How Unanimity Bargaining Can Resolve the Subjective Claims Problem*

Anita Gantner†, Kristian Horn‡, and Rudolf Kerschbamer§

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Abstract

In a subjective claims problem several partners have contributed to a joint surplus which is to be divided amongst them. Since contributions are difficult to compare, subjective evaluation of claims are likely to be conflicting. In a large-scale experiment, we investigate fairness and efficiency of three unanimity bargaining protocols used to reach a consensus in a three-person subjective claims problem. We elicit partial and impartial fairness views and use them – besides known fairness standards – to assess the performance of the bargaining procedures. We find that Shaked's Offer rule, where the proposing player has to specify a complete division proposal which the other two players have to accept sequentially, comes closest to the various fairness measures used.

Keywords: Fair Division, Subjective Claims, Bargaining, Experiment

JEL Classification: D63, C91, D61

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†University of Innsbruck, Department of Economics, Universitätsstr. 15, 6020 Innsbruck, Austria; anita.gantner@uibk.ac.at

‡University of Innsbruck, Department of Economics, Universitätsstr. 15, 6020 Innsbruck, Austria; kristian.horn@uibk.ac.at

§Corrresponding author; University of Innsbruck, Department of Economics, Universitätsstr. 15, 6020 Innsbruck, Austria; rudolf.kerschbamer@uibk.ac.at

1 Introduction

In a 'tragedy of the anticommons' problem, as defined by Heller (1998), several parties have the right to veto the coordinated use of a common resource, and by acting separately, they collectively waste the resource compared with a social optimum. Heller lists several examples, such as technological innovation that requires the accumulation of many patents held by diverse private parties, or a rundown neighbourhood where the value of the consolidated property greatly exceeds the sum of the values of the individual properties in their current uses. Common to these examples is the inefficiency of the stand-alone solution and the fact that diverse individual rights would have to be assembled to remove the inefficiency. Assembling the rights, however, is difficult because it requires unanimous consent about the value of each party's contribution to the partnership and the resulting fair share of the surplus and because there is no objective way to assign shares in a fair way to the parties involved.

Estimating the value of each party's contribution by removing it from the partnership is of limited help, since the market values of the individual rights are fairly small compared to the combined value of the resources. Asking an impartial outside observer to assign shares to the involved partners may be a solution, but an outsider typically has far less information on the contributions and the fairness judgments of the partners than the partners themselves, and eliciting truthful information from the partners is likely to be a non-trivial task. The partners may therefore prefer to rely on their own subjective perceptions on how the amount should be divided fairly, and they may find it useful to use a bargaining procedure to reach a consensus. The obvious question then is which procedure this should be.

The present study investigates this question by comparing – in a large-scale experiment with more than 600 participants – three unanimity bargaining procedures in terms of fairness and efficiency in a stylized version of the tragedy of the anticommons' problem, which shall be refered to as the *subjective claims problem*. It is characterized by a given surplus (the 'cake') which is to be divided amongst a given number of agents (the 'partners') holding entitlements to it. Entitlements (or 'claims') are subjective and have been derived from inputs towards the production of the cake. The contribution of inputs to the value of the cake is difficult to assess because inputs are difficult to compare and because they have a stand-alone value of zero.[1] Subjective assessments of claims are then likely to be conflicting. Throughout, we assume that the partners are interested not only in their own material payoff, but also in the fairness of the allocation. When n partners are involved, the division of a cake of size S that is considered fair by partner i is a vector with n entries summing up to S, and it shall be referred to as i's *subjective evaluation of claims*.

We generate a subjective claims problem involving three partners A, B and C in the experimental lab and study the effect of three different bargaining procedures on bargaining behavior and realized outcomes when the goal is to obtain an allocation $s = (s_A, s_B, s_C)$, where $\sum_i s_i \leq S$, which is considered fair by the partners (in the sense that it respects all claimants' fairness views in some appropriate sense – see the discussion below) and which is also efficient (in the sense that $S - \sum_i s_i$ is minimized). To induce entitlements, subjects perform a real effort task, from which they earn points based on their performance. Then each subject is matched with two other participants into a partnership which has to agree on the division of a surplus whose size depends on the points earned by the partners in the real effort task. Two design features are meant to help to induce conflicting evaluations of claims. First, the partners earn their contribution points from their relative performance in different subgroups. Thus, even if two partners contribute the same number of points toward the partnership, each might still think he should get a larger share – for instance, because he thinks he has earned his points in a more competitive subgroup. Secondly, the points of the three partners enter a non-linear production function. This makes it difficult to translate differences in contribution points into differences in fair shares in the joint surplus. In each partnership the jointly produced surplus is then allocated among the partners according to one of three bargaining protocols.

Most of the related experimental literature on bargaining and distribution games with joint production focuses on bilateral bargaining (see Karagözoglu 2012 for a survey). For the bilateral case, the Rubinstein (1982) protocol is probably the most prominent and best-understood bargaining procedure. In that protocol

[1] While in Heller's examples the combined value of rights is worth much more than the sum of individual rights, each right still has some value in isolation. In this study we abstract from positive stand-alone values of rights for the sake of simplicity.

in each round one of the two players is in the role of the proposer, the other in the role of the responder. The proposer's task is to make a proposal for the split of the cake which the responder either accepts or rejects. In case of acceptance the proposal is implemented and the game ends; in case of rejection the next bargaining round starts with the roles reversed. Rubinstein (1982) formalized this structure, showing that the unique subgame perfect equilibrium outcome converges to the Nash bargaining solution as the time delay between proposals goes to zero.

In this study we compare the performance of three extensions of the Rubinstein bargaining protocol to a three-player setting.[2] In the *Offer* rule due to Shaked (see Sutton 1986) players take turns in making complete division proposals, and an agreement is achieved if the other two partners sequentially agree to the proposal.[3] The *Exit* rule proposed by Krishna and Serrano (1996) extends Shaked's *Offer* rule by allowing a player to exit with his currently proposed share while the others continue to bargain. Finally, in the *Demand* rule due to Torstensson (2009) players only state proposals regarding their own share, and an agreement is reached if the proposals do not add up to more than the cake size. To the best of our knowledge none of these procedures has been tested in the lab before.

Our main research question is whether there is a trade-off between efficiency and fairness in three-person unanimity bargaining. The yardstick for the efficiency comparison across procedures is rather obvious – it is the share of the joint surplus which is finally paid out to the partners (after discounting). To compare bargaining procedures regarding the fairness of their outcomes, we need to define appropriate

[2]In extending the Rubinstein protocol to the $n > 2$ case several design decisions have to be made. First, one has to decide between majoritarian and unanimity bargaining. Majoritarian decision rules received high attention in political bargaining and voting models – see the theoretical models by Baron and Ferejohn (1987 and 1989), and Morelli (1999), as well as the experimental work by Frechette et al. (2005a, 2005b and 2005c), among others. Given our explicit goal that the outcome should take into consideration all partners' fairness views, we include only unanimity procedures in our horse race. Secondly, one has to decide between interpreting the Rubinstein protocol as an alternating-offers or an alternating-demand model. Our horse race includes two alternating-offers and one alternating-demands bargaining models. We leave aside models with a central player and several small players such as in Cai (2000) or separate negotiations among a subset of the players with partial agreements, such as in Chae and Yang (1994), as they impose an asymmetry amongst players or change the multilateral nature of bargaining, which is not in our focus.

