UNIVERSITY OF
Southampton
School of Social Sciences

Economics Division
University of Southampton
Southampton SO17 1BJ, UK

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By : Christos A Ioannou (University of Southampton), Shi Qi (Florida State University), Aldo Rustichini (University of Minnesota)

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A Test Of Social Preferences Theory

Christos A. Ioannou *†

Shi Qi ‡

Aldo Rustichini§

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Abstract

Theories of social preferences assume that individuals have a utility over monetary outcome profiles, that depends on their and other players' payments. Behavior in strategic interactions is explained as a Nash equilibrium of the game where final payoffs are paid in these utility units. These theories predict the estimated preferences to be independent of the subject's position in the game if in the experiment the allocation to a role is randomly determined, since subjects in each role have the same preferences ex-ante. We test and reject this hypothesis. We use the Quantal Response Equilibrium (QRE) of McKelvey and Palfrey (1995) to study first mover behavior in the Trust game. As standard in this literature we assume that first mover beliefs are consistent with the observed probability distribution of actions of the second movers. On the other hand, second mover behavior can be extrapolated without any a priori rational expectation assumptions. Our results show that the estimated preferences of first movers attach a significantly higher weight to their own payoff compared to the weight attached by second movers on their own payoff. This finding is inconsistent with the assumption that subjects approach a game with the same (that is, independent of the allocation to roles in the game) ex-ante preferences over monetary outcome profiles.

JEL Classification: C51, C92, C72, D03

Keywords: Quantal Response Equilibrium, Social Preferences, Trust Game

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†Department of Economics, University of Southampton, Southampton, SO17 1BJ, United Kingdom. Email: c.ioannou@soton.ac.uk

‡Department of Economics, Florida State University, 113 Collegiate Loop, Bellamy 288, P. O. Box 3062180, Tallahassee, FL 32306. Email: sqi@fsu.edu

§Corresponding Author: Department of Economics, University of Minnesota, 1925 Fourth Str. S., 4-149 Hanson Hall, Minneapolis, MN 55455. Email: arust@econ.umn.edu

1 Introduction

Since the work of Fehr and Schmidt (1999) and Charness and Rabin (2002) there has been an increased interest amongst researchers in extending their models to a variety of applications in order to explain agents' behavior. Although these venues are interesting and promising, one can only wonder if such interpretations constitute *true depictions* of subjects' preferences. Our objective in this study is to examine the empirical validity of a specific class of utility functions that has been used extensively in the literature to model social preferences. In its general form, an agent maximizes a weighted sum of his own payoff and the payoff of his match. A logical implication of the model of social preferences is that the estimated utility functions of individuals are independent of the order of play of a randomized sample. We test this assumption on experimental data and reject it.

In our experiment, a pair of subjects play the standard Trust game. One subject has the role of the first mover in the game, and the other subject has the role of the second mover. The first mover is initially given an endowment and is asked to specify a transfer to the second mover. Any amount that is not transferred to the second mover is secured as payment by the first mover. On the other hand, the transfer is multiplied by a factor, $f > 1$, before reaching the second mover who then has to decide on how to allocate the new amount. The subjects play the Trust game for a number of rounds. In each round, the subjects are matched with a different participant with the order of play determined by a random draw.

We posit a structural model to estimate the utility functions. First, we apply logistic response functions so that better responses are more likely to be observed than worse responses. We then use our experimental dataset to derive parameters using maximum likelihood estimation. Extrapolating second movers' behavior requires no *a priori* rational expectation assumptions. On the contrary, extrapolating behavioral information on first movers requires assumptions on their rationality. As an example, consider the following linear model to describe the behavior of player A (first mover) in a two-person response game. Player A's utility function is represented by

$$u_A(\pi_A, \pi_B) = w_B \cdot E[\pi_B] + (1 - w_B) \cdot E[\pi_A],$$

where player B is the responder (second mover). The monetary payoffs of player A and player B are denoted by π_A and π_B, respectively. Furthermore, the weight that player A places on B's payoff is w_B. Notice that at the time when player A decides on a choice, cannot foresee how the responder will respond to the choice made. Naturally, the payoffs that are incorporated into player A's utility function are based on expectation. As Charness and Rabin (2002) note, "interpreting A's behavior is problematic, since A's perceived consequences of his choice depend on his beliefs about what B will do." (p. 834)

