An Experimental Solidarity Game

REINHARD SELTEN
Rheinische-Friedrich-Wilhelms-Universität
Bonn

AXEL OCKENFELS[1]
Otto-von-Guericke-Universität
Magdeburg

Abstract

120 subjects played a three-person-game in which each player could win DM 10,00 with probability 2/3 or nothing with probability 1/3. Before the three independent random decisions were made, the players had to decide how much they were willing to give to one loser or each of two losers in the case of their winning. The experimental setup secured double blindness.

The great majority of subjects were willing to make substantial conditional gifts. Five types of gift behavior can be distinguished. The most common type (36% of the subjects) gives the same positive total amount to one loser and to two losers. This behavior does not lend itself to a straightforward interpretation as the result of altruistic utility maximization.

Subjects were also asked to estimate the average gifts of others. There is a significant positive correlation between the estimates and the subjects' own gifts. This is similar to false consensus effects known in literature (ROSS ET AL., 1977).

Among male subjects, those studying economics show a more "egoistical" behavior than others. Among female subjects, no such "education effect" can be found. Females tend to give more than males.

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1. Introduction

In experiments in which subjects are motivated by money payoffs one often observes that subjects are motivated not only by their own payoffs but also by those of others and the relationship between the payoffs of the players of the game. Such other-directed motivations have been explored in the context of ultimatum games (GÜTH AND TIETZ, 1990), dictator games (FORSYTHE ET AL., 1994), and games which appeal to reciprocity (FEHR ET AL., 1993). In ultimatum games, resistance to unfairness seems to be the driving force behind the usual deviations from subgame perfect equilibrium. Altruism can account for giving behavior in dictator games.

This paper also reports on experiments concerned with other-directed motivations. It is the purpose of the experimental setup to create a situation in which subjects can show solidarity in the sense that they are willing to help others who by chance came to a much worse position than they themselves. It seems to us that the everyday use of the word solidarity is aimed at situations of this kind. Solidarity means a willingness to help people in need who are similar to oneself but victims of outside influences such as unforeseen illness, natural catastrophes, etc. To some extent solidarity is similar to reciprocity, a motivation which urges you to give something in exchange for something you have received, even if you are not compelled to give anything. However, solidarity is different. Gifts are made but not reciprocated. They are made to recipients who presumably, if one were in need oneself, would have made a gift to oneself. Solidarity aims at a reciprocal relationship, but a more subtle one than giving after one has received.

In our experiments each subject participates in exactly one three-person-game in which each of the subjects can independently win either DM 10,00 with probability 2/3 or zero with probability 1/3. Before the random draws are made, the subjects have to decide how much in the case of their winning they are willing to give to a loser who is the only one in the group and to each of two losers. Of course no gifts are made if there is no loser in the group. The pledge to help a loser is conditioned on winning and on the presence of losers. In this sense we speak of conditional gifts.

2. Procedure

Subjects were recruited in a students' restaurant and the experiments were performed on the spot. Leaflets which invited the students to announce their willingness to participate without information about the nature of the game were distributed. Translations of all directions, which were given in German, can be found in appendix A. Students who wanted to play first had to give us their names and addresses. They then received an explanation of the rules and an envelope with a questionnaire and decision form, and an identification card carrying a code name. The rules explained the situation in a neutral form. The word "solidarity" was not used. After having received the envelope, the subjects sat behind a cardboard box which provided protection from being seen by the experimenter and other participants. Having filled in everything, the subjects would keep their code name card but put the questionnaire and decision form into the envelope. The closed envelope would then be given to the experimenter. Each subject had to throw a dice and the experimenter noted the result on the closed envelope. The rule was that one, two, three, or four win and five and six lose.

After thirty envelopes had been collected, the experimenter randomly formed ten groups of three players who played the game with each other. For each group the payoffs resulting from winning or losing and conditional gifts were computed for all players.

In order to convey the impression to the participants that everybody would come back to receive their payoffs, even in the case of their losing, an additional incentive was supplied by a lottery giving DM 25,00 to one of the thirty subjects. The rules specified that a loser winning the lottery would not receive any conditional gift. The lottery was introduced in order to make it unlikely that some people would not give anything in the expectation that losers would not bother to collect their payoffs believing that this would be anticipated by the winners.

Each subject's payoff was put in a closed envelope with the code name written on the outside. After having their meals, the subjects got their payoffs. Each subject first put his or her code name card through a slit in a cardboard wall hiding the subject from the experimenter. Then the subject had to sign a receipt with his or her code name and then a statement under a list of all code names which acknowledged that he or she had received a payoff under one of these code names. This acknowledgment was thrown into an urn in a way which made it impossible for the experimenter to see the signature. Finally, the subject received the envelope with his or her payoff. With this procedure we tried to secure as much double blindness as possible in a way which was acceptable to the university accountants.

The experiments were run on two separate days with sixty participants in each session. We made sure that nobody participated twice.

3. The Distribution of Conditional Gifts

Table 1 shows the distribution of conditional gifts. The rows correspond to x_1, the conditional gift for the case that there is exactly one loser in the group, and the columns correspond to x_2, the amount conditionally given to each of two losers in the group. Here and in the following, payoffs and gifts are always DM-amounts. The entries are numbers of subjects with the corresponding pair of gift parameters.

$x_1 \setminus x_2$	0,00	0,50	1,00	1,25	1,40	1,50	2,00	2,50	3,00	3,30	3,33	3,50	sum
0,00	25	-	-	-	-	-	-	-	-	-	-	-	25
0,50	-	1	-	-	-	-	-	-	-	-	-	-	1
1,00	-	3	6	-	-	-	-	-	-	-	-	-	9
2,00	-	-	17	-	-	2	1	-	-	-	-	-	20
2,50	-	-	-	4	-	1	-	2	-	-	-	-	7
2,80	-	-	-	-	1	-	-	-	-	-	-	-	1
3,00	-	-	2	-	-	1	9	3	1	-	-	-	16
3,30	-	-	-	-	-	-	-	-	-	1	-	-	1
3,33	-	-	-	-	-	-	-	-	-	-	7	-	7
3,50	-	-	-	-	-	-	-	1	-	-	-	-	1
4,00	-	-	-	-	-	-	7	1	1	-	-	-	9
5,00	-	-	-	-	-	-	-	9	8	-	3	-	20
6,00	-	-	-	-	-	-	-	-	-	-	-	1	1
sum	25	4	25	4	1	4	17	16	10	1	10	1	118

Table 1: *Distribution of conditional gifts*

The table excludes two of the 120 subjects. These two subjects gave DM 10,00 in the case of one loser and DM 5,00 to each of two losers. Both of them did not come back to collect their payoffs, even if there was a chance to get DM 10,00 in the case of no losers, or even DM 25,00 or DM 35,00 as a winner of the lottery. Obviously, these subjects participated out of curiosity and they were not interested in the money. We exclude both subjects from all evaluations reported here. A third subject with $x_1 = x_2 = 2{,}50$ also did not come to collect his payoff. We did not exclude this subject from our evaluations. A list of the complete data appears in appendix B.

We computed prominence levels for the two sets of conditional gift data with the help of the method explained by SELTEN (1987). We obtained a prominence level of 1,00 both for the x_1 values and the x_2 values separately. Seven subjects made gifts of DM 3,33 in both conditions. This is also a very prominent gift combination but the prominence does not arise from the decimal system but from the equal split of DM 10,00 into three parts. If this type of behavior is followed by all three subjects in a group, the payoff to each of them will be 2/3 of DM 10,00 in the case of two winners and 1/3 of DM 10,00 in the case of one winner. One may say that $x_1 = x_2 = 3{,}33$ is the absolutely egalitarian solution of the problem. Of course these considerations neglect the possibility of winning the lottery prize of DM 25,00.

