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Working Paper No. 14/2012

OTTO VON GUERICKE
UNIVERSITÄT
MAGDEBURG

FACULTY OF ECONOMICS
AND MANAGEMENT

Impressum (§ 5 TMG)
Herausgeber:
Otto-von-Guericke-Universität Magdeburg
Fakultät für Wirtschaftswissenschaft
Der Dekan

Verantwortlich für diese Ausgabe:
Bodo Vogt
Otto-von-Guericke-Universität Magdeburg
Fakultät für Wirtschaftswissenschaft
Postfach 4120
39016 Magdeburg
Germany

http://www.fww.ovgu.de/femm

Bezug über den Herausgeber
ISSN 1615-4274

Bargaining power does not matter when sharing losses – Experimental evidence of Inequality Aversion in the Nash bargaining game[1]

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Working Paper – June 13, 2012

Abstract

While experimental research on social dilemmas focuses on the distribution of gains, this paper analyzes social preferences in the case of losses. In this experimental study, participants share a loss in a Nash bargaining game. Instead of monetary losses, we use waiting time as an incentive. We assume that participants prefer less to more waiting time. Our experiment consists of four versions of the Nash bargaining game, which vary in a way that allows a comparison of four classical concepts on negotiations (Nash, Equal Loss, Equal Gain, and Kalai-Smorodinski), and Inequality Aversion. We find an equal split of waiting time for all parameter variations. Therefore, our experimental evidence shows that Inequality Aversion provides a better prediction than do classical concepts for the outcome of a Nash bargaining game involving losses. Furthermore, participants resort to Inequality Aversion at the cost of overall welfare.

Keywords: bargaining, losses, inequality aversion, experimental economics

JEL classification: C7, C9

[1] The authors acknowledge financial support by the Ministry for Education and Research of the Federal Republic of Germany (BMBF), Project Uni:prise – Universities as Enterprises.

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1 Introduction

Behavioral analyses of cooperation focus on situations in which one participant decides on an increase in the payoff of one or more other participants at the cost of a reduction of his own payoff. In corresponding experiments participants tend to behave fairly, i.e. they prefer outcomes in which all receive the same payoff (Bolton and Ockenfels, 2000; Fehr and Schmidt, 1999). The opposite of cooperation is competition. In a competitive situation participants focus exclusively on their own payoffs, i.e. they are myopic (Smith, 1994). While both concepts in isolation have been intensively studied, one central question remains: In situations in which both competition and cooperation are possible, can an increase in competition result in myopic behavior even though cooperation is still possible?

One game well suited to this kind of question is the Nash bargaining game (Nash, 1950). Here, two players bargain over the distribution of a divisible and limited good. Both players can cooperate by agreeing to give part of the good to the other player. At the same time, they compete with each other to obtain as much as possible. Typically, if the willingness to cooperate is too low, no agreement is reached and neither of the players receives any part of the good. In corresponding games, one can manipulate the importance of competition and cooperation in different ways: (1) Increasing the cost of not coming to an agreement leads to greater benefits attaching to cooperation. (2) Increasing the benefit derived from the good for one player over the other gives the latter a competitive advantage. (3) Distributing bads instead of goods leads to higher discrimination between competition and cooperation. As players are generally more sensitive to losses than to gains (Kahneman and Tversky, 1979), the utility they gain for a fixed amount of a good is inferior to the utility they lose from a loss at the same level. Hence, differences in payoffs in the presence of disagreement should have a stronger influence on the agreement in case of losses, leading players to discriminate more clearly based on their relative gains in the bargaining game. In the remainder of this paper, we focus on the last two aspects. That is to say, we investigate a Nash bargaining game over losses and vary the benefit that participants receive from the divisible good.

