Separating Non-Monetary and Strategic Motives in Public Good Games.

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Abstract

In this paper, I experimentally analyze the extent to which recent behavioral theories can explain subjects' overcontribution in public good games. I divide possible explanations into three groups: *non-monetary considerations* (fairness, altruism, etc.), *strategic considerations* (reciprocation, reputation, etc.) and *learning*. I suggest several treatments that make one or two of these groups inapplicable, but do not change the rest of the game. Most importantly, they do not change the strategic uncertainty that subjects face. The main result is that non-monetary and strategic considerations explain less than half of the observed overcontribution. In addition to that, I perform an econometric analysis of the data to demonstrate that the suggested treatments *did* remove these considerations from the actual subjects' behavior.

JEL classification: C9
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1 Introduction

A well-established finding in experimental economics is that people in Prisoner's Dilemma and Public Good games tend to behave considerably more cooperative than individual payoff-maximization prescribes. Given that both Prisoner's Dilemma (PD) and Public Good games (PG) have a dominant strategy, the difference between payoff-maximizing and observed behavior is especially hard to reconcile. Any positive amount of contribution is inconsistent with the former no matter what (unobserved) beliefs subjects might have about the opponents' choices. Thus an approach based on the assumption that subjects want to maximize their monetary payoffs and know how to do that fails to explain the observed behavior.

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Consequently, new theories have been introduced that stress the role of factors other than payoffs in subjects' decision-making. For instance, fairness considerations, reciprocation or confusion could cause people to play non-dominant strategies. While in theory many factors are capable of explaining cooperative behavior, we do not know to what extent they influence the *actual* decision-making and which of them are responsible for the observed over-contribution.

In my paper, I use an experimental approach to address these questions. I divide explanations of over-contribution suggested in the literature into three groups: *utility interdependence* (UI), which is that subjects care either positively or negatively about payoffs of their opponents (fairness, altruism); *action interdependence* or (AI), which is that subjects want to affect or reciprocate actions of opponents (reputation, reciprocity); and *confusion,* which is that subjects do not know what is the most optimal way to play the game.

Given this classification, I design several treatments of a public good game where some of the aforementioned considerations are made inapplicable, while the rest of the game remains unaltered. The resulting change in subjects' behavior should be solely due to the removed factors, and the larger the change is, the more important these factors are in the decision-making.

The main challenge in understanding the importance of UI and AI considerations is *not*, however, in designing treatments that would make them inapplicable. That could be easily done by matching subjects with computers. The main challenge is to make sure that other aspects of the game remain unaltered. For instance in the treatment with computerized opponents, subjects would have different strategic uncertainty (i.e. expectations about opponents' decisions) than they would have playing against real people. As a result, it would be impossible to determine to what extent the difference in the behavior is caused by the removed UI and AI considerations versus the change in strategic uncertainty.

Four treatments are suggested in the paper: a benchmark treatment which is a standard public good game; a *phantom treatment* where both UI and AI considerations are not applicable; and two *two-type treatments* where only UI considerations are not applicable.

The benchmark treatment is a standard public good experiment with a linear payoff function such that to contribute zero is a dominant strategy. The phantom treatment is a separate experiment that is conducted with a separate group of subjects. It is identical to the benchmark with the only difference that subjects are randomly matched with the decisions that were made in the benchmark treatment and not with decisions of each other. Figuratively speaking, in the phantom treatment subjects are playing not against real people, but against *"phantom players"* from the previous experiment, and this is common knowledge among them.

As it can easily be seen, this design removes both UI and AI considerations. The former is removed because subjects are not playing against real people and thus their decisions would not affect anyone's utility. The latter is removed because opponents' decisions are pre-determined, and thus it makes no sense to try to affect or reciprocate them. All other aspects of the game are minimally affected, if at all. The rules of the game, payoff functions and information available to subjects are identical across treatments. Furthermore, the strategic uncertainty is also the same since effectively subjects in the phantom treatment are matched against the same decisions as the subjects in the benchmark.

Therefore, if there is a difference in behavior between the treatments it should be exactly due to the removed UI and AI considerations.

The two other treatments designed in this paper remove UI considerations, while leaving AI factors applicable. In these treatments, called the *two-type treatments*, all subjects have one of two types — either type M which stands for *monetary affected* type, or type N which stands for *not affected* type. Type M players have a standard payoff function and so they are affected by decisions of their opponents. Type N players have a fixed payoff regardless of the outcome. This makes them unaffected by opponents' choices.

The information structure of the treatments has two important properties. First, subjects do not know their own type. This way, both types of players have similar monetary incentives at the time they make decisions. Second, subjects know the type of their opponents, which gives a key to separating the effects of UI and AI considerations. If a subject knows that (s)he is matched with type N then (s)he should not have UI considerations. On the other hand, AI considerations are equally applicable against both types. For example, when subjects play cooperatively in order to encourage other people to cooperate it does not matter what is the opponent's type. Thus, if contributions against type M are higher than against type N, then it must be due to utility interdependence. If, however, there is no difference in contributions it must imply that it is *not* utility interdependence that leads to over-contribution.

The main result of the paper is that both UI and AI considerations have relatively modest effect in explaining over-contributions. Specifically, removal of both utility and strategic interdependence decreases the over-contribution only by 40% as compared to the benchmark. Removal of UI considerations alone decreases the over-contribution by 20-25% on average. The result is rather negative than positive in a sense that it is still unclear what explains more than a half of the remaining over-contribution. The most plausible candidate would be a lack of understanding of the optimal strategy, though the test of this goes beyond the scope of the current paper.

The results in this paper contradict the findings of Andreoni (1995b), where it was shown that over-contribution in public good games is caused by altruism rather than by confusion. However, the treatments suggested in Andreoni's paper introduced some additional factors as compared to the benchmark. In particular, a different payoff function was used so that the game became a zero-sum game. Thus, the Rank treatment from Andreoni (1995b) and the Phantom treatment from this paper are quite different, and moreover, the Rank treatment seems to be further from the benchmark, so it is not surprising that the results documented in my paper and Andreoni's are different.

The remainder of the paper is organized as follows: in section 2, the review of relevant literature is given and groups of factors that I will analyze in the paper are classified. In section 3, the treatments are described, and their properties discussed. In section 4 the experimental procedure is explained, and in section 5 the results are presented. Finally, in sections 6 and 7 I give a discussion of the results and the concluding remarks.

2 Literature review

In this paper I am trying to understand the importance of different groups of factors in the decision-making process, and so it is instructive to define precisely the boundaries of each group. Below I give the list of the factors that are likely to be the most relevant in explaining over-contribution. To make it more comprehensive, I add the category "Others" to the list, though the analysis of the factors from that group is beyond the scope of this paper.