Only 25 subjects made no conditional gifts but all other subjects made positive gifts in both conditions. Surprisingly, x_2 was never greater than x_1. A possible approach to the problem could have been that one wants to secure a minimum payoff, say, DM 2,00 to a loser. In order to achieve this, two winners would have to give DM 1,00 each to a single loser and a single winner would have to give DM 2,00 to each of the losers. Obviously nobody took this approach.

The mean values $\bar{x}_1$ and $\bar{x}_2$ of the conditional gifts x_1 and x_2 to a single loser or to each of two losers, respectively, are as follows:

$$\bar{x}_1 = 2{,}46$$

$$\bar{x}_2 = 1{,}56$$

This means that a single loser can expect DM 4,92 in the mean since he receives gifts from two winners. However, one of two losers can only expect DM 1,56 in the mean, a much lower amount (we do not count the winner of the lottery as a loser).

It is not unreasonable to expect that a loser who is the only one in the group will have a greater gift expectation than one of two losers. After all, in the first case DM 20,00 is won by the whole group whereas DM 10,00 is obtained in the second case. The egalitarian solution would therefore give double as much to only one loser than to each of two losers. However, a loser in fact receives more than three times as much on average if he or she is alone than if there is a second loser in the group. What is the reason for this discrepancy? The answer will become clear after a discussion of the observed types of conditional gift behavior.

4. Types of Conditional Gift Behavior

Table 2 shows a classification of the subjects with respect to different types of conditional gift behavior. The classification is not primarily concerned with the size of the gifts but rather with the question of whether they are positive and how x_1 and x_2 relate to each other.

types	egoistical	fixed total sacrifice			intermediate	fixed gift to loser
		exact	up to rounding			
	$x_1 = x_2 = 0$	$x_1 = 2x_2 > 0$	$2x_2 > x_1 > 0$	$x_1 > 2x_2 > 0$	$2x_2 > x_1 > x_2 > 0$	$x_1 = x_2 > 0$
num. of subjects	25	42	17*)	2**)	13	19
perc.	21%	36%	14%	2%	11%	16%

*) 9 times $x_1 = 3{,}00$ and $x_2 = 2{,}00$
8 times $x_1 = 5{,}00$ and $x_2 = 3{,}00$
**) 2 times $x_1 = 3{,}00$ and $x_2 = 1{,}00$

Table 2: *Types of conditional gift behavior*

4.1 Egoistical behavior

The first group, called "egoistical", is formed by the 25 subjects who give nothing whatsoever. We are aware of the fact that maybe the name "egoistical" is not quite adequate because ex ante everybody has the same expectation of 2/3 of DM 10,00 even if no gifts are made. Risk neutral people who are only motivated by ex ante considerations may see no reason why any gifts should be made even if they are not really egoistical.

In their paper on entitlements, rights, and fairness, HOFFMANN AND SPITZER (1985) report that random entitlements are perceived as unfair. In this light it seems to be plausible to assume that conditional gifts serve the purpose of mitigating ex post inequality. The subjects who do not give anything are not sufficiently motivated by a desire to mitigate ex post inequality and in this respect may be looked upon as egoistical.

Of course, in the presence of risk aversion, conditional gifts also increase efficiency in a similar way to a mutual insurance arrangement. In a repeated game context KIMBALL (1988) and COATE AND RAVALLION (1993) emphasized this aspect in theoretical papers on a similar situation. However, here we are dealing with a one-shot game with anonymous interaction without communication.

4.2 Fixed total sacrifice

A very common behavior is shown by about 36 % of the subjects. They give the same total amount $x_1 = 2x_2 > 0$ in both loser conditions. One can imagine that a subject of this type first decides how much he or she is willing to give and then distributes the amount decided upon among the losers. Consequently, these subjects give double as much to a loser who is the only one in the game than to one of two losers. Suppose that everyone in a group behaves in this way, all with the same gift parameters. Then a single loser receives four times as much as one of two losers. We call this behavior "fixed total sacrifice". The needs of the other players or the reduction of inequality do not seem to be the guiding considerations of these subjects. "Fixed total sacrifice" behavior may be interpreted as the result of a norm concerning what one can be expected to sacrifice for solidarity.

The behavior of some subjects for whom $x_1 = 2x_2 > 0$ does not hold exactly can still be interpreted as following the principle of "fixed total sacrifice" up to rounding to an integer multiple of the prominence level 1,00. In 17 of the 19 cases classified in this way $2x_2$ is greater than x_1, and in only two of these cases is $2x_2$ smaller than x_1. This means that the rounding is mostly done in a way which favors losers who are not the only ones in the game.

52% of all subjects conform to the principle of "fixed total sacrifice" either exactly or up to rounding. This principle seems to have an important influence on the behavior of subjects in the solidarity game.

4.3 Fixed gift to loser

A minority of 19 subjects give the same amount to each loser regardless of whether there are one or two losers in the game. We call this behavior "fixed gift to loser". It seems to be based on the idea that it is appropriate to give a certain amount to a loser. If everybody follows a fixed rule of this kind with the same gift parameter, a loser who is the only one in the group will receive double as much as one of two losers. However, in view of the fact that with two winners the total gain is double as high as with only one winner this can be seen as fair. The seven subjects who use the egalitarian rule of giving DM 3,33 in both conditions belong to this category.

4.4 Intermediate behavior

The category "intermediate" contains 13 subjects with $2x_2 > x_1 > x_2 > 0$. These subjects neither follow the principle of "fixed total sacrifice" exactly or up to rounding nor the rule "fixed gift to loser". The behavior of these subjects is intermediate between these two norms since it differs from "fixed total sacrifice" insofar as the interests of the two recipients of the conditional gift x_2 are considered more strongly, but not to the full extent of equalizing x_1 and x_2.

Interestingly, we find only two subjects with $x_1 > 2x_2 > 0$ and these subjects follow the principle of "fixed total sacrifice" up to rounding.
The behavior of the subjects who are not egoistical can be interpreted as either guided by one of the principles "fixed total sacrifice" or "fixed gift to loser" or by a compromise between the two rules.

Let us now come back to the question why a loser who is alone in a group can expect more than three times as much than one of two losers. "Fixed gift to loser" would imply a factor two and "fixed total sacrifice" a factor four. The actual factor 3.15 fits into this range.

5. Implausibility of Altruistic Utility Maximization as an Explanation of "Fixed Total Sacrifice" Behavior

As we have seen "fixed total sacrifice" behavior is quite common. Therefore, it may be worthwhile to point out that "fixed total sacrifice" does not easily lend itself to an interpretation as the result of straightforward utility maximization. Of course, a utility maximization interpretation can always be concocted, but if we speak of a straightforward one we mean that some additional assumptions are made which appear quite frequently in the literature.
Suppose that y_1, y_2, and y_3 are the gains of the three players 1, 2, 3 of the game. Let U be the total utility of player 1 including the utility of payoffs of the others. We assume separability and symmetry with respect to both other players:

$$U = u(y_1) + v(y_2) + v(y_3)$$

In addition to this, we assume that u and v are differentiable, monotonically increasing, and strictly concave, which means that player 1 is altruistic and also risk aversive both for him- or herself and the other two players. In the case of only one loser, we also have to introduce a cumulative subjective probability distribution F of player 1 over the amounts x_1' given by the second winner. We assume that this probability distribution has a support in the interval [0,10].
It is our aim to show that these assumptions are incompatible with exact "fixed total sacrifice" $x_1 = 2x_2 > 0$. We shall do this both for the solidarity game without any additional lottery and with the lottery taken into account by which one of thirty subjects receives an additional prize of DM 25. Of course, if one wants to justice to the game as it was played the additional lottery cannot be neglected but one might argue that the subjects may simplify the task of utility maximization in this way. However, it makes no difference whether the additional lottery is

neglected or not. In the following, only the case without the lottery will be discussed. The analysis of the case with the lottery taken into account can be found in appendix C.

