GREQAM

**Groupement de Recherche en Economie
Quantitative d'Aix-Marseille - UMR-CNRS 6579
Ecole des Hautes études en Sciences Sociales
Universités d'Aix-Marseille II et III**

Experimental comparison of compulsory and non compulsory arbitration mechanisms

**Eric Guerci
Sylvie Thoron**

April 2011

DT-GREQAM

Experimental comparison of compulsory and non compulsory arbitration mechanisms

E. Guerci

GREQAM

2, rue de la Charité, 13236, Marseille

`eric.guerci@univmed.fr`

S. Thoron

GREQAM

2, rue de la Charité, 13236, Marseille

`sylvie.thoron@univmed.fr`

Abstract

We run a series of experiments to compare the well known arbitration scheme FOA (Final Offer Arbitration) with a new arbitration scheme, non compulsory, we proposed in a companion paper (Tanimura and Thoron (2008)): ROC (Recursive Offer Conciliation). The two mechanisms are also compared with a negotiation without arbitration. We observe that the ROC mechanism seems to cumulate the advantages of the two other procedures, it avoids the high frequency of impasses observed under the FOA procedure and it is as efficient as the Free procedure in this respect. Furthermore, in an asymmetric treatment, it helps the subjects to find an agreement on the equal split of the surplus, like the arbitrator of the FOA procedure does, but without imposing anything on them.

1   Introduction

We talk about arbitration mechanism when two parties fail to reach agreement in negotiations and have recourse to arbitration by a neutral third party. The objective of these mechanisms is to provide a solution to bargaining impasses and avoid the inefficiency due

1

to too long process of negotiation or a failure. Final Offer Arbitration (FOA) is one of the best known mechanisms. It is used, for example, for the settlement of commercial disputes, to settle grievances in union-management contracts (for a variety of examples see Ashenfelter and Bloom (1984)), but also at the international level to resolve disputes between countries in the framework of the Permanent Court of Arbitration. FOA has been proposed by Steven (1996) to solve a problem encountered with another well known mechanism, Conventional Offer Arbitration (COA). Indeed, an empirical literature had pointed out what was called the "chilling effect": the simple fact that COA is made available to the parties increases the frequency of deadlocks. The arbitration mechanism erodes agents' incentive to make concessions in bargaining and their proposed settlements remain distant from each other.

Steven proposed to solve this perverse effect by exploiting the parties' risk aversion. In COA, the arbitrator has the power to impose a settlement of his choice on the bargaining agents if their negotiations break down, that is if their demands are not compatible. In FOA the arbitrator chooses among the proposals the one he wishes to impose. Stevens' idea was that: "... [FOA] generates just the kind of uncertainty about the location of the arbitration awards that is well calculated to recommend maximum notions of prudence to the parties and, hence, compel them to seek security in agreement" (Stevens 1966 page 46). On the basis of this theoretical proposal, this procedure has been applied to settle public sector labor disputes in several U.S. state jurisdictions (see Hebdon (1996)). It turned out that this mechanism had to be implemented, meaning that the bargaining parties did not reach an agreement by themselves.

Indeed, several models in the literature show that Stevens' intuition was wrong. The results depend on the parties' belief as to the arbitrator's preference. Farber (1980, 1981) and Farber and Katz (1980) consider that the parties are uncertain as to the arbitrator's preference. They show that the two different mechanisms COA and FOA lead to different results which depend on the parties' attitude toward risk. However, the so called chilling effect persists. In addition, the comparison of the two kinds of mechanism has been the subject of experiments (see for example Ashenfelter et alii (1992), Dickinson (2006), Kriticos (2006)) which reinforce this theoretical result just mentioned. However, under some conditions FOA does eliminate the chilling effect. Crawford (1979) studied the case in which both parties know with certainty the arbitrator's preferred outcome and concluded that under this assumption both arbitration mechanisms support in fact the same outcome at the Nash equilibrium. Proposals are not compatible at the equilibrium of the COA but are compatible with FOA. However, "...there exists a unique Nash equilibrium in FOA, which leads to the feasible final settlement considered most reasonable by the arbitrator, without regard to the bargaining agents' preferences". Page 135. Under the threat of arbitration, the parties are not really involved in a real process of bargaining but are just

2

trying to conform to the arbitrator's preferred outcome or, as Crawford says, the parties "do not negotiate in good faith". This result has been confirmed recently in the framework of bargaining theory by Manzini and Mariotti (2001).

In the opposite case in which a judge or an arbitrator does not have a preferred outcome to impose on the parties, we show in a companion paper (Tanimura and Thoron (2008)) that the chilling effect is maximized under COA and FOA. Then, the role of the arbitrator is reduced to splitting the pie into two equal halves in the case of the COA or to flipping a coin in the case of the FOA. If this is common knowledge to the parties, they have an incentive to persist with extreme proposals and the chilling effect is maximal. Indeed, it is precisely in such situations that negotiation is useful.

In Tanimura and Thoron (2008) we propose a new mechanism, ROC (Recursive Offer Conciliation). In a game theoretical framework, we show that ROC gives the parties to a negotiation the incentive to make concessions until they reach an agreement. More precisely, at the subgame perfect Nash equilibrium of a sequential bargaining game governed by ROC, the parties make gradual concessions which converge to the Raiffa solution (Raiffa (1953)). This mechanism is especially well suited to situations in which a judge or an arbitrator does not have a preferred outcome to impose on the parties. Our analysis focused on the role of the parties' risk aversion in the negotiation as pointed out by Stevens. In the mechanism we proposed, which is a modified version of FOA, the incentive to reach agreement is based on the fact that incompatible offers lead to uncertainty as to outcomes and players who are risk averse may prefer to modify their offers to obtain sure payoffs. However, Stevens' intuition as to the role of risk aversion is only validated in ROC because of the recursivity of the mechanism. We specify a sequential bargaining game. When the proposals are not compatible, the bargaining parties have the possibility of opting out by implementing the ROC mechanism. In the spirit of FOA, ROC chooses one or the other of the two proposals. However, a first difference between FOA and ROC is that in the latter, a lottery draws with equal probability each party's proposal. A second difference is that the resulting proposal cannot be imposed on the other party since he has the right to reject it. Indeed, contrary to FOA, the ROC mechanism is not compulsory. The third difference is that the mechanism allows the parties to record the sequence of not compatible proposals. Thanks to this history of disagreements there may be several possibilities when a party decides to opt out. For example, if a party rejects the proposal which has been drawn by the lottery, the mechanism goes back to implement a lottery with the previous proposals. Thus, it is only if all the proposals are rejected that the negotiation ends in failure. In this paper, we present a series of experiments we ran in order to compare our mechanism with FOA. A first objective is to verify that, in the laboratory like in theory, ROC allows to eliminate the chilling effect generated by FOA.

3

Since ROC is a non compulsory mechanism, it has to be compared also with a negotiation procedure without arbitration. In the literature on bargaining theory, as first explained in the seminal paper by Rubinstein (1982), discounting is an important driving force in a negotiation. However, risk aversion is also considered as an important incentive. Myerson (1991) proposed a sequential bargaining game without discounting and with a finite horizon, in which one of two parties is drawn randomly at each period to make a proposal. We will use this simple and elegant game as a theoretical benchmark for a free negotiation. Myerson shows that, at the subgame perfect Nash equilibrium of his game, the two parties reach an efficient agreement immediately and that this converges to the Raiffa solution when the number of periods tends to infinity. The idea is that the first party to make a proposal gives the other party his certainty equivalent of pursuing in the game. The other party, because it is risk averse, accepts. However, this nice result depends on a strong assumption: the parties know the maximum number of periods that the negotiation process can last. The other difficulty with this assumption is an experimental one. Indeed, it is well known that real subjects do not use backward induction which is essential to find the subgame perfect equilibrium in Myerson game. Under the ROC mechanism, the parties can stop the negotiation when ever they wish, either with an agreement or by disagreement. Yet, thanks to its recursivity, the parties have an incentive to make concessions.

