Inequality aversion causes equal or unequal division in alternating-offer bargaining*

Stefan Kohler[1] and Karl H. Schlag[2]

[1]Institute of Public Health, Heidelberg University, Germany
[2]Department of Economics, University of Vienna, Austria

September 29, 2017

Abstract

A solution to Rubinstein (1982)'s open-ended, alternating-offer bargaining problem for two equally patient bargainers who exhibit similar degrees of inequality aversion is presented. Inequality-averse bargainers may experience envy if they are worse off, and guilt if they are better off, but they still reach agreement in the first period under complete information. If the guilt felt is strong, then the inequality-averse bargainers split a pie of size one equally regardless of their degree of envy. If the guilt experienced is weak, then the agreed split is tilted away from the Rubinstein division towards a more unequal split whenever the degree of envy is smaller than the discounted degree of guilt. Envy and weak guilt have opposite effects on the equilibrium division of the pie, and envy has a greater marginal impact than weak guilt. Equally inequality-averse bargainers agree on the Rubinstein division if the degree of envy equals the discounted degree of guilt. As both bargainers' sensation of inequality aversion diminishes, the bargaining outcome converges to the Rubinstein division.

Keywords: alternating offers, bargaining, bargaining power, behavioral economics, envy, equity, fairness, guilt, negotiation, social preferences
JEL classifications: C72, C78, D03, D31, D63, D64

1 Introduction

Some social preferences assume inequality aversion, a utility loss caused by receiving the smaller or the larger share (Bolton & Ockenfels 2000; Fehr & Schmidt 1999; Kohler 2011; Tan & Bolle 2006). Inequality aversion, and variations therein, can explain main features of experimental behavior observed across different bargaining games and sociocultural contexts (e.g., Barr et al. 2009; Bellemare et al. 2008; De Bruyn & Bolton 2008; Goeree & Holt 2000; Kohler 2013b). With some exceptions, theoretical and empirical work has focused on the study of inequality aversion in finite horizon bargaining.

This study adds a small theoretical contribution on inequality aversion and infinite horizon bargaining to the existing literature by presenting a solution to Rubinstein (1982)'s open-ended, alternating-offer bargaining problem for two equally patient bargainers who exhibit similar degrees of inequality aversion. It further illustrates how a generic solution to the Rubinstein bargaining problem can still be applied to the bargaining of inequality averse parties if

*Correspondence: Stefan Kohler, Institute of Public Health, Heidelberg University, Germany. Email: stefan.kohler@uni-heidelberg.de.

their degree of guilt is low enough. In the bargaining problem described by Rubinstein (1982), bargaining continues until an agreement about a split of a pie is reached and both bargainers receive nothing in a failed bargaining round. Since inequality aversion diminishes the utility from unequal splits of the pie, more equal divisions and disagreement become more attractive in Rubinstein's bargaining problem for more inequality averse bargainers. Thus, some previously incredible threats to reject uneven splits of the pie become credible for inequality-averse bargainers whose decision-making is affected by the fairness of their presently realizable outcome and the fairness of their outside option, i.e., the divisions of the pie realizable in case of disagreement.

Envy and guilt, the two components of an inequality aversion model by Fehr & Schmidt (1999)'s that we study, influence the equilibrium agreement in opposing directions. However, divisions of the pie which would make any party feel envy are not proposed throughout the bargaining under the equilibrium strategies if guilt is high. The relative degree of guilt in comparison to the bargaining parties' self-interest impacts the equilibrium outcome of the bargaining process in two ways: High guilt triggers an equal division because the bargainers' utility decreases when receiving more than half of the pie; low guilt diminishes the marginal utility of the own share of the pie, but preserves its positive marginal utility. One's own low guilt, *ceteris paribus*, weakens one's own bargaining position. Roth (1985) showed a similar influence of risk aversion that also works to a bargainer's disadvantage within each bargaining period. Overall, the same degree of low guilt in both bargainers helps the proposing bargainer to take a larger share of the pie than predicted by Rubinstein. As already described for other bargaining situations with inequality averse parties, feeling guilty about a larger share of the pie can result in a more unequal division of the pie than the bargaining of self-interested parties. This the apparent contradiction is driven by the weakened bargaining position of the disadvantaged bargainer. The disadvantaged bargainer compares accepting a share smaller than half of the pie to proposing a share larger than half of the pie in the subsequent period, the utility of which is diminished by guilt. As low guilt maintains a positive marginal utility of the own share of the pie, the proposing bargainer exploits the lowered value of the accepting bargainer's outside option by increasing his demand (see Montero 2007). Low guilt has the opposite effects of envy. Envy, *ceteris paribus*, reinforces the bargaining position of a bargainer and, if the two bargainers are equally envious, then the bargaining outcome departs from the Rubinstein division converging towards an equal split. If no bargainer is averse to inequality, then bargaining proceeds as predicted by Rubinstein.

Section 2 reviews related literature. Section 3 introduces the alternating-offer bargaining problem. In section 4, a subgame perfect equilibrium (SPE) with inequality-averse bargainers is derived. Section 5 discusses the equilibrium outcome and concludes.

2 Related literature

Various research suggested that at least some people show regard for others, which includes aspects of envy (e.g., Camerer 2003; Herreiner & Puppe 2009; Smith 2008; Zwick et al. 1992). The empirical evidence of guilt in addition to envy in bargaining experiments is mixed. De Bruyn & Bolton (2008) as well as Kohler (2008, 2013b) studied inequality aversion as introduced by Bolton & Ockenfels (2000) in a structural model of bounded rationality. Using ultimatum game data from a field experiment in Zimbabwe, Kohler (2008, 2013b) estimated significant degrees of inequality aversion and self-interest in population samples from three different Zimbabwean regions. Overall, the data was better explained by a model of guilt and envy, i.e., symmetric inequality aversion, than by a model of envy only. De Bruyn & Bolton conducted a meta-analysis of data from different finite horizon bargaining experiments. They also found that a symmetric specification of inequality aversion improved the statistical fit of the model to the data, but noted that an asymmetric model specification, which was restricted to self-interest and envy only, provided better out-of-sample forecasts.

