. We are interested in case in which δ -the discount factor- is sufficiently high, that is, when the cost of getting involved in multiple projects is sufficiently low to make defection not trivially dominated by cooperation, independently of the values of α and γ (although our simulation suggest that δ may not be that high for the result to hold). Under this condition, we can prove

Lemma 1 *$\psi(x,\delta)$ is monotonically decreasing in x.*

P roof. he payoff difference $\psi(x,\delta)$ can be written as follows

$$\psi(x,\delta) = \pi_c(x,\delta) - \pi_d(x,\delta) = \int_{k=0}^{1} (1-\gamma)^k g(x,\delta,k)dk \tag{6}$$

where $g(x,\delta,k) = \frac{1-k+\delta(k(1-\alpha)(1-x)-1)}{1+k(\alpha(1-x)^2+x(1-x)-1)}$.

Notice that $g_k(x,\delta,k) = \frac{(-x-\alpha(1-x))(1-(1-\delta)x)}{(1+k(\alpha(1-x)^2+x(1-x)-1))^2} < 0$ and $g_{kk}(x,\delta,k) = -\frac{2\alpha(1-\alpha(1-x))(1-(1-\delta)x)}{(1+k(\alpha(1-x)^2+x(1-x)-1))^3} < 0$. In other words, $g(x,\delta,k)$ is decreasing and concave in k. This, in turn, implies that

$$\breve{g}_x(x,\delta,k) \leq g_x(x,\delta,k) \leq \hat{g}_x(x,\delta,k) \tag{7}$$

where $\breve{g}(x,\delta,k) = g(x,\delta,0) + (g(x,\delta,1) - g(x,\delta,0))k$ and $\hat{g}(x,\alpha,\delta,k) = g(x,\alpha,\delta,0) + g_k(x,\alpha,\delta,0)k$. In words, we can fix bounds for $g_x(.)$ using two linear approximations of $g(.)$ for which we can prove the result much more easily than working directly with the original function.

Let $\breve{\psi}(x,\delta)$ ($\hat{\psi}(x,\delta)$) denote the function which approximates the payoff difference $\psi(x,\delta)$ when $g(x,\delta,k)$ is substituted in (6) by $\breve{g}(x,\delta,k)$ ($\hat{g}(x,\delta,k)$). If we differentiate wrt x and take the limit when $\delta \to 1$, we then have

$$\begin{aligned}
\lim_{\delta\to 1} \breve{\psi}_x(x,\delta) &= -\frac{(1-\alpha)(1-\gamma)\left(\frac{\gamma}{1-\gamma} + \log[1-\gamma]\right)}{\log[1-\gamma]^2} < 0, \text{ and} \\
\lim_{\delta\to 1} \hat{\psi}_x(x,\delta) &= -\frac{\gamma + (1-\gamma)\log[1-\gamma]}{(1-x)^2\log[1-\gamma]^2} < 0.
\end{aligned}$$

By continuity of $\psi_x(x,\delta)$, the result follows. ∎

We can apply Lemma 1 to define the equilibrium properties of our model. In this respect, three are the relevant cases:

1. $\lim_{x\to 0}\psi(x,\delta) \leq 0$ (remember that, for the extremes values of x, 0 and 1, the payoff difference function $\psi(x,\delta)$ is not defined). Since $\psi(x,\delta)$ is (strictly) decreasing in x, this implies that $\psi(x,\delta) < 0$, $\forall x \in (0,1)$. In other words, this is a situation for which α and γ are so high (low) to make the choice of defecting strictly dominant. In this case, the game admits only one equilibrium distribution $x^* = 0$, as it happens in our experimental treatment T_1.

2. $\lim_{x \to 1} \psi(x, \delta) \geq 0$. In this case, $\psi(x, \delta) > 0$, $\forall x \in (0, 1)$. In other words, this is a situation for which α and γ are so low (high) to make the choice of defecting strictly dominated. In this case, the game admits only one equilibrium distribution $x^* = 1$, as it happens in our experimental treatment T_4.

3. $\lim_{x \to 0} \psi(x, \delta) > 0$ and $\lim_{x \to 1} \psi(x, \delta) < 0$. This is the intermediate case, for which it is optimal to cooperate (defect) if the number of cooperators is sufficiently low (high). Also in this case, the game adomits a unique (interior) equilibrium distribution $x^* \in (0, 1)$, as is the case for our experimental treatments T_2 and T_3.