At the equilibrium, the ROC game and the Myerson game generate the same agreement. However, our hypothesis was that it would be easier for real subjects to negotiate under the ROC procedure than under a procedure close to Myerson's game. Indeed, if the rules characterizing the ROC game are more elaborated than the simple rules of the Myerson game, the rationality needed at the equilibrium seems simpler and more realistic. Therefore, the second objective of our experiments was to see if ROC could help subjects to negotiate in comparison with a free procedure, based on the Myerson game.

We propose three procedures in which the subjects are divided into pairs and sequentially in each pair one of the two subjects is chosen to make a proposal. At each step they can also opt out. What happens if they opt out depends on the procedure. In the Free procedure the subjects get a threat point payoff. In the FOA and ROC procedures the specific mechanism is implemented. Since risk aversion plays a role in theory, we also ask the subjects to answer a questionnaire in the spirit of Holt and Laury's (Holt and Laury (2002)).

In Section 2, we present the theoretical background. The design of the experiment and the protocol are described in Section 3. The results are discussed in the following Section 4. Section 5 concludes.

4

2 Theoretical background

The three procedures we are going to compare in our experiment can be modeled in the framework of bargaining game theory. This theoretical background will be presented in this section.

2.1 A bargaining game

We consider the following bargaining game. At the status quo, Player 1 and Player 2 have an endowment of, respectively, $\mathring{x}$ and $\mathring{y}$. They bargain over the partition of a pie of size K. The possible ways to split the pie are:

$$\{(x, y) : x, y \in [0, K] \text{ and } x + y \leq K\}$$

in which x is the share of Player 1 and y those of Player 2. Both players are assumed to be (weakly) risk averse in the sense that they have linear or concave utility functions, respectively $U^1(x)$ and $U^2(y)$, that are strictly increasing on $[0, K]$. In terms of possible utility pairs $(u, v) \in R^2$, the compact, convex bargaining set S is thus delimited by the curves $u = U^1(\mathring{x})$, $v = U^2(\mathring{y})$ and the curve $(U^1(x), U^2(1 - x))$, $x \in [0, K]$. In what follows, we define a well known cooperative solution of this bargaining game, the Raiffa solution (see Raiffa 1953). Let $m^1(U^2(y))$ be the maximum utility Player 1 can get when Player 2 gets y. Consider the following sequence:

$$U_0 = (U_0^1, U_0^2) = (U^1(\mathring{x}), U^2(\mathring{y}))$$

$$U_{t+1} = 1/2 * [(m^1(U_t^2), U_t^2) + (U_t^1, m^2(U_t^1))]$$

The Raiffa solution, as defined in Raiffa (1953), is the limit of this sequence when t tends to infinity and recently axiomatic characterizations have been found (Anbarci and Sun 2009, Trockel 2009). The Raiffa solution depends on the status quo and on the shape of the utility functions. However, if the two players have the same CRAA (constant relative ambiguity aversion) utility function, the Raiffa solution assigns to Player 1 (2) his threat point payoff $\mathring{x}$ ($\mathring{y}$) plus half of the surplus $s = K - \mathring{x} - \mathring{y}$. We will call this sharing the Equal Split of the Surplus (ESS). For example, taking the parameters we will use in the experiment, $K = 22.2$, $\mathring{x} = 8$ and $\mathring{y} = 2$, we have ESS = (14.1;8.1). When $\mathring{x} = \mathring{y} = 0$, we will call the equal split of the surplus simply the Equal Split: ES = (11.1;11.1).

In the following subsections, we will describe three non cooperative sequential bargaining games that share the same basic structure: Each of the two players in turn make

5

proposals over at most *n* periods. Each proposal is denoted by (x, y) in which x (respectively y) is the payment of Player 1 (2), with $x + y < K$. At each period t, one of the two players is drawn randomly to make a proposal (x_t, y_t) that the other player can accept or reject. If the proposal is accepted, the game ends and the two players get the payoffs x_t and y_t. The three games differ in their description of what happens in case of rejection by at least one of the players.

2.2 The Myerson game

In the first game, which has been proposed by Myerson (1991), if the proposal is rejected the next period starts, following the same procedure (see Figure 1). At the subgame perfect Nash equilibrium of the game, the sequence of proposals coincides with the Raiffa's sequence and the first proposal is accepted immediately (Myerson 1991). At one extreme, when there is only one period, the game is equivalent to an ultimatum game. The equilibrium is that the player who is drawn randomly proposes to keep the whole amount K minus the status quo payoff of the opponent who accepts. At the other extreme, when
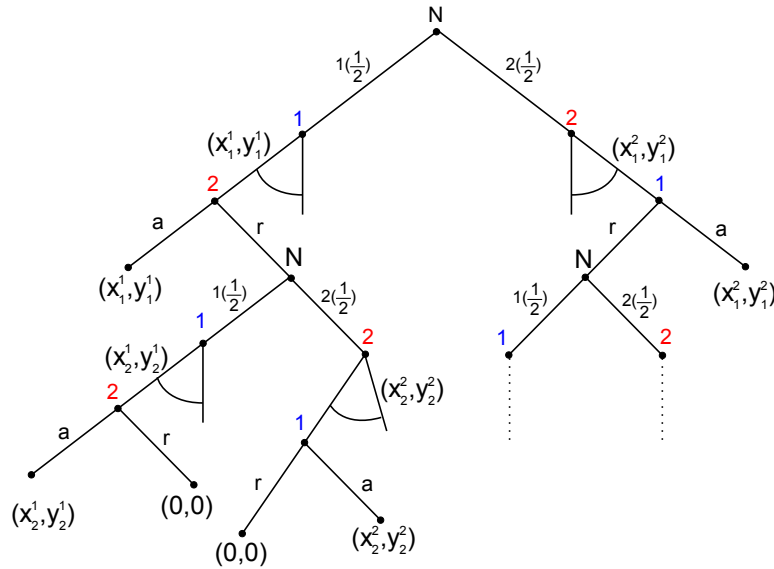

Figure 1: Myerson Game

the number of periods tends to infinity, the equilibrium converges towards the Raiffa solution defined above. Finally, when the number of periods is n, the strategy of Player 1 (respectively 2) is to propose $(m^1(U_n^2), U_n^2)$ (and $(U_n^1, m^2(U_n^1))$ for Player 2). These payoffs

6

coincide with the shares defined at the *n*th step of the Raiffa sequence. Whatever the number of periods, the proposal is always the certainty equivalent of the opponent's expected utility from continuing the negotiation and it is always accepted immediately. Therefore, one interpretation of the Raiffa sequence is that U_{t+1} is the vector of the Players' expected utilities from negotiating in the Myerson game over $t + 1$ periods.

2.3 The Final Offer Arbitration game

In this game, the difference with the Myerson game is as follows. When, at date t, Player i decides to reject a proposal (x_t^j, y_t^j), he has to make another proposal (x_t^i, y_t^i). Then, the two players have to decide simultaneously if they want to continue the negotiation or to opt out. If both players want to continue the next period starts with the same procedure. Otherwise, an arbitrator draws one of the two proposals (x_t^i, y_t^i) and (x_t^j, y_t^j) and the proposal drawn is imposed on the two players. The equilibrium depends on the arbitrator's preferences on the outcome.

