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ABSTRACT

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This dissertation consists of three essays. The first essay is an experimental study that examines a relative new type of arbitration called α-Final Offer Arbitration. The second is a theoretical study that introduces inequality aversion as a new explanatory factor for low agreements rates during disputes under arbitration mechanism. The final essay analyzes the effects of different polices on the price stricter in a two-sided market monopoly.

Promising results to improve arbitration used in the field are obtained from Amended Final Offer Arbitration (AFOA), which outperforms Final-Offer Arbitration (FOA) and weakly outperforms Conventional Arbitration (CA). The first essay presents an experiment to evaluate a more general case of AFOA, α-Final Offer Arbitration (α-FOA). This mechanism is similar to a second-price auction, which punishes the loser with a value proportional (α) to the difference between her final offer and the arbitrator's fair settlement. The experiment furthermore divides the pool of subjects within a session into two groups according to their estimated risk preferences in order to assess how the contract zone depends on the relative risk preferences of the subjects involved in negotiation.

Although agreement rates overall are low, the results show that α-FOA has a significantly higher agreement rate than both CA and FOA. Contrary to theoretical prediction the more risk-averse group of subjects does not have a higher agreement rate than the less risk-averse group of subjects.

The second essay proposes an as yet unstudied factor to explain disagreements between disputants under α-Final Offer Arbitration and Conventional Arbitration. Using a utility function proposed by Fehr & Schmidt (1999) that includes inequality aversion, the model predicts that two risk-neutral disputants will not reach an agreement if one of them has positively biased beliefs about the size of the pie.

The third essay investigates the effects of different policies on price structure and consumer surplus in a two-sided market monopoly. In a laboratory environment, most of the monopolists charge a price below cost even if there is no threat of new competitors. A policy that imposes that the monopolist must charge the same price for both sides of the market decreases the total consumer surplus, while a policy that imposes that prices must be above costs decreases the total consumer surplus even more. A tax that increases the cost on one side of the market leads to a decrease in the price that monopolist charges on the other side of the market. These results suggest that the policymakers should distinguish between a one-sided and a two-sided market before they impose different policies.

CHAPTER 1. INTRODUCTION

This thesis has five chapters. This introductory chapter, a literature review chapter on types of arbitration, two experimental studies about arbitration mechanisms and two-sided markets (chapters 3 and 5), and a theoretical chapter about the effect of inequality aversion on the agreements rates achieved by various arbitration mechanisms.

Chapter 2 presents different theoretical models of arbitration mechanism that have been proposed in order to improve the agreements rates obtained under Conventional Arbitration (CA). Stevens (1966) proposes Final Offer Arbitration (FOA). Under FOA the arbitrator chooses the final offer submitted by the two disputants that she thinks is closer to the fair settlement value. Stevens' (1966) intuition is that because under FOA the arbitrator cannot split the difference between the final two offers, the disputants try to submit final offers closer to the arbitrator's fair settlement. This induces those two final offers to converge to an agreement. Brams and Merrill (1983) prove that this intuition is not correct. The two final offers under FOA do not converge to an agreement. Because of that Brams and Merrill (1986) propose Combined Arbitration (CombA), which is a combination of CA and FOA. With some assumptions about the distribution function that describes disputants' beliefs about the arbitrator's choice of the fair settlement, the theoretical prediction for CombA is that two risk-neutral disputants submit final offers that converge to an agreement. Another arbitration mechanism that has similar theoretical predictions is Double-Offer Arbitration (DOA), proposed by Zeng (1996). Zeng (2003) proposes another type of arbitration, Amended Final Offer Arbitration (AFOA), which has a more general case called Alpha-Final Offer Arbitration (α-FOA). This type of arbitration is similar to a second-price auction in the sense that the final outcome of the arbitration does not depend on the final offer of the winner of the arbitration.

Chapter 3 is an experimental paper about risk preferences and agreements rates under α-FOA. While several arbitration mechanisms have a theoretical prediction that two risk-neutral disputants will reach an agreement under that specific arbitration mechanism, the most used arbitration mechanisms in the field are CA and FOA. However in laboratory experiments most of these arbitration mechanisms such as CombA or DOA, do not obtain higher agreement rates than CA. The only arbitration mechanism that obtains weakly higher agreement rates than CA is AFOA.

AFOA is just a particular case of α-FOA, for which $\alpha = 1$. For this paper I compare the agreement rates under α-FOA to the agreement rates under CA, FOA and under a treatment similar to a strike in which the two disputants get a payoff of $0 if they do not reach an agreement by themselves. The value of α can be viewed as a measurement of punishment for the disputant that submits an aggressive final offer and loses the arbitration. Because I want to give more incentive than under AFOA to the disputants to reach an agreement by themselves, I choose $\alpha = 2$. The results indicate that α-FOA outperforms FOA and CA, but does not reach agreements rate close to the predicted one (100%) for the more risk-averse group of people.

Another contribution of this paper is that it takes into consideration the risk preferences of the subjects. If there are risk-seeking subjects in the pool of the experiment, they might create a situation in which theoretically there is no contract zone. This leads to no agreement no matter what the arbitration mechanism is. This paper elicits the risk preferences of the subjects, ranks the subjects according to their risk preference and splits the pool of the subjects into a more risk-averse group of subjects (which might include only risk-averse and risk-neutral subjects) and a less risk-averse group of subjects (which might include risk-averse, risk-neutral and risk-seeking subjects). However, the results indicate that the agreement rate for the more risk-averse group of subjects is no higher than the agreement rate for the less risk-averse group of subjects.

Chapter 4 is a theoretical paper that introduces another factor in order to explain why the agreement rates under different arbitration mechanisms are lower than predicted, even for risk-neutral and risk-averse individuals. In most experimental studies of the arbitration mechanism there is also a treatment similar to a strike in which the two disputants get a payoff of $0 if they do not reach an agreement by themselves. In this treatment the agreement rates are lower than the predicted ones. While the low agreement rates under the treatments that involve an arbitration mechanism can be explained by the mechanism itself, by the risk preferences of disputants or by the disputants' beliefs about the arbitrator choice of a fair settlement, in this treatment these factors are not involved. This suggests that there may be other factors involved in the decision of the two disputants. My suggestion is that inequality aversion can explain this difference between the theoretical predictions and the experimental results.

Contrary to previous theoretical predictions, the results shows that two risk-neutral disputants with the same beliefs about the arbitrator's choice of a fair settlement do not reach an agreement if they exhibit inequality aversion and if at least one has positively biased beliefs about the size of the pie.

The last chapter is an experimental study of the effects of different policies on price structure and on consumer surplus in a two-sided market monopoly. A two-sided market has counterintuitive properties and regular policies might not have the desired effects. For example, a monopolist might set a price on one side of the market below cost not as a predatory pricing strategy, but because that it is the optimal price structure. This may be true even if there is no threat of a new entry. A policy that restricts the monopolists' price to be at or above cost might thus lead to a decrease in consumer surplus. A policy that restricts the monopolist to set the same price on both sides of the market might have a similar effect.

The results of the experiment show that most of the monopolists do in fact charge a price below cost on one side of the market even if there is no threat of new entry. For the specific parameters implemented in the experiment, a policy that constrains the monopolists to charge prices at or above costs decreases total consumer surplus by 18.1%. When the monopolists are constrained to charge the same price on both sides of the market, total surplus decreases by 10.4%. Contrary to the prediction on would obtain in a one-sided market monopoly, an increase in cost on one side of the market decreases the price on the other side of the market by 9.1%.

CHAPTER 2. LITERATURE REVIEW ON TYPE OF ARBITRATION MECHANISMS

In some economic sectors and occupations, a strike is not allowed as a solution for a dispute between management and employees. For instance, firefighters are not allowed to go on strike when negotiating with management for wages or benefits if an agreement is not reached. In order to solve this type of dispute, both parties are forced by law to participate in arbitration. The type of arbitration typically still used is CA. After Stevens (1966) proposed FOA as a new type of arbitration, FOA began being used to solve disputes. For instance FOA has been utilized since 1974 during Major League Baseball negotiations between baseball players and team owners. Other arbitration mechanisms have been proposed, but none are used in practice.

Stevens (1966) observes that CA does not effectively encourage the disputants to reach an agreement mainly due to Conventional Arbitration's method of "split the difference" compromise of the arbitrator. As a solution to this problem Stevens (1966) proposes Final-Offer Arbitration. Comparing to CA where the arbitrator can choose any value as the final settlement of the arbitration, FOA obliges the arbitrator to choose only between the final two offers of the disputants. In general under CA, the arbitrator is inclined to split the difference between the final offers of the disputants. This leads the disputants to make extreme final offers, in order to get a better final settlement when the arbitrator splits the difference between the two final offers. Stevens (1966) says that if an arbitrator is forced to choose between the final offers of the disputants (and not allowed to just "split the difference") then there is less incentive for disputants to make extreme final offers because it would be less likely that the arbitrator would select their offer as a fair settlement. In addition, FOA encourages disputants to make final offers that are more likely to converge, allowing disputants to reach an agreement without forcing an arbitrator to make the final decision.

Brams and Merrill (1983) study the equilibrium strategy for FOA and find that FOA will not induce the two disputants to converge to the arbitrator's median fair settlement and it will not cause them to reach an agreement. The intuition is that by starting with a certain point, the expected gain by making a more flexible offer, in order to win arbitration, will be smaller than the cost of the disputant would incur by making the offer more flexible. Brams and Merrill (1983) assume a zero sum game between two players in which each player tries to maximize her expected payoff given that they have some beliefs about what the arbitrator thinks is a fair settlement. Both players have the same beliefs about the arbitrator’s fair settlement and their beliefs are defined as a probability distribution function. For robustness, they solve the equilibrium strategies for different distribution functions. The main result is that the optimal final offers are more dispersed for "flat" distributions and will not converge to an agreement. The two optimal final offers tend to be separated by two standard deviations. This conclusion is important because FOA was designed to solve the problem of CA and help the two disputants to reach an agreement.

Several arbitration mechanisms that predict that the two final offers will converge and induce an agreement are Combined Arbitration (CombA) proposed by Brams and

Merrill (1986), Double-Offer Arbitration (DOA) proposed by Zeng et al. (1996) and Amended Final Offer Arbitration (AFOA) proposed by Zeng (2003).

Brams and Merrill (1986) present a new type of arbitration: Combined Arbitration (CombA). CombA is a combination of CA and FOA. Under CombA, if the disputants do not reach an agreement, even after they submit their final offers, one type of arbitration will be applied depending on arbitrator's notion of a fair settlement. If the arbitrator's notion of a fair settlement is between the final offers, then the outcome of the arbitration is determined using FOA. If this value falls outside of the two offers, the outcome of the arbitration is determined using CA. The theoretical prediction is that if both parties try to maximize their expected payoffs, their offers will converge to the median of the arbitrator's fair settlement, which is a global equilibrium if the probability distribution is continuous, unimodal, and symmetric around the median.

Zeng et al (1996) propose Double-Offer Arbitration. For this type or arbitration, each disputant has to submit two offers: a primary offer x_i, and a secondary offer y_i. The primary offer represents the disputant's final request. The secondary offer represents the disputant's belief about the arbitrator's fair settlement. If neither of the primary or secondary offers converge to an agreement, then given these final offers and the value of her fair settlement z_a, the arbitrator calculates the value for a criterion function C_i for each disputant:

$$C_s(x_s, y_s \,|z_a) = \alpha|y_s - x_s| + (1-\alpha)(y_s - z_a) \tag{1}$$

$$C_b(x_b, y_b \,|z_a) = \alpha|y_b - x_b| + (1-\alpha)(z_a - y_b) \tag{2}$$

The disputant that has a lowest criterion function value wins the arbitration and the outcome of the arbitration becomes his primary offer. The equations from above show that a disputant can minimize his criterion function in two ways. One is to decrease the difference between his belief about the fair settlement and the real value of the fair settlement. This will cause the disputant to be less optimistic about the fair settlement. The second way an individual can minimize his criterion function is to decrease the difference between his request and his belief about the fair settlement. This causes the disputant to offer a moderate final request. Zeng et al (1996) shows that the two secondary offers of the disputants should converge to the median of the distribution function, which describes the notion of arbitrator's fair if the arbitrator puts more weight on the second final offer, i.e. $\alpha < 0.5$.

Zeng (2003) presents another arbitration procedure called Amended Final Offer Arbitration. This new procedure amends FOA and is similar to the second-price auction proposed by Vickrey (1961). Compared to FOA, where the final outcome of the arbitration procedure depends on the final offer of the winner of the arbitration, the final outcome of AFOA depends on the final offer of the loser of the arbitration. Under FOA, the final offer has two functions: to win the arbitration and to determine the final settlement. These two functions are not compatible in the sense that a disputant should select increasing (decreasing) values for the first function, and decreasing (increasing) values for the second function. Therefor the optimal final offers of the two disputants will not converge. Under AFOA, the winner of the arbitration procedure is the disputant that has a final offer closer to the arbitrator fair settlement as in FOA. However the final outcome of the arbitration is equal to the fair settlement value of the arbitrator minus (plus) the distance between this value and the final offer of the loser depending if the winner prefers low (high) outcomes. In this case the two functions are separated because the outcome of the arbitration is not determined by disputant's own final offer, but by his opponent's final offer. Similar to a second-price auction, the disputant have no constraints on the value of the outcome when he submits his final offer. His final offer will be selected with the goal of maximizing his opportunity to win the arbitration. Zeng (2003) demonstrates that if the arbitrator's fair settlement is described by continuous and discrete distribution functions, the final offers will converge to the expected value of the arbitrator's fair settlement and the two disputants reach an agreement.

Brams and Merrill (1986) assume symmetry in the distribution function of the arbitrator's choice of the fair settlement in order to establish the existence of equilibrium under CombA. Without this assumption, there is no equilibrium in pure strategies. DOA and AFOA do not need such assumptions for the existence of the equilibrium. The equilibrium strategy for DOA is the median of the distribution function that describes the arbitrator's choice of the fair settlement, while for AFOA it is the expected value of this distribution function. The different results are due to how the value of the final outcome of arbitration is calculated under these two arbitration mechanisms. Under DOA, the arbitrator's choice of a fair settlement decides who wins the arbitration, but the value of final outcome is independent of the value of this choice. Under AFOA the value of arbitrator's choice also determines the value of the final outcome. Because of this, the final offers under the two arbitration mechanisms converge to the median and to the expected value, respectively.

Zeng (2003) also presents a general version of AFOA called Alpha-Final Offer Arbitration (α-FOA). Similar to AFOA, the two offers converge to the expected value of the arbitrator's fair settlement, however this distribution function needs to be continuous.

The difference is that for this type of arbitration, the punishment of the loser can be lighter or harsher depending on the value of the parameter α. A higher value for α implies a harsher punishment for the loser. For α-FOA the final outcome of the arbitration is equal to the value of the fair settlement of the arbitrator minus or plus (depending if the winner is the "buyer" or "seller") a proportion (α) of the distance between the "fair settlement" value and the final offer of the loser.

$$final\ outcome = z\ \pm \alpha \cdot |z - x_{loser}| \qquad (3)$$

where z is the arbitrator's fair settlement value and x_{loser} is the final offer of the loser.

For $\alpha = 1$ the α-FOA is in fact AFOA. For $\alpha = 0$ the α-FOA degenerates to CA.

CHAPTER 3. ALPHA-FINAL OFFER ARBITRATION AND RISK PREFERENCES

3.1 Introduction

When solving disputes, Conventional Arbitration (CA) and Final-Offer Arbitration (FOA) are the most commonly used methods of arbitration. However, theoretical predictions show that for these methods, final offers may not converge to allow for an agreement. Several theoretical arbitration mechanisms have been developed that can lead to agreement, but they do not outperform CA or FOA in laboratory experiments. Combined Arbitration (CombA) was proposed by Brams and Merrill (1986) and Zeng et al. (1996) proposed Double Offer Arbitration (DOA). The most promising results come from Amended Final Offer Arbitration (AFOA), proposed by Zeng (2003). Deck et al. (2007) find that in a laboratory experiment AFOA outperforms FOA and marginally outperforms CA.

In this paper, I present an experiment that evaluates a more general case of AFOA, α-Final Offer Arbitration (α-FOA). AFOA is just a particular case of α-FOA, where $\alpha = 1$. This mechanism is similar to a second-price auction, in the sense that the final outcome value of the arbitration does not depend on the winner's final offer. Also it punishes the loser with a value proportional (α) to the difference between her final offer and the arbitrator's fair settlement. In order to increase the punishment for the loser of arbitration, I choose $\alpha = 2$ so the incentive to reach an agreement should be stronger.

The experiment takes into account the relative risk preferences of the disputants, which, along with the type of arbitration used, plays an important role in influencing the outcome of a negotiation. Disputants should avoid arbitration if there is a contract zone, a region of outcomes that are mutually preferred to arbitration. However, the existence and the size of a contract zone depend on the risk preferences of the disputants. Zeng (2006) shows that if one disputant has risk-seeking preferences and has a coefficient of risk preference larger in absolute value than her opponent, the contract zone will not exist in CA, FOA or α-FOA. He also proves that if there is a contract zone, *ceteris paribus*, the size of the contract zone for α-FOA is larger for any $\alpha > 0$ than the contract zone for CA and larger for any $\alpha > \frac{\pi}{2} - 1$ than the contract zone for FOA. It is important to account for the risk preferences of the disputants when evaluating the empirical properties of these arbitration mechanisms. This experiment is the first to control for this factor.

The experimental results show that even if the agreement rates overall are low, α-FOA has significantly higher agreement rate than both CA and FOA. An interesting observation is related to whether subjects reach an agreement during negotiation or after they submit their final offers. The results show that the mean for agreement rates after they submit their final offers for α-FOA is strongly statistically significantly higher than the mean for agreement rates for both CA and FOA, while the mean for the agreement rates during negotiations for α-FOA is not statistically significant different than the agreement rates for FOA, but lower than for CA. This indicates stronger incentives to reach an agreement under α-FOA relative to CA and FOA. Contrary to theoretical predictions, the agreement rate of the more risk-averse group of subjects is not greater than the agreement rate for the less risk-averse group of subjects for any arbitration mechanism.

3.2 Literature review

Although theoretically all the new procedures predict convergence, only CA and FOA are used in practice. Due to a lack of data for the other types of arbitration, in order to study the other theoretical models one must use a laboratory experiment.

One of the first lab experiments related to arbitration procedures was presented by Ashenfelter et al. (1992). Ashenfelter et al. (1992) compare the dispute rates between different alternatives of arbitration like CA, FOA and tri-offer arbitration (in which the arbitrator selects one of the final offers of the disputants or an offer made by a neutral fact-finder). There is also a "no arbitration" treatment similar to a "strike" in real life, which will give a payoff of $0 in cases where the subjects do not reach an agreement. The subjects from the experiments are paired with the same partner throughout the entire 20 rounds of a session. In each round they have to split a pie by choosing a number between 100 and 500. The key result of the experiment is that FOA has dispute rates at least as high as in other arbitration mechanisms. This implies that FOA does not improve the agreement rates as Stevens (1966) suggested. The results also demonstrate that there is an inverse relationship between the cost of disputes and dispute rates.

My experiment design is similar to the experiment of Dickinson (2004) research paper in which he studies CombA proposed by Brams and Merrill (1986). His experiment has four treatments: a no-arbitration treatment (NA) in which the subjects have a payoff of $0 if they do not reach an agreement, a CA, a FOA, and a CombA treatment. In each treatment, the specific arbitration type is used in case of a dispute. The subjects are paired with the same partner for the entire experiment, which consists of 20 rounds of 2 minute long intervals, in which subjects had to decide upon the size of a variable X, which implied that they had to split in two a total of \$2. Thru a payoff table they were able to observe their payoffs depending on the size of the variable X. For one partner, the payoff increases when X increases. For the other partner, the payoff increases when X decreases. Their payoff table gives a private suggested bargain interval in such a way that the split of the pie in half (\$1 each), is not the half of this interval, in order to avoid a focal point problem. These intervals are $[200,700]$ and $[300,800]$, where the split of the pie in half is $X = 500$. If the subjects did not reach an agreement after two minutes, they would go to arbitration. Each arbitration type was applied for 5 rounds. The order of the arbitration type was different for different pairs of subjects in order to avoid an order effect, and the subjects did not know that the arbitration procedure would change after 5 rounds. In case of arbitration, the fair settlement value was given by a random draw from a normal distribution with the mean equal to 500 and the standard variation equal to 60. The distribution was explained to the subjects through a table with 100 past values from this distribution. Looking at these values, the subjects were able to build some expectations about what the arbitrator might consider a fair settlement.

Dickinson's (2004) main results are that the dispute rates are lower for the NA treatment, which is consistent with Ashenfelter et al. (1992) findings and with the theoretical prediction that an increase in the cost of arbitration would reduce the dispute rates. However, different from the theoretical prediction, the difference in dispute rates between CA and CombA is statistically significant, in the sense that CA has lower dispute rates. Also FOA has higher disputes rates than CA, but difference in dispute rates between CA and FOA is only marginally statistically significant.

In a similar experiment Dickinson (2005) compares DOA with CA and FOA. The main findings of this paper are that FOA has marginally higher dispute rates when compared to CA (similar to Ashenfelter et al. (1992) findings) and DOA will not decrease the dispute rates when compared to CA or FOA.

Deck et al. (2007) compare the dispute rate for CA and FOA with AFOA. Using data from Deck et al. (2007b), in which they study the effect of the uncertainty value of bargaining in CA and FOA, they run four more sessions using AFOA. In his experiment, the bargaining is designed like a negotiation between a worker and a firm over the wage level. The wage is the payoff for the worker and the firm has a profit equal to a revenue (which is common knowledge for both firm and worker) minus the wage. The level of the revenue has some uncertainty: a high revenue level and a low revenue level, each occurs with probability 50%. Deck et al. (2007) also vary the difference between high revenue and low revenue, in two different environments. So besides the uncertainty induced by the arbitrator's choice, they introduce some uncertainty of the surplus. They also consider the fair settlement of the arbitrator as a random draw from a uniform distribution and not from a normal distribution as in Ashenfelter et al. (1992) and Dickinson (2005). Another difference in their experiment design is that they add a cost for arbitration. Their main finding are that the agreement rates for AFOA are strictly higher than the agreement rates for FOA and weakly higher than the ones for CA.

Other studies related to arbitration procedures are reported by Dickinson (2006, 2009), and Bolton and Katok (1998). Dickinson (2009) studies the effect of optimism and risk preferences over the agreement rates of arbitration. His main findings are that optimism significantly increases the dispute rates and that risk aversion will not significantly change the dispute rates. Dickinson (2006) studies the chilling effect of optimism for FOA. Contrary to Stevens' (1966) beliefs, the results show that FOA has a chilling effect over the negotiations. As Brams and Merrill (1983) show, the final two offers will not converge and negotiation will reach the arbitration stage. In addition, optimism of the two parties concerning what the arbitrator will deem as a fair settlement will increase even more the difference between these two final offers. The results of the experiment confirm this theoretical prediction. He demonstrates that optimism will not only make subjects who could marginally reach an agreement go to arbitration, but it will also make subjects who do not reach an agreement submit even more divergent final offers. Bolton and Katok (1998) study the effects of learning in repeated bargaining situations, with and without arbitration. Their findings suggest that there is a bargaining learning effect in both situations, with and without arbitration. Learning is slower when arbitration is used as compared to a situation with no arbitration.

As presented in Dickinson (2009), two factors that play an important role in arbitration are optimism and the risk preference of the disputants. In a theoretical paper, Dickinson (2003) presents why and what the relationship is between these two factors and the agreements that can be reached in a dispute. The relationship is given by the contract zone: the region of outcomes which is mutually preferred with certainty by disputants instead of going for arbitration. In order to examine how these two factors influence the existence and size of the contract zone Dickinson (2003) presents a simple bargaining example in which two players must split a "pie". He first assumes that the first player is risk-averse and has a utility function of the form $U(x) = \sqrt{x}$ and the second player is risk-neutral, so his utility function is $U(y) = y$ where x and y are the amounts that they obtain from the bargaining process. For a similar example assume that $x + y = 100$. In cases where they do not reach an agreement, there will be a lottery that will give 25 units to one player and 75 units to the other player, each with a probability of 50%. Given the utility functions and this lottery, one can calculate the *certainty equivalent* for each player. Any value greater than these *certainty equivalent* values of each player makes each player better off than the lottery would.

Taking into consideration that $x + y = 100$, there will be an interval of values, the contract zone, in which both players will prefer to avoid the lottery, interval such as in Figure 1.

However, if the second player is risk-seeking and his utility function is $U(y) = y^2$ then his *certainty equivalent* value is equal to 55.90. With this certainty equivalent there is no value that is preferred by both players over the lottery.

In this case, both players would prefer not to reach an agreement and would prefer the lottery. Similarly to arbitration, there is a contract zone, a region of outcomes that is mutually preferred by both players when compared to the arbitration procedure. However, the contract zone depends on disputants' risk preferences. This is an important factor in arbitration experiments, as different papers have presented (Holt and Laury (2002)) that in a subject pool, as in everyday bargaining and disputes, there are both risk-seeking subjects and risk-averse subjects. Risk-seeking subjects, no matter what the arbitration procedure applied, might force arbitration. Dickinson (2003) discusses the effects of optimism and pessimism on the subjects. In his example, he changes the probability of the lottery depending on whether a person is an optimist (increasing the probability of winning the big prize of 75 units) or a pessimist (increasing the probability of winning the low prize of 25 units). Similarly, the contract zone can change size, and might disappear, in cases of optimistic subjects.

In order to account for risk preferences of subjects, there are many methods that can be used to measure risk preferences of subjects in a lab experiment. The most common method used is the one presented by Holt and Laury (2002) and discussed in Holt and Laury (2005). The procedure is based on 10 different choices between two paired lotteries: option A and option B. Option A has a lower variability between the prizes ($2.00 and $1.60), where option B has a higher variability ($3.85 and $0.10). The probability of winning the big (small) prize increases (decreases) from 1/10 (9/10) by 1/10 for each choice. Given the expected payoffs of the lotteries subjects should start by choosing option A and then should change to option B depending on their risk preferences. Given the number of choices of option A, Holt and Laury (2002) calculate the relative risk aversion coefficient.

Other procedures used to measure the risk preference of a subject were proposed by Eckel and Grossman (2008), in which they offer more simplistic lottery choices, and Andreoni and Harbaugh (2009), in which they present a procedure in which the subjects have a continuum of choices.

An interesting study about different methods of risk preference elicitation is Dulleck et al (2011). For their study, they choose to study Holt and Laury's (2002) method and Andreoni and Harbaugh's (2009). They find that there is a similar distribution of risk attitudes between the results of Holt and Laury's (2002) experiment and their replication of this experiment, but when they compare their results from the replication of Andreoni and Harbaugh's (2009) experiment, they find a much higher number of risk neutral subjects: 60% compared to around 25% from Holt and Laury (2002). These results raise an important question about the veracity of risk elicitation in an experiment, but to my knowledge these are the best methods available in the literature. The results are similar to Dave et al.'s (2010) paper in which they study which method is better to use: a simpler one like Eckel and Grossman's (2008) or a more complex one like Holt and Laury's (2002). Their results indicate that the answer to this question depends on the task that an individual is studying. However, even though it was not part of their research question, they find a difference in preference heterogeneity using the two methods

3.3 Experiment Design

This experiment has two stages. In the first stage, I elicit the risk preferences of the subjects by using a lottery-choice experiment similar to the experiment proposed by Holt and Laury (2002). In the second stage, I utilize a bargaining experiment in which different types of arbitration are used in order to settle possible impasses in agreements. For this stage, I use settings similar to Dickinson's experiments but add α-FOA as a new mechanism.

In the first stage, subjects choose between fifteen pairs of lotteries. One lottery is a "safer" one and gives a payoff of \$1 with a probability of 1. The "riskier" lottery has a high payoff of \$3 and a low payoff of \$0. The odds of winning the high payoff will increase by 1/20 starting from 0/20 chances until 14/20 chances, while the odds of winning the low payoff will decrease by 1/20 starting with 20/20 chances until 6/20 chances. The “safer” lottery is called “*Option A*” and the riskier lottery is called ”*Option B*”*,* as in figure 2.3.

For each of the fifteen pairs, the subjects have to choose between *Option A* and *Option B*. For monetary incentive purposes, at the end of the experiment, one line is randomly chosen and the subject is paid according to his/her choice. The payment is postponed until the end of the experiment to avoid a wealth effect. Subjects are also told that their decisions in this stage will not affect their possible earnings in the next stage of the experiment.

In theory, and based on the experiment's results, the subjects will choose *Option A* for the first states and then, depending on their risk preference, at some point moving down the list they will switch to *Option B*. In a few cases subjects switched back and forth between *Option A* and *Option B* (10 out of 95 subjects of this experiment switched back and forth between these two options).

The purpose of this stage is not to measure the CRRA coefficient, but to be able to rank the subjects depending on their risk preference from very risk-averse people to less risk-averse and risk-seeking individuals. The instructions do not mention anything about that, but based on their choices, at the end of stage one the subjects are separated in two different groups: more risk-averse and less risk-averse group. As other experiments have demonstrated, fewer than 50% of individuals are risk-seeking, no matter what risk elicitation method is used. Grouping the subjects in these two groups means that all of the risk-seeking people will be in the less risk-averse group. As a result there will be a contract zone for the group of more risk-averse subjects. By doing this, I am able to run the second stage of the experiment in such a way that I will not break one assumption of different models of arbitration which states that the subjects should be risk-averse or risk-neutral. If there are risk-seeking subjects in the model, the theory predicts that the contract zone can disappear (depending of the risk preferences of both subjects involved in the bargain) which will lead to a higher disagreement rate as Zeng (2006) showed. Zeng (2006) calculates the size of the contract zone for each of the following three types of arbitration CA, FOA, and α-FOA. The formulas are as follows:

$$\alpha\text{-FOA}: \left[m - \frac{1+\alpha}{2}\sigma^2\delta_p - C\,, m + \frac{1+\alpha}{2}\sigma^2\delta_d + C\right] \tag{1}$$

$$\text{CA}: \left[m - \frac{1}{2}\sigma^2\delta_p - C\,, m + \frac{1}{2}\sigma^2\delta_d + C\right] \tag{2}$$

$$\text{FOA}: \left[m - \frac{1}{\delta}ln\frac{2+\sqrt{2\pi}\sigma\delta}{2\sqrt{1+\sqrt{2\pi}\sigma\delta}} - C\,, m + \frac{1}{\delta}ln\frac{2+\sqrt{2\pi}\sigma\delta}{2\sqrt{1+\sqrt{2\pi}\sigma\delta}} + C\right] \tag{3}$$

where:

m – is the median of the distribution that describes the beliefs concerning the fair settlement of the arbitrator;

σ^2 - is the variance of the distribution that describes the beliefs concerning the fair settlement of the arbitrator;

δ – is the CRRA coefficient of the disputants (for FOA, he assumes that both players have the same coefficient);

C – is the cost of arbitration.

Given these formulas, the length of the contract zone for each type of arbitration is:

$$\Delta_{\alpha-FOA} = \frac{1+\alpha}{2}\sigma^2(\delta_p + \delta_d) + 2C \tag{4}$$

$$\Delta_{\alpha-FOA} = \frac{1+\alpha}{2}\sigma^2(\delta_p + \delta_d), if\ C = 0 \tag{5}$$

$$\Delta_{CA} = \frac{1}{2}\sigma^2(\delta_p + \delta_d) + 2C \tag{6}$$

$$\Delta_{FOA} = \frac{2}{\delta} ln \frac{2 + \sqrt{2\pi}\sigma\delta}{2\sqrt{1 + \sqrt{2\pi}\sigma\delta}} + 2C \tag{7}$$

From these formulas, it is apparent that with no cost for arbitration these values are positive if both players are risk-averse or risk-neutral.

Giving the parameters from the experiment and assuming that the subjects are slightly risk-averse, the size of the contract zone for each type of arbitration is given in Table 2.1. As Zeng (2006) demonstrates, α-FOA has the largest contract zone, which should lead to a higher agreement rate than CA and FOA.

The second stage of this experiment is a multi-treatment stage of bargaining using different types of arbitration in cases of disagreement.

After the first stage, subjects are randomly assigned to a position of "seller" or "buyer" and are generically named *Player A* or *Player B* for the entire session. Then each *Player A* is randomly paired with a *Player B* from the same type of risk preference group. Each subject is randomly repaired after each period of the second stage in order to avoid any strategic effects. Subjects are required to bargain for the value of a variable *X*. The "sellers" are better off if the value of *X* is higher, while the "buyers" are better off if the value of *X* is smaller.

They have a payoff table, similar to table 2.2, which shows them what the payoff is in US dollars for different values of *X*. Each subject is only able to observe his/her payoff table, which is the same for each "seller" and for each "buyer". The payoff functions that describes the relationship between the value of *X* and monetary payoff are similar to Dickinson's experiments.

