games

Article

A Choice Prediction Competition for Social Preferences in Simple Extensive Form Games: An Introduction

Eyal Ert [1],*, Ido Erev [2] and Alvin E. Roth [3,4]

[1] Agricultural Economics and Management, The Hebrew University of Jerusalem, P.O. Box 12, Rehovot 76100, Israel

[2] Max Wertheimer Minerva Center for Cognitive Studies, Faculty of Industrial Engineering and Management, Technion, Haifa 32000, Israel; E-Mail: erev@tx.technion.ac.il

[3] Department of Economics, 308 Littauer, Harvard University, Cambridge, MA 02138, USA

[4] Harvard Business School, 441 Baker Library, Boston, MA 02163, USA; E-Mail: aroth@hbs.edu

* Author to whom correspondence should be addressed; E-Mail: ert@agri.huji.ac.il.

Abstract: Two independent, but related, choice prediction competitions are organized that focus on behavior in simple two-person extensive form games (http://sites.google.com/site/extformpredcomp/): one focuses on predicting the choices of the first mover and the other on predicting the choices of the second mover. The competitions are based on an estimation experiment and a competition experiment. The two experiments use the same methods and subject pool, and examine games randomly selected from the same distribution. The current introductory paper presents the results of the estimation experiment, and clarifies the descriptive value of some baseline models. The best baseline model assumes that each choice is made based on one of several rules. The rules include: rational choice, level-1 reasoning, an attempt to maximize joint payoff, and an attempt to increase fairness. The probability of using the different rules is assumed to be stable over games. The estimated parameters imply that the most popular rule is rational choice; it is used in about half the cases. To participate in the competitions, researchers are asked to email the organizers models (implemented in computer programs) that read the incentive structure as input, and derive the predicted behavior as an output. The submission deadline is 1 December 2011, the results of the competition experiment will not be revealed until that date. The submitted models will be ranked based on their prediction

error. The winners of the competitions will be invited to write a paper that describes their model.

1. Introduction

Experimental studies of simple social interactions reveal robust behavioral deviations from the predictions of the rational economic model. People appear to be less selfish, and less sophisticated than the assumed Homo Economicus. The main deviations from rational choice (see a summary in Table 1) can be described as the product of a small set of psychological factors. Those factors include (i) altruism or warm glow [1]; (ii) envy or spitefulness [2]; (iii) inequality aversion [3,4]; (iv) reciprocity [5,6]; (v) maximizing joint payoff [7]; (vi) competitiveness [7]; and (vii) level-k reasoning [8].

Table 1. Sequential two-player games that show deviations from rationality. [1]

Game	Description	Rational prediction	Main findings
Ultimatum [9]	A Proposer offers an allocation of a pie (e.g., $10) between herself and a responder. If the responder accepts the offer, the money is allocated. If she rejects, both get nothing	The responder maximizes own payoff thus agrees to any allocation. The proposer, anticipating that, offers the lowest amount possible to the responder	Most proposers suggest equal split when such split is possible. Low offers (below 30% of the pie) are typically rejected. [9]
Dictator [10]	A "Dictator" determines an allocation of an endowment (e.g., $10) between herself and a recipient	The dictator, maximizing their own payoff, gives $0 to the recipient	Dictators, on average, give 30% of the endowment. [10]
Trust [11]	A sender receives an endowment (e.g., $10) and can send any proportion of it to the responder. The amount sent is multiplied (e.g., by 3). The responder then decides how much to send back.	Responder maximizes their own payoff and thus sends back $0. The sender, anticipating that, sends $0.	Most senders send half or more of their endowment. Many responders (e.g., 44% in [11]) return at least the amount sent.
Gift exchange [12]	A "manager" (*M*) determines a wage (*w*) to "hire" an "employee"(*E*). The employee then choose an effort level *e* which is costly (*c(e)*). The profit functions are:	The employee chooses minimum effort. Anticipating that, the manager chooses the minimum wage.	The minority of transactions (less than 9%) involve minimal wages and effort. About 2/3 of the managers offers are higher than 50. [12]

Recent research demonstrates the potential of simple models that capture these psychological factors e.g., [3,5,13]. However, there is little agreement concerning the best abstraction and the relative importance of the distinct psychological factors. The main goal of the current project is to address the

---

[1] Each of those games has been studied extensively with different variations. Table 1 is focused on the motivating experiments that introduced those games.

quantitative "best abstractions and relative importance" questions with the organization of a choice prediction competition. It focuses on simple response games, similar by structure to the games studied by Charness and Rabin [14]. The game structure, presented in Figure 1, involves two players acting sequentially. The first mover (Player 1) chooses between action *Out*, which enforces an "outside option" payoffs on the two players (f1 and s1 for Players 1 and 2 respectively), and action *In*. If *In* is chosen then the responder (Player 2) determines the allocation of payoffs by choosing between actions *Left* that yields the payoffs f2, s2, and action *Right* that yields the payoffs f3, s3.

Figure 1. The structure of the basic game. Player 1 (P1) selects between *Out* and *In*, and Player 2 (P2) selects between *Left* and *Right*.
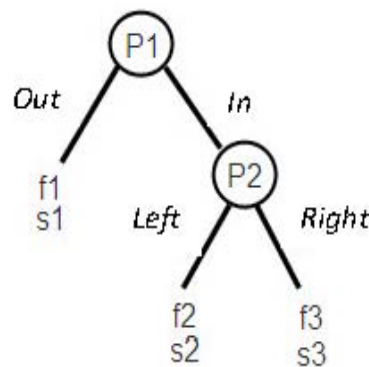
The selected structure has two main advantages: the first is that, depending on the relation between the different payoffs, this structure allows for studying games that are similar to the famous examples considered in Table 1 (ultimatum, trust *etc*.), and at the same time allows for expanding the set of game-types. Secondly, although this structure is simple, it is sufficient to reproduce the main deviations from rational choice considered by previous studies. For example, both players can exhibit their preferences over different outcome distributions between themselves and the other player. In addition, the "opting out" feature of the game can color action *In* by Player 1 as a selfish, altruistic, or neutral act (depending on the payoffs), allowing for reciprocal behavior by Player 2 (punishing or rewarding Player 1's decision). These properties make the current set of games a natural test case for models of social preferences.

Figure 2 presents a classification of the space of games implied by Figure 1's game structure. The classification is based on the relation between the different payoffs for each player in a specific class of games. It provides a closer look into the potential conflicts that may be involved in each game, as well as clarifying the game's likelihood of occurrence under a random selection from that space. The classification reveals that only a small proportion of the games in Figure 2's space are similar to the games that have been extensively used by previous studies. For example, ultimatum-like games, special cases of the costly punishment (c.p.) type of games in which f1 = s1, capture less than 1% of the entire space of possible games. Similarly, the likelihood that a trust-like game would be randomly sampled from the space is only about 4%. The most likely games are typically less interesting than the famous examples: a large proportion of games include a "common interest" option that maximizes both player's payoffs, and many other games are "safe shot" games for Player 1 as the payoff from *In* is higher than that of *Out* independently of Player 2's choice.

