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Fair and efficient division through unanimity bargaining when claims are subjective

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ABSTRACT

In a subjective claims problem several partners have conflicting perceptions on how a jointly produced surplus should be divided fairly amongst them. In a large-scale experiment, we compare the fairness and efficiency of three unanimity bargaining procedures used to reach a consensus in a three-partner subjective claims problem. Under each procedure partners move sequentially, making alternating proposals. The procedures differ in whether they ask for a complete division proposal (*Offer* and *Exit* rule) or only for a proposal regarding the partner's own fair share (*Demand* rule); and in whether partners have to accept the entire division proposal (*Offer* and *Demand* rule) or only their own share (*Exit* rule). For the fairness assessment partial and impartial fairness views are used and we find that the *Offer* rule performs best in terms of allocative fairness and no worse in terms of efficiency.

1. Introduction

Consider a start-up company, where several partners perform different tasks while one focuses mainly on acquiring new customers, the second works on improving the developed new technology and the third overlooks the work processes in the company. Eventually, the partners will want to divide the profits, and this requires unanimous consent about the value of each party's contribution to the partnership and the resulting fair share of each partner. At the beginning of the partnership, it was not precisely foreseeable which kind and amount of work each partner would contribute, and how each contribution would affect the company's overall performance. Thus, ex-ante contracted profit-sharing was not part of the partnership. Now, ex post there is no objective way to assign shares in a fair way to the parties involved because the contributions to the joint profit are difficult to compare and because the production function is non-linear.

Asking an impartial spectator 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. Bargaining is then a natural way to have parties resolve their dispute regarding the division of the amount.

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In this study, we investigate in a large-scale experiment with more than 600 participants the fairness and efficiency of three unanimity bargaining protocols used to reach a consensus in a stylized version of the above example, which shall be referred 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. Since inputs are difficult to compare and the production function is nonlinear, partners typically have conflicting subjective assessments about what constitutes a fair division of the cake. 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*. The subjective claims problem is then to find an allocation $s = (s_1, \ldots, s_n)$, where $\sum_i s_i \leqslant S$, 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).

Economic theory has identified two classes of approaches that might help to reach a consensus in a subjective claims problem: first, static mechanisms, which use partners' reports on fair divisions as inputs and yield a unique allocation as output; and second, dynamic bargaining procedures, where partners jointly come to an agreement over the division. While we have tested members of both classes in a series of experiments, the present paper focuses exclusively on the results of the bargaining experiments.[1]

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 alternating-offers protocol is probably the most prominent and best-understood bargaining procedure. Rubinstein (1982) formalized this structure, showing that in the selfish benchmark the unique subgame perfect equilibrium outcome converges to the Nash bargaining solution as the time delay between proposals goes to zero. Given that our subjective claims problem is not confined to two persons, we consider extensions of the Rubinstein bargaining protocol to the case where $n > 2$. For this case, several design decisions have to be made. First, one has to decide between majoritarian and unanimity bargaining. Given our explicit goal that the outcome should take into consideration all partners' fairness views, we include only unanimity procedures in our comparison.[2] Secondly, one has to decide between interpreting the Rubinstein protocol as an alternating-offer or an alternating-demand model. Economic theory has followed both directions and we include the most prominent members of both classes of extensions of the Rubinstein protocol in our comparison. Specifically, our comparison includes two alternating-offers and one alternating-demand bargaining model.[3]

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.[4] The *Exit* rule proposed by Krishna and Serrano (1996) modifies 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.

The following main research questions are addressed: (1) Which of the three bargaining procedures performs best as a solution to the subjective claims problem when the fairness of the allocation and its efficiency are the two goals considered? (2) Does one procedure outperform the others in both dimensions or is there a trade-off between fairness and efficiency in multi-party unanimity bargaining? (3) Does the relative ranking of the bargaining procedures depend on the distribution of contributions to the partnership, or is it robust in this regard? Since (almost per definition) there is no obvious way to determine what a fair division is in a subjective claims problem, we also address the following questions: (4) How do the contributions of the partners shape their fairness assessments and the assessments of impartial spectators? (5) How do partial and impartial fairness assessments compare to each other and how do they compare to prominent fairness standards such as the egalitarian or the proportional norm? To the best of our knowledge none of these questions has been addressed in the literature before and none of the considered unanimity bargaining procedures has been tested in the lab before.

To address our research questions we generate a subjective claims problem involving three partners A, B and C in the experimental lab and study the effect of contributions on fairness assessments and on the performance of the three bargaining procedures. 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 cohorts. 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

[1] The performance of various static division mechanisms is discussed in our companion paper (Gantner and Kerschbamer, 2016).