3 Experimental design

In what follows we describe the features of the experiment in detail.

Subjects. The experiment was conducted in 8 subsequent sessions in June 2003. A total of 96 students (12 per session) were recruited among the student population of the University of Alicante - mainly, undergraduate students from the Economics Department with no (or very little) prior exposure to game theory.

Experimental conditions. The experiment was computerized.[9] Instructions were provided by a self-paced, interactive computer program that introduced and described the experiment, the basic rules of the game and the computer interface. Copies of written instructions (identical to the instructions on the screen) were also distributed, together with a table indicating subjects' monetary payoff associated with the two possible actions at their disposal (cooperate or defect), conditional on every possible distribution of cooperators and defectors in their group.

In each experimental session, subjects played a sequence of two *treatments* (20 rounds for treatment) for a total of 20×2=40 rounds, out of the 4 possible treatments available (see Section *Treatments* below). The order of treatments varied among sessions, to control for order effects.[10] In each treatment, subjects were randomly assigned to a group of 6 (the same group within each treatment, two different random assignments for the two treatments characterizing a session). In each round subjects had to perform two tasks: *i)* they had to forecast how many (from 0 to 5) of the other members of their group would have chosen action A (cooperation); and *ii)* they had to express their own choice between action A and action B. At the end of each round each subject was informed about the game outcome through the following information: *a)* the number of group members that had chosen action A in that round; *b)* their individual monetary

[9] The experiment was programmed and conducted with the software *z-Tree* (Fischbacher [13]).

[10] In particular, the order assignment was such that each of the four treatments, T_1 to T_4 was played first and last an equal number of times.

payoff c) the average payoff of their group members in that round and d) their own accumulated payoff. The same information was also given in the form of a *History Table*, so that subjects could easily review the results of all the rounds that they had played so far.

At the end of the experimental session each subject has finally been submitted with a questionnaire. The questionnaire was an integral part of the experiment and contained control questions such as "have you understood the instructions of the game?", as well as question relevant for the analysis of the experimental data, such as three questions on trust taken from the World Values Survey questionnaire.

Each session lasted for about one hour.

Payoffs. All monetary payoffs were expressed in Spanish ptas. (1 euro is approximately 166 ptas.). Subjects participating in experiment received 1000 ptas. just to show up. Average earning varied among sessions, for a total average of 2000 ptas. per subject.

Frames. All experimental treatments had the same game-form, under the same frame. They only differed with respect to the incentive structure characterizing each of the four treatments, T_1 to T_4, as explained below. The strategic environment was introduced by means of the choice of two possible *alternative investment strategies.* The subjects could either maximize their personal payoff by choosing the most convenient action (A or B) on the basis of the number of cooperators they had forecasted; or subjects could choose to cooperate no matter what the other players were doing being aware that the more cooperation was within the group, the more projects were realized at their full potential value, and more money was paid to the group.

Treatments. As already described in Figure 1, we run four different treatments all 4 different treatments varying γ, keeping fixed $\alpha = .85$ and $\delta = .8$.

4 Results

In this section, we report the results of our experiment. We begin by presenting some descriptive statistics which summarize the evolution of subjects' aggregate behavior over time in the four experimental conditions, T_1 to T_4. Our main finding is that, even after controlling for learning effects and other experimental conditions (such as order treatment effects), cooperation patterns greatly differ among treatments. In particular, cooperation is mostly determined by the distribution of opportunities (rents), i.e. γ.

Our experimental results, however, also unambiguously show that economic rents are not the only determinants for cooperation, as cooperation patterns do not strictly follow the Nash equilibrium analysis that we derive in Section 2. To investigate further on this issue, we estimate some dynamic panel logit regressions in which cooperation is explained by both our treatments controls and questions from the questionnaire.