Figure 2. The structure and space of the games. The games are classified according to the relations between their outcomes for each player separately, and their main properties are described below the graph. Cells marked with gray are defined as "trivial games." The lower panel shows the proportion of games under random sampling from the space, from the space excluding the "trivial games," and under the quasi random sampling algorithm used in the estimation study.

		f1 best				f2 best					f3 best				Prop.
		f1=f2=f3	f1>f2>f3	f1>f2=f3	f1>f3>f2	f1=f2>f3	f2>f1>f3	f2>f1=f3	f2>f3>f1	f2=f3>f1	f3>f2>f1	f3>f1=f2	f3>f1>f2	f3=f1>f2	in space:
	s1=s2=s3														0.34%
	s1>s2>s3						c.p	s.s	s.s	s.s	s.s	s.s	r.p		13.84%
s1 best	s1>s2=s3						f.p	s.s	s.s	s.s & s.d	s.s	s.s	f.p		2.77%
	s1>s3>s2						r.p	s.s	s.s	s.s	s.s	s.s	c.p		13.84%
	s1=s2>s3		n.d	n.d	n.d	c.i		s.s	s.s	s.s	s.s	s.s		c.i	2.77%
	s2>s1>s3		n.d	n.d	n.d	f.h	c.i	s.s & c.i	s.s & c.i	s.s & c.i	s.s	s.s			13.84%
s2 best	s2>s1=s3		n.d	n.d	n.d	f.h	c.i	s.s & c.i	s.s & c.i	s.s & c.i	s.s	s.s	c.h	c.h	2.77%
	s2>s3>s1		n.d	n.d	n.d	f.h	c.i	s.s & c.i	s.s & c.i	s.s & c.i	s.s	s.s	c.h. & tr	c.h	13.84%
	s2=s3>s1		n.d	n.d & s.d	n.d	f.h		s.s	s.s	s.s & s.d	s.s	s.s		f.h	2.77%
	s3>s2>s1		n.d	n.d	n.d	c.h	c.h. & tr	s.s	s.s	s.s	s.s & c.i	s.s & c.i	c.i	f.h	13.84%
s3 best	s3>s1=s2		n.d	n.d	n.d	c.h	c.h	s.s	s.s	s.s	s.s & c.i	s.s & c.i	c.i	f.h	2.77%
	s3>s1>s2		n.d	n.d	n.d			s.s	s.s	s.s	s.s & c.i	s.s & c.i	c.i	f.h	13.84%
	s3=s1>s2		n.d	n.d	n.d	c.i		s.s	s.s	s.s	s.s	s.s		c.i	2.77%
proportion in space:		0.34%	13.84%	2.77%	13.84%	2.77%	13.84%	2.77%	13.84%	2.77%	13.84%	2.77%	13.84%	2.77%	100.00%

notation	class	Main Properties	Prop. in space	Prop. in space - trivial excluded	Prop. by algorithm
c.i	common interest	There is one option which is best for both players	19.7%	22.1%	19.0%
s.s	safe shot	*In* is the optimal choice for player 1	35.9%	40.3%	38.0%
s.d	strategic dummy	Player 2 cannot affect the payoffs: dictator is private case	0.2%	0.2%	3.5%
n.d	near dictator	Best payoff for player 1 is independent of player 2's choice	21.1%	23.7%	32.0%
c.p	costly punish	Punishing player 1's *In* choice is costly	3.8%	4.4%	4.0%
f.p	free punish	Player 2 can punish player 1's *In* choice with no cost	0.7%	0.8%	1.2%
r.p	rational punish	Punishing player 1's *In* choice maximizes player 2's payoff	3.8%	4.4%	5.3%
c.h	costly help	Improving other's payoff is costly for the helper	5.5%	6.2%	7.4%
f.h	free help	Improving others payoff is not costly	1.8%	2.1%	2.8%
tr	trust game	Choosing *In* improves 2's payoffs but reciprocation is irrational for player 2	3.8%	4.3%	6.5%
	trivial games	the player's three payoffs are equal or *Out* maximizes both players' payoffs	11.0%	--	--

Notice: the sum of the proprotions is higher than 100% since some games can be clasified to more than one type

The current study focuses on games that were sampled from Figure 2's space using the quasi random sampling algorithm described in Appendix 1. The algorithm excludes the sampling from the trivial class (games in which action *Out* yields the best payoff for both players or in which all payoffs are equal for a player—the dark gray cells) and implies slight oversampling of interesting games. The implied sampling proportions by this algorithm are presented on the rightmost column in the lower panel of Figure 2.

The Structure of the Competition and the Problem Selection Algorithm

The current paper introduces two independent but related competitions: one for predicting the proportion of *In* choices by Player 1, and the other for predicting the proportion of *Right* choices by Player 2. Both competitions focus on the same games, and are based on two experiments: An "estimation" and a "competition" experiment.[2] We describe the first experiment (and several baseline models) below, and challenge other researchers to predict the results of the second experiment. The

---

[2]This structure follows the structure of previous competitions we organized on other research questions [15,16].

competition criteria are described in Section 4. The two experiments examine different games and different participants, but use the same procedure, and sample the games and the participants from the same space.

Each experiment includes 120 games. The six parameters that define each game (the payoffs f1–f3, and s1–s3, see Figure 1) were selected using the algorithm presented in Appendix 1. The algorithm implies a nearly uniform distribution of each parameter in the range between −$8 and + $8. The 120 games studied in the estimation experiment are presented in Table 1.

2. Experimental Method

The estimation experiment was run in the CLER lab at Harvard. One hundred and sixteen students participated in the study, which was run in four independent sessions, each of which included between 26 and 30 participants. Each session focused on 60 of the 120 extensive form games presented in Table 2, and each subset of 60 games was run twice, counterbalancing the order of problems.[3] The experiment was computerized using Z-Tree [17]. After the instructions were read by the experimenter, each participant was randomly matched with a different partner in each of the 60 games, and played each of the 60 games using the strategy-method.[4] That is, participants marked their choices without knowing what the other player had chosen. Moreover, they did not receive any feedback during the experiment. At the end of the session one game was selected at random to determine the players' payoffs and the participants were reminded of the game's payoffs, and their choices, and were informed about the choice of the other player in that game and consequently their payoffs (see a copy of the instructions below). The whole procedure took about 30 minutes on average. Participants' final payoffs were composed from the sum of a $20 show-up fee, and their payoff (gain/loss) in one randomly selected trial. Final payoffs ranged between $14 and $28.

3. Experimental Results

Table 2 presents the 120 games, and the proportion of *In* choices (by Player 1) and *Right* choices (by Player 2). The rightmost columns of this table present the predicted choices under the subgame perfect equilibrium (SPE),[5] and the average Mean Squared Deviation (MSD) of the observed proportions from the two predictions. The results reveal high correlations between the players' behavior and the equilibrium predictions especially for Player 2's choices (r = 0.88, and r = 0.98 for Players 1 and 2 respectively).The ENO (equivalent value of observations[6]) score of the equilibrium prediction is 0.87 for Player 1, and 7.5 for Player 2.

---

[3]We checked the data for potential "order of game" effect but no such effect was found.

[4]Previous research that compares the strategy method to a sequential-decision method shows little difference between the two [18,19], albeit levels of punishment seem to be lower with the strategy method [19].

[5]The SPE prediction for Player 2 is 0 (*Left*) if S2 > S3, 1 (*Right*) if S2 < S3 and 0.5 (random choice) otherwise. To define the SPE prediction for Player 1 let EIN be the expected payoff for Player 1 from *In* assuming that Player 2 follows the SPE predictions. The SPE prediction for Player 1 is 0 (*Out*) if F1 > EIN, 1 (*In*) if F1 < EIN and 0.5 (random choice) otherwise.

