


# Inequality Aversion, Efficiency, and Maximin Preferences in Simple Distribution Experiments

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*We present simple one-shot distribution experiments comparing the relative importance of efficiency concerns, maximin preferences, and inequality aversion, as well as the relative performance of the fairness theories by Gary E Bolton and Axel Ockenfels and by Ernst Fehr and Klaus M. Schmidt. While the Fehr-Schmidt theory performs better in a direct comparison, this appears to be due to being in line with maximin preferences. More importantly, we find that a combination of efficiency concerns, maximin preferences, and selfishness can rationalize most of the data while the Bolton-Ockenfels and Fehr-Schmidt theories are unable to explain important patterns. (JEL D63, D64, C99)*

Among the recent attempts to explain behavior observed in economic experiments, models based on inequality aversion have received special attention. The attractiveness of these models is based on their ability to rationalize a number of well-known anomalies with just two motives, selfishness and inequality aversion. The latter is understood as disutility arising from differences between one's own payoff and others' payoffs.

The aim of this paper is on the one hand to

compare the relative importance of inequality aversion, concerns for efficiency, and maximin preferences<sup>1</sup> in simple distribution experiments. On the other hand, we compare the performance of the two theories based on inequality aversion by Fehr and Schmidt (1999, henceforth F&S) and Bolton and Ockenfels (2000, henceforth ERC).

Our first treatments that were designed to compare ERC and F&S recognized the potential importance of efficiency and thus controlled for it. It turned out that efficiency had a major impact (see treatments F and E in Section III). This finding inspired further experiments to test its robustness and to investigate to what extent inequality aversion is dominated by efficiency concerns or maximin preferences. In particular, these treatments allow us to compare the explanatory power of ERC and F&S to the model by Gary Charness and Matthew Rabin (2002, henceforth C&R), that is based on efficiency concerns and maximin preferences and was inspired by similar experiments.

Our results suggest that efficiency concerns and maximin preferences are important in simple distribution experiments. While this does not necessarily imply that they are equally important in other classes of games, common interpretations of several games may well be

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<sup>1</sup> Efficiency is here simply understood as the sum of payoffs, not in the sense of Pareto efficiency. Maximin preferences are a desire to maximize the minimal payoff in the group.

confounded with these motives. This may have been given too little attention in the past (see Engelmann and Strobel, 2002, for a discussion). To illustrate, consider the following example. First, let person 2 choose only between allocations A and B among persons 1, 2, and 3.

Allocation	A	B	C
Person 1	9	8	11
Person 2	8	8	10
Person 3	4	8	9
Total	21	24	30

If person 2 is inequality averse she prefers B over A, but B is also her preferred choice if she is driven by efficiency concerns or maximin preferences. Thus deriving any conclusions from a choice of B concerning the importance of inequality aversion is confounded by efficiency concerns and maximin preferences. One cannot tell whether person 2 wants to redistribute money because she dislikes inequality, cares for efficiency, or cares particularly for the poorest. Now consider the case that person 2 can choose from A, B, and C. A choice of B now clearly indicates inequality aversion, since selfishness, efficiency concerns, and maximin preferences all suggest a choice of C.

In our experiments, we disentangle efficiency concerns, maximin preferences, and inequality aversion to compare their relative importance. In order to exclude, as far as possible, motives like reciprocity, we chose degenerate games like the one above that were completely reduced to the question of distribution. Since both ERC and F&S are formulated on the basis of distributions only, these games seem to us the most neutral playground to compare their predictive accuracy.

In contrast to previous experiments, in several of our treatments ERC and F&S predict choices of allocations that are at the opposite ends of the choice set. Here, F&S does better in general. This, however, appears to result from F&S being in line with maximin preferences in this situation. For a complete explanation of our results, efficiency and maximin preferences are indispensable.<sup>2</sup>

<sup>2</sup> Other fairness theories could be applied to our setting as well. Our experiments, however, are not suited to test

In Section I we outline the difference between ERC and F&S that we focus on. Section II presents our experimental procedures, and Section III the experimental results. Section IV concludes.

## I. Inequality Measures in ERC and F&S

The difference between the inequality measures in ERC and F&S is represented in the motivation or utility function. The motivation function of ERC is given by  $v_i(y_i, \sigma_i)$ , with  $y_i$  denoting subject  $i$ 's own payoff and  $\sigma_i$  subject  $i$ 's share of the total payoff, and  $v_i$  for given  $y_i$  being maximal if  $\sigma_i = (1/n)$ ,  $n$  being the number of players. F&S assumes a utility function  $U_i(x) = x_i - \alpha_i[1/(n-1)] \sum_{j \neq i} \max\{x_j - x_i, 0\} - \beta_i[1/(n-1)] \sum_{j \neq i} \max\{x_i - x_j, 0\}$  with  $\alpha_i \geq \beta_i \geq 0$ ,  $\beta_i < 1$  and  $x_i$  the payoff of subject  $i$ .

Hence ERC assumes that subjects like the average payoff to be as close as possible to their own payoff while F&S assumes that subjects dislike a payoff difference to any other individual. According to ERC, a subject would thus be equally happy if all subjects received the same payoff or if some were rich and some were poor as long as she received the average payoff, but according to F&S she would clearly prefer that all subjects get the same. In a real-life situation F&S predicts that the middle class would tax the upper class to subsidize the poor, whereas ERC does not.