In the first situation to consider the arbitrator is a lottery which is perfectly random and draws the two proposals with equal probabilities. Then, at the subgame perfect Nash equilibrium each player proposes at each step to keep K (see Tanimura and Thoron 2008). There is a maximum chilling effect whatever the date at which the players terminate the negotiation.

We also consider a second case in which the arbitrator chooses the proposal closer to his preferred outcome. When the arbitrator's preferred outcome is common knowledge, and coincides for example to ESS, at the subgame perfect Nash equilibrium, the players propose and accept the arbitrator's preferred outcome (see Manzini and Mariotti 2001 but also Crawford 1979).

Finally, in an intermediate case, the players have an incomplete information about the arbitrator's preferences. They consider that the preferred outcome is drawn from a distribution centered on the payoffs at ESS. Then, each player has an incentive to make a proposal closer to the arbitrator's expected preferred outcome than his opponent's one, in order to increase the probability that it will be chosen in case of arbitration. However, by doing so, he decreases his payment in case it is chosen. At the equilibrium, the proposals remain distant from each other but are not extreme (see Farber 1980).

2.4 The Recursive Offer Conciliation game

The game is equivalent to the FOA game, except that, if at least one player has decided to opt out at step t, and if the lottery has drawn proposal (x_t^i, y_t^i), then, Player j can reject it. In case of rejection, the lottery draws randomly between (x_{t-1}^i, y_{t-1}^i), and (x_{t-1}^i, y_{t-1}^i) and
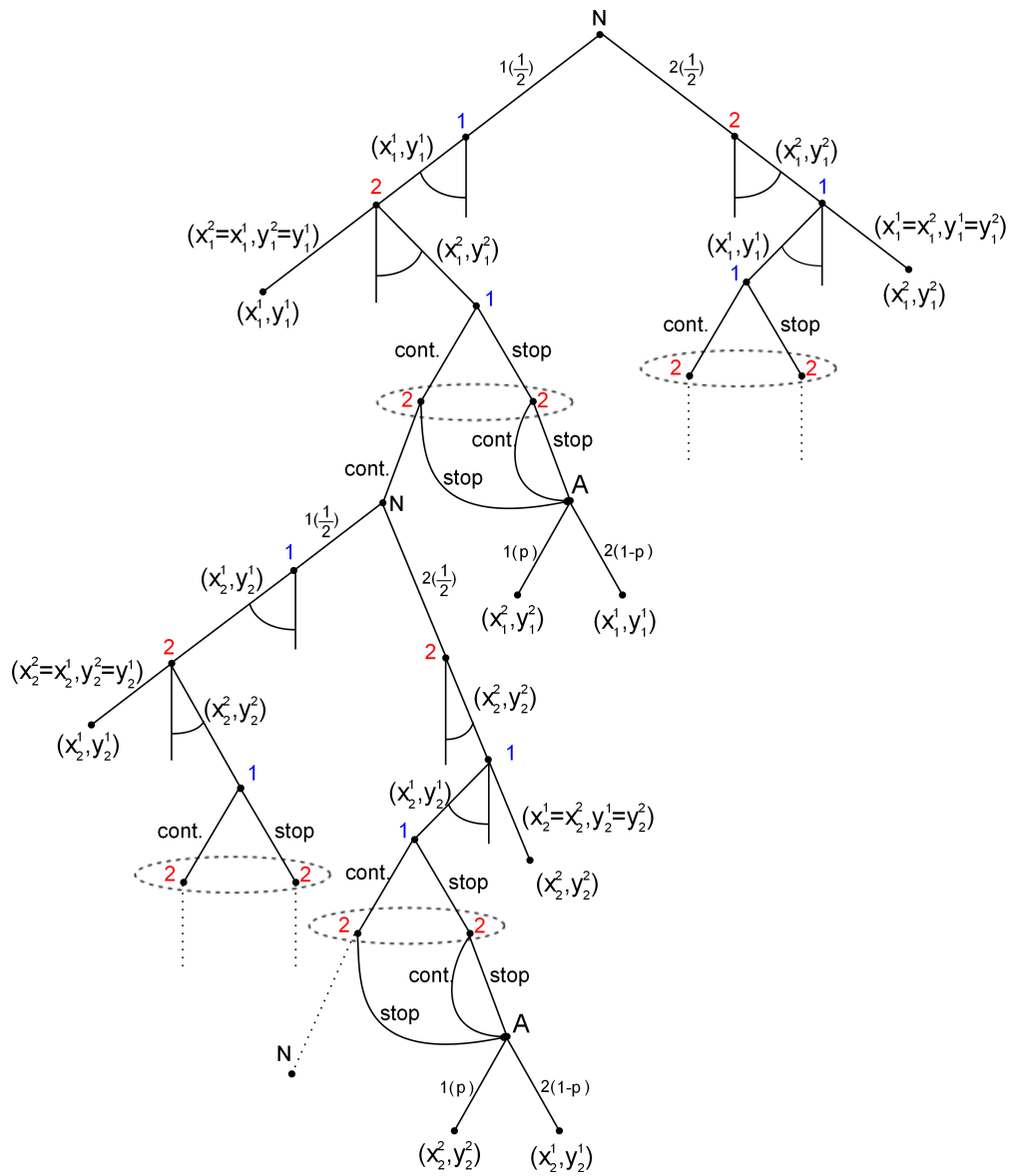
Figure 2: FOA Game

so forth. The procedure stops as soon as one player has accepted his opponent's proposal drawn randomly or at last when the first proposal is reached and rejected, in which case both players get their threat point payoffs.
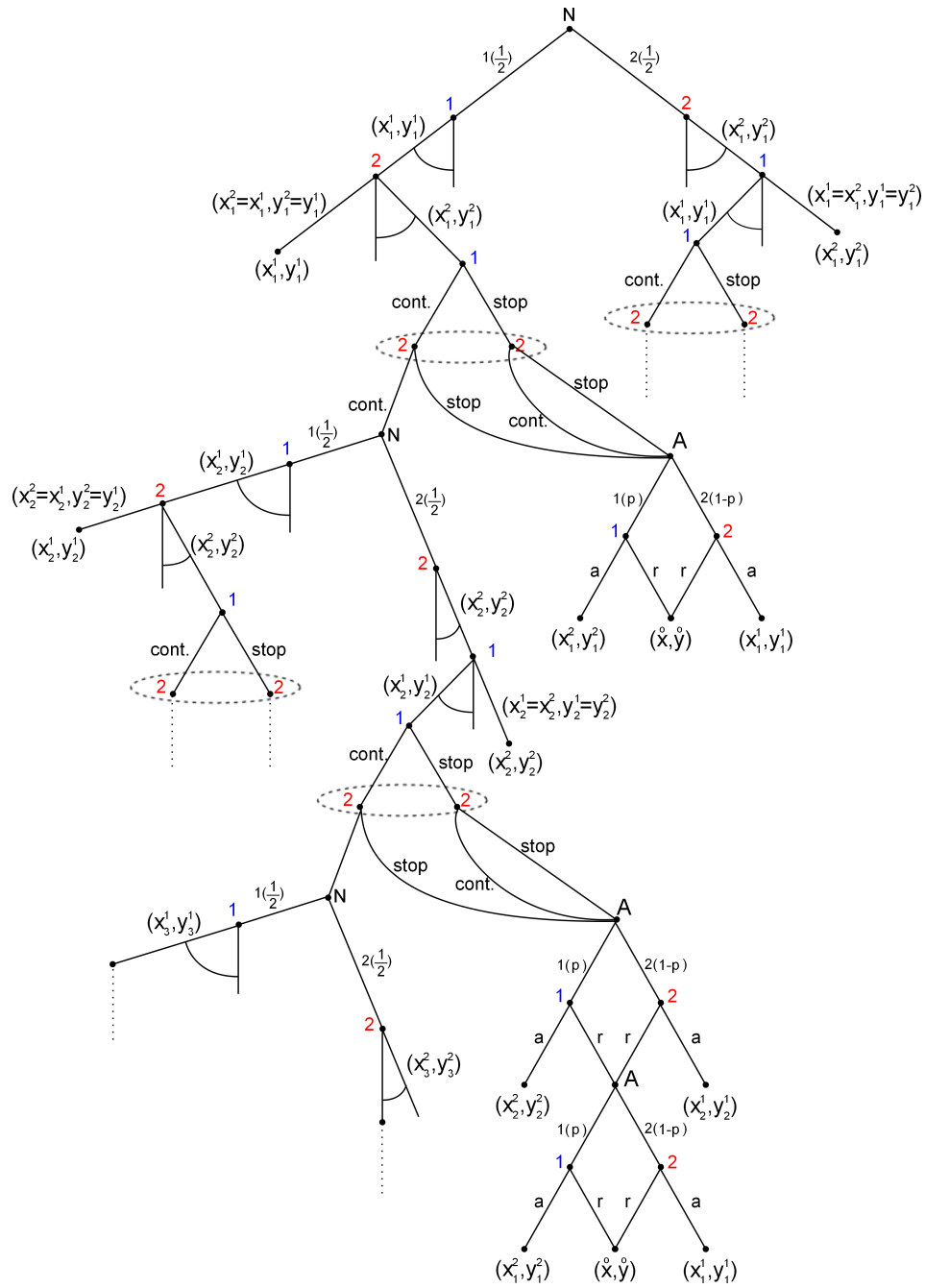
8