Before we begin to derive the result in a formal way, we want to point out that it is intuitively clear why exact "fixed total sacrifice" cannot be the result of straightforward utility maximization in the sense explained above.

Suppose that altruistic utility maximization yields $x_1 = 2x_2 > 0$. Then, regardless of whether there are one or two losers in the group, the marginal utility of $10 - x_1 = 10 - 2x_2$ with respect to *u* is the same. This marginal utility must be equal to the marginal utility with respect to *v* of increasing x_1 on the one hand, and to the marginal utility with respect to *v* of increasing x_2 on the other hand. Otherwise total utility could be increased in at least one of the two conditions. If $10 - 2x_2$ is decreased by a small amount ε, then x_2 can be increased by $\varepsilon / 2$. The utility gain of doing this is roughly equal to the utility gain of increasing x_2 for only one of the two losers by ε. Therefore the marginal utility of $10 - x_1 = 10 - 2x_2$ must, on the one hand, be equal to the marginal utility with respect to *v* of increasing x_1 and, on the other hand, to the marginal utility with respect to *v* of increasing x_2 for only one of the two losers. However, since the payoff x_2 for each of two losers is smaller than the payoff x_1 plus any conditional gift given by the second winner in the group for only one loser, this is impossible in view of the strict concavity of *v*. Of course, within the rules of the game, x_2 cannot be increased for only one of the two losers, but this does not make the argument invalid.

The formal derivation of the result is little more than an elaboration of this idea. Let U_1 be the expected utility of player 1 in the case that he or she wins and only one of the others loses. We have:

$$U_1 = u(10 - x_1) + \int_0^{10} [v(x_1 + x_1') + v(10 - x_1')] \, dFx_1' \, .$$

Similarly, U_2 stands for player 1's utility in the case that he or she wins and the other two players lose. We have:

$$U_2 = u(10 - 2x_2) + 2v(x_2) \, .$$

We want to explain the behavior of a subject who selects positive gifts x_1 and x_2 which are both smaller than ten. Therefore, we can proceed from the assumptions that U_1 and U_2 have interior maxima.

In the case of x_1 we obtain the necessary condition:

$$\frac{dU_1}{dx_1} = -u'(10 - x_1) + \int_0^{10} v'(x_1 + x_1')\, dFx_1' = 0.$$

Concavity of v implies:

$$v'(x_1 + x_1') \le v'(x_1).$$

In view of this inequality, the necessary condition for x_1 yields the following conclusion:

$$-u'(10 - x_1) + v'(x_1) \ge 0,$$

or equivalently:

(*) $$u'(10 - x_1) \le v'(x_1).$$

We obtain the following necessary condition for x_2:

$$\frac{dU_2}{dx_2} = -2u'(10 - 2x_2) + 2v'(x_2) = 0.$$

This yields:

$$u'(10 - 2x_2) = v'(x_2).$$

Assume that player 1 exhibits exact "fixed total sacrifice" behavior, which means $x_1 = 2x_2 > 0$. Instead of the last equation we can also write:

$$u'(10 - x_1) = v'(\frac{x_1}{2}).$$

In view of the strict concavity of v this yields the conclusion:

$$u'(10 - x_1) > v'(x_1).$$

This contradicts the inequality (*) which has been derived above. Consequently, it is not possible that exact "fixed total sacrifice" behavior arises from utility maximization under the assumptions of altruism, separability, risk aversiveness, and symmetry with respect to both players.

On the basis of what we have found, we think that a utility interpretation of "fixed total sacrifice" behavior is implausible. It is much more reasonable to assume a decision process which first fixes the total amount to be sacrificed for solidarity and then distributes it (up to rounding) among the losers regardless of their number.

This idea is quite similar to the one proposed by BOLTON ET AL. (forthcoming) for the interpretation of behavior in which one dictator can make gifts to many potential recipients. BOLTON ET AL. observed that in such situations the dictator often distributes his sacrifice quite unevenly among the anonymous recipients. This could not happen as the result of altruistic utility maximization under the assumptions made above.

BOLTON ET AL. suggested that the decision process has two parts. In the first part the amount to be distributed is fixed and in the second part the distribution is decided upon. In our case there is no analogue to the second part because, in the case of two losers, we forced the subjects to give the same amount to both.

6. Expectations about the Gifts of Others

In the questionnaire and decision form, the subjects were asked for the expected average amounts $\hat{x}_1$ and $\hat{x}_2$ about the conditional gifts of others for the cases of only one loser or two losers, respectively. Let $\bar{\hat{x}}_1$ and $\bar{\hat{x}}_2$ be the means of $\hat{x}_1$ and $\hat{x}_2$, respectively. As before, $\bar{x}_1$ and $\bar{x}_2$ denote the means of the decisions x_1 and x_2. It is interesting to compare the means of expected gifts with the means of observed gifts:

conditional gift	means		variances	
	$\bar{x}$	$\bar{\hat{x}}$	x	$\hat{x}$
for only one loser	2,46	2,47	3,02	1,60
for each of two losers	1,56	1,53	1,28	0,61

Table 3: *Means and variances of actual and expected gifts*

The mean expectations are surprisingly near to the mean decisions. The variances of the expected gifts are about half as big as the variances of the corresponding actual gifts. The question arises: What is the reason for the fact that the expectation means are such good predictors of the actual means? In the next section we will report a false consensus effect which throws light on this problem.

Twenty subjects decided on a gift of $x_1 = 5{,}00$ for the case of only one loser. All these subjects expected positive average amounts to be given by others in this situation. This means that for them $x_1 = 5{,}00$ is connected with the expectation that the loser will get more than they themselves, at least on average. One must suspect that these subjects were not really aware of this joint implication of their behavior and their expectations. All of them made "fixed total sacrifice" decisions. It fits into our image of the decision process underlying "fixed total sacrifice" behavior that somebody who sees his or her problem only in the amount to be sacrificed may easily neglect the joint consequences of behavior and expectations since he or she does not have to make judgments about the expected welfare of the losers and, therefore, does not need any expectations for his or her decisions.

In this connection it is interesting to note that in six of the forty groups a loser ended up with a higher payoff than one of the winners.

7. A False Consensus Effect

ROSS ET AL. (1977) have shown that expectations about the behavior of others are positively correlated with one's own behavioral inclinations. The words "false consensus" indicate that this involves an overestimation of the extent to which people behave similarly to each other.

AS DAWES ET AL. (1977) have pointed out, it is not quite clear what the basis of the false consensus effect is. Two explanations suggest themselves. It is possible that someone looks at his or her own behavioral inclinations in order to predict the behavior of others. We refer to this as "expectations based on own behavior". On the other hand it is also possible that someone predicts the behavior of others with the intention of making his or her own behavior dependent on the behavior of the population. We refer to this as "behavior based on expectations".

In our data we find a Spearman rank correlation coefficient $\rho_S = .58$ between the decisions x_1 and expectations $\hat{x}_1$ for the case of only one loser. The Spearman rank correlation coefficient of x_2 and $\hat{x}_2$ is $\rho_S = .55$. Both coefficients are highly significant ($p < 5*10^{-12}$, one-sided, for only one loser and $p < 6*10^{-11}$, one-sided, for two losers).

Figures 1 and 2 show the distributions of the deviations $x_i - \bar{x}_i$ from the actual mean and $x_i - \hat{x}_i$ from the expected mean ($i = 1,2$). The data are aggregated over intervals of length one. Light bars show the number of subjects with actual deviations in the interval concerned and dark bars show the number of subjects with expected deviations in the interval.