Alternating-offer bargaining between envious bargainers with player-specific preferences has been studied previously in an infinite horizon game with complete information and in a finite horizon game with incomplete information (Kohler 2012, 2013a). Infinite horizon alternating-offer bargaining between similar, merely guilt-experiencing bargainers has been studied by Kohler (2014). All three of these earlier studies assume versions of the Fehr & Schmidt model of inequality aversion. So does the study at hand, which considers similar bargainers who can experience envy and guilt in the Rubinstein bargaining problem. Our analysis of bargaining between inequality averse parties who have complete information generalizes the earlier analyses of bargaining among parties who may perceive either envy or guilt (Kohler 2013a, 2014), and it complements Kohler (2012) and Mauleon & Vannetelbosch (2013) who studied relative concerns and delay in alternating-offer bargaining with private information in a finite and infinite horizon alternating-offer bargaining models, respectively. Mauleon & Vannetelbosch, who focused on Rubinstein bargaining under incomplete information, also studied a case of complete information, in which both players have relative concerns captured by a special case of Fehr & Schmidt's model of inequality aversion. They derived that an increase of the first mover's envy can decreases the second mover's equilibrium payoff and that an increase of the second mover's guilt can increase the payoff of the first mover if the difference in discounting is sufficient. For inequality aversion preferences, in which the degree of envy and guilt are the same, Birkeland & Tungodden (2014) as well demonstrated that the Rubinstein bargaining outcome may be sensitive to the fairness motivation of the bargainers, unless both bargainers consider an equal division fair. They further showed that different views about what represents a fair division may end in disagreement.

Inequality aversion has furthermore been studied in bargaining games with three bargainers in which unanimity was not required (Montero 2007). Qualitatively in line with the findings of our study of two-person alternating-offer bargaining, Montero established that the equilibrium payoff division can be more unequal despite inequality-averse bargaining parties. In a double auction with asymmetrically informed inequity-averse parties, trade can break down in the limit of strong envy, whereas higher levels of guilt may increase the efficiency of the bargaining outcome (Rasch et al. 2012).

The particular inequality aversion model used in the study at hand and several previous studies was put forward by Fehr & Schmidt (1999). Fehr & Schmidt assume a utility function that and consists of additively separable concerns for envy and guilt. Guilt shares some features with altruism because a guilt-experiencing person feels altruistic towards others until the advantageous situation disappears (see Kohler 2011). Similarly, envy and spite are related. Both may influence behavior in the same direction, but typically envy is felt only with respect to a reference point whereas spite describes a more universal (negative) regard for others. Altruism may be beneficial when there is competition for bargaining partners in a bargaining process with three parties, and it may be detrimental if bargainers discriminate towards those to whom they feel altruistic (Montero 2008). For open-ended alternating-offer bargaining with two bargainers, Leroch (2015) reported an influence of altruism and spite on the bargaining outcome that can be similar to the influence of envy and guilt described by Mauleon & Vannetelbosch (2013).

In contrast to previous studies, we derive the explicit solution to Rubinstein's bargaining problem for bargainers with similar Fehr & Schmidt inequality aversion preferences and we establish the conditions for the existence of a unique SPE.

3 An open-ended bargaining game of alternating offers

Consider a situation in which two bargainers $i \in \{1,2\}$, also called players, have the opportunity to reach agreement on an outcome in the set $U = \{(v_1, f(v_1)) : \omega_1 \leq v_1 \leq \omega_2 \wedge \omega_1 \leq 0\}$. If bargainers fail to reach an agreement permanently, then the outcome will be a disagreement point $(0,0)$. For example, the set U may be the set of utilities $(v_1(x), f(v_1(x))$ corresponding to the feasible divisions of a 'pie' of size one, where v_1 is the utility player 1 get if he receives share x and $f(v_1)$ is the utility player 2 get if he receives share $1-x$ of the pie. Assumptions will be made below on f such that all elements of U are Pareto efficient. In a classic bargaining settting one would consider the bargaining over the convex hull of U. However, to simplify exposition we only consider bargaining over the efficient frontier, hence only over elements of U, as only these points will be offered in a SPE.

Bargaining takes place at periods of time $t = 1, 2, ..., T$. Players alternate roles each period. In odd periods, player 1 makes a proposal (a element of U) which player 2 can either accept or reject. In even periods, player 2 makes a proposal to player 1 who then can either accept or reject. Rejection leads to a new period. If a proposal is accepted, the game ends in period T. The utility received at the end of the game is called payoff.

We assume that f satisfies the following conditions:

(F1) f is continuous.
(F2) f is strictly decreasing.
(F3) $f(0) \geq 0$.
(F4) $f(\omega_2) \leq 0$.

Assumption (F1) implies that a sufficiently small change in bargaining behavior results in an arbitrarily small change in the bargaining outcome that can be realized through agreement. Assumption (F2) implies that players have some conflict of interest, which outcome better than the disagreement point to agree upon. By assumption (F2) the set U is the set of *Pareto efficient* agreements because there is no agreement $(\hat{v}_1, f(\hat{v}_1))$ such that $\hat{v}_1 \geq v_1$ and $f(\hat{v}_1) \geq f(v_1)$. Assumptions (F3) and (F4) require the existence of at least one element of U that is more desirable than disagreement for both players, hence such that $v_1 \geq 0$ and $f(v_1) \geq 0$. A necessary and sufficient condition for this, given that f is strictly decreasing, is that $f(0) \geq$ and $f(\omega_2) \leq 0$.

4 Subgame perfect equilibrium

Rubinstein (1982) was the first to describe a stylized bargaining game of alternating offers and to show how bargainers always reach a uniquely defined agreement immediately in an SPE, under some broad assumptions. Shaked & Sutton (1984) and Osborne & Rubinstein (1994) among others reproduced Rubinstein's key insights using arguments that simplified the original analyses.

Building and expanding on arguments from Osborne & Rubinstein (1994), we first derive the SPE of the above bargaining problem for the general setting where $U = \{(v_1, f(v_1)) : \omega_1 \leq v_1 \leq \omega_2 \wedge \omega_1 \leq 0\}$. Afterwards we present specific examples of the above bargaining game. In the first example self-interested players and, in the second example, inequality averse players with Fehr & Schmidt preferences bargain over the spit of a pie of size one. In both examples, the pie shrinks to zero if no agreement is ever reached.

Osborne & Rubinstein, like Rubinstein (1982), used players' preference relationships (that exclude inequality aversion preferences) in their argumentation. We, in contrast, derive optimal behavior using each player's utility in our arguments. On the one hand, formulating our arguments in terms of utilities implies some loss of generality. On the other hand, using utility in our arguments allows us to abstain from making the assumptions on the players' preferences, required by Rubinstein or Osborne & Rubinstein to guarantee that preferences relationships have a discounted-utility representation.

4.1 The general case

Intuitively, in an SPE of the bargaining game with alternating offers, both players propose the pair of utilities that just makes the other party indifferent between accepting and rejecting. Assume $(v_1^*, f(v_1^*))$ is the outcome whenever player 1 proposes. Then player 2 makes player 1 indifferent between accepting and rejecting by proposing the pair of utilities $(\delta_1 v_1^*, f(\delta_1 v_1^*))$. Thus, $(\delta_1 v_1^*, f(\delta_1 v_1^*))$ is the outcome whenever player 2 proposes, which in turn implies that player 1 makes player 2 indifferent by proposing $(v_1^*, f(v_1^*))$ such that $f(v_1^*) = \delta_2 \cdot f(\delta_1 v_1^*)$.