## II. Experimental Procedures

We conducted 13 experimental treatments in three sessions. These sessions were all conducted as classroom experiments at the end of a lecture during the first weeks of introductory economics courses at Humboldt-Universität zu Berlin. One hundred thirty-six participants took part in the first session in 1998, 240 in the

theories that explicitly take intentions into account (e.g., Rabin, 1993; Armin Falk and Urs Fischbacher, 2000; Martin Dufwenberg and Georg Kirchsteiger, 2004) since this would require assumptions about beliefs concerning the choices of subjects with whom one might be matched. The same holds for the full C&R model but we can shed some light on the basic model, relying on selfishness plus quasi-maximin preferences (maximizing a weighted sum of total and minimal payoff).

second session in 2000, and 210 in the third session in 2001. We had determined a number of seats corresponding to the desired number of participants in advance. We asked students to either take one of these seats or leave the classroom. Each participant then received a decision sheet with the instructions and a questionnaire. We used the questionnaires to gather some biographical data and to check whether the participants understood the task completely. The total procedure took about 20 minutes. Participants were paid after the lecture in the following week. They were identified by a code that was noted both on the decision sheet and on a detachable identification sheet. They received the payment in a sealed envelope in exchange for this sheet. These procedures implied anonymity with respect to the other participants.

The decision sheet contained three different allocations of money between three persons, of which the subjects had to choose one. They were informed that we would randomly form groups of three later on and would also assign the three roles randomly, hence subjects faced role uncertainty. Only the choice of the participant selected as person 2 mattered.<sup>3</sup> Two control treatments assigned fixed roles in advance, but kept the random *ex post* formation of groups. To avoid influence by computation errors we also noted the average payoffs of persons 1 and 3 and the total payoff for each allocation in the decision sheet. The precise allocations and the resulting predictions of the different theories will be presented along with the results for the individual treatments.<sup>4</sup>

### III. Experimental Results

#### A. Taxation Games

*Details and Predictions:* All of the treatments in this section involve a “middle income” individual (person 2) choosing payoffs for a “high income” individual (person 1) and a “low income” individual (person 3). One can think of the choices as tax systems corresponding to

different degrees of redistribution. All choices provide the “middle income” individual with the same payoff. This is to remove any effects of selfishness, so we can focus on motives related to fairness. For all treatments in this section, the F&S prediction coincides with the maximin allocation. This reflects the structure of this class of taxation problems and is not an artifact of our design. The crucial property of these treatments is that the allocation that minimizes the difference between the payoffs of person 2 and each of the other persons, maximizes the difference between the payoff of person 2 and the average payoff and vice versa. Thus ERC and F&S predict choices of opposite allocations.

In one treatment (F), we choose payoffs so that efficiency coincides with the F&S prediction and the maximin allocation; in another (E), we choose payoffs so that efficiency coincides with the ERC prediction. This allows us to investigate the extent to which efficiency counterbalances the various types of fairness concerns (F&S, ERC, and maximin) and it ensures that efficiency concerns do not bias the results in favor of either ERC or F&S.<sup>5</sup> We also consider a variation of treatment F, called Fx, and a variation of treatment E, called Ex, in which the outcome predicted by ERC involves exactly the “fair share,” i.e.,  $\frac{1}{3}$ , for the “middle income” individual. The purpose of these treatments is to make the ERC motive more salient.

The allocations for treatments F, E, Fx, and Ex are presented in Table 1 (all payoffs are given in DM, 1 DM corresponded to \$0.45 to \$0.55 by the time of the various sessions) along with the average payoff of persons 1 and 3, the relative payoff of person 2, and the total payoff. We also marked which allocations are predicted by ERC, F&S, efficiency concerns, and maximin preferences, as well as the actual choices.

Each of the treatments E and F was divided into two subtreatments that only differed by the order in which the allocations were presented on

<sup>3</sup> In other words, we used (a reduced form of) the strategy method. Apart from generating three times the data, it secured that all participants were considered equally entitled to the money since all performed the same task.

<sup>4</sup> Sample instructions can be found in Engelmann and Strobel (2002).

<sup>5</sup> The preferable way to prevent results from being confounded with efficiency would have been that all allocations yielded the same total payoff. If the decision maker's own payoff is fixed, however, ERC implies indifference between all allocations if the average and thus the total payoff of the other subjects is the same.

TABLE 1—ALLOCATIONS (IN DM), PREDICTIONS BY ERC AND F&amp;S, MAXIMIN AND EFFICIENT ALLOCATIONS, AND DECISIONS FOR THE TAXATION GAMES

Allocation	Treatment											
	F			E			Fx			Ex		
	A	B	C	A	B	C	A	B	C	A	B	C
Person 1	8.2	8.8	9.4	9.4	8.4	7.4	17	18	19	21	17	13
Person 2	5.6	5.6	5.6	6.4	6.4	6.4	10	10	10	12	12	12
Person 3	4.6	3.6	2.6	2.6	3.2	3.8	9	5	1	3	4	5
Total	18.4	18	17.6	18.4	18	17.6	36	33	30	36	33	30
Average 1, 3	6.4	6.2	6	6	5.8	5.6	13	11.5	10	12	10.5	9
Relative 2	0.304	0.311	0.318	0.348	0.356	0.364	0.278	0.303	0.333	0.333	0.364	0.4
Prediction												
Efficiency	A			A			A			A		
ERC			C	A					C	A		
F&S	A					C	A					C
Maximin	A					C	A					C
Choices												
Count	57	7	4	27	16	25	26	2	2	12	5	13
Percentage	83.8	10.3	5.9	39.7	23.5	36.7	86.7	6.7	6.7	40	16.7	43.3
Subtreatments												
F1 and E1	29	3	2	14	8	12						
F2 and E2	28	4	2	13	8	13						

the decision sheet.<sup>6</sup> All other treatments were divided into six subtreatments, one for each permutation of the allocations.