Non-understanding or Learning. It is difficult for subjects to understand immediately what the optimal way to play a game is, so they need to experiment to gain some experience, which necessarily implies over-contribution. Another reason why learning can create consistent over-contribution is the fact that in public good games NE is Pareto dominated by the cooperative outcome. And so the payoff-based learning might give "false" feedback and lead to a positive level of contribution.

Actions interdependence (AI) or strategic considerations. Subjects can play sub-optimally in order to change actions of the opponents in the future, or to respond to past opponents' actions. In the former case subjects want to create a reputation or to encourage others to behave cooperatively, in the latter case subjects reciprocate the opponents' actions. See Brandts and Schram (2001), Fischbacher, Gächter and Fehr (2001) for experimental evidence and Falk and Fischbacher (1998) for theoretical model of an equilibrium concept with reciprocation.

Utilities interdependence (UI) or non-monetary considerations. Subjects take into account (positively or negatively) utility of other players, either because of altruism (Andreoni (1990)), or because subjects care about fairness of the outcome (see Bolton (1991), Rabin (1993), Fehr and Schmidt (1999), Bolton and Ockenfels (2000)).

Others. There are other reasons why subjects tend to over-contribute. It is difficult to summarize all of them in only a couple of sentences, so I will just list some of them below.

Emotions. Emotions such as revenge and spitefulness in the ultimatum game or warm-glow in PG games influence the subjects' choices. However, in most cases emotions can be considered as either part of AI or UI groups. For example warm-glow is a UI factor, and spitefulness is an AI factor.

Insufficient motivation. In most of the experimental studies, the payoff range is relatively small, and so the losses from suboptimal playing can be negligible (see Harrison (1989)) and subjects' can be not motivated to look for the optimal strategy. Some studies, however, show that high stakes do not change subjects' behavior significantly see Camerer and Hogarth(1999) and Hoffman, McCabe and Smith (1996).

Mis-understanding. Subjects do not understand the game they are playing, which is especially likely to happen in more complex games (e.g. in financial markets experiments, see Kagel and Roth (1995) and Hirota and Sunder (2002)). It is a rather technical issue and usually can be addressed by using questionnaires.

Relevant literature

Among the many articles that analyze the role of different factors in subjects' behavior, I would like to mention several papers that are especially relevant to mine. In Blount (1995) the Ultimatum game was played as follows: in addition to a standard treatment, there were conducted two other treatments where the offer was made either by a third person or randomly generated by computer. Clearly the last two treatments eliminate negative reciprocation, or revenge to a low offer, since it is not the proposer who made the offer, and as the result, the rejection rate goes down considerably, especially in the treatment with computer-generated offers. Nonetheless approximately 15-20% of participants said that the smallest acceptable offer should be at least 45% of the pie (see Figure 1, p. 136).

Johnson et al. (2001) analyze three-period sequential bargaining game played with other people in one treatment and with payoff-maximizing robots in another treatment. As a result, the latter treatment produced only a moderate 30% decrease in the average proposer's offer from \$2.11 to \$1.84, while still being above the subgame perfect prediction of \$1.25. It suggests that subjects make generous offers not because they care about fairness, but because they do not understand what the optimal offer is.

In Palfrey and Prisbrey (1996), the authors suggest treatments for linear public goods game where subjects have to make decisions for different returns on the public good. This treatment gives enough variation to estimate econometrically the role of altruism, reputation and noise in subjects' behavior. Their analysis rejects altruism and reputation motives in subjects' behavior. In Fischbacher, Gächter and Fehr (2001) authors analyze the role of conditional cooperation, which can be summarized by the statement "I contribute as long as other people do." They ask subjects how much they would contribute as a function of the average contribution of the opponents. They found that approximately one third of all subjects prefer to free-ride, whereas half of the subjects are conditional cooperators.

In Andreoni (1995b) the author suggests the Rank treatment, which helps to separate kindness (altruism) from confusion (non-understanding) by making the former inapplicable. The result is that the level of contribution goes to zero very fast, which suggests that the contribution in the benchmark model is due to altruism and not non-understanding. Although his findings seem to contradict my results, this is probably due to the fact that the treatment he suggested changes the payoff function in such a way that it encourages competition (zero-sum game) and makes payoff-based learning less misleading than in the original public good game.

3 Treatment descriptions.

The main goal of this paper is to analyze the relative importance of three groups of factors mentioned above: *non-understanding* (learning), *utility interdependence* or UI and *actions interdependence* or AI. I designed two treatments that help to isolate the effects of different considerations, which I will describe in this section.

Benchmark treatment

All treatments described below are based on and compared to the benchmark treatment, which is a standard public good game with linear utility functions. In the benchmark treatment there are two projects: a private project and a social project (in the instructions, neutral project names are used to avoid framing effects). The private project yields a return of 1.00 to the subject only, and the social project yields a return of 0.75 to ALL members of the group. Thus, investing everything in the private project is the dominant strategy, while the public project is socially efficient.

Phantom treatment (elimination of all non-monetary considerations)

The Phantom treatment (PT) is designed to remove both non-monetary and strategic considerations from subjects' decision-making. Here, it is applied to the public good game, however as it will be seen from the description the idea is very general and it can be used in many other games. The PT consists of two different sessions A and B with two different groups of subjects. Session A is the benchmark treatment described above, which is a standard public good provision treatment with linear utilities and the strangers[1] matching procedure. Session A is conducted before session B, and its main purpose is to use subjects' decisions from session A during session B.

Session B is different from session A in that B-subjects (those who participate in session B) are matched with A-subjects, and not with other B-subjects. It is realized as follows: assume that in session A, there were N subjects in each group (the actual size of the group in the paper is two). Then in each period, t, for each B-subject, b, the computer randomly chooses $N-1$ of A-subjects, $a_1, \ldots, a_{N-1}$. The payoff of subject b is determined in the usual way[2] using the decision of subject b made in period t and decisions that were made by the chosen A-subjects $a_1, \ldots, a_{N-1}$ in period t.

It is crucial that subjects in session A are not affected by the outcome of session B, and that matching procedure and relation between sessions A and B are known to B-subjects. It is also important that the game remains simultaneous, that is B-subjects do not know the decisions they are matched with until after they make their decision.

I claim that:

1. *Phantom treatment removes all non-monetary and strategic considerations.*
2. *In* `all other aspects` *phantom treatment is identical to the benchmark. In particular, B-subjects have the same expectations about the opponents' behavior as in the benchmark.*

The first point is almost obvious. First of all, since A-subjects are not affected by decisions of B-subjects, clearly, the latter will not have any UI considerations. Second, since the decisions that subjects face are pre-determined, it

[1] The opponents are determined randomly every period.

[2] Sum of contributions to the public good times return on public good plus the subject's contribution to the private good.

does not make sense for subjects to try to encourage others, to build reputation or to reciprocate.