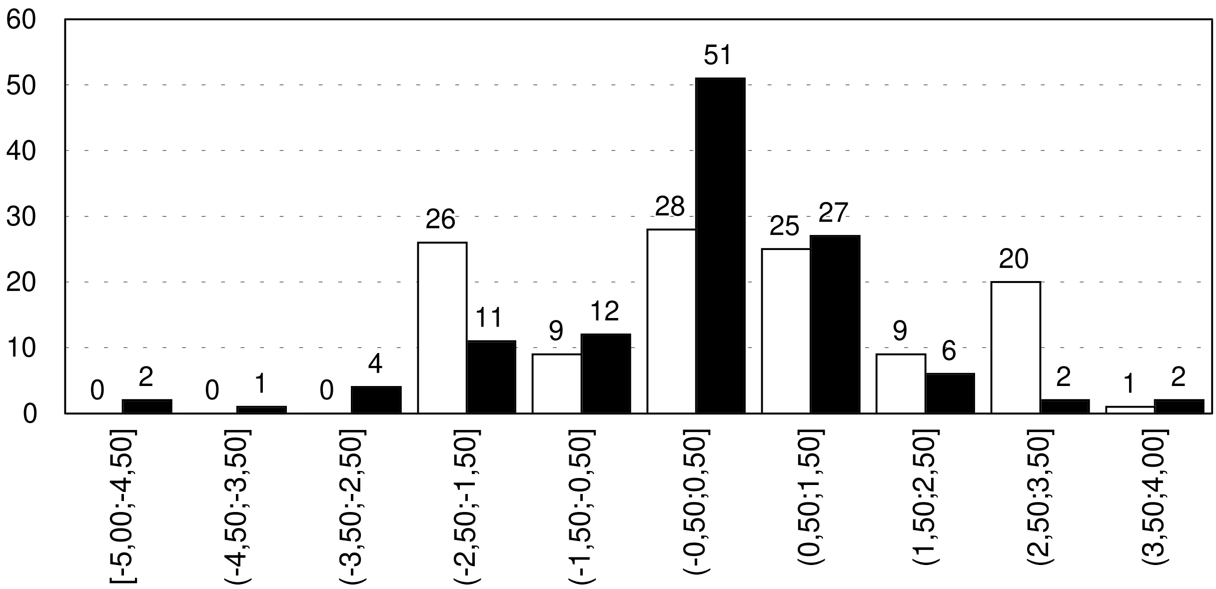

Figure 1: *Distributions of* $x_1 - \bar{x}_1$ *(light bars) and* $x_1 - \hat{x}_1$ *(dark bars)*

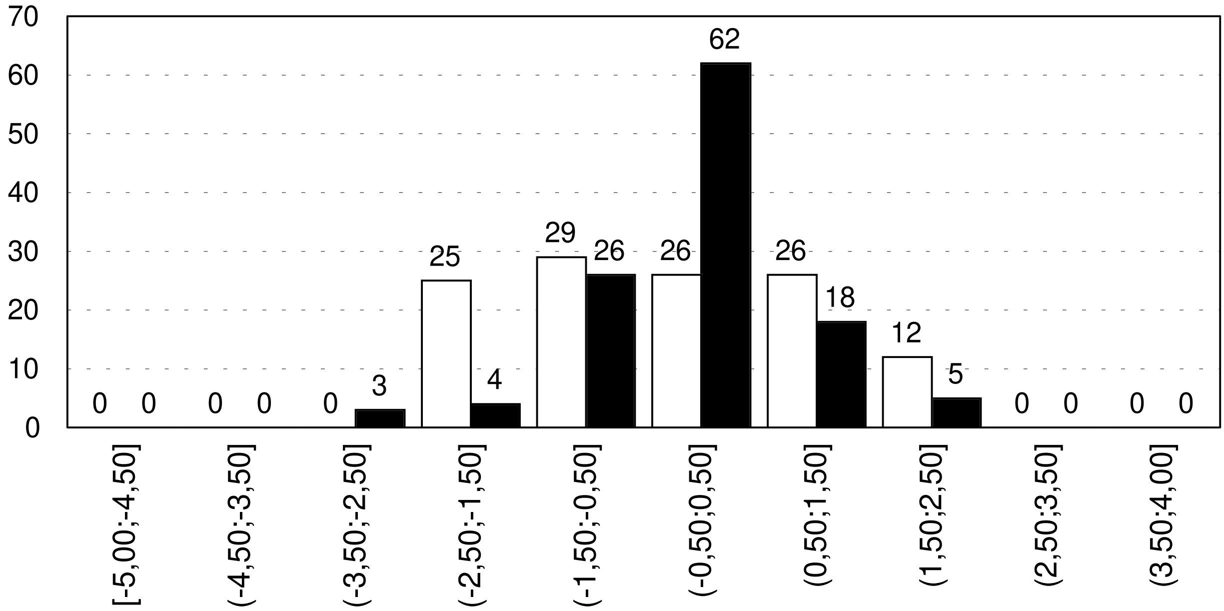

Figure 2: *Distributions of* $x_2 - \bar{x}_2$ *(light bars) and* $x_2 - \hat{x}_2$ *(dark bars)*

It can be seen immediately that in both cases both distributions have a mean near zero but the actual deviations have much higher variances than the expected ones.

In section 5 we have already seen that mean decisions and mean expectations are very near to each other. On the basis of the false consensus effect and figures 1 and 2, one can understand why this is the case. Regardless of whether the false consensus effect is due to "behavior based on expectations" or "expectations based on own behavior", it is easy to imagine a decision process which has the property that deviations of expectations from decisions are zero in the mean. A decision process in which expectations randomly vary around actual decisions, or vice versa, will produce means of actual decisions and expectations that lie near to each other.

Table 4 shows the distribution of subjects with respect to the directions of deviations of decisions from expectations. About 87% of the 118 subjects contribute to the cells in the main diagonal. This means that, with relatively few exceptions, in both conditions there are either no deviations of decisions from expectations, or deviations are in the same direction. This suggests that subjects usually look at themselves as either similar to the average of others, or as more "stingy" or more "magnanimous". Both views "expectations based on own behavior" and "behavior based on expectations" can be further elaborated by the idea that a self-image of this kind connects expectations and behavior.

numbers of subjects	$x_2 < \hat{x}_2$	$x_2 = \hat{x}_2$	$x_2 > \hat{x}_2$
$x_1 < \hat{x}_1$	28	2	0
$x_1 = \hat{x}_1$	4	39	1
$x_1 > \hat{x}_1$	1	7	36

Table 4: *Decisions and expectations*

Let us first look at "expectations based on own behavior". According to this explanation of the false consensus effect, a subject first forms the behavioral inclination and then makes an adjustment according to his or her self-image in order to obtain his or her expectations. Thus a subject who thinks that he or she is more magnanimous than the mean of the population will expect that this mean will be lower than his or her own conditional gift.

Now let us look at "behavior based on expectations". Here a subject first forms the expectation of the population mean and then makes decisions which confirm his or her self-image. Thus a subject who thinks of him- or herself as more magnanimous than the population mean will decide to make larger conditional gifts.

We now want to interpret our results on means and variances of conditional gifts in the light of both explanations of the false consensus effect. As we have seen, the mean expected gifts are almost equal to the corresponding means of actual gifts. The variances of the expected gifts are smaller than those of the corresponding actual gifts.

Let us first look at "expectations based on own behavior". Here we may assume that the subjects have randomly disturbed correct self-images in the sense that up to randomly distributed individual deviations they correctly assess the extent to which they are more or less magnanimous than the population means. They form their expectations by adjusting their behavioral inclinations according to their self-images. The individual random deviations from correctness even out in the aggregate. This makes it understandable that mean actual gifts and mean expected gifts are almost equal. To the extent that the self-images are correct, the expectations of the population means will be correct, too. This makes it understandable that the variances of expected gifts are smaller than those of the corresponding actual gifts.