In the present study, we estimate parameter values for first mover behavior using the Quantal Response Equilibrium (QRE) of McKelvey and Palfrey (1995) which maintains the assumption of equilibrium in that beliefs are statistically accurate. QRE can be viewed as an extension of standard random utility models of discrete ("quantal") choice to strategic settings. Under this process best response functions become probabilistic. Much recent work has shown that QRE can rationalize behavior in a variety of experimental settings including alternating-offer bargaining (Goeree and Holt (2000)), coordination games (Anderson, Goeree, and Holt (2001)), the traveler's dilemma (Capra, Goeree, Gomez, and Holt (1999), Goeree and Holt (2001)), all-pay and first-price auctions (Anderson, Goeree, and Holt (1998), Goeree, Holt, and Palfrey (2002)).

We find that first movers attach a significantly higher weight on their own payoff compared to the weight second movers attach on their own payoff. Thus, the preference characteristics of subjects are not stable but depend on the order of play. Yet, preferences should be immune to the position of the subject in the game. If a change in the agent's order in the game reveals different behavioral characteristics, then these characteristics cannot be interpreted as preferences. The rest of the paper is organized as follows. In Section 2, the experimental design is presented. In Section 3, we specify the structural model and the estimation techniques. In Section 4, we report and discuss the important findings. In Section 5, we offer our concluding remarks.

2 Experimental Design

The experimental sessions consisted of two stages. In the first stage, the subjects had to play the Trust game for 15 rounds. The number of rounds to come was not communicated to the subjects. In each round, the subjects had to face a different participant. In the second stage, the subjects were asked to complete a questionnaire. With the conclusion of the experimental session, the subjects were privately paid their earnings in cash.

The Trust game consists of two players. One subject has the role of the first mover and the other subject has the role of the second mover. Let $m \in \{1, 2\}$ index the order of the mover, where $m = 1$ denotes the first mover, and $m = 2$ denotes the second mover. The subjects' roles were determined by random assignment. The first mover was initially given an endowment of 4 quarters and was asked to specify an integer amount of quarters, between zero and 4 quarters inclusive, to transfer to the second mover. Any quarters that were not transferred to the second mover were secured as profit for the first mover. Denote the amount of quarters transferred as $x \in \{0, 1, 2, 3, 4\}$. The amount transferred was multiplied by 4 before reaching the second mover; that is, the second mover received $4x$ quarters for a transfer x. The second mover was then asked to allocate the new amount. Let $y \in \{1, 2, 3, 4, 5\}$ be the choice of the second mover. Notice that the second mover, regardless of the first mover's transfer, had always to choose from a set of five alternatives. Thus, our experimental design secured that changes in the estimated parameters across movers were not affected by the cardinality of the choice set as both, first movers and second movers, had five choices to select from. Let π^m denote the payoff of mover m in quarters for any transfer x and choice y. The payoff of the second mover is given by $\pi^2(x, y) = (y - 1) \times x$, whereas the payoff of the first mover is given by $\pi^1(x, y) = 3x + 4 - \pi^2(x, y)$. The choices together with the corresponding allocation of quarters between the second mover and the first mover, were indicated on the subjects' computer screens as well as mentioned explicitly in the experimental instructions. The round was completed with the earnings of the subject for the specific round indicated on the screen along with the cumulative earnings of the subject thus far in the game.

There were 16 subjects in each experimental session. We conducted 6 sessions in total in May of 2010 at the campus of Florida State University. The experimental sessions were conducted in the XSFS computer lab of the Florida State University in May of 2010. The subjects were recruited from the undergraduate population of the Florida State University using an electronic recruitment system. Participants were allowed to participate in only one session. Each session lasted approximately 45 minutes. The experiments were programmed and conducted with the use of the experimental software z-Tree (Fischbacher (2007)). The detailed instructions are reported in the Supplementary Appendix.