[6]In order to clarify this measure, consider the task of predicting the entry rate in a particular game. Assume that you can base your estimate on the observed rate in the first *m* cohorts that plays this game, and on a point prediction made by a specific model. It is easy to see that the value of the observed rate increases with *m*. ENO of 7.5 means that the prediction of the model is expected to be more accurate than the observed rate in an experiment with 6 cohorts. The exact computation is explained in [20].

Table 2. The 120 games studied in the estimation experiment ranked by the Mean Squared Deviation from the Subgame Perfect Equilibrium prediction. The left-hand columns present the payoffs of the 120 games, the right-hand columns present the experimental results (proportions of *In* and *Right* choices), the subgame perfect equilibrium predictions for these choices (SPE), and the average MSD (over the two players) between the predictions and the results.

Rank	Game	f1	s1	f2	s2	f3	s3	P(*In*)	P(*Right*)	P(*In*) SPE	P(*Right*) SPE	MSD
1	16	0	8	1	−6	−6	3	0	1	0	1	0
2	18	3	−4	−2	8	3	−5	0	0	0	0	0
3	31	−6	−6	2	−3	1	2	1	1	1	1	0
4	43	−7	1	6	4	0	−6	1	0	1	0	0
5	49	5	−2	4	−5	−3	5	0	1	0	1	0
6	56	0	−2	8	3	7	−7	1	0	1	0	0
7	63	5	3	−3	6	0	8	0	1	0	1	0
8	70	−6	−6	0	8	−1	−6	1	0	1	0	0
9	84	−4	1	1	−8	8	0	1	1	1	1	0
10	86	−5	1	0	−6	−4	−4	1	1	1	1	0
11	90	−4	−4	0	−7	7	−4	1	1	1	1	0
12	93	2	4	−7	7	3	−5	0	0	0	0	0
13	97	0	6	3	−7	6	−2	1	1	1	1	0
14	105	8	−5	−6	−5	−3	6	0	1	0	1	0
15	111	−5	6	4	−4	5	4	1	1	1	1	0
16	117	−3	−6	8	0	7	3	1	1	1	1	0
17	35	0	1	6	1	8	−6	1	0.03	1	0	0
18	39	5	7	7	−7	0	4	0.03	1	0	1	0
19	46	−4	−2	7	6	−4	3	1	0.03	1	0	0
20	3	−7	−4	−5	8	−5	8	1	0.47	1	0.5	0
21	4	−3	−4	−1	4	3	7	1	0.97	1	1	0
22	30	2	−8	7	−1	6	−7	0.97	0	1	0	0
23	36	−5	3	7	−7	−4	5	1	0.97	1	1	0
24	37	−6	1	−2	−6	1	−3	1	0.97	1	1	0
25	44	−7	6	−5	2	−4	7	1	0.97	1	1	0
26	79	0	0	−5	5	−1	−6	0.04	0	0	0	0
27	89	6	−7	−3	−3	6	−7	0.04	0	0	0	0
28	91	2	−6	−7	−1	0	−6	0.04	0	0	0	0
29	96	2	6	−3	6	3	−3	0	0.04	0	0	0
30	66	−6	−2	1	−4	−4	−4	0.96	0.5	1	0.5	0
31	81	−6	−5	0	−1	−4	−6	0.96	0	1	0	0
32	82	0	8	6	5	8	3	0.96	0	1	0	0
33	83	−6	−6	−1	−1	5	−5	0.96	0	1	0	0
34	103	−7	−5	−5	5	−6	−3	0.96	0	1	0	0

Table 2. *Cont.*

Rank	Game	f1	s1	f2	s2	f3	s3	P(*In*)	P(*Right*)	P(*In*) SPE	P(*Right*) SPE	MSD
35	104	−5	−4	4	−7	2	2	1	0.96	1	1	0
36	26	−1	4	1	0	5	−2	0.97	0.03	1	0	0
37	23	−3	−5	3	−3	6	−1	0.97	0.97	1	1	0
38	53	−6	2	−7	−2	0	2	0.97	0.97	1	1	0
39	67	−3	−1	−5	−3	6	0	0.96	0.96	1	1	0
40	101	2	−6	7	−8	6	−6	0.96	0.96	1	1	0
41	25	−7	1	−6	1	0	3	1	0.93	1	1	0
42	32	−3	6	2	−4	5	−3	1	0.93	1	1	0
43	87	3	−2	2	0	6	3	0.93	1	1	1	0
44	106	4	−1	6	3	0	−2	0.93	0	1	0	0
45	10	−2	5	−4	7	−2	−2	0.07	0	0	0	0
46	24	2	−4	−3	5	3	−2	0	0.07	0	0	0
47	55	6	0	−5	4	0	−2	0	0.07	0	0	0
48	12	2	−7	3	3	4	−6	0.93	0.03	1	0	0
49	15	1	−4	1	2	6	5	0.93	0.97	1	1	0
50	59	−6	5	2	0	7	−8	0.97	0.07	1	0	0
51	120	−2	−7	−3	−6	0	3	0.96	0.93	1	1	0
52	64	6	−2	1	1	4	−3	0.07	0.04	0	0	0
53	102	−1	−6	−4	−2	−4	−3	0.07	0.04	0	0	0
54	62	2	−6	3	−2	−4	5	0.07	0.96	0	1	0
55	99	−5	7	−2	−1	4	−4	0.96	0.07	1	0	0
56	114	−4	1	−3	6	6	1	0.96	0.07	1	0	0
57	118	−5	−6	7	7	4	-6	0.96	0.07	1	0	0
58	11	−2	1	5	−7	5	-7	0.93	0.43	1	0.5	0
59	58	−6	0	−1	−5	−6	−7	0.93	0.07	1	0	0
60	60	−8	3	6	4	−3	−2	0.93	0.07	1	0	0
61	13	5	−6	0	1	1	−7	0.07	0.07	0	0	0
62	29	0	1	−2	5	5	−5	0.1	0.03	0	0	0.01
63	71	7	−1	5	4	−5	7	0.04	0.89	0	1	0.01
64	107	4	−3	5	−7	2	−3	0.11	0.96	0	1	0.01
65	2	7	−6	5	3	−4	0	0.1	0.07	0	0	0.01
66	21	−6	2	0	−7	8	−7	1	0.63	1	0.5	0.01
67	47	7	−7	−6	−6	−4	−6	0	0.63	0	0.5	0.01
68	74	−3	7	0	−5	−3	−6	0.89	0.07	1	0	0.01
69	7	−3	−1	1	−7	−4	6	0.13	0.97	0	1	0.01
70	45	−1	7	4	6	−2	5	0.87	0.07	1	0	0.01
71	14	−6	2	−2	−4	6	−5	1	0.17	1	0	0.01
72	57	3	0	−4	3	−2	−2	0	0.17	0	0	0.01
73	48	7	−7	1	−5	5	2	0.17	0.97	0	1	0.01
74	77	−3	2	0	−5	−6	7	0.18	1	0	1	0.02
75	94	3	−6	3	−6	6	−5	0.82	1	1	1	0.02