Now let us look at "behavior based on expectations". We may assume that, apart from random errors, subjects correctly perceive population means. The random errors produce a variance of the expected mean gifts. Behavioral inclinations are formed by adjustments in order to achieve conformity to the self-image. Since the self-images of the subjects are different, the variance is increased in the transition from expectations to behavior. Here, too, it becomes understandable that the means of expected and corresponding actual gifts are almost equal and that the variances of expected gifts are smaller than those of corresponding actual gifts. "Behavior based on expectations" also implicitly assumes that self-images are correct apart from random errors. If, for example, everybody thought of him- or herself as more magnanimous than the population mean, actual gifts would have to be higher than mean expected gifts and population averages would not be perceived correctly apart from random errors.

Unfortunately, we did not succeed in finding a way of deciding which of both explanations is more plausible in the light of the data. The prominence levels for the $\hat{x}_1$ values and for the $\hat{x}_2$ values equal the corresponding prominence levels for the x_1 values and the x_2 values, being 1,00 for both data sets. Therefore the analysis of prominence of actual and expected gifts cannot reveal whether expectations are an adjustment of the decisions or vice versa. As far as we can see, our results are compatible with "expectations based on own behavior" as well as "behavior based on expectations". It would be interesting to find out which of both explanations is the better one. Of course, it is conceivable that the right explanation is a third one which might involve elements of both. It is also possible that different explanations apply to different subjects.

In both explanations we have elaborated above the idea of self-image plays an important role. However, in "expectations based on own behavior" the self-image is only an instrument to form expectations whereas in "behavior based on expectations" the expectations are an instrument to achieve conformity to the self-image.

8. A Gender Effect

In the questionnaires, students did not reveal their names but they did fill in gender, major field of study, and how many semesters they had been studying including the present one. It turns out that gender has a marked influence on behavior. Table 5 shows that the egoistical behavior of giving nothing in both conditions is much more common among males than among females. Fishers exact test yields a significance of $p<.001$ (two-sided).

Numbers of subjects	male	female	sum
egoistical ($x_1 = x_2 = 0$)	23	2	25
positive gifts ($x_i > 0,\ i = 1,2$)	52	41	93
sum	75	43	118

Table 5: *A gender effect*

For x_1 and x_2 separately we also tested the null hypothesis that the conditional gift contributions of males and females are the same. The Mann-Whitney-*U*-test in both cases supports the alternative hypothesis that males tend to give lower amounts. One obtains a significance level of $p < .006$ (two-sided) in the case of x_1 and $p < .026$ (two-sided) for x_2. We conclude that the conditional gift behavior of males is clearly less generous than that of females. In this sense, females show more solidarity than males. In literature we find results on reward allocation experiments which also show more generosity in females than in males (LANE AND MESSÉ, 1971). The gender comparisons made in connection with public good experiments (BROWN-KRUSE AND HUMMELS, 1993) yield mixed results. BOLTON AND KATOK (1995a) did not find gender differences in connection with dictator games.

9. An Education Effect

In this section we examine differences in the conditional gift behavior of economic students and other students. A casual investigation of the data already suggests that economists are less generous than students of other fields. However, a closer look at the data reveals that the phenomenon can be observed only among male students. Figures 3 and 4 show the arithmetic means of x_1, the conditional gift in the case of one loser, and of x_2, the conditional gift for each of two losers, for the four groups of male and female economists and non-economists.

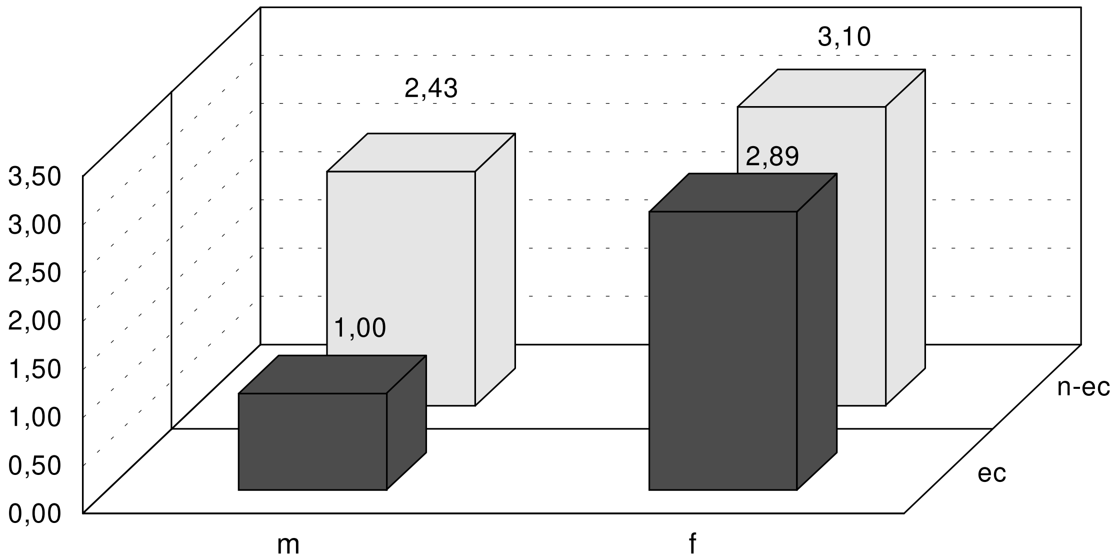

Figure 3: *Arithmetic means of* x_1

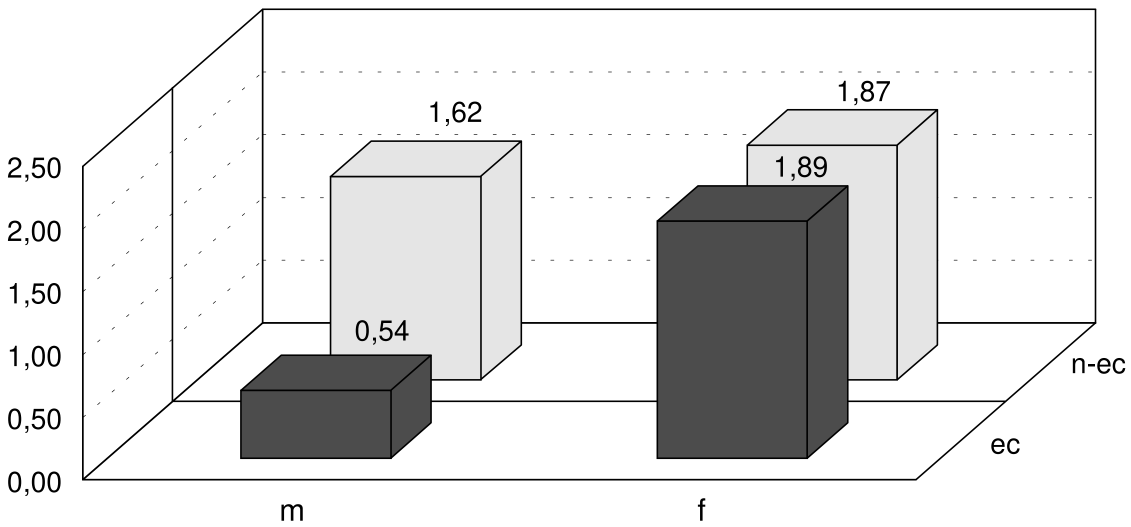

Figure 4: *Arithmetic means of* x_2

It can be seen that for both x_1 and x_2 there is a marked difference between male economists and male non-economists. However, in the case of female students these differences are small and in the case of x_2 in the opposite direction. For x_1 and x_2 separately we use a Mann-Whitney-*U*-test in order to examine the null hypothesis that conditional gifts of male economists and male non-economists come from the same distribution. This null hypothesis can be rejected on a significance level of $p < .004$ (two-sided) for x_1 and $p < .002$ (two-sided) for x_2. The corresponding tests for female economists versus female non-economists yield no significant results.