Table 1 reports descriptive statistics on the raw experimental data. In particular, Panel A presents the frequency of the transfer and the choice variables. 35% of first movers chose to transfer 0 quarters to second movers. Transfer-amounts of 1 quarter and 3 quarters were the least chosen by the first movers. Furthermore, only 36.7% of the first movers transferred more than half of their endowment to second movers. On the other hand, 57.7% of second movers kept the entire allowable amount, whereas only 24.4% selected one of choices $y = 2, 3$. In Panel B, we show how the distribution of each choice y changes with the first mover's transfer. With the exception of 6 observations at choice $y = 2$ (for a transfer $x = 4$), all other observations for transfers greater than 1 quarter were allocated to choices $y = 3, 4, 5$. When first movers transferred only one quarter, then 100% of the second movers chose to keep the entire amount. The percentage of second movers keeping the entire allowable amount remained high at 42.9%, 60%, and 48.3% for transfers $x = 2, 3, 4$, respectively.

Table 1: Descriptive Statistics of Transfers and Choices

Panel A	Transfer x	Freq.	Percent	Choice y	Freq.	Percent
	0	252	35.0	1	0	0.0
	1	78	10.8	2	6	1.3
	2	126	17.5	3	108	23.1
	3	90	12.5	4	84	18.0
	4	174	24.2	5	270	57.7
Total		720			468	

Panel B	Distribution of Choice y							
y╲x	1		2		3		4	
	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
1	0	0.0	0	0.0	0	0.0	0	0.0
2	0	0.0	0	0.0	0	0.0	6	3.5
3	0	0.0	42	33.3	24	26.7	42	24.1
4	0	0.0	30	23.8	12	13.3	42	24.1
5	78	100.0	54	42.9	54	60.0	84	48.3

Notes: In Panel A, we provide the frequencies and percentages of each transfer and choice amount. The choice of amount kept is conditional on a transfer $x > 0$. In Panel B, we provide the frequencies and percentages of choices for each transfer amount x.

3 Structural Model

We posit next a specific class of utility functions that has been used extensively in the literature to model agents' social preferences. Our specification does not impose any a priori restrictions on the weights and consequently on preferences. Thus, we remain agnostic if order *affects* weights. We then lay out our hypotheses to determine if the model can capture social preferences. Finally, we specify the estimation techniques.

3.1 Model Specification

We describe first the utility function of the first mover and then the utility function of the second mover. A first mover makes a choice of transfer $x \in \{0, 1, 2, 3, 4\}$ without knowing beforehand what the second mover will choose. Naturally, the payoffs that are incorporated into the utility function are based on the first mover's expectation over payoffs. More specifically, let the utility function of the first mover be

$$u_j^1(x) = v^1(x) + \epsilon_j(x) = (1 - w^1) \cdot E[\pi^1(x, y)|x] + w^1 \cdot E[\pi^2(x, y)|x] + \epsilon_j(x). \tag{1}$$

In this specification, the utility of a first mover j is separated into a value that is common across all subjects $v^1(x)$ and an idiosyncratic preference shock ϵ_j. The parameter of interest w^1 is the weight a first mover j assigns to the payoff of the second mover. In addition, we assume that the idiosyncratic preference shocks are identically and independently drawn from a Type I extreme value distribution. Denote, next, the first mover's belief on the probability of the second mover choosing y given a transfer x, as $\rho(y|x)$. Thus, the expected payoff of the first and second movers for a given transfer x is

$$E[\pi^m(x, y)|x] = \sum_{y=1}^{5} \rho(y|x)\pi^m(x, y) \quad \text{for } m = 1, 2.$$

Proof. The expected payoff of the second mover follows directly. The expected payoff of the first mover is

$$E[\pi^1(x, y)|x] = 3x + 4 - \sum_{y=1}^{5} \rho(y|x)\pi^2(x, y).$$

Given that $\sum_{y=1}^{5} \rho(y|x) = 1$ we get

$$\begin{aligned} E[\pi^1(x, y)|x] &= \sum_{y=1}^{5} \rho(y|x)(3x + 4) - \sum_{y=1}^{5} \rho(y|x)\pi^2(x, y) \\ &= \sum_{y=1}^{5} \rho(y|x)(3x + 4 - \pi^2(x, y)) \\ &= \sum_{y=1}^{5} \rho(y|x)\pi^1(x, y). \end{aligned}$$