[2] Majoritarian decision rules received high attention in political bargaining and voting models see the theoretical models by Baron and Ferejohn (1987, 1989), and Morelli (1999), as well as the experimental work by Frechette, Kagel, and Morelli (2005a, 2005b) and Frechette, Kagel, and Morelli (2005c), among others.

[3] 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.

[4] 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.

cohort. Secondly, the points of the three partners enter a non-linear production function that contains a fixed part which is independent of the performance of the partners. 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 the three bargaining protocols.

The bargaining outcomes are then assessed in terms of fairness and efficiency. While the efficiency comparison is straightforward – it refers to the share of the joint surplus which is finally paid out to the partners (after discounting) – the fairness assessment requires the definition of appropriate fairness benchmarks.

The first fairness 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.[5] 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; Yaari & Bar-Hillel, 1984). In our context, impartial spectators 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.[6]

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 & Riedl, 2005, 2006, or Herrero, Moreno-Ternero, & Ponti, 2010). Specifically, we consider the *egalitarian standard*, where the cake is distributed equally among the partners; the *proportional standard*, where shares of the total surplus are assigned proportionally to the points each partner has contributed; and a norm we refer to as *accountability standard*. According to the latter, the variable part of the surplus, which partners can directly be held accountable for, is divided proportionally to contribution points, while the fixed part, which cannot be clearly attributed to the individual contributions, is divided equally.[7]

Our results show that stakeholders' partial and spectators' impartial fairness views point to very similar allocations after correcting for the self-serving bias in the fairness judgments of stakeholders. Fair allocations typically reflect the contribution order but reduce the difference in payoffs between partners compared to the allocation implied by the proportional standard. This is also the case for the outcomes of all bargaining procedures. Bargaining outcomes are also shaped by the strategic position of a player in the respective bargaining procedure, and the size of this effect varies across procedures. Overall, we find that each of the three unanimity bargaining procedures performs 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 our findings imply that there is no tradeoff between efficiency and fairness in three-person unanimity bargaining – the *Offer* rule performs at least as well as the other procedures in terms of efficiency, and it performs better in terms of fairness.

The rest of the paper is organized as follows: Section 2 briefly discusses the related literature, and Section 3 describes the three bargaining procedures. Section 4 introduces the design of the experiment and the vignette study. Section 5 specifies our hypotheses regarding fairness assessments and bargaining outcomes. Section 6 discusses the various benchmarks we consider to evaluate the bargaining outcomes. Bargaining results are presented and discussed in Section 7. Section 8 concludes.

2. Related literature

Our paper is related to several strands of the literature. First, it contributes to the experimental literature on bargaining over a surplus that is produced with real effort. The underlying assumption is that efforts matter for fairness assessments, and the experimental results largely support this assumption. Gächter and Riedl (2005, 2006) implement an objective claims problem in the lab and investigate how infeasible objective claims shape negotiations in bilateral bargaining. In an objective claims (or bankruptcy) problem there exists a publicly known vector of objective claims that is infeasible because the sum of the claims exceeds the available amount. The results show that the agreements in the free-form bargaining were highly correlated with the induced claims. Our study differs from this in several respects. For instance, in our study the cake size is endogenous while it is exogenous in Gächter and Riedl (2005). More importantly, in Gächter and Riedl, subjects are given a common anchor for the entitlements in the form of unequal (objective) claims exceeding the amount available while our experimental design aims at inducing conflicting subjective evaluations of claims.

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

[6] See e.g. Croson and Konow (2009), who find that stakeholders allocate less to others than spectators.

[7] The term accountability standard is used differently in part of the literature – by Cappelen, Drange, Sorensen, and Tungodden (2007), for instance. The motivation for considering this standard (or for defining it this way) can be seen from our non-linear production function, which consists of a fixed part determined by the experimenter, and a variable part determined by partners' contributions. Players might not hold each other responsible for the fixed part, but only for the variable part that depends on contribution points and thus effort.

Closer to our paper regarding the bargaining environment is a contribution by Karagözoglu and Riedl (2014). The authors study bilateral free-form bargaining in a context where subjective entitlements arise because subjects were only informed whether they were the better or worse performer in the real effort task within their pair. Similar to our experiment, there was no other reference point for the division of the surplus. Since subjects only had ordinal information about their performance, the analysis of the authors focuses on qualitative deviations from the equal split. Our bargaining environment is richer because there are more parties involved and because subjects can (but might not wish to) use the contribution points as reference points.