We also examine the gender effect for economists and non-economists separately. In three of the four cases we receive significance levels lower or equal to .10 (two-sided). The comparison for x_2 among non-economists is not significant on this level. However, as figures 3 and 4 show, the comparisons of the arithmetic means always go in the right direction. We think it is safe to conclude that the gender effect is a general phenomenon valid for both economists and non-economists whereas the education effect is restricted to males.

The education effect is similar to results reported in the well-known paper "Economists Free Ride, Does Anyone Else?" (MARWELL AND AMES, 1981). However, there nothing is said about distinctions between male and female subjects.

Economic students may be less willing to make conditional gifts in the solidarity game or contributions in public good experiments either because they are indoctrinated to maximize profits or because of self-selection. Some empirical evidence seems to point in the direction of an indoctrination effect (FRANK ET AL., 1993). On the other hand, those who are strongly interested in their own economic success may be more likely to study economics than others. However, there are also many economic students who are motivated by the desire to improve society and economic institutions. It is not clear why an education effect should be restricted to males but maybe the reasons for studying economics have different distributions for males and females. It is, of course, also possible that men and women respond differently to the educational influences to which they are exposed in the study of economics.

10. Concluding Remarks

The solidarity game is similar to the dictator game but there are important differences. First of all, all players of the solidarity game have to decide on conditional gifts. All of them are both potential donors and potential recipients. The solidarity game has a motivational element of trust in reciprocity which is missing in the dictator game if it is looked upon in isolation. The solidarity game creates a situation in which ex ante everybody is in the same situation but the ex post distribution of payoffs may be very uneven unless the inequality is mitigated by positive conditional gifts. However, in a similar context BOLTON AND KATOK (1995b) found no evidence for the assumption that the gift behavior of subjects is influenced by their knowing or not knowing whether they are dictator or recipient in a dictator game.

The solidarity game also has some similarity to public good experiments in which everybody has the opportunity to make a contribution to a common pool which then is multiplied by a factor and divided equally among all participants. However, the conditional gifts in the solidarity game are different from the contributions in a public good experiment since gifts are specifically made from winners to losers and are not made at all if it turns out that there are no losers. Moreover, these gifts do not increase the total amount available but only serve to mitigate the inequality of the ex post distributions of payoffs. Of course, in the presence of risk aversion conditional gifts can increase efficiency even if they do not change total expected payoffs. But this effect is bound to be small in comparison to the gains available by cooperation if the factor applied to the common pool is sufficiently high.

The examination of conditional gift behavior has shown that "fixed total sacrifice" behavior in the sense of $x_1 = 2x_2 > 0$ is the most common. As we have seen, this way of fixing conditional gifts does not easily lend itself to a straightforward utility maximization interpretation. Behavior seems to be guided by different principles arising from bounded rationality and social norms.

It would be desirable to clarify the interpretation of the false consensus effect by experiments directly addressed to this question. It would be of great interest to know whether the decision process in the solidarity game proceeds from expectations to behavioral inclinations or in the opposite direction.

The gender effect is an interesting phenomenon but it is not clear what are the reasons behind it. The same is true for the education effect and for the fact that it is restricted to male students. Here, too, further research is necessary.

Appendix A: Written Directions (translation from German)

1. Leaflet

<u>Earning money with ease!</u> We would like to conduct an experiment as part of a research project in experimental economics in the students' restaurant "Nassestraße". Every participant of the experiment has to take two decisions only. The answers will be given anonymously and it is not possible to assign an answer to a certain person.

As a participant you have the chance to receive a money payoff without putting up a stake. This payoff is on average DM 7,50, but it can be more, less, or zero.

Prior to your decision whether to participate you should consider that we need some time to calculate your payoff. Therefore, we propose that you take your meal after making the decisions requested. Then you must come back to collect your payoffs. Payoffs will be made till 3.00 p.m.

If you want to take part, please follow the sign "ENTRY" at the stairway of the students' restaurant. There you will receive more information.

2. Explanation of the Rules

<u>The decisions</u>

Each participant of our experiment is a member of a three-person-group which is formed randomly. Nobody knows or gets to know the identity of the other members in his or her group. Each subject has to throw dice once. If one of the numbers 1, 2, 3, or 4 appears, he or she wins DM 10. If one of the numbers 5 or 6 appears he or she loses and receives nothing. Your decision is as follows: *Prior to throwing the dice you have to decide how much you are willing to hand over voluntarily from your winnings to the losers in your group in the case of your winnning.* Here you have to distinguish two cases. You have to decide on your transfer for the loser in the case that only one of the other members loses and you have to decide on the transfer for each of the losers if both other members lose and you win.

The other members in your group have to take the same decisions.

<u>Payoff</u>

If you win, you receive DM 10 possibly minus your voluntarily gifts to the losers in your group. If you lose, you receive the gifts of the members in your group who win.

In addition, an amount of DM 25 is given to one per thirty participants. This participant will in no case receive any transfers from the other members in his or her group, even if he or she loses when throwing the dice.

<u>The Process</u>

First you draw an envelope containing a questionnaire and decision form and an identification card carrying a code name. Please preserve this card carefully because you will need it to collect your payoff. Fill in your code name on the questionnaire and decision form and answer the questions. Then put the questionnaire and decision form in the envelope. Now you have to throw dice. We will note the result on the closed envelope and throw the envelope into a ballot box.

For every thirty envelopes we will draw the winner of the DM 25. Then we will randomly form three-person-groups and calculate the payoffs.

When we open the cash register, we will mark a cardboard wall with the sign "OPEN". Now you can collect your payoff with your identification card. You put your identification card through a slit in the cardboard wall and you receive your payoff. Consider that the experimenter cannot see you behind the cardboard wall.

Please keep in mind that - as in secret elections - no questionnaire and decision form can be assigned to a certain person during or after the experiments. The data will be analysed absolutely anonymously.

3. Questionnaire and Decision Form

Cover name: ______________ Gender: ○ m ○ f

I am studying ______________ in the ___ semester (including the present one).

If I win DM 10 I am willing to hand over to each loser in my group:

1.) in the case of one loser: ☐ DM.

2.) in the case of two losers (*per person*): ☐ DM.

How much do you think the others would be willing to hand over to each loser on average?

1.) In the case of one loser: [ ] DM.

2.) In the case of two losers (*per person)*: [ ] DM .

4. Statement

I confirm that I took part in an experiment of the Wirtschaftstheoretische Abteilung I of the University of Bonn in the students' restaurant "Nassestraße". In this connection I received and receipted a payoff under one of the following names:

> Agen, Akka, Alsa, Amna, Ande, Anka, Atre, Avin, Bale, Boda, Bras, Camo, Codu, Dabo, Dela, Dink, Dira, Dodo, Drak, Dune, Ehus, Eira, Elis, Elot, Enit, Faro, Fibo, Flex, Gent, Hova, Imon, Imra, Innu, Jult, Kaja, Karu, Kelo, Klas, Kola, Krok, Krus, Lina, Lusi, Marn, Moja, Nesu, Niob, Oden, Olin, Ombi, Renk, Reva, Runo, Salo, Selm, Sero, Spel, Stad, Tamo, Tana, Tedo, Tion, Tome, Tulk, Ubis, Udde, Wika, Wode, Zoba, Zute.