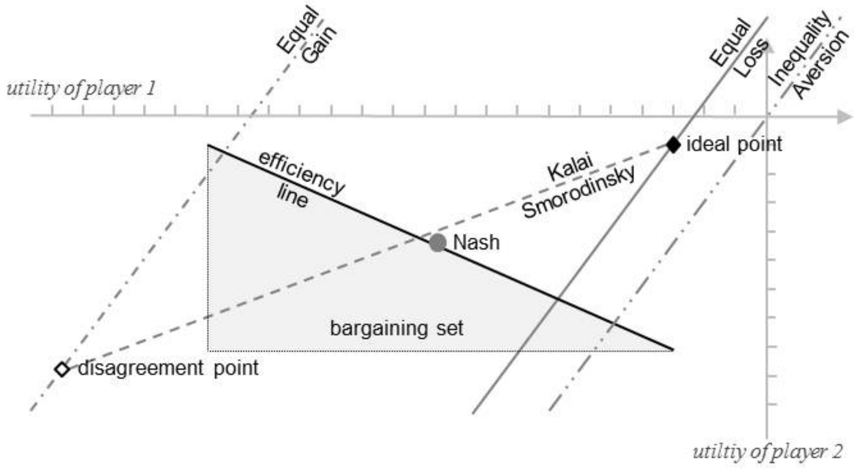

Figure 1: Graphical representation of Nash bargaining game

Figure 1 shows a typical illustration of the Nash bargaining game over losses, where the x-axis shows the utility of player 1 and the y-axis the utility of player 2. Both players bargain over a divisible bad. If player 1 (2) takes nothing of the bad, his utility is maximal. Namely his utility is close to the x-axis (y-axis). The combination in which both players take nothing of the bad is the ideal point (Chun, 1988). The set of all feasible distributions is called the bargaining set. In our example, the bargaining set is limited by one line representing all distributions in which the bad is exactly distributed (the efficiency line), and one line per player in which the corresponding player takes the whole bad and the other player takes any possible fraction of the bad (resulting in the players distributing too much). If both players come to no agreement, they reach the disagreement point (Kalai and Smorodinsky, 1975). In our example disagreement leads to a distribution in which player 2 receives about as much utility as if he had taken the whole bad, while player 1 is even worse off than if he had taken the whole bad.

The Nash bargaining game with two players distributing a loss differs slightly from the corresponding game over gains. While the disagreement point refers to the minimum gain the players can realize for goods, it represents the maximum loss they can realize for bads. The ideal point in the Nash bargaining game over gains describes a utility combination which is only theoretically of importance. Bargaining partners can never reach it. For bargaining over losses, this point has practical relevance. It characterizes the combination of losses that each partner realizes regardless of the outcome of the Nash bargaining game.

A set of solution concepts was introduced to solve the Nash bargaining game by finding an outcome combination with respect to both competition and cooperation. According to Nash (1950) the players pick the outcome combination on the efficiency line that maximizes the product of both players' gains relative to the disagreement point.

The Nash solution implies that extending the bargaining set can lead to solutions in which one of the players is worse off than with the limited bargaining set (Kalai, 1977). Addressing this argument, the Kalai-Smorodinsky solution incorporates the ideal point and lies on the intersection of the efficiency line and the connecting line between the disagreement and ideal points (Kalai and Smorodinsky, 1975).

Another critique of the Nash solution is that two players who distribute a divisible good agree on an equal split of the good even if one player receives less utility than the other from consuming a fixed share of the good (Kalai, 1977; Nydegger and Owen, 1974). The Equal-Gain (Equal-Loss) solution addresses this critique by identifying the point of the efficiency line that gives an equal utility increase (decrease) relative to the disagreement point (ideal point) for both players (Chun, 1988; Kalai, 1977).

