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Conditional Cooperation and Betrayal Aversion

Robin Cubitt
Simon Gächter
Simone Quercia

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Abstract

We investigate whether there is a link between conditional cooperation and betrayal aversion. We use a public goods game to classify subjects by type of contribution preference and by belief about the contributions of others; and we measure betrayal aversion for different categories of subject. We find that, among conditional cooperators, only those who expect others to contribute little to the public good are significantly betrayal averse, while there is no evidence of betrayal aversion for those who expect substantial contributions by others. This is consistent with their social risk taking in public goods games, as the pessimistic conditional cooperators tend to avoid contribution to avoid exploitation, whereas the optimistic ones typically contribute to the public good and thus take the social risk of being exploited.

JEL-Code: H410, C910, C720, D030.

Keywords: public goods game, conditional cooperation, trust, betrayal aversion, exploitation aversion, free riding, experiments.

Robin Cubitt
University of Nottingham
School of Economics
Sir Clive Granger Building
University Park
United Kingdom – Nottingham NG7 2RD
robin.cubitt@nottingham.ac.uk

*Simon Gächter**
University of Nottingham
School of Economics
Sir Clive Granger Building
University Park
United Kingdom – Nottingham NG7 2RD
simon.gaechter@nottingham.ac.uk

Simone Quercia
University of Bonn
Institute for Applied Microeconomics
Adenauerallee 24-42
Germany – 53113 Bonn
simone.quercia@uni-bonn.de

*corresponding author

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1. Introduction

The voluntary provision of public goods is an important economic problem where collective welfare and individual interest diverge. If economic agents are rational and self-interested, public goods will be underprovided, relative to the efficient benchmark (Samuelson (1954); Hardin (1968)). However, empirical evidence from lab and field studies shows that (i) people are to some extent willing to voluntarily provide public goods (Ledyard (1995)) and (ii) those who are willing to do so are mostly "conditional cooperators", that is, they cooperate only if (they expect) other group members to cooperate as well (see Chaudhuri (2011) for an overview).

This leaves open what drives people to be conditional cooperators. One psychological motive behind conditional cooperation may be that unconditional cooperation entails the risk of being exploited by free riders; and conditional cooperation protects against this exploitation. This attitude to cooperation suggests that conditional cooperators might be in general reluctant to take *social* risks, i.e., risky choices where (i) the outcome is caused intentionally by another person and (ii) this person can exploit the risk-taker.[1]

In this paper, we investigate this psychological motive empirically by linking conditional cooperation to betrayal aversion, a concept closely related to the willingness to take social risks. Betrayal aversion, as introduced by Bohnet and Zeckhauser (2004), is the tendency of people to require a higher risk premium to take *social* risks compared to the benchmark of *natural* risks (where the outcome is determined by nature, independently of human decisions).[2] This difference may arise, because people anticipate the emotional cost of *betrayal* that they suffer on top of the material cost of monetary losses.

We conjecture that the concepts of conditional cooperation and betrayal aversion, developed in two different strands of the literature, share common psychological characteristics. First of all, the anticipation of the emotional cost of betrayal could be a characteristic of conditional cooperators as their attitude towards cooperation reveals they are willing to cooperate conditional on not being exploited. Second, both conditional cooperation and betrayal aversion are in line

[1] A different notion of social risk could entail just the first of the two conditions, but in this paper we will refer to social risks as situation where both (i) and (ii) are present. In this sense, the structure of a socially risky situation is well represented by a sequential social dilemma where cooperative first movers risk being exploited by second movers.

[2] Betrayal aversion and more generally aversion to social risks has been investigated also by Hong and Bohnet (2007), Bohnet et al. (2008), Aimone and Houser (2011), Aimone and Houser (2012), Fetchenhauer and Dunning (2012) Aimone and Houser (2013), Dreber et al. (2013) and Butler and Miller (2014).

with the evidence that subjects care about intentions on top of outcomes (see, e.g., Blount (1995), Falk et al. (2003) and Falk et al. (2008)). In particular, psychological motives such as reciprocity could explain why people are reluctant to take the risk of intentional exploitation (betrayal aversion) and why they want to reciprocate by cooperating in return to others' cooperation (conditional cooperation).[3]

Hence, a first channel through which there might be a link between the two concepts is via preferences. To this end, our main strategy will be to measure betrayal aversion following Bohnet and Zeckhauser (2004) and to relate it to a measure for cooperation preferences provided by Fischbacher et al. (2001).

Another channel through which conditional cooperation and betrayal aversion might be related involves beliefs, as well as preferences. Betrayal aversion has been interpreted as a behavioural trait that inhibits social risk taking. Hence, it should be predictive of cooperation choices when subjects face the social risk of being exploited, i.e., in the presence of uncertainty about others' actions. However, in the strategy method elicitation of Fischbacher et al. (2001), subjects can condition their choices on the average contribution of others and this eliminates the uncertainty inherent in simultaneous cooperation decisions. Hence, it might also be important to consider information on whether people effectively take the risk of contributing when they do not know the other group members' actions. In particular for conditional cooperators, their degree of social risk taking will be reflected in their beliefs about others' cooperation. Consistently with their preference type, they will take the social risk of contributing only if they believe the others are contributing as well. In contrast, if they believe the others are not cooperating they will not take the risk, so avoiding exploitation. Thus, we may expect a weaker or stronger association between betrayal aversion and conditional cooperation, according to whether subjects are optimistic or pessimistic about the contributions of others.

We present the results of two experimental studies that investigate the relation between betrayal aversion and conditional cooperation. While the link between trust and cooperation has been studied before (see for example Gächter et al. (2004), Thöni et al. (2012); see Balliet and

[3] Note that these are two different sides of reciprocity: betrayal aversion seems related to negative reciprocity (hostile reaction to others' unkind intentions) while conditional cooperation is related to positive reciprocity (reward of others' kind intentions). These two aspects are usually modelled as governed by the same parameter (see e.g. Rabin (1993), Dufwenberg and Kirchsteiger (2004), Falk and Fischbacher (2006)).

Van Lange (2013) for a meta-analysis), we are the first, to our knowledge, to investigate how betrayal aversion relates to and inhibits cooperation.

Study 1, which we describe in Section 2, consists of two one-shot experiments: the first uses the design of Bohnet and Zeckhauser (2004) to elicit betrayal aversion and the second implements the design introduced by Fischbacher et al. (2001) to measure preferences for cooperation and to classify subjects into cooperation "types". Since the two concepts we study have operational definitions, we decided as a first step and in order to avoid procedural confounds, to replicate the existing classic designs.

Our results indicate that none of the types is significantly betrayal averse. Moreover, conditional co-operators, taken together, do not have a different level of betrayal aversion compared to other types. Our main result is found investigating the second possible channel described above, i.e., taking into account beliefs about others' cooperation. We find that pessimistic conditional cooperators are significantly betrayal averse, while optimistic ones are not. (A similar relation is not found among other types.) This result suggests a correlation between pessimism and the intensity of the psychological cost of trust betrayal. We investigate this through answers to hypothetical scenarios in our post-experimental questionnaire. Consistent with the behavioral data, the results show a significant difference between pessimistic and optimistic conditional cooperators in the self-reported psychological cost of betrayal.

Study 2, which we present in Section 3, tests the robustness of the findings of Study 1 introducing a novel measure of betrayal aversion. The results from Study 2 show, consistent with Study 1, no difference in betrayal aversion across types. However, when we use beliefs as additional classification criterion, we again find significant betrayal aversion for pessimistic conditional cooperators, and no betrayal aversion for the optimistic ones. In Section 4, we summarize and discuss the results.

2. Study 1 – Investigating the relation between conditional cooperation and betrayal aversion

2.1 Experimental design and procedures

Our design is composed of two parts: Part 1 elicits betrayal aversion replicating the design of Bohnet et al. (2008)[4] and Part 2 measures subjects' attitudes to cooperation following Fischbacher et al. (2001). We describe game payoffs in each part in terms of "points", for comparability with other studies. (Points were converted to cash at the end of each session.)

Part 1 – Betrayal aversion

The core of the design of Part 1 is a between-subjects comparison of behavior in two games: the Trust Game and the Risky Dictator Game (henceforth TG and RDG) whose extensive forms are presented in Figure 1.[5] Subjects are randomly matched in couples and assigned the roles of first movers and second movers in TG (first movers and recipients in RDG). In both games, the first mover chooses between a certain and a risky option. The certain option gives 10 points to him and to their counterpart. The risky option can produce either an unequal outcome of 8 points to the first mover and 22 to their counterpart or an equal split giving 15 points to both.

While in TG the outcome of the risky option is determined by a second mover and the first mover is exposed to the risk of betrayal, in RDG betrayal is removed by letting the outcome be determined by a random draw with the probabilities of outcomes (15; 15) and (8; 22) being p and $1\text{-}p$, respectively. This is the only difference between the two games.

[4] This is a follow up study to Bohnet and Zeckhauser (2004) that uses the same design and procedures.