**RESULTS:** The results for treatments E and F (including the subtreatments in the last two rows) as well as for Fx and Ex are presented in Table 1. In both treatments F and E there is virtually no difference between the two subtreatments ( $\chi^2 = 0.08$ ,  $p > 0.96$  for treatment E, and  $\chi^2 = 0.16$ ,  $p > 0.92$  for treatment F).<sup>7</sup> This consistency suggests that our data are not completely random.

The results for treatment F are very clear: 83.8 percent of subjects chose the allocation predicted by F&S, efficiency concerns, and

maximin preferences. The three allocations were not chosen with equal probability ( $p_{ABC} < 0.001$ ), in particular the F&S allocation was chosen significantly more often than the ERC allocation ( $p_{AC} < 0.001$ ).<sup>8</sup> For treatment E the results are more dispersed. Slightly more subjects chose the allocation predicted by ERC and efficiency than that predicted by F&S and maximin preferences, while 23.5 percent chose the intermediate allocation.<sup>9</sup> The hypotheses that all three or the two extreme allocations were chosen with equal probability cannot be rejected ( $p_{ABC} > 0.2$ ,  $p_{AC} > 0.8$ ). Since the two treatments balance the influence of efficiency concerns, we also study the pooled data. There, 60.2 percent of subjects chose the allocation

<sup>6</sup> This was done to avoid the conceivable influence of a preference for the center or right allocation. The allocation with intermediate payoffs was always presented on the left, since it was the one we were least interested in.

<sup>7</sup> Hence we can conclude that the results are not driven by a preference for either the middle or the right column and we pool the data from the respective subtreatments. For the other treatments we do not report results for the subtreatments, since the number of subjects in each of the subtreatments was only five.

<sup>8</sup> In the following,  $p_{ABC}$  will always denote the level of significance for a multinomial test of the hypothesis that all allocations are chosen with the same probability, whereas  $p_{XY}$  will denote the level of significance for a (two-sided) binomial test of the hypothesis that allocations X and Y are chosen with the same probability taking the number of choices for the third allocation as given.

<sup>9</sup> The explanation that some of these subjects provided in the questionnaires indicates that they were looking for a compromise between efficiency and fairness.

predicted by F&S, whereas 22.8 percent decided in line with ERC ( $p < 0.001$ , binomial test).

Of the 136 choices in both treatments, 61.8 percent are in line with the maximization of total payoffs while 21.3 percent minimize it ( $p < 0.001$ , binomial test). Furthermore, the distribution of decisions clearly differs between treatments E and F ( $\chi^2 = 33.07$ ,  $p < 0.001$ ). Since the crucial difference between E and F is the role of efficiency, we see this as substantial evidence that efficiency matters.

The results for treatments Fx and Ex almost exactly match those for F and E. (Fx:  $p_{ABC} < 0.001$ ,  $p_{AC} < 0.001$ ; Ex:  $p_{ABC} > 0.133$ ,  $p_{AC} = 1$ ; both treatments pooled, ERC vs. F&S allocation:  $p < 0.001$ , efficiency maximization vs. minimization:  $p < 0.003$ ; Ex vs. Fx:  $\chi^2 = 12.76$ ,  $p < 0.002$ .)

In treatments Fx and Ex the ERC prediction is much more salient than in F and E. Since the results changed only marginally (distributions are far from significantly different:  $\chi^2 = 0.69$ ,  $p > 0.7$  for Ex vs. E and  $\chi^2 = 0.34$ ,  $p > 0.84$  for Fx vs. F) and not in favor of ERC, we conclude that the poor performance of ERC in our original treatments cannot be attributed to nonsalient differences in relative payoffs. Arguably, these are still not huge, but if nonsalience was the issue, then the performance of ERC should improve at least somewhat compared to E and F.

Explaining their decisions in treatments E and F, 17 of the 18 subjects who explicitly referred to fairness chose according to F&S and one chose the intermediate allocation. Efficiency concerns were stated by 12 subjects as the reason for their decision. Only one subject referred to relative payoffs in the explanation, but contrary to ERC, this subject stated that he wanted to maximize his own share. In treatments Ex and Fx all 15 subjects who explicitly referred to fairness chose the F&S allocation. Efficiency concerns were mentioned by 16 subjects, and 6 indicated maximin preferences. Thus among the subjects who explicitly mentioned fairness as a motivation, F&S did much better than ERC and a substantial part of subjects explicitly stated efficiency concerns.

Hence, we conclude for the taxation games that F&S outperforms ERC and that efficiency clearly influences choices. Since the F&S prediction is always the maximin allocation, a sub-

stantial part of the data are consistent with maximin preferences. Furthermore, since most of the choices which are not in line with maximin preferences are efficient (the ERC allocation in treatments E and Ex), quasi-maximin preferences (as in C&R) are consistent with about 85 percent of the data, if one allows for heterogeneity of subjects.