All authors of these four classical solution concepts incorporate some form of fairness in the solution concept. More recent approaches, however, model fairness as part of the utility function (Bolton and Ockenfels, 2000; Charness and Rabin, 2002; Engelmann and Strobel, 2004; Fehr and Schmidt, 1999). Consequently, these models derive preferences from value functions of final experimental outcomes rather than gains and losses relative to either the disagreement or ideal point. The common property of these fairness models is Inequality Aversion, which means that the utility of an outcome combination for a player decreases once their own payoff differs from the payoffs of others (Engelmann and Strobel, 2004). In the context of the Nash bargaining game involving losses, Inequality Aversion implies that both partners realize the same loss at the end of the game regardless of what they would realize in the disagreement or ideal point. This means that in fairness models the origin is the point of reference for evaluating final experimental payoffs regardless of the specifications of the Nash bargaining game.

Recent experimental studies stress the importance of reference points in distribution games. This means that the equal split of final experimental payoffs is the easiest point of reference for experimental participants to find and is therefore the most likely payoff realized (Herreiner and Puppe, 2010). However, whether overall welfare considerations affect the distribution of experimental income has not been resolved. Specifically, the Pareto-efficient allocation in the Nash bargaining game that equalizes final payoffs of both participants does not necessarily maximize overall welfare. While decision makers in dictator games do not minimize inequality at the cost of overall welfare (Kritikos and Bolle, 2001), they do sacrifice overall welfare for equality in final payoffs in ultimatum games (Herreiner and Puppe, 2010). As a result, the question of whether welfare considerations affect the outcome combination realized in Nash bargaining games has remained open.

All solution concepts (Nash, Kalai-Smorodinsky, Equal Gain, Equal Loss, and Inequality Aversion) differ in the (sub-)set of parameters considered and in their predictions. In this paper, we analyze which of these solution concepts provides the best prediction for the outcome of a Nash bargaining game over losses. We implement individual losses using waiting time. Waiting time as the medium of experimental reward satisfies assumptions about its appropriateness as experimental reward. Waiting time is a bad since any waiting time is perceived to be worse than no waiting time and the longer the waiting time the higher the participant's disutility (Kroll, 2009; Leclerc et al., 1995).

We find that recent fairness models provide the best prediction for the outcome of the Nash bargaining game over losses. Participants arrive at this agreement while ignoring their competitive advantage, created by differences in the ideal and/or disagreement point. Furthermore, the analysis of the anonymous chat protocols of the bargaining stage shows that in most cases, the prediction of Inequality Aversion is the first outcome combination to be proposed in the experiment.

The outcome combination predicted by Inequality Aversion for our specifications of the Nash bargaining game does not minimize the overall waiting time of the partners. This means that, by choosing to split waiting time equally, the bargaining pairs accept a loss in their overall welfare.

2 Experiment

2.1 Nash Bargaining Game

At the beginning of our Nash bargaining game both players i with $i \in \{1,2\}$ receive a loss of a_i minutes waiting time. The combination of the initial losses is the ideal point (a_1, a_2). These losses are fixed and players cannot receive better payoffs than this—no matter what they play. The variable part of the payoff results from the distribution of 100 tokens. To distribute the tokens both players communicate via a chat window. As soon as one player ends this bargaining phase, each of the players specifies the number of tokens x_i he will keep. For both players one token represents f_i minutes waiting time. E.g., if player i keeps x_i tokens, his loss added to a_i is $x_i \cdot f_i$ minutes. Three outcomes of the game are possible: (1) $x_1 + x_2 < 100$: the players do not reach an agreement and have to wait for b_i minutes. Note, (b_1, b_2) is the disagreement point. (2) $x_1 + x_2 = 100$: the players reach an agreement and distribute exactly 100 tokens. In this case the payoff for player i is $a_i + x_i \cdot f_i$ minutes waiting time. All agreements fulfilling this condition form the efficiency line. (3) $x_1 + x_2 > 100$: the players reach an agreement, but distribute more than 100 tokens. In this case, the payoff for player i is $a_i + x_i \cdot f_i - \frac{x_1+x_2-100}{2}$ minutes of waiting time. Namely, the payoff of each player is reduced by half of the tokens distributed more than necessary. This ensures that if the players come to an agreement, they never face a combined loss of more than 100 tokens. In other words, in our design, bargaining set and efficiency line are identical.