Our paper is also related to the literature on fairness assessments of stakeholders when entitlements are present. Feng et al. (2013) run an experiment using dictator and ultimatum games to allocate shares of a surplus. They find that people tend to reject unequal but favorable offers when they feel that they do not deserve such offers, but also use earned entitlements asymmetrically in a self-serving way. The authors argue that people want to appear fair to themselves and others. A similar conclusion is reached by Rodriguez-Lara and Moreno-Garrido (2012) for behavior in a dictator game with a preceding real-effort task. Ubeda (2014) studies the role of consistency of using fairness rules in different contexts. She finds that a substantial number of subjects rely on fairness rules but use the most beneficial to them depending on the context.

Finally, our paper is also related to studies 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. Birkeland (2013) performs an experimental study, where pairs of subjects contribute different but objectively known amounts towards the surplus. He finds that 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.

As is the case in most of these studies, we investigate an environment in which communication is infeasible. While in our context communication may certainly help to reconcile the conflicting views on a division, our primary focus is on the effects of the different bargaining rules on behavior and outcomes in a controlled environment. With communication being absent, our findings can be interpreted as originating from a situation with adverse conditions for implementing a fair outcome. This allows for a clean comparison with results from other forms of bargaining in similar environments (e.g. free-form in Karagözoglu and Riedl, 2014).[8]

3. Three bargaining 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 $\sum_i s_i \leqslant S$.

3.1. 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 $\delta^{t-1} x_i$.

Turning to the theoretical benchmark, it is not possible to derive one for the case where the partners are interested in the fairness of the bargaining outcome (as we assume in the paper) without imposing strong assumptions on each player's fairness concerns and on her beliefs on the fairness concerns of the other players. Since we do not have this kind of information and since any ad hoc assumption is arbitrary, we report here and below only the theoretical benchmark for the case where it is common knowledge that all players are exclusively interested in their own material payoff.[9] For this case, 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

[8] Communication may improve coordinated common action, promote common knowledge regarding preferences and beliefs, and underline the presence of shared values, i.e. of social and fairness norms (see e.g. Bicchieri and Lev-On, 2007; Cason, Sheremeta, and Zhang, 2012; Chen and Li, 2009).

[9] While we do not want to impose precise assumptions on players' fairness concerns and thus do not have a theory on how fairness concerns would change the standard prediction, the well-understood standard solution based on purely selfish behavior is still considered as a potentially useful benchmark.

factor is sufficiently large ($\delta \geqslant \frac{1}{2}$). There is, however, a unique stationary ("history free") SPE, 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 $\delta < 1$. [10]

3.2. 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". For the case where it is common knowledge that all players are exclusively interested in their own material payoff, 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 $\delta < 1$.

3.3. 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 ($x_1 + x_2 \leqslant S$) 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, in the selfish benchmark most agreements can be supported as SPE outcomes by specified state-dependent strategies.[11] 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.

4. Design of experiment and vignette

4.1. 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, labeled A, B, C, each coming from a different cohort; [12] (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. Using a non-linear production function is meant to increase the likelihood that partners disagree on what constitutes a fair allocation even though contributions in terms of points are comparable.[13] 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.[14]

[10] See Herrero (1985), who also shows that the stationary SPE is the unique strong SPE in the selfish benchmark.

[11] More precisely, for $\delta > \frac{1}{2}$, every allocation where $s_3 \leqslant \delta S$ can be supported in a SPE of the selfish benchmark (Torstensson, 2009).

[12] The motivation for assigning subjects from different cohorts to a partnership was to support the idea that contribution points are only loosely related to ability and effort. With only limited information about ability and effort of the partners we hoped to increase the likelihood of inducing conflicting subjective evaluations of claims, since each partner might think that he has acquired his points in a more competitive environment or was exposed to more difficult questions.

[13] For example, there might be disagreement on how the constant term should be divided fairly among the partners, since it is fixed by the experimenter. Or, one may ask whether a division proportional to the contribution points is really fair, since the marginal contribution of an agent depends on his partners' contributions.

[14] 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.

4.2. 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 h, 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, 2015).

Cake production. After performing the real effort task as described above, 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 $S = 60$. [15]

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*. One could argue that an ex ante elicitation of fairness views may affect behavior in the bargaining games. Krupka and Weber (2009) show that if subjects' attention is drawn to actual or expected behavior of others, it focuses them on the social norm, i.e. they choose the pro-social outcome more often then they would do without such focus. While we cannot exclude such effects on behavior, we would not expect them to affect our comparison across the three bargaining rules.[16]

Actual division of the cake. In each experimental session, subjects are exposed to exactly one bargaining procedure and each subject participated in only one session.[17] The discount factor was $\delta = 0.9$ in all bargaining procedures.[18] 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. We made a random assignment regarding the move order of players during the bargaining game, however, due to the large number of variations we already have, this was a joint random decision for all subjects in a given group composition. This way, we could ensure comparability of the first movers across different bargaining protocols by keeping their contribution points fixed within a given group composition.[19]

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

[15] To facilitate reading, the group composition is labeled 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*).