As for the second point, notice that the decisions which were made by opponents of B-subjects were made by *motivated* players who were playing the exact same game. Consequently B-subjects face the same *strategic uncertainty* as if they were playing against other people in the room. This feature makes the treatment more advantageous in comparison with situations when subjects play against computer programs (no strategic uncertainty, some new considerations), or against non-motivated subjects.

In other aspects the phantom treatment is also similar to the benchmark. First of all, in both A and B sessions, subjects have the same information about the game and the same amount of feedback about the outcome of the game. Second, the random matching procedure used in session A is similar to the matching procedure used in session B in a sense that the opponent (real or phantom) is randomly determined every round. Third, B-subjects are matched with the decisions that were made by subjects with the same experience and background as they themselves have. To ensure this, decisions from the same period are matched and subjects are recruited from the same pool of undergraduate students. Fourth, since opponents' decisions are the same as in the benchmark, it does not distort the learning process, which would not be the case if the opponents decisions were on average different. For example, if the opponents' contribution level was close to 0% or 100% of their tokens. Finally, even the instructions are made as similar as possible. To be specific, instructions for B-subjects are the same as instructions for A-subjects plus one section in the end that describes the matching procedure for the B session.

The main problem for the phantom treatment is credibility, namely, it is essential that subjects should believe in the faithful execution of the rules of the treatment. To address this concern in the beginning of the experiment, the printed decision table together with hand-written decision tables that were filled out by A-subjects were demonstrated from a distance, and it was announced that in the end of the experiment, subjects are welcome to look at it, which at least half of the subjects did. This announcement had a two-fold purpose: first, it addressed the credibility concerns, and second, it helped to ensure that subjects understood the specifics of the treatment.

Since *the only* difference between sessions A and B is that in the latter subjects do not have any non-monetary or strategic considerations, by comparing the results of both sessions, we can see the importance of these considerations in decision-making. For example, if B-subjects over-contribute it should mean that the excessive cooperation in the benchmark model is not caused by non-monetary or strategic considerations, but rather by their inability to solve the game, or some other reason like insufficient motivation, for example. Whereas, if we observe fast convergence to the dominant strategy in experiment B, then we can attribute the excessive contribution in the benchmark model to the removed factors.

Two type treatments.

The two-type treatments are designed to measure the importance of utility interdependence in subjects' decision-making. These treatments enable us to compare the difference in decisions with and without UI considerations. To see the main idea behind these treatments, notice that the phantom treatment is different from the benchmark in two aspects: one, opponents are not affected and, two, their decisions are pre-determined. The former removes UI considerations and the latter removes AI considerations. The two-type treatments are the natural intermediates between the benchmark and the phantom treatment. In the two-type environment some subjects are still not affected by others' decisions, but their decisions are NOT predetermined, and thus the AI factors remain applicable, while UI considerations are removed.

The two-type treatments are designed as follows: at the beginning of each period, half of the players are randomly assigned to type M and another half to type N. Type M players are *monetary affected* players with a usual payoff function. Type N players are *not affected* players and they receive a fixed amount of points regardless of the game outcome. Groups consist of two subjects and each subject is informed about the type of his opponents, and thus subjects matched with type N should not have any UI considerations, whereas for subjects matched with type M non-monetary considerations are applicable to the same extent as in the benchmark.

It is crucial for this treatment to make sure that subjects do not know their *own* type, since otherwise type N subjects, would be unmotivated players. To address this issue, subjects were informed about their type only *after* they made their decisions, and each period types were re-assigned randomly. In addition to that subjects knew that groups are formed independently of types assignment and thus the opponent's type does not carry any information about the subject's type, and so for example it is quite possible that two players of the same type are matched. Moreover, two practice rounds were programmed in such a way that subjects were assigned against opponents of the same type in the first round and of the different type in the second round to show that both options are equally likely.

There were two two-type treatments designed. The first treatment, called uk2T (2 Types, own type is Unknown, the type of the opponent is Known), has the following timing and information structure: in each round, first, types and groups are assigned, but not disclosed; second, subjects are informed about the type of their opponent and are asked to make a decision; finally, profit is calculated and displayed, and also subjects are informed about the type they had that period.

The main difference in the second two-type treatment, called uk2SM (two types strategy method), is that in each period subjects are not informed about their opponent's type. Instead, they are asked to make two decisions — one, if they are matched with type M, and another if they are matched with type N. This is based on the so-called 'Strategy Method' introduced in Selton (1967). After the two decisions are made, groups are randomly assigned and corresponding decisions are used to calculate profits. For example, if a subject is matched with type M, then the decision he made against M will be used.

Each of the two-type treatments has its own advantages and disadvantages, and this is why both of them were used. The main disadvantage of the uk2T treatment is that it does not control for learning and experience. For example, if subject X decreases his contribution between periods 5 and 6, it can be because in period 6 he is matched with type N, or it can be because he suddenly realized that the private project is better, or because he responds to the low contribution of his opponent in round 5. The uk2SM treatment does not have this problem, since subjects make two decisions given the same experience, and so the difference is only due to the type of the opponent. The problem of the uk2SM treatment is that it might be too suggestive. The very fact that subjects are asked to make two decisions might suggest to them that they are supposed to make two *different* decisions. To minimize the problem, in the instructions it was said that subjects are allowed to make two decisions just to give them additional flexibility and so it does not mean that they should make the same or different decisions.

The two-type treatments should have the following impact on non-monetary considerations. First of all, clearly, if subjects over-contribute mainly because they care about payoffs of other players, they will contribute less against type N than against type M. Hence, the two-type treatments eliminate UI considerations for those subjects who are matched against type N. However, AI considerations are still applicable. Indeed, if subjects contribute to encourage others, then the type of the opponent does not matter. Similarly, for reciprocative behavior, if subjects reciprocate because they do not know how to play, using the strategies of others as a lead, then M and N strategies are equally useful. If they are generally grateful or outraged by their opponents, and merely want to demonstrate this to someone, then the type of the pair does not matter either. Among reciprocative behaviors, the only exception is the case when subjects reciprocate to specifically hurt or reward the next opponent. But this kind of reciprocation should be attributed to UI factors rather than AI, and is eliminated against type N.

Even though there are many ways how UI considerations can be eliminated from subjects' reasoning, the advantage of this treatments is that all decisions that subjects face are made by *motivated* human beings. The main side effect of the two-type treatments is that since we expect that contribution against type N will be smaller, it might distort the information that subjects will be getting about the behavior of the opponents, and somewhat bias the decisions towards under-contribution. This is a valid concern, and its importance is not clear *a priori*, since N-type subjects after they learn about their type will care less about the low contribution of the opponent.

In summary: two type treatments eliminate non-monetary considerations for subjects matched against type N, while AI considerations are still applicable regardless of the opponent's type. Thus the difference between contributions against type M and type N are solely due to UI factors.