2.2 Treatment Design

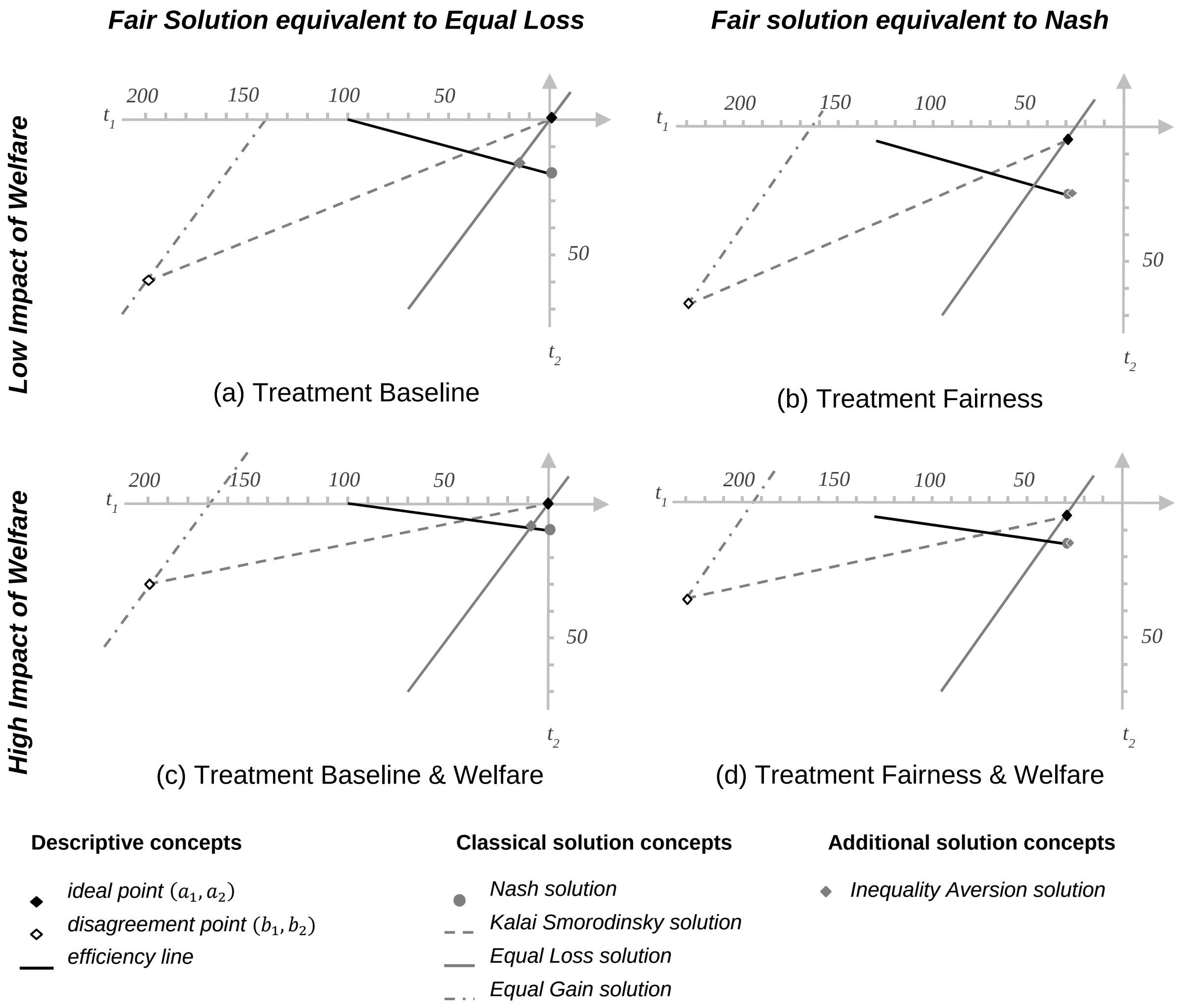

Figure 2: Graphical representation of our treatments and the theoretical solutions

