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Fundación Centro de Estudios Andaluces (**centrA**)
Bailén, 50 - 41001 Sevilla

Tel: 955 055 210, Fax: 955 055 211

e-mail: centra@fundacion-centra.org
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The Effects of Common Advice on One-shot Traveler's Dilemma Games: Explaining Behavior through an Introspective Model with Errors[1]

C. Monica Capra
Washington and Lee University USA

Susana Cabrera
Universidad de Málaga

Rosario Gómez
Universidad de Málaga

RESUMEN
Para probar la robustez de un modelo de introspección con ruido se muestran los resultados de un experimento sobre el dilema del viajero en un solo período. Se comparan los resultados alcanzados por los jugadores cuando reciben el consejo previo de un experto en este juego, con los resultados obtenidos cuando no interviene la opinión del experto. El modelo describe un proceso, no de equilibrio, mediante el cual los jugadores toman decisiones con error en contextos de un solo período. Varias simulaciones muestran que las predicciones del modelo son consistentes con los datos experimentales.

Palabras clave: teoría de juegos, introspección, experimentos, simulación, comportamientos con ruido.

ABSTRACT
We report results of single interaction Traveler's Dilemma game experiments with and without expert advice to test the robustness of a model of noisy introspection. The model describes an out-of-equilibrium process with errors by which players reach a decision of what to do in strategic situations. By tracing the process by which players determine what to do, one can find a prediction for single interaction games. Simulations show that the model's predictions are consistent with experimental data.

Keywords: game theory, introspection, experiments, simulations, noisy behavior.

JEL classification: C63, C72, C92.

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Please address correspondence to Rosario Gómez. E-mail: rosgomez@uma.es. Tel.: +34 952-13-12-51. Fax: +34 952-13-12-99.

1. Introduction

The idea that economic behavior can be best described by models of imperfect rationality is associated with the work of Herbert Simon (1957, 1959, 1987). Simon suggested that decisions are subject to error due to costs of making a choice or simply due to the lack of computational ability or cognitive limitations. These “constraints” result in behavior that is not perfectly rational, as economists assume, but procedurally rational in the sense that they are an outcome of some strategy of reasoning. [1]

There are only a few recent papers that model equilibrium in games under bounded rationality (see for instance Anderson, Goeree and Holt, 1997, 2002; McKelvey and Palfrey, 1995; 1998; and Rosenthal, 1989). However, with notably few exceptions, theory has almost entirely neglected procedural rationality when attempting to model choices. This is particularly serious in games because, when decisions are interdependent, modeling *how* bounded rational players decide what to do may actually provide more accurate predictions than modeling *what* players with bounded rationality are expected to do in equilibrium. In addition, as Binmore (1988) suggests, “…to seek to tackle procedural questions seriously is to commit oneself to an attempt to model the thinking processes of the players explicitly.” But traditional game theory thus far lacks such an explicit model of the thinking process.

The existence of an explicit model of decision making can, among other things, allow choices made in one-shot games to be better understood. In games played once, there is no chance for repetition or observation of others' actions; hence, arriving at an outcome requires agents to "solve" the game perhaps through some introspective process that consists of tracing through a series of responses without feedback from previous plays of the game. Thus, instead of focusing on equilibrium models to find a prediction for games played only once, one should consider the thought process that precedes an action.[2] Despite of this, equilibrium does not have to be ignored, but can be thought of as a state that is achieved after learning during a prolonged period of playing a game.

In this paper, we present data from one-shot Traveler's Dilemma games first introduced by Basu (1984) that can be accurately explained by "a model of introspection." Binmore (1988) calls a process that develops at the introspective level such as this one, an "eductive libration," which consists of "reasoning chains: I think that you think that I think…" We call this process the "introspective process." The introspective process consist of determining what a player should do given some possible actions by the others, and then calculating the others' response, iteratively until a stopping rule is satisfied. The beliefs that determine choice probabilities are degenerate distributions that put all of the probability mass into a single point. The choice probabilities that determine the responses follow the logit rule; this rule has the desirable property that response probabilities are a function of the player's payoffs and contains a parameter that measures the deviation from a best response. Better responses are more likely to be considered than worse responses, but best responses are not considered with certainty. Thus, our model introduces bounded rationality and errors in decision making and hence differs from other models similar in spirit (i.e., introspective) such as Bernheim's (1984) and Pearce's (1984) *rationalizability*, Harsanyi and Selten's (1988) *tracing procedure*, and Stahl (1993) and Stahl and Wilson's (1994) *n-level rationality*.

In our model, the stopping rule requires consistency in thinking or "internal consistency." If, for example, a player's own conjecture about the other's choice is what he postulates would be the other's reply to his own decision, choices are internally consistent and the player infers that that strategy combination is the solution. In this model, if the player's expectations are not *internally* consistent, the iterative thought process continues by iterating perceived best replies. As mentioned above, responses are assumed susceptible to calculation mistakes and become probabilistic rather than deterministic. Once players end their introspective process or satisfy the stopping rule, the model finds a probability distribution over the possible strategies as the prediction of behavior. Nevertheless, agents' beliefs do not have to be consistent with the actions generated by those beliefs; that is, the introspective model is not an equilibrium model. Presumably, either a deterministic equilibrium or a probabilistic equilibrium would arise from learning and previous experience, but these are not possible in our context of one-shot games.[3] Finally, because responses follow the logit rule, the solution has the property that it is sensitive to a player's own payoff and to the payoffs of the other players.

We use the Traveler's Dilemma to test the predictive power of the model and its robustness because in this game "reasoning chains" are likely to occur.[4] Indeed, comparisons between the data and simulations show that our introspective model is a good predictor of behavior in single interaction Traveler's Dilemma games. In addition, to test the robustness of the model, we look at the effect of a common advice on decisions. Common advice is introduced by making public a "best claim" advice that players of a repeated Traveler's Dilemma game give to subjects playing a single interaction game with the exact same parameters. Unlike other models of introspection that are based on "best-response" dynamics such as n-level rationality and rationalizability, the model we consider here explains choices that move away from equilibrium despite common knowledge of the advice. In other words, even after all players know that all know what the "adviced claim" is, choices move away from the direction predicted by "best response" behavior.

The next section is briefly devoted to the explanation of the Traveler's Dilemma game. Section 3 introduces the introspective process and Section 4 presents the simulations. The experimental design and procedures are presented in Section 5. In section 6 the experimental and simulated data are described and compared with the theoretical predictions. Finally, section 7 contains a conclusion.

2. The Traveler's Dilemma

Basu (1984), who introduced the Traveler's Dilemma, describes the game as a situation in which two travelers lose their luggage during a flight when returning from a remote island. The luggage of each traveler contains the exact same native art. To compensate for the damages, the airline manager asks each traveler to independently make a claim for the value of the lost art between $\underline{x}$ and $\overline{x}$. And, in an attempt to discourage lying, the manager offers to pay each traveler the minimum of the two claims, plus a reward of r for the lower claimant, minus a penalty of r for the higher claimant. If the claim amounts are the same, each traveler is fully reimbursed for the claim. Surprisingly to some, the only Nash equilibrium is for both to make the minimum claim, which is independent of the size of the penalty or reward. Indeed, no matter how small the reward and penalty are, each traveler has an incentive to "undercut" the other's claim, and the only state where nobody has such incentive to deviate happens when both claims are identical and equal to the minimum claim.

As Basu notes, the minimum allowed claim is also the only rationalizable equilibrium when claims are discrete. The concept of rationalizability is entirely derived from the assumptions of rationality and common knowledge of rationality. A rational player will only use those strategies that are best responses to some beliefs about the opponents' strategies. Moreover, since the player knows his opponents' payoffs and strategies, and rationality is common knowledge, he should expect his opponents to use only strategies that are best responses to beliefs that they might have. Indeed, for a choice to be rationalizable a player not only needs to find a best response to a forecast of what the other would do, but a player should also be able to construct a conjecture of the other's assessment of that player's own action for which the initial forecast is a best response. This process of applying best responses to best responses happens in the player's mind; hence, rationalizability requires a kind of introspective process to find a solution. Applied to the Traveler's Dilemma, rationalizability predicts that the travelers claim the lowest amount. To see this, consider the game in Table 1, which depicts the traveler's dilemma game in normal form. Note that claims are integers between $\underline{x}$=20 cents and $\overline{x}$=120 cents and that the reward and penalty in this example both are equal to 5 cents (r = 5 cents).