[3]Haller (1986) proposes a procedure that has the same protocol as Shaked's *Offer* rule except that players 2 and 3 simultaneously decide on the complete division proposal of player 1 instead of deciding sequentially. Since the two protocols are very similar, we decided to include only one of them in our comparison.

fairness benchmarks. The first benchmark we consider is an evaluation from a *partial point of view*. It is obtained by eliciting participants' subjective evaluations of claims in a hypothetical fairness question.[4] We consider stakeholders' view important here, since, after all, it is the involved parties who have to live with the final outcome, and they typically have more information than anyone else on partners' contributions and their fairness views.

The second benchmark regarding the fairness of bargaining outcomes is an evaluation from an *impartial point of view*. It is derived from the vignette technique, which uses questions in a survey describing concrete but hypothetical scenarios in order to elicit fairness views (see e.g. Konow 2003, or Yaari and Bar-Hillel 1984). In our context, impartial outside observers are asked what they consider a fair division of the surplus – on the basis of the description of the real effort task, the points achieved by the partners and the production function. The impartial view expressed in the vignette shall also help us put into perspective the self-serving bias which is expected in stakeholders' responses to the fairness question.

The third fairness benchmark will draw on *objective fairness norms*, which are known to play an important role for the evaluation of claims in division problems where entitlements are objective and common knowledge (see e.g. Gächter and Riedl 2005 and 2006, or Herrero et al. 2010). Specifically, we consider the *egalitarian standard*, where the cake is distributed equally among the partners; the *proportional standard*, where shares are assigned proportionally to the points each partner has contributed; and the *accountability standard*, where each partner receives an equal share of the fixed part of the production function and the remainder of the cake is divided proportionally to the points contributed.[5]

Our results show that stakeholders' partial and outside observers' impartial fairness views point to very similar allocations after correcting for the self-serving bias in the fairness judgements of stakeholders. Payoffs in all bargaining procedures reflect contribution orders, and the spread between low and high contributors is smaller than what the proportional standard would predict. Payoffs depend to different degrees on the strategic position of a player in the respective bargaining

[4] This is done before the partners actually bargain on a division of the cake.

[5] The motivation for considering this standard (or for defining it this way) is that players might not hold each other responsible for the fixed part of the production function, but only for the variable part that depends on contribution points and thus effort.

procedure, and fairness views are not reflected in bargaining outcomes in all procedures. Overall, we find that the three unanimity bargaining procedures perform extremely well in terms of efficiency – only for the *Exit* rule the share of the surplus that is lost due to delay is slightly larger. In terms of fairness, the Offer rule produces bargaining outcomes that are, on average, closest to the fairness ideas reflected in the partial and the impartial view. Together those findings imply that there is no tradeoff between efficiency and fairness in three-person unanimity bargaining – the Offer rule does not do worse than the other procedures in terms of efficiency and it does better in terms of fairness.

Regarding related literature our paper is closest to articles investigating how competing and conflicting fairness assessments cause inefficient delays in bargaining. An early contribution in this vein is Camerer and Loewenstein (1993) who find that disagreement about fairness is an essential ingredient for such inefficiencies. Birkeland and Tungodden (2014) show that incompatible fairness views can lead to disagreement in Nash bargaining when sufficient weight is put on fairness considerations. In Birkeland's (2013) experimental study, where pairs of subjects contribute different but objectively known amounts towards the surplus, a vast majority of divisions is close to proportionality with the dictator game as allocation rule. When alternating-offers bargaining is used instead, dispute costs increase because agreements take longer, and the impact of contributions on agreements decreases. Karagözoglu and Riedl (2014) study bilateral free-form bargaining in a setup similar to ours, where subjective entitlements arise because there is no or only ordinal information on the partner's contribution, or because of noise in the production process. They find that information about relative performance induces outcomes away from the equal split. Our study is complementary to this work as (i) we ask how subjects' fairness evaluations interact with initial proposals, bargaining duration and concessions in three different bargaining procedures, and (ii) we extend the context to more than two players.

The rest of the paper is organized as follows: Section 2 describes the three bargaining procedures. Section 3 introduces the design of the experiment and the vignette study. Section 4 discusses the various benchmarks we consider to evaluate the bargaining outcomes. Bargaining results are presented and discussed in Section 5. Section 6 concludes.

2 Bargaining Environment and the Three Procedures

Consider a subjective claims problem where the three partners A, B, and C have jointly produced the cake S, which has now to be divided amongst them. We assume that each partner is interested not only in her own payoff or share of S, but also in the fairness of the allocation. Denote agent i's subjective evaluation of claims by $e^i = (e^i_A, e^i_B, e^i_C)$, where e^i_j stands for the amount partner j should receive from agent i's perspective. Throughout we assume that $e^i_A + e^i_B + e^i_C = S$ for $i = A, B, C$. The three unanimity bargaining procedures we compare each yield an allocation $s = (s_A, s_B, s_C)$, where $\sum_i s_i \leq S$.

2.1 Shaked's *Offer* Rule

In the *Offer* rule due to Shaked (see Sutton 1986), players take turns in making complete division proposals $x = (x_1, x_2, x_3)$, where x_i is the share proposed for player i and where $\sum_i x_i = S$. Player 1 makes the first proposal in round $t = 1$. Player 2 and player 3 then respond sequentially, each either accepting or rejecting the proposal. If both responders accept, then the game ends with the allocation $s = (x_1, x_2, x_3)$ being implemented. In case of a rejection, the game proceeds to round $t = 2$, where player 2 makes a proposal and players 3 and 1 sequentially respond. If one of the latter two players rejects, then the next round begins with player 3 making an offer, and so on. There is no exogenous termination round, and payoffs are discounted by the common discount factor δ; that is, if an agreement is reached in round t where player i receives x_i, then i's actual payoff is $\delta^{t-1}x_i$. With the aid of an example for three players, Shaked showed that Rubinstein's result of a unique subgame perfect equilibrium (SPE) for the bilateral case does not carry over to the multilateral case. Rather, every allocation of the dollar can be supported as a SPE outcome under standard assumptions if the discount factor is sufficiently large ($\delta \geq \frac{1}{2}$).[6] There is, however, a unique stationary ("history free") SPE,

[6]The theoretical benchmark is based on the assumption of agents' purely selfish behavior, which is clearly not satisfied if fairness norms play a role (which is what we assume). While we do not want to impose precise assumptions on players' fairness concerns and thus do not have a (tractable) theory of how fairness concerns would change the standard prediction, the well-understood properties of the solution under purely selfish behavior are useful as a possible

which involves no delay and leads to the allocation $s = (\frac{S}{1+\delta+\delta^2}, \frac{\delta S}{1+\delta+\delta^2}, \frac{\delta^2 S}{1+\delta+\delta^2})$, implying a first-mover advantage for $\delta < 1$.[7] In our context, it is interesting to see whether the presence of subjective claims impedes the predicted fast agreement and how large the efficiency loss is when subjects care to see their fairness views implemented. Furthermore, it is interesting to see whether the predicted first-mover advantage manifests itself in observed payoffs in the presence of fairness concerns and subjective claims, which we can find out by comparing the payoffs of players with equal contributions in different roles in the bargaining game.[8]

2.2 Krishna and Serrano's *Exit* Rule

In the *Exit* rule introduced by Krishna and Serrano (1996), players take turns in making complete division proposals, just as in Shaked's offer rule. Again, player 1 makes the first offer in round $t = 1$, and player 2 and player 3 respond sequentially. Again, if both accept, then the game ends and if both reject the game proceeds to the second round, where it is player 2's turn to make an offer. The only difference occurs if only one of the responders agrees. In this case she exits with the payoff she has accepted. The responder who disagrees remains in the game with the proposer, and the game proceeds as a two-person alternating-offers bargaining game over the remainder of the cake. In sum, the only difference between Shaked's *Offer* rule and the current *Exit* rule is that a player satisfied with his or her share can "take the money and run". With this rule, Krishna and Serrano (1996) show that the resulting bargaining game has a unique SPE. It involves no delay and leads to the allocation $s = (\frac{S}{1+2\delta}, \frac{\delta S}{1+2\delta}, \frac{\delta S}{1+2\delta})$, again implying a first-mover advantage for any $\delta < 1$. From a behavioral viewpoint, a comparison of the *Offer* and the *Exit* rule is interesting, since the only difference lies in the option to exit. With this option present, the standard prediction implies that players 2 and 3 are treated equally; also, the predicted first-mover advantage is less pronounced than in the *Offer* rule. Thus, the *Exit* rule induces less distorsion due to the strategic position in the predicted equilibrium allocation. This may be a desirable feature, in particular

benchmark.