[16] If such effects were present, they would lead to a larger number of fair bargaining outcomes than without a fairness question. However, for our comparison this would only be problematic if there was an important interaction between those effects and the bargaining procedures. We do not see any reason for such an interaction. Note also that we do not provide any particular pro-social or selfish allocations to choose from as is the case in Krupka and Weber (2009); our subjects had no explicit reference point they could revert to regarding a fair allocation.

[17] In each experimental session, subjects were first exposed to three static mechanisms, which are separately discussed in Gantner and Kerschbamer (2016), 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.

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

[19] Ideally, one would have wanted to vary the contribution type of the first mover within each group composition, but this would have required a large number of additional observations. Since the experiment is (with more than 600 participating subjects) already large, we decided to keep the move order constant across the different bargaining protocols within a given group composition.

Table 1
Experimental treatments.

Group composition	Initial cake size	Initial move order	Contribution in points	# Observations		
				Offer	*Exit*	*Demand*
LML	$S = 24$	1 2 3	2 low 3 medium 2 low	22	24	22
MLH	$S = 36$	1 2 3	3 medium 2 low 4 high	22	24	22
HHM	$S = 60$	1 2 3	4 high 4 high 3 medium	22	24	22

5. Hypotheses

Taking into account the experimental results of the literature on fair division when entitlements are present, we expect to find differences between the elicited partial and impartial fairness views in our subjective claims problem. We thus formulate our hypothesis regarding these different viewpoints:

H 1. *Subjects' partial fairness assessments in the fairness question are self-servingly biased compared to impartial spectators' assessments in the vignette.*

If we were successful in inducing conflicting subjective evaluations of claims, then subjects disagree on what constitutes a fair allocation. Therefore, our hypothesis regarding the role of known fairness norms for fairness assessments is:

H 2. *Important fairness norms (egalitarian, proportional and accountability standard) are supported by fairness assessments, but there exists heterogeneity regarding the question what a fair outcome is.*

Turning to our hypotheses regarding the bargaining outcomes, it is clear that the three partners have to reconcile their subjective evaluations of claims. However, delay in bargaining is costly, and many bargaining experiments have shown that agreements are reached quickly in alternating-offers environments. We therefore hypothesize:

H 3. *Agreements under all three bargaining rules are reached quickly.*

Comparing the *Offer* and the *Exit* rule, notice that a proposal under both rules includes a full division vector. The only difference lies in the option to exit. If a player uses this option in the *Exit* rule, this leaves only two players and thus only two potentially conflicting views to reconcile.[20] Our second hypothesis regarding efficiency is therefore:

H 4. *Agreements in the Exit rule occur faster than in the Offer rule.*

The standard model, relying on the assumption of common knowledge that all players are exclusively interested in their own material payoff, clearly predicts a first-mover advantage.[21] In our context, subjective claims derived from different contributions are expected to shape bargaining outcomes as well. We can still test for a first-mover advantage by comparing the payoffs of players with equal contributions in different roles in the bargaining game. For this comparison our prediction is:

H 5. *The predicted first-mover advantage manifests itself in observed payoffs when comparing players with equal contributions in different player roles.*

Our behavioral hypotheses regarding the *Demand* rule would be that it pushes towards more selfish demands compared to the other two rules. This hypothesis is based on the observation that this rule does not require the proposing player to think about others' shares explicitly. Instead, in the *Offer* and *Exit* rule, fairness of the entire allocation is expected to be more salient due to the bargaining rule of requiring a complete division vector:

[20] Cadigan, Schmitt, Shupp, and Swope (2009) showed that the 'holdout problem', where the required agreement in multilateral bargaining creates an incentive for strategic delay, is empirically relevant.
[21] From the experimental literature on Stackelberg games – see, for example, Huck, Müller, and Normann (2001) and Kübler and Müller (2002) – we would expect that the first mover advantage is less pronounced than predicted.