[Table 1: The Traveler's Dilemma in Normal Form]

The process to find a rationalizable solution may go as follows: Row player would exclude playing the maximum claim of 120 cents because the choice of a claim k=120 has zero probability of happening. It is not a best reply to any strategy (recall that under the assumption of rationalizability, a player will *not* reasonably play a strategy that is *not* a best response to some subjective belief about the opponent's strategies). Moreover, since rationality is common knowledge, Row should expect Column to exclude 120 cents as well; hence, Row should not choose 119 since this claim is not a best response to a belief that happens with positive probability. And, since rationality is common knowledge, Row should not expect Column to choose 119, and so on. The same logic applies for all claims greater than the minimum claim. This iterative process leads to a unique strategy that cannot be excluded based on common knowledge of rationality, which is the minimum claim. In other words, 20 cents is the only strategy that survives all possible rounds of iterations of best responses. Thus, following rationalizability in the Traveler's Dilemma, selecting a maximum claim would be simply irrational even when the reward/penalty is very small. This is because it is not a best response to any belief about the other's choices for which a player assigns positive probability of occurring.

In contrast, Capra *et al.* (1999) use data from the last five periods of a multiple periods Traveler's Dilemma game to confirm that behavior is close to the Nash prediction when the penalty or reward is high, but that claims tend to the maximum level as the penalty or reward approaches zero. Moreover, a casual look at the first period data shown in Figure 1 suggests that payoff incentives affect first-period choices in a manner similar to how incentives affect equilibrium choices. We believe that this first-period effect indicates that, before any decision is made, players engage in an introspective type of decision-making process that takes into account payoffs from possible claims and their respective opportunity cost (i.e., penalty/reward). However, in the game below, players know that the game will be played a number of periods, thus first period choices are likely to be affected by factors other than payoffs and errors; such factors should disappear in single interaction games.

[Figure 1: Observed First-period Claim Frequencies]

In the section that follows a prediction for the single interaction Traveler's Dilemma game of Table 1 is found by using a noisy model of introspection. This introspective process is similar *in spirit* to rationalizability in the sense that expectations are iterated until a player finds a strategy that is "internally consistent" or satisfies a "stopping rule" criterion. However, their predictions are quite different. To begin, rationalizability provides a solution that is independent of the size of the reward/penalty since it is based on applying best responses to best responses. Moreover, rationalizability attempts to find a rational justification for a solution *post hoc* based on the assumption of common knowledge of rationality. In contrast, our introspective model reaches a solution by tracing the decision-making process of players. Hence, instead of looking at a strategy and trying to determine whether it is internally consistent, hence rationalizable, the decision making process is traced starting from an initial reference point, and this tracing leads to the solution. A result is that rationalizability expands the set of possible outcomes whereas our model provides a unique probability distribution over all choices.

3. The Introspective Model and the Traveler's Dilemma

Experimental data indicate that there is a statistically significant effect of the reward/punishment parameter on the first period choices. These claims are not equilibrium claims—claims tend to move away from their initial levels in later periods—and so, an equilibrium model will be an inappropriate model to use to predict decisions in the first period. Similarly, for one-shot games, an equilibrium model is not the right model since equilibrium is the result of an adjustment process through learning and repetition. As argued above, a model of introspection is a more adequate model of behavior in single interaction games. In addition, rationalizability, which can be thought of being an introspective model, is based on best responses and, for the Traveler's Dilemma, it predicts a unique solution independent of the size of the reward/penalty. In contrast, a model that traces the "noisy" decision making process of the players not only provides an appropriate prediction for single interaction choices, but it also responds to changes in the payoff values in a predictable manner and in accordance to what one observes in the data.

This introspective process consists of tracing the strategic decision making process that precedes an action. The process consists of reasoning chains such that a boundedly rational player forms a decision of what to do in view of what he/she thinks the others are likely to do, and of what he/she thinks the others think he/she is likely to do, etc. When calculating a response, these boundedly rational players put the entire belief probability mass on one of the strategies. In addition, responses are assumed susceptible to calculation mistakes and the probabilities that determine these responses follow the logit rule. These kind of stochastic responses have the desirable properties that response probabilities are a function of the players' payoffs and contain a parameter (μ) that measures the deviation from a best response (see McKelvey and Palfrey, 1995). The stopping rule requires that a point is mapped into itself by a linked pair of stochastic best responses. That is, the introspective process stops when what a player "calculates" the other is going to do is what he figures out he would do (if he were the other) as a response to what he himself believes he should do. Thus, the stopping rule criterion requires consistency in thinking or "internal consistency" and it is similar *in spirit* to the concept of Nash equilibrium.[5] Finally, if the player's expectations are not *internally* consistent, the iterative thought process continues by iterating perceived best replies. By tracing these noisy reasoning chains, one can find a prediction for a single interaction game that is a probability distribution over the possible strategies. This solution has the property that it is sensitive to a player's own payoff and to the payoffs of the other player.

To illustrate the way this model works, consider the simple 2x2 game of Table 2. In order to make a clearer distinction between player 1's choices and player 2's choices, we will call player 1 "she" and player 2 "he." Figure 2 depicts the introspective process for the game in Table 2; Up is U, Down is D, Left is L and Right is R.

[Table 2: A Simple 2x2 Game]

[Figure 2: The Introspective Process]

3.1. Finding a Solution for the Game

The tree in Figure 2 depicts the introspective process by which player 1 reaches a conclusion of what to do. With the help of this figure, one can see how this process works. The tree is composed of branches and end-nodes. The branches describe the stochastic responses of each player given a belief he or she has about the other's actions. The end-nodes represent the possible strategy combinations at which the thinking process can stop (i.e., (U, L), (U, R), (D, L), and (D, R)).

The solution to this model requires following the iterative process step by step. Let σ^2 be player 1's initial subjective "initial" belief or prior that player 2 will choose Left.[6] The probability that player 1 will think that Up is the "best thing to do" is given by $P_{U|\sigma^2}$ and follows the logit rule:

$$P_{U|\sigma^2} = \frac{\exp(\frac{1}{\mu}(\sigma^2 A_1 + (1-\sigma^2)B_1))}{\exp(\frac{1}{\mu}(\sigma^2 A_1 + (1-\sigma^2)B_1)) + \exp(\frac{1}{\mu}(\sigma^2 C_1 + (1-\sigma^2)D_1))}$$

This probability represents player 1's stochastic response to an initial belief and it means that with probability $P_{U|\sigma^2}$ she will think that she should definitely (for sure) choose Up. To determine what player 2 does, she would calculate player 2's response to a belief that she should, indeed, choose Up; thus, belief probabilities are always 1 or zero.[7] By dividing by the numerator, the expression above equals,

$$P_{U|\sigma^2} = \frac{1}{1 + \exp(\frac{1}{\mu}(\sigma^2 (C_1 - A_1) + (1-\sigma^2)(D_1 - B_1)))}$$

On the other hand,

$$P_{D|\sigma^2} = \frac{1}{1 + \exp(\frac{1}{\mu}(\sigma^2 (A_1 - C_1) + (1-\sigma^2)(B_1 - D_1)))} = 1 - P_{U|\sigma^2}$$

is the probability that player 1 will think that Down is a best reply to the initial beliefs about 2's actions. Suppose player 1 thinks that she should choose Up, the first bold arrow on the far-left branch of the thinking tree represents this "move." Then, player 1 forms an expectation of what the rival would do by calculating her rival's response given that she chooses Up. Will player 2 choose Left or Right?

Suppose that player 1 predicts that player 2 will choose Right as a response of her choosing Up; this happens with probability,

$$P_{R|U} = \frac{1}{1 + \exp(\frac{1}{\mu}(A_2 - C_2))}$$

and is represented by the bold arrow pointing down. Then, player 1 calculates her new response following her prediction that her rival would choose to Right. With probability,

$$P_{D|R} = \frac{1}{1 + \exp(\frac{1}{\mu}(B_1 - D_1))}$$

she will think that given that player 2 will choose Right, she should choose Down. The non-bold arrow pointing down on the far-left-branch of the tree represents this "move." Conversely, with probability,

$$P_{U|R} = \frac{1}{1+\exp(\frac{1}{\mu}(D_1 - B_1))}$$

she will think that Up is better. Suppose that she decides for Up, the third bold arrow pointing to the left represents this "move." If this happens, the stopping rule is satisfied since choices are consistent.[8] That is, given the other is expected to choose Right, she would like to choose Up, and given that she thinks the rival expects her to choose Up, she thinks the rival would want to choose Right. Player 1, then, stops thinking and infers the strategy pair $(Up, Right)$ should be the outcome of the game. From an observer's point of view, the probability that player 1 will infer the strategy pair $(Up, Right)$ is the solution of this game is given by $P_{U|\sigma^2} P_{R|U} P_{U|R}$.