4 Experimental procedures

The study consists of four treatments: the benchmark treatment (BT), the phantom treatment (PT) and the two-type treatments: uk2T and uk2SM. Each treatment was run twice to test for robustness of the results. Sessions were conducted at Yale University in July and September of 2004. The subject pool consisted mainly of Yale undergraduate students of non-Econ majors. The experiment was programmed and conducted with the software z-Tree (Fischbacher 1999). On average there were from 10 to 16 subjects at each treatment. Each treatment lasted approximately 45-60 minutes and the average payments were approximately 13-15 USD.

The main structure of all 8 sessions was quite similar. Each session started with subjects reading instructions that were printed out, so that they were readily available throughout the experiment. In addition to that, the summary of instructions was on the screen during the experiment. After reading instructions subjects took a short quiz to make sure that they understand the rules of the treatment. After the quiz, the game was played for 15 rounds and in the end of the session subjects were asked to fill out a post-experimental survey and were privately paid their cash earnings.

In the phantom treatment after instructions were read, the printed table with all of the decisions that were made by participants of the benchmark was demonstrated to subjects. It was announced that in the end of the experiment subjects were welcomed to look at it, as well as at decision sheets that were filled out by participants of the benchmark experiment. As mentioned earlier, the announcement had two purposes. First, it was intended to solve credibility problems, namely, to assure subjects that the experimenter was not lying to them and that the instructions describe the real experimental environment. Second, it made sure that subjects knew that they are not playing with other people in the room, but with the participants of the previous experiment.

In the two-type treatments, after reading instructions, subjects played two practice rounds and only afterwards were asked to take the quiz. Subjects knew that in the practice rounds they were all going to be matched with computer decision 17-3 (17 to private project, 3 to public project). The two practice rounds proved to be very helpful for subjects in understanding the types structure, especially in the 2TSM treatment. In addition, matching everyone against the same pre-announced computer decisions minimized any learning distortion created by the practice rounds.

Each round had the following structure: in the beginning subjects were randomly paired with another person (real or phantom). After that they were given 20 tokens (=10 US dollars) to divide between two projects. Each token invested into Project A (private good) gives a return of 1.00, and each token invested into Project B (public good) gives a return of 0.75 to both members of the group. Thus, it is clearly the dominant strategy to invest everything into project A. After all decisions were made, subjects were informed about the total contribution to project B and their profit. In addition, the history table was available to subjects throughout the experiment that contained the history of their decisions, profits and types.

As it was mentioned above, in total there were 8 different sessions, and special attention was paid to make sure that all the sessions were similar to each other, except for the specifics of the treatment (i.e. phantom players and types). For example, instructions were divided (implicitly) into a general section comprising 60-70% of the instructions (description of the public good game, project returns, examples, cash payments) which was the same across all sessions, and a section that explained the specifics of the treatment.

Nonetheless, there were a few differences between the treatments. One difference was that in the two-type treatments, there were two practice rounds, while in the benchmark and the phantom subjects started to play real rounds from the beginning. This difference has been discussed above, and should have minimal effects on the comparison. Also, there was an important procedural change in the two-type treatments. In the first uk2T treatment subjects read instructions, then took the quiz and then played practice rounds. This procedure turned out to be quite confusing for subjects. In the remaining three two-type treatments (one uk2T and two uk2SM) the following modification was used: first subjects read instructions, then they played two practice rounds, then they took the quiz, and then they played the 15 non-practice rounds. This change made it considerably easier for subjects to understand the rules of the treatments. However, as it will be shown in the next section, it also changed the observed behavior. Specifically, the results observed in the last three treatments are very similar to each other and different from the first uk2T treatment. Because of the robustness of results in the last three treatments (versus the first uk2T treatment), and because of budget constraints, another uk2T treatment under the modified procedure was not conducted.

5 Results

The phantom treatments

The average contributions in the benchmark and the phantom treatments are given in Figure 1. The left picture shows the average contribution in the benchmark - phantom pair, and the right picture shows the average contributions in the second, phantom - phantom pair. One remark is due here: in the second phantom treatment subject 5 contributed 100% of the endowment every period because (as he said in the questionnaire) he "does not want to give up his principles because of some study". Later in the section, this behavior will be discussed and it will be said that this motivation can be quite important for some subjects and is not removed by the phantom design. That said, we are going to exclude subject 5 from the sample for most of the following analysis.

[INSERT FIGURE 1 HERE]

As it can be seen from Figure 1 the phantom treatments produce lower level of contribution then the benchmark treatments, and using Kruskal-Wallis ranking test it can be established that the decrease in contributions is significant (see Table 1). Thus the first result is:

Result 1: *Phantom treatments produce a lower level of contribution than the corresponding benchmark treatment.*

[INSERT TABLE 1 HERE]

Result 1 confirms the well-known fact that some of the over-contribution in the public good games is caused by non-monetary and strategic considerations. However, as it can be seen from Figure 1 the decrease is not as strong as one would expect. We can roughly estimate the difference in the average contributions by comparing the medians. In the first pair of sessions the median contribution goes down from 10.69 to 5.8 (54%), and in the second pair the median contribution goes down from 7.11 to 4.44 (62%).

Result 2: *The non-monetary and strategic considerations on average account for approximately 40% of overcontribution.*

It has to be mentioned here that the number 40% in Result 2 makes sense only as long as we speak on the aggregated level. It is well-known that subjects behavior is heterogenous, and the same phenomenon is observed here.

Specifically, on the individual level, the difference between the treatments rises from the fact that subjects who would contribute in the benchmark because of non-monetary or strategic considerations, were contributing zero in the phantom treatments, whereas subjects who were just trying to find the best way to play the game played similar in both treatments. For example, in the phantom treatments, many subjects always contributed zero (7 out of 20 in the phantom versus 3 out of 24 in the benchmark), while the proportion of consistent contributors is much higher in the benchmark (8 subjects contributed more than half of the endowment in at least 12 rounds, whereas only 2 subjects did so in the phantom).

However, even on the aggregated level, result 2 is somewhat surprising since the drop in the contributions is not particularly high, which means that AI and UI considerations have a relatively modest impact on subjects' behavior, and can explain less than half of the observed over-contributions. Thus the natural question to ask would be *does the phantom treatment work at all?* In other words, does it really eliminate the non-monetary and strategic considerations from subject's reasoning or not? Clearly it should in theory, but it might be the case that some subjects still use the "removed" AI and UI considerations.

To answer this question I ran the Ultimatum game experiment under the phantom treatment rules. This should be a clear test of the phantom treatment performance since the Ultimatum is much simpler than the public good game, and so most of the rejections are more likely to be caused by non-monetary considerations rather than by non-understanding (as it could be in the public good games). As a consequence we should expect considerable drop in the rejection rates under the Phantom treatment rules.