The payoff function for buyers is:

$$P_B(\$) = 1.00 + (500 - x) \cdot (.005)\ , x \in [200,700] \tag{8}$$

The payoff function for sellers is:

$$P_S(\$) = 1.00 + (x - 500) \cdot (.005)\ \ , x \in [300,800] \tag{9}$$

In order to avoid a focal point at half of the pie, the sellers have the following suggestion range for *X*: $[300,800]$. Buyers have the following suggestion range: $[200,700]$. The pie is split in half for values of *X* equal to 500, which is not the half of these two intervals.

There are 4 treatments and each treatment has 7 periods[1] that consist of 1 minute bargaining periods. The treatment ordering was varied across sessions, as explained below. In the case of disagreements at the end of each period, an arbitration sub-stage is utilized. Each subject must submit a final offer. If a pair does not reach an agreement after the final offers are submitted, then an arbitration method is applied in order to decide how to split the pie.

The cost for arbitration in my experiment is zero. One finding of Ashenfelter et al. (1992) is that dispute rates are inversely related to the cost of arbitration. While Deck et al. (2007) impose a cost for the disputants that do not reach an agreement by themselves, Dickinson (2004) does not have such cost. My experiment is similar to Dickinson (2004) in that I also choose not to have a cost, as imposing a cost for going to arbitration creates a bigger contract zone and also creates a contract zone in situations in which a contract zone would otherwise not exist. A situation like this arises when one disputant is risk-

[1] For the last 4 sessions out of the total of 8, the treatment α-FOA had 10 periods instead of 7 and the examples in the instructions included also a graphical representation.

neutral and the other is slightly a risk-seeker. Without the cost of arbitration, there is no contract zone in this situation. However, depending upon the size of the cost, the contract zone might still exist. The main idea of my paper is to have a contract zone only because of the risk preferences of the subjects, and not because of other factors.

In the first treatment, called NA (no arbitration), if the subjects do not reach an agreement in the one minute timeframe or after they submit their final offers, the pie is destroyed and each subject gets $0.

In the second treatment, called CA (conventional arbitration), if the subjects do not reach an agreement after one minute, they must submit a final offer. If the final offers converge, then the pie is split at the mean value between the final offers. If the final offers do not converge, a third party decides how to split the pie. The third party decision is made by randomly drawing from a (normal) distribution that was previously provided to the subjects. The value that is drawn will be the final outcome of arbitration. The subjects are informed about the distribution used through a table with 100 previous drawings. The table that provides the sample distribution was drawn using the same distribution that the computer uses during the experiment.

The third treatment, FOA, uses final-offer arbitration in order to solve disputes. For this treatment, the computer draws a value from the same distribution function as in the previous treatment, and that value is what is considered the fair settlement value of the arbitrator. The subject that has the final offer closer to this value will "win" the dispute and the pie will be split according to his/her final offer.

The last treatment, α-FOA, uses the Alpha-Final Offer Arbitration in order to settle disputes. For this experiment I use $\alpha = 2$ in order to impose a greater punishment for the subject that is further from the fair settlement value. In cases of disagreement after one minute of negotiation, the subjects have to submit their final offers. The computer draws a value from the same distribution function as in the previous treatments, and that value becomes the fair settlement value of the arbitrator. The subject that has a final offer closer to this value will win the arbitration. However, the value at which the pie will be split will not be the same as his/her final offer. The value of the final outcome will be equal to the fair settlement plus (minus) twice the difference between the fair settlement and the final offer of the other subject for the subject who is the seller (buyer).

In each treatment, the value of the "fair settlement" of the third party will be a randomly draw from a normal distribution with the mean equal to 500 and the standard deviation equal to 30. This is the same distribution that Dickinson (2009) used in his experiment for the treatment with low variance. Using a small standard deviation I am able to control for some of the optimism of the subjects. Dickinson (2006) demonstrates that optimism has an important impact on subjects' decisions in bargaining, but the goal of this paper is not to study optimism hence the necessity to control for it.

Running an experiment at Purdue University during spring and fall semester of 2012 I used 96 Purdue undergraduate students during 8 sessions of 12 students each. Each session lasted on average 1 hour and 45 minutes and the average payment was between \$25 and \$30 per subject in each session. The program used to run the experiment was Z-Tree proposed by Fischbacher (2007). All 4 treatments were used in each session, according to a Replicated Latin Square design.

Hypothesis 1. The agreement rates for more risk-averse groups using α-FOA are close to 100%.

The theoretical prediction for α-FOA states that if there are risk-averse or risk-neutral individuals in the group, the subjects should be able to reach agreements all of the time. In Deck et al's (2007) paper, the agreement rates for AFOA do not meet this expectation, their agreement rates were significantly lower than 100%. One explanation for this is that the authors do not control for risk preferences and use risk-seeking subjects in their experiment. In contrast, my experiment will both control for risk preference, and utilize a greater value for α. Also by using a greater value for α my experiment imposes a larger punishment for the loser of arbitration, which should lead to higher agreement rates.

Hypothesis 2. The agreement rates in α-FOA are higher than in CA or FOA.

In cases of CA, there is no incentive to reach an agreement because the final decision does not depend on the subject's offer, it only depends on what the third party believes is a "fair" settlement. For FOA, Brams et al (1983) demonstrate that the equilibrium strategies for the two parties will not converge on what they perceive as a "fair" settlement from the arbitrator. They use different types of distribution functions to describe the arbitrator's notion of what a fair settlement is. So the theoretical predictions are that α-FOA should perform better than CA or FOA from the point of view of settlement rates.

Hypothesis 3. The agreement rate in α-FOA for more risk-averse groups is higher than the agreement rate for less risk-averse groups.

The theory shows that there is an inverse relationship between the size of the contract zone and the preference for risk: risk-seeking preferences imply lower contract zones or no contract zone. Zeng (2006) shares the same view as Farber et al. (1989) or Babcock et al. (1995) that there is a direct relationship between the contract zone and agreement rates: lower contract zones, lower agreement rates. So the theoretical predictions are that for α-FOA the agreement rates should be higher for more risk-averse individuals than for less risk-averse people.

3.4 Results

Out of 96 subjects, I dropped one set of results from a single subject[2].

Result 1. On average the NA offers the highest total agreement rate of 72%, followed by α-FOA with 35%, CA with 27%, and FOA with 18%.

Using an ANOVA type of analysis, the results show that there is no evidence of a difference between sessions, but there is an indication that differences in means due to order of the treatments exist. These differences are explained by the fact that the 4th treatment of a session has a higher mean than the 1st, 2nd or 3rd treatment of the session. However, there is a highly statistically significant difference in the means between the type of treatments. The output of the ANOVA analysis using SAS is presented in table 2.4. A Tukey's test of the ANOVA analysis shows that the mean for NA treatment is significantly different than the mean of any of the other treatments, and the means of α-FOA and CA treatments are significantly different than the mean of the FOA treatment.

These results regarding the agreement rates are consistent with Deck et al.'s (2007) results that NA treatment has the highest agreement rate, followed by the agreement rate for α-FOA (AFOA in Deck et al.'s (2007) study), CA agreement rate and FOA has the lowest agreement rate

[2] It seems that the student did not pay attention to the instructions and made offers of $-1. In addition, he accepted almost any offer from his counterpart.

A first observation is that contrary to the theoretical prediction, the α-FOA type of arbitration will not reach agreement rates close to 100%. Even when the less risk-averse group of subjects is removed, α-FOA had agreement rates equal to 34% for the more risk-averse subjects.

A non-parametric Wilcoxon Sum Rank exact one-sided test shows that there is a difference in means between NA treatment and the other treatments (*p-value*<0.001). The same test indicates that there is marginally statistically significant difference in means between α-FOA and CA (*p-value*=0.122), but there is a highly statistically significant difference in means between α-FOA and FOA (*p-value*=0.014).

A session-specific random effect Probit model presented in the next table shows that there is a strong statistically significant difference in means between α-FOA and NA, and between α-FOA and FOA, and statistically significant difference in means between α-FOA and CA. Table 6 displays marginal effects from different models. The first model is a basic treatment effect model that has α-FOA as a base treatment. The next models include more explanatory variables in order to control for other factors that might affect the agreement rates like risk preferences and learning effect. All four models are consistent that the NA treatment will increase the agreement rates, while CA and FOA treatments will decrease the agreement rates comparing to α-FOA treatment.

Risk is a binary variable that indicates if the pair of subjects is more risk-averse (*risk*=0) or if the pair of subjects is less risk-averse (*risk*=1). These values were attributed to each subject after they made their choice in the risk elicitation stage of the experiment and remained the same for the entire experiment. *Period within treatment* indicates the round number within a treatment; *Spring-Fall Experiment* is a binary variable that indicates if the session had the instructions modified and if α-FOA treatment had 10 periods; *Female/Male Ratio* can take 3 values: 0 if both subjects of a pair are females, 0.5 if one subject is female, one is male, and 1 if both subjects are males; *Period within session* is the number of the period within a session.

Last treatment is a dummy variable that has value 1 when the treatment was the last treatment in a session. ANOVA results indicate that the 4^{th} treatment has higher mean than the other treatments. The last two variables are two other metrics of the risk preferences of a pair of subjects: the average number of safe choices of a pair during the first stage of the experiment, and the average risk order within a session given the number of safe choices of the subjects that form a pair.

When the treatment is the last treatment in the session increases the agreement rates, while variables related to risk preferences that should increase the agreements rate, will decrease the rate contrary to the theoretical prediction.

The conclusion is that these results support hypothesis 2. However, they do not support hypothesis 1. In order to determine why hypothesis 1 is not supported, I examine what factors lead subjects in the α-FOA treatment to submit a more aggressive final offer in the situation when they did not reach an agreement. Their final offer might depend on the subject's characteristics, the number of the period within treatment or variables related to the outcome from the previous period. Table 7 shows a model in which the final offer of a subject that did not reach an agreement is the dependent variable, while the independent variables are some of the subject characteristics (risk preference, being *buyer* or *seller*, sex of the subject); a time variable (the number of the periods within the α-FOA treatment); and some variables that describe the outcome from the last period (if the subject reached an agreement or not, the outcome of the previous period, the value of the random draw in case of no agreement and the final offer of the counterpart in case of no agreement).

The values of some variables that describe the outcome in the previous period (outcome, final offer, random draw) have different interpretations for a *buyer* or for a *seller* (i.e. a draw equal to 450 for a *buyer* means that the draw is in her favor, while for a *seller* it means that the draw is not in her favor). Therefor I calculate the distance between the value of these variables and the point X=500 (the mean of the fair settlement distribution). A positive distance means that the value of the variable is in her favor, while a negative value means that it is not in her favor (i.e. a draw/an outcome/a final offer of 450 has the distance of 50 units for a *buyer*, but -50 for a *seller*, while a draw/an outcome/a final offer of 530 has the distance of -30 units for a *buyer* and 30 for a *seller*).

The first model in table 2.7 is an OLS model, while the second model is a time fixed effects model with clustered standard errors. Contrary to intuition and theoretical predictions, the only variable that has a coefficient that is statistically significant and increases the distance of the final offer from the median of the distribution function in the subject's favor, making the agreement more difficult, is the variable *Type* which represents the type of the subject: *buyer* or *seller*. The results from Table 7 indicate that a switch from *seller* to *buyer* will make the subject submit a more aggressive final offer by 15 units. On average, a *seller* that did not reach an agreement made a final offer of 510, while a *buyer* that did not reach an agreement made an offer of 472. This result is not explained by the fact that the random draw might influence the *buyers* to be more optimistic in the estimation of the value for the random draw. The mean of all draws in these cases was equal to 500. Likewise there was no selection problem related to subjects' risk preferences because the subjects were assigned randomly as a *buyer* or *seller*. Also the coefficients of the variables that control for the value of the past draw and the risk preference of the subjects are not statistically significant and they do not have a large effect on the final offer. Beliefs elicitation before subjects submit their final offer might help us understand why the subjects made such an offer.

Another explanation why hypothesis 1 is not supported might be related to the mechanism itself. Even if α-FOA appears to be a relatively simple mechanism, the subjects might not understand that the value of the final outcome does not depend on their final offer and that their final offer determines only if they win or lose the arbitration.

Beside the decision that the subjects had to take during the experiment in each of the two stages, the subjects had to answer to several quiz questions about the instructions. The questions were prior to the first stage, and before each treatment of the second stage. For the correctness of the answers, it is important to mention that there was no monetary incentive for subjects to give the best answer, the purpose of these questions is to help them understand the instructions better.

The first stage had 3 quiz questions. For the first question 75% of the subjects gave the correct answer, for the second question 96% and for the last one 98%. Only one subject switched back and forth between *Option A* and *Option B*, out of all subjects that gave at least one wrong answer. For CA and FOA treatments there was just one question per treatment and the percentages of correct answers were 81.3% and 92.7%, respectively. For NA and α-FOA treatments there were two questions per treatment. For the NA treatment the percentage of correct answers was at the same level as the other two treatments: 72.9% for the first question and 96.9% for the second question.

However for the α-FOA the percentage of the correct answers dropped to 21.9% for the first question and 36.5% for the second question. Given that they did not have any monetary incentive to try to calculate the exact value, I calculate the percentage of students that gave an approximate answer (that means that they understood which player from their example won the arbitration and they chose a value close to the correct answer). In that case, the percentage of an approximate answer is 76.0% for the first question and 69.8% for the second question. Given these results, my suggestion is that the subjects did not totally understand how this arbitration mechanism works.

A stage that will elicit subjects' beliefs before they submit their final offers might offer insights regarding if they understood the mechanism and also regarding their optimism about the random draw, a factor that Dickinson (2009) shows that affects the outcome of the arbitration.

Result 2. Agreement rate *after* the subjects submit their final offers for α-FOA treatment is statistically different than the mean for CA or FOA treatments.

This result does not concern the main research questions of this paper and is related to the moment in time when the subjects reached an agreement during the arbitration procedure. The subjects were able to reach an agreement during the two different stages of arbitration. The first stage is the negotiation stage before the subjects submitted their final offers, and they can reach an agreement by accepting the last offer made by their counterpart. They were also able to reach an agreement after they submitted their final offers, in cases where their final offers crossed-over. In other words they were able to reach an agreement *before* or *after* they submitted their final offers.

A Wilcoxon Sum Rank exact one-sided test shows that the mean for agreement rates *after* the subjects submitted their final offers for α-FOA is strongly statistically different than the mean for CA (*p-value*=0.0023) and the mean for FOA (*p-value*<0.001). Moreover, the agreement rate *after* the final offers were submitted for FOA is almost zero. On the other hand there is no difference in mean between agreement rates *before* the subjects submitted the final offer for α-FOA and FOA (*p-value*=0.3281), and there is a statistically significant difference in the means between agreement rates for α-FOA and CA (*p-value*=0.0079). This might imply that during the negotiation the subjects behave almost the same no matter what arbitration procedure is applied, but once they have to submit their final offers, they are more willing to reach an agreement under α-FOA. So α-FOA offers more incentives to reach an agreement as theory predicts but these incentives are not strong enough during negotiation process, but become stronger once the subjects have to submit their final offers.

Result 3. More risk-averse groups of subjects do not have higher agreement rates than less risk-averse groups of subjects.

The distribution of subjects by the number of safe choices from the first stage of the experiment is shown in Figure 2.6 for the two groups of subjects.

On average the more risk-averse subjects choose 10.28 safe choices while the less risk-averse subjects choose 7.02 safe choices. The graph below and the means show that most of the subjects are risk-averse. Due to the settings of the risk elicitation method, a risk-neutral subject should have 6 safe choices before she starts to choose the risky option.

Given subjects' choices during the risk elicitation stage, I calculate if a contract zone exists for each pair in each period. For the four sessions from spring of 2012 there were 4.5% cases in which there was no contract zone. All these cases were for the less risk-averse group of subjects. However, for the four sessions from fall 2012 this percentage was significantly higher: 20.3%. This high percentage is mainly due to subject 11 from session 7 and subject 10 of session 8, who may not have correctly understood the task from the risk elicitation stage. Both subjects chose only the risky option even for the cases in which the risky option earned them \$0 with certainty, compared to \$1 from the safe option (they chose option B even for line 1 from figure 2.3). Due to their choices, there is no contract zone for any pair which included one of them. Without taking into account their cases, 12% of cases resulted in no contract zone for the last four sessions.

While theory predicts that, due to the lack of a contract zone, the more risk-averse group of subjects should have a higher agreement rate than the less risk-averse group of subjects, the results do not support this prediction.

The same non-parametric test shows that there is a difference in the means of the agreements rates between more risk-averse groups of subjects and less risk-averse groups of students for CA (*p-values*=0.0149) and FOA (*p-values*=0.0618) types of arbitration. The agreement rate for more risk-averse group of subjects is smaller than the agreement rate for the less risk-averse group of subjects. For the α-FOA type of arbitration there is just a marginally significant difference in means, *p-values*=0.1048, while for the NA treatment there is no difference in means for the agreement rates between more risk-averse group of subjects and less risk-averse group of subjects.

This result is consistent with the Probit models from columns 3 and 4 from Table 2.6. In both models, the coefficient for the variable that measures the risk preference of a pair of subjects is negative and statistically significant. Because the value for both variables increases when a pair is more risk-averse, the coefficient indicates that the agreement rate will decrease when a pair of subjects is more risk-averse.

This result is contrary to the theoretical prediction that implies that more risk-averse people should reach an agreement more frequently than less risk-averse people. These results fail to support hypothesis 3.

One explanation why hypothesis 3 is not supported might be the method used for risk elicitation. As discussed above in section 2, papers have shown that the distribution of risk preferences can be quite different even for the same type of task when using different methods. A new method using arbitration in order to elicit risk preferences might be more appropriate. Another explanation is optimism. Even though the design of my experiment tried to control for optimism by using a small standard deviation for the normal distribution that describes the notion of the fair settlement of the arbitrator, the subjects can still be biased by the median of this distribution, which leads to disputes. A solution to this problem would be to elicit their beliefs about the draw of the value for the fair settlement, similar to Dickinson (2009), and to see if the subjects were biased or if they were just aggressive in negotiations.

Another way to investigate the problem of risk preferences in arbitration mechanisms is to take a similar approach to Brunner et al. (2013). Brunner et al. (2013) study the effect of risk preferences in English premium auctions. They asked 368 subjects to participate in an online risk elicitation method survey on Charlie Holt's Vecon website. Out of the 368 subjects, 48 observations were discarded because they were incomplete or inconsistent. Due the low number of risk-seeking subjects from the rest 320 subjects they used only 40 subjects for the main experiment. The subjects were then classified as risk-averse (with 7, 8 or 9 safe choices out of 10) or as risk-seeking (0-3 safe choices). With a design similar to that the theoretical prediction is that the contract zone does not exist for any pair of the risk-seeking group of subjects while it exits for all pairs of the risk-averse group of subjects. The only problem with this approach is the high cost of the risk elicitation stage.

3.5 Conclusions

Starting with Stevens (1966) a few arbitration mechanisms were proposed instead of CA, mechanisms that should improve agreement rates, but most of them did not reach higher agreement rates compared to CA, in practice or in lab experiments. A promising arbitration mechanism that offers marginally higher agreement rates compared to CA is AFOA proposed by Zeng (2003). In their experimental study, Deck et al. (2007) show that the agreement rate for AFOA is strictly higher than the agreement rate for FOA and weakly higher than the one for CA.

In this paper, I study a more general case of AFOA proposed by Zeng (2003) called α-FOA and also take into account the risk preferences of the subjects due to the fact that the existence of the contract zone depends on the risk preferences of the subjects. α-FOA is similar to a "second-price" auction in the sense that the value of the subject's final offer determines only if she wins the arbitration, but the value of the outcome of the arbitration depends on the value of the final offer of her counterpart. Due to this property, compared to FOA, α-FOA separates the two functions of the final offer: to win the arbitration and to obtain a favorable outcome after the arbitration. Compared to AFOA that offers the same property, α-FOA allows for changes in the punishment of a subject that is aggressive with her final offer in order to create stronger incentives to reach an agreement. With regard to the contract zone, α-FOA offers the largest contract zone for risk-neutral and risk-averse subjects compared to the other arbitration methods.

The experiment of this study is similar to the experiment of Dickinson (2004). Subjects are randomly assigned the role of a *buyer* or *seller* and each *buyer* is randomly paired each period with a *seller*. For each round, they have to agree upon the value of a variable X, a variable that offers high payoffs when it takes low values for *buyers* and high payoffs when it takes high values for *sellers*. If subjects do not reach an agreement in a one minute period, they have to submit their final offers. If these final offers do not cross-over to indicate an agreement, one of the arbitration mechanisms is applied in order to determine the outcome of that round. In addition, at the beginning of a session I elicit the subjects' risk preferences and split them into two groups, more risk-averse and less risk-averse, in order to have in the more risk-averse group of subjects only risk-neutral and risk-averse subjects and guarantee the existence of a contract zone.

The results of the experiment show that α-FOA has on average a higher agreement rate than CA or FOA. A non-parametric test shows that the agreement rate for α-FOA is statistically significantly greater than the agreement rate for FOA and weakly statistically significantly greater than the agreement rate for CA. A session-specific random effect Probit model shows that there is a strong statistically significant difference in means between α-FOA and FOA, and statistically significant difference in means between α-FOA and CA. Contrary to the theoretical prediction risk preferences have the opposite impact on the agreement rates for these arbitration mechanisms.

Despite the fact that α-FOA looks really promising in a laboratory experiment environment, future research should focus on finding an answer that will explain the difference in agreement rates between the theoretical prediction and the results obtain in a laboratory experiment. Also, I suggest that future studies of arbitration mechanisms should develop and use a better risk elicitation method.

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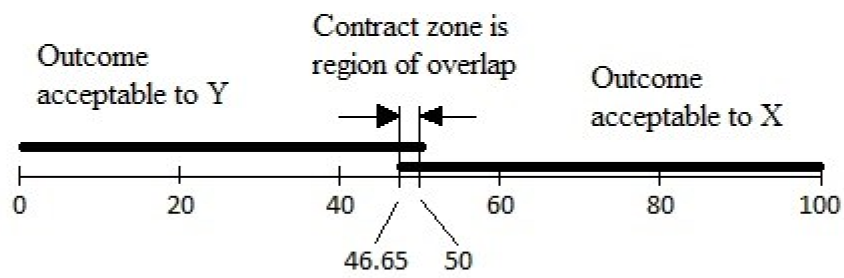


Figure 3.1 Contract zone for a risk-averse and a risk-neutral player.

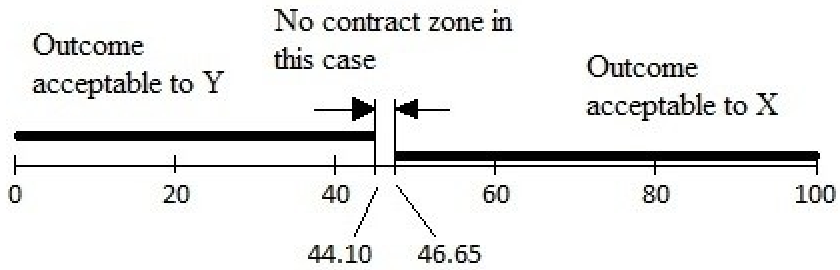
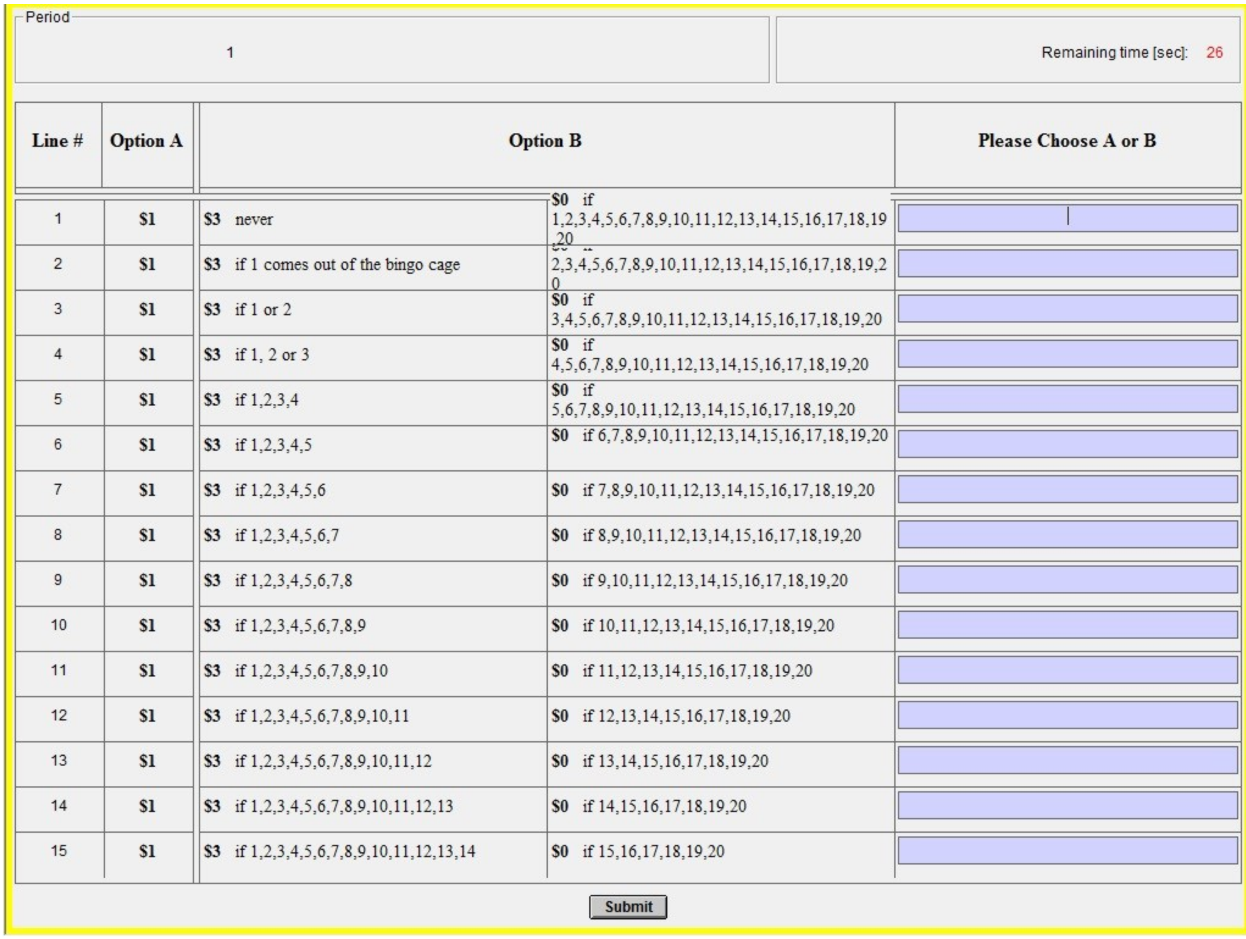


Figure 3.2 No contract zone for a risk-averse and a risk-seeking player



Period

1

Remaining time [sec]: 26

Line #	Option A	Option B		Please Choose A or B
1	$1	$3 never	$0 if 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20	
2	$1	$3 if 1 comes out of the bingo cage	$0 if 2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20	
3	$1	$3 if 1 or 2	$0 if 3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20	
4	$1	$3 if 1, 2 or 3	$0 if 4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20	
5	$1	$3 if 1,2,3,4	$0 if 5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20	
6	$1	$3 if 1,2,3,4,5	$0 if 6,7,8,9,10,11,12,13,14,15,16,17,18,19,20	
7	$1	$3 if 1,2,3,4,5,6	$0 if 7,8,9,10,11,12,13,14,15,16,17,18,19,20	
8	$1	$3 if 1,2,3,4,5,6,7	$0 if 8,9,10,11,12,13,14,15,16,17,18,19,20	
9	$1	$3 if 1,2,3,4,5,6,7,8	$0 if 9,10,11,12,13,14,15,16,17,18,19,20	
10	$1	$3 if 1,2,3,4,5,6,7,8,9	$0 if 10,11,12,13,14,15,16,17,18,19,20	
11	$1	$3 if 1,2,3,4,5,6,7,8,9,10	$0 if 11,12,13,14,15,16,17,18,19,20	
12	$1	$3 if 1,2,3,4,5,6,7,8,9,10,11	$0 if 12,13,14,15,16,17,18,19,20	
13	$1	$3 if 1,2,3,4,5,6,7,8,9,10,11,12	$0 if 13,14,15,16,17,18,19,20	
14	$1	$3 if 1,2,3,4,5,6,7,8,9,10,11,12,13	$0 if 14,15,16,17,18,19,20	
15	$1	$3 if 1,2,3,4,5,6,7,8,9,10,11,12,13,14	$0 if 15,16,17,18,19,20	

Submit

Figure 3.3 Screen shot of the risk elicitation stage

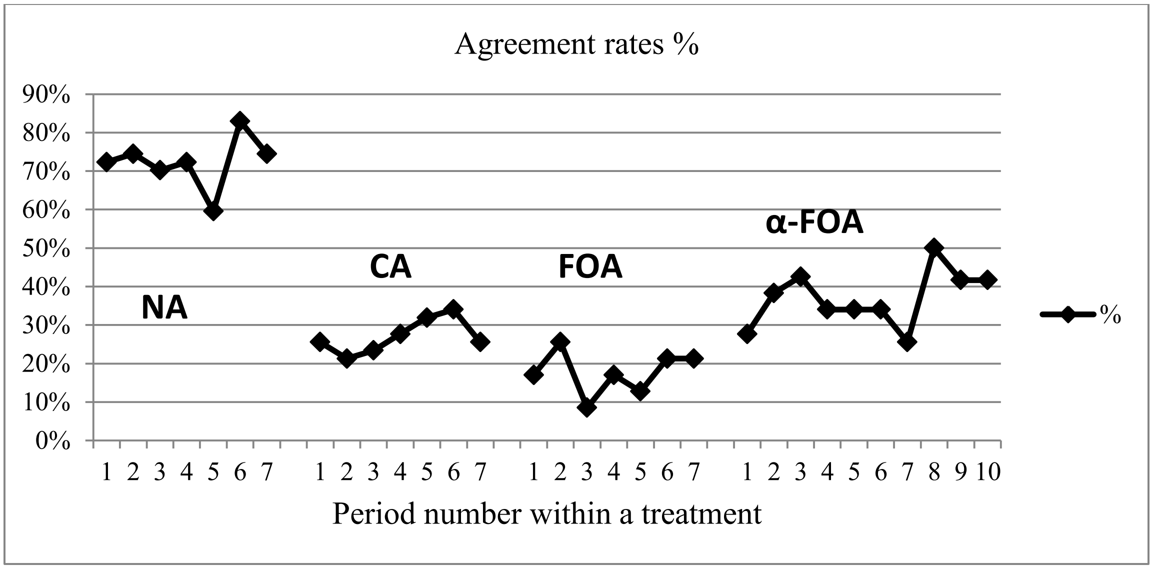


Figure 3.4 Note: Actual treatment order varied for different sessions.