H 6. *Own demands are more selfish in the Demand rule than in the other two rules.*

If we find support for H6, then agreements are likely to occur later, because if a fair division is important for players, then overly selfish demands of the preceding players will not be accepted. Therefore, we expect that this rule is less efficient compared to the other two:[22]

H 7. *Agreements in the Demand rule occur later than in the other two rules.*

Our main hypothesis regards the question which of the three rules comes closest to subjects' fairness views. Since we expect the *Demand* rule to induce more selfish demands to reconcile, it remains to consider the differences between *Offer* and *Exit* rule. Recall that in the latter, the option to exit changes the standard prediction in that players 2 and 3 are treated equally and the predicted first-mover advantage is less pronounced than in the *Offer* rule. Decreasing the distortion that arises from a player's strategic position would then allow for more room to consider fairness views:

H 8. *Outcomes in the Exit rule are closer to subjects' fairness views.*

Testing this hypothesis (and thus that *Demand* and *Offer* rule lead to outcomes that are farther from subjects' fairness views) ultimately provides an answer to our main research question regarding which bargaining rule yields an outcome that comes closest to what subjects themselves consider fair.

6. Fairness benchmarks

6.1. 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 benchmarks when interpreting participants' fairness assessments and observed bargaining payoffs in the experiment.[23] Table A.1 in Appendix A displays the predictions of the three fairness norms in terms of shares for each contribution type and group composition.

6.2. Partial and impartial fairness assessments

We analyze 67–70 observations per group composition for the vignette, and 68 observations per partner and group composition for the fairness question.[24] A subject's response to the fairness questions is interpreted as his subjective evaluation of claims as a stakeholder, while responses from the vignette reflect the assessments of impartial spectators.[25] Recall that we asked the fairness question after subjects were informed about all three partners' contribution points and the resulting cake size, but before any division procedure was presented. Subjects' assessment regarding fairness may differ once they understand their role in bargaining (i.e. their bargaining power).[26] However, we are not explicitly interested in subjects' fairness assessments in view of a given division procedure, but rather in stakeholders' fairness views in a division problem with subjective claims. These latter fairness assessments are then used to address the main research question: Which of the three bargaining procedures performs best as a solution to the subjective claims problem when the fairness of the allocation and its efficiency are the two goals considered?

Fig. 1 displays the means for a given group composition of (1) the share a subject considers as fair for himself in the fairness question (*fair share to self*), (2) the average of the shares assigned to the subject by the two partners (*fair share from others*), (3) the average share a subject is assigned in a partnership (*avg. fair share*), and (4) the share assigned to the subject by impartial spectators in the vignette (*fair from vignette*).[27] This distinction clearly reveals the self-serving bias in the fairness evaluations of stakeholders, as stated in hypothesis H1:[28]

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[22] One may also argue that asking players only about their own demand may induce less conflict, as there are fewer fairness views to be reconciled compared to the other two rules, where the full vector of subjective claims is part of the negotiation. We expect, however, that this aspect plays a minor role. The well-established self-serving bias supports the hypothesis that negotiating for one's own fair share is more important than insisting on others' fair shares.

[23] To calculate the shares according to the accountability standard, we divide the variable part $(pointsA) \cdot (pointsB) \cdot (pointsC)$ proportionally to contribution points. The additive constant of 12 is divided equally among the three partners.

[24] 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.

[25] As pointed out by Benjamin, Heffetz, Kimball, and Szembrot (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.

[26] Rustichini and Villeval (2014) also ask subjects to state their fairness views (and what they think others consider fair) in the shoes of both players in a dictator game, an ultimatum game and a trust game before they are put in the actual position to play the games for money. The authors find that subjects' later choices are not consistent with the fairness judgments before they knew their role. The range of what they define as fair increased after the game was played with real stakes. However, this behavior is less pronounced in games with strategic interaction.

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

[28] 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, 1983), Babcock, Wang, and Loewenstein (1996), or Konow (2000).

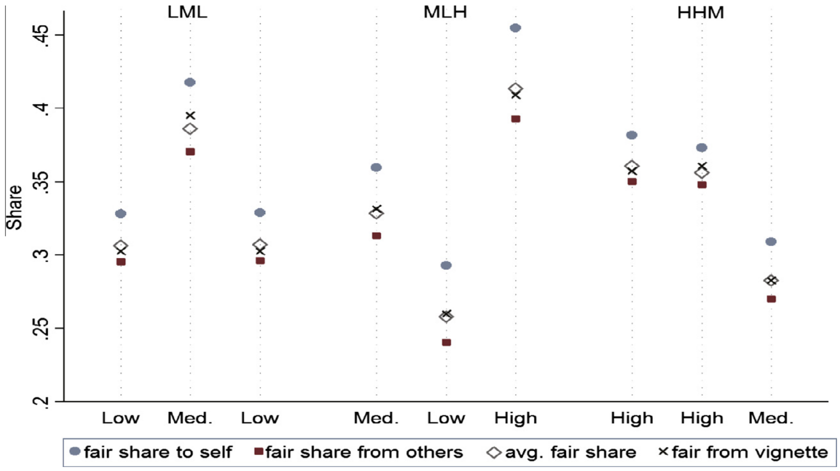

Fig. 1. Fair shares from vignette and fairness question.