Table 2. *Cont.*

Rank	Game	f1	s1	f2	s2	f3	s3	P(*In*)	P(*Right*)	P(*In*) SPE	P(*Right*) SPE	MSD
76	6	−1	4	−7	3	7	0	0.13	0.13	0	0	0.02
77	68	−1	4	2	−4	−3	−2	0.18	0.96	0	1	0.02
78	72	0	0	7	0	−5	7	0.18	0.96	0	1	0.02
79	19	1	−6	4	5	−1	−6	0.8	0.03	1	0	0.02
80	69	−4	8	−3	4	1	−4	0.79	0	1	0	0.02
81	88	−5	6	−4	0	−4	0	0.79	0.46	1	0.5	0.02
82	65	−7	−4	−4	−5	−6	−5	0.96	0.29	1	0.5	0.02
83	119	2	−4	−7	−6	2	−3	0.29	0.93	0.5	1	0.02
84	20	0	−3	−4	6	3	3	0.1	0.2	0	0	0.03
85	95	1	3	5	2	−4	3	0.21	0.89	0	1	0.03
86	112	5	−6	1	−1	6	−1	0.21	0.61	0	0.5	0.03
87	78	6	−1	−5	6	8	8	0.75	1	1	1	0.03
88	100	6	−1	−7	−5	5	4	0.25	1	0	1	0.03
89	116	1	1	2	−1	2	−1	0.75	0.57	1	0.5	0.03
90	51	2	−7	−1	3	7	−6	0.27	0	0	0	0.04
91	76	7	−7	5	6	−7	−5	0.29	0	0	0	0.04
92	108	7	−8	4	0	2	2	0.29	0.93	0	1	0.04
93	52	8	1	0	3	2	2	0	0.3	0	0	0.05
94	1	−3	−7	−7	5	−3	6	0.2	0.93	0.5	1	0.05
95	34	2	2	3	−7	3	−7	0.67	0.43	1	0.5	0.06
96	73	5	−3	2	0	4	5	0.36	1	0	1	0.06
97	92	0	3	5	−2	0	5	0.86	1	0.5	1	0.06
98	22	−5	7	−6	−2	8	−6	0.33	0.17	0	0	0.07
99	38	2	8	6	1	−7	−7	0.63	0.03	1	0	0.07
100	41	1	7	3	2	−4	−6	0.63	0.03	1	0	0.07
101	75	−5	3	−6	5	0	1	0.36	0.11	0	0	0.07
102	61	0	2	−1	6	2	6	0.79	0.82	1	0.5	0.07
103	54	−1	3	7	1	−2	8	0.37	0.87	0	1	0.08
104	98	4	8	6	3	1	2	0.61	0.07	1	0	0.08
105	5	−2	−7	6	5	−2	8	0.83	0.77	0.5	1	0.08
106	80	−1	−2	6	0	−3	1	0.39	0.89	0	1	0.08
107	28	5	−7	−5	−7	8	0	0.57	1	1	1	0.09
108	33	4	0	−8	−8	5	5	0.57	0.97	1	1	0.09
109	113	4	−7	2	−4	7	−4	0.57	0.64	1	0.5	0.1
110	110	1	7	0	2	3	2	0.61	0.79	1	0.5	0.12
111	42	4	−3	−3	7	5	7	0.23	0.93	0	0.5	0.12
112	27	4	1	−6	1	7	5	0.5	1	1	1	0.13
113	50	−1	2	0	1	−5	−3	0.5	0	1	0	0.13
114	9	1	−7	−4	4	3	4	0.4	0.83	0	0.5	0.13
115	109	1	−2	6	6	−3	7	0.5	0.75	0	1	0.16
116	8	0	2	−5	1	2	1	0.47	0.83	0	0.5	0.16

Table 2. *Cont.*

Rank	Game	f1	s1	f2	s2	f3	s3	P(*In*)	P(*Right*)	P(*In*) SPE	P(*Right*) SPE	MSD
117	115	3	2	−7	−6	5	−3	0.36	0.96	1	1	0.21
118	40	4	4	7	2	−3	1	0.33	0.03	1	0	0.22
119	17	0	0	5	−4	−5	−5	0.33	0.07	1	0	0.23
120	85	7	7	−1	−7	8	−1	0.14	1	1	1	0.37

In order to clarify the main deviations from rational choice we focused on the predictions of the seven strategies presented in Table 3. Each strategy can be described as an effort to maximize a certain "target value", and (in the case of Player 1) to reflect a certain belief about the behavior of Player 2. The "*Rational choice*" rule is the prescription of the subgame perfect equilibrium. It implies that the target value is the player's own payoff, and that Player 1 believes that Player 2 follows this rule too. The "*Maximin*" rule maximizes the worst own payoff. The "*Level-1*" rule maximizes own payoff assuming that the other player chooses randomly. The final three rules assume that Player 1 believes that the two agents have the same goal. The *"Joint max"* rule attempts to maximize the joint payoff. The "*Min difference*" rule attempts to choose the option that minimizes payoff difference. The "*Helping the weaker player*" rule attempts to maximize the payoff of the player who has the lower payoff of the two players.

Table 3. The seven strategies examined in the regression analyses, and the estimated equations (regression weights). Standard error in parenthesis, statistical significance at *0.05, **0.01, ***0.001 levels.

Rules	Player 1		Player 2	
	Prediction of P(*In*)	**weight (std. err)**	**Prediction of P(*Right*)**	**weight (std. err)**
Constant		−0.047 (0.028)		0.016 (0.009)
Rational (Ratio)	1 if *In* is the SPE choice 0 if *Out* is the SPE choice 0.5 otherwise	0.448*** (0.029)	1 if *s3 > s2* 0 if *s3 < s2* 0.5 if *s3 = s2*	0.497*** (0.036)
Nice rational (NiceR)	(Cannot be estimated based on the current data)	--	1 if *s3 > s2* or (*s3 = s2 and f3 > f2*) 0 if *s3 < s2* or (*s3 = s2 and f3 < f2*)	0.357*** (0.036)
Maxmin	1 if *f1 < min(f2,f3)* 0 if *f1 > min(f2,f3)* 0.5 if *f1 = min(f2,f3)*	0.199*** (0.034)	Perfectly correlated with Rational	--
Level-1	1 if *f1 < (f2 + f3)/2* 0 if *f1 > (f2 + f3)/2* 0.5 otherwise	0.206*** (0.030)	Perfectly correlated with Rational	--

Table 3. *Cont.*

Rules	Player 1			Player 2		
	Prediction of P(*In*)	**weight (std. err)**		**Prediction of P(*Right*)**	**weight (std. err)**	
Joint max (Joint Mx)	1 if $f1 + s1 < max(f2 + S2, f3 + s3)$ 0 if $f1 + s1 > max(f2 + S2, f3 + s3)$ 0.5 otherwise	0.085** (0.031)		1 if $f3 + s3 > f2 + s2$ 0 if $f3 + s3 < f2 + s2$ 0.5 otherwise	0.049** (0.017)	
Helping the weaker player (MxWeak)	1 if $min(f1,s1)<$ $Max[min(f2,s2), min(f3,s3)]$. 0 if $min(f1,s1)>$ $Max[min(f2,s2), min(f3,s3)]$. 0.5 otherwise	0.068* (0.034)		1 if $min(f3,s3)>min(f2,s2)$ 0 if $min(f3,s3)<min(f2,s2)$ 0.5 otherwise	0.049* (0.019)	
Minimize differences (MnDiff)	1 if $\lvert f1-s1 \rvert > Min[\lvert f2-s2 \rvert, \lvert f3-s3 \rvert]$. 0 if $\lvert f1-s1 \rvert < Min[\lvert f2-s2 \rvert, \lvert f3-s3 \rvert]$. 0.5 otherwise	0.062* (0.026)		1 if $\lvert f3-s3 \rvert < \lvert f2-s2 \rvert$ 0 if $\lvert f3-s3 \rvert > \lvert f2-s2 \rvert$ 0.5 otherwise	0.026* (0.013)	
Adjusted R²		0.920			0.984	

The prediction of each strategy for Player 1 takes the value "1" when the strategy implies the *In* choice, "0" when the strategy implies the *Out* choice, and "0.5" when the strategy leads to indifference. Similarly, the prediction of each rule for Player 2 takes the value "1" when the strategy implies choice of action *Right*, "0" when the strategy implies choice of *Left*, and "0.5" when the strategy leads to indifference.

