

Appendix

Some Strategic Aspects of Private Information: An Experimental Study[☆]

Andrés Salamanca Lugo¹

Toulouse School of Economics

Olga Manrique Chaparro

Department of Economics, Universidad Nacional de Colombia

1. Experimental Design

The experiment was conducted in the Computer Center at the Faculty of Economics of the Universidad Nacional de Colombia in April 2011. It was programmed using Z-Tree¹. Subjects were recruited through public announcements made via institutional e-mail. In total, 130 subjects participated, mostly of them were undergraduates from Economics, Accounting and Business administration. We implement two sessions, each one corresponding to a repeated game. Subjects were randomly assigned to a seat in the laboratory, and consequently to a role (player 1 or 2) in the corresponding session (revealing and non-revealing game). Once everyone was seated, subjects were instructed on the rules of the game with written instructions which were read aloud before the start of the experiment. Thereafter, roles were revealed and one of the two matrices was chosen with equal probability. Subjects were told that the stage matrices are equally likely, but only row players were informed about the actual stage matrix being played. Next, they played the repeated game for 17 rounds. No individual was informed about the number of repetitions. Subjects were only told that the game will be repeated for a “long” number of rounds, without any clear idea of *how* long. The number of repetitions was determined in such a way that the experiment did not exceed two hours. Subjects remained in the same role and played against the same opponent during the whole session. The NR (resp. FR) game was played by 33 (resp. 32) pairs, of which 16 (resp. 10) played the game A and 17 (resp. 22) the game B.

In addition to a participation fee of \$10.000 COP², subjects could earn up to \$3.000 COP depending on their performance.

[☆]This appendix contains supplementary material to the paper “Some Strategic Aspects of Private Information: An Experimental Study”. For publication on-line.

Email addresses: asalamanca1.tse@gmail.com (Andrés Salamanca Lugo), olmanriquec@unal.edu.co (Olga Manrique Chaparro)

¹Fischbacher, U. (2007) z-Tree. Zurich toolbox for ready-made economic experiments, *Experimental Economics*, 10(2), p. 171-178.

²For comparison purpose, \$10.000 COP allow (at the date) for 6 trips in public transportation or 2 balanced lunches.

In order to study whether uninformed players were able to learn the game they were playing, we elicited the corresponding beliefs. In each period uninformed players had to answer the following question: *Which do you think is the matrix you are playing?*

At any stage, we displayed on the subjects' computer screen the history of all previous actions from both players (perfect monitoring). During the whole experiment subjects did not receive any information about their payoffs. Oral and visual communication between subjects was not allowed. At the end of the game subjects were provided with full information about the realized payoffs and the actual matrix.

2. Written Instructions

In the following we will present the information subjects received during the experiment. The instructions below are a translation of the instructions for the non-revealing game. The instructions for the fully revealing game are similar.

INSTRUCTIONS

You are now taking part in an economics experiment. Please read the following instructions carefully. All your answers will be anonymous and you will make decisions using the computer in front of you. You are not allowed to communicate during the experiment. If you have any questions, please raise your hand. A member of the experimenter team will come to you and answer them.

General Information. The experiment consist of **several periods** where decision must be made and questions answered. You can win points with your decisions. These points represent your earnings and will be converted into pesos at the end of the experiment and paid out in cash.

Interaction per Period. At the beginning of the experiment, you will be anonymously and randomly assigned to another participant in the room. **This allocation is maintained throughout the whole experiment.** The participant who has been assigned to you will be called "your opponent". In each period, you and your opponent will be confronted to *one* of the following matrices:

	West	Est
North	1, -1	0, 0
South	0, 0	0, 0

Matrix A

	West	Est
North	0, 0	0, 0
South	0, 0	1, -1

Matrix B

One participant plays as Player 1, the other plays as Player 2. You will know at the beginning of the experiment whether you are Player 1 or Player 2. **Your role will remain the same during the whole experiment.**

In each matrix, Player 1 has to choose between one of the two rows, **North** and **South**; and player 2 has to choose one of the two columns, **Est** and **West**. The numbers in the matrices correspond to the outcomes of the game. The first number indicates the number of points earned by Player 1 depending on the decision of Player 1 (chosen row), the decision of Player 2 (chosen column) and the selected matrix (matrix A or matrix B). Similarly, the second number indicates the number of points earned by Player 2 depending on the decision of Player 1 (chosen row), the decision of Player 2 (chosen column) and the selected matrix (matrix A or matrix B). For instance, if Player 1 chooses “North”, Player 2 chooses “West”, and the payoff matrix is Matrix A, then Player 1 gets 1 point and Player 2 loses 1 point.