There were 40 subjects who participated in this experiment, and an offer of 1 dollar out of 20 was made to all of them under the phantom rules. The result was that 33 subjects out of 40 accepted the offer and 7 subjects rejected it. The result is consistent with the results published in Blount (1995) where 85% of subjects accepted randomly generated offer of the size $0.50 out of $10 (only 35% in the benchmark). Thus we see that the phantom treatment causes a significant drop in the rejection rates, and so we have the next result:

Result 3: *In the Ultimatum game the phantom treatment decreases the rejection rate of the smallest possible offer to 15%, and thus it removes the non-monetary considerations from subjects' decision-making.*

At least two people of those who rejected the offer said that they understood the treatment and the reason for the rejection was that the offer was "too lame (wrong)". Recall that in the second phantom treatment subject 5 was contributing 20 because he did not want to give up his principles in the study. Thus it suggests that there is a motivation that the phantom treatment does not remove, which is to follow principles and norms of behavior just for the sake of the principles[3]. Even though at least three subjects demonstrated this motivation in their behavior, the phantom treatment considerably diminishes its impact. The reason is, it is rather easy to realize that it does not make sense to be nice (even from the ethical point of view), if no one is affected, while you can

[3]This is not as irrational as it sounds. Consider that we ask the following question: you are driving a car and you see an old lady crossing the street. Will you hit her? If you say yes, we'll pay you five dollars, otherwise we'll pay you nothing. Clearly, even though no one gets hit in this scenario many people would prefer to forfeit the money and say no.

get hurt by doing so. For example, subject 9 in the second phantom treatment said in the questionnaire that she contributed zero every round exactly because it makes no sense to be nice. Even though she still felt irrational guilt about doing so, she nonetheless played optimally.

[INSERT TABLE 2 HERE]

The hypothesis that the phantom treatment removes non-monetary and strategic considerations from subjects behavior can be (at least partially) tested statistically. Clearly, it is impossible to see from the data whether subjects have any UI considerations, or if subjects contribute to encourage others. It is possible, however, to estimate the subjects' reaction to their opponents' contribution, and thus to see if reciprocation is removed or not. In Table 2 the results of the panel-data regression with fixed effects are demonstrated. The dependent variable is the contribution at round $t + 1$, and the regressors are the lags of the opponents' contributions. As it can be seen from the Table, in the benchmark, variable $OppCont_t$ is significant and positive which confirms the well-known fact that subjects tend to reciprocate the behavior of others. However, in the phantom treatment opponents' contributions are all insignificant, which suggests that this factor is removed from subjects' reasoning.

Tables 3 and 4 show results of fixed effect logit estimations. The dependent variables are *Negch* which is equal to 1 if there was a negative change in contributions, *Negbigch* which is equal to 1 if the decrease in contribution was at least 3, and variables *Posch* and *Posbigch* that are defined similarly for positive and big positive changes. In Table 3 the explanatory variable is *Profit* , and in Table 4 it is the opponent's contribution last period ($OppCont_t$).

[INSERT TABLE 3 HERE]

[INSERT TABLE 4 HERE]

First of all, the benchmark results are as expected. Both *Profit* and $OppCont_t$ are significant in all four regressions and their signs are intuitive. In the phantom treatment, the picture is different. First of all, as before, regressions on $OppCont_t$ are all insignificant (see Table 4). However, if we regress the binary variables on *Profit* , they are significant in the regressions with negative change variables and insignificant in the regressions with positive change variables.

The latter gives very strong evidence for my hypothesis. Indeed, the reason why subjects in the benchmark respond positively to the increase in profit is that usually this increase is caused by increases in the opponents' contribution and subjects reciprocate. However, this reasoning is not applicable in the phantom treatment, and this is why we have that profit is insignificant in the regressions with positive change variables. Nonetheless, in the regressions with negative change variables, profit is significant, while the opponent contribution is not. The former is due to the fact that subjects in the phantom treatment still use profit to learn about the optimal behavior which creates downward trend, and the latter is again due to the fact that subjects do not reciprocate in the phantom treatment.

Result 4: *Tables 2-4 give very strong support to the hypothesis that subjects do not reciprocate in the phantom treatment, while they do reciprocate in the benchmark.*

The two-type treatments

In total there were four two-type treatments: two uk2T and two uk2SM treatments. As it was explained in details in the end of Section 4, the original procedure that was used in the first uk2T session proved to be difficult for subjects, and so it was slightly modified to make it less confusing.

[INSERT FIGURE 2 HERE]

Average contributions in all four sessions are shown in Figure 2. As it can be seen from the picture the results in the last three modified sessions (uk2T-2 and both uk2SM) are different from the results in the uk2t-1 treatment and similar to each other[4]. In the uk2T-1 session contributions have higher variability and often contributions against type N were much higher than contributions against type M which is counterintuitive. In uk2T-2 and both uk2SM sessions the average contributions against type N are lower than the average contributions against type M, and Kruskal-Wallis ranking test in Table 5 shows that this difference is significant for all treatments but uk2T-1.

[INSERT TABLE 5 HERE]

A panel-data model with fixed effects was used to estimate the role of non-monetary considerations in the two-type treatments. The results of the estimation are given in Table 6. The dependent variable was subject contribution at period $t + 1$ and the regressors were the opponent's type at period $t + 1$ (recall that it was observed before subjects made their decisions) and opponents' contributions in periods t and $t - 1$. The type of the opponent was a binary variable that was equal to 1 if the opponent had type N. As it can be seen from the Table, the coefficient of the opponent's type is significantly negative in all treatments but uk2T-1. Moreover, its value is approximately the same in the three treatments and is somewhere between -2.5 and -2. This result is reasonably robust to using different regressors, in a sense that the coefficients at $OppType_{t+1}$ are always in the range between -3 and -2 and close to each other. Thus we have the following two results:

[INSERT TABLE 6 HERE]

Result 5: *In the two-type treatments the average contributions against type N are significantly lower than the average contributions against type M.*

Result 6: *As it follows from Table 6, non-monetary considerations account for an approximately 2-2.5 (out of 20) increase in contributions.*

[INSERT FIGURE 3 HERE]

As it was mentioned before, the numbers presented in Result 6 are meaningful only on the aggregated level. The individual decisions are less uniform and can be seen on Figure 3. Notice that even on the individual level, most of

[4]The best thing to do in this situation would be to throw away the results of uk2T-1 session and run another uk2T session under the modified procedure. However, because the results from the modified sessions are sufficiently robust to make reliable conclusions and and because of the budget constraints, it was not done.