Figure 3: ROC Game

The subgame perfect Nash equilibria of the game are described in Tanimura and Thoron (2008). At each step, Player i proposes to his opponent Player j the certainty equivalent of his expected payoff in case of opting out and this coincides with the Raiffa sequence. As a consequence, in case where one of the players opts out, both players always accept the first proposal drawn randomly by the lottery. The equilibria differ in the date at which the players opt out. However, it is always better for both players to continue for as long as possible. The *dominant* equilibrium converges towards the Raiffa solution when the number of periods tends to infinity. When there is a finite number of periods n, at the *dominant* equilibrium, the last pair of proposals coincides with U_n, the *nth* elements of the Raiffa sequence. Then, the lottery is implemented and the players accept the proposal which is drawn randomly.

Therefore, at the equilibrium the proposals are identical in the ROC game and in the Myerson game and coincide in both cases with the Raiffa sequence. However, while the first proposal is accepted immediately at the equilibrium of the Myerson game, players make proposals and counter-proposals as long as they can in the ROC game. This difference in the dynamics of the negotiating process is a consequence of the difference in the way the game is solved in each case. In the Myerson game, under the assumption that the players are perfectly farsighted, they solve the game by backward induction. In the ROC game, the players are backward looking and only consider the past proposals recorded. The ROC equilibrium then has the advantage of being more realistic than the Myerson or Rubinstein solution since in the latter no bargaining actually takes place.

Furthermore, the reason why the players have an incentive to make concessions in the ROC game is very simple and intuitive. Consider the simplest case in which there are at most two steps, the amount to share is $K = 1$ and the threat point payoffs are $(0; 0)$. Assume that each player proposes, at each step, to keep everything, $K = 1$. Then, the history of proposals is: $h_1 = [x_1 = (1; 0); y_1 = (0; 1)]; h_2 = [x_2 = (1; 0); y_2 = (0; 1)]$. At the end, the lottery draws $(1; 0)$ and $(0; 1)$ with equal probabilities. Then, a best reply for each player is to make a concession at the second step. Indeed, Player i can increase his expected payoff by making a concession c, just large enough for his opponent to prefer this sure payoff than to implement the first step lottery. Then, with probability 1/2 he will be in the previous situation but with probability 1/2 he will get $K - c$.

10

3 Experimental Design and Procedure

The main purpose of our study is to compare three distinct negotiation procedures by means of six controlled and independent experimental treatments, two for each negotiation procedures, that is, a free negotiation scheme, a compulsory mechanism, the Final Offer Arbitration (FOA) and a non compulsory mechanism, the Recursive Offer Conciliation (ROC). For each negotiation procedure we run both a symmetric and asymmetric case concerning incentives of negotiation parties. Our experimental design implements for each treatment two tasks: (i) a repeated negotiation procedure in a bargaining experiment and (ii) an experiment for eliciting risk attitudes among experimental subjects. The only difference among treatments refers to the design of the first task (i). In general, all conditions were kept as much as possible identical. In all treatments, the first task represented an experiment where two bargaining parties had to sequentially negotiate to share a pie of 22,2 euros (throughout the whole treatment 1 point were worth 1€.) whereas the second task implemented an individual test for the elicitation of individual risk aversion.

3.1 Design

Part I: The negotiation

The subjects were introduced to the specific negotiation framework by providing detailed instructions of task 1 of the experiment. Subjects were not aware that a second task was present up to the end of task 1. In the following, the common features of the negotiation schemes among the treatments are described.

The bargaining parties were involved in a repeated negotiation procedure over 10 identical periods adopting a stranger matching. At the beginning of each period, subjects were randomly and anonymously paired, this being common knowledge among participants. Each period consisted of a fixed number (five) of negotiation steps. After the fifth step the negotiation was finished and the following period was starting. Each step of the negotiation reproduced an alternating offer scheme. A randomly selected (at each step of each period) first proponent was requested to propose to split the pie. Only after his proposal was made publicly available, in turn the second proponent was in the position to agree and thus finish the negotiation by proposing the compatible proposal or to reject the opponent's proposal by counter-offering a non-compatible proposal. For instance, Let's suppose that bargainer X was selected to be the first proponent at step s, he had then to propose a split of the pie of 22.2 points between the two parties. He was only allowed to make one offer $x = (x, 22.2-x)$, being x the amount kept for him, within a set of eleven symmetric alternatives $\mathcal{X}$, i.e., $x \in \mathcal{X} = \{(0.0, 22.2), (2.2, 20.0), (4.4, 17.8), (6.7, 15.5), (8.9, 13.3), (11.1, 11.1), (13.3,$

8.9), (15.5, 6.7), (17.8, 4.4), (20.0, 2.2), (22.2, 0.0)}[1]. Let's assume $x_s =$ (13.3, 8.9). In turn, bargainer Y had the chance to make a counteroffer $y \in \mathcal{Y} = \{..., (y, 22.2-y), ...\}$, being $\mathcal{Y}$ the same set of alternatives. The choice of bargainer Y can determine the agreement and the end of the negotiation in case he proposes $y_s =$ (8.9, 13.3). We define this counter-offer a compatible proposal (y_s, x_s). In case of rejection, i.e., bargainer Y offer a non-compatible proposal. After this proposal is made available, both subjects are requested to explicitly decide if to continue the negotiation and to proceed to the next step (if s=5 the bargaining automatically ends) or to end the negotiation by declaring it. In this latter situation, the three negotiation protocols differ as follows.