Table 3 presents the results of regression analyses that focus on the prediction of the observed choice rates with these rules. The analysis of the behavior of Player 1 reveals that six rules have a significant contribution (the contribution of the seventh rule cannot be evaluated on the current data). That is, the average Player 1 appears to exhibit sensitivity to six targets. The analysis of Player 2's behavior reveals that the predictions of three of the rules (rational choice, maximin, and level-1) are perfectly correlated. The results reveal that the five remaining rules have a significant contribution.

Much of the debate in the previous studies of behavior in simple extensive form games focuses on the relative importance of inequality aversion [3,4] and reciprocation [5]. The results presented in Table 3 suggest that neither factor was very important in the current study. In order to clarify this observation it is constructive to consider the games presented in Table 4. The games on the left are Game 17 and 40 studied here, and the games on the right are mini-ultimatum games studied by Falk *et al*. [21] and Charness and Rabin [14].

The popular models of inequality aversion imply a high rate of *Right* choices by Player 2 in all the games in Table 4, yet in the current study only less than10% of the participants exhibit this behavior. The previous studies of the mini-ultimatum game reveal mixed results. The proportion of *Right* choices was 45% in Falk *et al*.'s study[7] and only 9% in Charness and Rabin's study. Thus, the current findings are similar to Charness and Rabin's results, and differ from Falk *et al*.'s results. We believe that this pattern may be a product of the class of games presented to each participant. The participants in

---

[7] Falk et al used the strategy method. In a similar study Güth *et al*. [22] got similar results, yet their settings in which responders replied only to the actual action of player 1, implied a lower number of observations (6 of 10 subjects rejected the "unequal split" offer).

Falk *et al.*'s study were presented with four similar games: rational choice implied higher payoff to Player 1 in all four games. In contrast, the participants here and in Charness and Rabin's study were presented with a wider class of games; in some of the games, rational choice implied higher payoff to Player 2. It seems that inequality aversion in each game is less important in this context.

Table 4. Mini ultimatum games: Results from current and previous studies.

Mini-ultimatum-like games in the current studies		Previous studies of mini-ultimatum games	
Game description	P(*Right*)	Game description	P(*Right*)
#17: Player 1 chooses between *Out* (0,0) or *In*: letting Player 2 choose between Left (5,–4), and Right (–5, –5).	7%	Falk *et al.* (5/5 game): Player 1 chooses between action *x*: *letting Player 2 choose between x-Left (8, 2) and x-Right (0,0)*; and action *y*: *letting Player 2 choose between y-Left (5, 5), and y-Right (0, 0)*.	45%
#40: Player 1 chooses between *Out* (4,4) or *In*: letting Player 2 choose between Left (7, 2), and Right (–3, 1)	3%	Charness and Rabin (Berk27): Player 1 chooses between *Out* (500,500) or *In*: letting *Player 2 choose between Left (800, 200), and Right (0, 0)*	9%

One explanation to this "class of games" effect is the distinction between two definitions of inequality aversion. One definition is local: it assumes aversion to inequality in each game.

The second definition is global: it assumes aversion to inequality over games. Table 4's findings can be consistent with the global strategy. Indeed, when the expected payoffs over games are approximately similar, almost any behavior can be consistent with global inequality aversion, since a lower payment in one game can be offset by a higher payment in another game.

Another potential explanation of the class of games effect is that players tend to select strategies that were found to be effective in similar situations in the past, and the class of games used in the experiment is one of the factors that affect perceived similarity. For example, it is possible that an experiment that focuses on ultimatum-like games, increases the perceived similarity to experiences in which the player might have been treated unfairly. And an experiment with a wider set of games increases similarity to situations in which efficiency might be more important. One attractive feature of this "distinct strategies" explanation is its consistency with the results of the regression analysis presented above. The best regression equation can be summarized with the assertion that players use distinct strategies. We return to this idea in the baseline models section below.

In an additional analysis we focused on the games in which Player 2 cannot affect his/her own payoff. Table 5 presents these games as a function of the implication of Player 1 choice. The *In* choice (assumed to be made by Player 1) increases Player 2's payoff in the first seven games, and decreases Player 2's Payoff in the remaining five games.

Table 5. Games in which Player 2's choice has no effect on his/her own payoff. The rightmost column (P(help)) presents the proportion of Player 2's choices in the alternative that maximizes Player 1's payoff.

Game	f1	s1	f2	s2	f3	s3	P(*Right*)	P(help)
Player 1 was "nice": The *In* choice increases Player 2's payoff								
112	5	−6	1	−1	6	−1	0.61	0.61
61	0	2	−1	6	2	6	0.82	0.82
113	4	−7	2	−4	7	−4	0.64	0.64
42	4	−3	−3	7	5	7	0.93	0.93
9	1	−7	−4	4	3	4	0.83	0.83
47	7	−7	−6	−6	−4	−6	0.63	0.63
							Mean	**0.77**
Player 1 was "not nice": The *In* choice decreases Player 2's payoff								
67	−6	−2	1	−4	−4	−4	0.5	0.5
22	−6	2	0	−7	8	−7	0.63	0.63
66	−7	−4	−4	−5	−6	−5	0.29	0.71
111	1	7	0	2	3	2	0.79	0.79
9	0	2	−5	1	2	1	0.83	0.83
							Mean	**0.69**

The results show only mild reciprocity: Player 2 selected the option that helps Player 1 in 77% of the times when Player 1's *In* choice helps Player 2, and in 69% of the times when the choice impairs Player 2's payoff.

4. Competition Criterion: Mean Squared Deviation (MSD)

The two competitions use the Mean Squared Deviation (MSD) criterion. Specifically, the winner of each competition will be the model that will minimize the average squared distance between its prediction and the observed choice proportion in the relevant condition: the proportion of *In* choices by Player 1 in the first competition, and the proportion of *Right* choices by Player 2 in the second competition. Participants are invited to submit their models to either one, or to both competitions.

5. Baseline Models

The results of the estimation study were posted on the competition website on January 2011. At the same time we posted several baseline models. Each model was implemented as a computer program that satisfies the requirements for submission to the competition. The baseline models were selected to achieve two main goals. The first goal is technical: The programs of the baseline models are part of the "instructions to participants". They serve as examples of feasible submissions. The second goal is to illustrate the range of MSD scores that can be obtained with different modeling approaches. Participants are encouraged to build on the best baselines while developing their models. The baseline models will not participate in the competitions. The following sections describe five baseline models and their fit scores on the 120 games that are presented in Table 6. The proposed baseline models can

predict both Player 1's choices and Player 2's choices. As noted above, submitted models can be designed to predict the behavior of Player 1, Player 2, or both.