## B. Envy Games

*Details and Predictions:* Treatments F and E demonstrated a major influence of efficiency. This inspired us to subject both theories of inequality aversion to a more severe test, in which they predict decisions that are Pareto-dominated. This situation is represented by treatment N, where the payoff to person 2 is again intermediate and kept constant. In this treatment F&S predicts a choice of C, which is Pareto-dominated by the ERC prediction B, which is in turn Pareto-dominated by allocation A (see Table 2 which is structured in the same way as Table 1). We call these games envy games, because envy could lead the middle class to take money from the poor, only to be able to take more from the rich.<sup>10</sup>

We also used this treatment as a baseline to test the robustness of our results with regard to the monetary incentives for person 2. To test whether subjects were willing to give up own payoff for their desire to increase efficiency or to reduce inequality, we let the payoff of person 2 vary across allocations in the treatments Nx, Ny, and Nyi (see Table 2). Since both F&S and ERC also take selfishness into account, their predictions depend on the weight assigned to selfishness relative to inequality aversion (see Table 2). The purpose of these treatments is to test whether our results in the other treatments might be artifacts of the irrelevance of the choice for the decision maker's own payoff, not to measure precisely the value subjects attach to either efficiency or equality.

**RESULTS:** In treatment N, 70 percent chose the Pareto-efficient allocation (which is consistent with quasi-maximin preferences) and ERC

<sup>10</sup> We do not claim that the motivation that leads subjects to behave in that way is in fact envy, which corresponds to the  $\alpha$ -component of F&S. It only seems a likely influence in this class of games. Hence our choice of name.

TABLE 2—ALLOCATIONS (IN DM), PREDICTIONS BY ERC AND F&amp;S, MAXIMIN AND EFFICIENT ALLOCATIONS, AND DECISIONS FOR THE ENVY GAMES

Allocation	Treatment											
	N			Nx			Ny			Nyi		
	A	B	C	A	B	C	A	B	C	A	B	C
Person 1	16	13	10	16	13	10	16	13	10	16	13	10
Person 2	8	8	8	9	8	7	7	8	9	7.5	8	8.5
Person 3	5	3	1	5	3	1	5	3	1	5	3	1
Total	29	24	19	30	24	18	28	24	20	28.5	24	19.5
Average 1, 3	10.5	8	5.5	10.5	8	5.5	10.5	8	5.5	10.5	8	5.5
Relative 2	0.276	0.333	0.421	0.3	0.333	0.389	0.25	0.333	0.45	0.263	0.333	0.436
Prediction												
Efficiency	A			A			A			A		
ERC	B			A or B			B or C			B or C		
F&S	C			A or C			C			C		
Maximin	A			A			A			A		
Choices												
Count	21	8	1	25	4	1	23	4	3	18	5	7
Percentage	70	26.7	3.3	83.3	13.3	3.3	76.7	13.3	10	60	16.7	23.3

clearly outperforms F&S, but with the aid of Pareto-dominance ( $p_{ABC} < 0.001$ ,  $p_{AB} < 0.025$ ,  $p_{BC} < 0.04$ ).

In treatment Nx we added 1 DM for person 2 in allocation A and subtracted 1 DM in C. As expected, this increased the number of choices of A and decreased that of B ( $p_{ABC} < 0.001$ ,  $p_{BC} > 0.3$ ). In treatment Ny (Nyi), we subtracted 1 DM (0.5 DM) in allocation A and added 1 DM (0.5 DM) in C. As expected, this increased the number of choices of C somewhat. However, again the majority chose A, whereas the choices of B are reduced (Ny:  $p_{ABC} < 0.001$ ,  $p_{AB} < 0.001$ ,  $p_{AC} < 0.001$ ; Nyi:  $p_{ABC} < 0.011$ ,  $p_{AB} < 0.011$ ,  $p_{AC} < 0.044$ ). Thus the results in these treatments are qualitatively well in line with the constant-own-payoff treatment N with deviations as expected by standard economic theory.<sup>11</sup> This result suggests that our results in the other treatments are not plain artifacts of the constancy of the decision maker's payoff. There is an (expected) effect of small variations in the decision maker's own

payoff, but it is minor.<sup>12</sup> Hence the relative importance of the different motives does not seem to change fundamentally if selfishness becomes an issue.

Note that Ny and Nyi are the only treatments where F&S makes a unique prediction (C) for all subjects, including those which are not inequality averse, since the decision maker's own payoff is maximal and inequality minimal. But this prediction only covers one-sixth of decisions in both treatments.

We conclude for the envy games that F&S performs poorly in the face of Pareto-dominance and that ERC does somewhat better but not well, whereas the basic C&R model does very well.<sup>13</sup>

<sup>12</sup> Note that in Ny 76.7 percent of subjects give up 22 percent of their own payoff, apparently to satisfy quasi-maximin preferences. While this share corresponds to only a relatively small absolute payoff, it is often considered strong evidence against selfishness if subjects are willing to give up 20 or 25 percent of their payoff to achieve, e.g., equality.

<sup>13</sup> The envy games also provide an example that the predictive power of F&S can in some cases substantially be improved by abstracting from the linear form. If the disutility is assumed to be, e.g., quadratic in inequality, F&S could also explain choices of B. In addition, if the restriction  $\beta \leq \alpha$  is relaxed, then F&S can be consistent with choices of A. Hence the results can be seen as evidence against some forms of inequality aversion but not as evidence against all possible forms of inequality aversion.