[5] The original Bohnet and Zeckhauser (2004) design consists of three between-subjects treatments called Trust Game, Risky Dictator Game and Decision Problem. The comparison between choices made in the first and the second treatment measures betrayal aversion, while the comparison between choices made in the second and in the third measures social preferences. As we are mainly interested in measuring betrayal aversion, we implemented only TG and RDG.

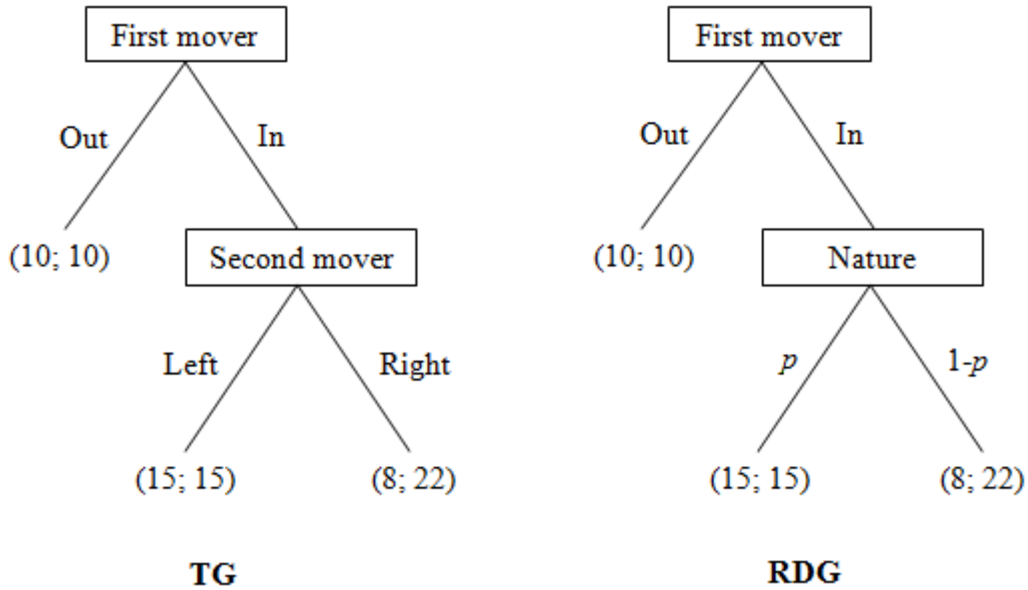

Figure 1: Extensive forms of the Trust Game (TG) and Risky Dictator Game (RDG).

In our experimental implementation of TG, first and second movers take decisions at the same time; second movers' decisions are elicited using the strategy method (Selten (1967)), i.e., each second mover is asked whether he would choose Left or Right if their first mover chooses In. In RDG, recipients are asked to wait for the decision of first movers and not to take any action.

For first movers in both TG and RDG, we elicit the lowest probability of the outcome (15; 15) at which they would choose In instead of Out. Following Bohnet et al. (2008), we call this value the minimum acceptance probability (MAP). Betrayal aversion is measured as the difference between average MAPs across the two treatments, that is, $BA = \overline{MAP}_{TG} - \overline{MAP}_{RDG}$. If the average MAP in the TG is higher than that in the RDG first movers are on average betrayal averse, i.e., they require a higher risk premium to take social risks compared to natural risks.

To elicit MAPs incentive compatibly, we use two different versions of the Becker-DeGroot-Marshak (BDM - Becker et al. (1964)) mechanism: an open-ended version that asks subjects directly their threshold probability and uses the same instructions and procedures of Bohnet et al. (2008) and a choice list version (documented in the Appendix) that uses frequencies instead of probabilities.[6] In both cases, subjects have an incentive to reveal their "true" preference value

[6] In a companion paper, Quercia (2015) compares these two versions of the BDM mechanism in the context of the elicitation of betrayal aversion. One of the main findings is that the two versions do not produce significantly

under expected utility theory (see Bohnet and Zeckhauser (2004) for a discussion of the incentive compatibility of the design).

Part 2 - Conditional cooperation

Part 2 uses the design introduced by Fischbacher et al. (2001), in which a variant of the strategy method is employed to elicit subjects' attitudes towards cooperation in a specially designed public goods game.[7] Participants are randomly assigned to groups of four subjects and endowed with 20 tokens, each of which they may either keep for themselves or invest in a "project". The following payoff function defines the material incentives subjects face:

$$y_i = 20 - x_i + 0.4 \sum_{i=1}^{4} x_j$$

where y_i are earnings in points and x_i denotes the contribution of player i to the project. As the marginal per capita return (MPCR) of the project is less than 1, it is individually optimal to put zero tokens into the project. However, because the MPCR is greater than $1/n$, it is socially optimal to contribute fully to the project.

Subjects have to make an "unconditional contribution" and a "conditional contribution". In the unconditional contribution, subjects are simply asked how much they contribute to the project. In the conditional contribution participants are asked to fill out a contribution table specifying a contribution decision for each possible average contribution (rounded to integers) of the other three subjects in their group. Thus, for each participant their contribution table consists of 21 entries (one for each possible average from 0 to 20). After all participants have taken both the unconditional and conditional decisions, we elicit each participant's belief about the average unconditional contribution of the other three members in their group.[8]

To ensure incentive compatibility, one group member is randomly selected in each group and their conditional decision is payoff relevant while for the other three group members their unconditional contributions are payoff relevant. The contribution of the randomly selected

different levels of betrayal aversion. Given this result, in this paper we pool the data from the two elicitation methods.

[7] This design has been frequently used to investigate heterogeneity of subjects preferences for cooperation in public goods experiments; see for example Kocher et al. (2008), Herrmann and Thöni (2009), Fischbacher and Gächter (2010), Fischbacher et al. (2012), Martinsson et al. (2013).

[8] We follow Fischbacher and Gächter (2010) regarding the mechanism to incentivize beliefs: for each correct belief the participants earned 3 points, for each belief that deviated by 1(2) point from the correct estimate the participants earned 2(1) points.

member is derived calculating the average unconditional contribution of the other three members and finding the corresponding entry in their contribution table.

Procedures

All the sessions were conducted at the University of Nottingham. Participants were recruited via ORSEE (Greiner (2004)). In total, 592 subjects participated in the experiment. Before each part, subjects had to answer a set of control questions to check their understanding of the decision situations. In Part 1, we used the instructions and control questions of Bohnet et al. (2008) for the open-ended elicitation of betrayal aversion[9] and we developed a novel set of instructions and control questions for the choice list elicitation of betrayal aversion. In Part 2, we used a slightly adapted version of the Fischbacher and Gächter (2010) instructions and we used the same control questions (see Appendix). Subjects were paid the sum of earnings from Part 1 and 2 and all feedbacks about the outcomes of the two parts were given at the end of Part 2 to avoid contamination of Part 2 behaviour by Part 1 outcomes. Each session lasted approximately 75 minutes and the average payment was £ 7.20.

2.2 Experimental results

2.2.1 Betrayal aversion and cooperation types

As a first step, we classify subjects according to their cooperation attitudes elicited in Part 2 of the experiment and we look at betrayal aversion for each cooperation "type". We divide subjects into three groups: conditional cooperators, free riders and others.[10] Since we measure betrayal aversion only for the subjects who are assigned the role of first mover in Part 1, the relevant distribution of types for our purposes uses observations only from that subsample (n = 273).[11]

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[9] The instructions are available as a web appendix (http://www.aeaweb.org/aer/data/mar08/20051024_app.pdf). We thank the authors for making available also their control questions.

[10] Following Fischbacher et al. (2001), "conditional cooperators" exhibit either a monotonically increasing schedule or a positive ρ (significant at 1% level) in the Spearman correlation test between their contribution table and the average contribution of the others in their group. "Free riders" are subjects whose contribution table presents only zeros. All the remaining subjects are classified as "others". In Fischbacher et al. (2001), "triangle contributors" constitute a fourth type. Because there are very few in our sample, we include them in the category "others".

[11] The distribution is not significantly different from the distribution for subjects who were in the role of second movers (recipients) in Part 1 (χ^2 (2) = 3.30, p = 0.192). Thus, we can exclude any spill-over effect of the role subjects were playing in Part 1 on Part 2 behaviour.

Consistent with previous literature (see Chaudhuri (2011)), conditional cooperators constitute the majority of our sample (59.7%), followed by free riders (25.6%) and others (14.7%).

Table 1 reports the analysis of betrayal aversion for the cooperation types classified in the public goods game. Surprisingly, betrayal aversion is not significantly different from zero for any category. A Kruskal-Wallis test on the distribution of MAPs across types cannot reject the null hypothesis of the data being drawn from the same populations in both games (p = 0.719 and p = 0.327 for TG and RDG, respectively). Hence, we conclude that there is little evidence for betrayal aversion as a general characteristic of conditional cooperators vis-à-vis other types.

Table 1 Betrayal aversion according to cooperation types (Std. Dev. in brackets).