□

The choice probability of the first mover choosing transfer $x = 0, 1, 2, 3, 4$ is therefore

$$\mathbb{P}^1(x) = \frac{\exp(v^1(x))}{\sum_{k=0}^4 \exp(v^1(k))}. \tag{2}$$

On the other hand, the utility function of a second mover i has the functional form

$$u_i^2(x, y) = v^2(x, y) + \varepsilon_i(x, y) = (1 - w^2) \cdot \pi^2(x, y) + w^2 \cdot \pi^1(x, y) + \varepsilon_i(x, y). \tag{3}$$

Parallel to the first mover's utility specification, the second mover's utility function consists of a value that is common across all subjects $v^2(x, y)$ and an idiosyncratic preference shock ε_i. The common value $v^2(x, y)$ can be divided further into a subject i's own payoff π^2 and the paired first mover's payoff π^1. The parameter of interest w^2 is the weight a second mover i assigns to the payoff of the first mover. In addition, the idiosyncratic preference shocks are identically and independently drawn from a Type I extreme value distribution. The latter assumption yields the convenient logit choice specification

$$\mathbb{P}^2(y|x) = \frac{\exp(v^2(x, y))}{\sum_{k=1}^5 \exp(v^2(x, k))} \quad \forall y \in \{1, 2, 3, 4, 5\}. \tag{4}$$

Our specification does not impose any a priori assumptions on the weights placed on the first and second movers. Yet, if the model properly addresses social preferences, then the weights should on average be equal regardless of the order of move. Recall that our experimental design imposes a random draw on the order of subjects in each period. Therefore, if indeed social preferences determine behavior in a Nash Equilibrium way, and preferences are, in fact, recovered from subjects' observed actions, then, we should expect that, on average, the same subject-characteristics are observed. Given this insight, we formulate our testable hypotheses next. Our null hypothesis is that the model can explain both, first and second mover behavior in the Trust game. That is, the weights assigned by first and second movers to their own payoffs are statistically the same; or equivalently, the weights placed by first and second movers on the other movers' payoffs are statistically the same. The alternative hypothesis is that the weights assigned to their own payoffs are not statistically the same.

NULL HYPOTHESIS: $w^1 = w^2$

ALTERNATIVE HYPOTHESIS: $w^1 \neq w^2$

Accepting the null hypothesis would provide evidence to support the specific linear utility function used to model social preferences in the Trust game. Otherwise, rejecting the null hypothesis would qualify us to reject the specific linear utility function as one that captures social preferences in the Trust game. We detail our approach of estimating the weights next.

3.2 Estimation Technique

Our estimation techniques require the use of maximum likelihood to estimate the parameters w^1 and w^2. Recall that the choice probability of first movers is given by (2), that is

$$\mathbb{P}^1(x|w^1) = \frac{\exp((1-w^1)\cdot E[\pi^1(x,y)|x] + w^1 \cdot E[\pi^2(x,y)|x])}{\sum_{k=0}^{4} \exp((1-w^1)\cdot E[\pi^1(k,y)|k] + w^1 \cdot E[\pi^2(k,y)|k])}.$$

To calculate the expected payoffs, we allow two alternative specifications of the first mover's beliefs $\rho(y|x)$. The first specification ensures that the beliefs of first movers are consistent with the observed probability distribution as posited by the QRE model; that is, $\rho(y|x) = \frac{n_{y|x}}{n_x}$, where n_x is the observed number of occurrences of some transfer x, and $n_{y|x}$ is the number of observed occurrences of choice y given a transfer x. The second specification depends on the estimated probability, as predicted by the model, so that $\rho(y|x) = \mathbb{P}^2(y|x, w^{2*})$. The two approaches indicated are the ones commonly used to specify $\rho(y|x)$. To ensure robustness for different specifications, we test our model using both approaches.

The likelihood function is then

$$\mathbb{L}^1 = \prod_x \mathbb{P}^1(x|w^1)^{n_x},$$

and the log-likelihood function is

$$\widetilde{\mathbb{L}}^1 = \sum_x n_x \log \mathbb{P}^1(x|w^1).$$

Thus, we calculate w^{1*} so as to maximize the above likelihood function.