4.1 Descriptive statistics

Figure 2 traces the evolution of the relative frequency of cooperators (2a) and best-responses (2b) in the four experimental treatments. Interestingly enough, only in treatments T_1 and T_4 the frequency of cooperators presents a significant trend toward Nash equilibrium behavior (either full defection or full cooperation) of the corresponding game; by contrast, for treatments T_2 and T_3 aggregate behavior fluctuates close to the corresponding equilibrium values with no particular time trend.[11] We now move on to analyze the evolution of best-responses (Figure 2b), where we trace, for each experimental treatment, the relative frequency of best-response behavior over time. Here we notice that subjects' behavior moves in the direction of best-response in all experimental treatments, even though this frequency is clearly higher in treatments T_1 and T_4, where best-response (either full defection or full cooperation) is independent on the other group members' behavior and, consequently, relatively easier to figure out.[12]

Put Figure 2 about here

As for T_2 and T_3, best-response is evaluated with respect to elicitated beliefs, which we trace in Figure 3 for all four experimental treatments. Figure 3 traces the evolution of the number of times in which subjects' elicited beliefs on the number of cooperators in their group was correct, or incorrect (either under or overestimated). As Figure 3 shows, we can notice that on average, predictions are hardly confirmed in T_2 and T_3, and they are particularly mistaken in T_3. This is probably due to the fact that forecasts are more difficult in this treatment, since the induced game has two equilibria. The number of correct forecasts also appears to increase slightly in T_2, but not in T_3, while forecasts' accuracy is significantly higher in T_1 and (particularly) T_4.

Put Figure 3 about here

As Figure 3 shows, there is a strong tendency, on subjects' behalf, to consistently overestimate other group members' attitude to cooperate, and this effect is particularly strong in T_2 and T_3, where beliefs are crucial to define best-responses. In other words, subjects tend to be overoptimistic toward the attitude of others to cooperate, even though this goes against subjects' actual experience.

[11](Panel) OLS regressions of the relative frequency of *action A* over our time variable produce significant estimations only for treatments T_1 and T_4, showing that there is no significative time trend for treatments T_2 and T_3.

[12](Panel) OLS regressions of the relative frequency of best-response over time presents significant positive trends for all our experimental treatments (with no significant difference in trend across treatments. In other words, learning effect distribute homogeneosly across treatments. By contrast, estimated fixed effects for treatments confirm a significantly higher frequency of best-responses in treatments T_1 and T_4 (with no significant difference between them).

In the theoretical model presented in Section 2, individual attitude to cooperation is explained as rational response to the structure of incentives induced by the level of economic rents (i.e. the level of γ). At this stage, it may be interesting to check whether our subject pool reacts homogeneously to our treatment (incentive) conditions. To this aim, we partition each experimental session's subject pool in two subsamples of equal size characterized by the highest (lowest) relative frequencies of best-responses.. In what follows, we shall assign a dummy variable $BR = 0$ (1) to each subject, depending on whether she was characterized by a relative frequency of best-replies lower (higher) than the session median.[13]

Figure 4 shows the relative frequency of cooperation of the two subsamples across the four experimental treatments.

Put Figure 4 about here

As Figure 4 shows, the two subsamples exhibit some heterogeneity in the individual attitude to cooperate. Here we see that -not surprisingly- subjects cooperate less (more) in T_4 (T_1) when BR=0. By contrast, both in T_2 and T_3, where best-reply crucially depends upon other group members' behavior, subjects cooperate more when $BR = 0$ (with this latter effect particularly pronounced in T_2). As a consequence, when $BR = 0$, subjects' decision to cooperate is less sensitive to γ.

The displayed heterogeneity might be explained by heterogeneity in the cognitive ability of different subjects to correctly figure out the strategic situation in which they were involved in the experiment, or, rather, different (conscious) motivations to action, not captured by the (extremely simplified) behavioral model developed in Section 2. To check how BR has to be considered as a proxy of the "degree of individual rationality" of each individual subject, we disaggregate in Figure 5 the information of Figure 3 (i.e. the level of accuracy of subjects' beliefs) with respect to the two subject subsamples induced by BR, both for the entire dataset (Figure 5a) and for the observations belonging to treatments T_2 and T_3, where beliefs are crucial in defining the current best-response (Figure 5b) .

Put Figure 5 about here

As Figure 5 shows, beliefs' accuracy does not seem to depend on the partition induced by BR, and this is particularly evident for T_2 and T_3, where belief accuracy in the two subsamples is practically identical. In other words, the higher tendency of cooperate on behalf of "not best-responders" does not depend

[13]There is a caveat here. As we already noticed, while in treatments T_1 and T_4 best-reponse does not depend on the other group member current decision (as defecting and cooperating correpond, respectively, to a strictly dominant strategy), in T_2 and T_3 optimal play in the game crucially depends on the other group members' strategy profile. In this respect, we define best-response as the strategy maximizing expected payoff conditional to each individual elicited belief.

on accuracy of beliefs. In the following section, we shall further investigate on this issue by way of some panel data logit regression.