[7]See Herrero (1985). She also demonstrates that the stationary SPE is the unique strong SPE.

[8]From the experimental literature on Stackelberg games – see, for example, Huck et al. (2001) and Kübler and Müller (2002) – we would expect that the first mover advantage is less pronounced than predicted.

when fairness considerations are important, and we can test whether this procedure leads to faster agreements.

2.3 Torstensson's *Demand* Rule

In the *Demand* rule introduced by Torstensson (2009), players take turns in making demands regarding their own share. In round $t = 1$, players 1 and 2 make successive demands x_1 and x_2. If these demands are compatible ($x_1 + x_2 \leq S$) and the third player accepts, the game ends with an agreement in which the allocation $s = (x_1, x_2, S - x_1 - x_2)$ is implemented. If $x_1 + x_2 > S$, or if the third player rejects, bargaining proceeds to round $t = 2$. In this round, player 2 makes the first demand and player 3 the second, while player 1 decides whether or not to accept the remainder of the cake. Again, there is no exogenous termination round and in case of agreement after round 1, payoffs are discounted by the common discount factor $\delta < 1$. Similar to the *Offer* rule, most agreements can be supported as SPE outcomes by specified state-dependent strategies.[9] Again there is a unique stationary SPE. It involves no delay and leads to the allocation $s = (\frac{S}{1+\delta+\delta^2}, \frac{\delta S}{1+\delta+\delta^2}, \frac{\delta^2 S}{1+\delta+\delta^2})$, again implying a first-mover advantage for any $\delta < 1$. Note that the stationary SPE outcome is identical to that of the *Offer* rule. From a behavioral viewpoint, it is interesting to see whether the small difference in the two procedures' rules affects the outcome. Since we do not know how important fairness views are for behavior, demanding only one's own share may push towards more selfish demands, since the proposer is not explicitly forced to think about others' shares, which, in turn, may lead to a delay in agreements. On the other hand, if fairness is important, a (fair) demand for one's own share may leave more room for agreement when fairness views differ, since no statement is made about one's evaluation of the others' claims.

[9] More precisely, for $\delta > \frac{1}{2}$, every allocation where $s_3 \leq \delta S$ can be supported in a SPE (Torstensson 2009).

3 Design of Experiment and Vignette

3.1 The Subjective Claims Problem

In the experiment and the vignette we consider subjective claims problems involving three partners who first produce a cake of size S in a real effort task, before S is divided amongst the three of them. For the real effort task, subjects are randomly assigned to one of three cohorts, each consisting of 6 subjects, and they are informed that (i) each subject in a cohort will be exposed to some set of questions which is the same across subjects in the cohort; (ii) each subject in a cohort will receive points depending on her relative performance within her cohort, with the two high performers (in terms of correctly answered quiz questions within a given time period) receiving 4 points, the two medium performers 3 points, and the two low performers 2 points; (iii) after the quiz each subject will be assigned to a group of three partners, labelled A, B, C, each coming from a different cohort; (iv) the points a subject acquires in the quiz will be her contribution to the joint profit of the group which is determined by the non-linear function

$$S = 12 + \textit{(points A)} \cdot \textit{(points B)} \cdot \textit{(points C);}$$

and (v) the joint profit of the group will later be distributed amongst group members by some procedure. Note that subjects are informed about the division rule only after having completed the real effort task in order to ensure that S is independent of the division rule, which is how we defined the subjective claims problem.[10]

3.2 Lab Experiment

Participants. We had a total of 612 students of all majors at the University of Innsbruck participate in this experiment. Sessions lasted for about 1 hour, and average earnings were 13.30 Euro. The experiment was programmed and conducted with the software z-Tree (Fischbacher 2007) and the recruitment was done via ORSEE (Greiner 2004).

Cake Production. After performing the real effort task as described above,

[10]The points earned by a subject in the quiz will not only depend on effort but also on skill (or knowledge) and luck. From earlier experimental work on entitlements – Hoffman and Spitzer (1985) is the pioneering paper in that respect – we know that each of these factors might contribute to entitlements.

subjects are informed about their own rank within their cohort and the points they achieved, and about the points (but not the rank or actual quiz performance) their partners bring into the partnership. Partnerships (groups) in the experiment are composed such that we have groups with two low and one medium contributor (LML) dividing a cake size of $S = 24$, groups where all partners make different contributions (MLH) dividing a cake size of $S = 36$, and groups with one medium and two high contributors (HHM) dividing a cake size of $S = 60$.[11]

Fairness Question. After being informed about their partners' contributions in points and the resulting cake size, subjects are privately asked what they consider a fair division of the jointly produced surplus. That is, each subject i is asked to report a vector of his subjective evaluation of claims, $e_i = (e^i_A, e^i_B, e^i_C)$, where the entries have to sum up to S, knowing that the answer to this question is irrelevant for her earnings in the experiment. We will refer to $\frac{e^i_i}{S}$ as partner i's *fair share to self* and to $\frac{e^j_i + e^k_i}{2S}$ (for $\{i, j, k\} = \{A, B, C\}$) as partner i's *fair share from others.*

Table 1 – Experimental Treatments

Group Composition	Initial Cake Size	Initial Move Order	Contribution in Points	# Observations *Demand*	*Offer*	*Exit*
		1	2 low			
LML	S=24	2	3 medium	22	22	24
		3	2 low			
		1	3 medium			
MLH	S=36	2	2 low	22	22	24
		3	4 high			
		1	4 high			
HHM	S=60	2	4 high	22	22	24
		3	3 medium			

Actual Division of the Cake. In each experimental session, subjects are exposed to exactly one bargaining procedure and each subject participated in only

[11] To facilitate reading, the group composition is labelled such that it also represents the order of players' moves in the first round of the bargaining game; e.g. in LML, player 1 in round 1 will be a low contributor (L), player 2 a medium contributor (M) and player 3 a high contributor (H).

one session.[12] The discount factor was $\delta = 0.9$ in all bargaining procedures.[13] For the *Demand* and the *Offer* rule, we have 198 subjects participating per procedure, with equal numbers of observations per cake size, while for the *Exit* rule we have 216 participanting subjects. Table 1 shows the details of the experimental design. The cake size is denoted in points, and for each point earned in the experiment subjects were paid 0.25 Euro. In each session, the bargaining procedure is first described in detail, then each subject is asked to submit a proposal, which would be used as the actual initial proposal in case the subject was selected as player 1 in round 1 of the bargaining game. For the *Offer* and *Exit* rule, this proposal entails a complete division vector, while the *Demand* rule only asks each subject for a proposal regarding the own payoff. We will refer to a subject's initial proposal regarding the own payoff as that subject's *initial demand*. Subjects are then informed about their player role in the procedure (i.e., whether they are player 1, 2 or 3 in the first round), and they go through the respective bargaining procedure until bargaining is completed.