Free negotiation mechanism: FREE

The key point distinguishing the Free scheme to the following ones is the way subjects can accept or reject opponents' offers. Subjects can only agree on a proposal of their opponent by counter-offering a compatible proposal within the 5 bargaining steps. On the other hand, subjects can cause the failure of the negotiation either by always counter-offering non compatible proposals up to the fifth steps or by ending at any time the negotiation, that is, it suffices that only one bargainer declares his/her intention to stop the negotiation after a generic negotiation step. In both opting-out cases, subjects receive their payoffs at the threat point $(\mathring{x}, \mathring{y})$. The threat point can be symmetric or asymmetric, we have considered the two possibilities for studying different incentive structures. In particular, we have considered $(\mathring{x} = 0, \mathring{y} = 0)$ as far as the *symmetric case* is concerned, and $(\mathring{x} = 8, \mathring{y} = 2)$ for the second *asymmetric case*[2]. It is worth noting that in the latter case, experimental subjects kept their role for the whole experiment, that is, after reading the generic instructions they were randomly selected before starting the experimental session to play endowed with one of the two threat point and this was obviously common knowledge since the beginning.

Recursive Offer Conciliation mechanism: ROC

ROC is conceived as a non-compulsory arbitration mechanism, that is, bargainers adopt it as a structured bargaining procedure which may help them to find an agreement. Therefore, the mechanism does not implement any compulsory third-party decision, each bargainer has one strategy to cause the failure of the negotiation and get his opting out option $(\mathring{x}, \mathring{y})$. Because of the non-compulsory nature of this procedure, we have adopted an identical incentives in *both symmetric and asymmetric cases*, that is, we have considered

---

[1]We adopted non integer values in order to avoid the identification of focal alternatives. For instance, it would had been the case, if we would had selected only integer values between 0 an 10, where an obvious focal points would had been 5.

[2]Being the threat point a focal point we adopted integer values

$(\mathring{x} = 0, \mathring{y} = 0)$ for the former case and $(\mathring{x} = 8, \mathring{y} = 2)$ for the latter case.

The mechanism is therefore identical to the free mechanism, except for the fact that by opting out they are involved in a mechanism which implements a third-party decision on their track of past proposals. In particular, given that bargainers opt out at step s, a random lottery draws one of the two offers proposed at step s, i.e., x_s or y_s. If the offer made by bargainer X is chosen (x_s), bargainer Y is faced with the decision to accept the offer or to reject it. The rejection implies that another lottery is implemented to choose between the two offers proposed at step $s-1$, i.e., x_{s-1} or y_{s-1} and the bargainer whose offer has not been chosen is faced with the decision to accept the opponent's offer or continue the lottery mechanism considering now proposal made at step $s-2$. This mechanism is repeated recursively unless one of the two bargainers accepts the opponent's proposal or the recursive mechanisms reach step $s = 0$. In this latter case, the negotiation fails and the bargainers get their threat point payoffs $(\mathring{x}, \mathring{y})$.

Final Offer Arbitration mechanism: FOA

FOA is a compulsory arbitration mechanism. Bargainers, if involved in such mechanism, cannot stop the negotiation without asking for and accepting the arbitrator's decision. The FOA mechanism is identical to the FREE mechanism except for the opportunities to opt-out. Similarly, subjects can only agree on a proposal of their opponent by counter-offering a compatible proposal within the 5 bargaining steps. On the other hand, subjects every-time they opt-out from proposing, they accept to rely on the arbitrator's decision, this obviously occur even if they fail to reach an agrement within the five steps. The arbitrator's decision is made by selecting one of the two final offers, that is, x_s or y_s, given that the negotiation ended at step s. Therefore no $(\mathring{x}, \mathring{y})$ threat point is defined.

In order to reproduce similar negotiation incentives for running both a symmetric and an asymmetric case, we have decided to adopt two different probability distributions for modeling the uncertainty of the arbitrator's decision-making process. In the *symmetric treatment*, the subjects knew that the two final opting-out non-compatible proposals (x_s or y_s, being s the last step of the negotiation) were drawn with equal probabilities. In the *asymmetric treatment*, the principle according to which the arbitrator decides between the two proposals is based on a random selection according to some probability distributions defined over the alternatives X. The idea behind this mechanisms is to mimic the realistic situation where bargainers have visibility of the track of record of previous arbitrator's decision on similar cases. Bargainers can extrapolate a probabilistic decision model of the arbitrator and make decision accordingly. This is similar to the method implemented by Ashenfelter et al. (1994). The probability distribution has been estimated in order to reproduce a similar incentive structure as the two previous asymmetric negotiation pro-

13

tocols, that is, we have adopted a normal distributions $N(14.1, 2.7)$. The mean has been determined in order to equally share the expected surplus of both bargainers in case of opting-out values. In the case of ROC given the uniform random lottery and the threat points ($\mathring{x} = 8, \mathring{y} = 2$), the expected surplus for player X were 4€, that is, 0€ or 8€ with equal probability, and for player Y were 1€, that is, 0€ or 2€ with equal probability. To keep the same difference in terms of surplus between the two bargainers (3€), we decided to consider a mean of 11.1€+3€=14.1€. The nice properties is that the mean almost over-laps with one of the alternatives of the bargainers 13.8€. The standard deviation had been estimated in order to guarantee that all arbitrator's decision fell within the alternatives, that is, three standard deviations plus the mean are equal to the maximum alternatives $(2.7 * 3 + 14.1 = 22.2)$.

Together with the instructions, in Period 1, bargainers received the bargaining record consisting of 50 arbitrator's decision for each possible couple of offer and counter-offer. An example is provided in Figure 4. The instructions (in French) were reporting the whole list

```
T1  -  T2 :                        Arbitrator's decision

(17.8 - 4.4):    xxxxxxxxxxx xxxxxxxxx xxxxxx x xxxxxxxxxxxxxxx xx
(2.2 - 20.0):              x         x      x x                   x

(20.0 - 2.2):    xxxxxxxxxxxxxx xxxxxxxx xxxxxxx xxxxxxx xx   xxxxxx
(2.2 - 20.0):               x         x        x       x  xx
                                    •
                                    •
                                    •
(17.8 - 4.4):    xxx xxxx xx xx xx x xxxxxx x xxx xxxxxxxxxxxx x
(6.7 - 15.5):       x    x x x  x x      x x   x          x xxx

(20.0 - 2.2):    xx x   xxx xx xxxx  xxxxx x  x xx xxxx x    x xxx
(6.7 - 15.5):       x xx   x  x    xx      x xx x  x    x xxxxx x   x
                                    •
                                    •
                                    •
(0.0 - 22.2):
(8.9 - 13.3):    xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
```

Figure 4: Track of record of previous arbitrator's decision on similar cases. The x notation is associated to only one arbitrator's decision and where the choice between the offer and counter-offer displayed in two consecutive lines. T1 stands for bargainers type 1, i.e., bargainers X.

14

of possible offers, here a sparse subset is reported.

Part II: Risk Aversion Test

The second task is aimed for eliciting risk aversion for each subject. A standard Holt and Laury's elicitation procedure has been adopted (Holt and Laury (2002)). The purpose was to collect information about the risk attitude of each subject in order to confirm some theoretical hypothesis. It is worth noting that the elicitation of risk aversion would be preferably implemented at the beginning of a treatment so to prevent the formation of emotional biases affecting individuals' risk attitudes. However, we have preferred to postpone this task in order to avoid a similar effect on the negotiation task as far as playing lotteries is concerned. The proposed negotiation mechanisms implement lotteries for selecting the order or proponents at each negotiation step and moreover for implementing the opting out option in the two mechanisms.