Table 6. The baseline models, the estimated parameters, and the MSD scores by player.

Model	Fitted parameters	Player 1 MSD	Player 2 MSD
Subgame Perfect Eq. (SPE)	--	0.0529	0.0105
Inequality Aversion	$\alpha_1 \sim U[0, 0.01]$, $\beta_1 \sim U[0, 0.05]$, $\alpha_2 \sim U[0, 0.05]$, $\beta_2 \sim U[0, 0.05]$, $\delta_1 = 0.5$, $\delta_2 = 2.1$	0.0307	0.0099
ERC	$b_1 = 0.36$, $b_2 = 0$, $\delta_1' = 0.13$, $\delta_2' = 0.7$, $\delta_1 = 0.05$	0.0367	0.0100
CR	$\rho_1 = 0.05$, $\sigma_1 = 0$, $\delta_1 = 0.6$, $\rho_2 = 0.05$, $\sigma_2 = 0.05$, $\theta = 0.1$, $\delta_2 = 2.9$	0.0292	0.0041
Seven Strategies	$\alpha_R = 0.438$, $\alpha_L = 0.193$, $\alpha_W = 0.075$, $\alpha_M = 0.192$, $\alpha_J = 0.075$, $\alpha_D = 0.027$, $\beta_R = 0.506$, $\beta_N = 0.354$, $\beta_J = 0.059$, $\beta_W = 0.044$, $\beta_D = 0.037$	0.0121	0.0029

5.1. Subgame Perfect Equilibrium

According to the subgame perfect equilibrium (SPE) Player 2 chooses the alternative that maximizes his/her payoff. Player 1 anticipates this and chooses *In* if and only if his/her payoff from this option, given Player 2's choice, is higher than the payoff from choosing *Out*.

5.2. Inequality Aversion

The core assumption of the inequity aversion model [3] is that individuals suffer a utility loss from any differences between their outcomes and the outcomes of others. The utility of Player i from getting payoff x_i when Player j gets x_j is described by:

$$U_i(x_i, x_j) = x_i - \alpha_i max\{x_j - x_i, 0\} - \beta_i max\{x_i - x_j, 0\}, i \neq j \tag{1}$$

Where   determines the level of utility loss from disadvantageous inequality and   determine the utility loss from advantageous inequality. The model asserts that the utility loss from disadvantageous inequality is at least the same or higher than the loss from advantageous inequality $(\beta_i \leq \alpha_i)$, and that $0 \leq \beta_i < 1$ ruling out the existence of players who might like getting higher payoffs than others. Fehr and Schmidt [3] assume that α and β are drawn from discrete, and approximately uniform, distributions. The current version also follows this assumption.[8]

---

[8] We started by estimating a variant of the model using the original distribution values reported by Fehr and Schmidt [3] but the model's fit was only slightly better than the equilibrium prediction (SPE) for player 1 (msd = 0.1825), and worse than the SPE for player 2 (0.1401). Thus, we chose to re-estimate the distributions on the current sample.

The probability of action *k* can be determined by the following stochastic choice rule:

$$P_k = \frac{e^{\delta_i U_k}}{\sum_{j=1}^{2} e^{\delta_i U_j}} \tag{2}$$

Where   is the player's choice consistency parameter capturing the importance of the differences between the expected utilities associated with each action.

Applying the model for Player 1's behavior requires an additional assumption regarding Player 1's beliefs of Player 2's action. The current version of the model assumes that Player 1 knows the distributions of α and β in the population and maximizes his/her own utility under the belief that he/she faces an arbitrary player from that distribution.[9]

5.3. Equity Reciprocity Competition Model (ERC)

Like the inequality aversion model, ERC [13,23] assumes distributional preferences such that utility is maximized with equal splits; its utility function is based on the proportional payoff that a player received from the payoff total, so the utility of player *i* from getting payoff x_i is defined by:

$$U_i = \begin{cases} (x_i' + x_j')(\sigma - \frac{b_i}{2}(\sigma - \frac{1}{2})^2) & \text{if } \sigma < \frac{1}{2} \\ (x_i' + x_j')\sigma & \text{if } \sigma \geq \frac{1}{2} \end{cases} \tag{3}$$

where σ is the proportion of the pie the player receives, such that $\sigma = \frac{x_i'}{(x_i' + x_j')}$ and $x_i' = x_i + min(f1, f2, f3, s1, s2, s3)$.

The parameter   measures the relative importance of the deviation from equal split to player *i*. Notice that this abstraction requires linear positive transformation of the rewards to exclude negative payoffs.

Both players' decisions are defined by the stochastic choice rule described in equation (2) above, with the additional assumptions that the choice sensitivity parameter   differs between players and is updated after playing each game as follows:

$$\delta_i = \delta_i'(1 + \delta_1 g) \tag{4}$$

where δ_i' is the estimated consistency parameter for each player (it is typically assumed that Player 2's choice is more consistent, as his/her choice is less complicated than that of Player 1 who needs to take the other player's actions into account). δ_1 is a parameter that defines the influence of experience and *g* is the number of games played. When applied for Player 1, the current version of the model asserts that Player 1 correctly anticipates Player 2 responses.[10]

5.4. Charness and Rabin (CR) Model

Charness and Rabin's [14] model assumes that the second mover (Player 2) has the following utility function:

---

[9]This assumption is a bit different from the original model that assumed that player 1 knows the distribution of player 2 and maximizes his/her own utility taking the whole distribution into account.
[10]We also estimated a version of the ERC model that includes individual differences in   but this version did not improve the MSD score.

$$U_2 = (\rho r + \sigma s + \theta q)x_1 + (1 - \rho r - \sigma s - \theta q)x_2 \qquad (5)$$

Where

r = 1 if $x_2 > x_1$ and r = 0 otherwise;

s = 1 if $x_2 < x_1$ and s = 0 otherwise;

q = −1 if P1 "misbehaved" and q = 0 otherwise.

and "misbehaved" in the current setting is defined as the case where Player 1 chose *In*, although choosing *Out* would have yielded the best joint payoff and the best payoff for Player 2.

Modeling the first mover's behavior requires additional assumptions about his/her beliefs of the responder's behavior. The current estimation assumes that Player 1 correctly anticipates Player 2's responses. It further assumes that Player 1 has a similar utility function (excluding the reciprocity parameter q).[11] The choice function for each player is defined by Equation (2).

5.5. The Seven Strategies Model

The Seven Strategies model is motivated by the regression analysis presented in the results section and the related distinct strategies explanation of the class effect suggested by Table 4. The model does not use the term "utility." Rather, it assumes that the players consider the seven simple strategies described in Table 3. The probabilities of following the different strategies were estimated using a regression analysis with the restrictions that the sum of the weights equal 1 and the intercept = 0. The estimated parameters imply that the probability of *In* choice by Player 1 is given by:

$$P(In) = \alpha_R Ratio + \alpha_L Level1 + \alpha_M MxMin + \alpha_W MxWeak + \alpha_J JointMx + \alpha_D MinDif \qquad (6)$$

The parameters $\alpha_R, \alpha_L, \alpha_M, \alpha_W, \alpha_J$ and α_D are the estimated probabilities of players choosing according to the distinct strategies. The different strategies are $Ratio$: choosing rationally, $Level1$: maximizing self payoffs assuming that Player 2 chooses randomly, $MxMin$: maximizing self payoffs assuming that Player 2 chooses the worst payoff for Player 1, $MxWeak$: maximizing the payoffs of the player who has the lower payoff of the two players, $JointMx$: maximizing the sum of the two players' payoffs, and $MinDif$: choosing the option with the minimum payoffs difference. Each of those dummy variables are assigned the value 1 if the strategy implies *In* choice, 0.5 if the strategy implies random choice, and 0 if the strategy implies *Out* choice.