Interaction in the Repeated Game. At the beginning of the experiment, one of the two matrices is randomly selected with equal chance of selecting either Matrix A or Matrix B. The mechanism for selecting the matrix is equivalent to the procedure of tossing a coin: with 50% of chance the coin lands on “heads” (so Matrix A is chosen) and with 50% of chance the coin lands “tails” (so Matrix B is chosen). **Player 1 is informed about the matrix that has been drawn. In contrast, Player 2 will NOT know the result of the random draw of the matrix.**

As soon as the matrix has been drawn, and Player 1 has been informed about the draw, period 1 starts. In each period, you and your opponent will be confronted with the matrix that has been drawn at the beginning of the experiment. **The matrix remains the same in ALL periods until the end of the experiment.** Each time, Player 1 have to choose between the alternatives “North” and “South”, and Player 2 must choose between alternatives “Est” and “West”. Both matrices are displayed on the screen of the computer at every period. After you and your opponent have chosen between the alternatives, you will be informed about your opponent’s choice. At any period, you will be able to look at feedback information regarding decisions in all previous periods. This is the only information you will be given during the experiment in each period. The next period begins after that. The total number of periods is uncertain *but large*.

Beliefs. In case you are assigned the role of Player 2, at the beginning of each period you will be asked about your belief on the matrix that has been drawn. You will have to answer the following question:

Which do you think is the matrix you are playing?

Converting Points into Pesos. At the end of the experiment a screen appears to inform you about the matrix drawn (in case you are Player 2), the choices of you and your opponent at each period, and the average number of points earned during the experiment. Your earnings will be computed as follows:

- In case you are Player 1, you will receive \$3.000 if the average number of points earned during the experiment is greater or equal to 0.5, i.e., if you manage to cumulate 1 point per period in at least 50% of the periods.
- In case you are Player 2, you will receive \$3.000 if the average number of points earned during the experiment is greater or equal to -0.5 , i.e., if you manage to cumulate 0 points per period in at least 50% of the periods.

In addition, a participation fee of \$10.000 will be added to your earnings from the experiment.

Because the probability that an uninformed player gets zero payoff in the fully revealing game is relatively high compared to the non-revealing game, the mechanism for rewarding performance in the fully revealing game is modified in the following manner:

- In case you are Player 1, you will receive \$3.000 if the average number of points earned during the experiment is greater or equal to -0.25 , i.e., if you manage to cumulate 0 points per period in at least 75% of the periods.
- In case you are Player 2, you will receive \$3.000 if the average number of points earned during the experiment is greater or equal to 0.25, i.e., if you manage to cumulate 1 point per period in at least 25% of the periods.

3. Statistical Evidence

Let $x_{i,n}$ be an indicator variable that takes the value 1 if the informed (resp. uninformed) player i has chosen S (resp. E) at stage n . Then $\bar{x}_i = \frac{\sum_{n=1}^{17} x_{i,n}}{17}$ is the relative frequency of the action S for individual i . Let M be the number of informed (resp. uninformed) subjects. Thus, $\bar{x} = \frac{1}{M} \sum_i \bar{x}_i$ is the average frequency of the action S .

3.1. Non-revealing Game

The distance of \bar{x} from 0.5 measures the extent to which informed players were able to optimally ignore their private information. Table 1 presents a z-test for statistically significant deviations of \bar{x} from 0.5³.

We find statistical evidence indicating that the informed subjects played the stage-dominant action more often. Thus we expect the uninformed players to choose more frequently the stage-dominant action of the revealed game. In table 2, we statistically test whether there is a significant deviation toward any particular action in the choice of the uninformed players. We did not find statistical evidence to reject the null hypothesis that $\bar{x} = 0.5$.

³In our data, the number of available observations for the z-test are too few for providing strong statistical evidence. In order to deal with this problem, we implemented a nonparametric bootstrapping method for computing the empirical distribution of \bar{x} . Henceforth, all bootstrap samples are based on 5000 draws.