Table 2
Fairness standards observed in vignette and fairness question.

Group compos.	Vignette				Fairness question			
	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.

Result 1. *The amount a subject states as fair for himself is significantly higher than what others consider fair for this subject for all group compositions and all contribution types (Wilcoxon signed-rank test, WSR: $p < 0.01$ for all comparisons), and it is higher than what the subject is assigned by impartial spectators in the vignette.*

While Result 1 does not come as a surprise, it leaves us with the question whether the self-servingly biased partial view is useful at all as a fairness benchmark. As Croson and Konow (2009) put it, investigating spectators' preferences may inform us of what behavior is considered fair or right. Interestingly, the fairness assessments of the impartial spectators in the vignette are very similar to the *average* fair shares in the fairness question. 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 of stakeholders 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*).

Hypothesis 2 refers to the question whether the three normative standards discussed previously are reflected in partial and impartial fairness views. Table 2 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.[29] While in partnerships where two partners contribute the same amount (*LLH* and *HHM*) a large part of the assignments are consistent with one of the three fairness standards, there is less agreement 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.

[29] 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.

Result 2. *Fairness assessments are conflicting. They are less consistent with known fairness norms when all partners' contributions differ.*

Overall, the *proportional standard*is the most prevalent in our data from both vignette and fairness question.[30] But while almost one half of the vignette assignments are consistent with proportionality, the support for this standard is considerably lower in the fairness question. When a low contributor is present, 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*). In the vignette, deviations from proportionality show the same pattern: 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 to the extremes by equalizing all payoffs, independent of contributions. The results displayed in Table 2 show that the egalitarian standard plays a more important role in partial than in impartial fairness assessments.[31] This might be due to the fact that low contributors who would benefit most from applying the egalitarian standard tend to refer to this standard more often: In *LML* low contributors 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: $p = 0.03$). These findings suggest that the discrepancies between partial and impartial view (a lower *classification rate* and more observations consistent with the *egalitarian standard* in the fairness question) are at least partly caused by the fact that stakeholders' view of what constitutes a fair division is biased by material self-interest.[32]

Since our analysis revealed findings beyond our initially stated hypotheses, we summarize these at the end of each subsection in form of observations.

Observation 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.*

7. Bargaining results

7.1. Bargaining duration and efficiency

We first investigate our hypotheses H3 regarding the efficiency of the three bargaining rules. Efficiency is calculated as the fraction of the initial cake size that is finally paid out to all partners. Table 3 shows that despite the conflicting fairness views, the efficiency loss in each of the three bargaining rules is less than 5%. Fig. 2 shows that by period 2 an agreement is reached in over 85% of all games under all three bargaining rules.

Result 3. *Despite conflicting fairness views, agreements are generally reached quickly under all three bargaining rules.*

Hypothesis 4 predicts that agreements under the *Exit* rule occur fastest. However, accroding to Fig. 2, the *Exit* rule shows the lowest number of agreements in each of the first three rounds. 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.

Result 4. *Agreements under the Exit rule do not occur faster; rather, bargaining takes longer than under the Demand and the Offer rule.*

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

[30] 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).

[31] The observed differences between fairness norms of stakeholders and impartial spectators confirm and extend the results of Konow, Saijo, and Akai (2009). By contrast, Fischbacher, Kairies, and Stefani (2009) find no difference in division allocations determined by stakeholders in an ultimatum game compared to those imposed by an impartial third party.

[32] According to Cappelen et al. (2007), the observation that in the presence of multiple fairness norms subjects tend to appeal to the one that benefits them most may be viewed as an application of the idea of "moral wiggle room". Dana, Weber, and Kuang (2007) refer to "moral wiggle room" when subjects behave self-interestedly while maintaining the illusion of fairness in the presence of uncertainty between actions and their resulting outcomes.

Table 3
Efficiency: proportion of initial cake size paid out across procedures.