Proposition 1. *Assume $f(v_1) = \delta_2 f(\delta_1 v_1)$ has a unique solution v_1^* and $f(v_2) = \delta_1 f(\delta_2 v_2)$ has a unique solution v_2^*. Then a bargaining game of alternating offers that satisfies (F1)–(F4) has a unique SPE and agreement will be immediately. In the SPE, player 1 offers v_1^* and player 2 accepts an offer v_1 if and only if $v_1 \leq v_2^*$. player 2 offers $\delta_1 v_1^*$ and player 1 accepts an offer v_1 if and only if $v_1 \geq \delta_1 v_1^*$.*

Note that Osborne & Rubinstein (1994) do not get a unique SPE as their bargaining set also contains inefficient allocations.

Proof. The proof has six steps. Assuming a SPE exists, steps 1–5 show that it has to be unique. Step 6 shows that a SPE exists.

Let $\underline{v}_i$ ($\overline{v}_i$) be infimum (supremum) of the payoff for player i among all SPE in which player i moves first.

Consider any subgame that starts by player 1 making an offer.

Step 1: We show that $\underline{v}_1 \geq f^{-1}(\delta_2 \overline{v}_2)$. If player 2 says no, she will get at most $\delta_2 \overline{v}_2$, hence she will accept any split $(v_1, f(v_1))$ that gives her strictly more than $\delta_2 \overline{v}_2$, i.e., where $f(v_1) > \delta_2 \overline{v}_2$, which is equivalent to $v_1 < f^{-1}(\delta_2 \overline{v}_2)$. Thus, no SPE payoff of player 1 can be strictly below $f^{-1}(\delta_2 \overline{v}_2)$, hence $\underline{v}_1 \geq f^{-1}(\delta_2 \overline{v}_2)$ or $f(\underline{v}_1) \leq \delta_2 \overline{v}_2$. Similarly, by exchanging the roles of players 1 and 2, it follows that $\underline{v}_2 \geq f(\delta_1 \overline{v}_1)$ or $f^{-1}(\underline{v}_2) \leq \delta_1 \overline{v}_1$.

Step 2: We show that $\underline{v}_1 = f^{-1}(\delta_2 \overline{v}_2)$. Assume that $\underline{v}_1 > f^{-1}(\delta_2 \overline{v}_2)$. Then by (F1) and (F2), there exists a SPE in which player 2 gets payoff $v_2^* \leq \overline{v}_2$ that satisfies $\underline{v}_1 > f^{-1}(\delta_2 v_2^*)$. We construct a SPE with a lower payoff to player 1. Assume that play starting the next round follows the SPE that gives player 2 a payoff of v_2^*. All we need to hence specify is what both players do in the present round. A best response of player 2 is to accept v_1 if and only if $f(v_1) \geq \delta_2 v_2^*$. Given this behavior of player 2, player 1 offers v_1 such that $v_1 = f^{-1}(\delta_2 v_2^*)$. This combines to a SPE in which player 1 offers $v_1 = f^{-1}(\delta_2 v_2^*)$ and player 2 accepts any offer v_1 that satisfies $f(v_1) \geq \delta_2 v_2^*$. This gives player 1 a utility $f^{-1}(\delta_2 v_2^*) < \underline{v}_1$ which is a contradiction to the definition of $\underline{v}_1$. Hence, we obtain that $\underline{v}_1 = f^{-1}(\delta_2 \overline{v}_2)$. Similarly, by exchanging the roles of players 1 and 2, it follows that $\underline{v}_2 = f(\delta_1 \overline{v}_1)$.

Step 3: We show that $\overline{v}_1 \geq f^{-1}(\delta_2 \underline{v}_2)$. We follow the reasoning in Step 2. For any $v_1^* < f^{-1}(\delta_2 \underline{v}_2)$ there exists by (F1) and (F2) a SPE starting the next round in which player 2 gets a payoff v_2^* such that $v_1^* < f^{-1}(\delta_2 v_2^*)$. Assume that both players follow this SPE starting the next round. In the present round assume that player 1 offers $v_1 = f^{-1}(\delta_2 v_2^*)$ and player 2 accepts any offer $v_1 \leq f^{-1}(\delta_2 v_2^*)$. Together this generates a SPE starting in the present round that gives player 1 a payoff $f^{-1}(\delta_2 v_2^*) > v_1^*$. As this is true for any $v_1^* < f^{-1}(\delta_2 \underline{v}_2)$ we obtain $\overline{v}_1 \geq f^{-1}(\delta_2 \underline{v}_2)$. Similarly, by exchanging the roles of players 1 and 2, it follows that $\overline{v}_2 \geq f^{-1}(\delta_1 \underline{v}_1)$.

Step 4: We show that $\overline{v}_1 = f^{-1}(\delta_2 \underline{v}_2)$. Any proposal $(v_1, f(v_1))$ by player 1 with $v_1 > f^{-1}(\delta_2 \underline{v}_2)$ is rejected as this means $f(v_1) < \delta_2 \underline{v}_2$. A rejected proposal gives player 1 at most $\delta_1 f^{-1}(\delta_2 \underline{v}_2)$. Any proposal $(v_1, f(v_1))$ by player 1 with $v_1 \leq f^{-1}(\delta_2 \underline{v}_2)$ gives player 1 a payoff of at most $f^{-1}(\delta_2 \underline{v}_2)$. Consequently, $\overline{v}_1 \leq f^{-1}(\delta_2 \underline{v}_2)$. Together with Step 3 this means that $\overline{v}_1 = f^{-1}(\delta_2 \underline{v}_2)$. Once again, by exhanging roles of players 1 and 2, we obtain $\overline{v}_2 = f^{-1}(\delta_1 \underline{v}_1)$.

Step 5: Combining steps 2 and 4 we obtain

$$f(\underline{v}_1) = \delta_2 \overline{v}_2 = \delta_2 f(\delta_1 \underline{v}_1) \tag{1}$$

and

$$f(\overline{v}_1) = \delta_2 \underline{v}_2 = \delta_2 f(\delta_1 \overline{v}_1) \,. \tag{2}$$

As by assumption the equation $f(x) = \delta_2 f(\delta_1 x)$ has a unique solution we obtain that $\underline{v}_1 = \overline{v}_1$ and similarly that $\underline{v}_2 = \overline{v}_2$. Consequently we obtain that there is a unique SPE outcome.