the subjects contribute less against N than against M. The precise numbers are as follows: first of all, as it could be expected many subjects made the same decisions against both types. It happened in 216 cases out of 450 (48%), and 12 subjects (out of 30) played the same strategies at least for 10 rounds. Clearly, these subjects (and it follows from the questionnaire as well) did not care about non-monetary considerations, and were contributing either because of AI reasonings or because they were trying to maximize their profit, and just did not see any reason to contribute differently. In 150 cases, the difference between M and N-contributions was positive and 7 subjects contributed consistently (at least for 10 rounds) more against M than N (see eg. subjects 4, 7, 11). Another example is subject 17 who was sometimes contributing less against N "since N does not care". These subjects clearly cared about the payoffs of the opponents and fairness. Naturally, some instances of positive difference were not because of the UI considerations, but just due to experimenting by subjects. In 84 decisions out of 450 (19%), the contribution against N was higher. Again as before, many subjects did not care about type differences and were just experimenting. There were also four subjects who contributed higher against N in at least 8 rounds, and one of them contributed higher against N in 13 rounds. The latter was a typical example of satisficing behavior, namely (s)he said that contributing 14-6 against M, and 6-14 against N gave enough profit. The other three subjects mentioned AI (encouragement) as the main factor that determined their behavior.

In general, it can be seen that the number of subjects who care about the payoffs of the opponents is not very high. In these treatments we have 7 subjects out of 30 (23%) who consistently contributed higher against type M. Most of the other subjects did not use the information about the opponent's type either at all or in any systematic manner. These results are not particularly surprising given the results obtained in the phantom treatment.

6 Discussion

The main goal of the paper is to measure the importance of non-monetary and strategic considerations in subjects' decision-making. Such non-classical theories as fairness, reciprocation and others become more and more popular in economics. They seem to be intuitive and psychologically appealing. Moreover, they explain subjects' behavior much better than the classical payoff-maximization approach. Given that, the results obtained in this paper are a little bit shocking, because it follows that these considerations are not as important for subjects as one would think.

To be more specific, applying the phantom treatment to the data from the benchmark caused only 40% decrease in the average contribution. Since in the phantom treatment, subjects do not have any non-monetary or strategic considerations it means that the remaining 60% are due to some other factors, and regardless of whether it is learning or insufficient motivation or something else it still means that subjects do not understand that it is always optimal for them to contribute zero. One must ask, "can it be that the main result of the paper is just that it is possible to construct an experiment that completely confuses subjects?" Not surprisingly, the answer is no, there is obviously more than that, and to show this I would like to mention couple of points.

The first point is that, *if any treatment is misleading, then the benchmark itself should be misleading for subjects, since the phantom treatment does not introduce additional confusion.* Indeed, first of all, as it was argued in the paper, the phantom treatment was designed to be as close to the benchmark as possible. In particular, instructions were also made similar to each other, and the only difference was that instructions to the phantom treatment had an additional section that explained the phantom rules. Furthermore, the sentence "you will be matched with decisions made by participants of another experiment" was actually found to be quite natural by subjects and neither the questions during the experiment nor the responses to the questionnaire revealed any sort of confusion. Second, in the paper it was shown that the phantom treatment worked properly, in a sense that it removed all non-monetary and strategic considerations, and in particular, the experimental procedure ensured that all subjects understood that they are playing with phantom players and not with other people in the room (instructions, quiz, showing the benchmark decision tables).

The second point is that *it was a standard public good experiment that was used as the benchmark.* In particular, the story with two projects (public and private) is an absolutely standard story in public good experiments which helps to remove any kind of framing from the instructions. The instructions themselves were based on the instructions in Andreoni and Petrie (2004), and the returns on the public project and group size were used as in Morgan and Sefton (2000). The results obtained in the benchmark are qualitatively similar to standard results in the literature, in particular to those in Morgan and Sefton (2000). Namely, the average contribution level starts at approximately 50% of the endowment, and then fluctuates around a decreasing trend with a sharp drop in the end. It means that the benchmark experiments that were conducted in the paper are no more confusing for participants than the standard public good games in the literature and so we should look at those in order to spot the cause of non-understanding.

To begin with, it is not immediately obvious that the public project is always worse (in terms of profit) than the private project. In addition to that, it is well-known that the strategic uncertainty that subjects face in the game can be a serious obstacle to finding the optimal strategy. The most persuading support to this claim can be found in Shafir and Tversky (1992), where in the sequential Prisoner' Dilemma, the second-movers were defecting considerably more often than in the benchmark even if the first-mover cooperated. The additional evidence can be found in the post-experimental surveys for this paper. One of the free-response questions was: *Assume you know that your pair's decision is 13-7 (13 to project A). What would you decide?* From 70 subjects who answered this question 33 (47%) said that they would contribute zero to public good, 9 subjects said that they would contribute no more than 5, and quarter of them said that they would play (around) 13-7 as well, which most likely indicated that they just do not know what to do in this situation. However, many subjects who gave selfish response played quite cooperatively during the experiment. Notice also that the question did not ask *What decision would maximize your profit* , thus still leaving non-monetary considerations applicable.

Another possible critique of the phantom treatment is that its results are not robust to changes in instructions. The easiest response would be that nothing is robust to changes in instructions. In most of the standard environments, the subjects behavior can differ in a systematic manner because of some small and seemingly irrelevant changes between treatments. The most recent example is given in Liberman et al. (2004), where the Prisoner's Dilemma was either called "The Wall Street Game" or "The Communal Game", which led to completely different behavior. The difference is of course, due to the framing effect and to the well-known fact that subjects tend to play in such a way that they think the experimenter expects them to play. In my paper, I tried to avoid framing or being suggestive in the experimental procedure, however there is no doubt that if the experimental procedure had been designed in such a way that it specifically encouraged cooperation or alternatively, selfish behavior, it would have changed the impact of the phantom treatment, but it would have changed the benchmark behavior as well. This is why the experiments in this paper were based on the standard public good experiment design, so that the results would be more relevant to what has been done in the literature.

7 Concluding remarks

In this paper two experiments were designed to understand the role of non-monetary and strategic considerations in subjects' reasoning. In the phantom treatment both UI and AI considerations are removed while the rest of the game is unchanged, and thus the positive contributions cannot be explained by the removed factors. In this treatment subjects are playing not with other people in the room, but with decisions made by the participants of the benchmark experiment, *(phantom players)*. Notice that in this environment, the non-monetary considerations are removed because the opponents are not affected and the strategic considerations are removed because their decisions are pre-determined. As it was shown the phantom treatment decreases the over-contribution by approximately 40% in comparison with the benchmark. Given that the standard level of contribution is around 10 (out of 20), the approximate decrease in contributions is 4.