<sup>11</sup> The effect should be larger in treatment Ny than in Nyi and the number of choices for A should not increase in Ny. These deviations, however, can be attributed to randomness in the data, that naturally follows from the random allocation of the subjects to the treatments. No pair of distributions is significantly different at 5 percent,  $\chi^2$ -test.

TABLE 3—ALLOCATIONS (IN DM), PREDICTIONS BY ERC AND F&amp;S, MAXIMIN AND EFFICIENT ALLOCATIONS, AND DECISIONS FOR THE RICH AND POOR GAMES, AS WELL AS FOR TREATMENT EY

Allocation	Treatment								
	R			P			Ey		
	A	B	C	A	B	C	A	B	C
Person 1	11	8	5	14	11	8	21	17	13
Person 2	12	12	12	4	4	4	9	9	9
Person 3	2	3	4	5	6	7	3	4	5
Total	25	23	21	23	21	19	33	30	27
Average 1, 3	6.5	5.5	4.5	9.5	8.5	7.5	12	10.5	9
Relative 2	0.48	0.522	0.571	0.174	0.19	0.211	0.273	0.3	0.333
Prediction									
Efficiency	A			A			A		
ERC	A						C		
F&S	A						C		
Maximin	C			A or B or C			C		
Choices									
Count	8	6	16	18	2	10	12	7	11
Percentage	26.7	20	53.3	60	6.7	33.3	40	23.3	36.7

The envy games emphasize the importance of efficiency and maximin preferences if they combine to Pareto-dominance. Even then, however, they do not capture all choices and thus there is a potential role for other motives like inequality aversion.<sup>14</sup>

In the questionnaires, references to (Pareto) efficiency are more prominent in treatment Nx (21 subjects) than in N (11) or Ny and Nyi (15 in total). In all envy games together fewer subjects mention fairness (7) than maximin preferences (11) and selfishness (13). One subject states preferences in line with ERC.

### C. Rich and Poor Games

*Details and Predictions:* In the preceding eight treatments person 2 always obtained an inter-

mediate payoff. Our treatments R and P study situations where the decision maker receives either the highest payoff (i.e., is “rich,” treatment R) or the lowest payoff (i.e., is “poor,” treatment P), which is again constant (see Table 3). Since F&S aggregates over all persons richer or poorer than oneself, it predicts the same as ERC in these situations. So these treatments do not allow us to distinguish between F&S and ERC. They allow us, however, to contrast efficiency, maximin preferences, and inequality aversion. In treatment R person 2 can choose for the other subjects payoffs that are relatively equal (C) or that are maximal in sum (A). Both F&S and ERC predict a choice of the efficient allocation A, whereas maximin preferences predict C. In contrast, in treatment P inequality aversion predicts a choice of the least efficient allocation C. The minimal payoff is constant, so maximin preferences cannot influence the results. Hence this treatment allows us to contrast efficiency and inequality aversion in a frame neutral to maximin preferences.

At this point we also study our last treatment Ey. It is identical to Ex except that the allocator’s payoff is 9 instead of 12. Ey has the basic structure of the taxation games, but it does not share the crucial property of the taxation games that allowed a comparison of F&S and ERC.

<sup>14</sup> Our results in treatment N do not necessarily imply that 30 percent of subjects are inequality averse rather than motivated by efficiency or maximin. The pattern of observed proportions declining with the efficiency and maximin rank of the allocations well fits a random utility version of quasi-maximin preferences. Error rates nearly this high have been estimated from retest reliabilities in two-alternative lottery choice tasks (see, e.g., T. Parker Ballinger and Nathaniel T. Wilcox, 1997) and in our treatments the error rates might be higher since they involve the choice among three alternatives.

The ERC prediction is shifted from A to C. Not only ERC and F&S, but also maximin and hence all fairness motives under consideration predict the choice of the least efficient allocation. Therefore, this treatment serves the same purpose as the poor game, namely the comparison of efficiency concerns and fairness motives.

**RESULTS:** In treatment R where both ERC and F&S predict the efficient allocation A, only 26.7 percent of the choices were in accordance, whereas 53.3 percent of the subjects chose C ( $p_{ABC} < 0.08$ ,  $p_{AC} > 0.15$ ). In contrast, in treatment P, where both ERC and F&S predict allocation C, 60 percent chose the efficient allocation A ( $p_{ABC} < 0.001$ ,  $p_{AC} > 0.18$ ), i.e., far more subjects chose the efficient allocation when it is not minimizing inequality compared to the case when it does ( $p < 0.08$ ). The distribution of choices differs significantly between R and P ( $\chi^2_2 = 7.23$ ,  $p < 0.03$ ).

The comparison indicates that maximin preferences are important. In R the minimal payoff is maximized in allocation C,<sup>15</sup> which was chosen by the majority of subjects, whereas in P the minimal payoff is constant, so maximin preferences have no influence.

The results of treatment Ey show roughly a tie between the efficient allocation A (40 percent) and the least efficient, but supposedly fair allocation C (36.7 percent). These results are well in line with treatment P, since the lower number of efficient choices and the marginally higher number of choices for C are consistent with a positive influence of maximin preferences.<sup>16</sup> The fundamental difference between the treatments Ey and Ex is the ERC prediction. The results are essentially identical (even marginally against ERC), which indicates that ERC is irrelevant in this context.