Step 6: We now show that a SPE exists and that it is unique. Note that (F1) and (F2) imply that $v_1^* > 0$ and hence both players prefer the split $(v_1^*, f(v_1^*))$ to the disagreement point. It is then straightforward to verify that the strategy profile defined in the statement of the proposition constitutes a SPE. By the following arguments we see that it is also unique. Clearly player 2 will accept more advantageous splits and reject more disadvantageous divisions. player 2 is indifferent between accepting and rejecting when offered the equilibrium split $(v_1^*, f(v_1^*))$. Yet this is the unique SPE outcome and rejecting this split with positive probability would lead to an inefficient SPE outcome which is a contradiction. So player 2 accepts this split. The unique best response for player 1, given this behavior of player 2 is to offer this split. Thus the SPE is unique.

□

Note that if the defining equations of v_1^* and v_2^*, stated in proposition (1), do not have a unique solution then the boundaries of the set of SPE payoffs satisfy these equations as shown in Step 4 of the proof.

In the proof above, continuity of f (F1) is required to ensure it is possible to have an equality of payoffs in the equations that relate the upper and the lower payoff bounds. The decreasing nature of f (F2) is required to guarantee the existence of its inverse function f^{-1}. Moreover, the requirement that f is strictly decreasing ensures that no player is indifferent between two agreements within the same bargaining period. The conditions (F3) and (F4) ensure there are elements of U that are at least as valuable to each player as disagreement.

4.2 The case with self-interested players

To illustrate the result of proposition 1 consider the classic example of the alternating-offer bargaining game in which each player's utility is the own share of a pie of size one and where the pie shrinks to zero in case of perpetual disagreement. Naming a split x of this pie the implies the following proposal in the set U: player 1 receives $u_1 = x$ and player 2 $u_2 = 1 - x$. In this case $f(v_1) = 1 - v_1$ and it follows that $v_1 = x = \frac{1-\delta_2}{1-\delta_1\delta_2}$ is the unique solution to $1 - v_1 = \delta_2(1 - \delta_1 v_1)$. Thus, for $\delta_1 = \delta_2$, player 1 proposes and player 2 accepts split $\frac{1}{1+\delta} \in [0.5, 1)$ in period 1. The demand of $\frac{1}{1+\delta}$ is the highest share that is accepted by player 2. player 1 cannot gain by asking for a lower share, for it too will be accepted. Stipulating a higher (and rejected) share and waiting to accept player 2's counteroffer in the next period hurts player 1. To show that assumptions (F1)–(F4) hold is left as an exercise.

4.3 The case with inequality-averse players

Now consider the strategic behavior of inequality averse bargainers who negotiate in a similar manner the split of a pie of size one, but who care, to some extent, about the relative as well as the absolute share of the pie obtained in the bargaining process. Relative share hereby means bargainers compare their own share from accepting a certain split to the share of the other bargainer, and put a common weight $\alpha \geq 0$ on the difference whenever their own share is lower and common weight $\beta \in [0, 1)$ on the difference whenever their own share is higher. These relative concerns are interpreted as envy and guilt.

Explicitly, we assume that the utility function of the players is given by

$$u_1(x) = x - \alpha \max\{0, 1 - 2x\} - \beta \max\{0, 2x - 1\} \tag{3}$$

and

$$u_2(x) = 1 - x - \alpha \max\{0, 2x - 1\} - \beta \max\{0, 1 - 2x\} \;, \tag{4}$$

where player 1 receives share x and player 2 receives share $1 - x$ of the pie in case agreement is reached. These preferences of inequality aversion were originally discussed for $\alpha \geq \beta$ in Fehr

& Schmidt (1999) and extended by altruism in Kohler (2011), which effectively permits $\alpha < \beta$ (Engelmann 2012). Inequality aversion, possibly in conjunction with a degree of direct altruism, is consistent with a rich set of stylized experimental behavior (see, e.g., Cooper & Kagel 2016; Fehr & Schmidt 1999; Kohler 2011). The inequality aversion preferences of our bargaining model violate two of Rubinstein and Osborne & Rubinstein (1994)'s preference assumptions, namely 'pie is desirable' if $\beta \geq 0.5$ and 'time is valuable' if $\frac{\alpha}{1+2\alpha} \geq x_i$. However, we show below that a unique bargaining outcome that includes immediate agreement continues to exist if $\beta \neq 0.5$. For $\beta < 0.5$, the proof of proposition (2) is based on showing that proposition (1) applies to such inequality averse bargainers. For $\beta \geq 0.5$, proposition (1) does not apply because assumption (F2) is violated and other arguments are made for the cases in which $\beta > 0.5$ and $\beta = 0.5$.

Proposition 2. *The alternating-offer bargaining problem with equally inequality-averse and discounting bargainers has a unique SPE that includes immediate agreement if $\beta \neq 0.5$. If guilt is low, i.e., $\beta < 0.5$, then player 1 immediately proposes*

$$x^* = \frac{1+\alpha-\beta\delta}{1+2\alpha+\delta(1-2\beta)} \geq \frac{1}{2} \tag{5}$$

and gets utility

$$v_1^* = \frac{1+\alpha-\beta}{1+2\alpha+\delta(1-2\beta)} \geq \frac{1}{2}\,. \tag{6}$$

player 2 immediately accepts $1-x^*$ and gets utility $v_2^* = \delta v_1^* \leq \frac{1}{2}$.

The equilibrium strategies are described in proposition 1. If guilt is high, i.e., $\beta > 0.5$, then player 1 immediately receives half of the pie. In the SPE with high guilt, each player offers $x^* = \frac{1}{2}$ and accepts a proposal if offered at least x^*. If $\beta = 0.5$ then multiple SPE exist.

Note that the bargaining outcome for the case with player-specific preferences and discount factor, where both players' degree of guilt is low, is derived in appendix 6.1.

Proof. **Assume $\beta < \frac{1}{2}$ "low guilt":**

This part of the proof follows from showing that proposition 1 can be applied to inequality aversion preferences if players have a positive marginal utility of the own share of the pie, i.e., if guilt is low enough.

Step 1: We determine U and then verify (F1)–(F4).

First, we compute $\omega_1 = -\alpha \leq 0$ as the minimum and $\omega_2 = 1-\beta$ as the maximum of v_1. Second, we compute the function $f(v_1) := u_2(u_1)$. Assume $x \geq \frac{1}{2}$ which implies $u_1 \geq \frac{1}{2}$. We solve $u_1(x) = \beta + x(1-2\beta)$ for x to obtain $x(u_1) = \frac{u_1-\beta}{1-2\beta}$. We insert $x(u_1)$ into $u_2(x) = 1+\alpha-x(1+2\alpha)$ to obtain $u_2(u_1)$ as a function of u_1, which defines $v_2 = f(v_1)$ for $v_1 \geq \frac{1}{2}$. Now assume $x < \frac{1}{2}$ which implies $u_1 < \frac{1}{2}$. We solve $u_1(x) = x(1+2\alpha) - \alpha$ for x to obtain $x(u_1) = \frac{u_1+\alpha}{1+2\alpha}$. We insert $x(u_1)$ into $u_2(x) = 1-\beta-x(1-2\beta)$ to obtain $u_2(u_1)$ as a function of u_1, which defines $v_2 = f(v_1)$ for $v_1 < \frac{1}{2}$.