3.2   Procedure

We had twelve experimental sessions, four for each of the three procedures (Free, FOA, ROA), one for the symmetric treatment and three for the asymmetric treatment. Students were recruited from University of Montpellier I and II via email (they were selected within a database of more than 5000 students) soliciting participants for a decision-making experiment of about 2 hours, with a reward that would depend on their decisions. For each session twenty subjects were invited. The subjects entered the room and were told to choose a position in the computerized room. Each position was properly isolated in order to prevent subjects to see, communicate or simply disturb other subjects. Instructions (in French) for part I were distributed at each desk in order to enable each participant to read carefully the procedure of the experiment. After 10 minutes the same instructions were read aloud to the subjects by the experimenter. Subjects were not informed that the experiment would consist of two parts. They were informed about the second part as well as supplied with a copy of their instructions (in French) only after part I was finished. Subjects were not informed about the correct matching procedure, they were just told that a stranger matching was implemented to select at each round the two negotiators. In reality, the twenty subjects, were randomly assigned to one of two groups. Each group comprising ten people was implementing a stranger treatment with one repetition (ten subjects for ten periods). This strategy was adopted to increase the number of statistically independent samples. In general, bargainers had complete information about the size of the pie, bargaining cost, opponent's payoffs and arbitration mechanism; thus, the game was designed to be one of common knowledge. At the end of the read of the instructions, experimental

subjects were informed that a first trial period identical to the following periods was implemented to make themselves acquainted with the software interface. It was declared the it was excluded from payment computation, accordingly we have not considered in our empirical analysis.

After the end of part I, subjects were told about a second part relative to an anonymous and individual test comprising a list of eleven lotteries. They were not informed about the nature of the test and neither about the score/payment relative to part I of the experiment.

Finally, after the two experimental parts were finished an anonymous questionnaire (in French) was submitted to each participant in order to collect some personal information (range of age, sex, studies, ...) after which all subjects were informed about their personal gains. The gains consisted of the final outcome of only one negotiation/period randomly selected among the ten periods plus the outcome of only one lottery of the risk aversion test. Approximately, both average payments were equal to 11.1 €. The attempt to equate payments in both experimental parts has been done in order to keep similar monetary incentives. They were then paid cash according to the experimental gains plus a fee of 5€. The average earnings (including the show-up fee of 5€) per subject was approximately (30€) for in average 2 hours of experimental session.

We conducted the experiments in the computerized lab of the Lameta - University of Montpellier I. We run all sessions in two time-periods, end of May 2010 and end of November 2010. One-hundred eighty subjects participated in the nine experimental sessions. We did not restrict our sample of subjects, by the way they were mainly undergraduate students (42% of men, average age 23) from different faculties, namely, Sciences, Social and Political Science, Engineering and Mathematics. The experiment was programmed and conducted with the experiment software z-Tree (Fischbacher (2007)). Finally, it is worth remembering that a sample copy of each instruction (in French) is made available on request.

4   Experimental Results

4.1   Frequency of impasses

Our first objective will be to compare the three procedures Free, FOA and ROC in terms of the frequency of bargaining impasses. First, we will do this comparison in the symmetric treatment, in which the threat point in the Free and ROC procedures is (0,0), while, in the FOA procedure, the final offers are drawn with equal probabilities.

Result 1: In the symmetric treatment, the frequency of impasses is equivalent in the Free (12%) and in the ROC (11%) procedures. The frequency of impasses in the FOA

16

procedure is much higher (76%).

In the asymmetric treatment, at the beginning of each session, a number 2 or 8 was randomly attributed to each subject. In the Free and ROC procedures, these numbers represented the subjects'payments at the threat point. In the FOA procedure, the arbitrator's choices were drawn from a normal distribution centered on the ESS (14.1;8.1), with a standard deviation 2.7.

Result 2: In the asymmetric treatment, the frequency of impasses is equivalent in the Free procedure (18.3%) and in the ROC procedure (19.3%). The frequency of impasses in the FOA procedure is much higher (74.5%).

The difference between the high frequency of impasses in the FOA procedure and the rather low frequency in the Free procedure is in line with most of the results in the experimental literature (see for example Ashenfelter et al. 1992 or Dickinson 2006) and can be interpreted as the observation of a chilling effect generated by FOA, as described in the empirical and theoretical literature. In addition, these first two results show that the ROC procedure does not generate a chilling effect.

Result 3: In the FOA procedure, the frequency of impasses is equivalent in the symmetric treatment (76%) and in the asymmetric treatment (74,5%).

We could have expected that the frequency of impasses had been different in the symmetric and the asymmetric treatments in the FOA procedure. The observation reported in Result 3, such that the frequencies are equivalent in both cases, may be a consequence of the difficulty, for the subjects, to understand the graphs provided. Maybe, it was not clear enough that the arbitrator had specific preferences in the asymmetric treatment and did not choose randomly. This would also explain the hight frequency of impasses in the experiment described by Ashenfelter et al. (1992), when they first introduced this representation of the arbitrator's preferences. However, we will not investigate further in this direction since this is not the point of this paper. On the contrary, we are interested in situations in which the parties to the negotiation do not think that the arbitrator has clear preferences on the outcome.

Result 4: In the Free and the ROC procedures, the frequency of impasses are higher in the asymmetric treatment than in the symmetric one (18.3% as opposed to 12% in the Free procedure and 19.3% as opposed to 11% in the ROC procedure).

17

The fact that the frequency of impasses is higher in the asymmetric treatment in the two other procedures, Free and ROC, is maybe due to the the fact that, in that case, there are two competing focal agreements. Equal Split (ES), which corresponds to a general social norm, is still a focal agreement. However, in comparison with the symmetric treatment, in the asymmetric treatment Equal Split of the Surplus (14.1;8.1) is a new focal point (see Knez and Camerer 1995 for this type of interpretation). The subjects do not have the possibility to choose the proposal which corresponds to ESS since it is not on the list provided (see the list in subsection 3.1), but if they had this principle in mind, they could choose the closest proposals, (13.3;8.9) and (15.5;6.7). We will elaborate on this point in the following Subsection 4.3.

4.2 Evolution of the bargaining process

We will discuss now what we observed about the process of the negotiation under the different procedures. We know that, at the theoretical equilibrium of the Myerson game, which constitutes the theoretical basis for the Free procedure, the two players find an agreement immediately. In the FOA game, the two players may opt out at every step and their proposals are always the same and extreme in the symmetric case which corresponds to a situation in which the arbitrator has no specific preferences and just flips a coin. In the asymmetric case which corresponds to a case in which the arbitrator has a preferred outcome, the result depends on the players' belief about the arbitrator's preferred outcome. In the ROC game, at the equilibrium the two players make gradual concessions and at the *dominant* equilibrium they pursue the negotiation until the end date.

Result 5: In the Free procedure, when the subjects reach an agreement in the symmetric treatment, this is at the *first step* with a hight frequency (47.7%). In the asymmetric treatment, this is at the *last step* with a hight frequency (67.3%).

The subjects' behavior described in Result 5, does not coincide with the equilibrium of the Myerson game. In the symmetric treatment, the subjects reach an agreement immediately, and we will see in the next subsection that this agreement coincides with Equal Split (ES). However, we do not think that the subjects "play" the equilibrium of the Myerson game, which is not necessarily ES when there are 5 steps. Our interpretation is that the subjects choose ES in this case because it is a focal point and coincides with an obvious social norm. This would explain also why, in the asymmetric treatment in which there is no obvious unique focal agreement, the subjects negotiate until the end.

Result 6: In the ROC procedure, when the subjects reach an agreement in the sym-

metric and asymmetric treatments, this is either at the *last step* or during the arbitration with a hight frequency (60.7% in the symmetric treatment and 70.7% in the asymmetric treatment).

On the opposite, the subjects' behavior described in Result 6 coincides with the players' behavior at the theoretical equilibrium of the ROC game.