3.3 Vignette

Participants. We had a total of 70 participants in our vignette study. Since our aim here is to get information on the impartial view of spectators, subjects from the lab study were excluded from participation in the vignette.

Impartial Fairness Question. In the vignette, we inform participants about the details of the subjective claims problem as described in Subsection 3.1. For each group composition that was used in the lab experiment, we asked vignette participants what they consider a fair division among the partners, knowing the points each partner contributed towards the cake size (but not knowing the number of correctly answered questions or the exact rank of the partner in his cohort). We

[12] Besides bargaining, we also tested the performance of static mechanisms to resolve the subjective claims problem. These mechanisms use agents' reports as inputs and yield a unique allocation as output. In each experimental session, subjects were first exposed to three static mechanisms and then to exactly one of the three bargaining procedures described here, without having feedback regarding the outcome of any other mechanism previously played. Bargaining was always the last procedure to avoid that the outcome of a procedure affects subjects' behavior in other procedures. We thus have a between-subjects design when comparing the bargaining procedures.

[13] We also tried out a discount factor of 0.8 in some separate sessions, but this did not affect behavior in any significant way.

will refer to the average share assigned by the participants in the vignette to a partner as *fair from vignette*.

4 Fairness Benchmarks

4.1 Normative Fairness Standards

Since we conjecture that participants' answers to the vignette as well as subjects' answers to the fairness question and their actual behavior in the experiment are shaped by norms of distributive justice, we will use the egalitarian, the proportional and the accountability standard (as defined earlier) as benchmarks when interpreting participants' fairness assessments and observed bargaining payoffs in the experiment. Table 2 displays the predictions of the three fairness norms in terms of shares for each contribution type and group composition.

Table 2 – Share Predictions of Fairness Standards

Group Composition		LML			MLH			HHM	
Contribution	2	3	2	3	2	4	4	4	3
egalit. standard									
share	0.333	0.333	0.333	0.333	0.333	0.333	0.333	0.333	0.333
proport. standard									
share	0.286	0.428	0.286	0.333	0.222	0.444	0.364	0.364	0.273
account. standard									
share	0.309	0.381	0.309	0.333	0.259	0.407	0.357	0.357	0.285

4.2 Partial and Impartial Fairness Assessments

A subject's response to the fairness questions reflects his subjective evaluation of claims as a stakeholder, while responses from the vignette reflect the assessments of impartial spectators.[14] In this subsection we present the results of the vignette and the fairness question, and we examine which of the normative standards described earlier play a role for these impartial and partial fairness assessments. We

[14] As pointed out by Benjamin et al. (2014), the results from a vignette may be biased compared to incentivised choices, for instance when one answer is viewed as socially more desirable than others. In our context such a bias would mean that vignette results reflect to a certain degree beliefs about social norms – which is also a useful benchmark for assessing fairness in our context.

analyze 67-70 observations per group composition for the vignette, and 68 observations per partner and group composition for the fairness question.[15] Figure 1 displays the means for a given group composition of (1) the share subjects consider as fair for themselves in the fairness question (*fair share to self*), (2) the average of the shares assigned to them by the two partners (*fair share from others*), (3) the average share each partner is assigned in a partnership (*avg. fair share*), and (4) the share assigned by impartial observers in the vignette (*fair from vignette*).[16] This distinction clearly reveals the self-serving bias in the fairness evaluations of stakeholders:[17] The amount subjects state as fair for themselves is significantly higher than what others consider fair for them for all group compositions and all contribution types (Wilcoxon signed-rank test, WSR: $p < 0.01$ for all comparisons).Interestingly, the fairness assessments of the impartial spectators in the vignette are very similar to the average fair shares in the fairness question. In fact, a pairwise t-test shows no significant differences for all group compositions and all contribution types between *avg. fair share* and *fair from vignette*. This is an important result, since it shows that the answers to the fairness question offer meaningful results: We are able to correct for the self-serving bias in the partial view by taking a simple mean over the three partners in a group, and this corrected measure (*avg. fair share*) points to the same allocation as the impartial fairness assessment obtained from the vignette (*fair from vignette*).

Next, we address the question whether the three normative standards discussed previously are reflected in partial and impartial fairness views. Table 3 shows which proportions of the results reflect the *egalitarian standard*, the *proportional standard*, and the *accountability standard*, respectively. The *classification rate* sums up these proportions, thus displaying how many observations are consistent with any one of the three standards.[18] In partnerships where two partners contribute the same amount (i.e. in LLH and HHM), well over 80% of all vignette assignments are consistent with one of the three fairness standards; in the fairness question, this

[15] We had to exclude some of the answers to the vignette due to inadmissible statements, e.g. allocations that sum up to more than the cake size.

[16] *Avg. fair share* is calculated as 1/3$\cdot$ *fair share to self* + 2/3$\cdot$ *fair share from others*.

[17] The existence of a self-serving bias in fairness assessments when stakes are involved is well documented in the literature (see, e.g., Messick and Sentis (1979 and 1983), Babcock et al. 1996, or Konow 2000).

[18] In assigning proposals to norms, we allow for intervals that round numbers to the next half unit in case the standard does not yield integers.

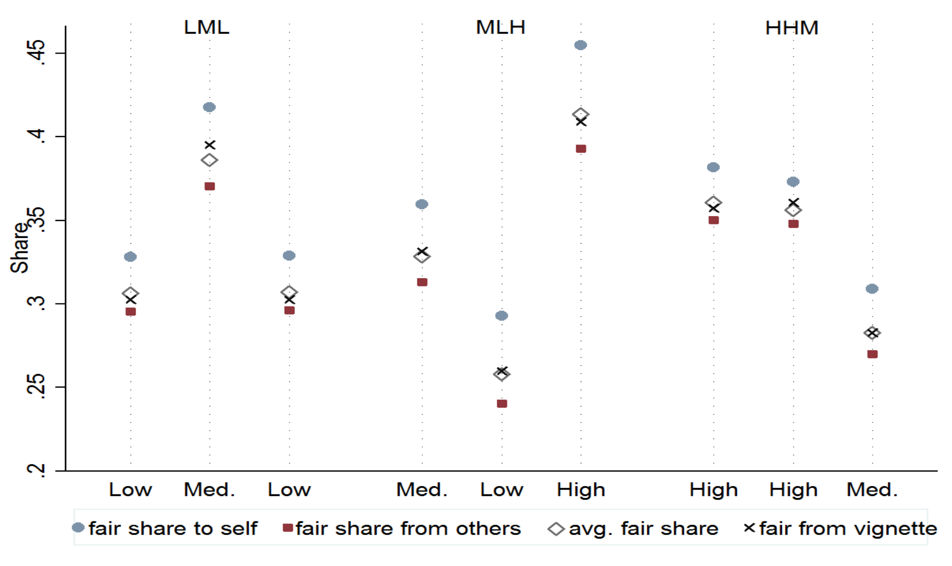

Figure 1 – Fair Shares from Vignette and Fairness Question

fraction is somewhat lower, which is likely due to the self-serving bias of stakeholders. By constrast, when all partners contribute different amounts (MLH), almost 40% of the observations in the vignette and more than 55% of the answers to the fairness question cannot be counted as reflecting any of these standards. This is consistent with our presumption that evaluations of claims are subjective, i.e. even though they generally reflect contributions earned in the real effort task, it is not clear what precisely constitutes a fair division of the surplus, from both the partial and the impartial point of view.