On the other hand, the choice probability of second movers is

$$\mathbb{P}^2(y|x, w^2) = \frac{\exp((1 - w^2) \cdot \pi^2(x, y) + w^2 \cdot \pi^1(x, y))}{\sum_{k=1}^{5} \exp((1 - w^2) \cdot \pi^2(x, k) + w^2 \cdot \pi^1(x, k))}$$

Suppose we observe $n_{y|x}$ occurrences of choice y given transfer x; then, the likelihood function is

$$\mathbb{L}^2 = \prod_x \prod_y \mathbb{P}^2(y|x, w^2)^{n_{y|x}},$$

and the log-likelihood function is

$$\widetilde{\mathbb{L}}_2 = \sum_x \sum_y n_{y|x} \log \mathbb{P}^2(y|x, w^2).$$

We calculate w^{2*} so as to maximize the above likelihood function.

4 Results

In this section, we present the important results and discuss their implications. In estimating the first mover's weight, w^1, we allow for two alternative specifications of beliefs, $\rho(y|x)$. Henceforth, Model 1 refers to the case where $\rho(y|x) = \mathbb{P}^2(y|x, w^{2*})$ and Model 2 refers to the case where $\rho(y|x) = n_{y|x}/n_x$. The estimates are presented below for both models. The standard errors of the estimates are reported in parentheses.

$$\text{Model 1}: \quad v^1(x) = \underset{(0.0131)}{0.119} \cdot E[\pi^2(x, y)|x] + \underset{(0.0131)}{0.881} \cdot E[\pi^1(x, y)|x]$$

$$\text{Model 2}: \quad v^1(x) = \underset{(0.0132)}{0.018} \cdot E[\pi^2(x, y)|x] + \underset{(0.0132)}{0.982} \cdot E[\pi^1(x, y)|x]$$

In the estimation, we impose that the sum of the weights placed on the first and second mover's payoff equals one. In Model 1, we find that a first mover, on average, attaches a weight $w^{1*} = 0.119$ on the payoff of the respective second mover and $1 - w^{1*} = 0.881$ on his own payoff. The standard error of the estimate is 0.0131. In addition, the weight w^{1*} is significantly different from zero at a 99% level. In Model 2, we find that a first mover, on average, attaches a weight $w^{1*} = 0.018$ on the payoff of the respective second mover and $1 - w^{1*} = 0.982$ on his own payoff. The standard error of the estimate is 0.0132, but the weight w^{1*} is not significantly different from zero.

In Table 2, we present the model fit of the first mover's choice probability $\mathbb{P}^1(x|w^{1*})$. In the case of Model 1, the model estimate misses a large proportion of subjects who choose $x = 0$. Additionally, the model overestimates the proportion of subjects who choose $x = 1$. This is because $\mathbb{P}^2(y|x, w^{2*})$ underestimates second mover's probability of choosing to keep all quarters when the transfer is only 1 quarter. In contrast, Model 2 corrects for the problems of Model 1 and thus the fit improves. Regardless of the model choice, it is evident that first movers attach almost no weight to a second mover's payoff.

Table 2: FIRST MOVER CHOICE PROBABILITY $\mathbb{P}^1(x)$: MODEL PREDICTIONS VS DATA

Transfer	Model 1	Model 2	Data
x=0	12.1%	29.3%	35.0%
x=1	25.6%	11.8%	10.8%
x=2	28.5%	27.1%	17.5%
x=3	21.0%	13.1%	12.5%
x=4	12.7%	18.7%	24.2%

Notes: We present the model fit of the first mover's choice probability. Model 1 assumes that $\rho(y|x) = \mathbb{P}^2(y|x, w^{2*})$ and Model 2 assumes that $\rho(y|x) = n_{y|x}/n_x$.