Thus f is given by

$$f(v_1) = \begin{cases} 1+\alpha-(v_1-\beta)\frac{1+2\alpha}{1-2\beta} & \text{if} \quad v_1 \geq \frac{1}{2} \\ 1-\beta-(v_1+\alpha)\frac{1-2\beta}{1+2\alpha} & \text{if} \quad v_1 < \frac{1}{2} \end{cases} , \tag{7}$$

and set U by

$$U = \{(v_1, f(v_1)) : -\alpha \leq v_1 \leq 1-\beta \wedge -\alpha \leq 0\} . \tag{8}$$

Noting that $\lim_{v_1 \to \frac{1}{2}} f(v_1) = \frac{1}{2}$ for $v_1 \gtrless \frac{1}{2}$ it is easy to see that f is continuous (F1). As $f' < 0$ for $v_1 \gtreqless \frac{1}{2}$ function f is strictly decreasing (F2). As $f(0) = \frac{1+\alpha-\beta}{1+2\alpha} \in (\frac{1}{2}, 1]$ it is true that $f(0) \geq 0$ (F3). Finally, as $\omega_2 = 1-\beta$ and $f(1-\beta) = -\alpha$ it is true that $f(\omega_2) \leq 0$ (F4). Thus, assumptions (F1)–(F4) underlying proposition 1 are satisfied.

Step 2: We establish that $h(v_1) := f(v_1) - \delta f(\delta v_1)$ is strictly decreasing, which implies that the solution to $h(v_1) = 0$ is uniquely determined. Note that h is continuous and satisfies

$$h'(v_1) = \begin{cases} -\frac{1+2\alpha}{1-2\beta}(1-\delta) < 0 & \text{if} \quad \delta v_1 > \frac{1}{2} \\ -\frac{1-2\beta}{1+2\alpha}(1-\delta) < 0 & \text{if} \quad v_1 < \frac{1}{2} \\ -\frac{1+2\alpha}{1-2\beta} + \delta\frac{1-2\beta}{1+2\alpha} < 0 & \text{if} \quad \frac{1}{2} < v_1 < \frac{1}{2\delta} \end{cases} . \tag{9}$$

Step 3: We search for solutions to $h(v_1) = 0$ starting in the segment of h where $v_1 \geq \frac{1}{2} > \delta v_1$. Thus, we solve $1+\alpha-(v_1-\beta)\frac{1+2\alpha}{1-2\beta} = \delta(1-\beta-(\delta v_1+\alpha)\frac{1-2\beta}{1+2\alpha})$ for v_1 and the corresponding outcome x, respectively. A solution $v_1^*(x^*)$ exist and is given by

$$v_1^* = \frac{1+\alpha-\beta}{1+2\alpha+\delta(1-2\beta)} , \tag{10}$$

or, in terms of the split of the pie, by

$$x^* = \frac{v_1-\beta}{1-2\beta} = \frac{1+\alpha-\delta\beta}{1+2\alpha+\delta(1-2\beta)} . \tag{11}$$

Assume $\beta > \frac{1}{2}$ "high guilt": Note that the derivation of f in step 1 holds for all values of $\beta \neq \frac{1}{2}$. For $\beta > \frac{1}{2}$, function f is increasing in v_1. Thus, bargainers no longer have competing interests and immediately agree an equal split, which maximizes the utility of both bargainers. As immediate agreement on an equal split strictly pareto dominates all other possible agreements, it is the only SPE outcome.

Assume $\beta = \frac{1}{2}$ "somewhat indifferent sharing": The existence of multiple SPE is shown by characterizing two different SPE. First, it follows from the upper hemi-continuity of the best response correspondences that the SPE identified for $\beta < \frac{1}{2}$ is also a SPE for $\beta = \frac{1}{2}$. In this SPE, $v_1^* = \frac{1}{2}$ and $x^* > \frac{1}{2}$. Second, similar arguments as made for $\beta > \frac{1}{2}$ show that $v_1^* = v_2^* = \frac{1}{2}$ where $x^* = \frac{1}{2}$ is an alternative SPE outcome.

□

5 Discussion and conclusion

Bargainers may incur inequality aversion, i.e., envy and guilt, in a bargaining process, which we modeled as a loss of utility if receiving a smaller or a larger share of a pie to be divided. In open-ended alternating-offer bargaining between two parties with similar time and inequality preferences, strongly guilt-experiencing bargainers gain utility from reducing an advantageous situation until the inequality between the bargainers is eliminated. Therefore, in the presence of sufficient guilt $\beta > 0.5$, the unique bargaining outcome is the immediate acceptance of an equal division of a pie of size one.

In contrast, bilateral low guilt $\beta < 0.5$, *ceteris paribus*, can materially benefit the proposing bargainer: If the bargaining parties perceive guilt only to such an extend that their utility remains increasing in the own share of the pie despite increasing inequality, then the impact of guilt results in a more unequal division of the pie than predicted by Rubinstein (1982) for purely self-interest bargainers for $\alpha < \delta\beta$ (see appendix 6.3). Envy, *ceteris paribus*, reinforces the bargaining position of each bargainer, but only if guilt is low, because a non-credible threat of a non-envious bargainer to reject unequal contracts may become credible in the case with envy. The bargaining outcome is more equal split of the pie than predicted by Rubinstein (1982) for purely self-interest bargainers if $\alpha > \delta\beta$. The condition $\alpha < \delta\beta$ is ruled out by Fehr & Schmidt (1999)'s original model of inequality aversion that assumes $\beta \leq \alpha$, but this assumption may be relaxed to account for welfare concerns that can interact with concern for inequality aversion (see Engelmann 2012; Kohler 2011). The partial derivatives of the equilibrium split of the pie for a low degree of guilt imply that the equilibrium split of the pie increases in the common degree of guilt and decreases in the common discount factor and degree of envy. Envy has thereby a stronger marginal impact on the equilibrium split of the pie than guilt. The bargainers' individual envy, guilt and discounting have opposite effects on the equilibrium split of the pie. The share of the pie of each bargainer increases/decreases in the degree of the own envy/guilt (see appendix 6.2).