In Figure 2, there are four branches that lead to the end-node $(Up, Right)$. Consider the left-hand branches in bold; the probability that player 1 thinks $(Up, Right)$ is the outcome of the game (on the first thought iteration) is equal to the product of the probabilities of being in each of the three branches. Likewise, there are three other ways by which $(Up, Right)$ could be reached in the first cycle, as is represented by the bold-dashed lines on the tree.

However, it could be that the process does not stop at any node on the first round, but the player continues iterating (or cycling around a branch). Let Ω represent a complete cycle around the far-left branch of the tree without stopping at any of the four end-nodes, $\Omega = P_{R|U} P_{D|R} P_{L|D} P_{U|L}$. Moreover, let n be the number of complete cycles; that is, the number of times the process cycles without stopping. Figure 3 depicts the cycle just described. Now, suppose that the thought process does not stop at $(Up, Right)$ on the first cycle, but stops there on the second cycle. Then, the probability of stopping at the far-left end-node $(Up, Right)$ in two cycles is equal to the following sum: $P_{U|\sigma^2} P_{R|U} P_{U|R}(1+\Omega)$.

[Figure 3: Complete Clockwise Cycle]

Following this same line of reasoning, as the number of complete cycles, n, goes to infinity, the probability of ending up in $(Up, Right)$ when we are on the far-left branch of the tree is equal to the following sum: $P_{U|\sigma^2} P_{R|U} P_{U|R} \sum_{n=0}^{\infty} (\Omega)^n$. Finally, when one considers *all* possible ways (the one just discussed and the other three represented by the dashed lines) of reaching the end-node $(Up, Right)$, one can calculate the probability with which player 1 reaches the conclusion that she should choose Up and the other should choose Right.

Define $Q^{(U,R)}$ to be the probability that the introspective process will lead player 1 to believe that $(Up, Right)$ is the solution of the game. In addition, let Γ represent a complete cycle on the center-left branch or the far right branch of the tree of Figure 2. That is, $\Gamma = P_{L|U} P_{D|L} P_{R|D} P_{U|R}$. The cycle Ω can be thought of being a clockwise cycle, while Γ is a counter-clockwise cycle. More specifically, the cycle will be equal to Ω when the process moves from $P_{U|\sigma}$ to a best response $P_{R|U}$, or from $P_{D|\sigma}$ to a best response $P_{L|D}$, respectively. Conversely, the cycle will equal Γ when the process moves from $P_{U|\sigma}$ to $P_{L|U}$, or from $P_{D|\sigma}$ to $P_{R|D}$. This cycle is depicted in Figure 4.

[Figure 4: Complete Counter-clockwise Cycle]

Considering all possible ways of getting to $(Up, Right)$, the probability $Q^{(U,R)}$ is then equal to the following expression:

$$Q^{(U,R)} = P_{U|\sigma^2} P_{R|U} P_{U|R} \sum_{n=0}^{\infty} (\Omega)^n + P_{U|\sigma^2} P_{L|U} P_{D|L} P_{R|D} P_{U|R} P_{R|U} \sum_{n=0}^{\infty} (\Gamma)^n$$
$$+ P_{Y^1|\sigma^2} P_{X^2|Y^1} P_{X^1|X^2} P_{Y^2|X^1} P_{X^1|Y^2} \sum_{n=0}^{\infty} (\Omega)^n + P_{Y^1|\sigma^2} P_{Y^2|Y^1} P_{X^1|Y^2} P_{Y^2|X^1} \sum_{n=0}^{\infty} (\Gamma)^n$$

Note that this is an infinite geometric series that converges to the expressions below:

$$Q^{(U,R)} = P_{U|\sigma^2} \left(\frac{P_{R|U} P_{U|R}}{1-\Omega} + \frac{\Gamma P_{R|U}}{1-\Gamma} \right) + P_{D|\sigma^2} \left(\frac{P_{R|D} P_{U|R} P_{R|U}}{1-\Gamma} + \frac{P_{L|D} P_{U|L} P_{R|U} P_{U|R}}{1-\Omega} \right)$$

In a similar manner, we can calculate the probabilities of ending up in any of the other nodes. Appendix 1 shows these probabilities.

3.2. *Properties of the Introspective Model*

Capra (1999) shows that, when the error parameter goes to infinity (random behavior), each strategy combination or end-node is reached with equal probability of ¼ and each strategy is played with equal probability of 1/2.[9] Conversely, as the error parameter goes to zero (perfect rationality), the probability of selecting a Nash equilibrium approaches one.[10]

3.3. *Numerical Example*

The results of numerical examples are interesting because they can be compared with empirical data from laboratory experiments. Consider, for example, the symmetric battle-of-the-sexes game described in Table 3. Cooper *et al.* (1989) and Straub (1995) present experimental results for battle-of-the-sexes games with payoff matrices similar to those of this table.[11]

[Table 3: A Numerical Example: The Battle of the Sexes Game.]

For the game of Table 3, the experimental results of Cooper *et al.* (1989) show that the strategies D and R were played 63 percent of the time compared to the mixed-strategy solution frequency of 75 percent. Moreover, one of Straub's (1995) data for the same game shows that the D and R strategies were chosen 60.56 percent of the time.[12] For an error parameter of μ=2.5, our introspective process predicts that the D and R strategy choices will be played 62.58 percent of the time, almost the exact same percentage observed experimentally by Cooper *et al.* (1989) and Straub (1995).

3.4. *Starting Point of the Introspective Process*

The thinking tree of Figure 2 starts at an initial node that describes the initial prior probabilities. It is reasonable to expect that initially players have uniformly distributed priors, reflecting total uncertainty about what the other would do, and by the introspective model these uniform prior beliefs are latter reassessed. However, there is an argument for considering other initial prior probabilities. Indeed, although the values of the starting belief probabilities do not affect the fact that there is a unique outcome in this process and that its properties are intuitive, they affect what the solution itself would be. In some contexts, players' initial beliefs may be affected by salient strategies that attract the attention of the players by virtue of their position, payoffs, or some other aspect. Schelling (1960) introduced the concept of a focal point, which people may use in order to coordinate their behavior in one-shot game situations. Schelling believed that certain strategies may prompt players to choose them, since they suggest themselves by virtue of analogies or associations of ideas which connect those strategies with some aspect of common experience, culture, or psychology of the players. Consider the following example: two players are asked to meet at some unspecified place in New York City, with the promise of a reward if their choices are matched. In this example, Times Square is a salient choice. Other streets, such as 71st street, or 32nd street are not salient, since there is nothing particular about them that can appeal to the players. Schelling calls a "focal point" an equilibrium that results from such salient choice (Times Square).

Some experimental research attempts to test whether salient strategies are used in coordination games (see Cooper *et al*., 1993, Van Huyck *et al*., 1990, and Mehta *et al*., 1994). Since it is reasonable to conjecture that salience may resolve coordination, it is natural to test this hypothesis in a laboratory context. Indeed, the results of Mehta *et al*. (1994) for behavior in two-person coordination experiments suggest that players sometimes coordinate by picking the strategy that is salient, but more often they "reason further" and would choose the strategy that is a best response to the focal point.[13]

A salient choice could be the starting point of the thought process discussed in the previous section. It is natural to expect that suggestive language, position of a strategy, or the size of the payoffs may prompt players to focus on a specific strategy. Yet, this may not necessarily be the strategy that is actually chosen. Players are likely to "reason further" and react to this initial reference point by forming a response and calculating a possible response by the opponent and maybe iterate on these responses.

Applied to the single interaction Traveler's Dilemma, we would expect initial beliefs to be uniformly distributed over all possible strategies. In contrast, when advice is introduced, we should expect the introspective process to begin at the advice—advice is common knowledge—. The next two sections depict the results of the simulations for each of the games we analyzed: 1) repeated Traveler's Dilemma game, 2) single interaction Traveler's Dilemma game, 3) single interaction Traveler's Dilemma game with high claim advice, and 4) single interaction Traveler's Dilemma game with low claim advice. The reason why advice is analysed is threefold; first, we can test the robustness of the introspective model by comparing the theoretical predictions to the experimental observations. Second, we can test the effectiveness of other models of introspection that are based on "best response" dynamics such as n-level rationality. Third, a decision-maker facing a single interaction situation is likely to search advice from experienced decision-makers.