Table 3 – Fairness Standards Observed in Vignette and Fairness Question

	Vignette				**Fairness Question**			
Group Compos.	LML	MLH	HHM	Pooled	LML	MLH	HHM	Pooled
egalitarian std	0.16	0.11	0.15	0.14	0.33	0.15	0.27	0.25
proportional std	0.49	0.41	0.47	0.46	0.45	0.24	0.26	0.32
accountability std	0.23	0.10	0.21	0.18	0.04	0.04	0.15	0.08
classification rate	0.88	0.62	0.83	0.78	0.82	0.43	0.68	0.65

Notes. For each fairness standard and group composition the fraction of observations consistent with the point prediction is listed. The classification rate sums up the fractions for a given group composition. For non-integer predictions intervals that round to the next half unit are allowed.

Overall, the *proportional standard* is the most prevalent in our data from both vignette and fairness question.[19] But, while $40 - 50\%$ of vignette assignments are consistent with proportionality, the support for this standard is considerably lower in the fairness question, in particular when a low contributor is present. Here, deviations from proportionality systematically assign a larger share to the low contributor and a lower share to the high contributor (Mann-Whitney U-test, MWU: $p < 0.01$ in LML and MLH). The tendency to implement smaller payoff differences than proportionality would predict is also found in the vignette, where almost 50% of the participants assign more than the proportional share to the low contributor. The *egalitarian standard* takes the idea of reducing payoff differences as implied, for example, by the proportional split to the extremes by equalizing all payoffs, independent of contributions. The results displayed in Table 3 show that the egalitarian standard plays a more important role in partial than in impartial fairness assessments.[20] Closer inspection reveals a possible reason for the differences in fairness assessments of stakeholders and spectators: The literature on moral wiggle room (e.g. Dana et al. 2005) suggests that stakeholders tend to appeal to the standard that yields the highest payoff for them, when multiple fairness standards can plausibly be applied. And this is indeed what we observe in the data: In LML low contributors, who profit most from an equal division, follow the *egalitarian standard* significantly more often than medium contributors (40% vs. 19%; χ^2-test: $p < 0.01$). This tendency is also present in HHM, (35% of medium vs. 22% of high contributors; χ^2-test: $p = 0.05$), and even in MLH (24% of low contributors refer to the egalitarian division, but only 11% of medium and 8% of high contributors; χ^2-test: $p = 0.03$). Taken together, these findings suggest that both the larger fraction of observations consistent with the *egalitarian standard* and the lower *classification rate* in the partial as compared to the impartial fiarness view are caused by the same factor – namely the fact that stakeholders' view of what constitutes a fair division is biased by material self-interest. Our findings below will show that not only the self-serving bias as stakeholder but also

[19]This is in line with the results by Schokkaert and Overlaet (1989) and Konow (1996), who find evidence for proportionality using vignettes with different scenarios varying inputs (that affect output) as well as other factors (that do not affect output).

[20]The observed differences between fairness norms of stakeholders and impartial observers confirm and extend the results of Konow et al. (2009) as well as Rodriguez-Lara and Moreno-Garrido (2012). By contrast, Fischbacher et al. (2009) find no difference in division allocations determined by stakeholders in an ultimatum game compared to those imposed by an impartial third party.

the strategic role in bargaining has an impact on which fairness ideas are finally reflected in bargaining outcomes.

Result 1: Fairness evaluations from a partial and impartial view. *Average fairness evaluations from vignette and fairness question point to the same allocation, while individual evaluations of stakeholders display a self-serving bias. Overall, the proportional standard is the most prevalent norm in our data from both vignette and fairness question. Deviations from the considered norms reflect the contribution order but reduce the difference in payoffs between partners compared to the allocation implied by the proportional standard.*

5 Bargaining Results

Besides the variation of bargaining procedures, one of our treatment variables is the composition of contribution types in partnerships, which allows us to see how this affects fairness assessments, behavior and divisions. Given our production function, this also affects the cake size, implying that strictly speaking we are not able to disentagle cake size effects from group composition effects with our design. The fact that the size of the surplus per se is not an important driver for bargaining behavior is suggested by the results of Karagözoglu and Riedl (2013).[21] We thus focus on group composition and bargaining procedures as the main treatment variables.

5.1 Initial Proposals

We first investigate to what degree subjects try to have their fairness assessments implemented in bargaining by comparing their initial proposals to their stated subjective evaluations of claims. Remember that before subjects were assigned the role of a player in the bargaining procedure, they were asked to submit a proposal, which would be used as actual initial proposal in case the subject was selected as player 1 in round 1. Depending on the bargaining procedure, this initial proposal consisted of a complete division proposal or only an own demand. To have comparable figures across subjects and bargaining procedures, we focus on the proposal

[21] In their experiment, the surplus to be divided varies in size over different pairs, and the authors find no effects of cake size on the main bargaining variables.

for the own share in the initial proposal which is available for all subjects and all bargaining procedures. We refer to this variable as the subject's *initial demand*. Table 4 displays the results of Tobit regressions (run separately for each group composition) of how a subject's *initial demand* is shaped by the stated evaluation of the own claim (*fair share to self*) and the contribution type (low, medium, high contributor). The higher the *fair share to self* and the higher the rank in the contribution order, the larger the *initial demand*. When all contributions differ (*MLH*), the bargaining procedure also affects the *initial demand*: In the *Demand* rule, where subjects have to state only their own demand, subjects demand systematically more for themselves than in the *Offer* rule (omitted in the regeression), where a complete division is required. The *Exit* rule, also asking for a complete division proposal of player 1, displays no significant difference to the *Offer* rule.

	LML		*MLH*		*HHM*	
indep. var.	coef.	std. err.	coef.	std. err.	coef.	std. err.
fair share to self	0.373***	0.038	0.164***	0.030	0.200***	0.027
med contrib	0.032***	0.009	0.029***	0.008	−0.036***	0.005
high contrib	–	–	0.083***	0.009	–	–
Demand	-0.005	0.009	0.024***	0.008	0.007	0.005
Exit	0.003	0.009	0.012	0.008	-0.003	0.005
intercept	0.207***	0.014	0.243***	0.011	0.284***	0.011
N	204		204		204	
$Prob > \chi^2$	0.000		0.000		0.000	

Table 4 – Regression of *Initial Demand* on *Fair Share to Self*, Contribution Type and Bargaining Procedure

Since the initial proposal is binding for subjects who are assigned the role of player 1 in round 1 of the bargaining game, we can infer from these results that subjective claims and rank in the contribution order play an important role for the initial proposal of player 1 in the bargaining process. After the assignment of player roles the actual entries of the three partners can be used to construct the division proposal on the table in round 1 of the bargaining game. We refer to this allocation as *proposal in round 1* and compare the entries in this proposal for players 2 and 3 in the various bargaining procedures to the respective subjects' fairness views.[22] Defining the *deviation from fair share to self* as the difference

[22]For the sake of comparability of proposals and payoffs of a given contribution type, we keep the move order fixed across bargaining procedures for a given group composition (see Table 1).

between a player's entry in *proposal in round 1* and the same player's *fair share to self*, this deviation differs systematically across procedures for player 2 (Kruskal-Wallis test, KW: $p < 0.001$) as well as for player 3 (KW: $p = 0.005$) in the group composition MLH. Table 5 shows the direction of these deviations, including the results of the MWU test for a comparison between procedures: In *Demand*, player 2's *deviation from fair share to self* is positive; thus, this procedure's rule of asking player 2 only for a proposal regarding the own share induces players in this role to ask for more than what they consider fair. Player 3, in turn, suffers most in *Demand* because very little is left for him on the table after players 1 and 2 stated their demands. Note that the mean deviation between what Player 3 is offered and what he considered fair for himself amounts to 13% of the cake size here. *Offer* and *Exit* share the same rule for the initial proposal, and they yield similar results regarding the *deviation from fair share to self*. Here we find that the share player 1 proposes to players 2 and 3 is smaller than what these players regarded as fair for themselves, but in particular *Offer* shows only a small deviation. Thus, *Demand* stands out by treating players 2 and 3 differently regarding the deviation of actual offers and players' *fair share to self*.