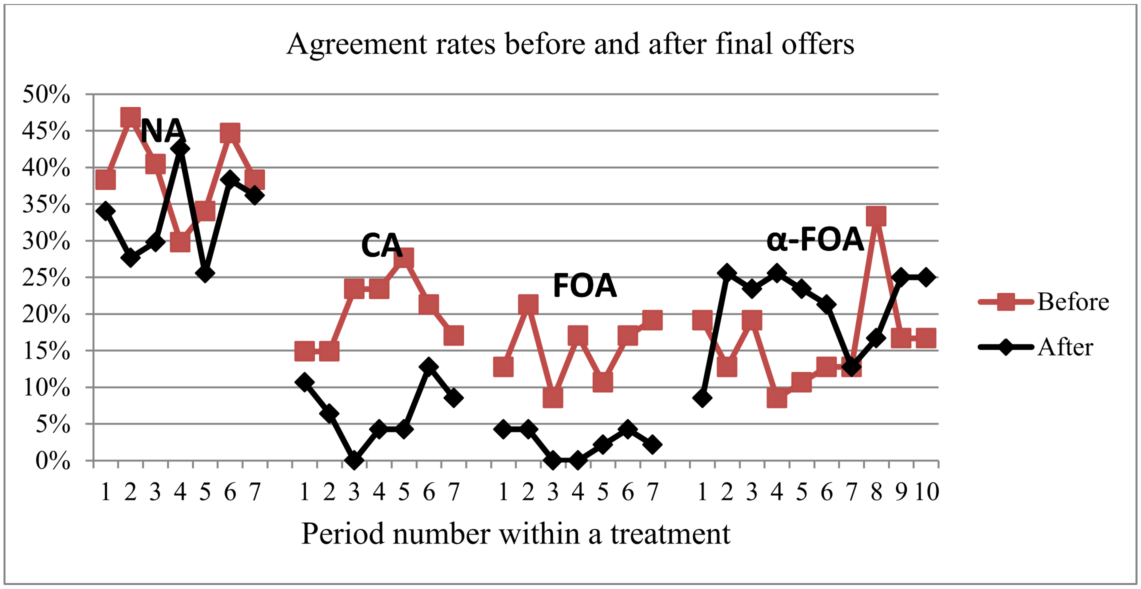


Figure 3.5 Agreement rates before and after final offers

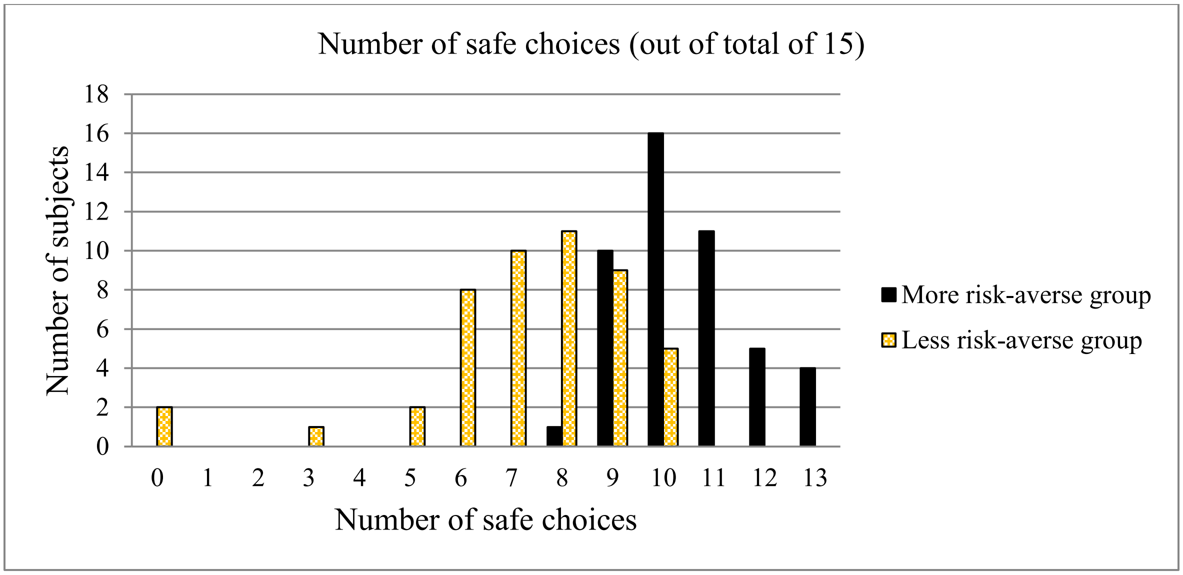


Figure 3.6 - The distribution of subjects by the number of safe choices

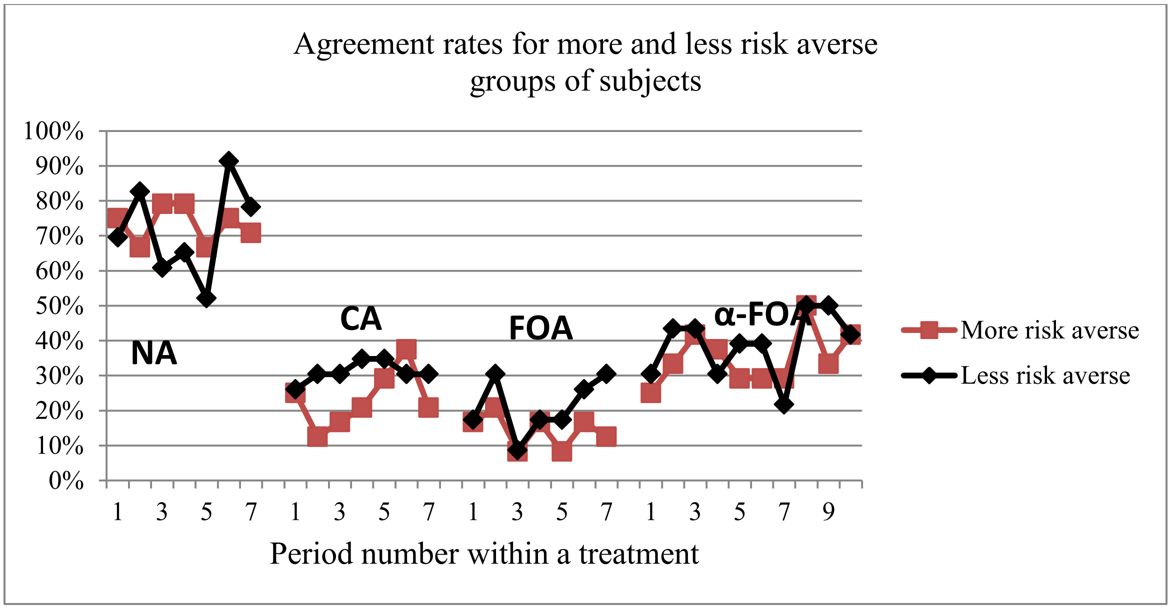


Figure 3.7 Agreement rate for more and less risk-averse group of subjects

Table 3.1 Size of the contract zone

							Contract zone			
	Mean	Std. dev.	δ_p	δ_d	Cost	α	Low limit	High limit	Size	% of "pie"
α-FOA	500	30	0.1	0.1	0	2	365.0	635.0	270.0	67.5%
CA	500	30	0.1	0.1	0	-	455.0	545.0	90.0	22.5%
FOA	500	30	0.1	0.1	0	-	499.1	500.9	1.8	0.5%

Table 3.2 The payoff tables for player A and player B

Player A		Player B	
Value of X	Payoff	Value of X	Payoff
300	\$0.00	200	\$2.50
350	\$0.25	250	\$2.25
400	\$0.50	300	\$2.00
450	\$0.75	350	\$1.75
500	\$1.00	400	\$1.50
550	\$1.25	450	\$1.25
600	\$1.50	500	\$1.00
650	\$1.75	550	\$0.75
700	\$2.00	600	\$0.50
750	\$2.25	650	\$0.25
800	\$2.50	700	\$0.00

Table 3.3 The order of treatments in each session according to Latin Square design

		Session number			
		1	**2**	**3**	**4**
Order in the session	**1st**	CA	FOA	α-FOA	NA
	2nd	FOA	α-FOA	NA	CA
	3rd	α-FOA	NA	CA	FOA
	4th	NA	CA	FOA	α-FOA

Table 3.4 ANOVA output

Source	***DF***	***Type III SS***	***Mean Square***	***F Value***	***Pr> F***
Treatment	3	12710.375	4236.791	46.95	<.0001
Session	6	987.875	164.645	1.82	0.1507
Order	3	812.625	270.875	3.00	0.0577

Table 3.5 Agreement rates per treatment in each session

Arbitration type	Session number							
	1	2	3	4	5	6	7	8
NA	69%	60%	69%	74%	83%	90%	76%	55%
CA	12%	34%	24%	31%	19%	12%	50%	36%
FOA	7%	6%	29%	19%	10%	14%	31%	24%
α-FOA	29%	17%	31%	40%	42%	25%	52%	40%

Table 3.6 Marginal effects - Random Effect Probit models

VARIABLES	(1) Agreements	(2) Agreements	(3) Agreements	(4) Agreements
No Arbitration (dummy)	0.390*** (0.0369)	0.394*** (0.0372)	0.397*** (0.0372)	0.394*** (0.0372)
Conventional Arb. (dummy)	-0.0718* (0.0372)	-0.0701* (0.0376)	-0.0713* (0.0377)	-0.0703* (0.0376)
Final-Offer Arb. (dummy)	-0.183*** (0.0355)	-0.187*** (0.0355)	-0.189*** (0.0355)	-0.187*** (0.0355)
Risk Preferences Group (dummy)		0.0444 (0.0284)		
Period within treatment		0.00431 (0.00764)	0.00432 (0.00766)	0.00427 (0.00764)
Spring-Fall Experiment (dummy)		0.0687 (0.0482)	0.0459 (0.0469)	0.0672 (0.0485)
Female/Male Ratio		-0.0372 (0.0457)	-0.0714 (0.0465)	-0.0420 (0.0458)
Period within session		-0.000800 (0.00272)	-0.000681 (0.00273)	-0.000743 (0.00272)
Last treatment (dummy)		0.153*** (0.0534)	0.151*** (0.0536)	0.152*** (0.0534)
Average number of safe choices			-0.0303*** (0.00707)	
Average risk order within a session				-0.0102** (0.00444)
Observations	1,316	1,316	1,316	1,316
Number of Session	8	8	8	8

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.7 OLS model and time fixed effect model estimates

VARIABLES	(1) Distance from 500 of the final offer	(2) Distance from 500 of the final offer
Risk preferences group (dummy)	-2.438	-1.857
	(3.151)	(2.889)
Type – Seller/Buyer (dummy ; Buyer=1)	15.60***	14.72***
	(3.286)	(2.976)
Period within treatment	-2.054***	-1.462**
	(0.687)	(0.714)
Female/Male (dummy ; Male=1)	-0.883	-2.343
	(3.215)	(4.542)
Agreement in t-1	-3.717	-5.758
	(4.048)	(3.465)
Dist. of the draw in t-1	0.140*	0.128
	(0.0729)	(0.0916)
Dist. of the outcome t-1	-0.0406**	-0.0369
	(0.0176)	(0.0295)
Dist. of the counterpart offer in t-1	-0.0349	-0.0767
	(0.0516)	(0.0609)
Constant	9.086	8.762*
	(7.286)	(5.003)
Observations	391	391
R-squared	0.130	0.138
Time fixed effects	NO	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

3.7 Appendix

Experiment Instructions (first stage)

This is an experiment in decision-making. Please read the following instructions carefully. The amount of money that you earn in this experiment will depend on your decisions.

Your screen will show 15 lines with a choice each, between two options: A and B. The decisions are listed on the left (like in the image below).

Period

1

Remaining time [sec]: 26

Line #	Option A	Option B		Please Choose A or B
1	$1	$3 never	$0 if 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20	
2	$1	$3 if 1 comes out of the bingo cage	$0 if 2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20	
3	$1	$3 if 1 or 2	$0 if 3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20	
4	$1	$3 if 1, 2 or 3	$0 if 4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20	
5	$1	$3 if 1,2,3,4	$0 if 5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20	
6	$1	$3 if 1,2,3,4,5	$0 if 6,7,8,9,10,11,12,13,14,15,16,17,18,19,20	
7	$1	$3 if 1,2,3,4,5,6	$0 if 7,8,9,10,11,12,13,14,15,16,17,18,19,20	
8	$1	$3 if 1,2,3,4,5,6,7	$0 if 8,9,10,11,12,13,14,15,16,17,18,19,20	
9	$1	$3 if 1,2,3,4,5,6,7,8	$0 if 9,10,11,12,13,14,15,16,17,18,19,20	
10	$1	$3 if 1,2,3,4,5,6,7,8,9	$0 if 10,11,12,13,14,15,16,17,18,19,20	
11	$1	$3 if 1,2,3,4,5,6,7,8,9,10	$0 if 11,12,13,14,15,16,17,18,19,20	
12	$1	$3 if 1,2,3,4,5,6,7,8,9,10,11	$0 if 12,13,14,15,16,17,18,19,20	
13	$1	$3 if 1,2,3,4,5,6,7,8,9,10,11,12	$0 if 13,14,15,16,17,18,19,20	
14	$1	$3 if 1,2,3,4,5,6,7,8,9,10,11,12,13	$0 if 14,15,16,17,18,19,20	
15	$1	$3 if 1,2,3,4,5,6,7,8,9,10,11,12,13,14	$0 if 15,16,17,18,19,20	

Submit

Each decision is a paired choice between "Option A" and "Option B." You will make 15 choices and record these in the final column, but only one of them will be used in the end to determine your earnings. Before you start making your 15 choices, please let me explain how these choices will affect your earnings for this part of the experiment.

There is a bingo cage containing 15 balls (for the first draw) and 20 balls (for the second draw). The balls have a number from 1 to 15, and 1 to 20 respectively. At the end of the experiment there will be two drawings, the first to select one of the 15 decisions to be used, and a second one to determine what your payoff is if you chose option B for that decision. Even though you will make 15 decisions, only one of these will end up affecting your earnings, but you will not know in advance which decision will be used. Obviously, each decision has an equal chance of being used in the end.

For example, please look at Decision 5 (Line 5). Option A pays $1 for sure. Option B pays $3 if the second ball is 1,2,3 or 4, and $0 if the second ball is 5,6,7…,20. The other decisions are similar, except that as you move down the table, the chances of the higher payoff for option B increase.

To summarize, you will make 15 choices: for each decision row you will have to choose between Option A and Option B. You may choose A for some decision rows and B for other rows, and you may change your decisions and make them in any order. When you are finished, click the “Submit” button. After you click the “Submit” button, you will not be able to change your choices. At the end of the experiment, we will use a bingo cage to determine what decision we will use for your payment and what your payoff is if you chose Option B for that particular decision.

Before you start to make your decisions, you will have to answer to couple of quiz questions about these instructions. The answers for these questions will NOT affect your earnings at all and they are just to be sure that you understood the instructions.

Are there any questions? Please do not talk with anyone while we are doing this. If you have any questions before starting and during the experiment, please raise your hand now and an instructor will come to you.

Instructions (second stage)

You have been randomly assigned as **Player B (Player A)** for the remainder of this experiment. ***You will have a new randomly chosen counterpart Player A (Player B), for following of the next periods***. You and your counterpart will be given ***1 minute*** in a decision-making period to mutually agree upon the size of a variable, X. The time will be displayed in the upper right hand corner of your screen.

Your range of possible X values lies from 200 to 700 (300 to 800) in increments of one (this may not be the same range as that of your counterpart). The value of X at the end of the period will determine your cash earnings for that period.

For a Player A, the cash earnings for any given period are larger for larger values of X. For a Player B, the cash earnings for any given period are larger for smaller values of X.

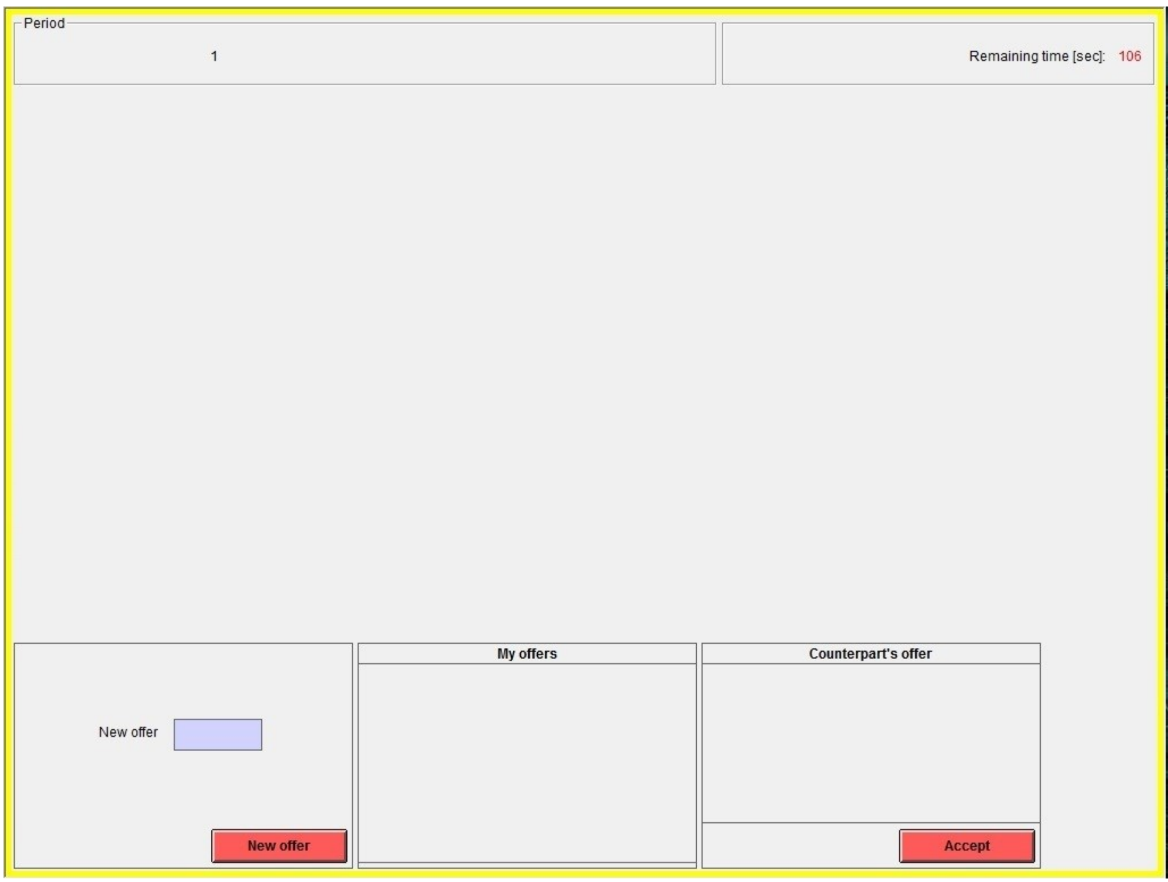
The payoff table below translates the different values of X into earnings in US dollars. Please study this payoff table carefully so that you fully understand how your earnings will vary given the different possible values of X.

Player A		Player B	
Value of X	Payoff	Value of X	Payoff
300	$0.00	200	$2.50
350	$0.25	250	$2.25
400	$0.50	300	$2.00
450	$0.75	350	$1.75
500	$1.00	400	$1.50
550	$1.25	450	$1.25
600	$1.50	500	$1.00
650	$1.75	550	$0.75
700	$2.00	600	$0.50
750	$2.25	650	$0.25
800	$2.50	700	$0.00

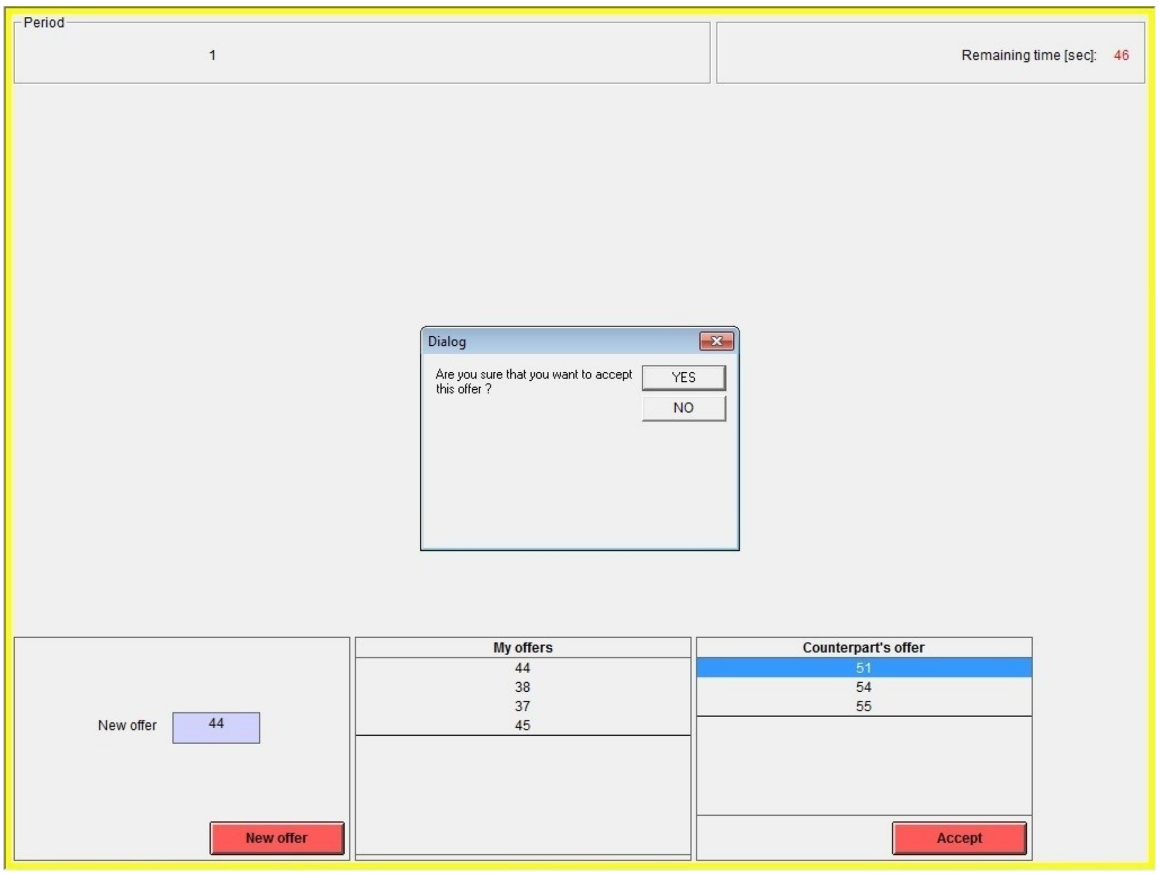
All integer values for X are possible, and those not shown in the table provide payoffs between those shown.

If you and your counterpart mutually agree upon the size of X for that period, then your payoff table indicates how much you will earn for that period. In a few moments we will discuss what will happen should you and your counterpart not be able to come to an agreement by the end of the allocated time. Your interaction with your counterpart will only occur through the computers. You will never know the identity of your counterpart and your counterpart will never know your identity.

The next screen shows the environment in which you will interact with your counterpart. In your interactions with your counterpart, you will submit your proposal for the size of X on this screen:

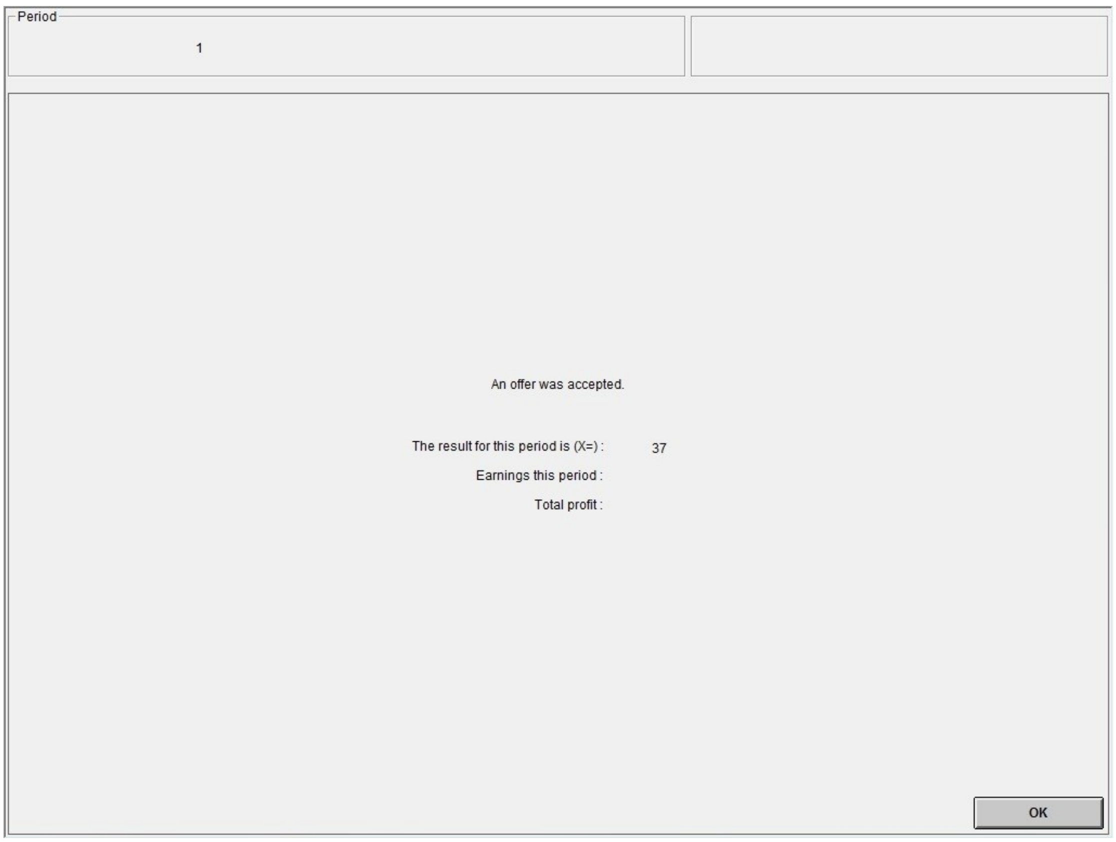


To enter a proposal for X, in the "New Offer" box, enter a value for X and then click "New offer" button. Your offer will be displayed in the middle box, called "My offers", in the order that you enter them, from top to bottom. These values will be displayed also in the same order for your counterpart, in his/her third box (from left to right) called “Counterpart’s offer”. The offers that your counterpart makes to you will be displayed in your box “Counterpart’s offer”. At any time you can choose ***only the last offer*** (offers at the top of the list) that your counterpart made by clicking on that offer and then the button “Accept”. If he/she makes a new offer you will not be able to accept the previous one. The same rule is valid for your counterpart. He/she will be able to accept only the last offer that you made. Offers can be updated at any time, but it may be wise to give the other player a few moments to either accept your offer or update his/her offer.



If you choose to accept your counterpart’s offer, a confirmation window will pop out and ask you to confirm your acceptance of this offer. If you click the “No” button then the offer is not accepted and you can continue to make and receive offers. If you click the “Yes” button, the offer is accepted and a screen with the final result and the payoff for that period will be displayed and the period is over. But if you take too much time between when you click the “Accept” button and the “Yes” button for confirmation, and you counterpart makes a new offer in the meantime, then you will not be able to accept this offer, even if you click “Yes” button on the confirmation window. As mentioned above, you are able to accept only the last offer made.

Once the period is over, either another period of similar interactions will occur, or new instructions will follow for the subsequent period(s). At the end of every period you should write down the information shown on your results screen on your Personal Record Sheet, then click the “OK” button.



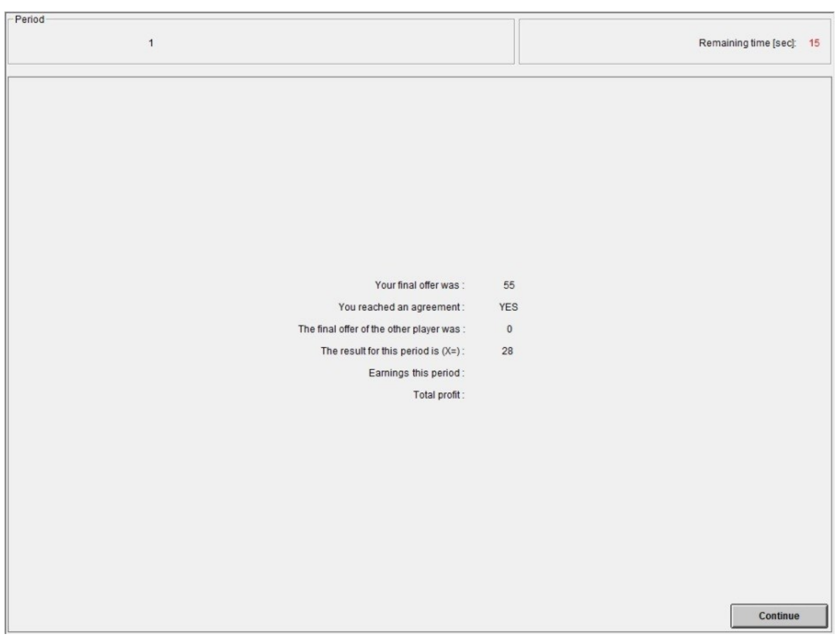
The computer will keep track of your cumulative experimental earnings and display them on your screen at the end of each period. You will also have a timer on the screen showing you how much time is left in a particular period. Please take a moment to locate these items on your screen. The instructions will inform you what will happen in the case that you and your counterpart do not reach an agreement within the time limit.

Part 1

For the next several periods, the following procedure is used if you and your counterpart do not reach an agreement by the end of the period. Should you reach the end of the period without having mutually agreed upon a value for X, you will then be prompted for a final offer. If your and your counterpart's final offers are equal, then that is the value of X for the period. If they cross (i.e. Player A's offer is smaller than Player B's offer), then X will be the average of these final offers. If there is still no agreement (i.e. Player A's offer is greater than player B's offer), then you will both receive $0 for that period. This does not affect any of your previous earnings, nor does it apply to future earnings (future periods of the experiment). It is important for you to understand this rule.

Before you start the decision-making periods regarding value of X, you will have to answer to couple of quiz questions about these instructions. The answers for these questions will NOT affect your earnings and they are just to be sure that you understood the instructions.

This procedure for addressing situations with no agreement at the end of the period will continue until you are otherwise notified. If you have any questions before starting this set of periods, please raise your hand now.



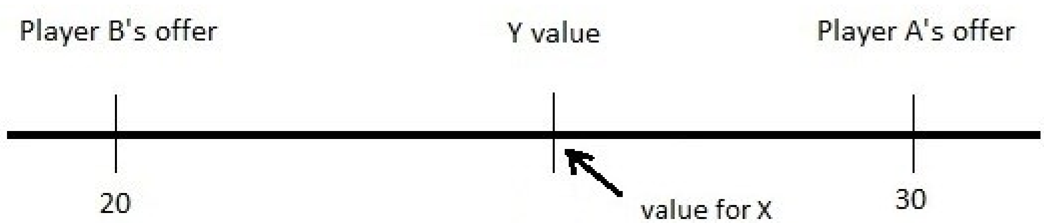
Personal Record Sheet

Period										
Your final offer										
Agreement (Yes/No)										
Counterpart final offer										
Result of the period										
Earnings this period										
Total profit										

Part 2

For the next several periods, the following procedure is used if you and your counterpart do not reach an agreement by the end of the period. Should you reach the end of the period without having mutually agreed upon a value for X, you will then be prompted for a final offer. If your and your counterpart's final offers are equal, then that is the value of X for the period. If they cross (i.e. Player A's offer is smaller than Player B's offer), then X will be the average of these final offers. If there is still no agreement, the computer will use a value, let's call it Y, for you and your counterpart. This value Y will determine what value of X will be chosen for that period. Some values of Y are more likely to be chosen than others, but there is a random element to the computer's choice. ***Whatever the value of Y the computer randomly chooses, that will also be the value of X used to determine both your and your counterpart's payoffs for that period.***

Example :



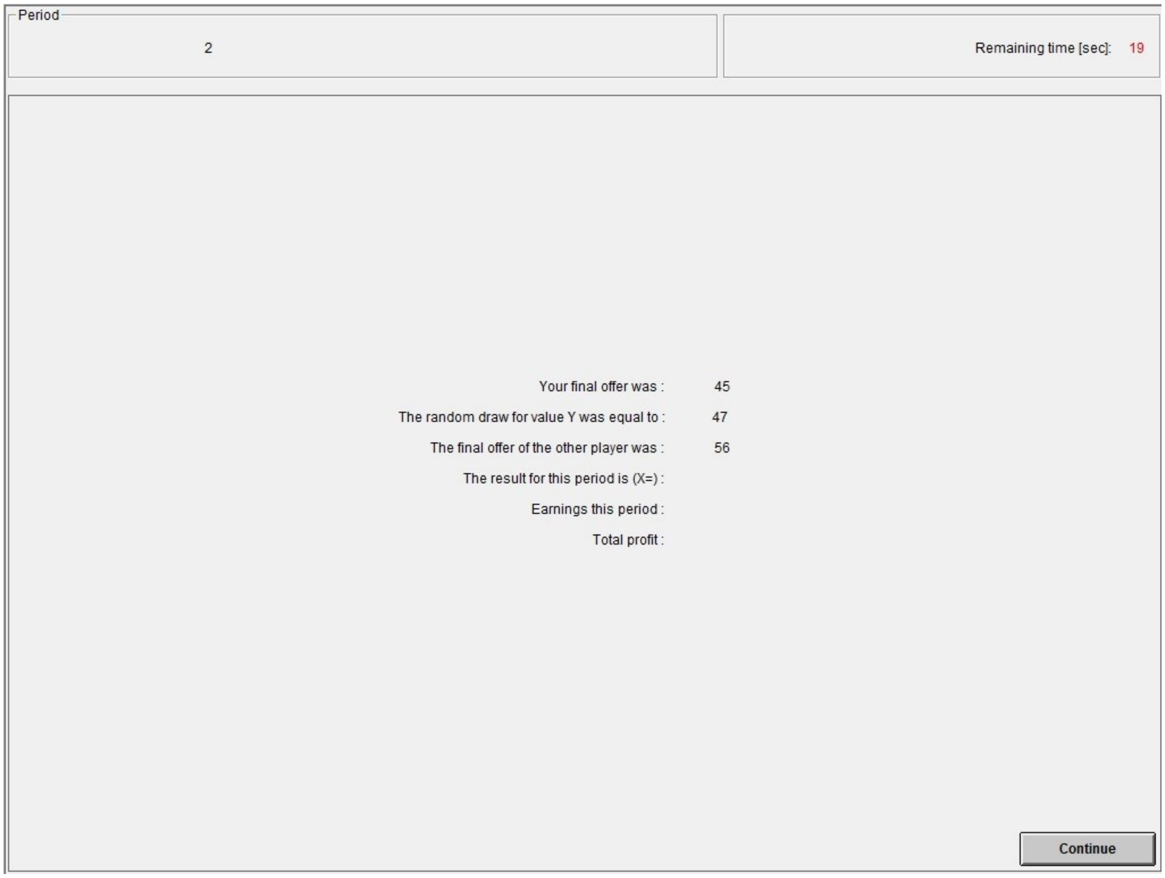
To give you some information about this random number generation procedure, the next table shows you 100 values of Y using the exact same method that will be used in your case. The order of these 100 values of Y is irrelevant.