4. Simulations

In a game played by two players, with two strategies each such as the game described above or in Capra (1999), one can find an analytical solution of the introspective process; however, when the number of strategies exceeds two, tracing the probabilistic responses analytically becomes very complex.[14] Complexity, in a way, can justify the use of simulations to find a prediction of the introspective process for a discrete version of the Traveler's Dilemma, which in our example has 121 strategies for each player.[15]

A detailed copy of the program that was used to run the simulations is attached to Appendix 3. Note that the simulation for the no-advice game was done assuming that the initial probabilities (the point at which the thought process starts) are flat rather than salient. For the advice treatments, we took the advice as the point of departure for the introspective process.

A total of 30 iterations were done for Traveler's Dilemma games with different starting point. When the stopping rule was satisfied, a count was recorded in one of the 14,641 (121x121) strategy combinations or end-nodes. Appendix 3 shows the number of stops at each end-node for the no advice and advice games. For the simulations, the value of the error parameter, μ, was different; higher for the no-advice and low-advice treatments and lower for the high-advice treatment. In the first two cases, we used an error term equal to one estimated by Capra (1999) for other one-shot games. For the high-advice treatment, we used an error parameter equal to the one estimated by Capra *et al*. (1999) for the repeated Traveler's Dilemma game (explanation for these choices follow). In section 6, we analyze the results of the simulations and compare them to the experimental observations.

5. Experimental Design and Procedures

We organized an experiment to test the prediction and robustness of our introspective. Our experimental design tests for robustness by introducing a common advice to one-shot Traveler's Dilemma games. There are three important reasons why we decided to test for the effects of advice on decisions. To begin with, a recurring argument for studying one-shot games is that, in many real life situations decision-makers do not have the opportunity to repeat their choices. Some argue: *decision-makers do not live a "Groundhog Day" reality*. Nevertheless, any decision-maker that faces a single interaction game (i.e., auction, voting, or war) is likely to ask for advice. Secondly, a common advice, if close enough to Nash equilibrium, should lead to lower claims if people's behavior is best described by models of introspection that use best responses such as n-level rationality. Such lower claims are not expected if people's behavior is best described by our model of introspection, since it uses probabilistic responses. Thus, a one-shot Traveler's Dilemma game with common advice should help us compare the predictive power of the "competing" models of introspection. Finally, a common advice can test the robustness of the model to changes in the starting point or departure of the introspective process.

Participants in our experiment were recruited from a variety of economics courses at the University of Malaga in Spain. They were paid 500 pesetas (about $3.00) for showing up, and during the experiment they made on average 1,318 pesetas (about $8.00).[16] Instructions were written in Spanish and read aloud. We designed an experiment that consisted of one repeated interaction Traveler's Dilemma game and three cells of single interaction (one-shot) Traveler's Dilemma games. The three one-shot treatments were no-advice (control), low advice, and high advice. The repeated game session lasted about one hour, whereas the other sessions lasted about 30 minutes each. Each session had 10 subjects and no single subject participated in more than one session. We organized three sessions under each one-shot treatment and each cell or set of sessions with identical treatment was administered simultaneously to avoid rumours (see Table 4). In all treatments, subjects were asked to choose a claim between and including 20 pesetas and

120 pesetas; they were told that the earnings would depend on their decisions and the decisions made by the persons randomly matched with them. The reward/penalty parameter for all sessions was equal to 5 pesetas. Table 4 below summarizes the experimental design.

[Table 4: Summary of Experimental Design]

In the repeated Traveler's Dilemma game session, participants interacted for 10 periods and in each period they were randomly matched with someone else in the room. At the end of the experiment, they were told to give advice to subjects who were going to play the exact same game, but only once (see Instructions in Appendix 2). In the single interaction sessions, participants were told that they had to make a single claim between and including 20 and 120 pesetas and that their earnings would depend on their choice and the choice made by someone else in the room (randomly chosen). In the low-advice and high-advice treatments, they were also given the following information: "*Other students, who showed high interest and motivation in this exercise, participated in this experiment before you. They had the advantage of being able to make decisions ten times; you are going to play only once. After they made their tenth decision, we asked them to give advice about which number someone who is playing only once should choose. This was their advice: "the best number that you could choose is __". You should keep in mind that you can choose any number that you want; that is, you are free to take or dismiss this advice.* The advice given by subjects in the previous repeated game ranged from 120 to 24.5. We selected an advice of 119 (given by two subjects) as the high advice and an advice of 79 as the low advice (given by one participant). [17]

6. Experimental Results

Figure 5 shows the relative frequencies of choices for each one-shot condition, separately. The medians, modes and means are also shown in this figure. No subject chose numbers below 45 in the advice sessions and only five subjects chose claims below 45 in the no advice sessions (16.6 percent)[18].

[Figures 5: Experimental Frequencies]

Claims spread on the full range of numbers when no advice is provided. However, choices between 110 and 120 are the most selected (33.3%). Dividing the range of choices into three and matching choices to each third of the range, 20 percent of the choices are in the first third, 23.3 percent in the second third, and 56.7 percent are numbers in the higher third.

When a low advice of 79 is provided, most subjects chose numbers between 110 and 120, but an equal percentage of subjects (23.3%) choose numbers between 60 and 70. Seventeen people out of 30 selected a number higher than 79. No subject chose the number advised. Dividing the range of possible choices in three thirds, the figure shows that people select a number in the middle or last third of the range: 3.3 percent of choices belongs to the first third, 53.3 percent to the second third, and 43.3 percent to the last third.

When the advice offered to subjects is high, most people (56.7%) choose a number between 110 and 120. Dividing the range of numbers in three parts, we can see that most people choose high numbers or those belonging to the last third of the range. About 3.3 percent of people select a number in the first third of the range, 13.3 percent in the second, and 83.4 percent of people in the last third.

In the extreme case of bounded rationality, subjects would take decisions at random and any number between 20 and 120 would be equally likely to be selected. In order to see whether subjects behave at random or follow some other more specific pattern of behavior, we used a Kolmogorov-Smirnov one-sample test of goodness-of-fit. The test is concerned with the degree of agreement between the distribution of observed claims and the uniform distribution. We can reject the null hypotheses that the data follow an uniform distribution at a 0.01 level of significance for the high and low advice sessions, and at a 0.05 level of significance for the no advice session.[19] Once we conclude that subjects do not behave at random, we are concerned with the possible treatment effects. According to a Wilcoxon-Mann-Whitney test for large samples, we can reject the null hypothesis that the data from the high and low advice sessions are drawn from the same distribution.[20] The same result holds for a test of the data from the high advice and no advice sessions (i.e., claims selected are higher in the high advice sessions, at a 0.02 level of significance). However, the null hypothesis that the data from the low advice and no advice sessions are equal cannot be rejected at a 0.05 level of statistical significance. [21]

We can use the data to test whether choices exhibit the structure suggested by models of introspection that are based on best response dynamics such as n-level rationality. When no advice is given to subjects, a player would be strategic of degree 0, (i.e. has a depth of reasoning of order 0), if he chooses the number 70 (the midpoint of the interval [20; 120]). This can be interpreted as the expected choice of a player who chooses randomly from an uniform distribution or as a salient number according to Schelling (1960). A player would be strategic of degree 1, if he chooses a number that is the best response to the number 70. A person has a depth of reasoning of order 2, if he chooses a number that is the best response to the best response of 70, etc. Similarly, when subjects are provided with an advice and that advice is common knowledge, the focal point of 70 would be replaced with the number advised. According to this model of behavior, the main feature of empirical frequencies is that most choices would be concentrated below the focal point. However, in the no-advice sessions 70 percent of the subjects chose a number higher than 70; and in the low-advice sessions, 56.6 percent chose a number higher than 79. It is obvious that n-level rationality does not explain data from these sessions. Indeed, in the high-advice sessions, only 6.7 percent of the subjects chose a number higher than 119; 6.7 percent chose the advice given; 20 percent chose numbers in the interval [118; 119); and 6.7 percent selected numbers belonging to the interval [117; 118). Then, in the high-advice sessions, only 33.4 percent of the subjects behave consistently with depths of reasoning of orders 0, 1 or 2.[22]