The probability that Player 2 will choose *Right* is given by:

$$P(Right) = \beta_R Ratio + \beta_N NiceR + \beta_J JointMx + \beta_W MxWeak + \beta_D MinDif \qquad (7)$$

The parameters $\beta_R, \beta_N, \beta_J, \beta_W,$ and β_D are the estimated proportions of players choosing according to the relevant choice rule. The choice rules variables $Ratio, JointMx, MxWeak,$ and $MinDif$ are as described above, and $NiceR$ is choosing rationally but maximizing the other player's payoff if rational choice implies indifference. The results (c.f. Table 6) show that the Seven Strategies model fits both Player 1's choices and Player 2's choices better than the other models presented above.

---

[11] We also estimated a version that includes individual difference in   but this version did not improve the MSD score.

6. The Equivalent Number of Observations (ENO)

In order to evaluate the risk of over fitting the data, we chose to estimate the ENO of the models by using half of the 120 games (the games played by the first cohort) to estimate the parameters, and the other 60 games to compute the ENO. Table 7 shows the results of this estimation.

Table 7. The ENO of the baseline models. The parameters of the models were estimated based on the first set of 60 games, and the ENO scores were calculated based on the second set.[12]

Model	Parameters	Set	MSD player1	MSD player2	ENO player1	ENO player2
Subgame Perfect Eq. (SPE)	--	1	0.0535	0.0138	0.87	6.16
		2	0.0524	0.0073	0.88	10.38
Inequality aversion	$\alpha_1 \sim U[0, 0.01], \beta_1 \sim U[0, 0.05],$ $\alpha_2 \sim U[0, 0.05], \beta_2 \sim U[0, 0.05],$ $\delta_1 = 0.5, \delta_2 = 2.1$	1	0.0339	0.0120	4.39	10.70
		2	0.0267	0.0070		
ERC	$b_1 = 0.40, b_2 = 0, \delta_1' = 0.13,$ $\delta_2' = 0.63, \delta_1 = 0.05$	1	0.0402	0.0133	3.38	11.39
		2	0.0333	0.0068		
CR	$\rho_1 = 0, \sigma_1 = 0, \theta = 0.1,$ $\delta_1 = 0.6, \rho_2 = 0.05,$ $\sigma_2 = 0.05, \delta_2 = 2.9$	1	0.0348	0.0044	5.02	28.56
		2	0.0236	0.0038		
Seven Strategies	$\alpha_R = 0.446, \alpha_L = 0.208,$ $\alpha_W = 0.111 \; \alpha_M = 0.213,$ $\alpha_J = 0.005, \alpha_D = 0.027$ $\beta_R = 0.506, \beta_N = 0.354,$ $\beta_J = 0.059, \beta_W = 0.044,$ $\beta_D = 0.037$	1	0.0100	0.0030	9.08	66.84
		2	0.0142	0.0027		

7. Summary

The two choice prediction competitions, presented above, are designed to improve our understanding of the relative I mportance of the distinct psychological factors that affect behavior in extensive form games. The results of the estimation study suggest that the rational model (subgame perfect equilibrium) provides relatively useful predictions of the behavior of Player 2 (ENO = 7.5), and less useful predictions of the behavior of Player 1 (ENO < 1). This observation is in line with those of Engelmann and Strobel [24] who also noticed the significance of efficiency concerns in simple extensive form games. In addition, the results reveal deviations from rational choice that can be attributed to six known behavioral tendencies. These tendencies include: (1) an attempt to be nice (*i.e.*, improve the other player's payoff) when this behavior is costless; (2) Maxmin: an attempt to maximize the worst possible payoff; (3) Level-1 reasoning: selection of the best option under the assumption that the second agent behaves randomly; (4) Joint max: trying to maximize joint payoff; (5) Helping the weaker player; and (6) an attempt to minimize payoff differences.

---

[12] An exception is the subgame perfect equilibrium predictions. Since this model is free of parameters, ENOs were computed for each of the two sets.

The results show only weak evidence for negative reciprocity (e.g., punishing unfair actions). Comparison of the current results to previous studies of negative reciprocity suggests that the likelihood of this behavior is sensitive to the context. Strong evidence for negative reciprocity was observed in studies in which the identity of the disadvantaged players remained constant during the experiment. Negative recency appears to be a less important factor when the identity of the disadvantaged players changes between games.

We tried to fit the results with two types of behavioral models: Models that abstract the behavioral tendency in the agent's social utility function, and models that assume reliance on several simple strategies. Comparison of the different models leads to the surprising observation that the popular social utility models might be outperformed by a seven-strategy model. We hope that the competition will clarify this observation.

Acknowledgements

References

1. Andreoni, J. Impure altruism and donations to public goods: A theory of warm-glow giving. *Econ. J.* **1990**, *100*, 464-477.
2. Bolton, G.E. A comparative model of bargaining: Theory and evidence. *Am. Econ. Rev.* **1991**, *81*, 1096-1136.
3. Fehr, E.; Schmidt, K.M. A theory of fairness, competition, and cooperation. *Quart. J. Econ.* **1999**, *114*, 817-868.
4. Loewenstein, G.F.; Thompson, L.; Bazerman, M.H. Social utility and decision making in interpersonal contexts. *J. Person. Soc. psychol.* **1989**, *57*, 426-441.
5. Falk, A.; Fischbacher, U. A theory of reciprocity. *Games Econ. Behav.* **2006**, *54*, 293-315.
6. Rabin, M. Incorporating fairness into game theory and economics. *Am. Econ. Rev.* **1993**, *83*, 1281-1302.
7. Messick, D.M.; McClintock, C.G. Motivational bases of choice in experimental games. *J. Exper. Soc. Psychol.* **1968**, *4*, 1-25.
8. Stahl, D.O.; Wilson, P.W. On players' models of other players: Theory and experimental evidence. *Games Econ. Behav.* **1995**, *10*, 218-254.
9. Güth, W.; Schmittberger, R.; Schwarze, B. An experimental analysis of ultimatum bargaining. *J. Econ. Behav. Organ.* **1982**, *3*, 367-388.
10. Forsythe, R.; Horowitz, J.L.; Savin, N.E.; Sefton, M. Fairness in simple bargaining experiments. *Games Econ. Behav.* **1994**, *6*, 347-369.
11. Berg, J.; Dickhaut, J.; McCabe, K. A comparative model of bargaining: Theory and evidence. *Games Econ. Behav.* **1995**, *10*, 122-142.
12. Fehr, E.; Kirchler, E.; Weichbold, A.; Gächter, S. When social norms overpower competition: Gift exchange in experimental labor markets. *J. Lab. Econ.* **1998**, *16*, 324-351.

13. Bolton, G.E.; Ockenfels, A.ERC: A theory of equity, reciprocity, and competition. *Am. Econ. Rev.* **2000**, *90*, 166-193.