Like in Rubinstein (1982)'s solution without inequality aversion, agreement is immediate and the higher the common discount factor, the more equal the agreed division of the pie. For low guilt, the equilibrium split is between the equal division of the pie and one. Inequality aversion with low guilt diminishes the utility each bargainer derives from the negotiated split of the pie, even for the party that materially gains, in comparison to the utility that purely self-interested bargainers derive from the Rubinstein division of the pie. Only the second mover realizes a larger share of the pie and a higher utility level than a purely self-interested bargainer if bargainers exhibit inequality aversion with high guilt and, thus, the equal split instead of the Rubinstein division of the pie is agreed. However, the sum of the utilities of inequality averse bargainers obtain in the equilibrium is never larger than the total utility purely self-interested bargainers will obtain (see appendix 6.4).

To conclude, the bargaining of symmetrically inequality-averse bargainers is not equivalent to the bargaining of impatient, purely self-interested bargainers, but the equilibrium split can coincide with the Rubinstein division if the opposing effects of envy and guilt on the alternating-offer bargaining outcome just offset each other, i.e. $\alpha = \delta\beta$.

6 Appendix

6.1 The case with low guilt for player-specific discounting and preferences

Here we derive the SPE with player-specific discounting and preferences to be able to differentiate the effects of each bargainer's preferences and discounting on the equilibrium outcome. This generalization proposition 2 is derived for bargaining parties that continue to share similar degrees of inequality aversion and impatience, a sufficient condition to allow evaluating the marginal impact of each player on the bargaining outcome.

Proposition 3. *The alternating-offer bargaining problem with not equally inequality-averse and discounting bargainers has a unique SPE that includes immediate agreement if players' inequality aversion and discounting are similar enough, i.e.,* $\max\{|\alpha_1 - \alpha_2|, |\beta_1 - \beta_2|, |\delta_1 - \delta_2|\} < \varepsilon$*, and if both players' guilt is low, i.e.,* $\beta_i < 0.5$ *for* $i = 1, 2$*. In the SPE, player* 1 *immediately proposes*

$$x^* = \frac{v_1 - \beta_1}{1 - 2\beta_1} = \frac{(1+\alpha_2)(1+2\alpha_1) - \delta_2(1+\alpha_1) + \delta_2(\beta_2 + \beta_1\delta_1(1-2\beta_2))}{(1+2\alpha_1)(1+2\alpha_2) - \delta_1\delta_2(1-2\beta_1)(1-2\beta_2)}$$

and gets utility

$$v_1^* = \frac{(1+2\alpha_1)(1-\beta_1+\alpha_2) - \delta_2(1-2\beta_1)(1-\beta_2+\alpha_1)}{(1+2\alpha_1)(1+2\alpha_2) - \delta_1\delta_2(1-2\beta_1)(1-2\beta_2)} .$$

Proof. **Assume $\beta < \frac{1}{2}$ "low guilt" and consider δ_i and α_i, β_i for each bargainer i:**

Step 1: Step 1: We determine U and then verify (F1)–(F4).

First, we compute $\omega_1 = -\alpha_1 \leq 0$ as the minimum and $\omega_2 = 1 - \beta_1$ as the maximum of v_1. Second, we compute the function $f(v_1) := u_2(u_1)$.

Assume $x \geq \frac{1}{2}$ which implies $u_1 \geq \frac{1}{2}$. We solve $u_1 = \beta_1 + x(1-2\beta_1)$ for x to obtain $x(u_1) = \frac{u_1 - \beta_1}{1-2\beta_1}$. We insert $x(u_1)$ into $u_2 = 1 + \alpha_2 - x(1+2\alpha_2)$ to obtain u_2 as a function of u_1, which defines $v_2 = f(v_1)$ for $v_1 \geq \frac{1}{2}$. Now assume $x < \frac{1}{2}$ which implies $u_1 < \frac{1}{2}$. We solve $u_1 = x(1+2\alpha_1) - \alpha_1$ for x to obtain $x(u_1) = \frac{u_1+\alpha_1}{1+2\alpha_1}$. We insert $x(u_1)$ into $u_2 = 1 - \beta_2 - x(1-2\beta_2)$ to obtain u_2 as a function of u_1, which defines $v_2 = f(v_1)$ for $v_1 < \frac{1}{2}$. Thus f is given by

$$f(v_1) = \begin{cases} 1 + \alpha_2 - \frac{(v_1-\beta_1)(1+2\alpha_2)}{1-2\beta_1} & \text{if} \quad v_1 \geq \frac{1}{2} \\ 1 - \beta_2 - \frac{(v_1+\alpha_1)(1-2\beta_2)}{1+2\alpha_1} & \text{if} \quad v_1 < \frac{1}{2} \end{cases}$$

and set U by

$$U = \{(v_1, f(v_1)) : -\alpha_1 \leq v_1 \leq 1 - \beta_1 \wedge -\alpha_1 \leq 0\} . \tag{12}$$

Noting that $\lim_{v_1 \to \frac{1}{2}} f(v_1) = \frac{1}{2}$ for $v_1 \gtrless \frac{1}{2}$ it is easy to see that f is continuous (F1). As $f' < 0$ for $v_1 \gtreqless \frac{1}{2}$ function f is strictly decreasing (F2). As $f(0) = \frac{1+\alpha_1-\beta_2}{1+2\alpha_1} \in (\frac{1}{2}, 1]$ it is true that $f(0) \geq 0$ (F3). Finally, as $\omega_2 = 1 - \beta_1$ and $f(1-\beta_1) = -\alpha_2$ it is true that $f(\omega_2) \leq 0$ (F4). Thus, assumptions (F1)–(F4) underlying proposition 1 are satisfied.

Step 2: We establish that $h(v_1) := f(v_1) - \delta_2 f(\delta_1 v_1) = 0$ is strictly decreasing, which implies that the solution to $h(v_1) = 0$ is uniquely determined. Note that h is continuous and satisfies

$$h'(v_1) = \begin{cases} -\frac{1+2\alpha_2}{1-2\beta_1}(1-\delta_2) < 0 & \text{if} \quad \delta_1 v_1 > \frac{1}{2} \\ -\frac{1-2\beta_2}{1+2\alpha_1}(1-\delta_2) < 0 & \text{if} \quad v_1 < \frac{1}{2} \\ -\frac{1+2\alpha_2}{1-2\beta_1} + \delta_2 \frac{1-2\beta_2}{1+2\alpha_1} < 0 & \text{if} \quad \frac{1}{2} < v_1 < \frac{1}{2\delta_1} \end{cases} .$$