	$\overline{MAP}_{TG}$	$\overline{MAP}_{RDG}$	$\overline{MAP}_{TG} - \overline{MAP}_{RDG}$	p-value
Conditional cooperators (n = 163)	0.53 [0.21]	0.47 [0.20]	0.06	0.109
Free riders (n = 70)	0.50 [0.22]	0.43 [0.20]	0.07	0.178
Others (n = 40)	0.54 [0.24]	0.50 [0.18]	0.04	0.506

Note: p-values based on Mann-Whitney U (MWU) test.

These results raise the question whether looking only at cooperation types is a sufficient description of conditional cooperators in relation to attitudes to betrayal. In particular, if the connection between conditional cooperation and betrayal aversion is related to social risk taking, attitudes elicited through the strategy method might not be a sufficient classification criterion. In the next subsection, we investigate the second channel through which conditional cooperation and betrayal aversion might be related. To do this, we take into account a measure of willingness to take social risks on top of cooperation preferences. In particular, we look at either beliefs about others' contributions or unconditional contributions in addition to cooperation preferences.

2.2.2 Betrayal aversion according to cooperation attitudes and beliefs

We use beliefs about the average unconditional contribution of the other three group members to distinguish between optimistic and pessimistic subjects. We define a subject as pessimistic if they hold a belief strictly below the median belief in their type sample and optimistic if they hold a belief equal to or above the median belief in their type sample.

Figure 2 reports betrayal aversion levels for pessimistic and optimistic members of each type sample. The figure reveals several interesting findings: pessimistic conditional cooperators are significantly betrayal averse (MWU-test, $z = 3.221$, $p = 0.001$), while this is not the case for optimistic conditional cooperators (MWU-test, $z = -0.735$, $p = 0.462$). This is consistent with their social risk taking in the public goods game: their average unconditional contributions amount to 13.4 for optimists and 4.3 for pessimists (MWU-test, $z = 8.075$, $p = 0.000$). No other category shows significant differences in average MAPs across treatments (MWU-test, $p \geq 0.231$).

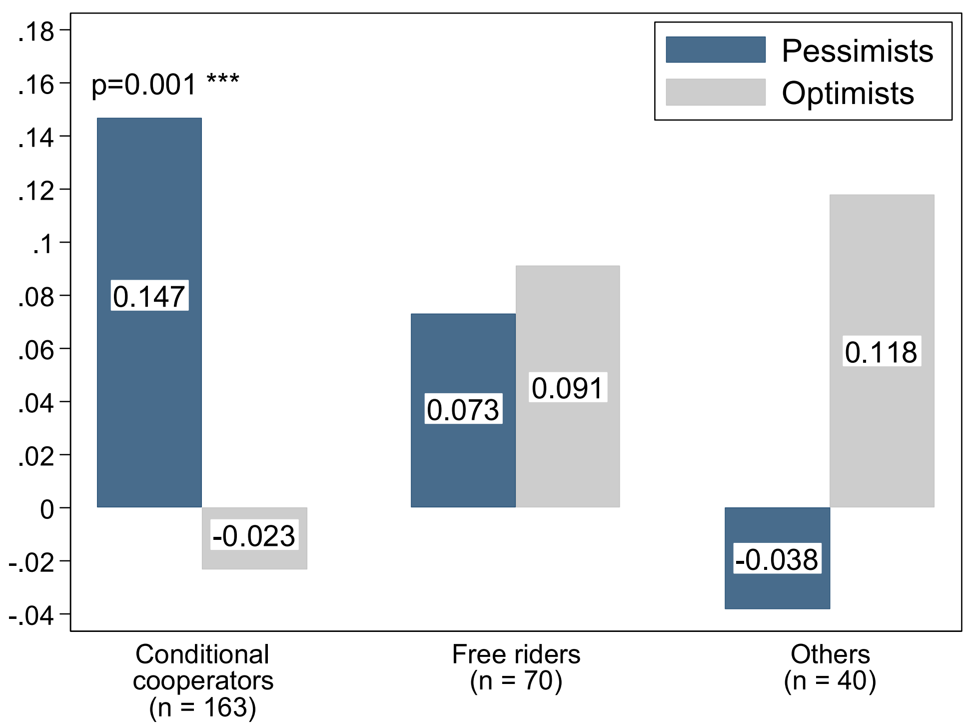

Figure 2: Betrayal aversion for each type classified according to attitudes and beliefs

As an alternative approach, we use unconditional contributions instead of beliefs as an indication of social risk taking in the public goods game. Hence, we classify as a "contributor" ("non-contributor") an individual who has an unconditional contribution equal or above (strictly lower than) the median unconditional contribution in their type sample. Conducting this additional analysis does not change our conclusions for conditional cooperators. Betrayal aversion is -0.01 for the "contributors" and 0.12 for the "non-contributors" (MWU – test, $z = -0.364$, $p = 0.715$; $z = 2.631$, $p = 0.009$, respectively). For free riders, we are not able to perform a median split because, as expected from their strategies, their median unconditional contribution is exactly zero. For Others, betrayal aversion is 0.08 for the "contributors" and -0.03 for "non-contributors". Both measures are not significantly different from zero (MWU – test, $p \geq 0.574$).[12]

The difference in betrayal aversion between optimistic and pessimistic conditional cooperators suggests an asymmetry in the psychological cost of betrayal across these two groups. In particular, we could expect that pessimists suffer a higher psychological betrayal cost compared to optimists. To check for this possibility, we included in some of our experimental sessions a questionnaire eliciting psychological reactions to betrayal. In the next subsection, we report the results from this additional question.

2.2.3 Eliciting the psychological cost of betrayal

We elicited reactions to betrayal through a vignette study that was conducted on a subsample of subjects of our main experimental sample ($n = 240$). Subjects were presented with one of the two following scenarios: [13]

[12] As the samples of free riders and others are smaller compared to the one of conditional cooperators, we also compared conditional cooperators versus all other subjects to increase the power of the test for the non-conditional cooperators. Results do not change substantially: we again find that no category is significantly betrayal averse except pessimistic conditional cooperators. This additional analysis is reported in the Appendix.

[13] The bold font and the titles are used here to highlight differences between the two scenarios but these elements were not used in the experiment.

Betrayal scenario

For private reasons, you have to travel frequently to a big city. From the airport, you usually take a cab to your final destination. The route is straightforward and the price you usually pay is £10. One day you take the cab and the driver takes a detour from the usual way **even though the road conditions do not require it**. This makes the fare more expensive. He charges you £15.

Bad luck scenario

For private reasons, you have to travel frequently to a big city. From the airport, you usually take a cab to your final destination. The route is straightforward and the price you usually pay is £10. One day you take the cab and the driver takes a detour from the usual way **because a tree fell on the street**. This makes the fare more expensive. He charges you £15.

The two scenarios are identical except that the subjects who are presented with the betrayal scenario can infer that the taxi driver is deliberately taking a detour to cheat them, while in the bad luck scenario the detour is outside of the driver's control. Subjects had to answer the question: "How do you feel about it?" on a scale from -5 to +5, where -5 corresponded to "Very Bad", 0 to "Neutral" and +5 to "Very Good". We interpret responses as indicators of emotional cost.

The results indicate very different reactions between the two scenarios. The mean (median) rating is -3.76 (-4) in the betrayal scenario compared to -1.55 (-1.5) in the bad luck scenario, suggesting that subjects suffer significantly more emotional cost from betrayal than from bad luck. The distribution of ratings is significantly different across the two scenarios (MWU-test, n = 240, z = -9.59, p = 0.000).

Our next step is to check whether pessimistic conditional cooperators suffer a higher cost of betrayal compared to optimistic ones. We expect no differences in ratings in the bad luck scenario between optimistic and pessimistic conditional cooperators, while we expect a difference in the ratings of the betrayal scenario.

Figure 3 presents the histograms of subjects' ratings splitting the sample in pessimistic/optimistic conditional cooperators. Panel A and C presents the results from the betrayal scenario and Panel B and D the ones from the bad luck scenario. A first observation is that there is a clear difference in the modal response between pessimistic and optimistic conditional cooperators in the betrayal scenario (-5 vs. -3, respectively). The average rating in the betrayal scenario is significantly lower for pessimists compared to optimists (-3.97 and -3.38, respectively; MWU-test, n = 72, z = 2.43, p = 0.015). We do not find significant differences in the bad luck scenario; averages amount to -1.48 for pessimists and -1.40 for optimists (MWU-test, n = 74, z = 0.419, p = 0.675).

As a comparison group, we look at free riders.[14] In the betrayal scenario, free riders seem to exhibit the opposite pattern compared to conditional cooperators with the average rating from pessimistic (optimistic) free riders being -3.6 (-4.2). However, this difference is not significant (MWU-test, n = 35, z = -1.57, p = 0.117). In the bad luck scenario, we do not find any difference in ratings also for free riders (MWU-test, n = 32, z = 0.159, p = 0.874).