There are two possible intermediate designs between the phantom treatment and the benchmark. The first design is where the opponents' decisions are still pre-determined, but the opponents are affected. This environment is almost the phantom treatment and it has not been realized in the paper because of the credibility concerns. The second intermediate design, is when the decisions of the opponents are not affected, and their decisions are not pre-determined. This was realized by the two-type treatments, where players had one of two types: M — *monetary affected* and N — *non-affected*. In this setting, subjects who matched with type N did not have non-monetary considerations, and thus the difference between contributions against M and N is exactly due to UI factors. The role of these factors is also quite modest — the removal of UI factors reduces the average contributions by 2-2.5 tokens (out of 20). And thus the overall result is that both non-monetary and strategic considerations explain less than a half of the observed over-contribution in the public good games.

The final remark is that the treatments designed in the paper, specifically the phantom treatment, can be applied to a broader range of questions than just public good games. In literature, the experiments are conducted because of two reasons: either to approximate the theory, or to approximate reality. In the first case, the applicability of the phantom treatment is almost obvious, since most of the theories so far do not use behavioral assumptions to model subjects' behavior and thus it is not surprising that very often subjects behave differently from the theoretical predictions. Maybe somewhat surprisingly, the phantom treatment can be used to approximate reality as well. It happens when the agents in the real markets are likely to be more rational than subjects in the lab. For instance, the phantom treatment can be used to analyze the performance of auctions. In real life, the participants of the auctions, especially multiple-unit auctions, are firms who are more rational and are less susceptible to such considerations as fairness or altruism. In the laboratory, however, subjects are people and so non-monetary considerations can distort the results as compared to reality[5]. Consequently, by applying the phantom treatment it would be possible to obtain a more precise estimate of auction performance.

[5]For example in multiple-unit auctions where subjects can prefer to be fair and buy only one good, so that other people can buy some as well.

8 Figures and Tables

Figure 1: Contributions in benchmark and phantom treatments

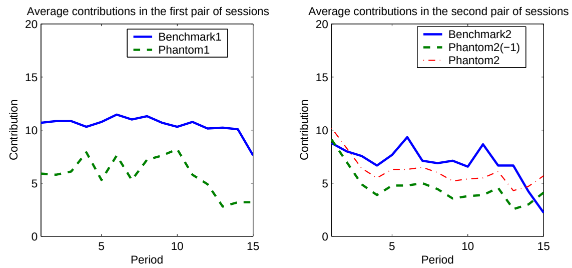

Figure 1: The solid lines represent the average contributions in the Benchmark treatments. The dashdotted line in the second picture represents the average contribution of all subjects, the dashed line on the second picture shows the average contribution of all subjects excluding the one who always contributed 20.

Figure 2: Contributions in two type treatments

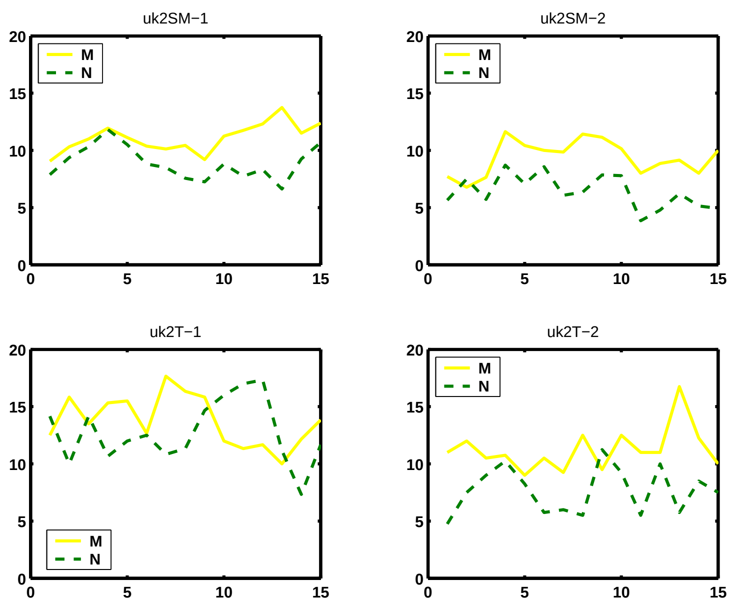

Figure 2: The solid line represents the average contribution against type M, the dashed line against type N. uk2SM is the two-type treatment with the strategy method, and uk2T is a standard two-type treatment.

Figure 3: Individual decisions in uk2SM treatments

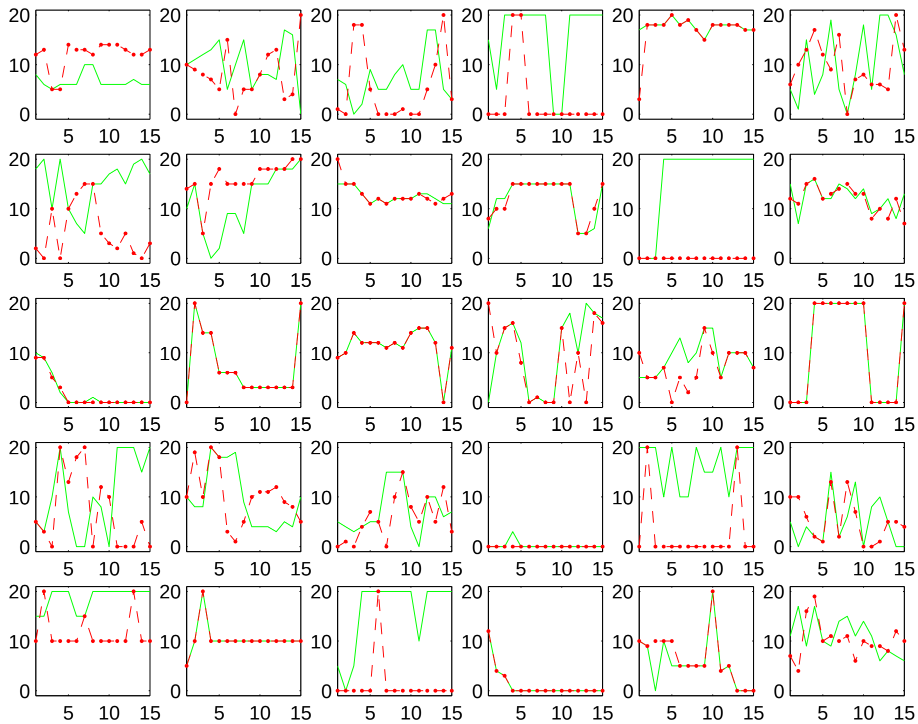

Figure 3: The solid line represents contributions against type M. The dashed line with points represents contributions against type N.

Table 1: Kruskal-Wallis ranking test of the benchmark and phantom treatments

Treatments	Kruskal-Wallis ranking test *p-value*
BT1 - PT1	4.48E-06
BT2 - PT2 (all)	0.0135
BT2 - PT2 (-1)	0.0026

Table 1: Comparison of contributions in the benchmark and the phantom treatments. PT2 (all) means the contributions in the phantom treatments including subject 5 (the one who contributed 100% every period), and PT2(-1) excludes this subjects from the sample.