4.3   Nature of the agreements reached

Now, in order to go further in the description of the subjects' behavior, we will discuss the type of agreements which are reached under the different procedures. Some proposals in the list that was available to the subjects should be considered in particular (see Subsection 3.1). As a matter of notation and except if the contrary is specified, in the asymmetric treatments, the first number in the proposal will be the Type 8's amount. In the symmetric treatments, the extreme proposal (22.2;0) would be made by pure Nash players in the FOA procedure and at the first step of the ROC procedure. In the asymmetric treatments of the Free and Roc procedures, the extreme proposals are in theory (20.2;2) and (8.9;13.3), since a player is not supposed to make a proposal which is below his opponent's threat point payment. These extreme proposals are chosen by pure Nash players at the first step of the ROC procedure and at the theoretical equilibrium in a Myerson procedure with only one step, which is equivalent to an ultimatum game. The Equal Split (ES) (11.1;11.1), is the Raiffa solution of the symmetric bargaining game of course, but it is also considered by the subjects as a social norm in many experiments on bargaining (see Roth 1995). This is the case even when the design of the experiment is not symmetric (Knez and Camerer 1995). Finally, in the asymmetric treatments, the proposal (14.1;8.1) would be the Equal Split of the Surplus (ESS). This proposal is not on the list, but the closest proposals are (13.3;8.9) and (15.5;6.7). Therefore, these two proposals would constitute the nearest approximation of ESS.

Result 7: Under the Free procedure, in the symmetric treatment, the agreements reached are ES with a hight frequency (77 over 88, 87.5%).

Result 8: Under the FOA procedure, in the symmetric treatment, the extreme proposal (22.2;0) is drawn by the lottery in 44.8% of the cases (39 over 87).

Result 9: Under the ROC procedure, in the symmetric treatment, the compatible proposals are ES with a very hight frequency (38 over 40) but only 20 over 49 agreements drawn by the lottery are ES.

19

Results in the symmetric treatments are not surprising. When the subjects reach an agreement, this is the focal agreement ES with a very hight frequency under the Free and ROC procedures. It is also the case in the FOA procedure but the number of agreements reached by the subjects is too low (9 ES over 13 agreements). The fact that the extreme proposal is drawn with a high frequency by the FOA means that, when the subject disagree and ask for arbitration, they make extreme proposals. This coincides with the maximal chilling effect described at the theoretical equilibrium. Under the ROC procedure, the fact that the compatible proposals are essentially all ES, while it appears with a rather low frequency among the proposals drawn by the lottery coincides with the theoretical equilibrium. When the players want to avoid the arbitration, for example because there is a small cost of arbitration or a small discounting, they reach the agreement at the last step. Otherwise, they call for an arbitration with non compatible but close proposals (Tanimura and Thoron 2008).

Result 10: In the asymmetric treatment of the FOA procedure, if we consider all the agreements reached by the subjects, 80.4% are ES. Among the agreements either reached by the subjects or imposed by the arbitrator, 35.5% are ES and 46% are (13.3;8.9) or (15.5;6.7).

Result 11: In the asymmetric treatments in the two other procedures, if we consider all the agreements reached, more than 55% are ES in the Free procedure, as opposed to 41.7% in the ROC procedure. Agreements (13.3;8.9) or (15.5;6.7) appear with a frequency of 36.3% in the Free procedure as opposed to 45.87% in the ROC procedure.

Result 10 and 11 show that in the asymmetric treatment, the ROC procedure does better than the Free procedure in helping the subjects to reach the agreements which are closest to the ESS. Under the FOA procedure, the subjects are unable to reach these agreements on their own. However, since the arbitrator's preferences are centered on the agreement (14.1;8.1), overall, the agreements close to the ESS constitute the outcome in 46 percent of the cases. Therefore, the ROC procedure is as efficient as the FOA procedure in helping the subjects find the ESS but without imposing the agreement on the subjects. In this respect, the advantage of the ROC procedure over the FOA procedure is that the outcome does not depend on the arbitrator's preferences. In comparison, in the symmetric treatment of the FOA procedure, when the arbitrator has no preferences on the outcome, the extreme proposals in which one subjects keep everything, appears with a frequency of 40%. In other words, when FOA is made available to negotiators, a risk is taken that, in certain situations, the arbitrator does not have a preferred outcome and just flip a coin. In these

20

situations, the compulsory arbitration may result in very unfair agreements. This problem does not occur under a ROC procedure.

5 Conclusion

We ran a series of experiments to test the effectiveness of a new mechanism presented in a companion paper (Tanimura and Thoron 2008). The ROC mechanism was proposed to help two parties to negotiate. It is a modified version of the FOA compulsory arbitration mechanism. We observed that the ROC procedure does not increase the frequency of impasses in comparison with the Free procedure. Therefore, a first important conclusion of our experiment is that, contrary to what happens with the FOA mechanism, the ROC mechanism does not generate what is designated in the literature as the *chilling effect* often discussed in the literature. Secondly, subjects do actually bargain for several steps which is not consistent with the standard theoretical results but which is consistent with the theoretical predictions for the ROC procedure. Furthermore, the ROC mechanism helps the subjects to agree around the Equal Split of the Surplus which can be considered as a "fair" agreement in an asymmetric treatment. Indeed, when two players have different threat point payments, the simple Equal Split of the amount to be shared is chosen with a lower frequency in the ROC procedure than in the Free procedure. Therefore, the ROC mechanism seems to cumulate the advantages of the two other procedures. It avoids the high frequency of impasses observed in the FOA procedure and it is as efficient as the Free procedure in this respect. The ROC mechanism helps the subjects to find a "fair" agreement, as the arbitrator of the FOA mechanism does when the arbitrator has specific preferences as to the outcome of the negotiation, but has the merit of not being compulsory.

Acknowledgments

References

Ashenfelter, Orley. and David. E. Bloom. 1984. "Models of Arbitrator Behavior: Theory and Evidence".*The American Economic Review*, 74 (1): 111-124.

Ashenfelter, Orley, Janet Currie, Henry S. Farber and Matthew Spiegel. 1992. "An Expermimental Comparison of Dispute Rates in Alternative Arbitration Systems". *Econometrica*, 60 (6): 1407-1433.

Crawford, Vincent, P. 1979. "On Compulsory-Arbitration Schemes". *Journal of Political Economy*, 87 (1): 131-159.

Dickinson, David, L. 2006. "The chilling effect of optimism: The case of final-offer arbitration". *The Journal of Socio-Economics* , 35: 17-30.

Farber, Henry, S. 1980. "An analysis of final-offer arbitration". *The Journal of Conflict Resolution*, 24 (4): 683-705.

Farber, Henry, S. 1981. "Splitting-the-Difference in Interest Arbitration". *Industrial and Labor Relations Review*, 35: 70-77.

Farber, Henry, S and Harry C. Katz. 1979. "nterest Arbitration, Outcomes, and the Incentive to Bargain: The Role of Risk Preferences". *Industrial and Labor Relations Review* , 33: 55-63.

U. Fischbacher, z-Tree: Zurich Toolbox for Ready-made Economic Experiments, Experimental Economics 10 (2) (2007) 171–178, `http://www.iew.uzh.ch/ztree/support.php`

Hebdon, Robert. 1996. "Public sector dispute resolution in transition". In *Public Sector Employment in a Time of Transition*, ed. D. Belman, M. Gunderson and H. Douglas. Industrial Relation Research Association: University of Wisconsin-Madison, 85-125.

Holt, C.A. and Laury, S.K. 2002. "Risk Aversion and Incentive Effects". *The American Economic Review*, 92(5), 1644-1655.

Knez, M. J. and Camerer, Colin. 1995, "Outside Options and Social Comparison in Three-Player Ultimatum Game Experiments", *Games and Economic Behavior* 10, 65-94.