Once we reach the result that neither rationalizability nor n-level rationality explains the data, our introspective process for a discrete version of the Traveler's Dilemma is simulated using the advice as the focal or salient departure point. For the no-advice simulation, we use uniformly distributed initial conditions. Error decision parameters do not have to be equal in the three cases considered. Indeed, maximum likelihood estimates of the decision error cannot be obtained here due to the lack of data. In general, the amount of noise in the data should depend on the subject pool, the complexity of the game, the experience and learning subjects would have acquired, and the importance of "un-modeled" factors in the decision-making process. We assume that the size of the error parameter would be lower when the advice is high than when the advice is low or there is no advice. In fact, when the advice given to the subjects is 119, people would think that this is a very good advice because it allows obtaining high payoffs if they believe others will follow it (or stay close to 119). In a way, providing an advice of 119 could be a substitute for experience in this game; consequently, we selected a low error parameter, μ=8, which had been roughly the error parameter estimate for the equilibrium model using data from a "Traveler's Dilemma" experiment in a previous paper.[23]

However, when a low advice is provided, subjects do not confirm their expectations about how the game should be played in order to obtain high payoffs and they could find themselves confused, and even reject the advice as reference point of behavior. Thus, we selected a higher error parameter, μ=22, for the low and no advice cases.[24] In order to see how the laboratory data fit the simulated data we applied a Kolmogorov-Smirnov one-sample test again. As a result, we cannot reject the null hypotheses that data follow the theoretical distributions at the 0.01 level of significance.[25] Figures 6 show the empirical and simulated distributions for the three cases considered.[26]

[Figure 6: Experimental Frequencies]

7. Conclusion

An explicit model of decision making allow us to better understand choices made in one-shot games. In games played once, there is no chance for repetition or observation of others' action; hence, arriving at an outcome requires agents to solve the game through some *introspective* process that consists of tracing through a series of responses without feedback from previous plays of the game. Thus, instead of focusing on equilibrium models to find a prediction for games played only once, we argue that we should consider the thought process that precedes an action.

In this paper we present a model of introspection that provides a unique probability distribution over all choices as a prediction. The model traces reasoning chains, which consist of determining what a player should do given some possible actions by the others, and then calculating the others' response iteratively until a stopping rule is satisfied. The beliefs that determine choice probabilities are degenerate distributions that put all of the probability mass into a single point. The choice probabilities that determine the responses follow the logit rule. Thus, our model introduces bounded rationality in decision making and hence differs from other models similar *in spirit* (i.e., introspective) such as rationalizability and n-level rationality.

In the empirical part of this paper, we analyze behavior in the context of a single interaction Traveler's Dilemma game with an additional twist: advice. The Traveler's Dilemma game was chosen because, in this game "reasoning chains" are likely to occur. Advice is introduced because of three reasons: robustness, comparison and reality. We test the robustness of the introspective model by comparing the theoretical predictions to the experimental observations when a particular advice becomes common knowledge. We compare the effectiveness of our model vis-à-vis other models of introspection that are based on "best response" dynamics such as n-level rationality. Third, we ad reality by providing one-shot players with advice; indeed, a recurring argument for studying one-shot games is that in many real life situations decision-makers do not have the opportunity to repeat their choices under constant external conditions (i.e., "Groundhog Day" reality). However, in real life one-shot situations players are likely to search for advice.

We organized four experimental treatments: one repeated Traveler's Dilemma game and three one-shot games with identical parameters. After playing the repeated game, subjects provided advice to other subjects that participated in two of the three one-shot sessions. The three one shot sessions were no advice (control), high claim advice, and low claim advice. Our results suggest that rationalizability and n-level rationality do not explain the empirical choices. Conversely, the data accurately fit the theoretical distributions provided by simulations of our model and is robust to changes in the initial conditions. Hence, bounded rationality, out-of-equilibrium behaviour, decision errors and probabilistic choice seem to be the key ideas to better understand choices made in single interaction games.

References

Anderson, S., Goeree, J.K. and Holt, C.A. 1997. "Stochastic Game Theory: Adjustment to Equilibrium Under Bounded Rationality". Working Paper. University of Virginia.

Anderson, S., Goeree, J.K. and Holt, C.A. 2002. "The Logit Equilibrium: A Perspective on Intuitive Behavioral Anomalies". *Southern Economic Journal* 69 (1): 21-47.

Anderson, L. And Holt, C.A. 1997. "Information Cascades in the Laboratory". *American Economic Review* 87 (5): 847-62.

Basu, K. 1984. "The Traveler's Dilemma: Paradoxes of Rationality in Game Theory". *American Economic Review. Papers and Proceedings* 84 (2): 391-95.

Bernheim B.D. 1984. "Rationalizable Strategic Behavior". *Econometrica* 52 (4): 1007-28.

Binmore, K. 1988. "Modeling Rational Players: Part II". *Economics and Philosophy* 4 (1): 9-55.

Camerer, C. F. 1997 "Rules for Experimenting in psychology and economics and why they differ." *In Understanding Strategic Interaction: essays in honor of Reinhard Selten*, ed. W. Albers, W. Guth, Hammerstein, Molduvanu and Van Damme, Springer

Camerer, C. F and Ho T. "Experience Weighted Attraction Learning (EWA) in Normal Form Games: a Unifying Approach." *Econometrica* 67: 827-74

Capra, C.M. 1999. "Noisy Expectation Formation In One-shot Games." PhD Dissertation, UMI Academic Press.

Capra, C.M., Goeree, J.K., Gomez, R. and Holt, C.A. 1999. "Anomalous Behavior in a Traveler's Dilemma?". *American Economic Review* 89 (3): 678-690.

Capra, C..M., Goeree, J.K., Gomez, R. and Holt, C.A. 2002. "Learning and Noisy Equilibrium Behavior in an Experimental Study of Imperfect Price Competition". *International Economic Review* 43 (3): 613-636.

Chen, H., Friedman, J.W. and Thisse, J.F. 1997. "Boundedly Rational Nash Equilibrium: A Probabilistic Approach". *Games and Economic Behavior* 18: 32-54.

Cooper, R., DeJong, D., Forsythe, R. and Ross, T. 1989. "Communication in the Battle-of-the-Sexes Game: Some Experimental Results". *RAND Journal of Economics* 20: 568-587.

Cooper, R., DeJong, D., Forsythe, R. and Ross, T. 1993. "Forward Induction in the Battle of the Sexes Game". *Americqan Economic Review* 83 (4): 1303-16.

Harsanyi, J. and Selten, R. 1988. *A General Theory of Equilibrium Selection in Games*. Cambridge: MIT Press.

McKelvey, R.D. and Palfrey, T.R. 1995. "Quantal Response Equilibria for Normal Form Games". *Games and Economic Behavior* 10 (1): 6-38.

McKelvey, R.D. and Palfrey, T.R. 1998. "Quantal Response Equilibria for Extensive Form Games". *Experimental Economics* 1 (1): 9-41.

Mehta, J., Starmer, C. and Sudgen, R. 1994. "The Nature of Salience: An Experimental Investigation of Pure Coordination Games". *American Economic Review* 84 (3): 658-73.

Nagel, R. 1995. "Unraveling Guessing Games: An Experimental Study". *American Economic Review* 85 (5): 1313-1326.

Ochs, J. 1995. "Games with Unique Mixed Strategy Equilibria: An Experimental Study". *Games and Economic Behavior* 10 (1): 202-17.

Pearce, D.G. 1984. "Rationalizable Strategic Behavior and the Problem of Perfection". *Econometrica* 52 (4): 1029-50.

Rosenthal, R.W. 1989. "A Bounded-Rationality Approach to the Study of Non-cooperative Games". *International Journal of Game Theory* 18 (3): 273-92.

Roth, A. and Erev, I. 1995. "Learning in Extensive-Form Games: Experimental Data and Simple Dynamic Models in the Intermediate Term". *Games and Economic Behavior* 8: 164-212.

Rubinstein, A. 1998. *Modeling Bounded Rationality*. Cambridge, the MIT Press.

Schelling, T.C. 1960. *The Strategy of Conflict*. Cambridge, MA: Harvard University Press.

Siegel, S. and Castellan, N.J. 1988. *Nonparametric Statistics for the Behavioral Sciences*. Second Edition. McGraw-Hill.

Simon, H.A. 1957. *Models of Man*. New York: John Wiley & Sons.

Simon, H.A. 1959. "Theories of Decision-Making in Economics and Behavioral Sciences". *American Economic Review* 49 (3): 253-83.

Simon, H.A. 1987. "Bounded Rationality". In J. Eatwell, M. Milgate, and P. Newman, eds., *The New Palgrave: Utility and Probability*. London: The McMillan Press.

Stahl, D.O. 1993. "Evolution of Smart-n Players". *Games and Economic Behavior* 5 (4): 604-17.