Again, if you and your counterpart have not reached an agreement by the end of the period, you will be prompted for a final offer. If your final offers still do not indicate an agreement (i.e. Player A's offer is greater than player B's offer), then the same random number generation procedure that chose these 100 values of Y will be used to determine your value of X for that period.

100 random draws of Y									
461	494	531	543	499	546	503	458	521	506
487	496	522	510	495	477	455	457	525	498
510	545	491	477	519	511	478	515	493	442
607	542	509	541	533	493	468	495	506	487
583	543	476	449	533	534	571	494	465	446
460	520	527	497	474	467	482	543	466	525
591	464	466	493	502	501	522	509	503	473
522	522	468	510	464	517	494	506	522	503
498	549	476	509	467	533	527	548	578	484
521	515	412	474	500	546	477	476	480	509

Before you start the decision-making periods regarding value of X, you will have to answer to couple of quiz questions about these instructions. The answers for these questions will NOT affect your earnings and they are just to be sure that you understood the instructions.

This procedure for addressing situations with no agreement at the end of the period will continue until you are otherwise notified. If you have any questions before starting this set of periods, please raise your hand now.


Period
2
Remaining time [sec]: 19
Your final offer was : 45
The random draw for value Y was equal to : 47
The final offer of the other player was : 56
The result for this period is (X=) :
Earnings this period :
Total profit :
Continue

Personal Record Sheet

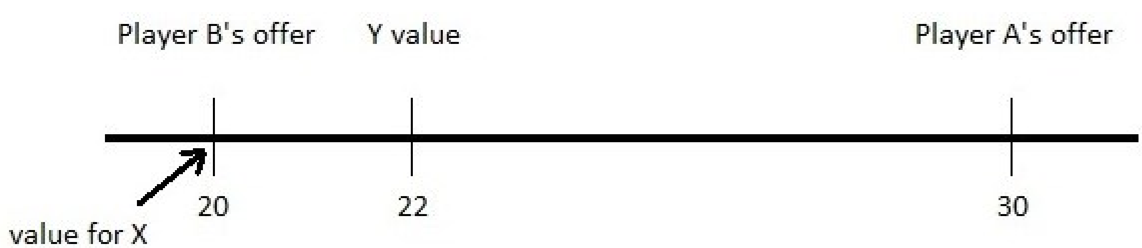
Period										
Your final offer										
Agreement (Yes/No)										
Counterpart final offer										
Result of the period										
Earnings this period										
Total profit										

Part 3

For the next several periods, the following procedure is used if you and your counterpart do not reach an agreement by the end of the period. Should you reach the end of the period without having mutually agreed upon a value for X, you will then be prompted for a final offer. If your and your counterpart's final offers are equal, then that is the value of X for the period. If they cross (i.e. Player A's offer is smaller than Player B's offer), then X will be the average of these final offers. If there is still no agreement, the computer will use a value, let's call it Y, for you and your counterpart. This value Y will determine what value of X will be chosen for that period. Some values of Y are more likely to be chosen than others, but there is a random element to the computer's choice. ***Whichever person's final offer is closer to the value Y will be chosen as the final outcome for X, used to both you and your counterpart payoff for that period.***

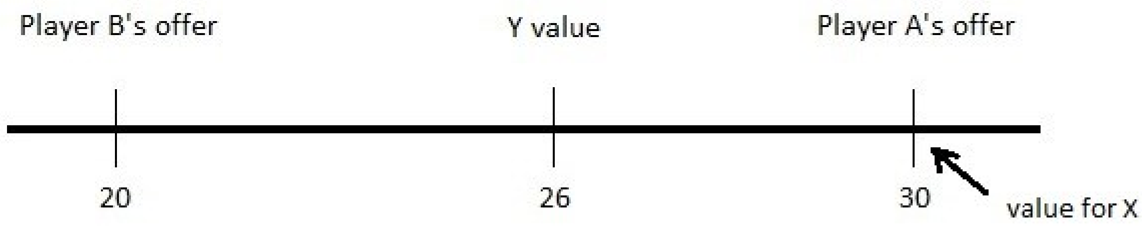
Example 1:

Assume that Player A's final offer was 30, Player B's final offer was 20 and Y=22. Player B's offer is closer to the value Y than Player A's offer. Therefore the value for X for this period will be equal to Player B's final offer, X= 20.



Example 2:

Assume that Player A's last offer was 30, Player B's last offer was 20 and Y=26. Player A's offer is closer to the value Y than Player B's offer. Therefore the value for X for this period will be equal to Player A's final offer, X= 30.



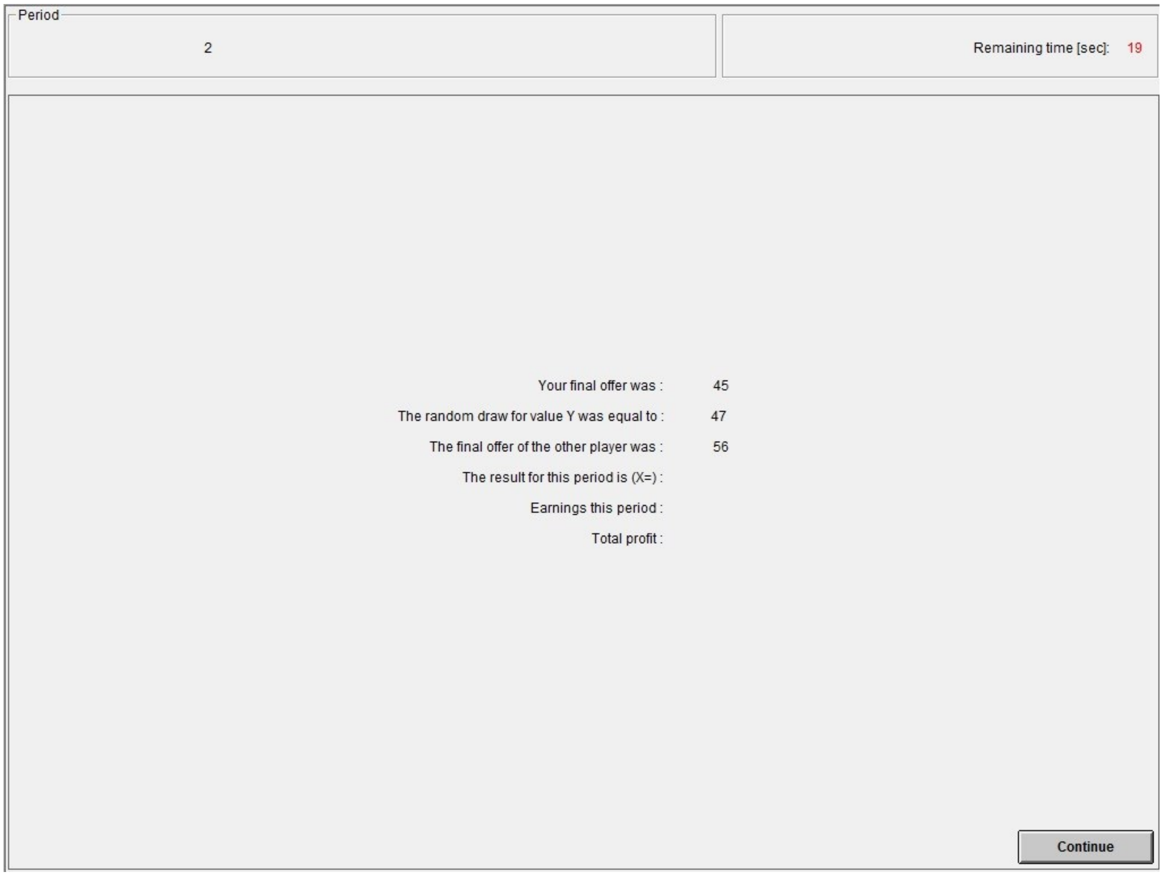
To give you some information about this random number generation procedure, the table below shows you 100 values of Y using the exact same method that will be used in your case. The order of these 100 values of Y is irrelevant.

100 random draws of Y									
461	494	531	543	499	546	503	458	521	506
487	496	522	510	495	477	455	457	525	498
510	545	491	477	519	511	478	515	493	442
607	542	509	541	533	493	468	495	506	487
583	543	476	449	533	534	571	494	465	446
460	520	527	497	474	467	482	543	466	525
591	464	466	493	502	501	522	509	503	473
522	522	468	510	464	517	494	506	522	503
498	549	476	509	467	533	527	548	578	484
521	515	412	474	500	546	477	476	480	509

Again, if you and your counterpart have not reached an agreement by the end of the period, you will be prompted for a final offer. If your final offers still do not indicate an agreement (i.e. Player A’s offer is greater than player B’s offer), then the same random number generation procedure that chose these 100 values of Y will be used to determine your value of X for that period.

Before you start the decision-making periods regarding value of X, you will have to answer to couple of quiz questions about these instructions. The answers for these questions will NOT affect your earnings and they are just to be sure that you understood the instructions.

This procedure for addressing situations with no agreement at the end of the period will continue until you are otherwise notified. If you have any questions before starting this set of periods, please raise your hand now.



Personal Record Sheet

Period										
Your final offer										
Agreement (Yes/No)										
Counterpart final offer										
Result of the period										
Earnings this period										
Total profit										

Part 4

For the next several periods, the following procedure is used if you and your counterpart do not reach an agreement by the end of the period. Should you reach the end of the period without having mutually agreed upon a value for X, you will then be prompted for a final offer. If your and your counterpart's final offers are equal, then that is the value of X for the period. If they cross (i.e. Player A's offer is smaller than Player B's offer), then X will be the average of these final offers. If there is still no agreement, the computer will use a value, let's call it Y, for you and your counterpart. This value Y will determine what value of X will be chosen for that period. Some values of Y are more likely to be chosen than others, but there is a random element to the computer's choice. ***The result for X for that period will be:***

- **<u>if Player B's offer is closer to the value of Y:</u>** ***X will be equal to the value of Y*** **<u>minus</u>** ***twice the difference between Player A's offer and the value of Y.***

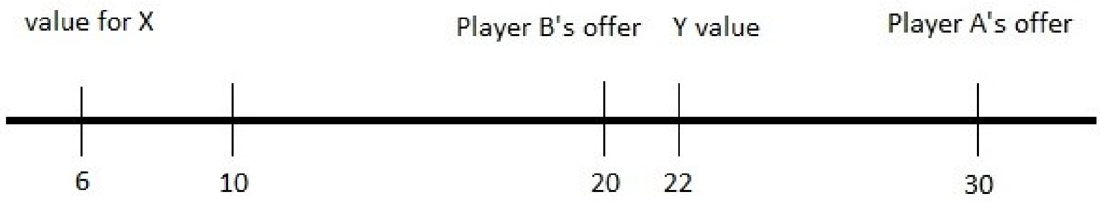
- **<u>if Player A's offer is closer to the value Y:</u>** ***X will be equal to the value of Y*** **<u>plus</u>** ***twice the difference between the value of Y and Player B's offer.***

In other words, the value of X will be even more favorable to an individual than her last offer, if that person has a final offer closer to the value of Y than her counterpart.

Example 1:

Assume that Player A's last offer was 30, Player B's last offer was 20 and Y=22. Player B's offer is closer to the value of Y than Player A's offer. **Then the value for X** for this period **will be equal** to the value of Y ***minus*** twice the difference between Player A's offer and the value of Y:

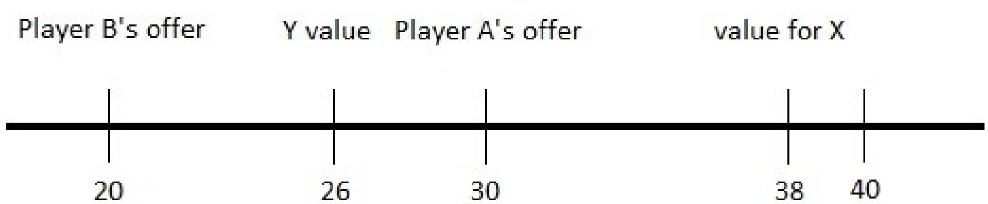
X=22-[2*(30-22)]=6.



Example 2:

Assume that Player A’s last offer was 30, Player B’s last offer was 20 and Y=26. Player A’s offer is closer to the value of Y than Player B’s offer. **Then the value for X** for this period **will be equal** to the value of Y ***plus*** twice the difference between the value of Y and Player B’s offer:

X=26+[2*(26-20)]=38.



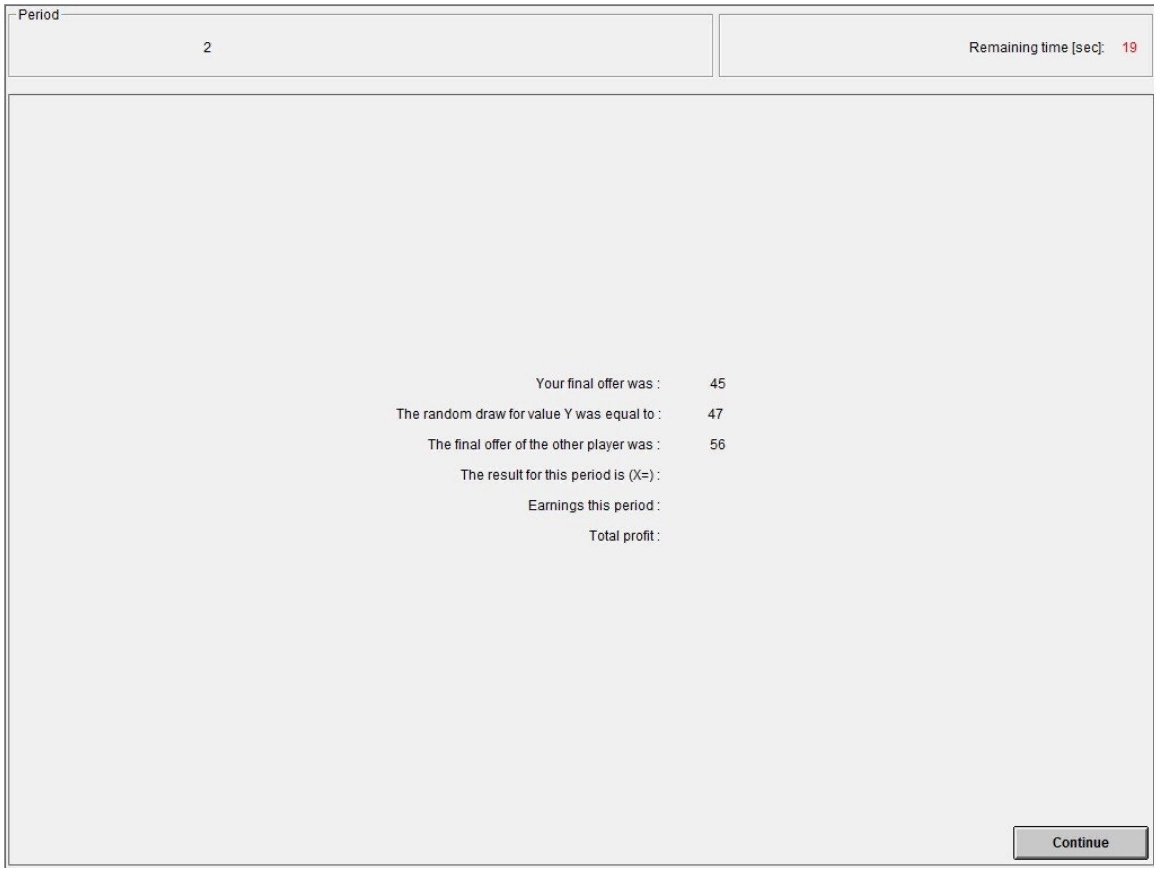
To give you some information about this random number generation procedure, the next table shows you 100 values of Y using the exact same method that will be used in your case. The order of these 100 values of Y is irrelevant.

Again, if you and your counterpart have not reached an agreement by the end of the period, you will be prompted for a final offer. If your final offers still do not indicate an agreement (i.e. Player A’s offer is greater than player B’s offer), then the same random number generation procedure that chose these 100 values of Y will be used to determine your value of X for that period.

100 random draws of Y									
461	494	531	543	499	546	503	458	521	506
487	496	522	510	495	477	455	457	525	498
510	545	491	477	519	511	478	515	493	442
607	542	509	541	533	493	468	495	506	487
583	543	476	449	533	534	571	494	465	446
460	520	527	497	474	467	482	543	466	525
591	464	466	493	502	501	522	509	503	473
522	522	468	510	464	517	494	506	522	503
498	549	476	509	467	533	527	548	578	484
521	515	412	474	500	546	477	476	480	509

Before you start the decision-making periods regarding value of X, you will have to answer to couple of quiz questions about these instructions. The answers for these questions will NOT affect your earnings and they are just to be sure that you understood the instructions.

This procedure for addressing situations with no agreement at the end of the period will continue until you are otherwise notified. If you have any questions before starting this set of periods, please raise your hand now.


Period
2
Remaining time [sec]: 19
Your final offer was : 45
The random draw for value Y was equal to : 47
The final offer of the other player was : 56
The result for this period is (X=) :
Earnings this period :
Total profit :
Continue

Personal Record Sheet

Period										
Your final offer										
Agreement (Yes/No)										
Counterpart final offer										
Result of the period										
Earnings this period										
Total profit										

CHAPTER 4. FAIRNESS AND ARBITRATION MECHANISMS

4.1 Introduction

In this paper I present a model of an arbitration mechanism that includes inequality aversion between disputants. Previous theoretical models show that for different arbitration mechanisms, two risk-neutral disputants with identical beliefs about the choice of the arbitrator as a fair settlement will reach an agreement. In my model, if the two disputants are inequality-averse, as in Fehr & Schmidt (1999), and if they have optimistically biased beliefs about the size of the pie that they try to split, they will not reach an agreement. Thus, inequality aversion might explain the low agreement rates observed in laboratory experiments for different arbitration mechanisms.

In the literature on arbitration mechanisms there are different explanations as to why mechanisms that are designed to help two disputants reach an agreement do not always reach their goal. Stevens (1966) says the Conventional Arbitration (CA) gives the two disputants the incentive to make final offers that diverge instead of converge because the arbitrator usually splits in two the difference between these final offers. To eliminate this incentive, Stevens (1966) proposes Final Offer Arbitration (FOA). Ashenfelter at al. (1992) conduct a laboratory experiment and show that FOA has lower agreement rates than CA. Brams and Merrill (1983) show for FOA that if the two disputants are risk-neutral and the fair settlement of the arbitrator is a random draw from a known distribution function, the final offers do not converge to an agreement and thus the two disputants do not reach an agreement by themselves. Brams and Merrill (1983) show for different distribution functions that the final offers are almost two standard deviations apart. As a conclusion, Brams and Merrill (1986) propose Combined Arbitration (CombA), which is a combination between CA and FOA. The theoretical prediction for this arbitration mechanism is that if the two disputants are risk-neutral, the final offers converge to the median of the distribution function that describes the beliefs about the fair settlement of the arbitrator. Other arbitration mechanisms, such as Double-Offer Arbitration (DOA) proposed by Zeng et al. (1996) and Amended Final Offer Arbitration (AFOA) proposed by Zeng (2003) have a similar theoretical prediction. Zeng (2003) also proposes a more general case of AFOA called Alpha-Final Offer Arbitration (α-FOA).

To my knowledge these new mechanisms have not been applied in the field, but laboratory experiments such as the one described in Chapter 2 and other studies (Dickinson (2004), Dickinson (2005), Deck et al. (2007)) show that the agreement rate is much lower than the predicted one. An explanation for this lower agreement rate is that the models assume that the disputants are risk-neutral and that they have identical expectations about the arbitrator's choice of the fair settlement. Dickinson (2003) shows how the existence and the size of the contract zone (the region of outcomes that is mutually preferred to arbitration with certainty by disputants) depends on the risk preferences of the disputants and on their beliefs about the choice of the fair settlement of the arbitrator. Dickinson (2003) also shows that the disputants might fail to reach an agreement because of these two factors. Dickinson (2009) conducts a laboratory experiment to study the effect of these two factors and concludes that both of them can decrease the agreement rate.

The Chapter 3 experimental paper ranks the subjects on their risk preferences in order to avoid situations in which the contract zone does not exist, and in which there is thus no agreement between disputants. The variance of the distribution function that describes the arbitrator's fair settlement is low in this experiment in order to induce disputants to have identical beliefs about the arbitrator's choice of a fair settlement. But even controlling for these two factors, the agreements rate for α-FOA is very low for the more risk-averse group of subjects compared to the theoretical prediction: around 35% instead of 100%.

In most experimental studies there is also a treatment called *No Arbitration* that does not involve arbitration and in which the disputants receive a payoff of $0 if they do not reach an agreement by themselves. The theoretical prediction is that the disputants should reach an agreement 100% of the time, and that they should accept any offer made by their counterpart. However, even for this treatment, which does not involve risk or an arbitrator and beliefs about her choices of a fair settlement, the agreement rate is still lower than predicted. In this study, as in most previous experimental studies, the agreement rate is around 75%. This indicates that in addition to factors such as type of arbitration, risk preferences of the disputants or their beliefs about the arbitrator's choice of a fair settlement, there are also other factors that influence the outcome of the dispute.

Results from other bargaining games, like an ultimatum game, have similar deviation from predictions of the standard model. Different papers like Fehr & Schmidt (1999) or Cox et al. (2007) use different social preferences to explain these differences.

In the model of this paper I include inequality aversion as another explanatory factor for the lower agreement rates achieved by proposed arbitration mechanisms. If the utility function takes into account the inequality aversion and the disputants have optimistically biased beliefs about the size of the pie, the final offers of the two risk-neutral disputants do not lead to an agreement anymore. However, this result holds only under the non-standard assumption that the inequality aversion coefficient has different values if the outcome is the result of the negotiation rather than is the result of arbitration. Although the Cox et al. (2007) model allows some flexibility for the emotional state function and avoids such an assumption, this model does not offer tractable solutions for this application.

4.2 Literature review

The *No Arbitration* treatment is similar to a strike. There are two disputants who have a period of negotiation to agree upon the value of a variable X. The value of variable X determines how the economic pie is split between the two disputants. For one disputant higher values of X imply better payoffs, while for the other disputant lower values of X imply better payoffs. If the two disputants do not reach an agreement once the negotiation period is over, their payoff is equal to $0. Because of strategic effects in a game that is played more than once between the same disputants, the optimal strategy might be not to accept any offer made by the counterpart, which leads to no agreements in early periods of the game. However, in a one-shot game if any strictly positive payoff is offered, the two disputants should reach an agreement, as any agreement will result in a better payoff than $0. The results from experiments show that in such situations there are more than 20% of disputes in which the two disputants do not reach an agreement.

Such disagreements cannot be explained by the risk preferences of the subjects or by their beliefs about the choice of the arbitrator like in the other treatments. One factor that might explain these disagreements is inequality aversion.

Güth et al. (1982) conduct the first experiment of a simplified version of an *ultimatum game*. The game has two players (proposer and responder) and two stages. In the first stage player 1 (the proposer) receives an amount of money and has to decide how much she will keep and how much she will give to player 2 (the responder). In the second stage player 2 can keep the amount received or reject it. If she rejects the offer, both players receive a payoff of $0. The subgame perfect equilibrium prediction is the player 1 offers nothing (or almost nothing) and player 2 accepts any positive offer. Contrary to the theoretical prediction, in most of the economic experiments involving the ultimatum game, player 1 offers on average 30%-40% of the pie with the mode at 50% and player 2 often rejects offers below 20% (Camerer et al. (1995)).

Forsythe et al. (1994) run an experiment to explain if the difference between experimental results and theoretical predictions can be explained by strategic behavior or by fairness. In one treatment the subjects play a dictator game instead of the ultimatum game. The dictator game is a modified version of the ultimatum game, in which player 1's split of the pie is the final outcome of the game and player 2 does not have any choice. The distributions of offers in the two treatments (dictator game and ultimatum game) are different, which implies that fairness cannot explain the entire difference between the experimental outcomes and the theoretical predictions in ultimatum games. In the dictator game the amount offered by player 1 moves towards the theoretical prediction. On the other hand player 1 still offers nontrivial amount of money, which implies that there are social preferences that lead player 1 to offer a positive amount to player 2.

Güth et al. (1998) conduct a similar experiment in which they try to distinguish between strategic behavior and fairness by changing the information that player 2 receives. Their experiment is similar to the ultimatum game but includes 3 players: the proposer, the decider and a passive player. In the first stage player 1 decides how to split the pie between the three of them. A message is sent to the decider about the split of the pie and player 2 decides to accept or reject the offer. The difference between treatments is the information that the message contains. In one treatment (full information) the message has the shares of the pie for each player. In the second treatment (essential information) the message contains only the share for player 2 and in the last treatment (irrelevant information) the message contains only the share for player 3 (the passive player). The results of the experiment show that the proposer offers only marginal amounts to the passive players and small shares to the decider in the irrelevant information treatment. One of the authors' conclusions is similar to the one from the dictator game: high offers in the ultimatum game are not entirely because of fairness, but rather because the proposer tries to appear fair. However, the proposers are not completely selfish.

To explain why in certain situations, such as the ultimatum game, a public goods game with punishments, or gift exchange games standard self-interest models cannot explain the empirical results, Fehr and Schmidt (1999) consider inequality aversion. Their utility function includes two types of inequality aversion. For a two-player case, a person has a decrease in her utility function if her payoff is smaller than the other person and also has a smaller decrease in her utility function when her payoff is bigger than the payoff of the other person:

$$U_i(x_i, x_j) = x_i - \alpha_i \max\{x_j - x_i, 0\} - \beta_i \max\{x_i - x_j, 0\}, \quad i \neq j \tag{1}$$

The authors assume $\beta_i \leq \alpha_i$ and $0 \leq \beta_i \leq 1$.

The assumption $\beta_i \leq \alpha_i$ implies that a person has a stronger dislike for a disadvantageous split of the pie than an advantageous split of the pie. The assumption $0 \leq \beta_i$ implies that there are not subjects that get some positive utility from being better off than the counterpart. The assumption $\beta_i \leq 1$ implies that there are not subjects that are willing to give up more than $1 in order to reduce the difference by $1. Situations in which there are subjects that break these three assumptions are very implausible.

One important result of the paper is that in a market with competition, such as in an ultimatum game with multiple proposers or multiple responders, the inequality aversion effect disappears and the outcome is similar to the standard model of self-interested agents. Another result is that, given that the proposer has beliefs about her opponent's parameter α_j and given that these believes are described by a discrete distribution - which is consistent with previous experimental results - it is possible to calculate the optimal offer of the proposer as a function of her own parameter β_i. The result shows that it is not optimal to offer less than 33% of the pie even if the proposer is completely selfish. This is consistent with the results from experiments that show that offers below 25% are rare. Furthermore, the value of the parameter β_i can be elicited using the dictator game. List (2007) mentions that "the dictator game represents the workhorse within experimental economics, frequently used to test theory and provide insights into the prevalence of social preferences."

While this model takes into account the final outcomes of the two players, it does not take into account other factors, such as player intentions toward the counterpart (hostile or kind, self-interested or not) or the institution of the game, which might change the two players' behavior.

Blount (1995) investigates the ultimatum game in a setting in which the opponent is non-human (the choice of the opponent is a random draw made by a computer) and in which the choice of how to split the initial amount is made by a neutral-third party (with no self-interest), as opposed to a self-interested player, as in the standard game. In her experiment the subjects receive a 3- or 4-page instruction which includes three questions. The subjects have to complete each page before they moved to the next one. The first page explains the ultimatum game to the students. For each treatment, player 1 is a self-interested person, a neutral third-party or a computer-simulated player. The first treatment of the experiment is a standard ultimatum game. Two subjects are randomly matched and randomly assigned as a player 1 ("proposer") or player 2 ("decider"). Player 1 decides how to split $10 between them and player 2 decides to accept or reject the offer. In the second treatment the two subjects are randomly matched, but the decision of how to split the $10 between the two subjects is made by a neutral-third party and not by player 1. Player 2 still can accept or reject the offer. In the last treatment the neutral third-party is replaced by a lottery that has equal probability for each possible allocation of the endowment between the two subjects.

Page 2 has a question related to the beliefs of the subjects about how the offers will be distributed across all possible outcomes if 100 players are in the situation described by that specific treatment. On page 3 subjects have to write the minimum offer that they would accept if they were randomly assigned as player 2 ("decider"). For the first treatment there is also a fourth page on which the subjects have to write what offer they would make if they were randomly assigned as player 1 ("proposer").

The third treatment has a lower mean of minimum acceptable outcomes than the other two treatments ($1.20 compared to $2.91 in treatment 1 and $2.08 in treatment 2). Tests show that there is a statistically significant difference in means.

List (2007) and Bardsley (2008) show that institution in a dictator game is very important. Both papers offer a set of choices for player 1 which includes the action of taking money from player 2's initial endowment. List (2007) extends Bardsley (2008)'s design by introducing another origin of the initial endowment (in one treatment the subjects perform a task in order to earn their initial endowment) and by varying the maximum amount of money that player 1 can take from player 2. Both authors find that such manipulations in the set of actions change the behavior of the subjects. However, as in previous studies, no matter what the set of actions is, the subjects do not choose the most selfish outcome.

The main assumption of my model is related to the change in institutions between the negotiation stage and arbitration. During negotiation, if an agent accepts an offer she takes into account the split of the pie offered by her counterpart (who is seen as a self-interested person). If she goes for arbitration, she takes into account the split of the pie that is determined by the arbitrator (a random draw in arbitration experiments). Because of this change in the institution of the game, I assume that each agent has different inequality aversion coefficients (α_i) during the two stages.

One difference between a standard ultimatum game and arbitration is related to the information about the size of the pie. In most ultimatum games both players know exactly the size of the pie that they should split. In contrast, in arbitration, the subjects generally only have information regarding their own payoff. When a firefighter negotiates his contract, he does not know what the size of the pie is. He only has beliefs regarding what a fair wage for him is. The same situation occurs with an injured person that asks for compensation. In laboratory experiments each player has information about her payoff function, but not the counterpart's payoff function. Kagel et al. (1996) examine an ultimatum game with incomplete information. In this experiment two subjects participate in an ultimatum game and have to split a number of chips. These chips have different conversion rates for player 1 and player 2. Because of these conversion rates the experimenter is able to offer information about the payoff functions to one of the players or to both players. Depending on which player receives information about the conversion rates, the amount offer by player 1 and the rejection rates vary.

The case of *No Arbitration* treatments in which the two subjects do not reach an agreement during negotiation and need to submit final offers is similar to the social dilemma called the *resource dilemma*. The resource dilemma has the following setting: there are n players and a common resource of size x. Each player makes her request r_j from this resource. After all members make their request, if $r_1 + r_2 + r_3 + \cdots + r_n \leq x$, each of the subject receives her request. Otherwise, each of them receives nothing. As in the situation described in the previous paragraph, incomplete information about the size of the pie leads to lower provision rates (which is similar to higher disagreement rates).

Budescu et al. (1992) conduct an experiment involving a resource dilemma with simultaneous or sequential requests with incomplete information about the size of the resource. The Nash equilibrium solution for the simultaneous game with uncertainty about the size of the resource is derived by Rapoport and Suleiman (1992). The simultaneous request setting for two players is exactly like the final offers stage of the *No Arbitration* treatment in an arbitration experiment. In their experiment there are groups of five subjects. The size of the resource is drawn from a uniform distribution defined on the closed interval $[\alpha, \beta]$. There are three distributions: $\alpha = \beta = 500$, $\alpha = 250, \beta = 750$ and $\alpha = 0, \beta = 1000$. One result of this paper is that increasing the uncertainty of the size of the resource leads to lower provision rates. This result, together with the result of Kagel et al. (1996), suggests that disagreement in disputes solved by an arbitration mechanism should also depend on information that the subjects have about the size of the pie.

4.3 The model

Theoretical papers about arbitration mechanisms assume that the disputants are risk-neutral and they prove if the two disputants' final offers converge to reach an agreement or not. The literature has found that for DOA, CombA and α-FOA, two risk-neutral disputants will reach an agreement by themselves. In the following model I include also the inequality aversion. I calculate the certainty equivalent for α-FOA and CA (the most promising arbitration mechanisms), and show that, contrary to previous theoretical predictions, the two disputants do not always reach an agreement by themselves.