Group Composition: MLH - all different contributions

Procedure	player 2 (L) *deviation from fair share to self*	player 2 (L) MWU test p-value	player 3 (H) *deviation from fair share to self*	player 3 (H) MWU test p-value
Demand	0.040	**D-O**: 0.01	-0.130	**D-O**: 0.01
Offer	-0.027	**O-E**: 0.18	-0.018	**O-E**: 0.20
Exit	-0.072	**D-E**: 0.01	-0.066	**D-E**: 0.02

Table 5 – Difference between *Proposal in Round 1* and *Fair Share to Self*

A similar result is also found for player 3 in LML, where the *deviation from fair share to self* is again larger in *Demand* than in *Offer* (MWU: $p < 0.03$). Only in HHM we find no effect of the bargaining procedure on the difference between the high and medium contributor's *deviation from fair share to self* (KW: $p = 0.82$).

Result 2: Effect of bargaining procedure on initial proposal. *The initial demand of player 1 is shaped by the reported fair share to self and by the rank in the contribution order in all procedures. The Demand rule creates a distortion due to the assigned player role, in particular when all partners contribute different* *amounts: Player 1 demands systematically more in the Demand rule than in the Offer and the Exit rule. Furthermore, player 2 demands more than he considers fair for himself in Demand. As a result, player 3 is systematically disadvantaged in the initial proposal under the Demand rule.*

5.2 Responses to Initial Proposals

Given the effect of the bargaining procedure on initial proposals, we would expect that responses to these proposals also differ across procedures. For *Demand,* no player 2 'rejects' the *proposal in round 1*; i.e. the observed demands of player 1 and player 2 never exceed the cake size. For the other two bargaining rules, 18% of subjects in the role of player 2 reject the *proposal in round 1* in *Offer*, and 23% in *Exit.* The proportion of rejections increases if we only consider offers that are below player 2's *fair share to self* (22% and 33%, resp.), but this difference is not significant (Pearson χ^2: $p = 0.31$). For player 3 then, we may expect that the *proposal in round 1* is more often rejected in *Demand,* since we already know that under this protocol player 3 receives lower initial shares than under any other procedure. The Pearson χ^2 test, however, shows no difference in accpetance rates for player 3 across procedures ($p = 0.53$) – there are also none if we consider only entries below player 3's *fair share to self* ($p = 0.95$). This, in conclusion, points to lower final payoff shares for player 3 in the *Demand* rule.

What are the new proposals in round 2 then? We have 16 observations for *Demand* and 20 for *Offer*, where no agreement was reached in round 1. Deviations of these new proposals (as share of the now discounted cake size) from the *fair share to self* are overall very small (mostly less than 1%), with the exception of the former player 1 in *Demand*, who is now player 3: the proposed share on the table in round 2 for him is 7% below his *fair share to self.* This shows that the distorting effect of *Demand* of leaving too little for player 3 continues also in later rounds. Interestingly, subjects seem to accept this weak position of player 3 as the acceptance of the low offers has already shown.

The *Exit* rule has to be treated separately due to its option for a player to accept his currently proposed share and quit, leaving the other two in a bilateral bargaining situation. Regarding this option, we see no differences in behavior between player 2 and player 3, as an almost equal number of subjects in each position (14 vs. 15) exit the game after round 1. But the option to exit has an effect on the overall duration: Bargaining in the *Exit* rule takes significantly longer than in the *Demand* and the *Offer* rule (KW: $p < 0.05$, pooled for all cake sizes). Also, the extremes are more pronounced in the *Exit* rule. Indeed, only for the *Exit* rule we observe cases where the bargaining length exceeds three rounds – in all those cases, one partner has left while the other two continue to bargain. Overall, the option to exit is taken in 30% of all games for the group composition LML, in 54% of MLH, and in 42% of HHM.

Result 3: Effect of bargaining procedure on continuation of bargaining. *Despite the fact that player 3 is systematically disadvantaged in round 1 of the Demand rule, there are no differences in acceptance rates of player 3 across bargaining procedures. New proposals confirm the disadvantage for player 3 in Demand. Bargaining in the Exit rule takes significantly longer than in the Demand and the Offer rule, which perform similarly in terms of bargaining length.*

5.3 Bargaining Payoffs

Standard Predictions. As expected, the point predictions for all three bargaining rules fail largely. This is particularly evident for groups in which all contributions differ; here realized payoffs differ from predictions at high significance levels for all bargaining rules and all player roles. When two equal contributors are present, we find similar differences between point predictions and realized payoffs only for players 1 and 2: Player 1 gets less and player 2 gets more than predicted (WSR is significant at common levels for all comparisons). It is important to note that the significant deviations from the predictions for partners who are not assigned the role of player 1 in round 1 always go in the direction of rewarding higher contributions with higher payoffs, which stands in contrast to the standard prediction, where subjects are not motivated by entitlements and where contributions to the joint surplus are treated as sunk. Another important observation is that even when two partners have equal contributions, there is no first-mover advantage for player 1: Comparing the payoff of player 1 to that of player 3 in LML (where both are low contributors), and the payoff of player 1 to that of player 2 in HHM (where both are high contributors), we find no significant differences, neither in the *Demand* rule (MWU: $p = 0.56$ and $p = 0.53$), nor in the *Offer* rule (MWU:

$p = 1.00$ and 0.97). This finding is in line with the results of Huck et al. (2001).[23] In the *Exit* rule, player 1 even has a disadvantage: Despite equal contributions, he receives less than player 3 in LML (MWU: $p = 0.11$), and less than player 2 in HHM (MWU: $p < 0.02$). This points towards a distortive effect of the *Exit* rule on bargaining outcome.

Impact of Contribution, Player Position and Procedure. Realized payoffs reflect the contribution order for all bargaining rules. High contributors receive systematically more than the equal split and low contributors receive less (WSR: $p < 0.01$ for all procedures and group compositions).[24] Table 6 displays the regression results for the realized payoff, controlling for contribution, bargaining procedure and player role with dummy variables using effect coding.[25] These results show that the differences between procedures identified for initial proposals also carry over to payoffs: In the *Demand* rule, player 2 indeed profits from being able to state his own entry in the *proposal in round 1*, while player 3 is systematically disadvantaged as he is suggested to just collect the leftovers. In the *Exit* rule, player 3 receives a higher payoff while players 1 and 2 receive significantly less compared to the grand mean over all treatments and groups. The *Exit* rule's particular feature, allowing a player to leave with his current offer, results in this different treatment of the last mover and stands in sharp contrast to the *Demand* rule's rule of asking only for a proposal regarding the own share without forcing the player to explicitly consider other players' shares.

Importance of Fairness Standards. In Appendix A2 we present a table

[23]Specifically, Huck et al. (2001) find that first movers produce lower quantities than predicted and that second movers react to first movers' higher quantity choices by producing higher quantities themselves. A possible explanation for these findings is that second mover behavior is shaped by reciprocity concerns (as modelled by Cox et al. 2008, for instance) and that this is anticipated by first movers. We searched for evidence for reciprocity in our data but found only limited support for its importance. For instance, for the *Demand* rule the reciprocity model by Cox et al. (2008) would predict that player 2 "rewards" player 1's low own demand by choosing a low own demand herself (since a low demand by player 1 would be interpreted as generous behavior). In a regression of player 2's own demand on player 1's entry in the proposal in round 1 we find evidence that points in that direction only for the case where player 1 und player 2 are of the same contribution type. See Appendix A1 for details.