Stahl, D. and Wilson, P. 1994. "Experimental Evidence on Players' Models of Other Players". *Journal of Economic Behavior and Organization* 25 (3): 309-27.

Straub, P. 1995. "Risk Dominance and Coordination Failures in Static Games". *Quarterly Review of Economics and Finance* 35 (4): 339-63.

Van Huyck, J.B., Battaglio, R.C. and Beil, R.O. 1990. "Tacit Coordination Games, Strategic Uncertainty and Coordination Failure". *American Economic Review* 80 (1): 234-48.

22

Appendices

APPENDIX 1

For $\Omega = P_{R|U}P_{D|R}P_{L|D}P_{U|L}$,and $\Gamma = P_{L|U}P_{D|L}P_{R|D}P_{U|R}$

$$Q^{(D,L)} = P_{U|\sigma^2}\left(\frac{P_{R|U}P_{D|R}P_{L|D}P_{D|L}}{1-\Omega} + \frac{P_{L|U}P_{D|L}P_{L|D}}{1-\Gamma}\right) + P_{D|\sigma^2}\left(\frac{(\Gamma)P_{L|D}}{1-\Gamma} + \frac{P_{L|D}P_{D|L}}{1-\Omega}\right)$$

$$Q^{(D,R)} = P_{U|\sigma^2}\left(\frac{P_{R|U}P_{D|R}P_{R|D}}{1-\Omega} + \frac{P_{L|U}P_{D|L}P_{R|D}P_{D|R}}{1-\Gamma}\right) + P_{D|\sigma^2}\left(\frac{P_{R|D}P_{D|R}}{1-\Gamma} + \frac{(\Omega)P_{R|D}}{1-\Omega}\right)$$

$$Q^{(U,L)} = P_{U|\sigma^2}\left(\frac{(\Omega)P_{L|U}}{1-\Omega} + \frac{P_{L|U}P_{U|L}}{1-\Gamma}\right) + P_{D|\sigma^2}\left(\frac{P_{R|D}P_{U|R}P_{L|U}P_{U|L}}{1-\Gamma} + \frac{P_{L|D}P_{U|L}P_{L|U}}{1-\Omega}\right)$$

Where:

$$P_{U|L} = \frac{1}{1+\exp(\frac{1}{\mu}(C_1 - A_1))} \qquad P_{U|R} = \frac{1}{1+\exp(\frac{1}{\mu}(D_1 - B_1))}$$

$$P_{D|L} = \frac{1}{1+\exp(\frac{1}{\mu}(A_1 - C_1))} \qquad P_{D|R} = \frac{1}{1+\exp(\frac{1}{\mu}(D_1 - B_1))}$$

$$P_{L|U} = \frac{1}{1+\exp(\frac{1}{\mu}(C_2 - A_2))} \qquad P_{L|D} = \frac{1}{1+\exp(\frac{1}{\mu}(D_2 - B_2))}$$

$$P_{R|U} = \frac{1}{1+\exp(\frac{1}{\mu}(A_2 - C_2))} \qquad P_{R|D} = \frac{1}{1+\exp(\frac{1}{\mu}(B_2 - D_2))}$$

Note that $P_{D|L} = 1 - P_{U|L}$, $P_{R|U} = 1 - P_{L|U}$, $P_{U|R} = 1 - P_{D|R}$,

and $P_{L|D} = 1 - P_{R|D}$

23

APPENDIX 2

Your Identification Number__________

Instructions: (translated from Spanish)

You are going to take part in an experimental study of decision making. The funding for this study has been provided by several foundations. The instructions are simple, and by following them carefully, you may earn a considerable amount of money that will be paid to you in cash at the end of this experiment At this moment you should have already received some money for showing up. We will start by reading the instructions, and then you will have the opportunity to ask questions about the procedures described.

NOTE: THE FOLLOWING PARAGRAPH WAS INCLUDED IN THE REPEATED TRAVELER'S DILEMMA GAME ONLY

Partners: The experiment consist of a number of periods. In each period, you will be randomly matched with another participant in the room. We will randomly pair you in each period by writing your identification numbers on pieces of paper that we later pick, two at a time. We will take note of the numbers of each pair in each period, but none of you will know the identity of your partners at any moment.

NOTE: THE FOLLOWING PARAGRAPH WAS INCLUDED IN THE ONE-SHOT TRAVELER'S DILEMMA GAMES ONLY

Partners: *Each of you will be randomly matched with another participant in the room.* None of you will know the identity of your partners at any moment.

Decisions: To begin, each of you will choose a number or "claim" between 20 and 120 and write it down on the table below. You can choose any number between and including 20 and 120, with or without decimals. Once you have chosen your number, we will collect your decision and match it in pairs with someone else's decision.

Earnings: The decisions that you and your partner make will determine the amount earned by each of you. Once that we have collected and matched the decision sheets, we will compare the numbers chosen. If the numbers are equal, then you and your partner each receive the amount claimed. If the numbers are not equal, then each of you receives the lower of the two claims. In addition, the person who chooses the lower number earns a reward of 5, and the person with the higher number pays a penalty of 5. Thus, you will earn an amount that equals the lower of the two claims, plus a 5 reward if you are the person making the lower claim, or minus a 5 penalty if you are the person making the higher claim. There is no penalty or reward if the two claims are exactly equal, in which case each person receives what they claimed.

Example: Suppose that your claim is **X** and the other's claim is **Y**.
If **X=Y**, you get X, and the other gets Y.
If **X>Y**, you get Y minus 5, and the other gets Y plus 5.
If **X>Y**, you get X plus 5, and the other gets X minus 5.

NOTE: THE FOLLOWING PART WAS ADDED TO THE ADVICE SESSIONS ONLY

Other students, who showed high interest and motivation in this exercise, participated in this experiment before you. They had the advantage of being able to make decisions ten times; you are going to play only once. After they made their tenth decision, we asked them to give advice about which number someone who is playing only once should choose. This was their advice: *the best number that you could choose is __".* You should keep in mind that you can choose any number that you want; that is, you are free to take or dismiss this advice.

NOTE: THE FOLLOWING PARTS WERE INCLUDED IN ALL ONE-SHOT SESSIONS

Summary and Record of Results:

Each one of you is matched randomly with another participant in the room. Each one of you is going to write a number between 20 and 120 in the cell of the first column on the table below (in the column called "Your claim"). We will collect all the sheets and we will compare the numbers chosen by each pair of participants. We will write the number chosen by the other participant in the pair, and the earnings (in tokens). Your earnings in pesetas will be the result of multiplying your earnings in **tokens by 10**. Finally, we will return the decision sheets and then we will pay you privately and in cash the total amount that you earned.

Your claim	The other's claim	Earnings
		A. Your earnings in tokens ________________
		B. Your earnings in pesetas _______________ = 10*A
		C. Total earnings in pesetas _______________= B + show up money

NOTE: THE FOLLOWING PARTS WERE INCLUDED IN THE REPEATED SESSION ONLY

Summary and Record of Results:

Each period, each one of you is matched randomly with another participant in the room. Each period, each one of you is going to write a number between 20 and 120 in the cell of the first column on the table below (in the column called "Your claim"). We will collect all the sheets and we will compare the numbers chosen by each pair of participants. We will write the number chosen by the other participant in the pair, and the earnings (in tokens). Then, we will return your decision sheets and start a new period by pairing you randomly with someone else in the room. Your earnings in tokens is the sum of the earnings in each period. Your earnings in pesetas will be the result of multiplying your earnings in **tokens by 2**. Finally, we will return de decision sheets and then we will pay you privately and in cash the total amount that you earned.

Period	Your claim	The other's claim	Earnings
1			
2			
….			
10			
			A. Your cumulative earnings in tokens _________
			B. Your earnings in pesetas __________= 2*A
			C. Total earnings in pesetas _________= B + show up money

NOTE: THIS SECTION WAS ADDED TO THE REPEATED TRAVELER'S DILEMMA SESSION, AFTER THE 10TH PERIOD

Your identification number_________

Please, answer the next question.

Other students are going to take part in this experiment in the future. The difference is that they are going to play one period only, instead of several periods like you did. You have got some experience that they will not have time to reach. Which number would you recommend they choose? In other words, if you could play this game again tomorrow, but only one period, which number would you choose?