The experiment consists of four treatments that differ in the specification of the Nash bargaining game (Figure 1 provides a list of the specification of parameters and Table 1 provides a graphical representation of the treatments and corresponding solutions). With our Baseline Treatment we clearly differentiate the prediction of the classical solution concepts (Nash, Kalai-Smorodinsky, Equal Gain, and Equal Loss). According to the specification, player 1 does not take any additional waiting time given the Nash solution, while he should take all waiting time when behaving according to the Equal Gain solution. According to Equal Loss player 1 accepts 16.67 tokens and according to Kalai-Smorodinsky player 1 accepts 40 tokens.

	Parameter Set			*Prediction (tokens assigned to player 1)*					
Treatment	***Disagreement*** (b_1, b_2)	***Ideal*** (a_1, a_2)	***Factors*** (f_1, f_2)	***Nash***	***Equal Loss***	***Equal Gain***	***Kalai-Smoro.***	***Inequality Aversion***	***Welfare Maximal***
Baseline	(-200;-60)	(0;0)	(1;0.2)	0	17	100	40	17	0
Fairness	(-230;-65)	(-30;-5)	(1;0.2)	0	17	100	40	0	0
Baseline & Welfare	(-200;-30)	(0;0)	(1;0.1)	0	9	100	40	9	0
Fairness & Welfare	(-230;-35)	(-30;-5)	(1;0.1)	0	9	100	40	0	0

Table 1: Treatments and theoretical solutions

In the Baseline Treatment, the predictions of Equal Loss and Inequality Aversion are identical. We analyze the influence of Inequality Aversion by shifting the bargaining set away from the origin (see Figure 2). We achieve this by adding additional waiting time to both ideal and disagreement point. In particular, player 1 needs to wait 30 minutes and player 2 needs to wait 5 minutes in addition to the waiting time resulting from the distributed tokens. Independent of this shift, the predictions of the classical solution concepts remain identical. The prediction of Inequality Aversion, however, takes the relative disadvantage of player 1 into account. Therefore, the prediction of Inequality Aversion changes in the Fairness Treatment and predicts that player 1 does not receive any additional waiting time in the Nash bargaining game.

Welfare, defined as the sum of waiting times for both players, is maximized in our Nash bargaining game, if the player with the smaller factor (player 2) takes all tokens. In other words, for each token player 1 has to wait 1 minute while player 2 only has to wait 12 seconds. To analyze whether welfare influences behavior in Nash bargaining games, we reduce f_2 for player 2 to 0.1 for both the Baseline and Fairness Treatment. As for the Baseline and Fairness Treatment, player 2 should still take all tokens, however any deviation from taking all tokens results in a higher loss of welfare. We call the modification of the Baseline (Fairness) Treatment with factor 0.1 for player 2 the Baseline & Welfare (Fairness & Welfare) Treatment.

2.3 Experimental procedure

We recruited a total of 84 participants and allocated them to the experimental treatments using ORSEE (Greiner, 2004). All participants were students at the Otto-von-Guericke University Magdeburg, enrolled in various fields of studies. We assigned the participants in pairs of two to different sessions with ten participants per session. Participants who did not show up in time caused departures from this number.

We assigned each participant to a separate sound-proof cabin in the university's MaXLab. We placed a computer terminal in each cabin to play one Nash bargaining game implemented using z-Tree (Fischbacher, 2007). During the experiment, we closed each cabin in order to inhibit communication between the participants.