Table 1: z-test for the frequency of S in the NR game

$H_0 : \bar{x} = 0.5$	$H_a : \bar{x} < 0.5$		$H_a : \bar{x} > 0.5$	
	G_A	G_B	G_A	G_B
\bar{x}	0.356	0.685	0.356	0.685
Asymptotic p-value	0.008	0.997	0.992	0.003
Bootstrap p-value	0.034	0.984	0.966	0.016
Observations	16	17	16	17

Table 2: z-test for the frequency of E in the NR game

$H_0 : \bar{x} = 0.5$	$H_a : \bar{x} < 0.5$		$H_a : \bar{x} > 0.5$	
	G_A	G_B	G_A	G_B
\bar{x}	0.548	0.412	0.548	0.412
Asymptotic p-value	0.789	0.092	0.210	0.908
Bootstrap p-value	0.726	0.164	0.274	0.836
Observations	16	17	16	17

3.2. Fully Revealing Game

Statistical evidence in table 3 indicates that informed subjects played the stage-dominant action more often in both stage games.

Table 3: z-test for the frequency of S in the FR game

$H_0 : \bar{x} = 0.5$	$H_a : \bar{x} < 0.5$		$H_a : \bar{x} > 0.5$	
	G_A	G_B	G_A	G_B
\bar{x}	0.782	0.254	0.782	0.254
Asymptotic p-value	0.997	0.000	0.004	0.999
Bootstrap p-value	0.984	0.005	0.016	0.995
Observations	10	22	10	22

Table 4 presents the results for the uninformed subjects. We found that the stage-*dominated* action was played too often when the actual stage game was A, however there is no statistical evidence for rejecting the null hypothesis that $\bar{x} = 0.5$ in stage game B.

A possible explanation for the observed behavior of uninformed players is that they consistently believed to be in the wrong stage game. Figure 1 provides a summary of the evolution of the beliefs on each actual stage game.

Whenever the actual stage game was A (resp. B), the average frequency of uninformed players that believed to be in game B (resp. A) was around 70% (resp. 50%). We define y_i as the average belief of individual i across all stages. Then, $\bar{y} = \frac{1}{M} \sum_i y_i$ is the average belief in the game. Table 5 presents a z-test for statistically significant deviations of \bar{y} from 0.5.

In stage game A beliefs were significantly below 0.5, while in stage game B the statistical evidence did not allow to reject the null hypothesis that $\bar{y} = 0.5$.

Table 4: z-test for the frequency of E in the FR game

$H_0 : \bar{x} = 0.5$	$H_a : \bar{x} < 0.5$		$H_a : \bar{x} > 0.5$	
	G_A	G_B	G_A	G_B
\bar{x}	0.712	0.439	0.712	0.439
Asymptotic p-value	0.998	0.143	0.002	0.858
Bootstrap p-value	0.996	0.214	0.004	0.786
Observations	10	22	10	22

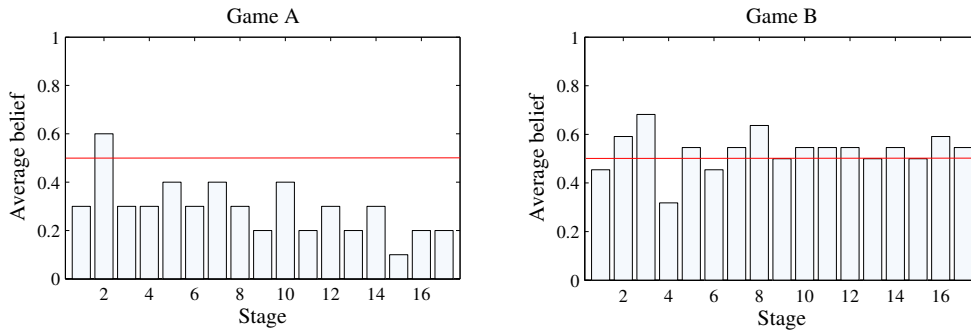


Figure 1: Average uninformed players' beliefs about game A

Table 5: z-test for beliefs in the FR game

$H_0 : \bar{y} = 0.5$	$H_a : \bar{y} < 0.5$		$H_a : \bar{y} > 0.5$	
	G_A	G_B	G_A	G_B
\bar{y}	0.294	0.532	0.294	0.532
Asymptotic p-value	0.007	0.706	0.992	0.294
Bootstrap p-value	0.021	0.658	0.979	0.342
Observations	10	22	10	22