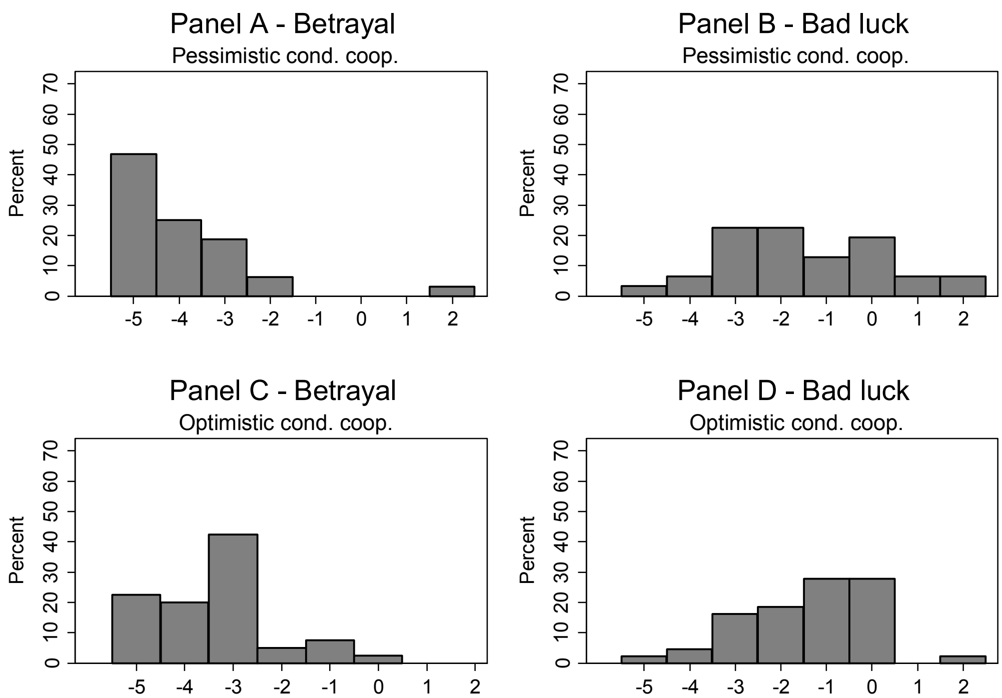

Figure 3: Ratings in the betrayal and bad luck scenarios for pessimistic/optimistic conditional cooperators (CC)

[14] We compare conditional cooperators' ratings only with free riders because in the category Others we have too few subjects to make meaningful comparisons. We report the figure analogous to Figure 3 for free riders in the Appendix.

Overall, our results suggest that beliefs play an important role in the link between conditional cooperation and betrayal aversion. In particular, only pessimistic conditional cooperators are betrayal averse. The same relation does not hold for any other cooperation type classified in the public goods game. Moreover, in this section, we have presented evidence that the differences in betrayal aversion are correlated with different psychological costs of *trust betrayal* as elicited by responses to a hypothetical scenario. In the next section, we introduce Study 2 where we test the robustness of the previous findings introducing a novel method to measure betrayal aversion.

3. Study 2 – A novel measure of betrayal aversion

In Study 2, we introduce a new measure of betrayal aversion, which addresses one concern about the design of Bohnet and Zeckhauser (2004). Their design uses the Becker-DeGroot-Marshak (BDM - Becker et al. (1964)) mechanism to elicit betrayal aversion in an incentive compatible way. However, the BDM mechanism is arguably a very cognitive method. As betrayal aversion stems from the anticipation of an emotional state, such a "cold" elicitation method could underestimate the extent of the phenomenon.[15]

Drawing on the scenarios reported in the previous section, we develop novel ones where we ask subjects to choose hypothetically between a safe and risky bet. Thus, in contrast to the previous section, where we only look at *ex post* reactions to betrayal (bad luck), we elicit the anticipation of these reactions, i.e., betrayal aversion.

3.1 Experimental design and procedures

Study 2 was an online experiment conducted using Amazon Mechanical Turk (see Horton et al. (2011)). The experiment was composed by two one-shot experiments. The first was a strategy method public goods game experiment identical to the one used in Study 1 (Fischbacher et al. (2001)). The second game was a direct response public goods game where we also elicited incentivized beliefs about the average contribution of the other three group members. After subjects made their decisions in the two games above, they were presented with one of the two following scenarios (as before, bold font and titles were not presented to subjects):

[15] The BDM mechanism has been also questioned for being not fully transparent to subjects (see, e.g., Cason and Plott (2014)). See Quercia (2015) for an analysis and discussion of use of the BDM mechanism to elicit betrayal aversion and Bartling et al. (2015) for a response to Cason and Plott (2014).

Natural risk scenario

For personal reasons, you have to travel to a big city. From the airport you can choose between two taxi companies to reach your final destination for which you don't know the exact route. Company A charges you a fixed price of $12. Company B charges you according to the taxi meter. If **the weather is fine**, it costs you $8. However, 1 out of 5 **times**, **due to bad weather conditions the ride takes longer** and the fare is then $16.

Social risk scenario

For personal reasons, you have to travel to a big city. From the airport you can choose between two taxi companies to reach your final destination for which you don't know the exact route. Company A charges you a fixed price of $12. Company B charges you according to the taxi meter. If **the driver takes the direct route**, it costs you $8. However, 1 out of 5 **drivers take detours to make more money out of you** and the fare is then $16.

After reading, subjects were asked to choose one of the two companies. Notice that a risk neutral subject would always choose Company B, which has an expected cost of $9.6. However, depending on their degree of risk aversion some subjects may choose Company A in the natural risk scenario. Compared to the benchmark of the natural risk scenario, we expect that the possibility of betrayal would make subjects even more likely to choose Company A in the social risk scenario. We will interpret such evidence as betrayal aversion. In total, we had 359 subjects who were paid $2 for participating plus an additional bonus that depended on their earnings from the two one-shot public goods games. The average bonus earnings were $ 2.56 and the experiment lasted on average 9 minutes.

3.2 Experimental results

The results from the classification of cooperation types show a very high proportion of conditional cooperators compared to the laboratory sample of Study 1. In particular, we find 79.7% conditional cooperators, 8.6% free riders and 11.7% others. This is consistent with previous experiment on US subject pools (see Kocher et al. (2008)).[16] However, it does not allow us to draw meaningful conclusions on free riders and others. We, therefore, concentrate on the relation between conditional cooperators, optimism/pessimism and betrayal aversion.

[16] In particular, they find 80.6% conditional cooperators, 8.3% free riders and 11.1% others. This distribution is not statistically different from ours ($\chi^2(2) = 0.016$, $p = 0.992$). We thank the authors for supplying their data.

The results from the scenarios reveal that overall participants are significantly betrayal averse: the percentage of people choosing Company A (safe option) increases from 45% in the natural risk scenario to 63.7% in the social risk one ($\chi^2(1) = 12.63$, $p = 0.000$).

In Table 2 we report the percentage of subjects choosing Company A in each type sample in the natural and social risk scenarios. All the three groups seem to be substantially betrayal averse as measured by the percentage points difference in risk avoidance between the social and natural risk scenarios. Statistical comparison reveals significant betrayal aversion only for conditional cooperators and others. However, as mentioned before, the results for free riders and others should be taken carefully as the test may be under-powered due to the small number of observations.

Table 2 Percentage choosing the safe option (Company A) for each cooperation type

	Social Risk	Natural Risk	*p*-value
Conditional cooperators ($n = 286$)	63%	47%	0.007
Free riders ($n = 30$)	50%	24%	0.125
Others ($n = 43$)	80%	50%	0.043

Note: *p*-values based on χ^2 test.

We turn next to the analysis of betrayal aversion considering also beliefs about others' cooperation. Figure 4 shows the difference in risk avoidance between pessimistic and optimistic conditional cooperators in the natural and social risk scenarios. While the percentage of risk avoidance increases by 11.5 percentage points moving from natural to social risk for optimists, it increases by more than twice as much for pessimists (from 51% to 74.1%). Moreover, the former difference is not significantly different from zero ($\chi^2(1) = 2.41$, $p = 0.120$), while the latter is ($\chi^2(1) = 5.86$, $p = 0.015$).

It is also interesting to look at the comparison of choices of pessimists/optimists within each scenario. While we find that there is no difference in risk avoidance between pessimistic and optimistic conditional cooperators in the natural risk scenario, pessimists avoid risk significantly more than optimists in the social risk scenario ($\chi^2(1) = 4.71$, $p = 0.030$).