At the beginning of each session the participants received a show-up fee of 10 euros for their participation. We informed them that during the experiment no further monetary payoffs would be earned, and that the decisions they performed during the experiment would determine only the duration of the experiment. We informed the participants that they would have to return the show-up fee if they left before the waiting time ended. During all our sessions none of the participants decided to leave early.

Next, participants received written instructions about the Nash bargaining game and the procedure of the unstructured bargaining process. After reading the instructions, participants were allowed to address questions in private to the experimenter. For each question the experimenter joined the participant in her cabin. This kept other participants from following communication between the experimenter and the individual asking the question.

When it was clear that there were no further questions, the z-Tree program started. The computer terminal showed each participant the parameters of the game, namely the disagreement point, ideal point and the exchange rates determining how the tokens they received would be converted to waiting time. Then the participants entered the bargaining stage. They were now given the opportunity to negotiate with their partners using a chat interface. We instructed the participants to communicate freely. However, we told the participants not to state anything about their identity, which would compromise anonymity in the experiment. We set no time limit for this bargaining stage. After both partners had left this communication stage, each partner used the computer terminal to enter the number of tokens they had offered to accept. The experimental software then calculated the distribution of waiting times according to the rules of the game (as specified in subsection 2.1).

Each participant spent the resulting waiting time in the experimental cabin. The computer terminal showed a countdown of the remaining waiting time. During the waiting time the participants had no access to books, study materials, the Internet, mp3-players or any other form of entertainment. At the end of the waiting time, the experimenter released the participant.

The participants spent an average of 23.75 minutes waiting after ending the bargaining process. The highest waiting time was 200 minutes and the lowest 5 minutes. On average each session lasted about 45 minutes.

3 Results

We consider the data from each pair of two participants playing one bargaining game as one independent observation. In total, we collected data from 42 pairs. Table 1 gives an overview of the aggregated data. Only one pair came to no agreement, five pairs overbid, and 36 came to an exact distribution of all 100 points. The pair that came to no agreement was so far wide of any theoretical solution (player 1 offered 10, player 2 offered 60) that we considered it an outlier.

Unless otherwise specified, we ignore the outlier throughout our analysis. We focus on player 1’s offer because, given that the pair reached an agreement, the offers together add up to 100 so player 2’s offer can be derived from that of player 1.

Treatment	Player 1		Player 2		Frequency of Agreement Types		
	Mean	SD	Mean	SD	No	Overbidding	Exact
Baseline	23.10	13.87	76.90	10.17	1	2	7
Fairness	19.10	37.56	91.00	24.79	0	3	7
Baseline & Welfare	12.83	5.87	87.17	5.87	0	0	12
Fairness & Welfare	2.10	4.18	97.90	4.18	0	0	10

Table 2: Observed averages

3.1 Impact of Inequality Aversion

As motivated when introducing our treatments (see Section 2), all classical solution concepts (Nash, Kalai-Smorodinsky, Equal Gain, and Equal Loss) predict no difference in offers between Treatment Baseline (Baseline & Welfare) and Treatment Fairness (Fairness & Welfare). However, predictions of Inequality Aversion for both treatment combinations differ.

The average offer of player 1 (see Table 2) in both Baseline Treatments, Baseline (23.10) and Baseline & Welfare (12.83), is higher than it is in the shifted version of the game, Fairness (19.10) and Fairness & Welfare (2.10). This difference is significant (Baseline vs. Fairness: MWU-Test, U=18.0, p=0.028, Baseline & Welfare vs. Fairness & Welfare: MWU-Test, U=10.0, p=0.000).

This analysis shows that shifting the bargaining set does affect the agreement. In contrast to the classical solution concepts, Inequality Aversion allows for this difference. While the ideal point and disagreement point—used to calculate the classical solution concepts—are moved when shifting the bargaining set, the point used to calculate the Inequality Aversion solution, the origin, remains fixed. Inequality Aversion also correctly predicts the direction of change in offers. The waiting time per token of player 2 in both treatments with high impact of welfare is half as high as in both other treatments. Hence, in these treatments inequality-averse participants should assign more tokens to player 2 and fewer to player 1, as we in fact observe in our experiments.