[24]This result is in line with the findings of Gächter and Riedl (2005) and Frohlich et al. (2004) for a setting with objective claims.

[25]With effect coding we analyze deviations from the (unweighted) grand mean, the mean of all observations across all groups, equal to the constant. Regressions are run separately for each group composition, since the position in bargaining given each contribution was fixed for a given group composition.

	LML	MLH	HHM
const	7.946***	11.419***	18.921***
	(0.152)	(0.108)	(0.163)
Player1	-0.054	-0.065	-0.220
	(0.085)	(0.182)	(0.198)
Player2	-0.014	-0.547***	-0.411*
	(0.118)	(0.177)	(0.243)
Player3	0.068	0.612***	0.631*
	(0.098)	(0.196)	(0.326)
*Demand**Player1	0.013	0.333	0.522*
	(0.121)	(0.204)	(0.265)
*Demand**Player2	0.277**	0.582**	0.266
	(0.130)	(0.240)	(0.280)
*Demand**Player3	-0.290**	-0.915***	-0.788**
	(0.133)	(0.233)	(0.323)
*Offer**Player1	-0.019	0.198	0.035
	(0.115)	(0.190)	(0.258)
*Offer**Player2	-0.030	0.010	0.283
	(0.122)	(0.204)	(0.263)
*Offer**Player3	0.049	-0.208	-0.318
	(0.107)	(0.201)	(0.318)
*Exit**Player1	0.005	-0.531**	-0.557**
	(0.110)	(0.221)	(0.277)
*Exit**Player2	-0.247*	-0.592**	-0.549**
	(0.126)	(0.257)	(0.259)
*Exit**Player3	0.242**	1.123***	1.106***
	(0.102)	(0.235)	(0.295)
Demand	0.024	0.210	-0.118
	(0.091)	(0.156)	(0.210)
Offer	-0.085	-0.008	0.236
	(0.080)	(0.139)	(0.198)
Exit	0.060	-0.202	-0.118
	(0.080)	(0.161)	(0.190)
low contrib	-0.654***	-1.612***	
	(0.094)	(0.184)	
med contrib	0.654***	-0.067	-1.709***
	(0.094)	(0.186)	(0.240)
high contrib		1.678***	1.709***
		(0.205)	(0.240)
N	204	204	204
R^2	0.374	0.571	0.376
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$			

Notes. For each cake size the *realized payoff* is regressed on contribution and categorical variables for the bargaining rule interacted with the bargaining position, OLS using effect coding. Robust standard errors in parantheses.

Table 6 – Impact of Bargaining Procedures and Contributions on Realized Payoffs

showing the fraction of *realized allocations* that are classified as reflecting the egalitarian, the proportional and the accountability fairness standard. For completeness the table also lists the corresponding entries for the *proposal in round 1.* The results show that except for group composition *MLH* (where the classification rate is rather low for all procedures) the fraction of *realized allocations* that is classified as consistent with one of the fairness standards is significantly lower for the *Demand* rule than for the other two bargaining procedures. We see two possible explanation for this finding, both originating from the rule of asking only for a proposal regarding the own share. On the one hand, it fosters the self-serving bias of player 2, who, as already noted, asks for more in this rule, implying that the complete vector *proposal in round 1* may be inconsistent with any fairness standard. On the other hand, even with fair-minded players, it may well be that player 1 and player 2 endorse different fairness standards, and therefore, the *proposal in round 1*, which is composed of demands from these two players, as well as the *realized allocation*, which is derived from a proposal in the final round, may be inconsistent with any fairness standard. We also find that for the *Exit* rule, *proposal in round 1* often reflects one of the fairness standards; however, *realized allocation* does not. This is consistent with our earlier finding that the option to exit introduces a distortion with respect to fair payoffs, in particular when contributions are equal.

Partial and Impartial Fairness Assessments. As a measure for how close bargaining outcomes come to participants' fairness assessments, we consider the absolute deviation of the *realized payoff*, which denotes a partner's share in the *realized allocation*, from this partner's *avg. fair share* as calculated from the fairness question.[26] We also look at the absolute deviation of the *proposal in round 1* from the *avg. fair share* to see how fairness changes from initial proposals to final outcomes. In pairwise comparisons between the *Offer* and *Exit* rule, we find no significant differences in deviations of *proposal in round 1* from *avg. fair share*. The *Demand* rule, on the other hand, shows higher deviations for player 2 compared to the *Exit* rule (t-test: $p < 0.03$), and for player 3 it shows higher deviations than the *Exit* rule (t-test: $p = 0.11$) as well as the *Offer* rule (t-test: $p < 0.1$). This is another affirmation of our finding that the *Demand* rule is distortive through

[26]We only use the corrected partial fairness assessments (*avg. fair share*) as benchmarks here, knowing that they come very close to impartial spectators' assignments in *fair from vignette*, thus yielding similar results.

	Demand		Offer		Exit	
avg. fair share	0.186	(0.118)	0.208*	(0.101)	0.063	(0.060)
low contrib.	-1.082**	(0.375)	-1.177***	(0.258)	-1.923***	(0.258)
med. contrib.	-0.284*	(0.171)	-0.351**	0.134)	-0.215	(0.157)
high contrib.	1.366**	(0.455)	1.528***	(0.279)	2.138***	(0.298)
LML	-3.355***	(0.463)	-3.270***	(0.432)	-3.314***	(0.267)
MLH	-1.040***	(0.244)	-1.238***	(0.185)	-1.491***	(0.182)
HHM	4.395***	(0.647)	4.508***	(0.578)	4.805***	(0.356)
player 1	0.296**	(0.148)	0.117	(0.126)	-0.393***	(0.153)
player 2	0.101	(0.170)	-0.194	(0.131)	-0.705***	(0.163)
player 3	-0.397*	(0.181)	0.077	(0.139)	1.098***	(0.152)
const	10.432***	(1.609)	10.147***	(1.347)	11.952***	(0.800)
N	198		198		216	
F	320.87		839.80		828.85	

Notes. OLS regression; dummmy variables with effect coding. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Robust SE in parentheses; clustered on group level.

Table 7 – Regression of Realized Payoff on Average Fair Share

its rule of asking for own demands only. The *proposal in round 1* in *Offer* and *Exit* shows more accordance with stakeholders' own fairness considerations, and it shows more accordance with the three fairness norms considered above. However, the *Exit* rule cannot keep this promising initial assessment: Looking at the deviation of the *realized payoff* from the *avg. fair share*, the *Exit* rule yields a worse result than both the *Offer* and the *Demand* rule for player 1 (t-test: $p < 0.01$). The *Offer* rule also yields a better result (lower deviation) for player 2 compared to the *Demand* rule (t-test: $p < 0.02$). This points to the result that amongst our three bargaining procedures, the *Offer* rule comes closest to *avg. fair share*, which we use as a measure of fairness from a partial view, and due to similar results on average in the vignette, the *Offer* rule also comes closest to *fair from vignette*.