On the other hand, for second movers, the estimated weight, w^{2*}, is 0.354 with a standard error of 0.053. Thus, the utility of the second mover is

$$v^2(x, y) = \underset{(0.053)}{0.354} \cdot \pi^1(x, y) + \underset{(0.053)}{0.646} \cdot \pi^2(x, y),$$

which implies that second movers attach a strictly positive weight to a first mover's payoff. The estimated parameters are, at a 99% level, significantly different from zero. The estimation of w^{2*} allows us to approximate the second movers' conditional choice probabilities $\mathbb{P}^2(y|x, w^{2*})$. We compare this estimated choice probability with the actual observed probability $n_{y|x}/n_x$ in Table 3. We see from Table 3 that the model does a fairly good job in matching data except for the case of $x = 1$, where all subjects choose an amount kept of $y = 5$.

Table 3: Second Mover Choice Probability $\mathbb{P}(y|x, w^{2*})$: Model Prediction vs Data

	Transfer (x)							
	x=1		x=2		x=3		x=4	
Amount-Kept (y)	Model	Data	Model	Data	Model	Data	Model	Data
y=1	11.4%	0.0%	5.8%	0.0%	2.7%	0.0%	1.2%	0.0%
y=2	14.6%	0.0%	9.6%	0.0%	5.7%	0.0%	3.2%	3.4%
y=3	18.8%	0.0%	15.8%	33.3%	12.1%	26.7%	8.6%	24.1%
y=4	24.1%	0.0%	26.0%	23.8%	25.5%	13.3%	23.4%	24.1%
y=5	31.0%	100.0%	42.9%	42.9%	54.0%	60.0%	63.7%	48.3%

Notes: The table compares the estimated choice probability with the actual observed probability $n_{y|x}/n_x$.

In order to formally establish the difference between w^{2*} and w^{1*}, we present next the 95% confidence intervals of the estimates. It is clear from Table 4 that the estimated w^{2*} and w^{1*} have no overlap in the 95% confidence intervals of either model. Therefore, the null hypothesis is rejected and $w^2 > w^1$. Thus, the recovered model weights from the observed subject behaviors, indeed depend on the order of play.

Table 4: Confidence Intervals of the Estimated Weights

Estimated Weights	Coefficients	C. I.	
w^{2*}	0.353	[0.250,	0.457]
$w^{1*}_{MODEL\ 1}$	0.119	[0.093,	0.144]
$w^{1*}_{MODEL\ 2}$	0.018	[-0.008,	0.044]

Notes: The table reports the confidence intervals of the parameters at the 95% level.

Preferences refer to stable characteristics of subjects. Such characteristics need to be immune to the order of play. Preferences are unobserved, thus can only be recovered via subjects' observed choice of actions (behavior). To estimate subjects' preferences, we need to assume that the observed behavior is consistent with subjects' utility maximization under a Nash equilibrium framework, and the utility function specification is suitable to capture preferences. In estimation, we find that the recovered utility parameters are different; that is, $w^2 > w^1$ for both specifications of the utility function. One simple explanation of the observed difference in weights is that subjects' preferences are conditional on the order of play. However, this is in direct contradiction with the defining criterion of preferences. On the other hand, a plausible explanation rests on the strategic considerations that affect subjects' behaviors. Such strategic considerations may depend upon the position of the node in the game-tree. In this case, the detected weight difference $w^2 - w^1$ is reflecting *conditional behaviors* rather than social preferences.

5 Conclusion

We studied the behavior of subjects in an experimental Trust game and estimated their preferences. We test the model under the Quantal Response Equilibrium (QRE), which maintains that first mover beliefs are consistent with the observed probability distribution. On the other hand, second mover behavior is extrapolated without any a priori rationality assumptions. In particular, we estimate the parameters of a piecewise linear utility function where each agent is assumed to maximize the weighted sum of his own payoff and the payoff of his partner. Our model is commonly used in the literature to describe agents' social preferences.

Our results indicate that the estimated weight placed on the payoff of a subject's partner depends significantly on the position that the subject occupies in the game. More specifically, second movers attach significantly higher weight to the payoff of first movers than the weight first movers attach to the payoff of second movers. But a preference is, by definition, a stable characteristic of an individual and therefore should not significantly depend upon environmental conditions such as the position of the subject in the game. This finding puts in question the usefulness of social preferences in interpreting behavior.

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