We conclude that Inequality Aversion is the only solution concept predicting the impact of shifting the bargaining set in our experiment. This result suggests that Inequality Aversion is the best predictor for this type of Nash bargaining game. To further investigate the impact of Inequality Aversion, we evaluate the predictive success of each solution concept using the absolute difference between offer and prediction of the solution concept for player 1. Table 3 gives a first impression of the quality of all solution concepts by showing the mean squared differences per treatment.

Treatment	Nash	Equal Loss	Equal Gain	Kalai-Smorodinsky	Inequality Aversion
Baseline	774	228	5.863	410	228
Fairness	1.634	1.273	7.814	1.706	1.634
Baseline & Welfare	196	46	7.630	770	46
Fairness & Welfare	20	63	9.600	1.452	20

Table 3: Mean squared differences for solution concepts

For the Baseline Treatment and the Baseline & Welfare Treatment, predictions of Inequality Aversion and Equal Loss are identical. The offers made by participants differ less from Inequality Aversion (and Equal Loss) than from the remaining classical solution concepts (Baseline: Inequality

Aversion vs. Nash, WX-Test, Z=-3.000, p=0.003; Inequality Aversion vs. Equal Gain, WX-Test, Z=-2.579, p=0.010; Inequality Aversion vs. Kalai-Smorodinsky, WX-Test, Z=-1.688, p=0.091; Baseline & Welfare: Inequality Aversion vs. Nash, WX-Test, Z=-3.357, p=0.001; Inequality Aversion vs. Equal Gain, WX-Text, Z=-3.104, p=0.002; Inequality Aversion vs. Kalai-Smorodinsky, WX-Test, Z=-3.024, p=0.002).

Since the difference between Fairness and Fairness & Welfare is only the shift away from the origin, only the prediction of Inequality Aversion is affected while those of the classical solution concepts are not. In these treatments, Nash and Inequality Aversion predict the same outcome, while the prediction of Inequality Aversion differs from Equal Loss. The comparison of absolute differences between offers and predictions is less clear in our Fairness Treatment. Here, predictions are significantly better for Inequality Aversion than for Equal Gain (Inequality Aversion vs. Equal Gain, WX-Text, Z=-1.984, p=0.047). However, the benevolence inherent in inequality aversion as compared with that in Equal Loss and Kalai-Smorodinsky is not significant (Inequality Aversion vs. Equal Loss, WX-Test, Z=-1.324, p=0.185; Inequality Aversion vs. Kalai-Smorodinsky, WX-Test, Z=-1.430, p=0.153). For Treatment Fairness & Welfare, Inequality Aversion again outperforms all other solution concepts (Inequality Aversion vs. Equal Loss, WX-Test, Z=-1.720, p=0.086; Inequality Aversion vs. Equal Gain, WX-Text, Z=-2.913, p=0.004; Inequality Aversion vs. Kalai-Smorodinsky, WX-Test, Z=-2.913, p=0.004).

The low significance level of the results in Treatment Fairness results from those groups who reach an agreement by overbidding. Here, player 1 accepts more tokens than agreed to, according to the chat protocol. In one case player 1 even offered 100 tokens instead of the ten tokens specified in the chat. The deviations in these two groups of Treatment Fairness are the main drivers of both, the larger mean squared difference of Inequality Aversion and the high p-value for the comparison of Inequality Aversion to Equal Loss.

In order to provide a qualitative ranking of all the solution concepts under consideration, we conduct pairwise comparisons of the predictive success, i.e. the difference between offer and prediction, for all solution concepts. Table 4 shows the p-values of a test checking whether the solution concept in the row outperforms the solution concept in the column (using a binomial test). The order of predictive quality of the solution concepts starting with the best alternative is (1) Inequality Aversion, (2) Equal Loss, (3) Nash, (4) Kalai-Smorodinsky, and (5) Equal Gain.