Please sign with your <u>real</u> name and throw this statement into the ballot box: ________________

Appendix B: Data

The table below lists the data collected in September 1994 (groups 1 to 20) and February 1995 (groups 21-40). For each subject, it contains the group number (gr.), subject number (sj.), gender (m/f), field of study, numbers of semesters including the present one (sem.), the conditional gift in the case of only one loser (x_1 in DM) and of two losers (x_2 in DM), the expected average conditional gifts of others for the case of only one loser ($\hat{x}_1$ in DM) and two losers ($\hat{x}_2$ in DM), the result of throwing the dice (w = won, l = lost), and the payoff. Subjects number 1, 31, 61, and 91 won the additional lottery prizes of DM 25.

gr.	sj.	m/f	field of study	sem.	x_1	x_2	$\hat{x}_1$	$\hat{x}_2$	w/l	payoff
1	1	m	physics	17	2,00	1,00	2,00	1,00	w	33,00
	2	m	japanese	9	1,00	0,50	2,00	1,00	w	9,00
	3	m	mathematics	7	3,33	3,33	2,00	1,00	l	3,00
2	4	m	history	5	0,00	0,00	2,00	1,00	w	10,00
	5	m	physics	5	5,00	3,33	4,00	1,00	w	5,00
	6	m	mathematics	4	0,00	0,00	3,00	1,00	l	5,00
3	7	f	musicology	6	1,00	1,00	0,20	0,10	w	9,00
	8	m	mathematics	7	5,00	3,33	4,00	2,00	w	5,00
	9	m	medicine	3	0,00	0,00	2,00	1,50	l	6,00
4	10	m	biology	15	2,00	1,00	2,00	1,00	w	10,00
	11	m	mathematics	7	4,00	2,00	3,00	1,00	w	10,00
	12	f	mathematics	7	3,00	2,50	1,30	1,00	w	10,00
5	13	f	law	11	3,00	2,50	2,00	2,00	w	5,00
	14	f	law	3	2,00	1,00	2,00	1,00	l	2,50
	15	m	law	7	2,00	1,00	2,00	1,00	l	2,50
6	16	m	law	12	6,00	3,50	2,00	1,00	w	4,00
	17	f	latin	7	1,00	1,00	1,00	1,00	w	9,00
	18	m	law	3	0,00	0,00	0,00	0,00	l	7,00
7	19	m	computer science	13	1,00	1,00	0,50	0,50	w	9,00
	20	m	psychology	9	10,00	5,00	5,00	2,50	w	0,00
	21	f	theology/law	9/4	3,00	1,00	3,00	2,00	l	11,00
8	22	m	theology/philosophy	2	2,00	1,00	2,00	1,00	l	0,00
	23	f	law	3	3,33	3,33	2,50	2,50	l	0,00
	24	m	law	1	2,00	1,50	2,00	2,00	l	0,00
9	25	f	medicine	11	5,00	2,50	2,00	1,00	w	5,00
	26	f	educational theory	2	0,00	0,00	0,00	0,00	l	2,50
	27	m	law	9	5,00	3,00	1,00	1,00	l	2,50
10	28	m	law	8	0,00	0,00	2,00	1,00	w	10,00
	29	m	law	3	0,00	0,00	4,00	2,00	w	10,00
	30	f	physics	1	2,00	1,00	1,00	0,50	w	10,00
11	31	m	law	4	2,80	1,40	2,00	1,00	w	32,20
	32	m	economics	5	0,00	0,00	2,00	2,00	w	10,00
	33	f	economics	12	3,33	3,33	3,00	2,50	l	2,80
12	34	m	law	12	2,00	1,00	2,50	1,50	w	8,00
	35	m	english/french	14	3,00	2,00	2,50	1,50	w	7,00
	36	f	economics	7	2,00	2,00	3,00	2,00	l	5,00
13	37	f	law	4	5,00	3,00	3,00	2,00	w	5,00
	38	f	ethnology	8	2,00	1,00	3,00	2,00	w	8,00
	39	m	slavic/english	15	0,00	0,00	2,00	1,00	l	7,00

14	40	f	comparatistics	12	5,00	2,50	5,00	2,50	w	5,00
	41	m	biology	9	2,50	2,50	5,00	3,00	w	7,50
	42	f	economics	13	0,00	0,00	0,00	0,00	l	7,50
15	43	m	economics	7	2,00	1,00	2,00	1,00	w	8,00
	44	m	physics	7	4,00	3,00	2,00	2,00	w	6,00
	45	m	law	5	2,00	1,00	5,00	2,00	l	6,00
16	46	m	medicine	13	1,00	1,00	1,00	1,00	w	10,00
	47	m	physics	8	3,30	3,30	3,30	3,30	w	10,00
	48	m	economics	4	0,00	0,00	0,00	0,00	w	10,00
17	49	m	latin	10	0,00	0,00	5,00	2,50	w	10,00
	50	f	english/americ. studies	4	5,00	3,00	4,00	2,00	w	5,00
	51	m	communication studies	7	5,00	3,33	3,30	2,00	l	5,00
18	52	m	history	3	0,00	0,00	0,00	0,00	w	10,00
	53	m	sinology	3	4,00	2,00	5,00	2,50	w	6,00
	54	f	agriculture studies	5	3,00	3,00	3,00	2,00	l	4,00
19	55	m	japanology	13	5,00	2,50	5,00	2,50	w	5,00
	56	m	economics	5	2,50	1,25	2,50	1,25	l	2,50
	57	m	economics	6	0,00	0,00	0,00	0,00	l	2,50
20	58	m	economics	6	0,00	0,00	1,00	0,50	w	10,00
	59	f	economics	9	5,00	2,50	4,00	2,00	w	5,00
	60	f	linguistics	4	2,00	1,00	2,00	1,00	l	5,00
21	61	m	economics	5	0,00	0,00	2,00	1,00	w	35,00
	62	f	geography	4	5,00	3,00	5,00	3,00	w	10,00
	63	m	economics	6	2,50	1,25	2,50	1,25	w	10,00
22	64	m	economics	7	3,00	2,00	2,00	1,00	w	7,00
	65	m	political science	3	3,33	3,33	2,00	2,00	w	6,67
	66	m	law	1	1,00	0,50	2,00	1,00	l	6,33
23	67	f	geodesy	7	5,00	3,00	4,00	2,50	w	10,00
	68	m	law	8	4,00	2,00	3,00	2,00	w	10,00
	69	f	economics	5	4,00	2,00	4,00	2,00	w	10,00
24	70	m	geography	8	2,00	1,00	4,00	2,00	w	8,00
	71	m	history	10	3,33	3,33	3,33	3,33	l	1,00
	72	m	physics	9	3,00	2,00	3,00	2,00	l	1,00
25	73	m	economics	9	2,50	1,50	3,00	2,00	w	10,00
	74	m	mathematics	13	3,33	3,33	3,00	2,00	w	10,00
	75	m	political science	5	2,00	1,50	1,50	1,50	w	10,00
26	76	f	translation	6	5,00	3,00	4,00	3,00	w	5,00
	77	f	food chemistry	9	3,00	2,50	2,50	2,00	w	7,00
	78	f	law	2	5,00	3,00	4,00	3,00	l	8,00
27	79	f	german philology	9	10,00	5,00	3,00	2,00	w	0,00
	80	m	economics	7	0,00	0,00	1,00	1,00	l	5,00
	81	m	economics	11	2,00	1,00	2,00	1,00	l	5,00
28	82	f	mathematics	10	1,00	0,50	1,00	1,00	w	10,00
	83	m	medicine	2	0,50	0,50	1,00	1,00	w	10,00
	84	m	law	7	3,00	2,00	3,00	2,00	w	10,00
29	85	f	law	3	3,00	1,00	2,00	2,00	w	7,00
	86	m	law	7	0,00	0,00	0,00	0,00	w	10,00
	87	m	economics	5	0,00	0,00	2,00	1,00	l	3,00
30	88	m	japanology	16	0,00	0,00	5,00	2,50	w	10,00
	89	f	law	7	3,00	2,00	3,00	2,00	w	10,00
	90	f	law	7	2,00	1,00	2,00	1,00	w	10,00
31	91	f	law	14	1,00	1,00	1,00	1,00	w	35,00
	92	f	mathematics	13	3,00	2,00	2,00	1,00	w	10,00
	93	f	theology	3	5,00	2,50	5,00	2,50	w	10,00
32	94	m	law	16	2,00	1,00	2,00	1,00	w	8,00
	95	m	theology	3	5,00	3,00	2,00	2,00	w	5,00
	96	m	economics	3	0,00	0,00	2,00	1,00	l	7,00