Consider a setting in which there is a "seller" and a "buyer" who negotiate over the value of a variable x. For the seller, higher values of x increase her utility function, while for the buyer lower values of x increase her utility function. If the buyer and seller do not reach an agreement after a period of negotiation, one of the arbitration methods (either α-FOA or CA) is applied. Under arbitration, the fair settlement of the arbitrator is a random draw from a distribution function with cumulative distribution $F(z) \sim (-\infty, \infty)$ continuous. Both disputants are risk-neutral and exhibit inequality aversion, so that their utility function is described by Fehr and Schmidt's (1999) utility function:

$$U_i(x_i, x_j) = x_i - \alpha_i \max\{x_j - x_i, 0\} - \beta_i \max\{x_i - x_j, 0\}, \quad i \neq j \ , i = S, B \tag{2}$$

where $\beta_i \leq \alpha_i$ and $0 \leq \beta_i \leq 1$.

Given this utility function I calculate the certainty equivalent for the seller and buyer under α-FOA and CA. I then compare the two final offers, x_i^{CE} ,to see if these values indicate that the two disputants have reached an agreement or not.

For α-FOA Zeng (2006) proves that two x_S, x_B offers form an equilibrium if and only if $x_S = x_B = s$ and:

$$U_S(x_S) \geq \int_{-\infty}^{\infty} U_S\big((1+\theta) \cdot z - \theta \cdot x_S\big) \cdot f(z) dz \tag{3}$$

$$U_B(x_B) \geq \int_{-\infty}^{\infty} U_B((1+\theta) \cdot z - \theta \cdot x_B) \cdot f(z) dz \tag{4}$$

The value of x_S that makes equation 2 hold with equality is the seller's certainty equivalent x_S^{CE} (the value that makes her indifferent between arbitration and accepting that offer). Similarly, there is a certainty equivalent for the buyer x_B^{CE} . When the two values of the certainty equivalent are compared, if $x_S^{CE} > x_B^{CE}$ then there is no value s that satisfies (3) and (4), and thus there is no equilibrium strategy (i.e. the two disputants do not reach an agreement).

Assumption 1: The two disputants have different coefficients of inequality aversion α_i when they consider an outcome as a result of an offer from the counterpart (α_i^C) compared to an outcome as a result of a choice of the arbitrator (α_i^A), and $\alpha_i^C > \alpha_i^A$.

The inequality $\alpha_i^C > \alpha_i^A$implies that an agent is willing to accept a lower offer from arbitration (a random draw) than from her counterpart.

Assumption 1 is crucial to these results. This assumption is non-standard in the literature on inequality aversion. A different approach, which would avoid such an assumption, would be to use the Cox et al. (2007) model of reciprocity and fairness. Unfortunately, the Cox et al. (2007) model does not offer tractable solutions for this application. I include a more detailed discussion of this approach at the end of this section. However, Fehr and Schmidt's (1999) model with this assumption is similar to the Cox et al. (2007) model in which $\alpha = 1$ (where α is the coefficient from the Cox et al. (2007) model that describes the curvature of the indifference curve) and in which the emotional state function $\theta(r, s)$ takes two values: α_i^A if the outcome if determined by the arbitrator and α_i^C if the outcome is determined by negotiations. This can be viewed as an attempt to capture social preferences related to the manner in which the final outcome is obtained.

Thus, despite the fact that the assumption of varying α's is not common in the literature, it is closely related to previous work employing an emotional state function, as described above.

Given that the size of the pie that the two disputants try to split is π, and that $\pi = x_S + x_B$, the utility function for the "seller" is:

$$U_S(x_S) = \begin{cases} x_S - \beta_S \cdot (2x_S - \pi), & if\ \pi < 2x_S \\ x_S - \alpha_S \cdot (\pi - 2x_S), & if\ \pi \geq 2x_S \end{cases} \tag{5}$$

Case 1: $\pi \geq 2x_S$

As described in Chapter 2, α-FOA is similar to a second-price auction. If the two disputants do not reach an agreement during the negotiation stage, they must submit their final offers. If these final offers still do not imply an agreement, then the arbitrator makes her choice of a fair settlement. The disputant that has the final offer closest to this fair settlement wins the arbitration. The final outcome of the arbitration depends on the value of the fair settlement of the arbitrator and on the final offer of the loser of the arbitration. The equation that gives the value of the final outcome is the following:

$$final\ outcome = z\ \pm \alpha \cdot |z - x_{loser}| \tag{6}$$

where z is the arbitrator's fair settlement value and x_{loser} is the final offer of the loser. The sign is positive if the winner is the seller and negative if the winner is the buyer. The CA's final outcome is equal to the value of the fair settlement, so that CA is a degenerate case of α-FOA, where $\theta = 0$. Thus, for this model I consider the more general case of α-FOA.

The certainty equivalent for α-FOA is given by the following equality:

$$U_S(x_S) = \int_{-\infty}^{\infty} U_S((1+\theta)\cdot z - \theta \cdot x_S)\cdot f(z)dz \tag{7}$$

where $f(z)$ is the distribution function that describes the beliefs about the arbitrator's choice of the fair settlement.

Observation: Fehr and Schmidt (1999) and Zeng (2003) each use α as a parameter, but with different meanings. In order to avoid confusion, I change Zeng's (2003) notation from α to θ.

$$U_S(x_S) = x_S - \alpha_S^C \cdot (\pi - 2x_S) = (1+2\alpha_S^C)\cdot x_S - \alpha_S^C \cdot \pi \tag{8}$$

$$\int_{-\infty}^{\infty} U_S((1+\theta)\cdot z - \theta \cdot x_S)\cdot f(z)dz =$$

$$= \int_{-\infty}^{\infty} \left[(1+2\alpha_S^A)\big((1+\theta)z - \theta \cdot x_S\big) - \alpha_S^A \cdot \pi\right]\cdot f(z)dz$$

$$= (1+2\alpha_S^A)\cdot(1+\theta)\cdot E - (1+2\alpha_S^A)\cdot\theta\cdot x_S - \alpha_S^A\cdot\pi \tag{9}$$

where E is the expected value of $f(z)$.

To calculate the certainty equivalent, I set equation (8) equal to equation (9):

$$(1+2\alpha_S^C)\cdot x_S - \alpha_S^C\cdot\pi = (1+2\alpha_S^A)\cdot(1+\theta)\cdot E - (1+2\alpha_S^A)\cdot\theta\cdot x_S - \alpha_S^A\cdot\pi$$

Solving for x_S , the certainty equivalent is:

$$x_S^{CE} = \frac{(1+2\alpha_S^A)\cdot(1+\theta)}{\big(1+2\alpha_S^C+\theta\cdot(1+2\alpha_S^A)\big)}\cdot E + \frac{\alpha_S^C-\alpha_S^A}{\big(1+2\alpha_S^C+\theta\cdot(1+2\alpha_S^A)\big)}\cdot\pi \tag{10}$$

In the CA case ($\theta = 0$) the certainty equivalent is equal to:

$$x_S^{CE} = \frac{(1+2\alpha_S^A)}{(1+2\alpha_S^C)}\cdot E + \frac{\alpha_S^C-\alpha_S^A}{(1+2\alpha_S^C)}\cdot\pi \tag{11}$$

If subjects do not exhibit inequality aversion ($\alpha_S^A = \alpha_S^C = 0$) the solution is $x_S^{CE} = E$ for both types of arbitration. Using the same logic for the buyer results in $x_B^{CE} = E.$ This implies that $x_S^{CE} = x_B^{CE} = E.$ So there is a value $s = E$ that satisfies the conditions from Zeng (2006) for an equilibrium offer. The same result holds when the *Assumption 1* is broken ($\alpha_S^A = \alpha_S^C$). This result is due to the fact that if the subjects exhibit inequality aversion and $\alpha_S^A = \alpha_S^C = \alpha_S$, the utility function takes a different functional form than $U_S(x_S) = x_S$, but is still a utility function for a risk-neutral person. As Zeng (2006) shows, $s = E$ is a Nash equilibrium strategy for any general utility function that describes a risk-neutral person.

Given *Assumption 1*, x_S^{CE} can still be equal to E. Assuming that $\alpha_S^A \neq \alpha_S^C$, $x_S^{CE} = E$ if equation (10) is equal to E:

$$\frac{(1+2\alpha_S^A)\cdot(1+\theta)}{\left(1+2\alpha_S^C+\theta\cdot(1+2\alpha_S^A)\right)}\cdot E + \frac{\alpha_S^C-\alpha_S^A}{\left(1+2\alpha_S^C+\theta\cdot(1+2\alpha_S^A)\right)}\cdot \pi = E \tag{12}$$

Solving for π results in $\pi = 2\cdot E$. This implies that the two disputants still reach an agreement by themselves if the arbitrator's expected choice of fair settlement is not biased towards one of the disputants: $E = \frac{\pi}{2}$. This is possible due to the fact that even if the utility function is $U_S(x_S) = x_S - \alpha_S\cdot(\pi - 2x_S)$, if $E = \frac{\pi}{2}$, the second term of the function that involves inequality aversion is equal to 0.

However if the seller has optimistically biased beliefs about the size of the pie $\pi^{bias} = \pi + \varepsilon$, even if the arbitrator's choice is not biased, replacing π with π^{bias} results in:

$$x_S^{CE} = E + \varepsilon\cdot\frac{\alpha_S^C-\alpha_S^A}{\left(1+2\alpha_S^C+\theta\cdot(1+2\alpha_S^A)\right)} > E \tag{13}$$

By symmetry, it implies that the buyer also wants a share of the pie bigger than E. Because $x_S^{CE} > x_B^{CE}$, there is no s to satisfy equations (3) and (4). In this case the two disputants do not reach an agreement by themselves.

It worth mentioning that this is a different type of biased beliefs than the one described by Dickinson (2003). Dickinson (2003) assumes that the disputants have biased beliefs about the choice of a fair settlement of the arbitrator. In other words, there are two different distribution functions $f_S(z)$ and $f_B(z)$ that describe this fair settlement. Even if the two disputants choose to play the Nash equilibrium strategy - which is the expected value of the distribution function that describes their own beliefs - it might be the case $E_S > E_B$. In such a case, the two disputants will not reach an agreement. This is the case when the disputants have optimistic beliefs about the choice of the fair settlement. In this model the two disputants have the same beliefs about the distribution functions $f_S(z) = f_B(z) = f(z)$ that describe this fair settlement. But because the disputants are now inequality-averse, they also have beliefs about the size of the pie. If the disputants have optimistically biased beliefs about the size of the pie, then it results in no contract zone, and thus in no agreement.

However, it is not necessary for both players to have biased beliefs about the size of the pie in order not to reach the agreement. For example, without loss of generality if only the buyer knows the size of the pie ($\pi^{bias} = \pi$) , it results in $x_B^{CE} = E$. But $x_S^{CE} > E$, so the two disputants still do not reach an agreement.

Proposition 1: If the 2 disputants have different coefficients of inequality aversion α_i with $\alpha_i^C > \alpha_i^A$, and if at least one of the disputant has optimistically biased beliefs about the size of the pie, the two risk-neutral disputants do not reach an agreement under α-FOA.

As I mention in Section 1 of this chapter, in real cases and in most arbitration laboratory experiments, the disputants do not know the size of the pie that they have to split. In the experiment presented in Chapter 3 the sellers and the buyers have information about their own payoff functions but do not have any information about the payoff function of the counterpart. This result is similar to what Kagel et al. (1996) find for an ultimatum game and Budescu et al. (1992) find for a resource dilemma when subjects do not have perfect information about the size of the pie.

This result can explain why in the *No Arbitration* treatment subjects prefer a payoff of $0 to an offer that they might think represents an unfair split of the pie. It can also can explain why risk-neutral subjects do not reach an agreement under α-FOA and choose instead to go to arbitration.

In the case when the arbitrator's choice of fair settlement is biased in the sense that the seller gets an expected share of the pie less than $\frac{1}{2}$ $(E < \frac{\pi}{2}\ or\ \pi = 2 \cdot E + \varepsilon)$, using the same logic as above implies $x_S^{CE} = E + \varepsilon \cdot \frac{\alpha_S^C - \alpha_S^A}{\left(1+2\alpha_S^C+\theta\cdot(1+2\alpha_S^A)\right)} > E$. But in this case the buyer gets an expected value from arbitration equal to $\pi - E > \frac{\pi}{2}$. This implies that, for the buyer, $\pi < 2x_B$and $U_B(x_B) = x_B - \beta_B \cdot (2x_B - \pi)$. Calculating her certainty equivalent in this situation results in:

$$x_B^{CE} = \frac{(1-2\beta_B^A)\cdot(1+\theta)}{(1-2\beta_B^C+(1-2\beta_B^A)\cdot\theta)}\cdot E + \frac{\beta_B^A-\beta_S^C}{(1-2\beta_B^C+(1-2\beta_B^A)\cdot\theta)}\cdot\pi$$

$$= E - \varepsilon\cdot\frac{\beta_B^A-\beta_S^C}{(1-2\beta_B^C+(1-2\beta_B^A)\cdot\theta)} \tag{14}$$

In this situation it is ambiguous if $x_S^{CE} < x_B^{CE}$ and if there is any value s that satisfies equations (3) and (4) because there is no argument that suggests if $\frac{\beta_B^A-\beta_S^C}{(1-2\beta_B^C+(1-2\beta_B^A)\cdot\theta)}$ has a positive or negative sign. Even if it has a positive sign (implying that the buyer will have a certainty equivalent similar to the one in figure 3.2), whether or not there is a contract zone depends on relative size of $\frac{\alpha_S^C-\alpha_S^A}{(1+2\alpha_S^C)}$ compared to $\frac{\beta_B^A-\beta_S^C}{(1-2\beta_B^C+(1-2\beta_B^A)\cdot\theta)}$. It can be shown, however, that when $\beta_B^A = \beta_B^C$, $x_B^{CE} = E$ so there is no contract zone and the two disputants will not reach an agreement.

Proposition 2: In the case when the arbitrator's choice of fair settlement is biased and the two disputants have different coefficients of inequality aversion α_i, with $\alpha_i^C > \alpha_i^A$, it is ambiguous if there is a contract zone or not under α-FOA. If $\beta_B^A = \beta_B^C$, then there is no contract zone, so that the two disputants do not reach an agreement.

For the case of CA the results hold, because, as mentioned above, CA is the case of case of α-FOA where $\theta = 0$.

Case 2: $\pi < 2x_S$. This case is the situation presented in the previous paragraphs but reversing the role of the seller and buyer.

As noted above, Assumption 1 is not common in the literature. As such, I would like to relax this assumption if possible. However, as I will now describe, relaxing this assumption by using the Cox et al. (2007) model of reciprocity and fairness leads to an intractable solution for the certainty equivalent. This solution does not provide a functional form that allows one to make any predictions regarding the value of the certainty equivalent relative to the expected value of the distribution function that describes arbitrator's choice of fair settlement. It is therefore impossible to determine whether or not a contract zone exists. Thus, I believe Assumption 1 is necessary to make progress on the questions of interest.

Cox et al. (2007) consider a two-player game with perfect information. The first mover, F receives a payoff y and the second mover S receives a payoff m. The utility function of S has the following functional form:

$$u(m,y) = \begin{cases} \dfrac{(m^{\alpha} + \theta y^{\alpha})}{\alpha}, \alpha \in (-\infty, 0) \cup (0,1] \\ \quad my^{\alpha}, \qquad \alpha = 1 \end{cases} \tag{15}$$

where θ is the emotional state of the player and is a function of status s and reciprocity r. Reciprocity is $r(x) = m(x) - m_0$ where $m(x)$ is the maximum payoff the second mover can guarantee himself when the first mover chooses x and $m_0 = m(x_0)$, where x_0 is neutral in some appropriate sense. In addition to the curvature of the utility function, one difference between this and the Fehr and Schmidt (1999)'s model comes from the fact that Cox et al. (2007) assume that a player gains utility from his own income, and either gains utility or is neutral regarding the other player's income.

In arbitration both players make offers or accept offers, so there is no first or second mover. This assumption is important in order to determine the functional form for status s and reciprocity r. One might make the assumption that in the last moment of negotiation both players are second movers because they have the time to accept the offer of the counterpart, but not to make additional counteroffers. Given this assumption the next step is to calculate the certainty equivalent for each player. This implies solving the following integral:

$$\int_{-\infty}^{\infty} \frac{\{[(1+\gamma)z-\gamma m]^{\alpha}+\theta(r,s)\cdot[\pi-(1+\gamma)z+\gamma m]^{\alpha}\}}{\alpha}\cdot f(z)dz \tag{16}$$

Because of the coefficient α, which describes the curvature of the utility function, the integral does not offer a tractable solution. To obtain a convenient form for utility function, consider $\alpha = 1$, which implies linear utility curves, similar to Fehr and Schmidt (1999). In this case the utility function proposed by Cox et al. (2007) becomes similar to the utility function Fehr and Schmidt (1999) when $x_i > x_j$:

$$u(m,y) = m + \theta(r,s)\cdot y \tag{17}$$

$$u(x_i,x_j) = (1-\beta_i)\cdot x_i + \beta_i \cdot x_j \tag{18}$$

Further it is important to describe the functional form of the emotional state function $\theta(r,s)$. Because both players are second movers, there is no difference in status between players, which implies $s = 0$. The reciprocity variable is $r(x) = m(x) - m_0$. While m_0 is a parameter of the model, $m(x)$ represents the maximum that a player can obtain when the counterpart offered him x. In this application, under the assumption that there is no time for a counteroffer, a player that has received an offer of x can obtain no more than x, so $r(x) = x - m_0$. This functional form is the same assumed by Cox et al. (2007) for the ultimatum game. This implies that the emotional state function is equal to $\theta(r,s) = a(x - m_0)$. Under these assumptions integral (16) can be solved. However, the solution for the certainty equivalent does not offer a closed-form solution that is comparable with the expected value. Thus it is impossible to determine whether or not there is a contract zone.

Using various parameters values, such as those from Chapter 3 and values estimated by Cox et al. (2007)), I am able solve the model numerically. However, the numerical results do not offer a reasonable economic interpretation. I thus conclude that while the model of Cox et al. (2007) does not need Assumption 1, this model does not offer a tractable solution for my application.

4.4 Conclusion

Under the arbitration mechanisms of DOA, CombA and α-FOA two risk-neutral disputants should reach an agreement according to existing theory. However, laboratory experiments show that all three mechanisms offer low agreements rates and that only α-FOA is able to obtain higher agreements rate than CA. These low agreements rates cannot be fully explained by the risk preferences of the disputants or by their optimism about the arbitrator's choice of the fair settlement. This idea is supported by the fact that in the *No Arbitration* treatment described in Chapter 3 and similar studies the disputants do not reach an agreement and prefer a payoff of \$0 even if any amount offered by the counterpart is better than \$0.

In this paper I propose separate factor that can change subjects' behavior and prevent them from reaching an agreement: inequality aversion. The model described in this paper includes inequality aversion and assumes that disputants have different coefficients of inequality aversion when they consider an outcome as the result of an offer from the counterpart rather than the result of a choice of the arbitrator. The model predicts that under α-FOA or CA two risk-neutral disputants will not reach an agreement if at least one of them has optimistically-biased beliefs about the size of the pie that they will share. This is contrary to the previous predictions of theoretical models that do not include inequality aversion, and offers a possible explanation for the low agreement rates observed in experimental settings.

As in most of the papers about arbitration mechanisms, this one assumes that the disputants are risk-neutral, while in fact some of the subjects are risk-averse. While assuming that the subjects are risk-averse might not change the existence of a contract zone, the size of the contract zone may differ when the model includes risk aversion and inequality aversion. Future research should try to compare the size of the contract zone under α-FOA or CA when the model takes into account risk aversion and inequality aversion with the contract zones from Zeng (2006).

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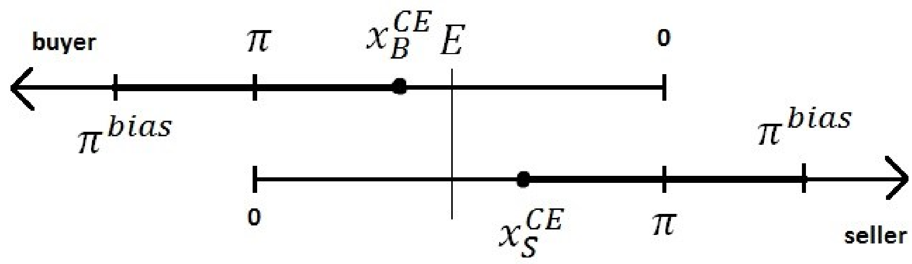

Figure 4.1 The certainty equivalent in case of biased beliefs about the size of the pie

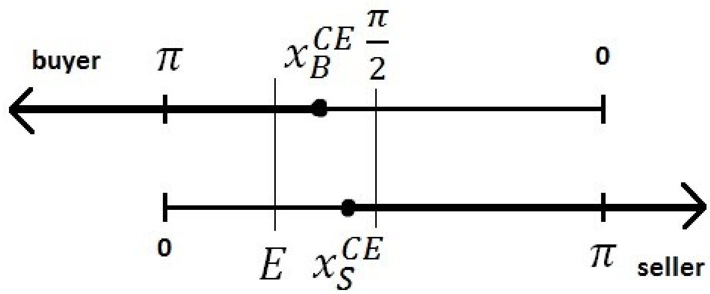

Figure 4.2 The certainty equivalent in case of biased choice of the arbitrator

CHAPTER 5. PRICE STRUCTURE IN A TWO-SIDED MARKET MONOPOLY – AND ECONOMICS EXPERIMENT

5.1 Introduction

The network effects literature (Katz and Shapiro (1985, 1994)) shows that due to externalities, the utility generated by the consumption of a good might depend on the number of consumers of that good. When a person buys a telephone, that person will take into account the number of people that have telephones. She does not get any utility from the telephone if no one else uses them. There are also post-purchase externalities. People who would like to purchase a car would like to have access to auto parts and auto repair shops. A person has a better chance to find auto parts if more consumers bought the same model as she did. One of the main assumptions in this literature is that only one type of consumer exists and the network effects affect only this type of consumer. However, in the credit card market, for example, there are two different types of agents: merchants (the sellers) and buyers (the consumers). If more merchants accept credit cards as a method of payment, then more buyers would like to have and use credit cards. On the other hand, a larger number of buyers that hold credit cards will influence more merchants to accept credit cards as a method of payment.

Recently Armstrong (2006), Armstrong and Wright (2007), Caillaud and Jullien (2003), Rochet and Tirole (2003, 2006) and Hagiu (2009) presented theoretical models for the case of network effects with cross-group externalities. To date there is little empirical work regarding this literature (Chakravorti and Roson (2006)), other than the case of the credit card market. In one such paper, Kaiser and Wright (2006) estimated a model of competition in the magazines market using a data set that covers 18 magazine markets from Germany. My study presents the design and the results of an experiment investigating the effects of different policies in a two-sided market monopoly on the price structure and on the consumer surplus.

The optimal price structure in this type of market has specific properties that are important for policy makers. In a one-sided market a firm is not allowed by law to charge a price below cost, since a firm could adopt predatory pricing to force the competitors to exit the market or limit price to cause them to not enter the market. In a two-sided market, however, a firm might choose to charge one type of agents a price below cost in order to increase the number of this type of agents, which would lead to an increase in profit from the other type of agents. Thus, the theoretical models predict that, depending on cost and demand, the optimal price may be below cost on one side of the market even for a monopolist with no threat of new entry. The total consumer surplus (the surplus of the agents from both sides of the market) might also increase compared to the situation in which the monopolist is not allow to charge a price below cost. This indicates that policy makers should take into account the type of the market with consumption externalities, one sided or two-sided, in order to differentiate a predatory pricing strategy in a one-sided market and an optimal price structure strategy in a two-sided market. This experiment will implement a two-sided market monopoly in order to provide empirical evidence to investigate actual pricing behavior in a controlled setting. In the parameter environment of the base model, the predicted price for type A agents is 50% less then cost per-agent but the platform is able to make a positive total profit in both the short run and long run. The results from the experiment are consistent with these predictions in the sense that subjects charge a price below cost on one side of the market even if there is no threat of new entry.

The experiment also investigates the results of three different policies on the prices that a monopolist charges the two types of agents. If a policy maker does not identify the market as a two-sided market, she might prohibit prices below marginal cost. This policy would have the effect of increasing the price on the side where the price was below cost and decreasing the price on the other side of the market. Because of the increase in price on their side of the market, fewer agents on that side will join the platform. This will lead to fewer agents on the other side of the market even though the price on their side of the market decreases. In the end this policy might lead to a decrease in consumer surplus. Another constraint that the policy maker might impose is that the monopolist must charge the same price on both sides of the market. For example dating websites, like eHarmony.com or Match.com, have to charge the same price for both women and men. Especially in a market with strong cross-group externalities, this constraint leads to a strong distortion of the optimal price structure, which will lead to a decrease in total consumer surplus. The last policy that this study investigates is the effect of a tax or subsidy on price structure. In a one-sided monopolistic market an increase in cost due to a tax leads to an increase in price. If the policy maker applies a tax that leads to an increase in cost on the side of the agents that most value the other type of agents, the effect is the same as in a one-sided market: the prices on both sides of the market increase. But a tax that leads to an increase in cost on the side of the agents that value the other type of agents less leads to an increase in price on that side of the market, but a decrease in price on the other side of the market. The results of the experiment confirm these predictions.

5.2 Terminology

The platform. In this literature, the firm that helps the two types of agents to interact is called the "platform". It is common to say that the agents "join the platform" in order to explain the fact that the agents decided to buy the good or service from a particular firm that will help the agents to interact. Some examples of platforms in two sided markets are: credit card associations like VISA and MasterCard, websites like Amazon.com and eHarmony.com, and video consoles like Wii and PlayStation.

Single-homing and multi-homing. The agents can join one platform or multiple platforms. Armstrong (2006) uses the term "single-home" to describe the situation in which an agent chooses to use just one platform, and when the agent chooses several platforms, the agent is said to "multi-home". In the newspaper market, most readers will choose to read only one newspaper. So the readers single-home. But in the same market, the advertisers will like to reach all readers, so they will publish their ads in multiple newspapers. The advertisers multi-home.

Competitive bottlenecks. Depending upon whether a side of the market is single-homing or multi-homing, there are three possible situations: when both sides are single-homing, when one side is single-homing and the other is multi-homing and when both sides are multi-homing. Armstrong (2006) says that we might not expect the last case. His argument is that if one side of the market speaks both English and French, there is no reason for the other side to learn both English and French, because knowing just one of these languages is enough to interact and communicate with the other side. Indeed there are not many cases in which both sides multi-home. Armstrong (2006) refers to the case in which on side single-homes and the other multi-homes as a "competitive bottleneck". In this case, the multi-homing agents have no choice but to deal with the platform that was chosen by each single-homing agent from the other side.

5.3 Literature Review

Evans (2003a) has a review of this type of market and presents some specific businesses that are described as two-sided markets. Evans has a more detailed presentation in "The Antitrust Economics of Multi-Sided Platform Markets." Another paper that is interesting as an introduction to this field is Wright (2004). This paper presents some differences between one-sided and two-sided markets through eight fallacies that a policy maker might face if he applies one-sided logic in two-sided markets. These fallacies are illustrated through several real life examples, from reports of different institutions, including the Reserve Bank of Australia (RBA) and the Australia Competition and Consumer Commission (ACCC). The reports concern pricing rules in the credit card market and show how a wrong approach (the logic from one-sided markets) can make things worse or have no effect. The second fallacy of the paper states: "*A high price-cost margin indicates market power*" (p.47). Even in a very competitive market, if there are cross-group externalities, we can observe a high price-cost margin on one side of the market. As in Wright (2004), he uses nightclubs as an example of this phenomenon. Nightclubs will compete to attract more women that will then bring more men to join the platform by setting a lower price for women. But at the same time the platforms set a higher price for men due to the benefits that women bring to the men, not because of market power. A more balanced price structure will not necessarily attract more users to join the platform and the platform's profit may be lower. But ACCC and RBA state in their report that: "*Competitive pressures in card payment networks in Australia have not been sufficiently strong to bring interchange fees into line with costs*" (p.56). This example is also related to the third fallacy of the paper, which states: "*A price below marginal cost indicates predation.*" Using Wright's example, we can observe that even in a monopoly case, a nightclub might charge women a price below cost to increase the number of the women that attend the club. The increase in number of women will attract more men and will increase the overall profit. So a platform may charge a price below cost not because it wants to compete very aggressively against competitors, but because that it is the optimal price structure.

Genakos and Valletti (2012) also have a short review of the recent literature related to the "waterbed effect" of the price structure in mobile telephony as a two-sided market. This study has two important conclusions regarding regulating prices in two-sided markets. The first one underlines the fact that two-sided markets are special markets and policy makers should be more careful when they try to regulate such markets. On the other hand, prices in a competitive two-sided market might differ from the socially-optimal prices and require a more regulatory oversight rather than less, like in a one-sided market.

Hagiu (2007) has a similar approach, but he presents a theoretical model that studies the choice of an intermediation agent to be a "merchant" or a two-sided platform. In "merchant mode", the third-party buys the goods from the sellers and then sells them to the consumers. In "two-sided mode", the third-party just helps the sellers and the buyers to interact, without buying the goods. A good example of a firm that is a two-sided platform is Amazon.com. Although Amazon.com started to maintain its own stocks of goods, its main business is to bring together two types of agents, sellers and buyers. Amazon.com does not buy the goods, but it helps these types of agents interact and charges them different fees. The choice between being a "merchant" or a two-sided platform depends on different factors. The main ones are:

- indirect network effects between buyers and sellers; when the probability of unfavorable seller expectations if other sellers join the same platform is high enough, the merchant is able to internalize the network effects and the "merchant" mode is preferred to the two-sided platform.
- asymmetric information between sellers and the third-party; when the sellers are more efficient at distributing their own products (for example, it is impossible for eBay to have accurate knowledge about all goods' markets and all the goods that are sold on this website), then the platform is preferred to the merchant mode.
- investment incentives; the producers of the videogame console chose to be a platform and they charge the game developers royalties. They don't buy the game software from the game developers because they want to give some incentive to the game developers to improve the game. If the cost of the improvement is relatively low for the platform, then the platform might buy the game software and will choose to be a merchant.

- product complementarity/substitutability; the merchant is able to internalize the complementarity (substitutability) between sellers' products, so the merchant mode is preferred to the platform one.

The analysis and the results of Hagiu (2007) hold for monopoly. As the author mentions, a competition model should raise more strategic issues, but his paper does not analyze this situation.

Caillaud and Jullien (2001) present a basic model of intermediation. Their study focuses especially on intermediation via the internet, but the paper is a first step in approaching two-sided markets more broadly. As they mention, a more complete analysis of the equilibrium is provided by Caillaud and Jullien(2003). The latter study presents a competition model of intermediation providers (platforms). The authors consider two homogeneous populations, each consisting of a continuum of mass one of identical agents. The agents get utility by finding a match with an agent of a different type. Without the platform, the agents are not able to find a match (therefore their utility is zero). If both types of agents join a platform, the platform has a probability $\lambda \leq 1$ to find a match for any agent. Each of the two platforms charge a registration fee p_i^k and a total transaction fee t^k. If the user can register with at most one platform an efficient allocation of the users is one in which all users will register with the same platform. If all users choose one platform (and the other one is inactive) then the equilibrium is called "dominant-firm equilibrium". In order to keep the other platform inactive, the dominant platform should choose such prices that no divide-and-conquer strategy will provide positive profit for the second platform. With exogenous single-homing there are only dominant-firm equilibria, where one platform captures all agents on both sides, charges a maximal transaction fee, subsidizes registration and makes zero profit. If we allow for multi-homing and pure equilibria (their definition of "pure equilibrium" is an equilibrium in which agents of the same type all make the same choice), there is a global multi-homing equilibrium if and only if $\lambda(1-\lambda) > c$ or a dominant-firm equilibrium if and only if $\lambda(1-\lambda) \leq c$, where c is the marginal cost. For a mixed equilibrium (where users of the same type can make different choices) there is no equilibrium with both platforms active and no multi-homing if $c \neq \lambda/2$. If there is no transaction fee (as in the case when it is difficult to monitor transactions), a dominant-firm equilibrium exists if and only if $u_2 \cdot \lambda(1-\lambda) \leq c$, where u_i is the share of the total net surplus of the agent of type i, so $u_1 + u_2 = 1$ and $u_2 \geq \frac{1}{2} \geq u_1$ (Caillaud and Jullien assume that type-2 agents have a better bargaining position). Another important result for the case of competitive bottlenecks is that the single-homing side is subsidized while the multi-homing side has no surplus.