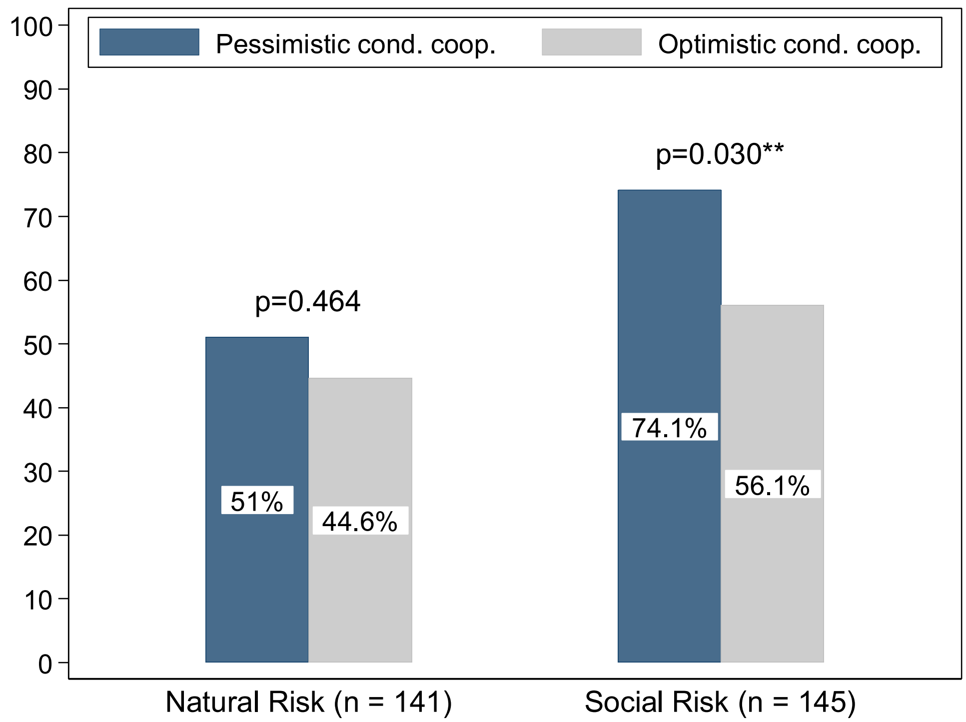

Figure 4: Responses of pessimistic/optimistic CCs to natural and social risk scenarios

Like in Study 1, an alternative classification approach is to use unconditional contribution decisions to discriminate between subjects who contribute above and below the median. The results using this additional classification procedure confirm the one shown in Figure 4. Considering only conditional cooperators, there is, indeed, no significant difference between the "non-contributors" and the "contributors" in natural risk taking (fractions choosing Company A amount to 47.5% and 46.5%, respectively; $\chi^2(1) = 0.011$, $p = 0.918$), while the difference is around 20 percentage points in social risk taking (75.5% and 56.2%, respectively; $\chi^2(1) = 5.15$, $p = 0.023$). Moreover, betrayal aversion is significantly different from zero for the "non-contributors", while it is not for "contributors" ($\chi^2(1) = 7.40$, $p = 0.007$; $\chi^2(1) = 1.86$, $p = 0.173$, respectively).

Taken together these results reveal that (i) pessimistic conditional cooperators are significantly betrayal averse and optimistic ones are not also according to our new measure of betrayal aversion and (ii) this is due to differences in willingness to take social risks rather than natural risks. The second finding is consistent with the evidence presented in Section 2.2.3 that pessimistic conditional cooperators feel worse than optimistic ones if they are intentionally exploited but, instead, there is no difference when bad luck occurs.

4. Summary and concluding remarks

In this paper we have reported the results of two studies that investigate the link between betrayal aversion and conditional cooperation, two concepts studied up to now in two different strands of the experimental literature. We have hypothesized two channels through which the two concepts may be related. The first channel links betrayal preferences to preferences for cooperation, while the second links them to the combination of cooperation preferences and beliefs.

We have presented results from two studies investigating the two channels. We find stronger support for the second channel. In particular, we find that only pessimistic conditional cooperators are significantly betrayal averse, while optimistic ones are not. This is consistent with their social risk taking in public goods games, as the optimistic conditional cooperators are the ones who contribute and thus take the social risk of being exploited, whereas the pessimistic ones tend to avoid contribution to avoid exploitation.

Overall, our results establish an important correlation between cooperation preferences, beliefs and betrayal aversion. One question that remains unanswered from our study is whether the correlation we find is a causal one and what is the direction of causality.

Betrayal aversion has been interpreted in previous literature as a preference trait and hence as a primitive. If this is the case, our results suggest that betrayal aversion shapes beliefs and contributions of conditional cooperators in the public goods game. Hence, the group of conditional cooperators who suffer a high cost of *betrayal* might adopt pessimistic beliefs about others' cooperation as self-defensive strategy to minimize the likelihood of exploitation. Interventions aimed at mitigating the cost or reducing the likelihood of betrayal could induce more optimism and hence higher cooperation in social dilemmas.[17] However, we cannot exclude

[17] Suggestive evidence for this comes from Gächter and Thöni (2005), where subjects were grouped according to a one-shot game contributions to play a repeated public goods game. The results suggest that cooperators increase

that the direction of causality goes in the opposite way and thus a general inclination to pessimism causes subjects to be more betrayal averse. A third possibility is that there is some deeper cause which jointly drives betrayal aversion, pessimism and the disinclination to contribute to public goods when others do not. While we can only be suggestive about these possibilities in this paper, we think these are interesting questions for future research.

their contribution when they learn that they are only grouped with other cooperators, that is, when the likelihood of betrayal is reduced.

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APPENDIX

A1. Pessimistic/optimistic subjects analysis for conditional co-operators versus everyone else.

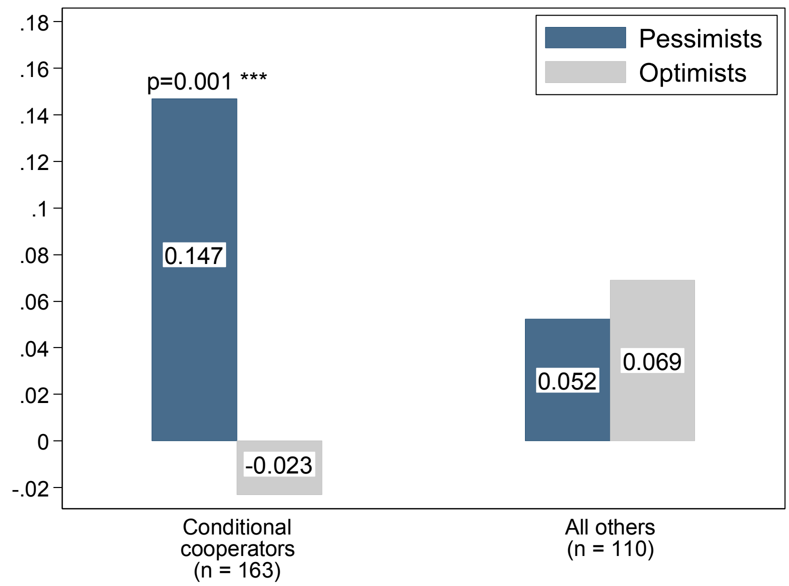


Figure A1: Betrayal aversion according to preferences and beliefs

A2. Reactions to betrayal/bad luck scenarios for free riders

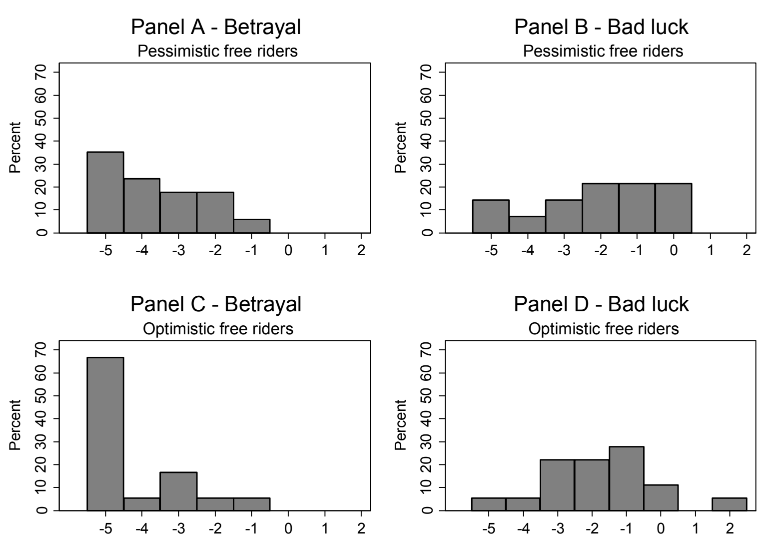


Figure A2: Reactions to betrayal/bad luck scenarios for free riders

A3. Instructions for the public goods game adapted from Fischbacher and Gächter (2010)

Instructions

You are now taking part in a second experiment. The money you earn in this experiment will be added to what you earned in the first one. As before, we will not speak of Pounds during the experiment, but rather of points. At the end, the total number of points you have earned will be converted to Pounds at the following rate:

1 point=£0.2

These instructions are solely for your private information. **You are not allowed to communicate during the experiment.** If you have any questions, please raise your hand. A member of the experimental team will come to you and answer them in private.

All participants will be divided into groups of four members. **Only the experimenters will know who is in which group.**

The decision situation

We first introduce you to the basic decision situation. Then, you will complete a pre-study questionnaire on the screen in front of you, which is intended to help you understand the decision situation.