Step 3: We search for solutions to $h(v_1) = 0$ starting in the segment of h where $v_1 \geq \frac{1}{2} > \delta_1 v_1$. Thus, we solve $1 + \alpha_2 - \frac{(v_1-\beta_1)(1+2\alpha_2)}{1-2\beta_1} = \delta_2(1 - \beta_2 - \frac{(\delta_1 v_1+\alpha_1)(1-2\beta_2)}{1+2\alpha_1})$ and for v_1 and the corresponding outcome x, respectively. A solutions $v_1^*(x^*)$ exist and is given by

$$v_1^* = \frac{(1+2\alpha_1)(1-\beta_1+\alpha_2) - \delta_2(1-2\beta_1)(1-\beta_2+\alpha_1)}{(1+2\alpha_1)(1+2\alpha_2) - \delta_1\delta_2(1-2\beta_1)(1-2\beta_2)}$$

or, in terms of the split of the pie, by

$$x^* = \frac{v_1 - \beta_1}{1-2\beta_1} = \frac{(1+\alpha_2)(1+2\alpha_1) - \delta_2(1+\alpha_1) + \delta_2(\beta_2 + \beta_1\delta_1(1-2\beta_2))}{(1+2\alpha_1)(1+2\alpha_2) - \delta_1\delta_2(1-2\beta_1)(1-2\beta_2)} .$$

Note that there exists $\varepsilon > 0$ such that this is the solution if $\max\{|\alpha_1 - \alpha_2|, |\beta_1 - \beta_2|, |\delta_1 - \delta_2|\} < \varepsilon$. The reason is as follows. Above we derived that $\frac{1}{2} > v_1^* > \delta v_1^*$ when $\alpha_1 = \alpha_2$, $\beta_1 = \beta_2$ and $\delta_1 = \delta_2$. As these inequalities are strict and as the space of parameters is compact, there exists $\varepsilon > 0$ such that $\frac{1}{2} > v_1^* > \delta_1 v_1^*$ holds when $\max\{|\alpha_1 - \alpha_2|, |\beta_1 - \beta_2|, |\delta_1 - \delta_2|\} < \varepsilon$. In contrast, if players' discounting and inequality differ by more than ε, it possible that the conditions $\frac{1}{2} > v_1^* > \delta v_1^*$ are violated, for example, if $\delta_2 = \alpha = \beta = 0$ and $\delta_1 = 1$. □

6.2 Partial derivatives and limits for low guilt

The common marginal effects of the players' common impatience δ, envy α and guilt β on equilibrium split are given by the following partial derivatives:

$$\begin{aligned} \frac{\partial x^*}{\partial \delta} &= -(1+\alpha-\beta) * D^{-2} < 0 \\ \frac{\partial x^*}{\partial \alpha} &= -(1-\delta) * D^{-2} < 0 \\ \frac{\partial x^*}{\partial \beta} &= -\delta \frac{\delta-1}{(2\alpha+\delta-2\beta\delta+1)^2} = \delta(1-\delta) * D^{-2} \geq 0 \end{aligned} ,$$

where the equilibrium split x^* is given by

$$x^* = \frac{(1+\alpha_2)(1+2\alpha_1) - \delta_2(1+\alpha_1) + \delta_2(\beta_2 + \beta_1\delta_1(1-2\beta_2))}{(1+2\alpha_2)(1+2\alpha_1) - \delta_2\delta_1(1-2\beta_2)(1-2\beta_1)} =: \frac{N}{D} .$$

The player-specific marginal effects of the players' impatience δ_i, envy α_i and guilt β_i on equilibrium split are given by the following partial derivatives:

$$\begin{array}{ll}\frac{\partial x^*}{\partial \delta_1} & = \delta_2(1-2\beta)(1+\alpha-\beta)(1+2\alpha-\delta_2(1-2\beta)) * D^{-2} \geq 0 \\ \frac{\partial x^*}{\partial \delta_2} & = -(1+2\alpha)(1+\alpha-\beta)(1+2\alpha-\delta_1(1-2\beta)) * D^{-2} < 0 \\ \frac{\partial x^*}{\partial \alpha_1} & = \delta(1-\delta)(1-2\beta_2)(1+2\alpha_2-\delta(1-2\beta_1)) * D^{-2} \geq 0 \\ \frac{\partial x^*}{\partial \alpha_2} & = -(1-\delta)(1+2\alpha_1)(1+2\alpha_1-\delta(1-2\beta_2)) * D^{-2} < 0 \\ \frac{\partial x^*}{\partial \beta_1} & = -\delta^2(1-\delta)(1-2\beta_2)(1+2\alpha_1-\delta(1-2\beta_2)) * D^{-2} \leq 0 \\ \frac{\partial x^*}{\partial \beta_2} & = \delta(1-\delta)(1+2\alpha_1)(1+2\alpha_2-\delta(1-2\beta_1)) * D^{-2} \geq 0\end{array},$$

where the equilibrium split x^* for $\max\{|\alpha_1-\alpha_2|, |\beta_1-\beta_2|, |\delta_1-\delta_2|\} < \varepsilon$ is given by

$$x^* = \frac{1+\alpha-\beta\delta}{1+2\alpha+\delta(1-2\beta)} =: \frac{N}{D}.$$

The respective signs follow from evaluating the derivatives. The limits of the equilibrium split x^* are given by $\lim_{\delta\to 0} x^* = \frac{1+\alpha}{1+2\alpha} \in [0.5,1]$, $\lim_{\delta\to 1} x^* = 0.5$, $\lim_{\alpha\to 0} x^* = \frac{1-\beta\delta}{1+\delta(1-2\beta)} \in (0.5,1]$, $\lim_{\alpha\to\infty} x^* = \frac{1+\alpha-\beta\delta}{1+2\alpha+\delta(1-2\beta)} = 0.5$, $\lim_{\beta\to 0} x^* = \frac{1+\alpha}{1+2\alpha+\delta} \in [0.5,1]$ and $\lim_{\beta\to 0.5} x^* = \frac{1+\alpha-0.5\delta}{1+2\alpha} \in [0.5,1]$. The limit values follow from evaluating the limits.