33	97	f	law	8	1,00	1,00	2,00	1,00	w	8,00
	98	m	political science	5	5,00	2,50	3,00	2,00	l	1,00
	99	m	english	4	5,00	2,50	5,00	2,50	l	1,00
34	100	f	english/french	1	5,00	2,50	4,00	2,00	w	5,00
	101	f	theology/french	9	4,00	2,00	3,00	2,00	w	6,00
	102	m	medicine	6	2,50	2,50	2,50	2,50	l	9,00
35	103	f	biology/theology	13	2,50	1,25	2,50	1,25	w	7,50
	104	m	philosophy	8	3,00	2,00	3,00	2,00	w	7,00
	105	f	law	7	2,00	1,00	1,00	0,50	l	5,50
36	106	m	musicology	9	4,00	2,50	3,00	2,00	w	6,00
	107	f	german	3	2,00	1,00	2,00	1,00	w	8,00
	108	m	economics	12	0,00	0,00	3,00	1,00	l	6,00
37	109	m	physics	1	3,00	2,00	2,00	2,00	w	7,00
	110	m	economics	11	0,00	0,00	2,00	3,00	w	10,00
	111	f	economics	2	3,00	1,50	3,00	2,00	l	3,00
38	112	m	law	5	0,00	0,00	2,00	2,00	w	10,00
	113	f	mathematics	7	3,00	2,00	2,00	1,00	l	0,00
	114	f	english	9	5,00	2,50	2,50	2,50	l	0,00
39	115	m	physics	3	0,00	0,00	1,00	0,50	w	10,00
	116	m	law	1	3,50	2,50	3,00	2,00	w	10,00
	117	f	english/french	10	4,00	2,00	4,00	2,00	w	10,00
40	118	m	mathematics	7	3,33	3,33	2,00	1,00	w	10,00
	119	m	economics	7	2,50	1,25	2,50	1,25	w	10,00
	120	m	german	15	4,00	2,00	3,00	1,50	w	10,00

Appendix C: Proof

– Formal derivation of the incompatibility of exact "fixed total sacrifice" behavior and straightforward utility maximization when the additional lottery is included –

In addition to the solidarity game, in which each subject wins DM 10 with probability 2/3 or zero with probability 1/3, an amount of DM 25 is given to one per thirty subjects. The recipient of this prize in no case receives any conditional gift, even if he or she loses in the game. Taking this additional lottery into account and under the assumptions made in chapter 5, let *EU* now be the total expected utility of player 1. The following equation exhibits *EU* as the sum of the "relevant" part of *EU* with respect to the group states in which player 1 has to give x_1 to a loser plus a term C_1 which does not depend on x_1. Player 1 has to give x_1 to one loser if he or she wins and one of the players 2 and 3 loses and nobody in the group receives the prize of the additional lottery. These states of the group can be abbreviated by [w;w;l] and [w;l;w], where the three terms within the brackets indicate whether player 1, 2, or 3 wins (w) or loses (l). Secondly, x_1 has to be given to a loser if player 1 wins and one of the other players loses and in addition player 1 receives the prize (P) of the lottery, which can be abbreviated by [wP;w;l] and [wP;l;w]. Thirdly, player 1 has to give x_1 if he or she wins and one of the players 2 and 3 loses and the other one receives the prize, [w;wP;l] and [w;l;wP], and, finally, if player 1 wins and both other players lose but one of them receives the prize, [w;lP;l] and [w;l;lP]. We have:

$$\begin{aligned}
EU = {} & \frac{27}{30}\frac{8}{27}\left\{u(10-x_1)+\int_0^{10}\left[v(x_1+x_1')+v(10-x_1')\right]dFx_1'\right\} && \text{[w;w;l] and [w;l;w]}\\
& +\frac{1}{30}\frac{8}{27}\left\{u(35-x_1)+\int_0^{10}\left[v(x_1+x_1')+v(10-x_1')\right]dFx_1'\right\} && \text{[wP;w;l] and [wP;l;w]}\\
& +\frac{1}{30}\frac{8}{27}\left\{u(10-x_1)+\int_0^{10}\left[v(x_1+x_1')+v(35-x_1')\right]dFx_1'\right\} && \text{[w;wP;l] and [w;l;wP]}\\
& +\frac{1}{30}\frac{4}{27}\left\{u(10-x_1)+v(x_1)+v(25)\right\} && \text{[w;lP;l] and [w;l;lP]}\\
& +C_1 .
\end{aligned}$$

Similarly, the next equation exhibits *EU* as the sum of the "relevant" part of *EU* with respect to the group states in which player 1 has to give x_2 to each of two losers plus a term C_2 which does not depend on x_2. Player 1 has to give x_2 to each of two losers firstly if he or she wins and both other players lose and nobody in the group receives the prize, [w;l;l], and secondly if player 1 wins and both other players lose and in addition player 1 receives the prize, [wP;l;l].

We have:

$$EU = \frac{27}{30}\frac{2}{27}\left\{u(10-2x_2)+2v(x_2)\right\}$$ [w;l;l] [wP;l;l]

$$+\frac{1}{30}\frac{2}{27}\left\{u(35-2x_2)+2v(x_2)\right\}$$

$$+C_2 .$$

In the case of x_1 we have the necessary condition:

$$\frac{dEU}{dx_1} = \frac{27}{30}\frac{8}{27}\left\{-u'(10-x_1)+\int_0^{10} v'(x_1+x_1')\,dFx_1'\right\}$$

$$+\frac{1}{30}\frac{8}{27}\left\{-u'(35-x_1)+\int_0^{10} v'(x_1+x_1')\,dFx_1'\right\}$$

$$+\frac{1}{30}\frac{8}{27}\left\{-u'(10-x_1)+\int_0^{10} v'(x_1+x_1')\,dFx_1'\right\}$$

$$+\frac{1}{30}\frac{4}{27}\left\{-u'(10-x_1)+v'(x_1)\right\}=0.$$

or equivalently:

$$-57u'(10-x_1)-2u'(35-x_1)+58\int_0^{10} v'(x_1+x_1')\,dFx_1'+v'(x_1)=0.$$

Concavity of v implies:

$$v'(x_1+x_1') \le v'(x_1).$$

In view of this inequality the necessary condition for x_1 yields the following conclusion:

$$-57u'(10-x_1)-2u'(35-x_1)+59v'(x_1)\ge 0,$$

or equivalently:

(*) $$\frac{57}{59}u'(10-x_1)+\frac{2}{59}u'(35-x_1)\le v'(x_1).$$

We obtain the following necessary condition for x_2:

$$\frac{dEU}{dx_2} = \frac{27}{30}\frac{2}{27}\left\{-2u'(10-2x_2)+2v'(x_2)\right\}$$

$$+\frac{1}{30}\frac{2}{27}\left\{-2u'(35-2x_2)+2v'(x_2)\right\}=0.$$

This yields:

$$\frac{27}{28}u'(10-2x_2)+\frac{1}{28}u'(35-2x_2)=v'(x_2).$$

Assume that player 1 exhibits exact "fixed total sacrifice" behavior which means $x_1 = 2x_2 > 0$. Instead of the last equation we can also write:

$$\frac{27}{28}u'(10-x_1)+\frac{1}{28}u'(35-x_1)=v'(\frac{x_1}{2}).$$

In view of the strict concavity of *v*, this yields the conclusion:

$$\frac{27}{28}u'(10-x_1)+\frac{1}{28}u'(35-x_1)>v'(x_1)\,.$$

This contradicts the inequality (*) which has been derived above. Consequently, exact "fixed total sacrifice" behavior cannot be explained as the result of an altruistic utility maximization – under the assumptions of separability, risk aversion, and symmetry with respect to both players – whether taking or not taking into account the additional lottery.

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