14. Charness, G.; Rabin, M. Understanding social preferences with simple tests. *Quart. J. Econ.* **2002**, *117*, 817-869.

15. Erev, I.; Ert, E.; Roth, A.E.; Haruvy, E.; Herzog, S.M.; Hau, R.; Hertwig, R.; Stewart, T.; West, R.; Lebiere, C. A choice prediction competition: Choices from experience and from description. *J. Behav. Dec. Making* **2010**, *23*, 15-47.

16. Erev, I.; Ert, E.; Roth, A.E. A choice prediction competition for market entry games: An introduction. *Games* **2010**, *1*, 117-136.

17. Fischbacher, U. Z-Tree: Zurich toolbox for ready-made economic experiments. *Exp. Econ.* **2007**, *10*, 171-178.

18. Brandts, J.; Charness, G. Hot *vs.* cold: Sequential responses and preference stability in experimental games. *Exper. Econ.* **2000**, *2*, 227-238.

19. Brandts, J.; Charness, G. The strategy *versus* direct response method: A first survey of experimental comparisons. *Exp. Econ.* **2011**, doi:10.1007/s10683-011-9272-x.

20. Erev, I.; Roth, A.E.; Slonim, R.; Barron, G. Learning and equilibrium as useful approximations: Accuracy of prediction on randomly selected constant sum games. *Econ. Theory* **2007**, *33*, 29-51.

21. Falk, A.; Fehr, E.; Fischbacher, U. On the nature of fair behavior. *Econ. Inq.* **2003**, *41*, 20-26.

22. Güth, W.; Huck, S.; Müller, W. The relevance of equal splits in ultimatum games. *Games Econ. Behav.* **2001**, *37*, 161-169.

23. De Bruyn, A.; Bolton, G.E. Estimating the influence of fairness on bargaining behavior. *Manag. Sci.* **2008**, *54*, 1774-1791.

24. Engelmann, D.; Strobel, M. Inequality aversion, efficiency, and maximin preferences in simple distribution games. *Am. Econ. Rev.* **2004**, *94*, 857-869.

Appendix 1

Problem Selection Algorithm:

The algorithm generates 60 games in a way that ensures that each of the 10 "game types" from Figure 2 (excluding "trivial games") is represented at least once in the sample. In addition, it ensures selection of one "ultimatum-like game" (determined as a sub-class of "costly punishment" class in which $f1 = s1$), and one "dictator-like game" (a sub-class of the "strategic dummy" class in which Player 1's payoffs are higher than Player 2's payoffs). The rest of the 48 games in the sample are drawn randomly from the nontrivial games.

Notations:

$f1, f2, f3, s1, s2, s3$: The parameters of the game as defined in Figure 1
The basic set: $\{-8, -7, -6, -5, -4, -3, -2, -1, 0, +1, +2, +3, +4, +5, +6, +7, +8\}$
$fmax = \max(f1, f2, f3)$
$smax = \max(s1, s2, s3)$
$fbest = 1$ if $f1 = fmax$; 2 if $f2 = fmax > f1$; 3 if $f3 = fmax > f1$ and $f3 > f2$
$sbest = \max(s1, s2, s3)$

sbest = 1 if s1 = smax; 2 if s2 = smax > s1; 3 if s3 = smax > s1 and s3 > s2

f(x) the payoff for Player 1 in outcome x (x = 1, 2, or 3)

s(x) the payoff for Player 2 in outcome x (x = 1, 2, or 3)

Trivial game: A game in which (f1 = fmax and s1 = smax) or (f1 = f2 = f3) or (s1 = s2 = s3)

Select games:

Draw the six payoffs repeatedly from the basic set until:

For Game 1 (c.i: "common interest"): there is x such that f(x) = fmax and s(x) = s(max)

For Game 2 (s.d: "strategic dummy"): s2 = s3 and f2 = f3

For Game 3("dictator"): s2 = s3 and f2 = f3 and f2 > s2 [13]

For Game 4 (s.s: "safe shot"): f1 ≤ min(f2, f3)

For Game 5 (n.d: "near dictator"): f1 = fbest

For Game 6 (c.p: "costly punishment"): sbest = 1 and (f2 < f1 < f3 or f3 < f1 < f2) and s(fbest) = max(s2, s3), and s2 ≠ s3

For Game 7 ("ultimatum"): f1 = s1 and sbest = 1 and (f2 < f1 < f3 or f3 < f1 < f2), and s(fbest) = max(s2,s3), and s2 ≠ s3

For Game 8 (f.p: "free punishment"): sbest = 1 and (f2 < f1 < f3 or f3 < f1 < f2) and s(fbest) = max(s2,s3), and s2 = s3

For Game 9 (r.p: "rational punishment"): sbest = 1 and (f2 < f1 < f3 or f3 < f1 < f2) and s(fbest) < max(s2,s3)

For Game 10 (f.h: "free help"): sbest > 1 and f1 > min(f2,f3) and f(sbest) = f1

For Game 11 (c.h. "costly help"): s1 < min(s2,s3) and f(sbest) = min(f1,f2,f3) and fbest > 1

For Game 12 (tr: "trust"): s1 < min(s2, s3) and min(f2,f3) < f1 < max(f2,f3) and f(sbest) = min(f1,f2,f3) and s(fbest) < max(s2,s3)

For Game = 13 to 60: randomly select (with equal probability, with replacement) six payoffs from the "basic set," if the game turns out to be "trivial" erase it and search again.

Appendix 2

Instructions:

In this experiment you will make decisions in several different situations ("games"). Each decision (and outcome) is independent of each of your other decisions, so that your decisions and outcomes in one game will not affect your outcomes in any other game.

In every case, you will be anonymously paired with one other participant, so that your decision may affect the payoffs of others, just as the decisions of the other people may affect your payoffs. For every decision task, you will be paired with a new person.

---

[13] Note: Dictator-like game is defined by this algorithm as a private case of strategic dummy in which the first mover's payoffs are higher than the second mover.

The graph below shows an example of a game. There are "roles" in each game: "Player 1" and "Player 2". Player 1 chooses between L and R. If he/she chooses L the game ends, and Player 1's payoff will be $x dollars, and Player 2's will be $y.

If Player 1 chooses R, then the payoffs are determined by Player 2's choice.

Specifically, if Player 2 selects A then Player 1 receives $z and Player 2 receives $k. Otherwise, if Player 2 selects B then Player 1 gets $i and Player 2 gets $j.
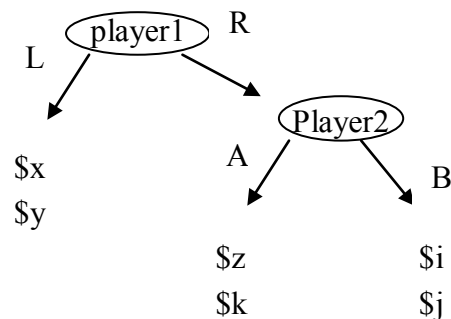
When you make your choice you will not know the choice of the other player. After you make your choice you will presented with the next game without seeing the actual outcomes of the game you just played. The different games will involve the same structure but different payoffs. Before the start of each new game you will receive information about the payoffs in the game.

Your final payoff will be composed of a starting fee of $20 plus/minus your payoff in one randomly selected game (each game is equally likely to be selected). Recall that this payoff is determined by your choice and the choice of the person you were matched with in the selected game.

Good Luck!