4.2 Panel data regressions

To investigate more deeply on the determinant of our subjects' decision, and to contrast our theoretical results with the experimental evidence, we now present some econometric estimates in which our subjects' decisions are explained by two sets of variables, both coming from our experimental conditions, as well as the demographics/personal information on (pro) social attitude and behavior recorded in our questionnaire.

In the analysis that follows, our dependent variable will be subject's decision to cooperate. Let $\delta_s(t)$ denote an index variable that takes the value of 1 (0) if subject s has cooperated at time t. To fully exploit the panel structure of our database, we employ some logit (random effect) regressions of the following form:

$$prob(\delta_s(t) = 1) = f(\beta' x_s(t)) + \epsilon_s + \varepsilon_s(t), \tag{8}$$

where f is the logistic function and $\epsilon_s \sim iid(0, \sigma_\epsilon^2)$ is the unobserved (time-invariant) heterogeneity that characterizes subject s and $\varepsilon_s(t) \sim iid(0, \sigma_\varepsilon^2)$ is an idiosyncratic error term (we further assume, as standard in the literature, $\epsilon_s \perp \varepsilon_s(t)$). Note that $x_s(t)$ represents the vector of regressors and β represents the vector of the corresponding coefficients in (8).

4.2.1 Choice of regressors

We shall now describe the regressors used in our econometric analysis.

1. **Group 1 variables: experimental conditions.**

    (a) *Gamma* is a payoff-related variable. In our theoretical model the individual attitude to cooperation is explained by the level of economic rents, γ. A different value of γ, indeed, determines a different set of payoffs as a result of different distributions of rents. As we already discussed, in the experiment the value of γ is uniquely defined by the corresponding experimental treatment, being set to 0.1, 0.31, 0.33 and $0,5$ in treatments T_1 to T_4 respectively.

    (b) *Trseq* captures sequencing effects in playing treatments. Since two treatments were played in each experimental session, *trseq* equals 0 when the treatment has been played first and 1 when the treatment has been played second.

    (c) *Periodone* controls for learning effects within the treatment, the dummy being equal to 0 for the first 10 periods and 1 for the second 10.

(d) *Timeaction* is the number of seconds that it has taken to the subject to decide for what action to choose. Assuming that players are "equally clever", this variable is an attempt to measure if "more thinking" has an impact on cooperative behavior..

(e) *Reciproc,* that is the difference between the agent's predicted number of cooperators for time $t-1$ and the actual number of cooperators at time $t-1$. The purpose of this regressor is to understand whether players react when their expectations about cooperation are betrayed (and therefore, being reciprocal in their intentions).

(f) *Moneydiff* is the difference between the subject's last payoff and the last average payoff of the group.

2. **Group 2 variables: questionnaire.**

(a) *Strateg* is a dummy resulting from questions 27 and 28, and stating that the subject was paying attention to the other players' past actions (i.e. being strategic), or otherwise.

(b) *Inequal* is a dummy resulting from questions 25 and 26 of the questionnaire, and stating that the subject was taking into consideration the other players' payoff because he was concerned about equality in their distribution.

(c) *Notakeadv* is a dummy for those who believe that the others would not take advantage of them if they could.

(d) *Help* is a dummy to indicate that the subject believes the others would help her/him if in need.

(e) *Girl,* a dummy to account for the gender of the subject.

(f) *Clubs*, which measures the number of clubs and associations to which a subject is member. [14]

(g) *Muchpract,* a dummy that catches whether the subject is very religious.[15]

(h) *Money* (question 7 of the questionnaire), a regressor that has been introduced to test whether income plays a role in determining cooperation, such as if income lower the relative opportunity cost that is attached to cooperation.

The table of correlations of our explanatory variables is reported in the Appendix.

[14] Drawing from the classic approach by Putnam [28] we aim to test whether belonging to social clubs increases the predisposition for pro social behaviour.

[15] The introduction of these last questions has been inspired by works such as [32] or [20] which claim that religion positively impacts pro-social behaviours.