Table 7 shows the results of a regression run separately for each bargaining rule with *realized payoff* as the dependent variable and *avg. fair share* as the main independent variable, where we control for group composition, contribution, and player role with dummy variables using effect coding. The results show a significant positive effect of *avg. fair share* on the *realized payoff* only for the *Offer* rule, thus underlining the finding that the *Offer* rule is least distortive with regard to fair bargaining outcomes. Other previous results, such as the effect of contributions on payoffs, are confirmed by this regression.[27] Finally, the effect of the bargaining rules on players' strategic behavior becomes evident in the different treatment of player 1 and player 3 in the *Demand* and the *Exit* rule. Thus, while we find that people initially adhere to certain fairness norms as revealed in the answers to the fairness question, they exploit "the strategic realities of the situation" (Binmore 1991) when facing the bargaining rules of the *Demand* and the *Exit* rule. By contrast, role assignment has no significant effect on payoffs in the *Offer* rule, implying that this procedure does not influence the bargaining outcome in a systematic way, thus providing the cleanest transformation of subjective claims into allocations within our bargaining environment.

Procedure	# Obs	Mean	Std. Dev.	Min	Max
Demand	66	0.968	0.059	0.81	1
Offer	66	0.964	0.058	0.81	1
Exit	72	0.958	0.058	0.77	1

Table 8 – Efficiency: Proportion of Initial Cake Size Paid Out Across Procedures

Efficiency. As displayed in Table 8, all three bargaining rules have a relatively high level of efficiency, which is calculated as the total amount paid out to all partners as a share of the initial cake size. Pairwise comparisons show that the *Exit* rule is less efficient than the *Demand* rule (MWU: $p < 0.1$), while the differences in the other two comparisons are not significant (D-O: $p = 0.47$, O-E: $p = 0.40$). This may seem surprising given our previous result that bargaining takes significantly longer in *Exit*. However, looking into what happens in games where no immediate agreement is achieved, we find that *Exit* is more efficient than *Demand* and *Offer* (MWU: $p < 0.01$ for both). This is due to the fact that in *Exit* most games have only two agents left bargaining after round 1, while in the other two rules all three agents suffer from the delay. Thus, while for a given bargaining length

[27] We ran a further regression where *realized payoff* is explained as a fraction of the respective amount derived from the proportional fairness standard (s_i/s_i^{prop}) as a robustness check for our finding that realized payoffs are more equal than the proportional standard would predict. As expected, contributions have a negative effect on s_i/s_i^{prop} in this regression, that is, the fraction of realized payoff relative to the proportional standard is significantly higher for low contributors and lower for high contributors for all bargaining rules. Thus, while contributions are acknowledged, differences in payoffs are reduced compared to a division according to the proportional standard. This in line with our findings from vignette and fairness question.

the unilateral option to exit has a positive effect on efficiency, longer bargaining in *Exit* counteracts this effect, so that overall, *Exit* is not more efficient.

Result 4: Effect of bargaining procedure on realized payoff, fairness assessment and efficiency. *Standard predictions fail largely for all three bargaining rules; instead, realized payoffs systematically reflect contribution orders. The Exit and the Demand rule systematically treat players differently, depending on their player position, while the latter has no effect in the Offer rule. Payoffs in the Offer rule are most closely in line with the de-biased fairness benchmark 'avg. fair share' as well as with fairness standards. Efficiency is relatively high overall, only in Exit the share of the surplus that is lost due to delay is slightly larger.*

6 Conclusion

When several agents have contributed towards the production of a surplus, but the value of their contributions is difficult to assess, agents are likely to have different perceptions on what constitutes a fair division of the surplus. It is then difficult to find a division the involved partied are content with. In search for a solution for such a subjective claims problem, this paper compared the outcomes of three unanimity bargaining procedures with respect to fairness and efficiency. Our efficiency measure was the share of the surplus finally paid out to the parties. As a measure of the fairness of an outcome we used the results of a vignette indicating which allocations are considered fair by impartial outside observers, and we also used the results of a fairness question posed to (partial) stakeholders in the bargaining experiment. A further measure employed are normative fairness standards such as the proportional or the egalitarian standard that play a prominent role in objective claims problems.

In our efficiency comparison we found that the three procedures all perform quite well – only for the *Exit* rule the share of the surplus that is lost in bargaining is slightly larger.

While partial fairness assessments were found to be distorted by a self-serving bias, a simple group average of the agents' assessments turned out to yield similar results as the impartial fairness assessments from the vignette. A fair division derived from these assessments qualitatively reflects contribution levels, but to a lesser extent than the proportional standard would suggest. We found significant differences in the degree to which bargaining outcomes come close to this fair division. When each player is only asked to make a proposal regarding the own share – as in the *Demand* rule of unanimity bargaining – the last player is disadvantaged, as the other players take too much compared to what is considered fair by stakeholders and outside observers. When a player may leave the bargaining table as soon as he is satisfied with the share he is currently offered – as in the *Exit* rule – the first mover is disadvantaged, since he has to remain at the bargaining table until all players agree, and agreements are reached later in this rule. When the proposing player has to make a complete division proposal, to which all other players have to agree – as in the *Offer* rule – bargaining outcomes are more closely in line with the varying fairness measures we use. Indeed, the payoffs achieved in the *Offer* rule show the smallest deviations from the impartial and the corrected partial fairness assessment, and they also reflect normative fairness standards more often than the outcomes of the other two bargaining rules.

Turning to our main research question of whether there is a trade-off between fairness and efficiency in three-person unanimity bargaining, our overall conclusion is that there is no such trade-off: The *Offer* rule does not perform worse than the other two procedures in terms of efficiency and it performs better in terms of fairness.

7 References

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A Appendix

A.1 Importance of Reciprocity Concerns for Behavior

Table A.1 – Regression of Player 2's own demand on Player 1's initial proposal in the *Demand* rule

independent variable	coeff.	std. err.	p-value
P1's initial proposal	-0.339	0.296	0.256
low contrib. type*P1's initial proposal	0.214	0.133	0.113
high contrib. type*P1's initial proposal	0.763	0.203	0.000
const	12.217	2.167	0.000
		N	66
		$Prob. > F$	0.0000

A.2 Importance of Fairness Standards on Main Bargaining Variables

Group Composition	LML			MLH			HHM			Pooled		
Rule	*Demand*	*Offer*	*Exit*	*Demand*	*Offer*	*Exit*	*Demand*	*Offer*	*Exit*	*Demand*	*Offer*	*Exit*
egalitarian std												
proposal in round 1	0.14	0.50	0.50	0.35	0.15	0.11	0.14	0.42	0.21	0.21	0.36	0.27
realized allocation	0.15	0.55	0.36	0.32	0.14	0.08	0.19	0.45	0.23	0.22	0.38	0.22
proportional std												
proposal in round 1	0.27	0.32	0.32	0.04	0.04	0.32	0.09	0.18	0.27	0.13	0.18	0.30
realized allocation	0.30	0.20	0.23	0.05	0.10	0.17	0.05	0.18	0.18	0.13	0.16	0.19
accountability std												
proposal in round 1	0.00	0.13	0.17	0.04	0.14	0.08	0.08	0.17	0.17	0.04	0.15	0.14
realized allocation	0.10	0.25	0.18	0.05	0.15	0.05	0.09	0.18	0.18	0.08	0.19	0.14
Classific. Rate												
proposal in round 1	0.41	0.95	0.99	0.43	0.33	0.51	0.31	0.77	0.65	0.38	0.68	0.72
realized allocation	0.55	1.00	0.77	0.37	0.39	0.30	0.33	0.81	0.59	0.42	0.73	0.55

Notes. The fraction of observations which is consistent with a given fairness standards is listed, for the *proposal in round 1* as well as the *realized allocation.* The classification rate sums up the fractions. For non-integer predictions intervals that round to the next half unit are allowed.

Table A.2 – Fairness Standards Observed in Initial Proposals and Realized Allocations in Bargaining