6.3 Rubinstein division versus equilibrium split with inequality aversion

If $\beta < 0.5$, then envy and guilt determine if and how the equilibrium split with inequality aversion deviates from the Rubinstein division

$$\frac{1}{1+\delta} \lesseqgtr \frac{1+\alpha-\beta\delta}{1+2\alpha+\delta(1-2\beta)} \quad \text{if} \quad \alpha \lesseqgtr \beta\delta.$$

6.4 Utility in the subgame perfect equilibrium with inequality aversion

Irrespective of the degree of guilt, the utility of an inequality averse player 1, who experiences guilt in the equilibrium, is not higher than the utility of a purely self-interested player 1 who receives $\frac{1}{1+\delta}$

$$\frac{u_1(x^*)}{u_1(\frac{1}{1+\delta})\big|_{\alpha=0,\beta=0}} = \begin{cases} \frac{(1+\delta)(1+\alpha-\beta)}{1+2\alpha+\delta(1-2\beta)} \in [0.5,1] & \text{if} \quad \beta < 0.5 \\ \frac{1+\delta}{2} \in [0.5,1) & \text{if} \quad \beta \geq 0.5 \end{cases}.$$

The utility of an inequality averse player 2, whose utility in equilibrium is unaffected by guilt, is not lower than the utility of a purely self-interested player 2 if guilt is low and higher if guilt is high:

$$\frac{u_2(x^*)}{u_2(\frac{1}{1+\delta})\big|_{\alpha=0,\beta=0}} = \begin{cases} \frac{(1+\delta)(1+\alpha-\beta)}{1+2\alpha+\delta(1-2\beta)} \in [0.5,1] & \text{if} \quad \beta < 0.5 \\ \frac{1+\delta}{2\delta} \in (1,\infty] & \text{if} \quad \beta \geq 0.5 \end{cases}.$$

The sum of the equilibrium utilities of the inequality averse players 1 and 2 is given by

$$\sum_i v_i^* = \begin{cases} (1+\delta)v_i^* = (1+\delta)\frac{1+\alpha-\beta}{1+2\alpha+\delta(1-2\beta)} \in (0.5,1] & \text{if} \quad \beta < 0.5 \\ x^* - \beta(2x^*-1) + (1-x^*) - \beta(1-2x^*) = 1 & \text{if} \quad \beta \geq 0.5 \end{cases}.$$

Hence, the sum of the utilities of inequality averse bargainers obtain in the equilibrium is equal or smaller than the sum of the utilities of purely self-interested bargainers that is always equal to one.

References

Barr, A., Wallace, C., Ensminger, J., Henrich, J., Barrette, C., Bolyanatz, A., Cardenas, J.-C., Gurven, M., Gwako, E., Lesorogol, C., Marlowe, F., McElreath, R., Tracer, D., & Ziker, J. (2009). Homo aequalis: A cross-society experimental analysis of three bargaining games. *Department of Economics Discussion Paper Series, Number 422. Oxford: University of Oxford*.

Bellemare, C., Kröger, S., & Van Soest, A. (2008). Measuring inequity aversion in a heterogeneous population using experimental decisions and subjective probabilities. *Econometrica*, *76*, 815–839.

Birkeland, S., & Tungodden, B. (2014). Fairness motivation in bargaining: A matter of principle. *Theory and Decision*, *77*, 125–151.

Bolton, G. E., & Ockenfels, A. (2000). ERC: A theory of equity, reciprocity and competition. *American Economic Review*, *90*, 166–193.

Camerer, C. F. (2003). *Behavioral Game Theory. Experiments in Strategic Interaction*. Princeton: Princeton University Press.

Cooper, D. J., & Kagel, J. H. (2016). Other-Regarding Preferences: A Selective Survey of Experimental Results. In J. H. Kagel, & A. E. Roth (Eds.), *Handbook of experimental economics* chapter 4. (pp. 217–289). Princeton, NJ: Princeton University Press volume 2.

De Bruyn, A., & Bolton, G. E. (2008). Estimating the influence of fairness on bargaining behavior. *Management Science*, *54*, 1774–1791.

Engelmann, D. (2012). How not to extend models of inequality aversion. *Journal of Economic Behavior & Organization*, *81*, 599–605.

Fehr, E., & Schmidt, K. M. (1999). A theory of fairness, competition, and cooperation. *Quarterly Journal of Economics*, *114*, 817–868.

Goeree, J. K., & Holt, C. A. (2000). Asymmetric inequality aversion and noisy behavior in alternating-offer bargaining games. *European Economic Review*, *44*, 1079–1089.

Herreiner, D., & Puppe, C. (2009). Envy freeness in experimental fair division problems. *Theory and Decision*, *67*, 65–100.

Kohler, S. (2008). Inequality aversion and stochastic decision-making: Experimental evidence from Zimbabwean villages after land reform. In A. Innocenti, & P. Sbriglia (Eds.), *Games, Rationality and Behavior: Essays on Behavioral Game Theory and Experiments* (pp. 63–100). Basingstoke: Palgrave McMillan.

Kohler, S. (2011). Altruism and fairness in experimental decisions. *Journal of Economic Behavior & Organization*, *80*, 101–109.

Kohler, S. (2012). Incomplete information about social preferences explains equal division and delay in bargaining. *Games*, *3*, 119–137.

Kohler, S. (2013a). Envy can promote more equal division in alternating-offer bargaining. *Journal of Neuroscience, Psychology, and Economics*, *6*, 31–41.

Kohler, S. (2013b). More fair play in an ultimatum game after resettlement in Zimbabwe: A field experiment and a structural model. *PLOS ONE*, *8*, e64791.

Kohler, S. (2014). Guilt causes equal or unequal division in alternating-offer bargaining. *Economics Bulletin*, *34*, 1611–1617.

Leroch, M. A. (2015). Rubinstein bargaining with other-regarding preferences. *Gutenberg School of Management and Economics & Research Unit "Interdisciplinary Public Policy" Discussion Paper Series, Discussion paper number 1509. Mainz: Johannes Gutenberg University*.

Mauleon, A., & Vannetelbosch, V. (2013). Relative concerns and delays in bargaining with private information. *Games*, *4*, 329–338.

Montero, M. (2007). Inequity aversion may increase inequity. *Economic Journal*, *117*, C192–C204.

Montero, M. (2008). Altruism, spite and competition in bargaining games. *Theory and Decision*, *65*, 125–151.

Osborne, M. J., & Rubinstein, A. (1994). *A Course in Game Theory*. Cambridge, MA: MIT Press.

Rasch, A., Wambach, A., & Wiener, K. (2012). Bargaining and inequity aversion: On the efficiency of the double auction. *Economics Letters*, *114*, 178–181.

Roth, A. E. (1985). A note on risk aversion in a perfect equilibrium model of bargaining. *Econometrica*, *53*, 207.

Rubinstein, A. (1982). Perfect equilibrium in a bargaining model. *Econometrica*, *50*, 97–109.

Shaked, A., & Sutton, J. (1984). Involuntary unemployment as a perfect equilibrium in a bargaining model. *Econometrica*, *52*, 1351–1364.

Smith, R. (Ed.) (2008). *Envy: Theory and Research*. New York, NY: Oxford University Press.

Tan, J. H. W., & Bolle, F. (2006). On the relative strengths of altruism and fairness. *Theory and Decision*, *60*, 35–67.

Zwick, R., Rapoport, A., & Howard, J. C. (1992). Two-person sequential bargaining behavior with exogenous breakdown. *Theory and Decision*, *32*, 241–268.