In each group, every member has to decide the allocation of 20 tokens. You can put these 20 tokens into your **private account** or you can put some or all of them into a **project**.

Your income from the private account

You will earn 1 point for each token you put into your private account. For example, if you put all 20 tokens into your private account, your income from your private account would be 20 points. If you put 6 tokens into your private account, your income from this account would be 6 points. **No one except you earns anything from tokens you put in your private account.**

Your income from the project

Each group member will profit equally from the amount you or any other group member put into the project. The income for each group member from the **project** will be determined as follows:

Income from the project *= 0.4 × sum of all contributions*

If, for example, the sum of all contributions to the project by you and your other group members is 60 tokens, then you and each other member of your group would earn 60 × 0.4 = 24 points out of the project. If four members of the group contribute a total of 10 tokens to the project, you and the other members of your group would each earn 10 × 0.4 = 4 points.

Total income

Your total income is the sum of your income from your private account and from the project:

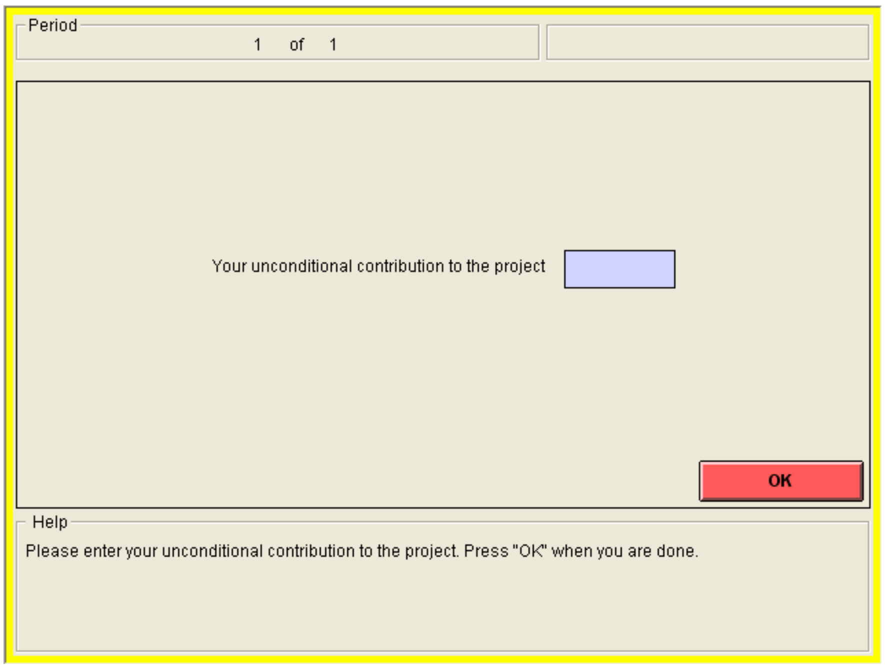
Your Total Income = *Income from your private account + Income from the project* *=20 – your contribution to the project + 0.4 × sum of all contributions to the project*

The Experiment

The experiment is based on the decision situation just described to you, conducted **once.** You will enter your decisions in the screen in front of you.

As you know, you will have 20 tokens at your disposal. You can put them into a private account or into a project. Each subject has to make **two types** of decisions in this experiment, which we will refer to below as the **"unconditional contribution"** and the **"contribution table"**.

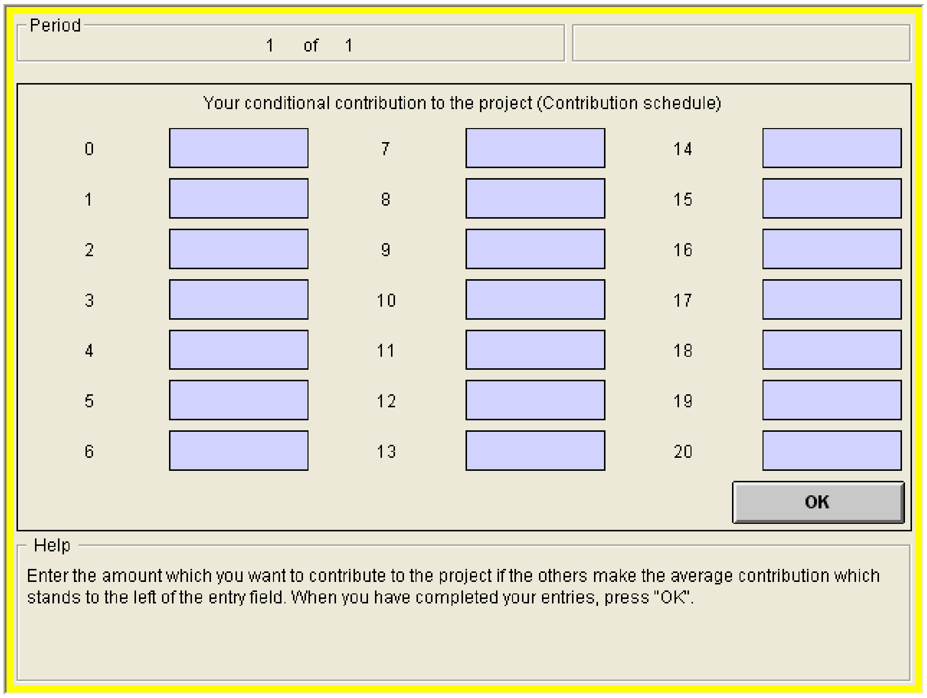
- In the **unconditional** contribution you simply decide how many of the 20 tokens you want to put in the **project**. Please indicate your contribution in the following screen:



After you have determined your unconditional contribution, please click "OK".

- Your second task is to fill in a "contribution table" where you indicate how many tokens **you want to contribute** to the project **for each possible average contribution of the other group members** (rounded to the next integer). Here, you can condition your contribution on that of the other group members. This will be immediately clear to you if you take a look at the following table.

  This table will be presented to you in the experiment:



The numbers to the left of the blue cells are the possible (rounded) average contributions of the **other** group members to the project. You have to insert how many tokens you want to contribute to the project into each input box – conditional on the indicated average contribution by the other members of your group. **You must enter a number between 0 and 20 inclusive in each input box**. For example, you have to indicate how much you contribute to the project if the others contribute 0 tokens on average to the project; how much you contribute if the others contribute 1, 2, or 3 tokens on average; etc. Once you have made an entry in each input box, click "OK".

After all participants of the experiment have made an unconditional contribution and have filled in their contribution table, a random mechanism will select one member from every group. For **this** group member, it is his **contribution table** that will determine his actual contribution; whereas, for the **other three** group members, it is their **unconditional contributions** that will determine their actual contributions. You will not know whom the random mechanism will select when you make your unconditional contribution and fill in your contribution table. You must therefore think carefully about both decisions because either could determine your actual contribution. Two examples should make this clear.

EXAMPLE 1: Suppose that **the random mechanism selects you;** and that the other three group members made unconditional contributions of 0, 2, and 4 tokens, respectively. The average contribution of these three group members is, therefore, 2 tokens. If you indicated in your contribution table that you will contribute 1 token if the others contribute 2 tokens on average, then the total contribution to the project is given by 0+2+4+1=7 tokens. Each group member would, therefore, earn 0.4×7=2.8 points from the project plus their respective income from their own private account. If, instead, you indicated in your contribution table that you would contribute 19 tokens if the others contribute 2 tokens on average, then the total contribution of the group to the project would be given by 0+2+4+19=25 tokens. Each group member would earn 0.4×25=10 points from the project plus their respective income from their own private account.

EXAMPLE 2: Suppose **that the random mechanism does not select you;** and that your unconditional contribution is 16 tokens, while those of the other two group members not selected by the random mechanism are 18 and 20 tokens respectively. Your average unconditional contribution and that of these two other group members is, therefore, 18 tokens. If the group member whom the random mechanism did select indicates in her contribution table that she will contribute 1 token if the other three group members contribute on average 18 tokens, then the total contribution of the group to the project is given by 16+18+20+1=55 tokens. Each group member will therefore earn 0.4×55=22 points from the project plus their respective income from their own private account. If, instead, the randomly selected group member indicates in her contribution table that she contributes 19 if the others contribute on average 18 tokens, then the total contribution of the group to the project is 16+18+20+19=73 tokens. Each group member would therefore earn 0.4×73=29.2 points from the project plus their respective income from their own private account.

The random selection of the group member whose contribution table will determine his actual contribution will be made as follows. Each group member is assigned a **Group Member ID** between 1 and 4, which denote his/her number inside his group. Moreover, participant number 2 was randomly selected at the very beginning of the experiment. This participant will draw a ball from an urn **after** all participants have made their unconditional contribution and have filled out their contribution table. Each ball in the urn has a different colour and each colour corresponds to a **Group Member ID**: orange=1, blue=2, yellow=3, green=4. The resulting number will be entered into the computer. If participant 1 draws the Group Member ID that was assigned to you, then your contribution table will determine your contribution and their unconditional contributions will determine the contribution of the other group members. Otherwise, your unconditional contribution determines your contribution.