Treatment	***Equal Loss***	***Nash***	***Kalai-Smorodinsky***	***Equal Gain***
Inequality Aversion	0.041	0.000	0.000	0.000
Equal Loss		0.118	0.000	0.000
Nash			0.000	0.000
Kalai-Smorodinsky				0.000

Table 4: Predictive success – p-values in favor of the row concept

The solution concepts differ in their interpretation of different reference points, i.e. origin, disagreement point and ideal point. While the classical solution concepts only resort to disagreement point and ideal point, fairness models focus on the origin (e.g. Fehr and Schmidt, 1999). In our experiment, due to Inequality Aversion, participants do not utilize their competitive advantage given by favorable exchange rates, ideal and disagreement points. They use the origin as reference point. It seems that the equal split of final waiting time is the easiest reference point to identify. This result is also confirmed by an analysis of our chat protocols. They show that 30 out of 42 pairs first mention equal splits of waiting times before any other outcome combination. This result is significant (Binomial-Test, p=0.008) and supports the argument that the equal split is the easiest reference point for the negotiation that the partners can agree on and is therefore the most likely outcome. This result is in line with (Herreiner and Puppe, 2010).

3.2 Welfare considerations

The classical solution concepts regard efficiency of agreements in the Nash bargaining game in the sense of Pareto. In this sense, all solution concepts are efficient. However, one can also consider efficiency in terms of overall welfare (Engelmann and Strobel, 2004). In all the treatments of our experiment, player 2 receives fewer minutes of waiting time per token accepted. The overall waiting time of each pair is therefore minimal (overall welfare is maximal), if player 1 takes no token in the Nash bargaining game.

We find that for 29 of the 41 pairs, player 1 receives tokens. This means that the participants in our experiment do not maximize overall welfare by minimizing the total loss experienced in each pair. However, the behavior associated with our treatments stressing the importance of welfare, Baseline & Welfare and Fairness & Welfare, seems to be different from that associated with the treatments that gave less importance to welfare, Baseline and Fairness (see Table 2). In treatments in which welfare is given more importance, participants always find an agreement and standard deviations of their offers are lower. To analyze whether this effect has a significant impact on the players' offers, we investigated whether offers in the treatments with low impact of welfare, Baseline and Fairness, deviate more from the prediction of Inequality Aversion than offers in the treatments with high impact of welfare. This effect is not significant (Baseline vs. Baseline & Welfare: MWU-Test, U=52.5, p=0.917, Baseline & Welfare vs. Fairness & Fairness & Welfare: MWU-Test, U=38.5, p=0.393). We conclude that participants realize fair distributions of the loss at the cost of overall welfare. They are, however, more likely to stick to the agreement they made during the chat.

4 Conclusion

This experimental study shows that in a Nash bargaining game involving the distribution of losses, out of 41 bargaining pairs all but one came to an agreement. The equal split of final losses is the best predictor for the experimental outcomes. Fairness provides a better prediction for outcomes of bargaining games involving losses than the classical solution concepts, Nash, Equal Loss, Equal Gain, and Kalai-Smorodinsky. This result is especially interesting since, in our pairs, participants did not make use of the bargaining power they possessed due to their different bargaining situations, but tried to reach a fair outcome.

The realization of social equality in terms of an equal split of final losses, however, was realized at the cost of social welfare. By allowing asymmetry in realized losses, the partners could have maximized welfare by minimizing the sum of losses of both partners. That they did not is in contrast to previous findings that efficiency outweighs Inequality Aversion as a motive in distributional games (Engelmann and Strobel, 2004; Kritikos and Bolle, 2001). It does, however, support the findings of Herreiner and Puppe (2010) who find decision makers to be equality oriented in a structured bargaining game.

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ISSN 1615-4274