Write your answer here:_____________

APPENDIX 3

```
Program Single Interaction Traveler's Dilemma;
{Uses DOS, Crt;}

Const
  n = 120;    {n is the highest claim}
  k = 20;   {k is the lowest claim}
  R = 5;   {R is the reward or penalty}

Var
  row_prior, col_prior, row_belief, col_belief, previous_row_belief,
        previous_col_belief, row_prob, col_prob, row_ex_payoff,
        col_ex_payoff, cum_row_prob, cum_col_prob:
                          ARRAY[k..n] of REAL;
  row_payoff, col_payoff: REAL;
  i : Integer;
  j : Integer;
  m : Integer;
  x, realization: REAL;  {random number}
  lamda: REAL; {rationality parameter, reciprocal to mu}
  t: Integer;  {count for number of terminations of iterative process}
  sum_end_node_count: ARRAY[k..n, k..n] of INTEGER;
  sum_r: REAL;
  sum_c: REAL;
  number_of_terminations: INTEGER;
  Convergence: Boolean;

PROCEDURE initialize;
Begin
  lamda:= 0.125; {lamda is 0.125 for the low-advice and no-advice simulations}
  i:=119; {starting point of the introspective process}
{  i is 79 for low-advice}
{  for the no-advice simulation, there is an initial equal chance that the other chooses any of the 121 possible
claims}
{   randomize;}
    row_prior[i] := 1;
{    For i := k to n DO col_prior[i] := 1/(n-k+1);}
    For i := k to n DO
      Begin
        For j := k to n DO
          sum_end_node_count[i,j] := 0;
      End;
    number_of_terminations := 30;
End; {Initialize ends}

PROCEDURE Initialize_tracing;

Begin
  Convergence:= FALSE;
  For i := k to n DO   {initial beliefs = priors}
      Begin
          row_belief[i] := row_prior[i];
      End;
```

```
End; {Ends Initialize tracing ends}

PROCEDURE Calculate_row_expected_payoffs;
Begin

     FOR i := k TO n DO
       Begin
          row_ex_payoff[i] := 0;
           FOR j := k TO n DO
           begin
              IF (i = j) THEN row_payoff:= i;
              IF (i < j) THEN row_payoff := i + R;
              IF (i > j) THEN row_payoff := j - R;
              row_ex_payoff[i] := row_ex_payoff[i] + row_payoff * row_belief[j];
           end;
       End;
End; {ends calculate_row_expected_payoff}

PROCEDURE Calculate_row_decision_probabilities;
Begin
    sum_r := 0;
    FOR i := k TO n DO
       sum_r := sum_r + exp(lamda * row_ex_payoff[i]);

    FOR i := k to n DO
       cum_row_prob[i] := 0.0;

    FOR i := k TO n DO
       row_prob[i] := exp(lamda * row_ex_payoff[i])/sum_r;
       cum_row_prob[k] := row_prob[k];

    FOR i := k + 1  TO n DO
       cum_row_prob[i] := cum_row_prob[i-1] + row_prob[i];

End;

PROCEDURE Calculate_row_beliefs;
Begin
     FOR i := k TO n DO  {reset previous_beliefs before calculating new ones}
     Begin
          previous_row_belief[i] := row_belief[i];
     End;

   realization := random;
     For i := k TO n DO
        Begin
          IF (i = k) THEN
             begin
             IF (realization < cum_row_prob[i]) THEN col_belief[i] := 1.0
             ELSE col_belief[i] := 0.0;
             end;
          IF (i > k) THEN
             begin
          IF ( (cum_row_prob[i-1] < realization) AND (realization <
            cum_row_prob[i]))
             THEN col_belief[i] := 1.0
```

```
            ELSE col_belief[i] := 0.0;
            end;
        End;
End;

PROCEDURE Calculate_col_expected_payoffs;
Begin

     FOR j := k TO n DO
       Begin
           col_ex_payoff[j] := 0;
           FOR i :=k TO n DO
           begin
              IF (i = j) THEN col_payoff := i;
              IF (i < j) THEN col_payoff := i - R;
              IF (i > j) THEN col_payoff := j + R;
              col_ex_payoff[j] := col_ex_payoff[j] + col_belief[i] * col_payoff;
           end;
       End;
End; {calculate_expected_payoffs ends}

PROCEDURE Calculate_col_decision_probabilities;
Begin
    sum_c := 0;
    FOR j := k TO n DO
       sum_c := sum_c + exp(lamda * col_ex_payoff[j]);

    FOR i := k to n DO
       cum_col_prob[i] := 0.0;

    FOR i := k TO n DO
       col_prob[i] := exp(lamda * col_ex_payoff[i])/sum_c;
    cum_col_prob[k] := col_prob[k];

    FOR i := k +1  TO n DO
       cum_col_prob[i] := cum_col_prob[i-1] + col_prob[i];

End; {Calculate_decision_probabilities ends}

PROCEDURE Calculate_col_beliefs;

Begin
    FOR i := k TO n DO  {reset previous_beliefs before calculating new ones}
    Begin
    previous_col_belief[i] := col_belief[i];
    End;

    realization := random;
      For i := k TO n DO
        Begin
          IF (i = k) THEN
            begin
            IF (realization < cum_col_prob[i]) THEN row_belief[i] := 1.0
            ELSE row_belief[i] := 0.0;
            end;
          IF (i > k) THEN
```

```
            begin
          IF ( (cum_col_prob[i-1] < realization) AND (realization <
           cum_col_prob[i]))
            THEN row_belief[i] := 1.0
            ELSE row_belief[i] := 0.0;
            end;
      End;
End; {Calculate_beliefs ends}

PROCEDURE Check_convergence;
Begin
   m := 0;
     FOR i := k TO n DO
      Begin
          IF (  (previous_row_belief[i] = row_belief[i]) AND
          (previous_col_belief[i] = col_belief[i] ) ) THEN m := m+1;
      End;
  IF  (m = (n-k+1))   THEN Convergence := TRUE;
End;

PROCEDURE  Record_end_node;
Begin
   FOR i:= k TO n DO
     Begin
      FOR j:= k  To n DO
       Begin
          IF( (row_belief[i] = 1.0) and (col_belief[j] = 1.0 ) ) THEN
          sum_end_node_count[i,j] := sum_end_node_count[i,j]+ 1;
       End;
    End;
End; {Record_end_nodes ends}

PROCEDURE Write_up_results;
Begin
    writeln(' Total numbers of terminations for each outcome: ');
    FOR i := k TO n DO  {write out the number of terminations at each end node}
        Begin
          FOR j :=k TO n Do
          writeln( 'i = ', i:3, ' j = ', j:3, '    [i,j]= ',
            sum_end_node_count[i,j]:7);
          readln;
        End;
        readln;
End;

PROCEDURE Save_output_to_disk;
Var
  z: BYTE;
  index: INTEGER;
  expdatafile: TEXT;
  expdatafilename: STRING;
Begin
    expdatafilename:= 'a:\outmonica';
    {$I-}
    assign(expdatafile, expdatafilename);
    reset(expdatafile);
```

```
    close(expdatafile);
    {$I+}
    IF ioresult<>0
    THEN rewrite(expdatafile)
    ELSE append(expdatafile);
    writeln (expdatafile, ' k= ' , k , ' n= ' , n , 'lamda= ', lamda:2:4, ' R= ' , R:3, ' t= ', t);
    writeln (expdatafile, ' prior=119 ');
    writeln (expdatafile, ' i is column choice and j is row choice');
    FOR i := k TO n DO  {write out the number of terminations at each end node}
      Begin
        FOR j :=k TO n DO
        writeln(expdatafile, 'i = ', i:3, 'j = ', j:3, 'sum_end_node_count = ', sum_end_node_count[i,j]:7);
      End;
    Close(expdatafile);
End;

Begin {main Program}
      Initialize;
      FOR t := 1 TO number_of_terminations DO
      BEGIN {Begin tracing number, t}
          Initialize_tracing;
          While ( Convergence = FALSE) DO
              Begin {Introspective process}
                          Calculate_row_expected_payoffs;
                          Calculate_row_decision_probabilities;
                          Calculate_row_beliefs;
                          Calculate_col_expected_payoffs;
                          Calculate_col_decision_probabilities;
                          Calculate_col_beliefs;
                Check_convergence;
              End; {Introspective process}
          Record_end_node;
      END; {ends tracing}
      Write_up_results;
      Save_output_to_disk;
End. {main program}
```

Tables

Table 1: The Traveler's Dilemma in Normal Form
(claims are between 20 and 120 cents with reward/penalty of 5 cents)
* = Nash equilibrium/ rationalizable equilibrium