Rochet and Tirole (2003) show that the choice of the model for a platform (which side of the market should be charged more or subsidized, and whether to charge a fixed fee and/or a per-transaction fee) is a key factor in the success of the business. They propose a model for a monopoly platform and competitive platforms. The main difference from Caillaud and Jullien (2003) is that the two types of agents are heterogeneous. The surplus that the agents get from a transaction on the platform is b^B for one type, named "buyers", and b^S for the other type, named "sellers". This leads to different elasticities on the two sides of the market. They take as given the matching process, so the volume of the transactions is equal to $D^B(p^B) \times D^S(p^S)$, where $D^i(p^i)$ is a "quasi-demand function"[3], for $i = B, S$. One more difference is that in the first part of the paper, they assume that the platform only charges a per-transaction fee and no fixed fee. They also consider fixed costs for platform and fixed fees for agents.

For the monopoly case, the optimal prices charged by the platform are given by the formula:

$$p^B + p^S - c = \frac{p^B}{\eta^B} = \frac{p^S}{\eta^S} \tag{1}$$

where η^i are the elasticities of the quasi-demands. We can observe that the agents that have a higher elasticity will be charged more by the monopoly platform. The formula is similar to the Lerner formula.

For the competition model with a symmetric equilibrium, the optimal prices are:

$$p^B + p^S - c = \frac{p^B}{\eta_o^B} = \frac{p^S}{(\eta^S/\sigma)} \tag{2}$$

where η_o^B is own-brand elasticity and σ is the single-homing index. Rochet and Tirole define σ_i as a proportion of "loyal" consumers, i.e. consumers that will stop trading when the platform i is not available anymore, and $\sigma_i \in [0,1]$. Because of the symmetric price structure, it follows that $\sigma_1 = \sigma_2 = \sigma$. When all buyers single-home, which is equivalent to $\sigma = 1$, the own-brand elasticity and demand elasticity coincide, and we get the same formula as in the monopoly case.

If platforms also charge a fixed fee, the symmetric equilibrium prices are given by:

[3] The phrase "quasi-demand function" is used to reflect the fact that, in a two-sided market, actual demand depends on the decision of both types of agents (buyers and sellers). In their specification, this demand is simply the product of the quasi-demands of buyers and sellers.

$$p^B + p^S - c = \frac{p^B}{\eta_o^B(1 + \eta_N^S)} = \frac{p^S}{\eta^S + \eta_S^B(1 + \eta_N^S)} \tag{3}$$

where $\eta_N^S = \frac{\partial D^S}{\partial N^B}\frac{N^B}{D^S}$ is network elasticity and η_S^B is cross-price elasticity (the authors assume single-homing, i.e. $\sigma = 1$).

Armstrong (2006) is closely related to Rochet and Tirole (2003). The difference between these two articles is how the authors treat the heterogeneity of the agents, the structure of fees charged by the platforms and the cost of the platforms. The utility of an agent that joins a platform is:

$$u_j^i = \alpha_j^i n^i + \zeta_j^i \tag{4}$$

where α_j^i is the benefit of the agent j when she interacts with a different type agent, n^i is the number of agents of a different type that join the platform, and ζ_j^i is her benefit from joining platform i. Regarding the heterogeneity of the agent, Rochet and Tirole (2003) assume that α_j^i depends on i and j, but ζ_j^i doesn't depend on i and j. Armstrong (2006) assumes α_j^i doesn't depend on i and j, but ζ_j^i depends on i and j. Regarding the price structure, Rochet and Tirole(2003) assume that the platform charges only a per-transaction fee and not a fixed fee. Armstrong assumes that the platform charges a fixed fee. Because Rochet and Tirole (2003) assume a per-transaction fee, the cost for the platform is cn_1n_2, while Armstrong (2006) assumes a fixed fee, so the cost of the platform is equal to $f_1n_1 + f_2n_2$.

For the monopoly case, Armstrong (2006) assumes that there are two types of agents, denoted 1 and 2, and that each agent cares about the number of agents from the other group (n_j). Then each agent's utility is:

$$u_i = \alpha_i \cdot n_j - p_i\,, \qquad i,j = 1,2 \text{ and } i \neq j \tag{5}$$

where p_i are the prices that the platform charges each agent of the two groups and α_i measures the benefit of agent *i* when she interacts with an agent *j*.

Assuming that the platform incurs a per-agent cost f_i , the platform's profit is:

$$\pi = n_1(p_1 - f_1) + n_2(p_2 - f_2) \tag{6}$$

In terms of utility and given the notation:

$$n_i = \phi_i(u_i) \tag{7}$$

the platform's profit is:

$$\pi(u_1, u_2) = \phi_1(u_1)[\alpha_1\phi_2(u_2) - u_1 - f_1] + \phi_2(u_2)[\alpha_2\phi_1(u_1) - u_2 - f_2] \tag{8}$$

Using the last equation, the optimal prices are:

$$p_i = f_i - \alpha_k n_k + \frac{\phi_i(u_i)}{\phi_i'(u_i)}\,, \qquad i,k = 1,2, \qquad i \neq k \tag{9}$$

The formula says that the price charged on one side of the market is equal to the cost of providing service on that side minus the external benefit of the other side plus a factor that is related to the elasticity of the demand. We can observe that if the external benefit of the other side is bigger than the elasticity factor, the price is below the cost (that side of the market is subsidized). And if the external benefit has a high enough value, the price can be negative. Given the formula of elasticity, Armstrong obtains a result similar to Rochet and Tirole's (2003) result and the formula of the prices is similar to the Lerner formula:

$$\frac{p_i - (f_i - \alpha_k n_k)}{p_i} = \frac{1}{\eta_i(p_i|n_k)}, \qquad i,k = 1,2, \qquad i \neq k \tag{10}$$

where η_i is the price elasticity of demand for one type of agents given a level of participation of the other type.

For the competition model, with two platforms, Armstrong (2006) uses a Hotelling model specification. In the first case that he approaches he assumes exogenously that agents will single-home. The two platforms, A and B, are situated at the end points of a unit interval. The agents are uniformly distributed and the transportation costs for the two types of agents are $t_1$and t_2. If the agent joins platform i , groups 1 and 2 will have the utility $\{u_1^i, u_2^i\}$. Given the number of agents that a platform attracts and the prices that the platform charges, the utility of each agent is:

$$u_1^i = \alpha_1 n_2^i - p_1^i \; ; \; u_2^i = \alpha_2 n_1^i - p_2^i \tag{11}$$

When each group has to choose between the two platforms, Armstrong assumes that the number of each group that will join a platform i is given by the Hotelling specification:

$$n_1^i = \frac{1}{2} + \frac{u_1^i - u_1^j}{2t_1} \; ; n_2^i = \frac{1}{2} + \frac{u_2^i - u_2^j}{2t_2} \tag{12}$$

Using equations (11) and (12) and solving the simultaneous equation for n_1^i and n_2^i, the market shares are:

$$n_1^i = \frac{1}{2} + \frac{1}{2}\frac{\alpha_1(p_2^j - p_2^i) + t_2(p_1^j - p_1^i)}{t_1 t_2 - \alpha_1 \alpha_2} \; ; \; n_2^i = \frac{1}{2} + \frac{1}{2}\frac{\alpha_2(p_1^j - p_1^i) + t_1(p_2^j - p_2^i)}{t_1 t_2 - \alpha_1 \alpha_2} \tag{13}$$

The platform *i's* profit is:

$$\pi^i = n_1^i(p_1^i - f_1) + n_2^i(p_2^i - f_2) \tag{14}$$

$$\pi^i = \left[\frac{1}{2} + \frac{1}{2}\frac{\alpha_1\left(p_2^j - p_2^i\right) + t_2\left(p_1^j - p_1^i\right)}{t_1 t_2 - \alpha_1\alpha_2}\right]\left(p_1^i - f_1\right)$$

$$+ \left[\frac{1}{2} + \frac{1}{2}\frac{\alpha_2\left(p_1^j - p_1^i\right) + t_1\left(p_2^j - p_2^i\right)}{t_1 t_2 - \alpha_1\alpha_2}\right]\left(p_2^i - f_2\right) \tag{15}$$

From the first order conditions, Armstrong (2006) obtains the following formula for the prices:

$$p_i = f_i + t_i - \frac{\alpha_k}{t_k} \times (\alpha_i + p_k - f_k)\,, i, k = 1{,}2\,, i \neq k \tag{16}$$

The first term on the right side is the cost, the second one is the market power, the third represents the extra agent of *type-k* that joins the platform when an agent of *type-i* joins the platform and the last term represents the profit from an extra *type-k* agent. Solving the system of these two equations, the equilibrium prices are:

$$p_i = f_i + t_i - \alpha_k\,, \qquad i, k = 1{,}2, \qquad i \neq k \tag{17}$$

Again, if we write the last formula in terms of own-price elasticity, the results are similar to the Lerner formula:

$$\frac{p_i - (f_i - 2\alpha_k n_k)}{p_i} = \frac{1}{\eta_i}, \qquad i, k = 1{,}2, \qquad i \neq k \tag{18}$$

Comparing this with the monopoly formula, the duopolist places twice the weight on the external benefits for a group when it sets the price for the other group.

For the case when one side is single-homing and the other is multi-homing (competitive bottlenecks), the platform will choose a price for the multi-homing side that will bring on the platform the number of agents from the multi-homing side that will maximize the total surplus of the platform and single-homing agents, while the interest of multi-homing agents is ignored. This result is similar to Caillaud and Jullien (2003), who find that single-homing agents (the "buyers") will be subsidized, while multi-homing agents (the "sellers") will have no surplus.

Armstrong and Wright (2007) study the case of platform competition, also using the Hotelling model. They show that if there is strong product differentiation on both sides of the market, and if the transportation costs are higher than the benefits that agents obtain from interacting with the other side of the market. Then no agent will multi-home at a non-negative price. In other words, they don't impose exogenously that the agents single-home. If product differentiation exists on only one side of the market, then there is an equilibrium in which the agents from the other side will multi-home. Unlike Armstrong (2006), they impose a non-negative price constraint. This constraint is plausible as negative prices are rarely observed in the field. In the most cases when a platform would like to charge a negative price on one side, usually the platform charges nothing the agents from that side.

Their model is similar to the Armstrong (2006) competitive model: two type of agents (buyers and sellers – B and S) interact over two platforms (1 and 2), but the agents can join one platform (single-home) or both of them (multi-home). Denoting n_k^i as the number of agents of type k who join exclusively platform i and N_k as the number of agents that multi-home, the utility of an agent that joins platform 1 and is located at $x \in [0,1]$ is:

$$v_k^1(x) = v_k^0 - p_k^1 - t_k x + b_k(n_l^1 + N_l) \quad (19)$$

for $k, l = Seller, Buyer\ ,\ and\ l \neq k$, where v_k^0 is the utility that an agent gets when she joins any platform, p_k^i is the price that platform i charges an agent of type k, t_k is the transportation cost and b_k is the benefit of an agent of type k when she interacts with an agent of different type.

If the same agent joins platform 2, then her utility is:

$$v_k^2(x) = v_k^0 - p_k^2 - t_k(1-x) + b_k(n_l^2 + N_l) \tag{20}$$

If she chooses to multi-home, her utility is:

$$v_k^{12}(x) = v_k^0 - p_k^1 - p_k^2 - t_k + b_k(n_l^1 + n_l^2 + N_l) \tag{21}$$

The platform's profit is equal with the price charged on each side of the market p_k^i minus the cost of providing the service per-interaction on each side f_k, multiplied by the number of agents that join each side:

$$\pi^i = \left(p_S^i - f_S\right)\left(n_S^i + N_S\right) + \left(p_B^i - f_B\right)\left(n_B^i + N_B\right) \tag{22}$$

First, Armstrong and Wright assume that there is strong product differentiation on both sides. In particular, if $t_k > b_k$, $k = S, B$, they prove that no agent multi-homes at any non-negative prices set by the two platforms (Lemma 1 in their paper). Given this lemma, they can focus exclusively on the case when all agents single-home. If v_k^0 is sufficiently high such that all agents choose at least one platform, $t_k > b_k$, $k = S, B$ and $4t_S t_B > (b_S + b_B)^2$, there is a unique equilibrium in which all agents single-home, the two platforms offer the same prices and half the agents from each group will join each platform. If the cost per-interaction plus the transportation cost is greater than the benefits on each side $f_i + t_i \geq b_k$ (the equilibrium price is positive on both sides), the equilibrium price has a formula similar to Armstrong (2006):

$$p_i = f_i + t_i - b_k\,, \qquad i, k = B, S\,, \qquad i \neq k \tag{23}$$

But when this inequality does not hold on one side, so the price on one side should be negative ($f_i + t_i < b_k$), due to the constraint of non-negative prices the equilibrium price on that side is zero. Moreover, the platforms will compete more aggressively on the other side since competition is constrained on the side where the price is zero. Consequently, the equilibrium price on the side with non-zero price will decrease:

$$p_i = 0 \tag{24}$$

$$p_k = f_k + t_k - \left[\frac{b_k - f_i}{t_i}\right] b_i > 0 \tag{25}$$

Their conclusion is that the more platforms want to set a negative price on one side, the more they will lower the price on the other side.

The first result is obtained in the same way as in Armstrong (2006) with the observation that due to Lemma 1 we have $N_S = N_B = 0$, so the formulas for the platform's profit in both papers are the same in this case. For the cases when non-negative price constraints bind, we have the same profit maximization problem, but with the relevant constraints $p_k^i \geq 0$.

Another important result of this paper concerns exclusive contracts. If platforms are able to offer exclusive contracts to one side (the "sellers"), then one platform can set a high non-exclusive price and a slightly lower (compared to the rival's) exclusive price. The result is that all sellers will sign a contract with this platform. After the platform attracts all sellers, it is able to charge the other side (the "buyers") a premium price. This strategy will undermine the competitive bottlenecks equilibrium. Moreover, it will reverse the surplus result from the competitive bottlenecks equilibrium. Now, the buyers are the group that will have all surplus extracted.

Amelio and Jullien (2012) present a model similar to Armstrong (2006) in which it is not possible to set a negative price. They relax this constraint, letting the platform to tie the sale of another good. In a monopoly this technique raises participation and also increases the consumer surplus. In a duopoly, the change in consumers' surplus depends on what will happen on the profitable side: if the competition becomes softer or more intense. The competition softening leads to an increase in both prices at the equilibrium which will lead to a decrease in consumer surplus (and the other way around).

Hagiu (2009) shows that another important factor determining the price structure charged by the platform is consumer demand for product variety. Consumer demand for product variety gives more market power to the sellers as long as their products are less substitutable, so the sellers are able to earn greater profits. The platforms realize this and will try to extract more profits from the sellers' side of the market. For the monopoly case, Hagiu (2009) shows that depending on the market power of the sellers (λ), elasticity of consumers' demand (ε_F), elasticity of sellers' demand (ε_H) and the intensity of consumers' preference for variety (ε_V), the platform can subsidize one side, or make positive profits on both sides. Hagiu calculates the optimal price structure as a ratio between the share of total profits made on sellers Π^{PD} and the share made on consumers Π^{PU}. This ratio[4] is equal to:

$$\frac{\Pi^{PD}}{\Pi^{\mathrm{PU}}} = \frac{\varepsilon_V(1+\varepsilon_F)\big(1-(1-\lambda)(1+\varepsilon_H)\big)}{(1+\varepsilon_H)\big(1-\lambda\varepsilon_V(1+\varepsilon_F)\big)} \qquad (26)$$

Depending upon whether the nominator or the denominator is negative, Hagiu concludes that:

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[4] As in Hagiu's paper, I omit functions' arguments in order to avoid clutter.

- if $\lambda \leq \frac{\varepsilon_H}{1+\varepsilon_H}$, the sellers are subsidized;
- if $\lambda \geq \frac{1}{\varepsilon_V+(1+\varepsilon_F)}$, the buyers are subsidized;
- if $\frac{\varepsilon_H}{1+\varepsilon_H} < \lambda < \frac{1}{\varepsilon_V+(1+\varepsilon_F)}$, the platform makes positive profits on both sides of the market ;

Another two contributions of this paper are: i) Hagiu shows that allowing for the consumer preference for variety, the strategy in which one platform tries to undercut the price of the consumers of the other platform in order to attract more consumers and indirectly more sellers will have a smaller effect in driving away the sellers form the other platform; ii) Hagiu also shows that in some settings, the platform is indifferent between a membership fee (fixed fee) and a royalties/usage fee (per-transaction fee) – these two instruments are perfect substitutes. But when the platform is interested in the sellers' (producers') level of investment, the usage fee plays an important role.

Hagiu (2006) approaches another factor that can change the structure of the pricing in a two-sided market: commitment. One main characteristic of this type of market is that the indirect network effects between buyers and sellers will generate the "chicken-and-egg" problem. In order to avoid this problem, the platforms might commit *ex ante* to charge one side a price *ex post* in order to attract a larger number of agents from the other side. A good example is when the producers of game consoles announce the price of the console (the fixed fee paid by the buyers) in order to be able to make the game developers join their platform and to charge them a higher price.

The timing of his model is consistent with the game consoles market, where usually the game developers (sellers) decide first to join the platform or not. In this situation, the platform has two options: to announce the price for sellers only, and announce the price for buyers after sellers join the platform; or to announce the price for buyers (if there is any credible commitment) and the price for sellers at the same time. These two different strategies will offer different results. The model is similar to Caillaud and Jullien (2003).

Gabszewicz and Wauthy (2004) present a competition model similar to Caillaud and Jullien (2003), but with some modifications. In their paper the platforms are heterogeneous rather than homogenous; the agents can choose not to join any platform, where Caillaud and Jullien (2003) assume that all agents join at least one platform. They also assume that the agents only pay a registration fee (fixed fee). As in some of the papers presented above, Gabszewicz and Wauthy find the equilibrium prices for the monopoly case, the duopoly case with single-homing and the duopoly case with multi-homing.

Roson (2005) and Rochet and Tirole (2006) have short presentations of the progress in the literature of the two-sided market. Moreover, Rochet and Tirole (2006) try to develop a more general model and to incorporate the model of Rochet and Tirole (2003) with pure per-transaction fees and the model of Armstrong (2006) with pure fixed fees. Another important contribution of Rochet and Tirole (2006) is that they establish a definition for a two-sided market. A market is a two-sided market if a platform charges a per-interaction fee of a^B for buyers and a^S for sellers, so that the aggregate price level is $a = a^B + a^S$, keeping constant the aggregate price a, the total transaction volume changes as a^B and a^S change.

Gabszewicz et al (2001) study the location of newspapers relative to their political opinions. They show that newspapers tend to have the policy of *"Pensée Unique"*. In other words, they choose a location which is a "middle point" and not an extreme.

Their model uses a Hotelling model in which two newspapers can choose their political opinion on a unit interval – they can choose their location, where a is the distance from the far left extreme to the location of the first newspaper and b is the distance from the far right extreme to the location of the second newspaper. By notation, the cost per copy of each newspaper is c, t is the intensity of readers' political opinions and $4k$ is the density of the population of advertisers of type θ. Given that the two newspapers choose their political opinion *(a,b)*, the Nash equilibrium of the game is:

- $(a^*, b^*) = (0,0)$, if $k \leq c + \frac{t}{2}$
- $(a^*, b^*) = (0.5,0.5)$, if $k \geq c + \frac{25t}{72}$

  When $c + \frac{25t}{72} \leq k \leq c + \frac{t}{2}$, both strategies are equilibrium strategies, but the strategy (0,0) Pareto-dominates the strategy (0.5,0.5).

Kaiser and Wright (2006) estimate the market for magazines in Germany and find that this market behaves like a two-sided market. The results are consistent with the theory that advertisers value readers more than readers value advertisers. Magazines subsidize the readers and make a profit by charging the advertisers. Also, this market fits the model where the agents of the both sides of the market pay a fixed fee (to join the platform), and not a transaction fee. For estimation, the authors use Armstrong's (2006) model.

Their data set has information about cover prices, ad prices, the number of ad pages, the number of content pages and the circulation numbers of the magazines in Germany for each quarter from 1972 to 2003. They group the magazines in different market segments depending on their content in such a way that they have two magazines in each market segment. Out of 18 market segments, 9 were ruled out due to different difficulties.

Due to endogeneity problems, they use instruments for circulation numbers, the number of content pages, the number of ad pages, cover prices and ad rates. They use GMM and SUR estimations, and in some cases get quite different results depending on the particular estimation strategy.

The magazines earn an estimated profit of -2,100,830 Euros per year from readers. This result shows that readers are subsidized by the platform. At the same time, magazines earn an estimated profit of 6,911,360 Euros per year from advertisers. Based on these point estimates, these magazines are able to make a positive profit in total, even if they have losses on one side.

Chakravorti and Roson (2006) study platform competition using a particular case of payment networks. One interesting result is related to the fact that market competition has two effects: a reduction in the total level of the price and a change in the price structure.

Chakravorti and Roson assume that consumers are charged a fixed fee and sellers (merchants) are charged a per-transaction fee. The profit for the platform is then:

$$\Pi = (f^c - g)D^c + (f^m - c)D^c D^m \tag{27}$$

where f^c is the fixed fee charged for consumers, f^m is per-transaction fee charged for sellers, D^c is the number of consumers, D^m is the number of sellers and *g* and *c* are the fixed costs that the platform incurs for every consumer and seller that join the platform.

They construct an index related to the total welfare. Given a fixed level of profit for the platform and a change in prices for consumers and sellers, the index is equal to:

$$\eta = \left(\frac{\partial CW}{\partial f^c} + \frac{\partial MW}{\partial f^c}\right) D^m - \left(\frac{\partial CW}{\partial f^m} + \frac{\partial MW}{\partial f^m}\right) \tag{28}$$

where *CW* is consumer welfare, and *MW* is the sellers surplus. A positive value for η means that if there is an increase in f^c and a decrease in f^m, keeping profit constant, it is possible to have an increase in the aggregate welfare. Calculating the value η for given values for some parameters of the model for duopolistic competition and a monopolistic cartel, Chakravorti and Roson conclude that competition will increase the pressure on the total level of prices and will decrease the total level of prices, but will also change the price structure. These changes can have opposing effects. Due to the decrease in the total level of prices, there is an increase in welfare. Due to the change in the price structure, a decrease in welfare for one side may occur. In their settings, the increase dominates the possible decrease, so overall the consumers and the sellers are better off. This result has an important policy implication in the credit card market.

Chakravarty (2003) conducts an experiment concerning technology adoption when there are network externalities. He studies the effects of network size on pricing and adoption of two competing technologies. Even if there are no cross-group externalities, his setting is similar to a two-sided market experiment. The theoretical model is similar, in some ways to Armstrong (2006). There are two technologies (instead of platforms) A and B, N_t homogenous consumers (but just one type of consumer), and the consumers' utility depends on the size of the network that the consumer adopts:

$$v_A = v(x_1 + x_2) - p_A \tag{29}$$

$$v_B = v(y_1 + y_2) - p_B \tag{30}$$

Because there is a two stage game, the size of the network is the sum of the number of agents that adopt each technology in each stage: $x_1 + x_2$. The consumers are homogenous so they have the same benefit function $v(.)$. In the experiment, this function has the following form: $v(N) = 10 + 8N$. In Armstrong (2006), for the monopoly model, the functional form for $v(.)$ is $v(N) = \alpha N$. If we change the settings of Chakravarty (2003) and add one more type of agent, the experiment is quite similar to Armstrong's model. The model assumes that each technology has a marginal cost of production that can be different in each stage: MC_t^A and MC_t^B. Each session of the experiment has 2 stages and 10 subjects: 2 sellers (one for each technology), 4 buyers for stage 1 and 4 buyers for stage 2. The time line is the following: the sellers set the prices for stage 1, the stage 1 buyers simultaneously decide which technology they want to buy, and then the sellers set the price for stage 2 and the stage 2 buyers decide which technology they want to buy. After that the computer calculates the payoffs for each subject.

Another experimental study that helps in the design of a two-sided market experiment is Brown-Kruse et al. (1993), which examines spatial competition. The subjects were paired as sellers (in the two-sided market they can be the platforms). The consumers (one type of agent) were simulated and uniformly distributed on the interval $[0,100]$. Because the experiment cannot allow a continuum representation of the interval, the consumers' location was at each unit interval. The subjects could choose their location and were told that the consumers had a transportation cost t. The consumers were homogenous and each consumer's demand function was $q(p) = 10 - p$, where $p = p_0 + 0.1 \times d$, where p_0 is fixed FOB price that sellers could charge and d is the distance to the seller from whom they bought a good. A similar setting can be used in a two-sided experiment, with the modification that the platforms have a fixed location (at the end of the interval), but the subjects can choose the price that they want to charge the agents.

5.4 Experimental design

5.4.1 Model structure

For this experiment, I use Armstrong's (2006) monopolistic market model. Armstrong assumes that there are two types of agents, denoted 1 and 2, and that each agent cares about the number of agents from the other group (n_j). Each agent's utility is:

$$u_i = \alpha_i \cdot n_j - p_i\,, \qquad i,j = 1{,}2 \text{ and } i \neq j \tag{31}$$

where, p_i is the price that the platform charges each type of agent and α_i measures the benefit of agent *i* when she interacts with agent *j*. The platform's profit is:

$$\pi = n_1(p_1 - f_1) + n_2(p_2 - f_2) - fixed\ cost \tag{32}$$

In terms of utility, Armstrong (2006) assumes the following relationship between the number of agents on one side of the market and the utility the agents get:

$$n_i = \phi_i(u_i) \tag{33}$$

where $\phi_i(u_i)$ is some increasing function. For simplicity, in my experiment I assume $\phi_i(u_i) = u_i + d_i$, where d_i is a constant. This constant allows for positive number of agents in the model. Rewriting the demand functions described by (31) and (33), so they are not a function of the number of agents on the other side of the market, the equations that describe the demand functions (as a function of prices) are the following:

$$n_i = \frac{d_i + \alpha_i \cdot d_j}{1 - \alpha_i \cdot \alpha_j} - \frac{1}{1 - \alpha_i \cdot \alpha_j} \cdot p_i - \frac{\alpha_i}{1 - \alpha_i \cdot \alpha_j} \cdot p_j, \qquad i, j = 1,2, \qquad i \neq j \quad (34)$$

I impose restriction $\left(1 - \alpha_i \cdot \alpha_j\right) > 0$ so the demand is decreasing in p_i.

Given this notation, for the model with no restrictions the optimal prices as a function of the parameters of the model are:

$$p_i^* = \frac{\alpha_j \cdot d_j - \alpha_i \cdot d_j - 2 \cdot d_i + \alpha_j^2 \cdot d_i + \alpha_i \cdot \alpha_j \cdot d_i}{\alpha_i^2 + 2 \cdot \alpha_i \cdot \alpha_j + \alpha_j^2 - 4} + f_i \cdot \frac{\alpha_i^2 + \alpha_i \cdot \alpha_j - 2}{\alpha_i^2 + 2 \cdot \alpha_i \cdot \alpha_j + \alpha_j^2 - 4} +$$

$$+ f_j \cdot \frac{\alpha_i - \alpha_j}{\alpha_i^2 + 2 \cdot \alpha_i \cdot \alpha_j + \alpha_j^2 - 4}, \qquad i, j = 1,2, \qquad i \neq j \quad (35)$$

Plugging the optimal prices in to the demand functions, the number of agents that will join the platform at the equilibrium is equal to:

$$n_i = -\frac{2 \cdot d_i + \alpha_i \cdot d_j + \alpha_j \cdot d_j}{\alpha_i^2 + 2 \cdot \alpha_i \cdot \alpha_j + \alpha_j^2 - 4} + f_i \cdot \frac{2}{\alpha_i^2 + 2 \cdot \alpha_i \cdot \alpha_j + \alpha_j^2 - 4} +$$

$$+ f_j \cdot \frac{\alpha_i + \alpha_j}{\alpha_i^2 + 2 \cdot \alpha_i \cdot \alpha_j + \alpha_j^2 - 4}, \qquad i, j = 1,2, \qquad i \neq j \quad (36)$$

Assume that at the optimal price $p_1^* < f_1$ and the monopolist is not allowed to charge a price below cost. Then the optimal prices are:

$$p_1^* = f_1 \quad (37)$$

$$p_2^* = \frac{d_2 + \alpha_2 \cdot d_1}{2} + \frac{f_2}{2} - \frac{\alpha_2 \cdot f_1}{2} \quad (38)$$

and the number of agents that will join the platform is equal to:

$$n_1 = -\frac{2 \cdot d_1 + \alpha_1 \cdot d_2 - \alpha_1 \cdot \alpha_2 \cdot d_1}{2 \cdot (\alpha_1 \cdot \alpha_2 - 1)} + f_1 \cdot \frac{2 - \alpha_1 \cdot \alpha_2}{2 \cdot (\alpha_1 \cdot \alpha_2 - 1)} + f_2 \cdot \frac{\alpha_1}{2 \cdot (\alpha_1 \cdot \alpha_2 - 1)} \quad (39)$$

$$n_2 = -\frac{d_2 + \alpha_2 \cdot d_1}{2 \cdot (\alpha_1 \cdot \alpha_2 - 1)} + f_1 \cdot \frac{\alpha_2}{2 \cdot (\alpha_1 \cdot \alpha_2 - 1)} + f_2 \cdot \frac{1}{2 \cdot (\alpha_1 \cdot \alpha_2 - 1)} \quad (40)$$

For the situation when the monopolist is not allowed to charge different prices for the two types of agents the optimal prices are:

$$p_1^* = p_2^* = \frac{d_1 + d_2 + f_1 + f_2 + \alpha_1 \cdot d_2 + \alpha_2 \cdot d_1 + \alpha_1 \cdot f_1 + \alpha_2 \cdot f_2}{2 \cdot (\alpha_1 + \alpha_2 + 2)} \quad (41)$$

and the number of agents that will join the platform is equal to:

$$n_i = \frac{d_j - 3 \cdot d_i - \alpha_i \cdot d_i - 2 \cdot \alpha_i \cdot d_j - \alpha_j \cdot d_i - \alpha_i^2 \cdot d_j + \alpha_i \cdot \alpha_j \cdot d_i - 2 \cdot \alpha_i \cdot \alpha_j \cdot d_j}{2 \cdot \left(\alpha_i \cdot \alpha_j - 1\right) \cdot \left(\alpha_i + \alpha_j + 2\right)} +$$

$$+ f_i \cdot \frac{1 + 2 \cdot \alpha_i + \alpha_i^2}{2\left(\alpha_i \cdot \alpha_j - 1\right) \cdot \left(\alpha_i + \alpha_j + 2\right)} + f_j \cdot \frac{1 + \alpha_i + \alpha_j + \alpha_i \cdot \alpha_j}{2\left(\alpha_i \cdot \alpha_j - 1\right) \cdot \left(\alpha_i + \alpha_j + 2\right)}, i, j = 1,2, i \neq j$$

5.4.2 Experimental Procedures

The experiment has 4 treatments: a treatment with no restrictions regarding the prices that a subject can charge (called *Base*); a treatment in which the prices are not allowed to be below cost (*Above cost*); a treatment in which the monopolist is not allowed to charge the two types of agents different prices (*Same price*); and a treatment in which there is a higher cost on the side where the agents' valuation for the other type of agents is the lowest (*High Cost*). There are 3 treatments in each session and the order of the treatments is different from one session to another. Each treatment has 20 periods. The first 10 periods are practice periods in order to give subjects the freedom to explore with no cost their payoff function and only the last 10 periods of each treatment are considered for payment. Moreover, in order to ensure that the subjects treat each period with the same amount of importance, only two of the last 10 periods of the each treatment are randomly drawn for the final payment. The sum of profits for these periods is the subjects' total experimental earnings. Before each treatment starts, the program shows subjects a screen with the restriction or changes compared to the previous treatment. For example, before the *Same price* treatment the screen says: "For the next 20 periods you must charge type A customers and type B customers the same price."

For each period, each subject owns a firm and this firm is the only firm in the market no additional entry allowed. The firm helps two types of agents (in this experiment called type A and type B customers) to interact. The customers are computer simulated and they decide if they want to join the business in order to be able to interact with the agents of the other type. The consumers' decision to join the business or not depends on the prices that the firm charges and the number of agents of the other type that join the business. Each subject must choose what prices to charge the two types of agents each period. Given these prices and the parameters of the model, equation (34) gives the number of agents of each type that join the business. Plugging these results in to equation (32), the calculator displays the profit for that period on the screen. At the end of each period, the subjects see a screen with the prices that they charged, the number of each type of agents that joined their business and the profit that they made. The costs, the prices and the profit during the experiment are in francs. The profit is converted to US dollars and is paid to each subject at the end of the experiment at a rate of 350 francs to 1 USD. To help subjects to keep track of this information, a history table with the results from each period is displayed on their decision screen. In figure 4.2 there is a screen shot with a subjects' decision screen after 3 periods.

For this experiment, the parameters of the model are equal to the values from table 4.1.