<sup>15</sup> Nine of ten subjects who mentioned fairness chose C, only two subjects explicitly indicated maximin preferences.

<sup>16</sup> From this comparison, though, this influence seems rather weak. Furthermore, maximin does worse in comparison to efficiency than in treatment R (distributions are, however, far from significantly different,  $\chi^2_2 = 1.8$ ,  $p > 0.4$ ). A possible explanation is that the trade-off between efficiency and the minimal payoff is more favorable to maximin in R than in Ey. Thus the difference is consistent with reasonable parameter distributions in the C&R model.

Treatments Ey and P provide evidence against a primary importance of inequality aversion in general form, not just the specific formulations of F&S and ERC. According to the axiomatic characterization of F&S provided by William S. Neilson (2002), a choice of C in treatment R only contradicts a combination of inequality aversion and linearity.<sup>17</sup> A choice of A in treatments N, Ny, and Nyi contradicts a combination of inequality aversion and positional asymmetry (which is reflected by the condition  $\alpha \geq \beta$ ). In contrast, in treatments P and Ey, a choice of A is inconsistent with the inequality aversion property alone<sup>18</sup> as well as with non-self-centered inequality aversion and ERC. In both treatments fewer subjects chose the allocation predicted by all versions of inequality aversion than the efficient allocation, although the former is also consistent with competitiveness and in Ey even with maximin preferences, motives that appear to be of substantial importance.<sup>19</sup>

Treatment P also shows the limits of quasi-maximin preferences, since for any positive weight on efficiency quasi-maximin preferences imply a choice of A, chosen by only 60 percent of the subjects. A third of the subjects instead seems to be guided by either inequality aversion or by competitiveness.

It is conceivable that the role uncertainty that subjects faced in the preceding treatments might have enhanced their concerns for efficiency. They were clearly confronted with the possibility to end up in any of the three roles and this might have increased their concern for the well-being of the subjects in the other roles. It also might have increased in particular the concern for the subject with the lowest payoff and hence

<sup>17</sup> A choice of C would, however, only be consistent with unrealistically extreme forms of inequality aversion that have absurd implications. Even if the disutility was cubic in the payoff difference, B would still be preferred over C.

<sup>18</sup> The results in P would be consistent with inequality aversion if the utility function was highly convex in the inequality, but this property is just the opposite of what is necessary to reconcile results in R and the basic dictator game with inequality aversion. Choices for A in Ey are even inconsistent with this form of inequality aversion.

<sup>19</sup> Charness and Brit Grosskopf (2001) also study pure distribution experiments and they find that about 10 percent of choices can clearly be attributed to competitive preferences. Falk et al. (2000a) find even 19 percent competitive subjects.



increased the role of maximin preferences.<sup>20</sup> We have conducted control treatments for Ex and P (with 90 subjects each), where subjects knew their role in advance. Only subjects in the role of person 2 were asked to choose an allocation and they knew that their choice would be implemented.<sup>21</sup> Treatment P allows us to study the isolated effect on efficiency, treatment Ex possible effects on both efficiency and maximin preferences.

The control treatments do not provide any indication that our results are primarily driven by the role uncertainty method. In both treatments without role uncertainty the number of choices for the efficient allocation decreases by one-sixth (see Engelmann and Strobel, 2002, for the detailed results). This is in line with the hypothesis that role uncertainty favors efficiency, but the differences are small and far from significant (Ex:  $\chi^2_2 = 1.22$ ,  $p > 0.54$ , P:  $\chi^2_2 = 0.65$ ,  $p > 0.72$ ). There is also no indication that the role uncertainty increased the focus on maximin preferences (if anything, the data point in the opposite direction). Charness and Rabin (2001) conducted control treatments for 11 games to test whether the role reversal they employed in Charness and Rabin (2002) affects behavior. They do not find significant or substantial effects either.

#### D. The Relative Importance of the Different Motives

In order to better understand the relative influences of the different motives we pool the data and estimate a conditional logit model (our situation is captured by McFadden's choice model, see, e.g., G. S. Maddala, 1983).

For each allocation  $j \in \{A, B, C\}$  that person  $i$  can choose we define the following explana-

tory variables, with  $x_{jk}$  the payoff to person  $k$  in allocation  $j$ :

$$Eff_{ij} = \sum_{k=1}^3 x_{jk},$$

$$MM_{ij} = \min\{x_{jk}, k = 1, 2, 3\},$$

$$Self_{ij} = x_{j2},$$

$$FS\alpha_{ij} = -\frac{1}{2} \sum_{k \neq 2} \max\{x_{jk} - x_{j2}, 0\},$$

$$FS\beta_{ij} = -\frac{1}{2} \sum_{k \neq 2} \max\{x_{j2} - x_{jk}, 0\},$$

$$ERC_{ij} = -100 \left| \frac{1}{3} - \frac{x_{j2}}{Eff_{ij}} \right|, \quad \text{and let}$$

$$V_{ij} = \gamma_1 Eff_{ij} + \gamma_2 MM_{ij} + \gamma_3 Self_{ij} \\ + \gamma_4 FS\alpha_{ij} + \gamma_5 FS\beta_{ij} + \gamma_6 ERC_{ij}.$$

Then according to the conditional logit model the probability that person  $i$  chooses allocation  $j$  is given by

$$P_{ij} = \frac{\exp(V_{ij})}{\sum_{g \in \{A, B, C\}} \exp(V_{ig})}.$$

Since we only have one decision per subject, we cannot take into account any individual differences. Hence with this approach we estimate the preferences of an "average subject" and all heterogeneity is incorporated in the error.