A4. Instructions for the choice list elicitation of betrayal aversion

Welcome to research project CGQ.1! **[First movers – TG]**

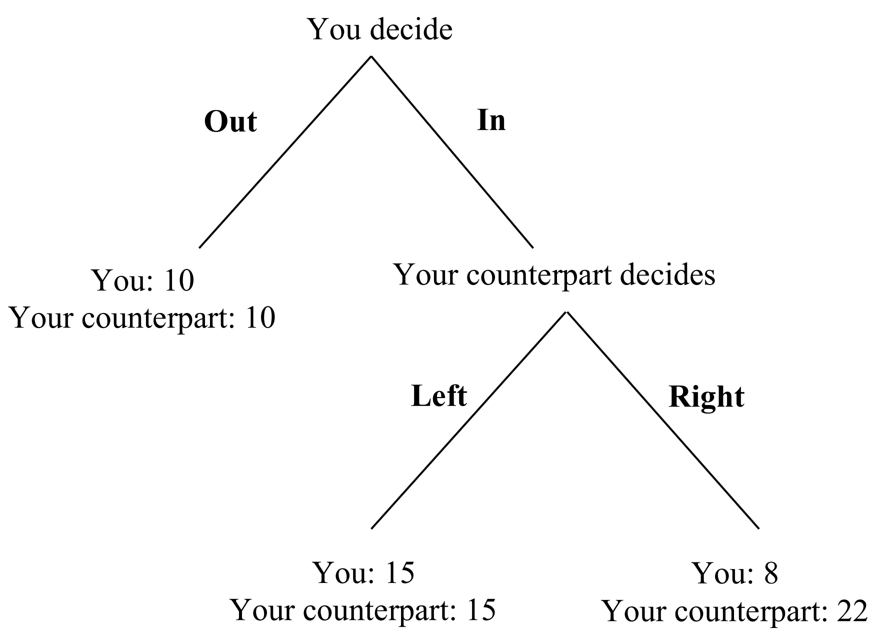
You are participating in a study in which you will earn some money. The amount you earn will depend on the outcome of a game you will play. It will be paid to you in cash at the end of today's session. However, during the session, we will speak of points, rather than Pounds. At the end, the points you earn will be converted to Pounds at the following rate:

1 point=£0.20

<u>The decision situation</u>

We first introduce you to the basic decision situation. You are randomly matched with another participant: your counterpart. You are confronted with two alternatives, **In** or **Out**. If you play **Out,** you and your counterpart get 10 points each. If you play **In**, the outcome depends on your counterpart's decision.

Your counterpart chooses between **Left** or **Right**. If he/she plays **Left,** you and your counterpart get 15 points each. If instead, he/she plays **Right,** you get 8 points and your counterpart gets 22 points.



<u>The experiment</u>

The experiment is based on the decision situation just described to you.

In this experiment there are 40 participants in total, divided into two groups: Group A and Group B. You belong to Group A, which is composed of 20 participants. Every participant in Group A has to decide between **In** and **Out**. Your counterpart belongs to Group B, which is also composed of 20 subjects. Every participant in Group B has to decide between **Left** and **Right**. In this experiment, we ask you to take your decisions considering not only the possible action of your counterpart but also the possible actions of all participants in Group B. In particular, we ask you to take a separate decision between **In** and **Out for each possible value of the number of participants in Group B who choose Left**.

We ask you to take your decisions by filling in a table that will be distributed later but which will look similar to the one below.

Number of participants in Group B choosing **Left**	You choose	
20 out of 20	In	Out
19 out of 20	In	Out
18 out of 20	In	Out
...	...	
2 out of 20	In	Out
1 out of 20	In	Out
0 out of 20	In	Out

The first column indicates the possible values of the number of participants in Group B who choose **Left.** The second column indicates your choice. In EACH row of the table, you have to circle either **In** or **Out**. Your choice will determine your action in the event that the actual number of participants in Group B choosing **Left** is the number given at the start of the row.

For example, if you circle **In** in the second row, it means that you would choose **In** for the case where 19 out of 20 participants in Group B choose **Left**.

We imagine that, if all 20 participants in Group B play Left, you will probably want to play **In**, since this would give you and your counterpart 15 points each, instead of just 10 points each. However, there may be some rows where the number of participants in Group B playing Left is low enough for you to prefer to select **Out** in them. If you do feel this way, you would choose **In** in the top row and perhaps some more rows, and **Out** in some lower rows. Thus, you would switch from **In** to **Out** at some point in the table. We emphasise, however, that it is entirely up to you what to choose in each row.

(While you are circling either **In** or **Out** in each row of the table, all the participants in Group B have to answer the following question:

"Which option, **Left** or **Right**, do you choose in case your counterpart chooses **In**?"

After all participants have made their choices, we will collect the response sheets. We will then count the number of participants in Group B who chose **Left**.This will indicate the row of the table you completed that determines your action and so is relevant for your earnings. Thus, all

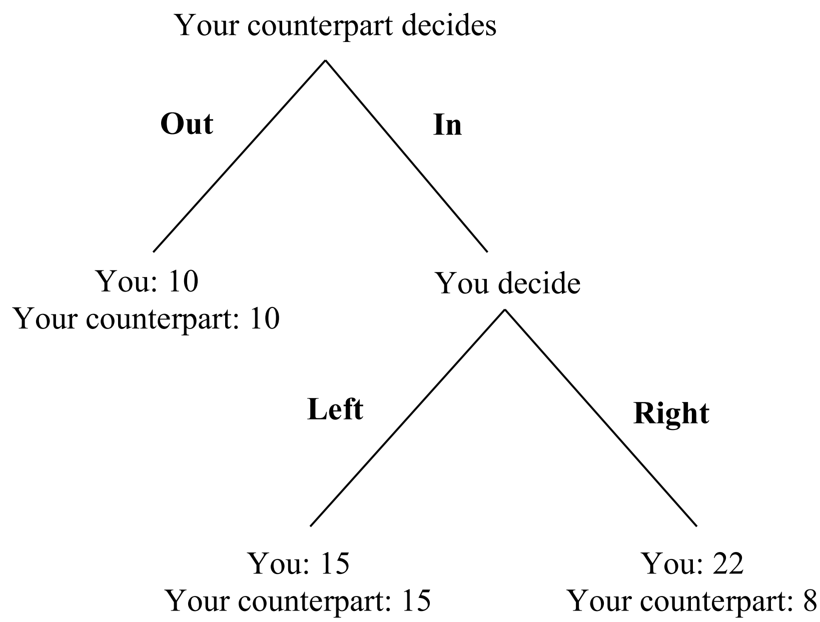
the decisions you take in the table are potentially important because you don't yet know what the actual number of participants in Group B choosing **Left** will be.
Two examples should make this clear.
EXAMPLE 1: Suppose 19 out of 20 participants in Group B choose **Left**. Then, we will determine your action by selecting your decision in the second row of the table you completed. Suppose further that, in that row, you circled **In**. Then, **In** would be the decision of yours relevant to your earnings. At that point, there would be two possible cases: either your counterpart is one of the 19 participants in Group B who chose **Left** or he/she is the one who chose **Right**. In the former case, you and your counterpart get 15 points. In the latter case, you get 8 points and your counterpart gets 22 points.

EXAMPLE 2: Suppose 1 out of 20 participants in Group B choose **Left** and suppose further that in the corresponding row you circled **Out**. Then, **Out** will be the decision you took that is relevant for your earnings. In this case, you and your counterpart each get 10 points, regardless of whether your counterpart chose **Left** or **Right**.
.
Before you take your decisions, we ask you to complete a pre-study questionnaire to help us check that you understand the determination of your income. We will distribute the response sheets for the experiment once everyone has correctly filled out their questionnaire.

Welcome to research project CGQ.2! **[Second movers – TG]**
You are participating in a study in which you will earn some money. The amount you earn will depend on the outcome of a game you will play. It will be paid to you in cash at the end of today's session. However, during the session, we will speak of points, rather than Pounds. At the end, the points you earn will be converted to Pounds at the following rate:

1 point=£0.20

<u>The decision situation</u>
We first introduce you to the basic decision situation. You are randomly matched with another participant: your counterpart. He/she is confronted with two alternatives, **In** or **Out**. If he/she plays **Out** you and your counterpart get 10 points each. If he/she plays **In**, the outcome depends on your decision. You choose between **Left** or **Right**. If you choose **Left** you and your counterpart get 15 points each. If, instead, you choose **Right** you get 22 points and your counterpart gets 8 points.



In this experiment, we ask you to answer the following question on a separate response sheet that we will distribute later: **which option, Left or Right, do you choose in case your counterpart chooses In?**

Before you take your decisions, we ask you to complete a pre-study questionnaire to help us check that you understand the determination of your income. We will distribute the response sheets for the experiment once everyone has correctly filled out their questionnaire.