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

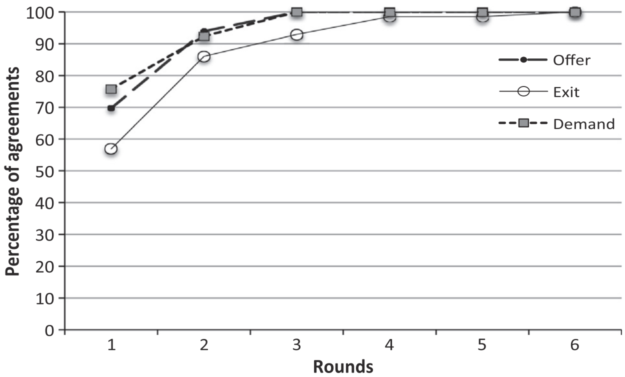

Fig. 2. Proportion of agreements by round across bargaining rules.

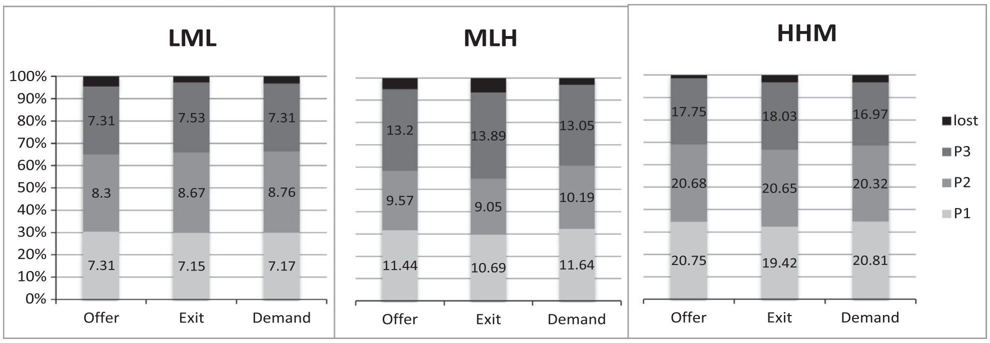

Fig. 3. Mean payoffs by group composition across bargaining rules.

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 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.

7.2. Bargaining payoffs and standard predictions

Fig. 3 displays mean payoffs across the three bargaining rules depending on player position and group composition. As expected due to induced claims and fairness concerns, the point predictions derived under the assumption that all subjects are exclusively interested in their own material payoff fail largely for all three bargaining rules. 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. Hypothesis 5 stated a weaker version of the standard prediction: when comparing players with equal contributions in different player roles, we should observe a first-mover advantage. 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

Table 4
Regression of *Initial Demand* on *Fair Share to Self*, contribution type and bargaining procedure.

Indep. var.	*LML*		*MLH*		*HHM*	
	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	–	–
Exit	0.003	0.009	0.012	0.008	−0.003	0.005
Demand	−0.005	0.009	0.024***	0.008	0.007	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 5
Difference between *Proposal in Round 1* and *Fair Share to Self*.

Procedure	Player 2 (L)		Player 3 (H)	
	Deviation from fair share to self	MWU test *p*-value	*Deviation from fair share to self*	MWU test *p*-value
Group composition: MLH – all different contributions				
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
Demand	0.040	**D-O**: 0.01	−0.130	**D-O**: 0.01

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).[33] 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.

Result 5. *No first-mover advantage is observed in any of the three bargaining rules when players with equal contribution points are compared. Under the Exit rule, player 1 receives even less than player 2 or 3 in case of equal contributions.*

Since we find no support for the standard prediction, we investigate below what the major factors are that determine the observed bargaining outcomes. We consider initial proposals and responses to these proposals to understand how final outcomes come about.

7.3. Initial proposals

We first investigate to what degree subjects try to have their fairness assessments implemented in bargaining under the three rules by comparing their initial proposals to their stated subjective evaluations of claims. We use subjects' proposal for their own share and refer to this variable as a subject's *initial demand*.[34] 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*, as stated in hypothesis H6: 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 regression), 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.

Subjective claims, ranks in the contribution order and the bargaining rule thus play an important role for the initial demand of player 1 in the bargaining process. In order to consider also players 2 and 3, we use 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

[33] 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 modeled 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, Friedman, and Sadiraj (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 A for details.

[34] Recall that we asked for subjects' initial proposal in case they would be assigned the role of player 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 for the own share in the initial proposal which is available for all subjects and all bargaining procedures.

this proposal for players 2 and 3 in the various bargaining procedures to the respective subjects' fairness views.[35] Defining the *deviation from fair share to self* as the difference 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 and size (in percent of the cake size) of these deviations, confirming hypothesis H6: In *Demand*, player 2's *deviation from fair share to self* is actually 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 for themselves.