4.2.2 Regressions results

We run three regressions. The Regression 1 aims to estimate the determinants of our subjects' decision to cooperate for the entire dataset. Regressions 2 and 3 apply the same set of regressors on observations coming from subjects belonging to each subsample induced by BR. Here the aim is to estimate which the determinants that induce different cooperative behavior in the two subject subsamples are. We want especially to investigate what the incentives of not best-responders' cooperative behavior are, given that the level accuracy of their beliefs does not explain their higher tendency to cooperate (as shown above in Figures 4 and 5).

Figure 6 shows the estimation results of the three regressions.

Put Figure 6 about here

A first element that emerges from Regression 1 is that the most consistent determinants of cooperation are the distributions of monetary incentives, induced by the level of the economic rents (*gamma*). This result is consistent with the result of the theoretical model, presented in section 2. The relationship between rents and cooperation is also confirmed in Regressions 2 and 3.

As for the analysis of the influence of the other variables on cooperation, the comparison between regressions is very interesting, showing significant differences between our two subsamples.

- *Reciprocity.* As for *reciproc*, i.e. the difference between the actual and the predicted number of cooperators at time t-1, the estimated coefficient is negative and significant both in Regressions 1 and 2 (p-values 0.08 and 0.03 respectively), but not in Regression 3. This implies that, when $BR = 0$, subjects reacted negatively to a cooperation level lower than expected. By contrast, this reciprocal motive to action is totally absent in the pool of "best-responders", as the estimated coefficient for reciproc is not significant.[16] This result seems to be consistent with the positive and significant estimated coefficient for the variable *timeaction* in Regression 2: thinking more about what strategy to play has a positive impact on cooperation of "not best-responders", who need significant less time to decide to defect. In other words, non best-responders seem to be careful before granting trust to the other players of the group and cooperate.
- *Strategic thinking.* The estimates of *Strateg* and *moneydiff* are consistent with the line of argument we just discussed. Both coefficients are positive and significant in Regressions 1 and 3, but not in Regression 2. In other words, better-responders look at payoff (rather than actions) to motivate behaviors, and put themselves in the other group members' shoes before choosing what to do in the game.

[16] This is in line with the literature (take, for example, [11] [12] [29] [34] and [31]), which highlights how disappointment of expectations triggers punishment via reciprocity.

- *Relative payoffs.* Concerns for inequality, measured by the variable *inequal,* seem to matter only for not-best responders.

- *Trust as a motive for action.* In our regressions, trust is proxied by the variable n*otakeadv*, whose estimated coefficient is positive and significant in Regressions 1 and 2, but not in regression 3. Hence, subjects who do not play the best-response, and who believe people would not take advantage of them cooperate more.

- *Socio-economic variables.* Finally, our experimental data do not show any significant impact of socio-economic variables (such as *clubs muchpract* or *money)* on cooperation, despite the fact that, in our sample, these variables display relatively high variability..

5 Conclusions

The debate on measurability is one of the most prolific in the SC literature. Most contributions recognize that the empirical difficulties of measuring cooperation and SC are due to weak evidence on the actual direction of causality between cooperation and performance. By distinguishing "natural" from "residual" cooperation, and by framing both types into the pre-existent structure of incentives, we think we provide a new powerful tool to understand which social dynamics are behind the evolution of cooperation. This is an important added value to the debate of measurability, since to our judgement, the contemporary literature on SC, particularly empirical, does not pay sufficient attention to the pre-existent structure of incentives that may determine cooperation. Our findings show that a prior understanding of the distribution of rents has to be the starting point for any research on collective behavior and SC. With closer reference to what are the determinants of SC, our results show that deviations from payoff maximizing behavior towards higher levels of cooperation are mostly determined by the degree of subjects' "faith in others" and the possibility of reciprocal sanctions.

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6 Appendix

6.1 Experimental instructions (Treatment T_1)

The instructions were presented in Spanish to the subjects. Below is a translation.

SCREEN 1: Welcome to the Experiment

- This is an experiment to study how people solve decision problems.
- We are only interested in what people do on average, and keep no record at all of how our individual subjects behave.
- Please do not feel that any particular behaviour is expected from you. On the other hand, keep also in mind that your behaviour will affect the amount of money you will earn.