The values for the cost per agent f_i and the constant d_i are the same for both sides of the market, in order to guarantee that the results of the experiment are due to cross-group externalities and the policies imposed in the market. The equilibrium prices and the equilibrium number of agents for each treatment are presented in the following table:

The experiment was conducted at Purdue University during the spring semester of 2013 using 24 Purdue undergraduate students during 3 sessions of 8 students each. Session lasted on average 1 hour and 15 minutes and the average payment was approximately $25 per subject in each session. The program used to run the experiment was Z-Tree (Fischbacher, 2007). The order of each treatment in each session is presented in the table 4.3.

Hypothesis 1. Even with no threat of new competitors, the price-cost margin for a monopoly platform is negative on one side of the market.

This monopoly model highlights that if a platform sets a price below cost on one side of the market, this does not mean that the platform wants to drive the competitor out of the market or that the platform wants to create barriers to entry. The platform does not have a predatory pricing strategy, but by choosing a price below cost on that side of the market, the platform wants to attract more agents on that side of the market, which will bring even more agents to the other side. Thus, even with no threat of new competitors, a monopoly platform sets a price below cost on one side of the market. The agents on that side of the market will attract more agents of the other type, so the platform will be able to increase its profit on the other side, and thus its profit overall. Moreover, in such a situation the platform can have positive profit in both the short-run and the long-run. For the *Base* treatment the predicted price for type A agents is equal to 25 francs while the cost per costumer on that side is 50 francs. For the *Cost increase* treatment the predicted price for type A agents is equal to 61.5 francs while the cost per costumer on that side is 90 francs.

Hypothesis 2. If the equilibrium price on one side of the market is below cost and the monopolist is restricted to charge a price at or above cost, the total consumer surplus decreases.

If the equilibrium price on one side of the market is below cost and the monopolist is restricted to charge a price above cost, then on that side there will be fewer agents because of the increase in price. The decrease in the number of agents on that side will lead to fewer agents on the other side also. Even if the monopolist decreases the price on the other side in order to maximize the profit, the decrease in price does not compensate for the loss in consumer surplus. Overall the consumer surplus decreases. In this experimental setting the prediction is that there is a decrease of 66.4% in total consumer surplus from treatment *Base* to treatment *Above cost*.

Hypothesis 3. If the monopolist is restricted to charge the same price on both sides of the market, the total consumer surplus decreases.

If a policymaker does not recognize a market as a two-sided market, she might force the platform to charge the same price for both types of agents if the service or good provided by the platform is the same for every agent. An example is dating websites. Wright (2004) cites an article from *The San Diego Union Tribute* that states that a group of lawyers filled a case against several dating services from California and reached an agreement base on gender-pricing discrimination against men. The dating services offered discounts for female costumers. *Wall Street Journal* (Gold, Reddy (2012)) has an article that states that 138 businesses like nail salons in New York City paid fines for violating a New York City law against gender-pricing discrimination. While nail salons are not classified as a two-sided market, dating websites are classified as two-sided market and they are still required to follow gender discrimination legislation. Websites like eHarmony.com and Match.com charge the same price both to women and men. Imposing such restrictions, the prediction in this experimental environment is that the total consumer surplus decreases by 56.6%.

Hypothesis 4. An increase in the cost per-agent on one side of the market may decrease the price on the other side.

In a one-sided market, an increase in cost induces an increase in price charged by the monopolist. In a two-sided market, an increase in the cost per-agent on one side might induce an increase in prices on both sides or an increase in price on that side and a decrease in price on the other side. The change in price at the equilibrium on one side due to a change in cost per-agent on the other side is:

$$\frac{\partial p_i}{\partial f_j} = \frac{\alpha_i - \alpha_j}{\alpha_i^2 + 2 \cdot \alpha_i \cdot \alpha_j + \alpha_j^2 - 4} \tag{43}$$

Given the parameters in the model $\alpha_i^2 + 2 \cdot \alpha_i \cdot \alpha_j + \alpha_j^2 - 4 < 0$, which implies that $\frac{\partial p_i}{\partial f_j} > 0$ if $\alpha_i - \alpha_j < 0$ and $\frac{\partial p_i}{\partial f_j} < 0$ if $\alpha_i - \alpha_j > 0$. Depending on which side of the market it is applied, a tax on one side of the market has different effects on the price on the other side. In this experiment, the prediction is that an increase in cost for type A agents induces a decrease in price for type B agents by 23.5 francs which means a decrease by 19%.

5.5 Results

As noted above, in order to encourage experimentation and help subjects investigate and better understand the relationship between the prices they charge and the profit they make, the first 10 periods of each treatment were not considered for payment. Due to the lack of financial incentives for these first 10 periods, the statistical tests presented in this section use data only from the last 10 periods of each treatment. For better illustration however, some graphs use the data for all 20 periods of a treatment.

Result 1. Given strong cross-group externalities, a monopolist in a two-sided market charges a price blow cost on one side of the market.

The result is that the average prices are not close to those predicted in equilibrium. But when the *Base* treatment is not the first treatment in the session, the average price charged to type A agents is below cost. Figure 5.5 and 5.6 present the average prices charged in session 2 and session 3, when the *Base* treatment was not the first treatment of the session.

At the individual level only two out of the 16 total subjects in these two sessions did not charge type A agents a price below cost. Across three sessions, the average price charged to type A agents for the last 10 periods was 43 francs, while the cost was 50 francs.

Testing the assumptions of a Student's *t*-test, Levene's robust test does not reject the null hypothesis of equal variances between different orders of the *Base* treatment within each of the three sessions, however t-tests reject the null hypothesis of equal means between session 1 and session 2 (*p-value*=0.003), and between session 1 and session 3 (*p-value*=0.027). Because the sample population of the *Base* treatment in session 1 comes from a different distribution, I provide the results of a one-sample one-tailed t-test of the null-hypothesis *mean price>cost* (50 francs) for session 1 separately from sessions 2 and 3. For sessions 2 and 3 the null hypothesis is rejected (*p-value*=0.001) and the mean price charged to type A agents is equal to 36.1 francs. This result supports hypothesis 1 that a monopolist in a two-sided market with no threat of new entry charges a price below cost on one side of the market. On the other hand a t-test rejects the null hypothesis that the mean price is equal to the optimal price of 25 francs (*p-value*=0.001).

However, for session 1 the null hypothesis is not rejected and the mean price for type A agents equals 56.6 francs. The lack of experience of the subjects or the existence of a restriction not to charge a price below cost before *Base* treatment might affect the behavior of the monopolist.

Session 1 was the only session that had a mean price above cost for type A agents above cost, and also the only session in which the *Base* treatment was the first treatment of the session. Figure 4.5 presents the average prices per period charged in session 1. The graph shows that even with no restriction that prohibits setting a price below cost, on average the subjects did not charge a price below cost, contrary to the prediction of the model. Looking at the individual choices, figure 4.6 shows that only two out of eight subjects charged a price below cost (50 francs).

Evaluating the deviation from the equilibrium in terms of payoffs, figure 5.7 shows the profit loss for the *Base* treatment in all three sessions. Due to the fact that subjects do not charge prices below cost on side A, despite the fact that the optimal price is below cost , there is a bigger profit loss for first session. The profit loss decreases in the next two sessions, once subjects start to charge a price below cost, consistent with the equilibrium prediction.

Result 2. A policy that restricts a monopolist to charge prices above cost reduces total consumer surplus.

Figure 4.7 presents the average consumer surplus per period for the *Base* and *Above Cost* treatments for all three sessions.

Levene's robust test rejects the null hypothesis of equal variances between prices for type A agents from session 1 and 2 (*p-value*=0.007), and from session 1 and 3 (*p-value*=0.009). Welch's t-tests reject the null hypothesis of equal price means of the *Above cost* treatment (for type A agents) only between session 1 and 3 (*p-value*=0.12), but the differences between means are not as high as in the *Base* treatment. Session 3 has the highest mean price at 58.8 francs, which is 6.8 francs above the mean price in session 1 and 3.5 francs above the mean price in session 2. Similar to the *Base* treatment, the *Above Cost* treatment has a higher mean price for type A agents for the sessions in which the *Above Cost* treatment is the first treatment. Thus, no matter what the second treatment is within a session, the subjects use their experience from the first treatment to charge prices closer to the predicted prices in the second treatment of the session. The t-test rejects the null hypothesis that the mean price is equal to the optimal price of 50 francs for session 1 (*p-value*=0.033), and sessions 2 and 3 (*p-value*=0.007).

Differences from one session to another session are also observed in terms of the decrease in consumer surplus across treatments. For the first session there is an average decrease of 7% in consumer surplus from the *Base* treatment to the *Above Cost* treatment.

For session 2 the average decrease in consumer surplus is 28% and in session 3 is equal to 21.8%.

In terms of the average consumer surplus, Levene's robust test rejects the null hypothesis of equal variances between the *Base* treatment and the *Above Cost* treatment (*p-value*=0.001). Welch's t-test rejects the null hypothesis of equal means between the *Base* treatment and the *Above Cost* treatment (*p-value*=0.001). A two-sample Wilcoxon rank-sum test also rejects the null hypothesis of equal means between these 2 treatments (*p-value*=0.001). A policy that requires that the prices must be above cost decreases total consumer surplus in this experimental environment by 18.1%.

Table 4.4 shows the results of random effect model estimation using average consumer surplus as the dependent variable. The coefficient for the variable *Treatment* is statistically significant at the 1% level, which indicates that the average consumer surplus decreases from the *Base* treatment to the *Above Cost* treatment. The coefficient for the variable *Order* is also statistically significant at the 1% level which indicates that there is an increase in consumer surplus when the treatment is run later in the session.

These results support hypothesis 2, that consumer surplus decreases when a policy requires a price above cost.

The observed decrease of 18.1% is less than the predicted decrease of 66.4%. The difference between the predicted value and the actual value is explained by the fact that the average prices in the *Base* treatment are not close to the predicted prices. For type A agents the average price of 43 francs is below the cost of 50 francs but is still 18 francs above the predicted price of 25 francs. On the other hand, for the *Above Cost* treatment the average price for type A agents is equal to 55.3 francs, just 5.3 francs above the predicted price. This means the subjects were less able to attract an optimal number of agents under the *Base* treatment, which implies a lower consumer surplus than predicted and also a decrease in the difference between the consumer surpluses in the two treatments.

Similarly to consumer surplus, a small difference in profits that monopolists obtain is observed between the two treatments. In the first session, when the *Above Cost* treatment is not the first treatment, the profit loss is insignificant. Once the order of the treatments is reversed the average percentage profit loss for the *Base* treatment is less than the average percentage profit loss for the *Above Cost*. Another observation is that subjects are able to increase the profit within sessions for the *Above Cost* treatment, while for the *Base* treatment profit stays almost the same. The average profit losses in the two treatments are displayed in figure 5.10.

Result 3. A policy that constrains a monopolist to charge the same price on both sides of the market reduces total consumer surplus.

This treatment was a search problem in one dimension so it was not difficult for the subjects to find the equilibrium price. As such, this treatment was only included in session 1. The average price charged by the subjects is displayed in figure 4.9.

The overall average price for the last 10 periods is equal to 74.9 francs while the equilibrium price is 75 francs. A Student *t*-test does not reject the null hypothesis that the mean price for the *Same Price* treatment is equal to the equilibrium price (*p-value*=0.242). Regarding the average consumer surplus per period, Levene's robust test rejects the null hypothesis of equal variances between the *Base* treatment and the *Same Price* treatment (*p-value*=0.00). A Welch's t-test, that allows for unequal sample sizes, rejects the null hypothesis of equal consumer surplus means between the two treatments (*p-value*=0.001).

The decrease in consumer surplus between these two treatments is equal to 10.4%. This result supports hypothesis 3 that a policy that imposes the same prices for both types of agents decreases consumer surplus.

In the *Same Price* treatment subjects choose the equilibrium price, which indicates that they maximize they profit under this treatment. Figure 5.10 supports this conclusion.

Result 4. An increase in the cost per-agent on one side of the market induces a decrease in the price charged to the agents on the other side of the market.

For this treatment there are two important observations. First, the average price in the last 10 periods charged to type B agents is equal to 98.35 francs. This implies that there is a decrease in the price for type B agents compared to the price in the *Base* treatment, where the average was 108.25 francs. Second, the price charged to type A agents is always lower than the cost per-agent on that side. The figure 4.12 and 4.13 present the prices charged in the *High Cost* treatment for the two sessions.

For the prices for type B agents, Levene's robust test rejects the null hypothesis of equal variances between the *Base* treatment and the *High Cost* treatment (*p-value*=0.02). A Welch's t-test for unequal sample sizes rejects the null-hypothesis of equal price means between *Base* treatment and *High Cost* treatment (*p-value*=0.022). The mean price for type B agents is lower in the *High Cost* treatment than in *Base* treatment by 9.9 francs (9.1%). A two-sample Wilcoxon rank-sum test also rejects the null hypothesis of equal price means between the two treatments (*p-value*=0.01). This implies that a policy that increases the cost on one side of the market will decrease the price that the monopolist charges on the other side of the market. This result supports hypothesis 4.

Related to the prices charged to type A agents, in the *High Cost* treatment, a one-sample t-test rejects the null-hypothesis that *mean price>cost*=90 francs (*p-value*=0.001). Also the null-hypothesis that *mean price=predicted price* is rejected (*p-value*=0.11). The mean price is equal to 66.5 while the predicted price is equal to 61.5 francs. These results support hypothesis 1, that a monopolist with no threat of new entry charges a price below cost on one side of the market. However, the subjects do not charge the optimal price.

The difference between the optimal prices and the average prices on the two sides of the market is reflected in the profit loss. Figure 5.17 presents the average profit loss in percentage per each period in the two sessions.

5.6 Conclusions

This paper presents the experimental design and the initial results of an economic experiment that studies the price structure in a two-side market monopoly and the effects of different policies on price structure and total consumer surplus. Theoretical models, from the relatively new literature on two-sided markets, show that the optimal price structure can have such prices that can mislead the policymakers.

In this laboratory environment, the predicted price for type A agents is only one-half of the per-agent cost for the side of the market that provides a strong demand externality to the other side. While this can be viewed by a naïve policymaker as a predatory pricing strategy, results 1 and 4 show that most of the monopolists charged a price below cost even if they did not have a threat of new competitors.

However, contrary to the prediction of the model, there were subjects that did not charge a price below cost under the *Base* treatment. The only situation when the subjects charged an average price above cost, even if the optimal price was below cost on that side of the market, was when the treatment with no restriction on price setting occurred before a treatment that imposes such restriction. This might have been because of lack of experience of the subjects. Also the fact that there was initially no constraint on price before the *Base* treatment in session 1 can also explain why subjects did not charge a price below the cost per-agent, close to the optimal price. This implies that platforms with inexperienced managers might not charge the optimal prices if there is no initial regulation in the market. If there was a regulation and the regulation is removed, the prices tend to be the optimal prices. If the goal of a policymaker is to help platforms to charge the optimal prices, a good strategy for the policymaker is to impose a price regulation for a short time period and then remove it.

A policy that requires the monopolist to charge a price above cost leads to a decrease in total consumer surplus, as does a policy that imposes the same price for both types of agents. The decreases in consumer surplus are not as big as the predicted decreases, but there still is a statistically significant difference in means. Also a tax that leads to an increase in the cost per-agent for type A agents, contrary to the effect in a one-sided market, decreases the price for type B agents.

The goal of this paper is to offer empirical evidence that will help policymakers to implement some regulations in such markets. The results prove that two-sided markets have counterintuitive properties and suggest that policymakers should pay attention to the type of the market, one-sided or two-sided, and that regular policies might not have the desired effects in a two-sided market. Future research should try to find answers to similar questions for duopoly markets and for mergers.

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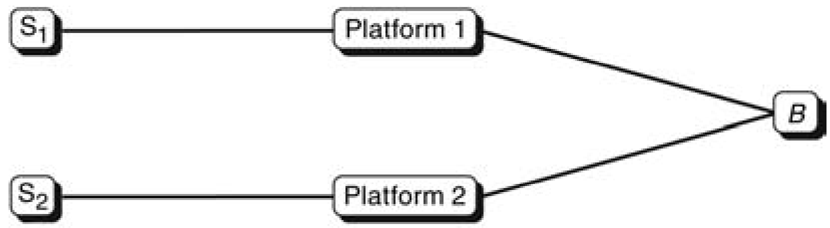


Figure 5.1 The case of the competitive bottlenecks

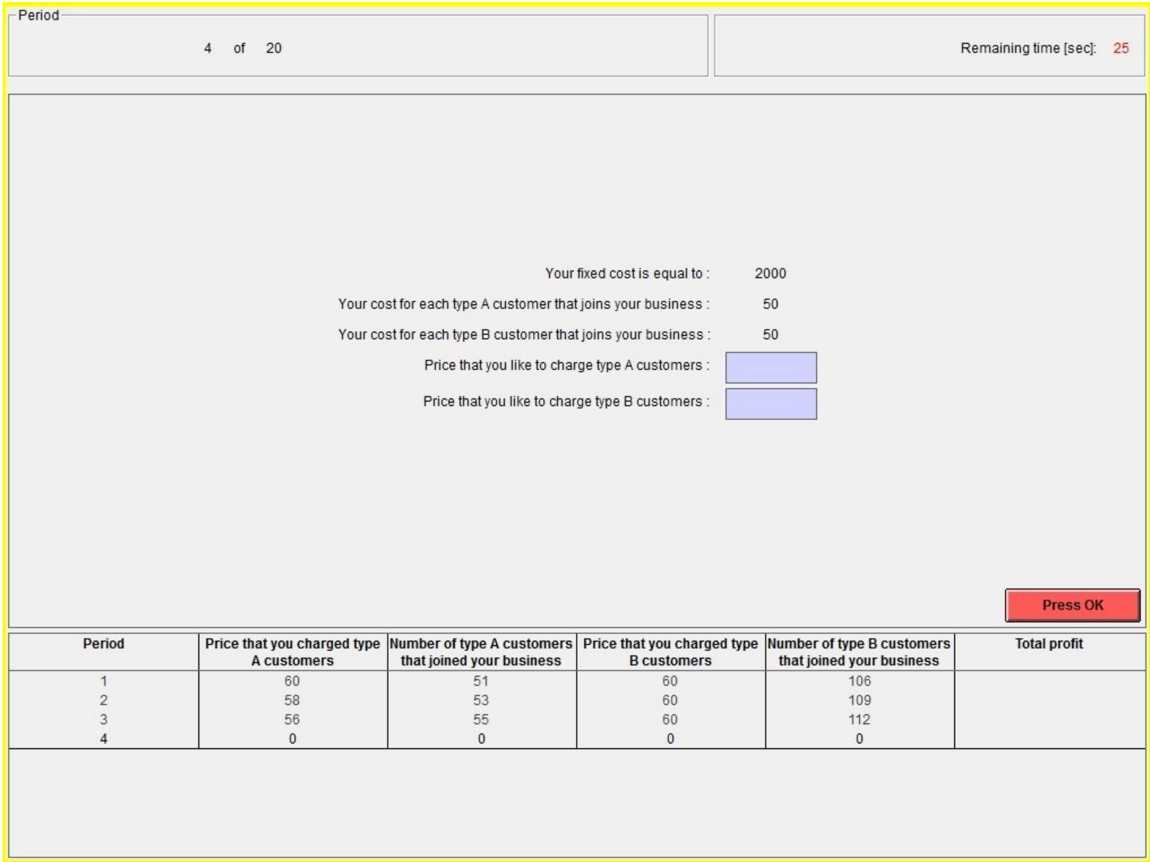


Figure 5.2 Subjects’ decision screen.

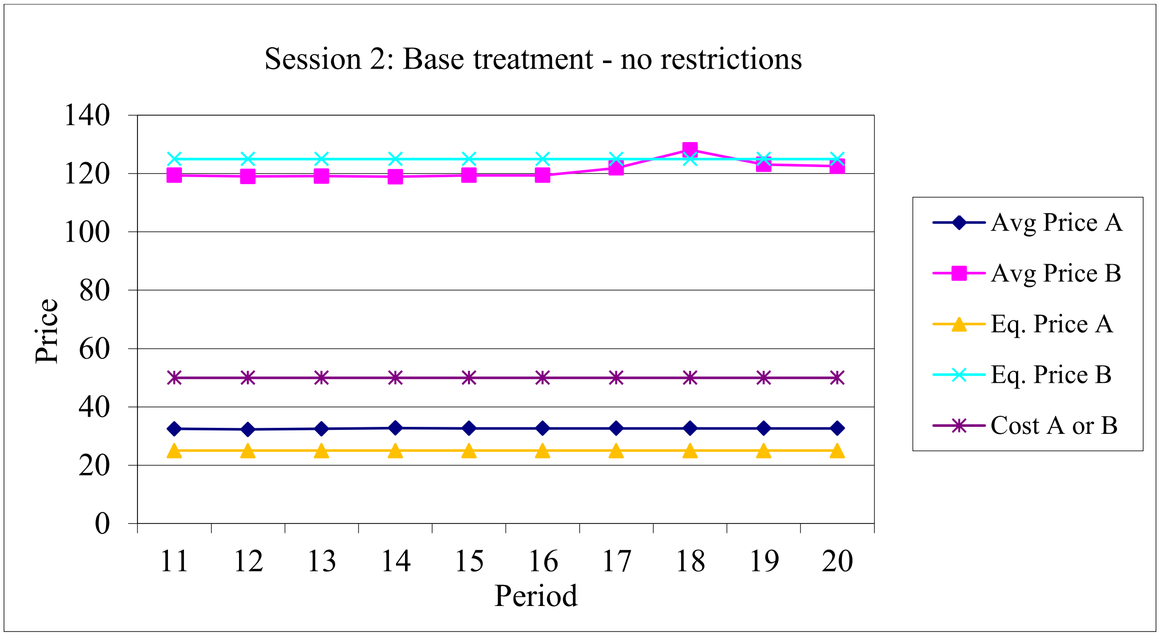


Figure 5.3 Session 2 – *Base* treatment

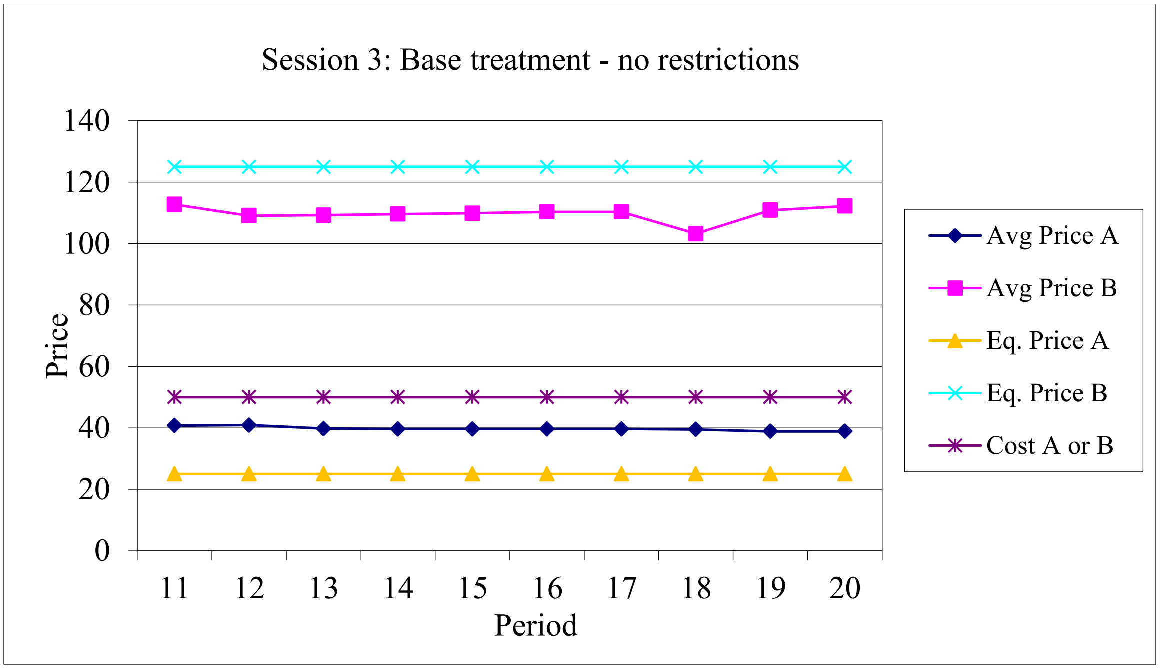


Figure 5.4 Session 3 – *Base* treatment

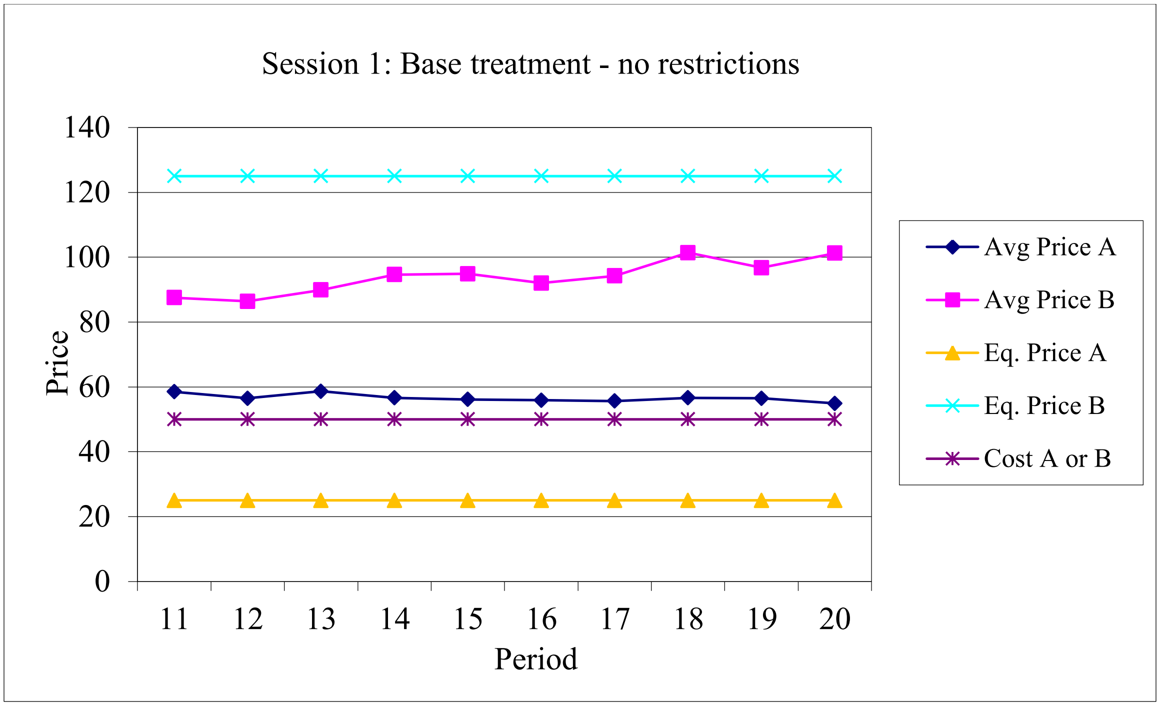


Figure 5.5 Session 1 – *Base* treatment

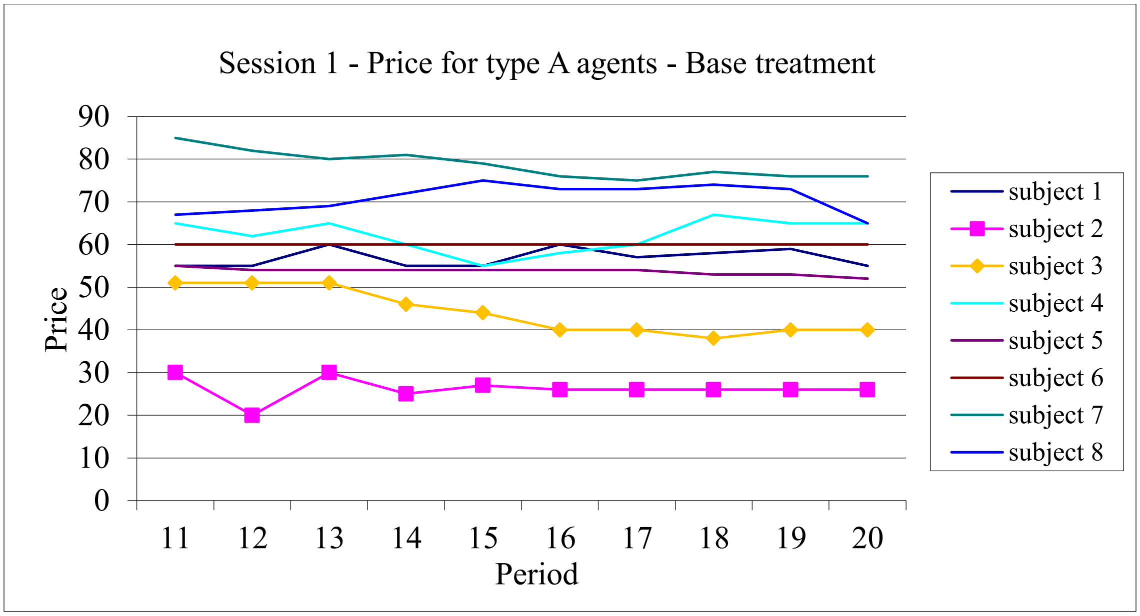


Figure 5.6 Session 1 – Prices for type A agents for each subject in the *Base* treatment

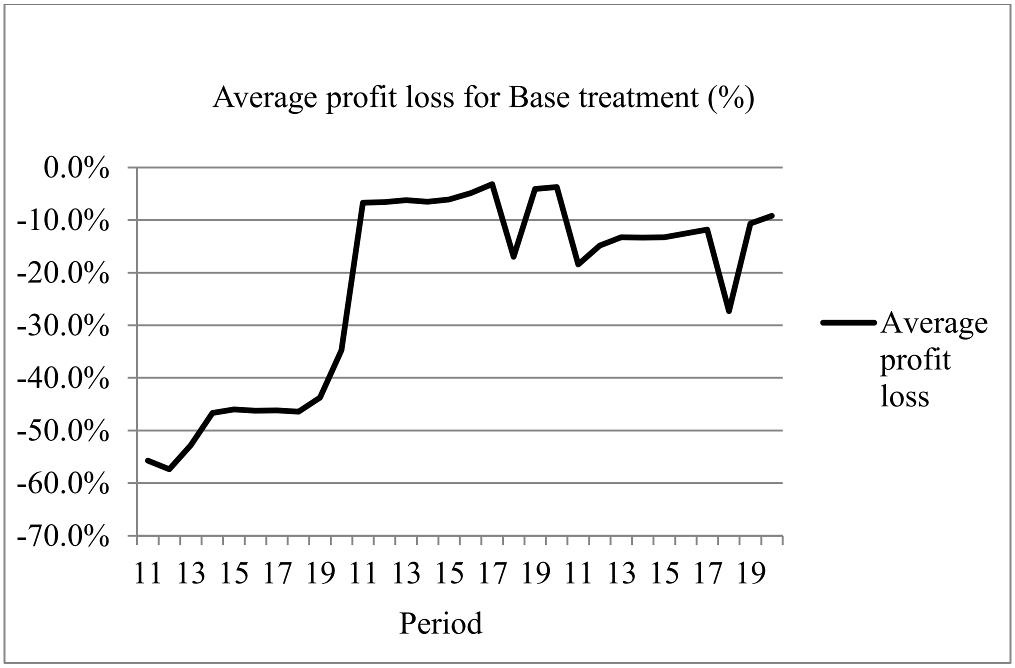


Figure 5.7 Average profit loss for *Base* treatment

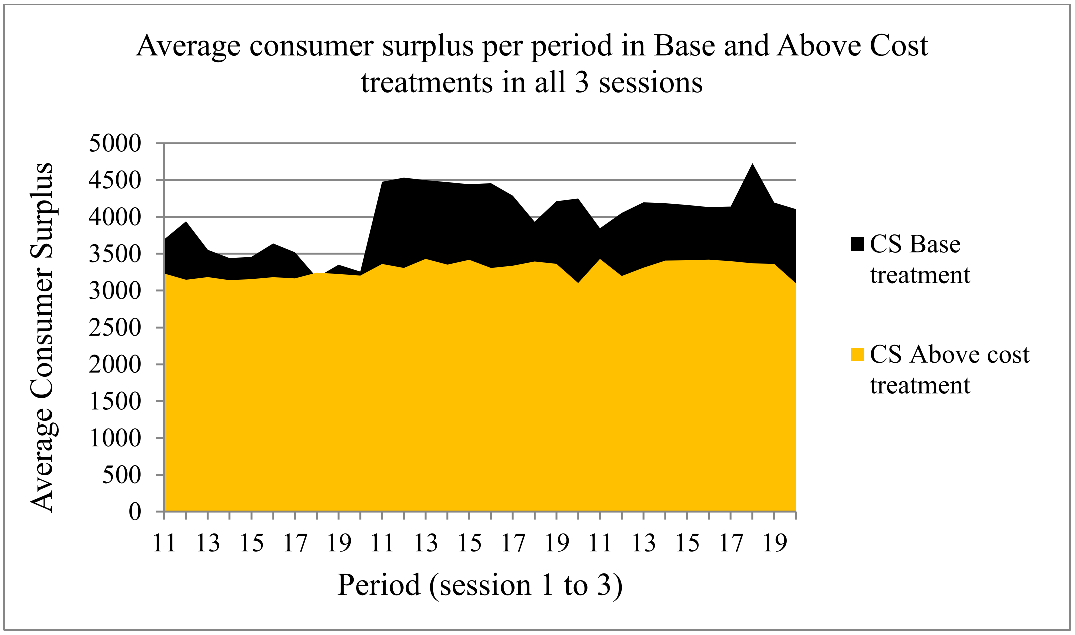


Figure 5.8 Session 1 – Prices for type A agents for each subject in the *Base* treatment[5]

[5] For a better illustration of the average consumer surplus, I add 8000 units to the values from the data. I choose 8000 units because it maintains the right proportions of the actual average consumer surplus for both treatments.