Kriticos, Arthur. 2006. "The Impact of Compulsory Arbitration on Bargaining Behavior - An Experimental Study". *Economics of Governance*, 7 (3): 293-315.

Manzini, P. and Mariotti, M.. 2001, "Perfect Equilibria in a Model of Bargaining with Arbitration", *Games and Economic Behavior* 37, 170-195.

Myerson, R.B.. 1991, "Game Theory, Analysis of Conflict", Harvard University Press, Cambridge, Mass.

Raiffa, H.. 1953. "Arbitration schemes for generalized two-person games", in Kuhn, H. and Tucker, A.W. (eds.): *Contributions to the Theory of Games II, Annals of Mathematics Studies* 361-387, Princeton University Press, Princeton.

Roth, Alvin. 1995. "Bargaining Experiments". *Handbook of Experimental Economics*, (J. Kagel and A. E. Roth Eds.). Princeton, NJ: Princeton Univ. Press.

Rubinstein, Ariel. 1982. "Perfect Equilibrium in a Bargaining Model". *Econometrica*, 50, 97-109.

Stevens, Carl, M. 1966. "Is Compulsory Arbitration Compatible With Bargaining?" *Industrial Relations*, 5: 38-52.

Tanimura, Emily and Thoron, Sylvie. 2008. "A Mechanism for Resolving Bagaining Impasses Between Risk Averse Parties", *Working paper GREQAM* n.2008-31.

Trockel, Walter. 2009. "Axiomatization of the Sequential Raiffa Solution", *Working paper Bielefeld University* n.2009-..
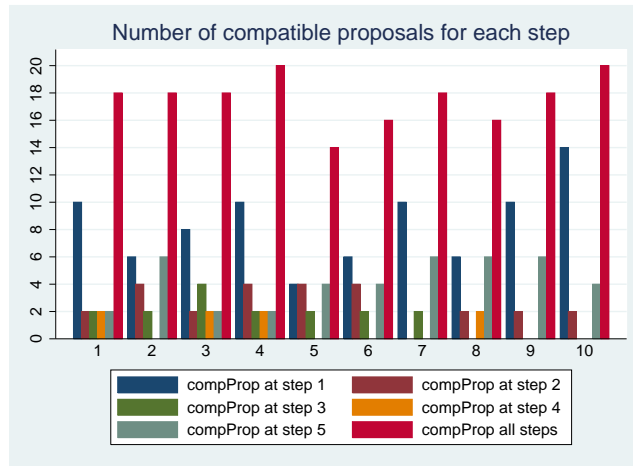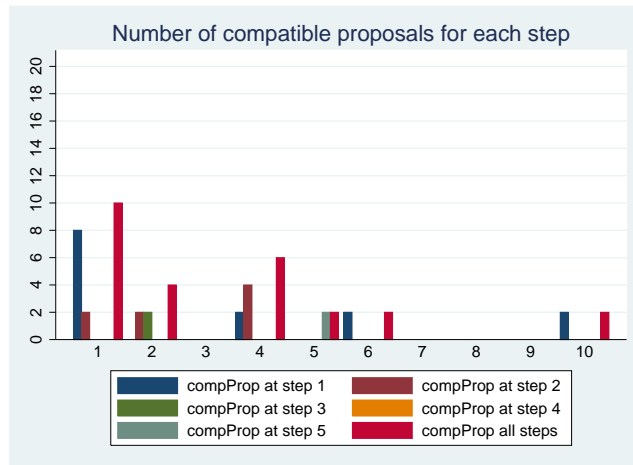
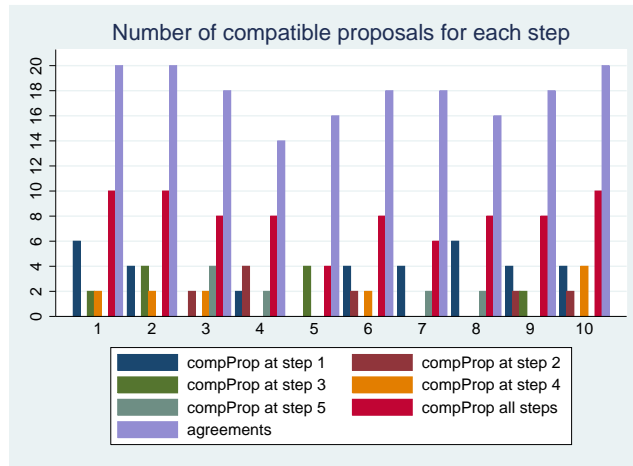Figure 5: FREE symmetric.

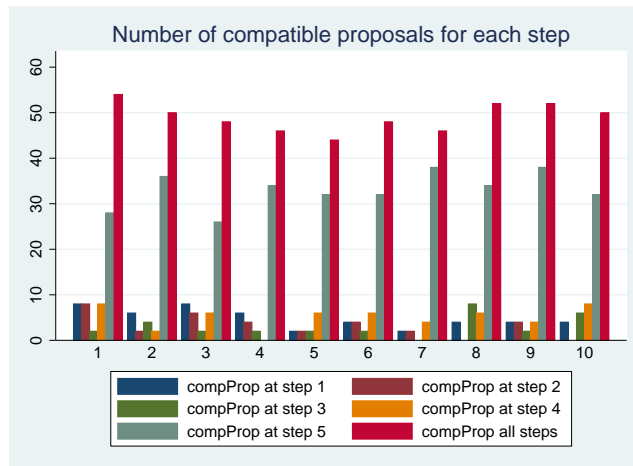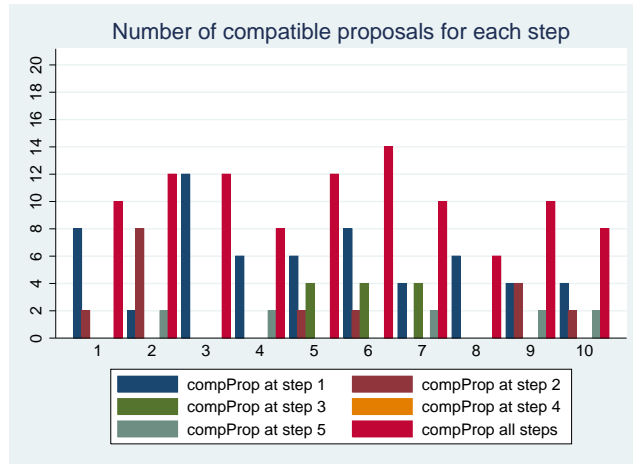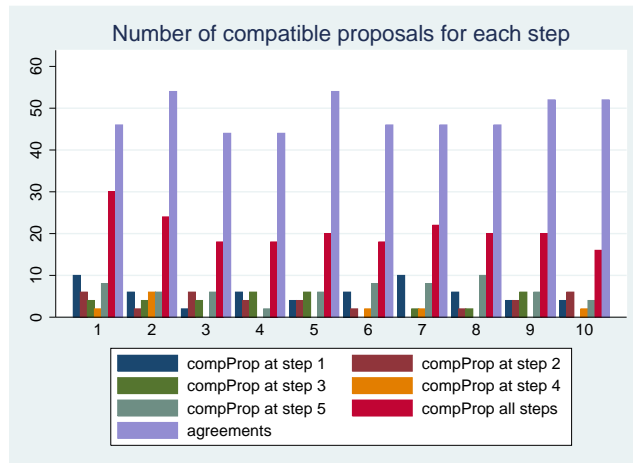Figure 6: FOA symmetric.

24

Figure 7: ROA symmetric

Figure 8: FREE asymmetric.

25

Figure 9: FOA asymmetric.

Figure 10: ROA asymmetric

26