- On the following you will find a series of instructions explaining how the experiment works and how to use the computer during the experiment.
- Please do not disturb the other subjects during the course of the experiment. If you need any help, please raise your hand and wait silently. You will be assisted shortly.

SCREEN 2: How you can make money

- To begin you will receive 1000 pesetas just for participating in this experiment.
- The experiment will consist of two sessions of 20 rounds each. In each round, for all sessions, you and other 5 persons in this room will be assigned to a GROUP. In each round, each person in the group will have to make a decision. Your decision, matched with the decision of the other 5 persons in your group will determine how much money you and the others will win for that round.
- The composition of the group WILL REMAIN THE SAME DURING EACH SESSION.
- At the beginning of the second session the computer will select at random the composition of your new group WHICH WILL REMAIN THE SAME FOR THE ENTIRE SECOND SESSION.
- At the end of the experiment you will receive the TOTAL sum of money you obtained in the two sessions, plus the show-up fee of 1000 pesetas.

SCREEN 3: The game (1)

- The Economy in which you operate in is made of 6 projects, just as many as the number of players in your group.
- Projects have different values, and can be ranked, from the highest to the smallest. In this session the values of the 6 projects is as follows.

Project	Value
1	100
2	90
3	81
4	73
5	66
6	60

- As more people will be competing for them, higher projects will be more difficult to get than lower ones.

SCREEN 4: The game (2)

- In each round you will have to choose between two ACTIONS: A or B.
- If you choose ACTION A you will provide all of your effort in competing for ONE project. This will ensure the project will be realised at full and you to earn the full value of it.
- If you choose ACTION B you will instead distribute your effort in competing for TWO projects. Since your "effort" will have to be distributed between the two both will be realised only at their 70%.
- With ACTION A will therefore take home the full value of one project. With ACTION B you will get the sum of the 70% of two projects.
- Remember also that there are only 6 projects for 6 players. Competing for TWO with ACTION B therefore makes it harder for everyone to get any project.
- At the beginning of each round you will also be asked to estimate how many of THE OTHER players in your group will choose ACTION A according to you. This information is requested only for statistical reasons, no other player will see it, and it won't affect the amount of money you earn. Nevertheless, you must provide an answer as closer to your expectation as possible.

SCREEN 5: The game (3)

In order to rule out the influence of chance, avoid luckier players get the best projects, and the unlucky the worse, we have calculated the probabilities to get each single project according to how many choose action A and we have computed the table of the respective expected profits for ACTION A and ACTION B.

Number of other players who have chosen ACTION A	Your pay-off according to the action you have chosen	
	ACTION A	ACTION B
0	58	62
1	60	66
2	63	70
3	66	75
4	70	82
5	78	93

The amount of money you will make will therefore depend on what ACTION you will choose (A or B) and on how the other players are distributed between ACTION A and ACTION B. Remember that with ACTION A you decide to provide maximum effort for ONE project only, with B you instead try to get some benefit from TWO projects, having the chance to earn more money. These values however are also determined by the number of players who choose ACTION A, since the more choose A, the more projects will be realises at their full value (the more the economy will produce) and more pesetas will be distributed.

SCREEN 6: Summary

- At each session you will be matched randomly in a group of 6 people.
- At the beginning of each session you will be provided with a table of expected pay-offs, this table will always remain in the upper right corner of your screen for your reference.
- You first will be asked to give an estimate of how many of the OTHER PLAYERS in your group will choose ACTION A.
- Then you will be asked to choose between ACTION A and ACTION B.
- The computer will then match all players decisions and you will be notified about how much you have earned in the turn. This amount will be added to your previous earnings.
- You will also will given information about how many players among the components of your group have chosen action A and how much they have earned on average.

6.2 Payoff matrices

Treatment T_1:

$\gamma = .1$ $\delta = .9$ (.8?) $\alpha = .4$ (.5?)