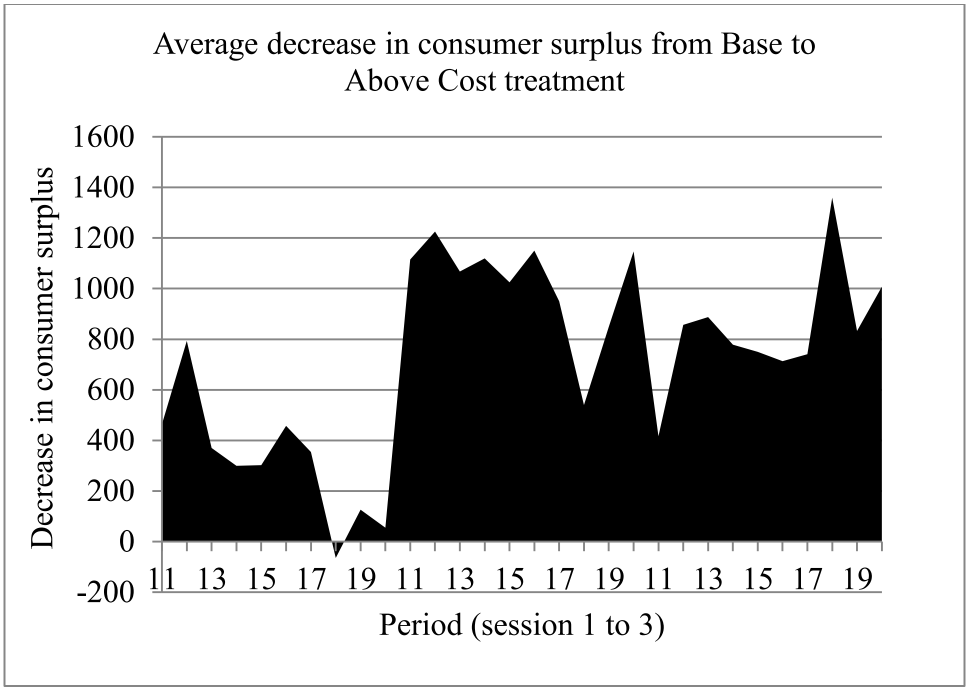


Figure 5.9 Average decrease in consumer surplus per period from *Base* to *Above Cost* treatment

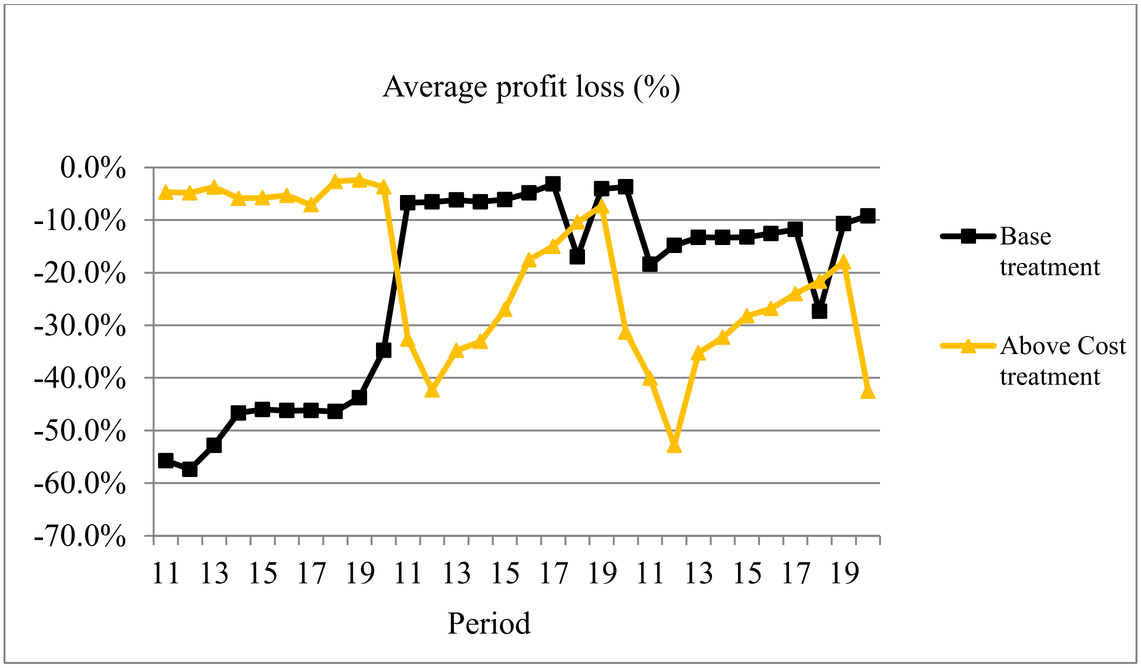


Figure 5.10 Average profit loss in *Base* and *Above Cost* treatments

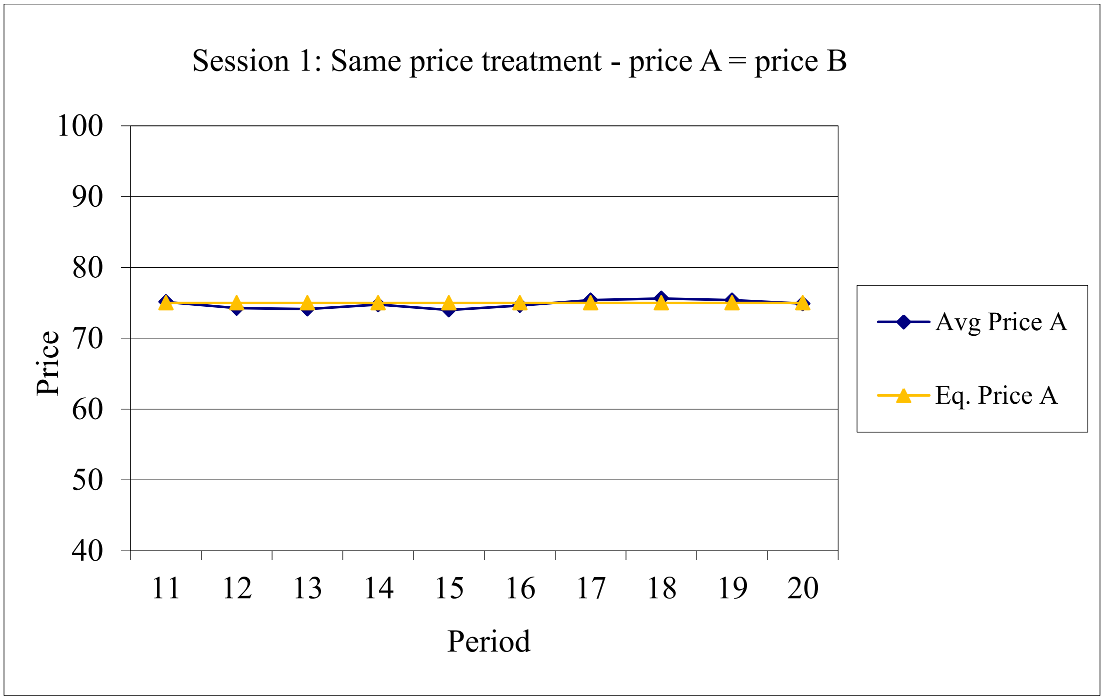


Figure 5.11 Session 1 – *Same price* treatment

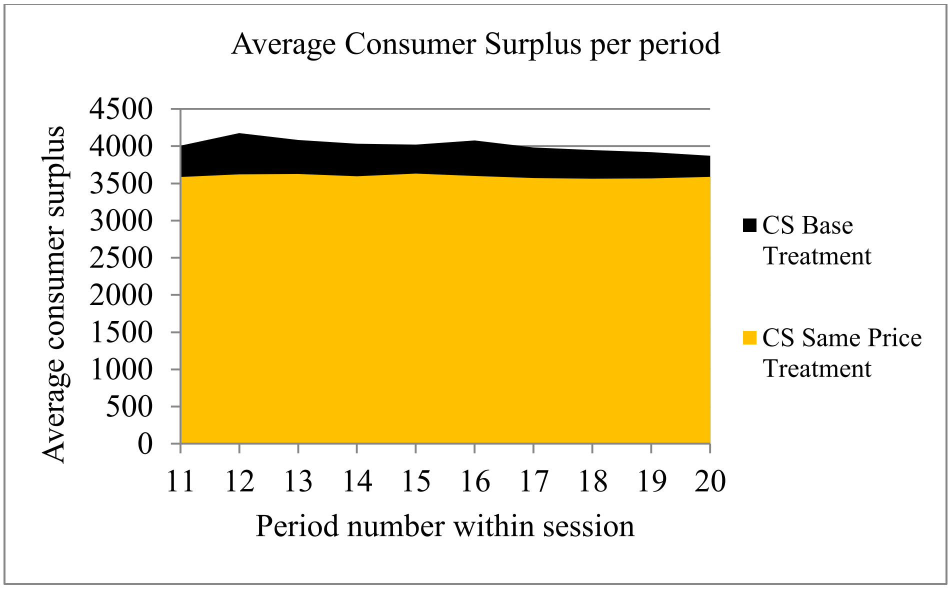


Figure 5.12 Average consumer surplus for the *Base* and *Same Price* treatments[6]

[6] For a better illustration of the average consumer surplus, I add 8000 units to the values from the data. I chose 8000 units because it maintains the correct proportions of the actual average consumer surplus for both treatments. For the *Base* treatment the average consumer surplus in each period represents the average of the consumer surpluses from all 3 sessions for that particular period.

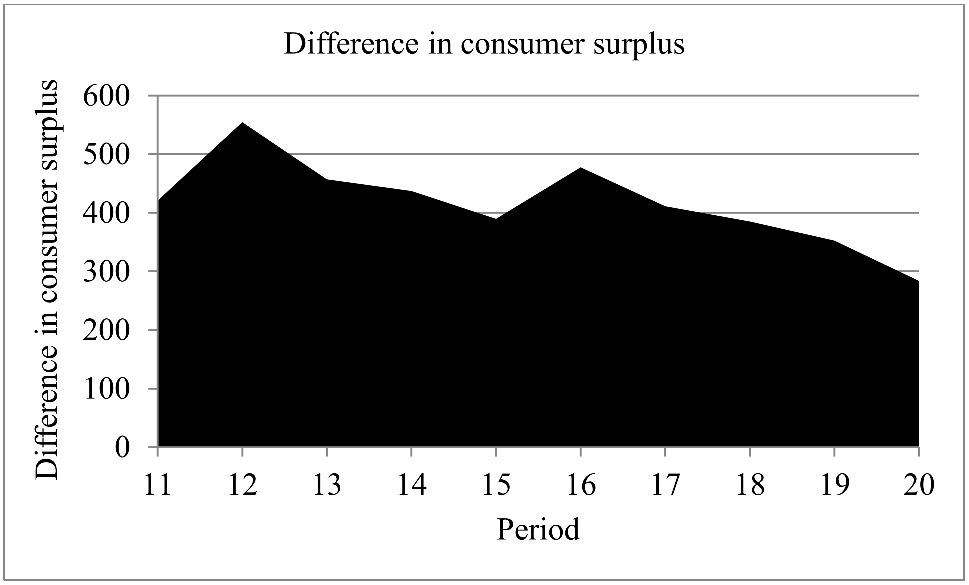


Figure 5.13 Difference in average consumer surplus per period between the *Base* and *Same Price* treatments[7]

[7] For the *Base* treatment the average consumer surplus in each period represents the average of the consumer surpluses from all 3 sessions for that particular period.

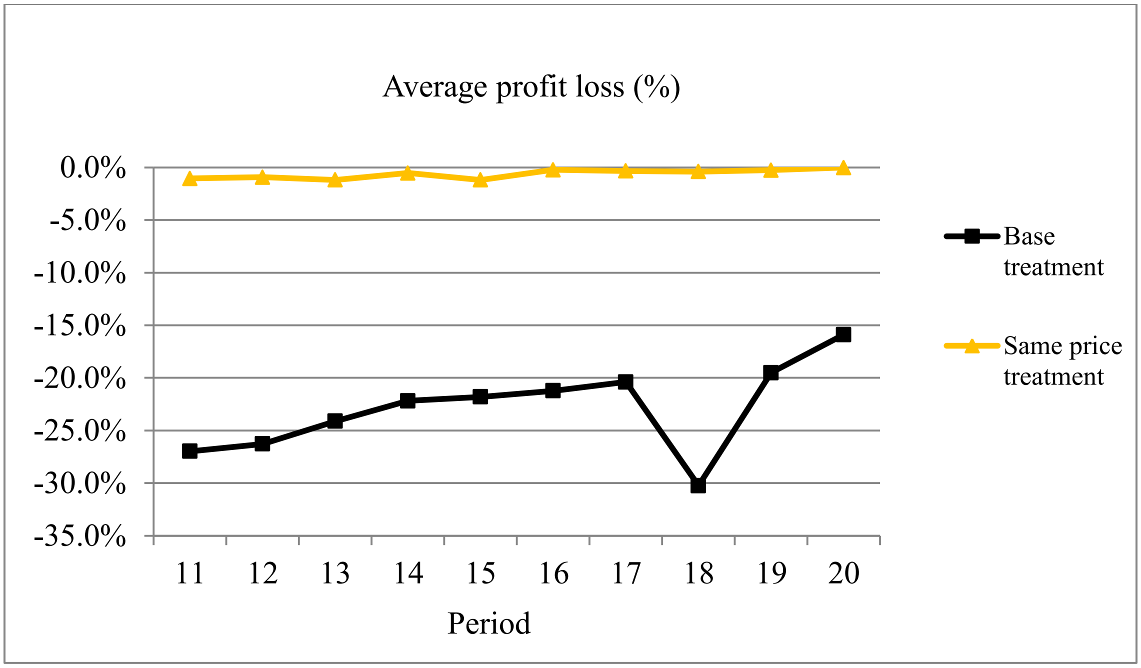


Figure 5.14 Average profit loss in *Base* and *Same Price* treatments

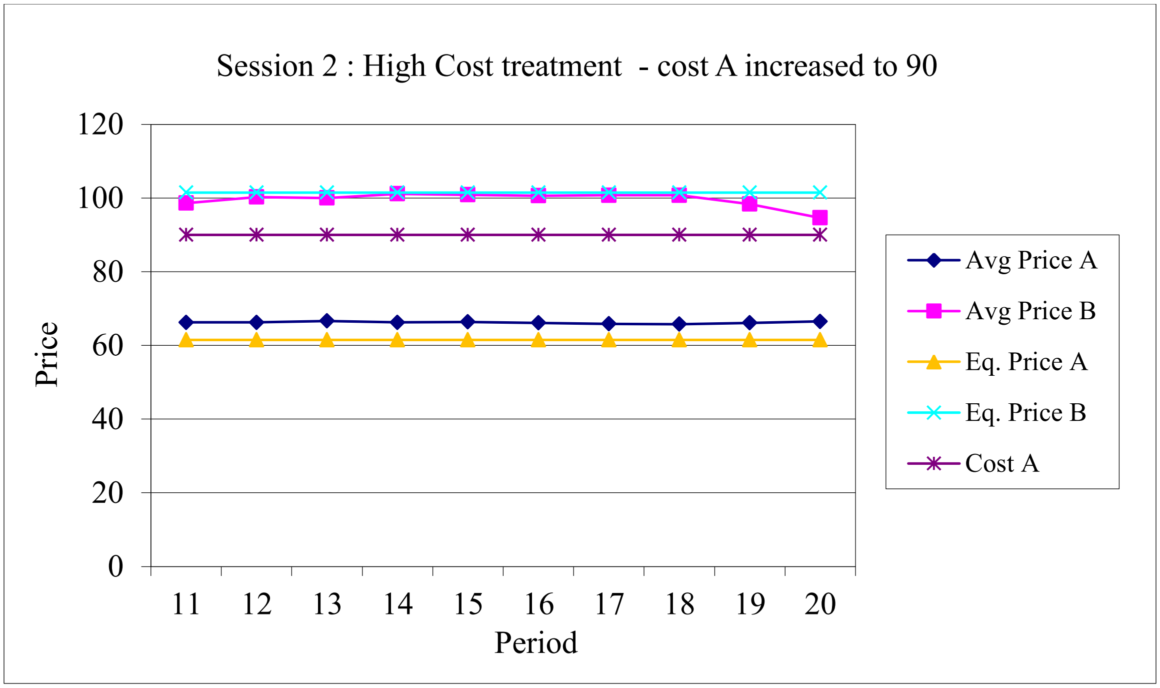


Figure 5.15 Session 2 – *High Cost* treatment

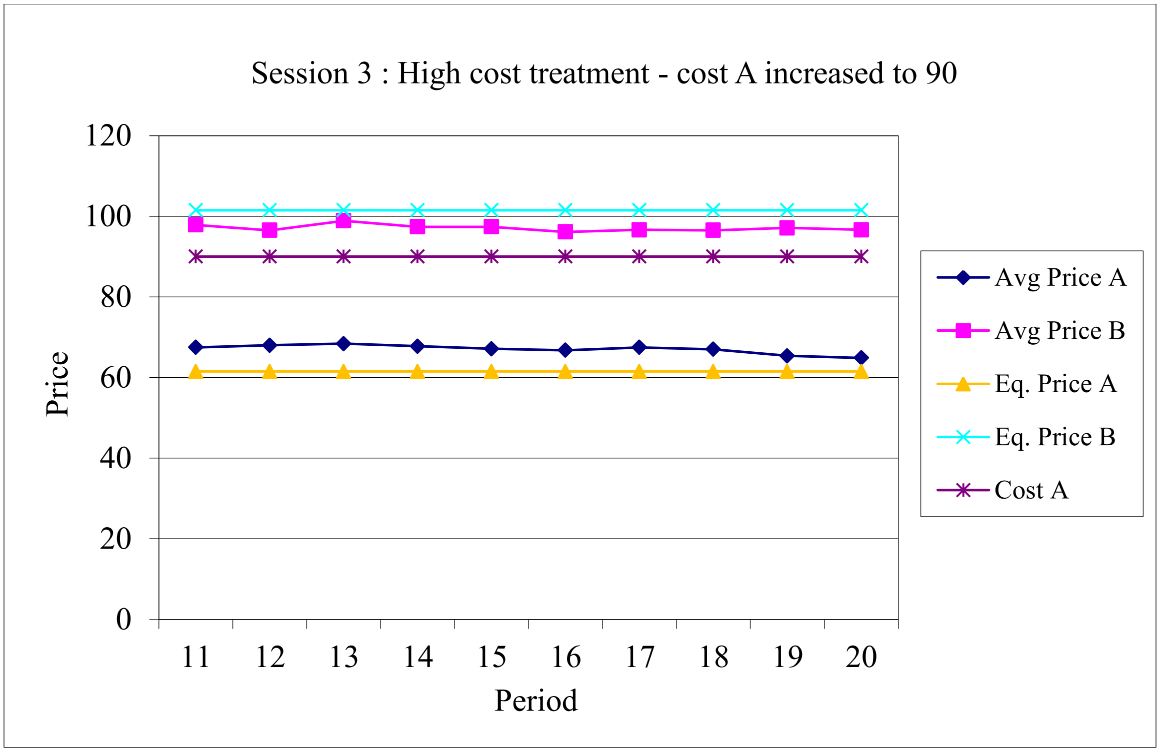


Figure 5.16 Session 3 – *High Cost* treatment

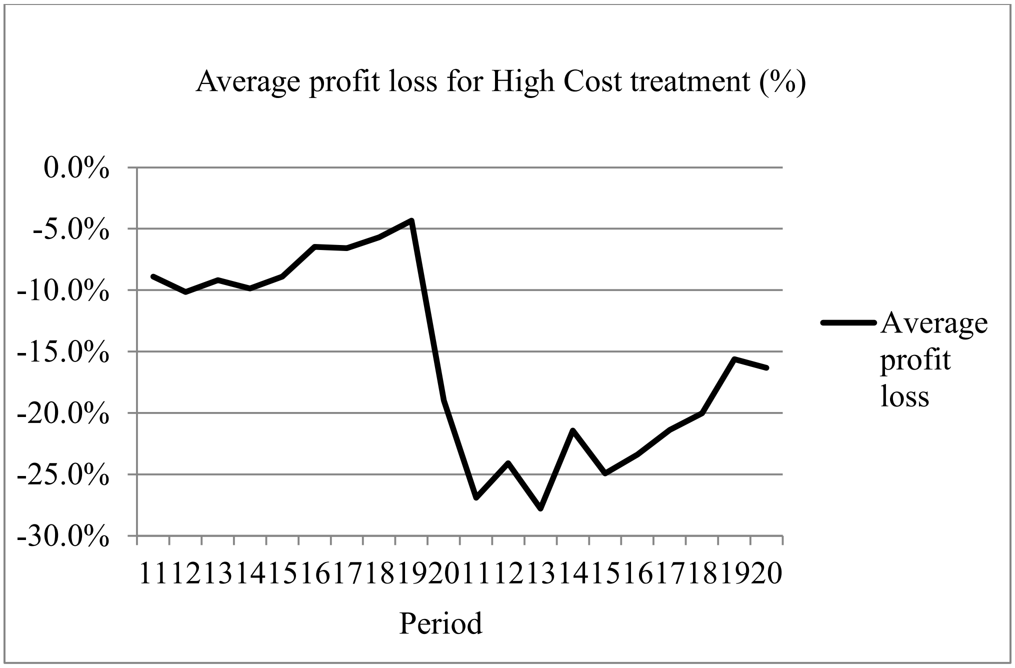


Figure 5.17 Average profit loss for *High Cost* treatment

Table 5.1 Values for the parameters of the model

	Parameters		
Side	Alpha (α)	Cost (f)[8]	Const. (d)
A	0.1	50 (90)	100
B	1.3	50	100

[8] For the *High Cost* treatment the cost on side A increases from 50 francs to 90 francs.

Table 5.2 The equilibrium prices, the equilibrium number of agents, total profit and total consumer surplus

		Treatment			
Equilibrium	Side	*Base*	*Above cost*	*Same price*	*High Cost*
Price	A	25.0	50.0	75.0	61.5
	B	125.0	107.5	75.0	101.5
Number of agents	A	83	57	32	44
	B	83	66	66	56
Profit		4150	3795	2450	1627
TOTAL CS		-2822	-4695	-4420	-4928

Table 5.3 Order of the treatment in each session

Order of the treatments	Session		
	I	II	III
1	*Base*	*Above cost*	*Above cost*
2	*Above cost*	*Base*	*High Cost*
3	*Same price*	*High Cost*	*Base*

Table 5.4 The effects of imposing a policy that requires prices to be set above cost on consumer surplus. Random effect model estimates (clustered by session)

VARIABLES	(1) Consumer Surplus
Period within session	-29.36**
	(13.40)
Treatment	-824.5***
(dummy ; *Above Cost*=1)	(87.21)
Order of the treatment	610.6**
within session	(274.9)
Constant	-3,822***
	(250.9)
Observations	480
Number of session	3

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5.8 Appendix

Experiment Instructions.

This experiment is about the economics of decision making. The instructions are simple, and if you follow them carefully and make good decisions you may earn a considerable amount of money which will be paid to you privately in cash at the end of the experiment.

Your payoff (or earnings) will be determined by your choices. All earnings will be in terms of francs. 350 francs will be converted to 1US dollar.

The information on your screen is private. Please do not talk to your fellow participants while the experiment is in progress. This is important to the validity of the study.

If you have any questions, please raise your hand and an experimenter will come to you and answer your question privately.

Description of the market

You own and manage a firm that helps two types of customers interact. We will call these customers "type A" and "type B". Your firm is the only firm in the market and no other firm can enter the market. Each of the two types of customers is interested in interacting with customers of the other type, but can only do so through your firm, after paying you a price for it. Your task is to choose the price that each type of customer has to pay your firm for this service. The price that you charge customers of type A might be the same price or not as the price you charge customers of type B.

In this experiment, customers of each type are computer simulated. They will decide if they want to pay for your service depending on two things:

1. The price you charge them: holding everything else constant, the higher the price you charge, the less likely they are to use your service (this is true for both types of customers).

2. The number of customers of the other type that are also using your service: holding everything else constant, the likelihood that a customer of type A decides to pay for your service increases with the number of customers of type B that are currently using

your service (and the other way around). So if you manage to attract one extra customer of type A, then your service will become more valuable to every customer of type B, and this increase in valuation will be the same to EVERY customer of type B (the same goes the other way around). In today's experiment holding everything else constant, the valuation that each type has for the other will be the following: for each additional 10 type A customers that will join your business, 13 more type B customers will join your business too. But for each 10 type B customers that will join your business just 1 more type A customer will join your business. That means that type B customers value type A customers more than type A customers value type B customers.

Example:

During the experiment the number of customers is rounded to the nearest whole number, but in this example for better illustration the number of customers is rounded to one decimal.

Assume that there is a firm that charges type A customers 60 francs and type B customers 60 francs for joining its business. Then there will be 50.6 type A customers that join the business and 105.8 type B customers that join its business (see the first line of the next 2 tables). Also assume the valuation that each type has for the other is the one from the previous paragraph.

First assume that the firm reduces the price for type A customers by 2 francs (see the second line of the next table), then another 2.3 type A customers will join the business. But even if the price for type B customers is the same, another 3 type B customers will join the business because now there are more type A customers in that business. If the firm lowers the price it charges the type A customers even more, then more type A customers will join the business. Again, more type B customers will join the business even if the price for type B customers did not change.

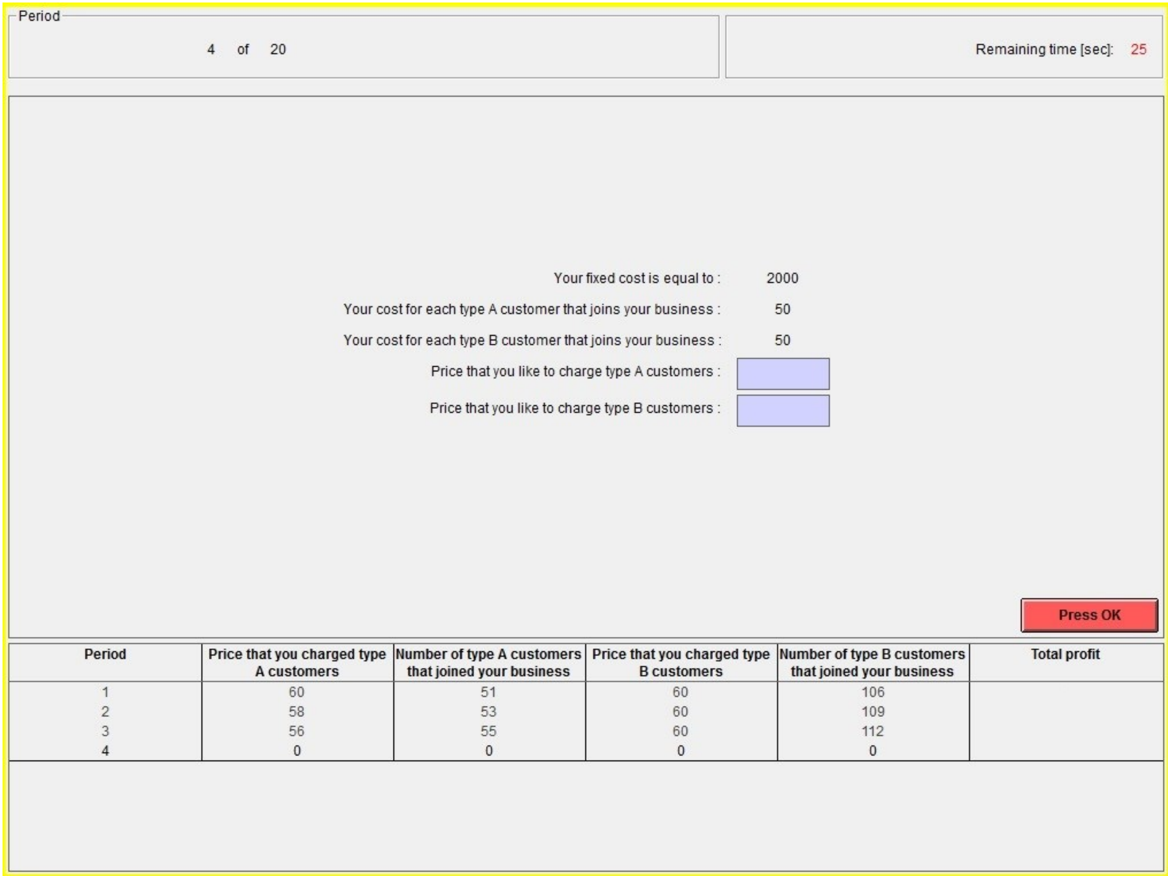
Example of lowering the price for type A costumers

Period	Price that the business charges type A customers	Number of type A customers that joined the business	Price that business charges type B customers	Number of type B customers that joined the business
1	60	50.6	60	105.8
2	58	52.9	60	108.8
3	56	55.2	60	111.8
4	54	57.5	60	114.8

Now assume that the firm lowers the price for type B customers by 2 francs (see the second line of next table), you can see that 2.3 more type B customers will join the business. But because type A customers are less interested in interacting with type B customers, the increase in the number of type B customers will increase the number of type A customers by only 0.2.

Example of lowering the price for type B costumers

Period	Price that the business charges type A customers	Number of type A customers that joined the business	Price that business charges type B customers	Number of type B customers that joined the business
1	60	50.6	60	105.8
2	60	50.8	58	108.1
3	60	51.0	56	110.4
4	60	51.2	54	112.7



Period	Price that you charged type A customers	Number of type A customers that joined your business	Price that you charged type B customers	Number of type B customers that joined your business	Total profit
1	60	51	60	106	
2	58	53	60	109	
3	56	55	60	112	
4	0	0	0	0	

(end of the example)

You face a constant cost of 50 francs for each type A customer that joins your business and a constant cost of 50 francs for each type B customer that joins your business. The difference between the price that you charge one type of customers (for example type A customers) and the cost that your firm has for that type of customer (in this example 50 francs) is the profit per-customer. If you multiply this difference times the number of customers of that type (type A customers in our example) that joined your business, you get the profit from that type of customer. The total profit for that period is the sum of the profit from type A customers and the profit from the type B customers minus a fixed cost. The fixed cost will be displayed on your screen and it stays constant during each part of the experiment. However, it may change from one part to the other part. You do not have to calculate your profit each period; this value will be displayed on your screen each period.

General specifications

This experiment will have 3 parts with 20 periods each. In each period you must choose the prices to charge type A customers and type B customers that join your business. The first 10 periods of each part will not be chosen for payment, so you may use those periods to investigate the relationship between the prices you charge and the profit you make. Two periods will be randomly chosen from the last 10 periods of each part (a total of 6 periods) and your total earnings in francs will be equal to the sum of the total profits for these 6 periods.

You will submit your chosen prices for each period using your computer. At the beginning of each new period the computer will show information about the outcomes from the previous periods. All that is required from you is to carefully choose the prices for your firm for each period.

At the end of each period your computer screen will show:

· the prices that you charged each period;

· the number of customers of each type that joined your business each period;

· the profit you earned each period.

Please record this information on the record sheet provided before you click the "Continue" button.

Part 1

Period	Price for type A customers	Number of type A customers	Price for type B customers	Number of type B customers	Total profit
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

Part 2

Period	Price for type A customers	Number of type A customers	Price for type B customers	Number of type B customers	Total profit
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

Part 3

Period	Price for type A customers	Number of type A customers	Price for type B customers	Number of type B customers	Total profit
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

Payment:

	Period	**Your profit in each period**
Part 1		
Part 1		
Part 2		
Part 2		
Part 3		
Part 3		
Total experimental earnings		
Total US dollars		

VITA

VITA

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