Considering the  $\alpha$  and  $\beta$  components of F&S separately allows us to investigate for both components individually whether they explain any of the variance. This, however, causes a collinearity problem because in all of our treatments  $FS\alpha = FS\beta - \frac{1}{2} Eff + \frac{3}{2} Self$ . To overcome this problem, in a first approach we exclude  $Self$ , because we are not primarily interested in the role of self-interest. In a second approach, we include a strict version of F&S,  $FSstrict = FS\alpha + FS\beta$ , replacing the separate components by an aggregate measure of inequality that assumes equal weights assigned to disadvantageous and advantageous inequality.

<sup>20</sup> On the other hand, the role uncertainty could also enhance the role of inequality aversion since this method underlines that all players are a priori in the same situation, so that no one deserves more or less than the others.

<sup>21</sup> The subjects who were assigned the roles of person 1 or 3 were asked how they would have chosen if they had been in the role of person 2 and what choice they expected person 2 to make. Neither the distribution of the hypothetical choices nor of the expectations differs significantly from the distribution of actual choices for any group of subjects or treatment ( $\chi^2_2 < 3.1$ ,  $p > 0.21$  for all pairwise comparisons).

TABLE 4—ESTIMATED ODDS RATIOS FOR THE CONDITIONAL LOGIT MODEL AND RESULTS OF LIKELIHOOD RATIO TESTS

	Odds ratio	Significance ( <i>p</i> -value)
$\gamma_1$ ( <i>Eff</i> )	1.232	0.012
$\gamma_2$ ( <i>MM</i> )	1.492	<0.001
$\gamma_4$ ( <i>FS<math>\alpha</math></i> )	1.245	0.161
$\gamma_5$ ( <i>FS<math>\beta</math></i> )	0.816	0.286
$\gamma_6$ ( <i>ERC</i> )	0.953	0.078
L-R $\gamma_4 = \gamma_5 = 0$		0.315
L-R $\gamma_4 = \gamma_5 = \gamma_6 = 0$		0.109
$\gamma_1$ ( <i>Eff</i> )	1.109	0.026
$\gamma_2$ ( <i>MM</i> )	1.492	<0.001
$\gamma_3$ ( <i>SELF</i> )	1.373	0.150
$\gamma_4$ ( <i>FSstrict</i> )	1.007	0.937
$\gamma_6$ ( <i>ERC</i> )	0.953	0.078
L-R $\gamma_4 = \gamma_6 = 0$		0.157
$\gamma_1$ ( <i>Eff</i> )	1.286	<0.001
$\gamma_3$ ( <i>SELF</i> )	1.032	0.862
$\gamma_4$ ( <i>FSstrict</i> )	1.351	<0.001
$\gamma_6$ ( <i>ERC</i> )	0.898	<0.001

We also conducted another run excluding *MM*. The results are reported in Table 4 along with the results of likelihood ratio tests of hypotheses that certain subsets of the motives are irrelevant.<sup>22</sup>

If we include both components of F&S separately, we find that efficiency and especially maximin preferences have a clear significant influence. In contrast, neither component of F&S has significant impact, with the  $\alpha$  component having a positive impact and the  $\beta$  component a negative. Hence the motivation to increase poorer subjects' payoffs is entirely captured by the maximin motive. The ERC motive has a negative, marginally significant impact. Likelihood ratio tests reveal that both F&S components together do not explain additional variance ( $p > 0.3$ ) and that F&S and ERC jointly add only marginally to the explanation ( $p > 0.1$ ). Including *FSstrict* and *Self* instead of the

separate F&S components yields qualitatively the same results.

Excluding the maximin motive provides an important insight. We now find a highly significant positive effect of *FSstrict* and a highly significant negative impact of the ERC motive. This means that if we ignore the maximin motive, F&S appears to be a much better model of distributional preferences than ERC. This provides a deeper understanding of why F&S clearly outperforms ERC in the taxation games, but does poorly in the other games. The superior performance of F&S in the taxation games seems to result from being in line with maximin there, but not from being a more accurate model of behavior in general.<sup>23</sup>

#### IV. Conclusion

Bolton (1998) suggests three building blocks to explain behavior in games: motivation, learning, and strategic reasoning. In the present experiments we have completely isolated distributional preferences from issues such as learning, intentions, and strategic reasoning, because distributions are given the central role in F&S and ERC. We are thus able to provide a pure test both for the comparison of ERC and F&S and for the relative importance of inequality aversion, efficiency, and maximin preferences as components of the motivation block. It turns out that inequality aversion does not seem to be a major part in a complete explanation in this setting. F&S and ERC are unable to explain important patterns in our data. In contrast, a combination of efficiency concerns, maximin preferences, and selfishness (which amounts to the basic C&R model) can rationalize most of the data. The conditional logit analysis of the pooled data shows that the basic C&R model is virtually sufficient to explain the data. While F&S and ERC do not account for additional variance, both efficiency and maximin do. This is consistent with results for similar simple distribution games in Charness and Grosskopf

<sup>22</sup> The odds ratio denotes the factor by which the odds [ $P_{ij}/(1 - P_{ij})$ ] are multiplied if the corresponding independent variable increases by one unit. Choosing the negative of the inequality as measured by F&S and ERC as explanatory variables implies that estimating an odds ratio  $>1$  amounts to an influence in line with F&S or ERC. Note that the odds ratios for different explanatory variables are in general not directly comparable because the variables are partly scaled in different ways.