Table 2: Panel-data estimation

xtreg, fe	**Benchmark**		**Phantom**	
y=Cont_{t+1}	Coef.	p-value	Coef.	p-value
OppCont_t	0.139404	*0.000*	0.024931	*0.481*
OppCont_{t-1}	0.058127	*0.060*	0.056728	*0.107*
Const	6.856729	*0.000*	5.151072	*0.000*

Table 2: Panel-data regression with fixed effects of the contribution at period $t+1$ as a function of the previous opponents' contributions.

Table 3: Fixed-effects logit regressions on Profit

	Benchmark		Phantom	
xtlogit, fe	Coef.	p-value	Coef	p-value
negch				
Profit	-0.142	0.000	-0.081	0.013
posch				
Profit	0.136	0.000	0.059	0.077
negbigch				
Profit	-0.185	0.000	-0.132	0.002
posbigch				
Profit	0.127	0.001	0.046	0.242

Table 3: Results of fixed-effects logit regressions with Profit as dependent variable. Negch (Posch) is equal to 1 if the change in contribution is negative (positive). Negbigch is equal to 1 if the decrease in contribution is at least 3.

Table 4: Fixed-effects logit regressions on opponent's contribution

	Benchmark		Phantom	
	Coef.	p-value	Coef	p-value
negch				
$OppCont_t$	-0.072	0.003	-0.030	0.219
posch				
$OppCont_t$	0.073	0.003	0.020	0.425
negbigch				
$OppCont_t$	-0.083	0.007	-0.047	0.115
posbigch				
$OppCont_t$	0.062	0.031	0.008	0.790

Table 4: Results of the fixed-effects logit regressions where the regressor is the opponent's contribution last period. Negch (Posch) is equal to 1 if the change in contribution is negative (positive). Negbigch is equal to 1 if the decrease in contribution is at least 3.

Table 5: Kruskal-Wallis ranking test of the similarity between contributions against M and N

Treatments	Kruskal-Wallis ranking test
	p-value
uk2T-1	0.2451
uk2T-2	0.0001
uk2SM-1	0.0007
uk2SM-2	0.0001

Table 5: Kruskal-Wallis test shows that in all treatments but uk2T-1 the difference between the contributions against type M and N is statistically significant.

Table 6: The role of opponent's type in contribution decisions.

xtreg, fe	**uk2SM-1**		**uk2SM-2**		**uk2T-1**		**uk2T-2**	
y=Cont$_{t+1}$	Coef.	p-value	Coef.	p-value	Coef.	p-value	Coef.	p-value
$OppType_{t+1}$	-2.411	0.005	-2.081	0.032	-0.860	0.315	-2.344	0.009
$OppCont_t$	0.108	0.084	0.098	0.142	0.161	0.010	0.214	0.009
$OppCont_{t-1}$	-0.005	0.935	0.086	0.194	0.137	0.029	0.119	0.156
Const	9.809	0.000	7.697	0.000	9.682	0.000	7.534	0.000

Table 6: Results of panel-data regressions with fixed effects. The variable OppType is equal to 1 if the opponent's type is N, and 0 otherwise. It is significant in all but uk2T-1 regression. In uk2SM treatments, the variable $Cont_{t+1}$ is equal to the decision that was used for profit calculations.

9 Appendix: Phantom Treatment Instructions

Welcome to a decision-making study!

Introduction.

You will participate in a decision making experiment. These instructions describe a game that you will play for 15 rounds. The instructions are simple and include many examples to make sure that you understand the rules of the experiment. If you follow the instructions carefully and make good decisions you will earn a considerable amount of money. Your payoffs in this experiment will depend on the choices made by you and the other players you will be paired with.

If you have any questions while these instructions are being read, please raise your hand. Please do not talk with the other subjects, even to ask questions about the instructions. If we hear you talking at any point in the experiment you will be removed from the room and will not receive any payment.

General Rules. Decisions.

In the experiment you will play the same game for 15 periods. In the beginning of each period you will be randomly paired with another person **according to the rule described in the end of the instructions**. You and the person you are paired with will form a group, and your earnings will depend on what you and your pair decide.

In the beginning of each period you will be given endowment of 20 ECU[6] and your decision will be to choose how to divide it between two investment projects:

- *Project A:* Each ECU you invest in project A will give you a return of 1 ECU.
- *Project B:* Each ECU invested in Project B by either member of the group will yield a return of .75 to EACH member.

Your task is to decide what part of your endowment to invest in project A and what part invest in project B. You can invest some of your endowment in project A and some in project B. Alternatively, you can invest all your money into project A or into project B. **Your experimental profit in each period will be equal to the sum of project returns.**

Example. If both you and the other member of your group invest 10 ECU to project A and the remaining 10 in project B, then your income will be equal to $10 \cdot 1 + (10 + 10) \cdot 0.75 = 25$. The first term, $10 \cdot 1$, is your return from project A. The second, $(10 + 10) \cdot 0.75$, is your return from the combined (yours and your pair's) investments in project B.

[6] Experiment Currency Units

Your experimental profit and cash earnings.

You will be paid in private and in cash at the end of the experiment. Your cash earnings are determined in the following way: using a deck of cards we will openly and randomly choose one *payment* period among the periods that you played, and your cash earnings will be equal to your experimental profit in the payment period times 0.5.

For example: assume period 5 was chosen as the payment period, and your profit in period 5 was 100 ECU. Then your cash earnings will be $100 \cdot 0.5 = 50$ USD. (**Number in the example are taken to be higher than the earnings you can get in the experiment. Sorry!**).

How pairs will be formed.

For each decision you will be paired with a randomly chosen participant from another experiment (Experiment A). This experiment was conducted at Yale University on September 14. Experiment A was absolutely identical to the current experiment (Experiment B), except that participants of experiment A were playing with each other, while you will play with participants of the different experiment. Participants of Experiment A were paid based on their performance according to the same rule as you will be paid. All participants of Experiment A were chosen from the same pool as you were, namely students of non-Economics majors at Yale University.

Experiment A was entirely independent of Experiment B. In particular, participants of experiment A were not, and will not be informed about experiment B. Furthermore, they will not receive any actual cash payments as a result of experiment B.

To make sure that you and the random participant of Experiment A, with whom you are paired, are equally experienced in this particular game, you will be matched with decisions made in the same round that you are playing.

Example: assume you are playing round 6. The computer will randomly assign for you Mr. X from Experiment A and your earnings will depend on your decision in round 6 and the decision that Mr. X made in round 6. In round 7 you will be randomly matched with another participant of experiment A (say Ms. Y) and your earnings will depend on your decision in round 7 and the decision Ms. Y made in round 7.

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