Result 6. *More selfish demands are observed for player 1 in MLH under the Demand rule than under the other two rules. Subjects in the role of player 2 ask more for themselves compared to their own fairness assessments only in the Demand rule.*

More selfish demands of players 1 and 2 under the *Demand* rule imply that there is little left for player 3, who is clearly disadvantaged under this rule. 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. This is significantly larger than the deviations observed in *Offer* and *Exit* (see Table 5). Here we find that in particular *Offer* shows only a small deviation, and the difference of deviations in *Offer* and *Demand* are not significant. Thus, the *Demand* rule stands out by treating players 2 and 3 differently regarding the deviation of actual offers and players' *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: $p = 0.82$).

Observation 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. As a result, player 3 is systematically disadvantaged in the initial proposal under the Demand rule.*

7.4. 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 $\chi^2 : p = 0.31$). 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 acceptance 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. As for differences across group compositions, we observe that rejection rates do not differ significantly in *Demand* ($\chi^2 : p = 0.78$). In *Offer* and *Exit*, however, we find such differences ($\chi^2 : p < 0.01$ for both), with the largest rejection rate always occurring in MLH, i.e. where all partners' contributions differ.

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 result, as already noticed, is that the difference in the bargaining duration between *Offer* and *Demand* is not significant (MWU: $p = 0.47$), and agreements are even faster in *Demand* compared to *Exit* (MWU: $p < 0.1$).

Result 7. *Even though player 3 is systematically disadvantaged under the Demand rule, this has no effect on the duration of the game.*

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. Result 4 already stated that bargaining under the *Exit* rule takes significantly longer than under *Demand* and *Offer*. We found no differences in the behavior of player 2 and player 3 regarding the option to exit: An almost equal number of subjects in each position (14 vs. 15) left the game after round 1. Overall, the option to exit was taken in 30% of all games for the group composition *LML*, in 54% of *MLH*, and in 42% of *HHM*.

Observation 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.*

[35] 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).

7.5. Bargaining payoffs and fairness assessments

Up to now our analysis showed how initial proposals and responses are shaped by players' contributions, their position in the game and the bargaining rule. Now we consider how these factors carry over to final payoffs, and which role fairness assessments play in the final allocations.

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).[36] Regression results for the realized payoff, controlling for contribution, bargaining procedure and player role show that the differences between procedures identified for initial proposals also carry over to payoffs (see Table A.3 in Appendix A).[37] 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 property of asking only for a proposal regarding the own share without forcing the player to explicitly consider other players' shares.

Importance of Fairness Standards. Table A.4 in Appendix A shows the fraction of *proposals in round 1* and *realized allocations* that are classified as reflecting the egalitarian, the proportional and the accountability fairness standard. 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. This is in line with our finding that the focus on own demand fosters the self-serving bias of players 1 and 2 as seen in Result 6, implying that the complete vector *proposal in round 1* 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 finding in Result 5 that the option to exit introduces a distortion with respect to 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.[38] 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 the *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 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*.

Result 8. *While under the Exit rule proposals in round 1 are in high accordance with stakeholders' own fairness assessments and fairness norms, the Offer rule yields significantly better results for realized payoff.*

Table A.5 in Appendix A further underlines the finding that the *Offer* rule is least distortive with regard to fair bargaining outcomes.[39] The results show a significant positive effect of *avg. fair share* on the *realized payoff* only for the *Offer* rule. Other previous results, such as the effect of contributions on payoffs, are confirmed by this regression. 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.

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[36] This result is in line with the findings of Gächter and Riedl (2005) and Frohlich, Oppenheimer, and Kurki (2004) for a setting with objective claims.

[37] Using 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.

[38] 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.

[39] The regression is 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.

Observation 4. *Effect of bargaining procedure on realized payoff and fairness assessment. The Exit and the Demand rule systematically treat players differently, depending on their player position. Only in the Offer rule strategic consideration due to player position has no effect. 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.*

8. Conclusion

When several agents have contributed towards the production of a surplus, but their fair share of the surplus is difficult to assess, agents are likely to have conflicting 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 multi-party 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 spectators, 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 spectators. 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 allocative fairness.

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Appendix A

Tables A.1–A.5.

Table A.1
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

Table A.2
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

Table A.3
Impact of bargaining procedures and contributions on realized payoffs.

	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)
*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**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	−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)
Demand	0.024	0.210	−0.118
	(0.091)	(0.156)	(0.210)
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

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.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

Table A.4
Fairness standards observed in initial proposals and realized allocations in bargaining.

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.5
Regression of realized payoff on average fair share.

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

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

Appendix B. Supplementary material

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.joep.2016.09.004.

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