<sup>23</sup> All results reported in this section are robust to the exclusion of treatments E, F, and Ey (see Engelmann and Strobel, 2002, for details and the motivation for excluding these treatments). We excluded the control treatments for Ex and P from the analysis because they were run with a different procedure.

(2001), Alexander Kritikos and Friedel Bolle (2001), and Charness and Rabin (2002).<sup>24</sup>

The superior performance of F&S over ERC in the taxation games, which we consider the most neutral playground for the comparison of F&S and ERC, appears to be driven by the fact that F&S is in line with maximin preferences. Hence the results cannot be interpreted in a way that more subjects have F&S preferences than ERC preferences but that F&S takes into account that subjects (other things being equal) care about the minimal payoff in the group. It appears a limitation of ERC that it does not do so.

A further deficiency of both F&S and ERC is that they do not explicitly consider intentions (a matter that we deliberately designed out of our experiments), as is demonstrated by the experiments of, e.g., Sally Blount (1995), Falk et al. (2000a, b), and John H. Kagel and Katherine Willey Wolfe (2001).

The degenerate games we study are certainly of a special kind. Hence at the current stage, our results do not discard inequality aversion as a motive in general. Both F&S and ERC are, however, exclusively formulated on the basis of distributions and interaction and intentions should rather appear as confounding factors. We conclude that theories that are based on distributions should, in general, carefully clarify under which conditions they are appropriate. Inequality aversion may do better in situations involving perceived intentions, because in these games reciprocity may coincide with inequality aversion and hence the latter may serve as a black box model of the former, as Fehr and Schmidt (1999) suggest. This, however, may be an artifact of the classes of games that have been the focus of experimental research so far (in particular those where a player who treats another player unfairly has a higher payoff, as in the ultimatum game).<sup>25</sup>

<sup>24</sup> Our results are also consistent with the purely distributional model by James C. Cox et al. (2002). A similar model is studied by James Andreoni and John H. Miller (2002) and they show that it fits the data of dictator games well.

<sup>25</sup> Inequality aversion might also be more important when perfect equality is an option. Werner Güth et al. (2001) show that in mini-ultimatum games the availability of only nearly instead of perfectly equal allocations substantially increases the rate of unfair proposals and reduces rejection rates.

Our games can be considered special in three respects. First, in most treatments the allocator's payoff is not affected. Second, there is role uncertainty. Third, there is no strategic interaction.

Concerning the first two issues, our treatments  $N_x$ ,  $N_y$ , and  $N_{y_i}$  as well as the control treatments for  $Ex$  and  $P$  provide no indication that the absence of monetary incentives or the role uncertainty substantially change the relative importance of inequality aversion, efficiency, and maximin preferences. Therefore, we can at least clearly refute the claim that our results are entirely driven by these factors. While large incentives would most likely change subjects' decisions, we see no obvious reason why they should change the relative importance of the different motives.

The remaining issue is the absence of strategic interaction in our experiments. It is conceivable that apart from the influence of reciprocity, strategic interaction alone might change the importance of different distributional motives. It is difficult to disentangle this potential effect from effects of perceived intentions and to the best of our knowledge there is yet no persuasive evidence on this matter.<sup>26</sup> It is an issue of substantial importance. If the relative importance of different distributional preferences depends on the presence and the nature of the strategic interaction, then the whole approach to test distributional preferences in one strategic situation, to understand the results in another, appears to be problematic. There are, however, also important situations, which may well not be perceived as strategic interaction, and for these our results are thus more directly applicable. An example would be voting in large groups.

As long as there is no conclusive evidence that the relevance of our results is entirely confined to noninteractive situations, they also have some general implications. In interpreting experimental results one should keep efficiency concerns and maximin preferences in mind as alternative explanations. They are consistent

<sup>26</sup> Evidence on this issue so far indicates primarily that subjects become more selfish when part of the responsibility for the outcome can be attributed to the other subject (Bolton and Rami Zwick, 1995, and Charness and Rabin, 2001, who call this "complicity effect").

with many results that are readily interpreted as evidence for other motives.<sup>27</sup> For example, in the investment game (Joyce E. Berg et al., 1995) sending money by the first mover appears to reflect trust, but as shown by Cox (2004) in a comparison with dictator control experiments, to a large part it can be attributed to efficiency concerns. Similarly, a positive relation between the amount sent and the amount returned by the second mover suggests reciprocity or inequality aversion, but might as well be driven by maximin preferences.<sup>28</sup>

Deviations from pure selfishness have been interpreted that subjects are better people (i.e., more altruistic or fair), but maybe they are just better economists. It is surprising that for economists the goal in designing economic institutions is to maximize efficiency, while as experimentalists, when designing economic experiments, they tend to ignore that subjects might share this goal.

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<sup>27</sup> Charness and Rabin (2002) present a similar argument.

<sup>28</sup> In Engelmann and Strobel (2002) we present an extensive review of classical experiments and discuss to what extent the results are consistent with quasi-maximin preferences. Furthermore, we discuss other experiments that compare different fairness motives and point out limitations of quasi-maximin preferences.

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