Project	Value
1	100
2	90
3	81
4	73
5	66
6	60

Number of other players who have chosen ACTION A	Your pay-off according to the action you have chosen	
	ACTION A	ACTION B
0	58	62
1	60	66
2	63	70
3	66	75
4	70	82
5	78	93

Treatment T_2:

$\gamma = .31$ $\delta = .9$ (.8?) $\alpha = .4$

Project	Value
1	100
2	69
3	48
4	33
5	23
6	16

Number of other players who have chosen ACTION A	Your pay-off according to the action you have chosen	
	ACTION A	ACTION B
0	39	38
1	41	39
2	42	41
3	43	44
4	45	46
5	48	50

Treatment T_3:
$\gamma = .33$ $\delta = .9$ (.8) $\alpha = .4$

Project	Value
1	100
2	67
3	45
4	30
5	20
6	14

Number of other players who have chosen ACTION A	Your pay-off according to the action you have chosen	
	ACTION A	ACTION B
0	38	37
1	39	38
2	40	39
3	42	42
4	43	44
5	46	48

Treatment T_4:
$\gamma = .5$ $\delta = .9$ (.8?) $\alpha = .4$

Project	Value
1	100
2	50
3	25
4	13
5	6
6	3

Number of other players who have chosen ACTION A	Your pay-off according to the action you have chosen	
	ACTION A	ACTION B
0	29	26
1	30	27
2	30	28
3	31	28
4	32	29
5	33	31

6.3 The questionnaire

PERSONAL INFORMATION
1) Name?
2) Surname?
3) Male or Female? M - F
4) How many social group/club/religious associations during the last 10 years?
5) Religion? Catholic - Protestant - Muslim - Other - Agnostic - Non-believer
6) Are you practicing? Very - Not much - Not at all
7) What is your average weakly allowance? (in euro)
8) Have you taken part into other economic experiments before this one? Yes - No

9) Have you found the game instructions difficult to understand? Yes - No
10) Have you found this experiment interesting? Yes - No
11) Are you graduated? Yes - No
12) What school subject are you taking? If you are not studying write "none"; If you are graduated indicate in what subject
13) Have you ever attended any class of game theory? Yes - No
14) How many exams have you passed in your university career so far? (If you are not studying write 0)
15) Have you clearly understood what was the difference between the project table and the table of expected payoffs? Yes - No
16) Have you changed your strategy between the first and second session? Yes - No
17) Generally speaking, would you say that most people can be trusted or that you can't be too careful in dealing with people? Yes, they can be trusted - No, you are never too careful
18) Do you think that most people would try to take advantage of you if they had a chance or would they try to be fair? Yes, they would take advantage - No, they would be fair
19) Would you say most of the time people try to be helpful or that they are mostly looking out for themselves? Yes, they try to be helpful - No, they look our for themselves

QUESTIONS RELATIVE TO THE FIRST SESSION
20) How have you chosen between action A and B? Randomly - I had a strategy
21) If you were using a strategy, please describe it briefly.
22) Were you using the projects table to decide your action? Yes - No
23) Were you considering the historic sequence of actions (the result of the previous rounds) to take your decision? Yes - No
24) How many rounds were you taking into consideration? None - Only the last one - The first rounds - The last rounds - All.
25) Were you taking into consideration how much the other players were earning to take your decision? Yes - No
26) If yes, please explain briefly in what way.
27) Were you taking into consideration the actions of the other players in previous rounds to take your decision? Yes - No
28) If yes, please explain briefly in what way.

QUESTIONS RELATIVE TO THE SECOND SESSION
20) How have you chosen between action A and B? Randomly - I had a strategy
21) If you were using a strategy, please describe it briefly.
22) Were you using the projects table to decide your action? Yes - No
23) Were you considering the historic sequence of actions (the result of the previous rounds) to take your decision? Yes - No
24) How many rounds were you taking into consideration? None - Only the last one - The first rounds - The last rounds - All.

25) Were you taking into consideration how much the other players were earning to take your decision? Yes - No
26) If yes, please explain briefly in what way.
27) Were you taking into consideration the actions of the other players in previous rounds to take your decision? Yes - No
28) If yes, please explain briefly in what way.

6.4 How regressors have been chosen

The pool of regressors, both hard and , to choose from was much larger than the ones we have actually chosen. Before starting the regression analysis, we have in facts carried out a preliminary selection of regressors by studying the full correlation matrix of covariates. A threshold was fixed at 0.35: above this absolute value of correlation, variables were discarded, keeping the one with the least serious correlation problem overall. This procedure is aimed at reducing the collinearity problem in the regressions. Table 4 shows the correlation matrix only for those regressors that have been dropped and that are not to be found in the previous tables.