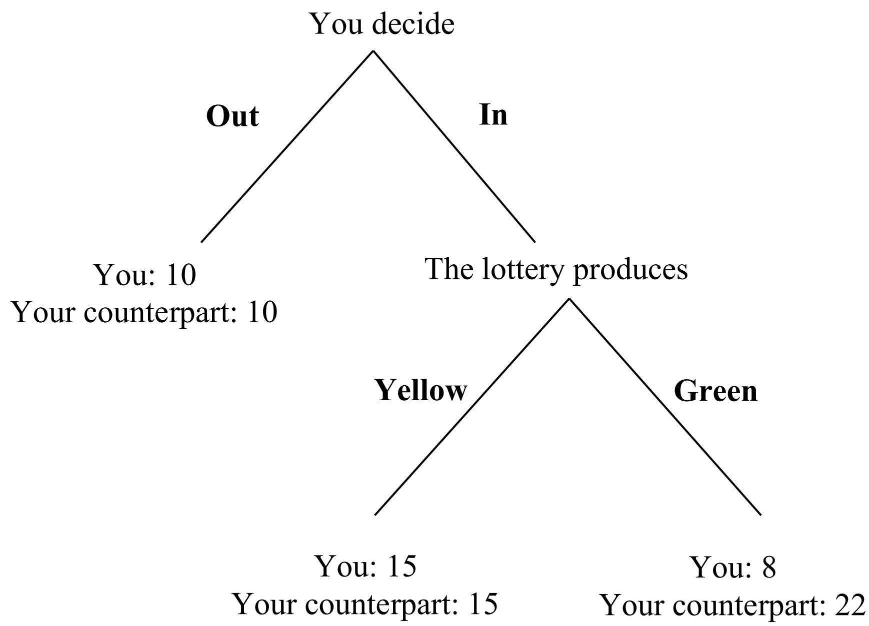
Welcome to research project CGQ.3! **[First movers – RDG]**

You are participating in a study in which you will earn some money. The amount you earn will depend on the outcome of a game you will play. It will be paid to you in cash at the end of today's session. However, during the session, we will speak of points, rather than Pounds. At the end, the points you earn will be converted to Pounds at the following rate:

1 point=£0.20

<u>The decision situation</u>

We first introduce you to the basic decision situation. You are randomly matched with another participant: your counterpart. You are confronted with two alternatives, **In** or **Out**. If you play **Out,** you and your counterpart get 10 points each. If you play **In**, the outcome depends on a random lottery. The lottery can produce **Yellow** or **Green**. If the lottery produces **Yellow** you and your counterpart get 15 points each. If, instead, the lottery produces **Green** you get 8 points and your counterpart gets 22 points.



The lottery will be conducted at the end of the experiment. We will draw one ball from an urn containing a total of 20 coloured balls, each of which may be either yellow of green. If one yellow ball is drawn the lottery produces **Yellow**. If one green ball is drawn the lottery produces **Green**. The number of yellow balls (and consequently green balls) in the urn has been pre-determined before the experiment. You will know the actual number of yellow balls in the urn for this session only after you take your decisions.

The experiment

The experiment is based on the decision situation just described to you.
In this experiment, we ask you to take your decisions considering all the possible values of the number of yellow balls in the urn. In particular, we ask you to take separate decision between **In** and **Out for each possible value of the number of yellow balls in the urn**.
We ask you to take your decisions by filling in a table that will be distributed later but which will look similar to the one below.

Number of **Yellow** balls in the urn	You choose	
20 out of 20	In	Out
19 out of 20	In	Out
18 out of 20	In	Out
...	...	
2 out of 20	In	Out
1 out of 20	In	Out
0 out of 20	In	Out

The first column indicates the possible values of the number of yellow balls in the urn**.** The second column indicates your choice. In EACH row of the table, you have to circle either **In** or **Out**. Your choice will determine your action in the event that the actual number of yellow balls in the urn is the number given at the start of the row.

For example, if you circle **In** in the second row, it means that you would choose **In** for the case where where the number of yellow balls in the urn is 19 out of 20.

We imagine that, if all 20 balls in the urn are yellow, you will probably want to play **In**, since this would give you and your counterpart 15 points each, instead of just 10 points each. However, there may be some rows where the number of yellow balls in the urn is low enough for you to prefer to select **Out** in them. If you do feel this way, you would choose **In** in the top row and perhaps some more rows, and **Out** in some lower rows. Thus, you would switch from **In** to **Out** at some point in the table. We emphasise, however, that it is entirely up to you what to choose in each row.

(While you are circling either **In** or **Out** in each row of the table, all the participants in Group B have to answer the following question:

"Which option, **Left** or **Right**, do you choose in case your counterpart chooses **In**?"

After all participants have made their choices, we will collect the response sheets. We will reveal the number of yellow balls in the urn for this experiment. This will indicate the row of the table you completed that determines your action and so is relevant for your earnings. Thus, all the decisions you take in the table are potentially important because you don't yet know what the actual number of yellow balls in the urn will be.

Two examples should make this clear.

EXAMPLE 1: Suppose there are 19 out of 20 yellow balls in the urn**.** Then, we will determine your action by selecting your decision in the second row of the table you completed. Suppose further that, in that row, you circled **In**. Then, **In** would be the decision of yours relevant to your earnings. At that point, there would be two possible cases: either we draw one yellow ball from the urn or we draw the green one. In the former case, you and your counterpart get 15 points. In the latter case, you get 8 points and your counterpart gets 22 points.

EXAMPLE 2: Suppose there are 1 out of 20 yellow balls in the urn and suppose further that in the corresponding row you circled **Out**. Then, **Out** will be the decision you took that is relevant for your earnings. In this case, you and your counterpart each get 10 points, regardless of whether we draw a yellow or a green ball from the urn.

Before you take your decisions, we ask you to complete a pre-study questionnaire to help us check that you understand the determination of your income. We will distribute the response sheets for the experiment once everyone has correctly filled out their questionnaire.

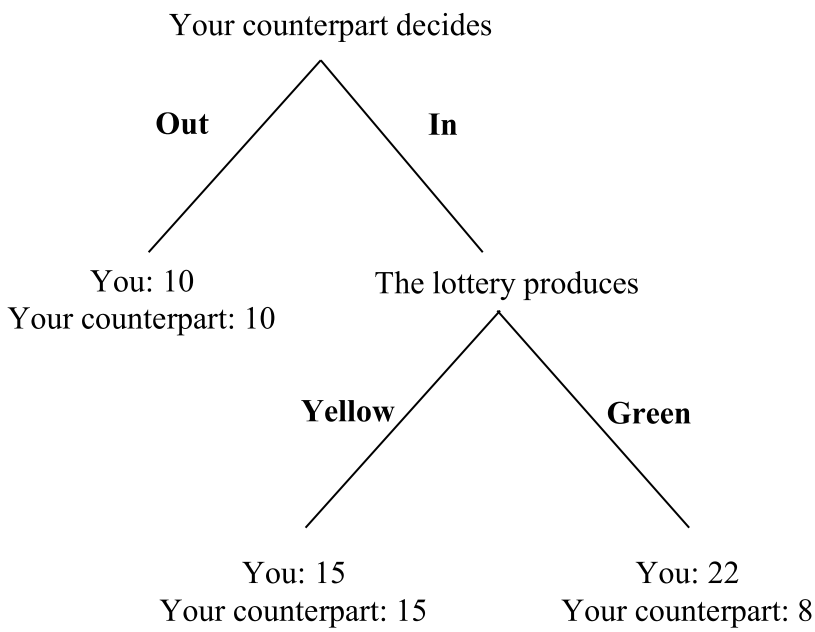
Welcome to research project CGQ.4! **[Recipients – RDG]**

You are participating in a study in which you will earn some money. The amount you earn will depend on the outcome of a game you will play. It will be paid to you in cash at the end of today's session. However, during the session, we will speak of points, rather than Pounds. At the end, the points you earn will be converted to Pounds at the following rate:

1 point=£0.20

The decision situation

We first introduce you to the basic decision situation. You are randomly matched with another participant: your counterpart. He/she is confronted with two alternatives, **In** or **Out**. If he/she plays **Out** you and your counterpart get 10 points each. If he/she plays **In**, the outcome depends on a random lottery. The lottery can produce **Yellow** or **Green**. If the lottery produces **Yellow** you and your counterpart get 15 points each. If, instead, the lottery produces **Green** you get 22 points and your counterpart gets 8 points.



The lottery will be conducted at the end of the experiment. We will pick a ball from an urn containing a total of 20 coloured balls, which can be either yellow or green. If one yellow ball is drawn the lottery produces **Yellow**. If one green ball is drawn the lottery produces **Green**. The number of yellow balls (and consequently green balls) in the urn has been pre-determined before the experiment.

Before your counterpart takes his/her decision, we ask you to complete a pre-study questionnaire to help us check that you understand the determination of your income.