		Column Player							
		k=20	k=21	k=22	k=23	…	…	k=119	k=120
	k=20	20, 20*	25, 15	25, 15	25, 15			25, 15	25, 15
	k=21	15, 25	21, 21	26, 16	26, 16			26, 16	26, 16
	k=22	15, 25	16, 26	22, 22	21, 11			21, 11	21, 11
Row Player	k=23	15, 25	16, 26	11, 21	23, 23			22, 12	22, 12
	k=24	15, 25	16, 26	11, 21	12, 22			29, 19	29, 19
	…							…	…
	…							…	…
	k=119	15, 25	16, 26	11, 21	12, 22		…	119, 119	114, 124
	k=120	15, 25	16, 26	11, 21	12, 22		…	114, 124	120, 120

Table 2: A Simple 2x2 Game

		Player 2 (he)	
		Left	Right
Player 1 (she)	Up	A_1 , A_2	B_1 , C_2
	Down	C_1 , B_2	D_1 , D_2

Table 3: A Numerical Example: The Battle of the Sexes Game

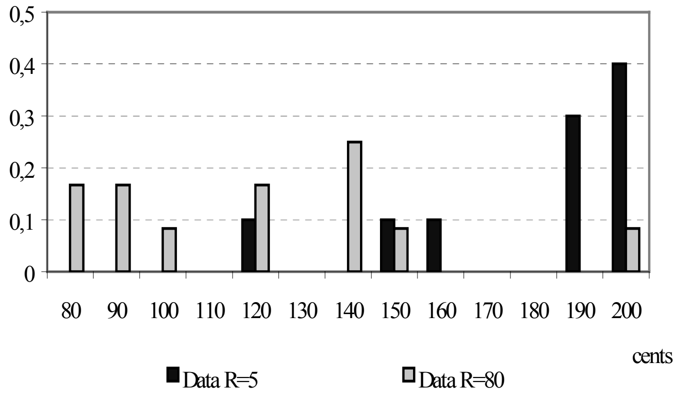
		Player 2	
		L	R
Player 1	U	0, 0	6, 2
	D	2, 6	0, 0

Table 4: Summary of Experimental Design

Session	# of subjects per session	# of subjects per treatment	# of periods	Treatment	
1	10	10	10	Repeated TD	Subjects were asked to give advice
2, 3, 4	10	30	1	One-shot TD with no advice	Parallel sessions
5, 6, 7	10	30	1	One-shot TD w High claim advice	Parallel sessions
8, 9, 10	10	30	1	One-shot TD w Low claim advice	Parallel sessions

Figures

Figure 1. Observed First-period Claim Frequencies*
(Claims are between 80 and 200 cents with penalty/reward of 5 and 80 cents)



* Data from Capra *et al*. (1999).

Figure 2. The Introspective Process

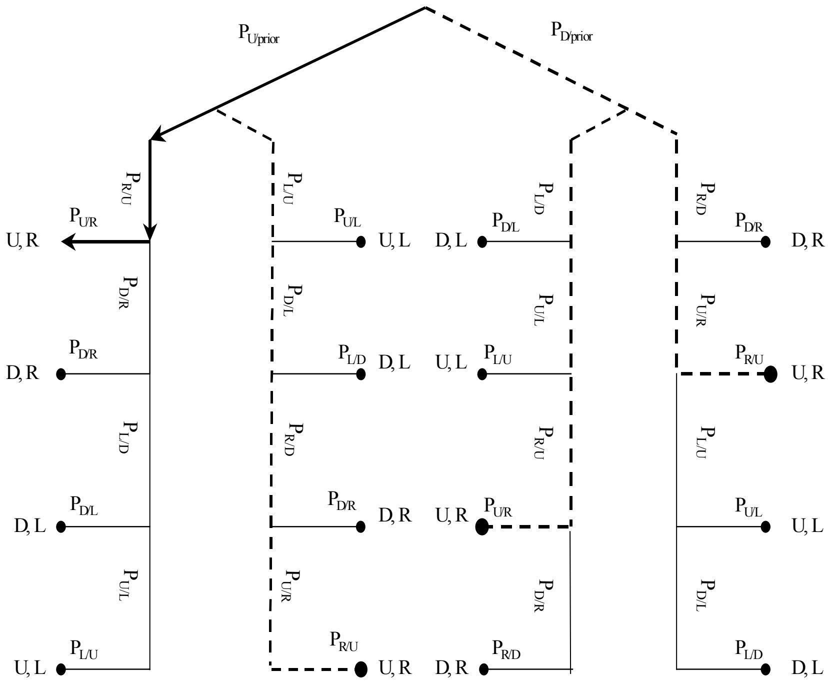


Figure 3. Complete Clockwise Cycle

($\Phi = P_{R/U}\, P_{D/R}\, P_{L/D}\, P_{U/L}$)

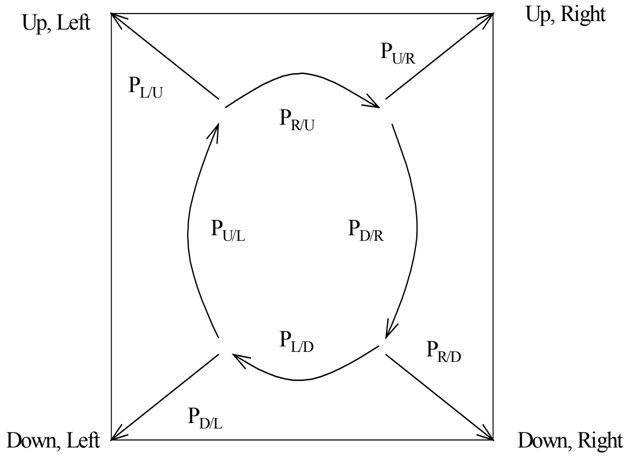
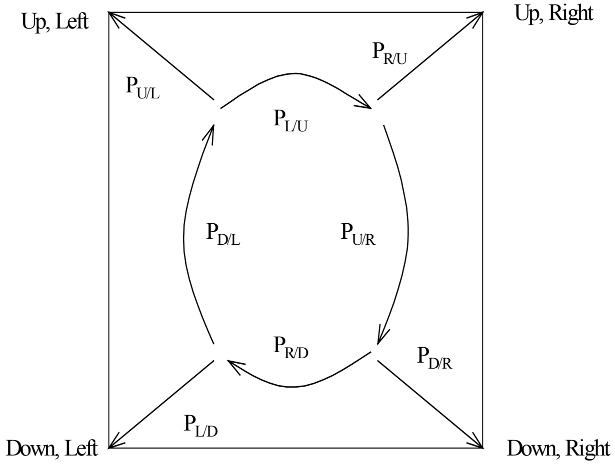
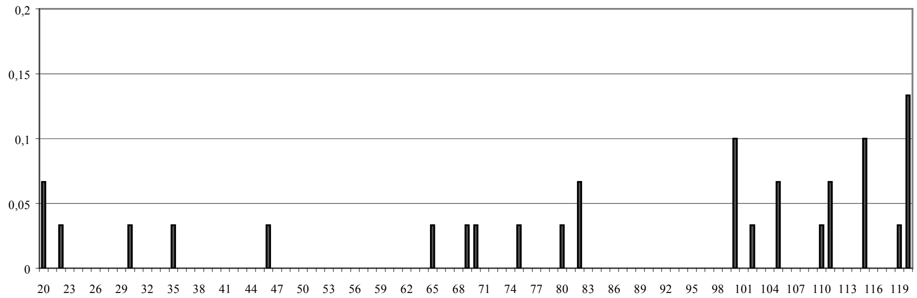


Figure 4. Complete Counter-clockwise Cycle
(☝ = $P_{L/U}\ P_{D/L}\ P_{R/D}\ P_{U/R}$)

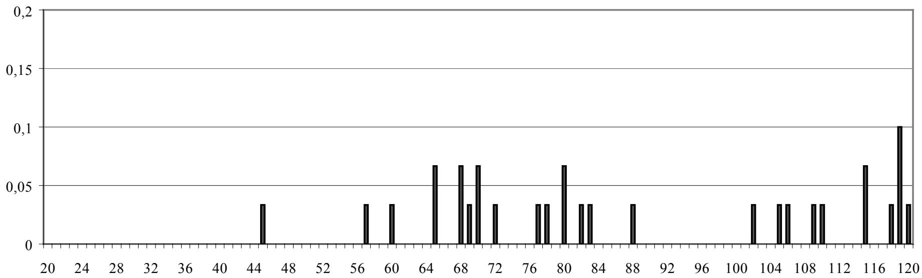


Figures 5. Experimental Frequencies

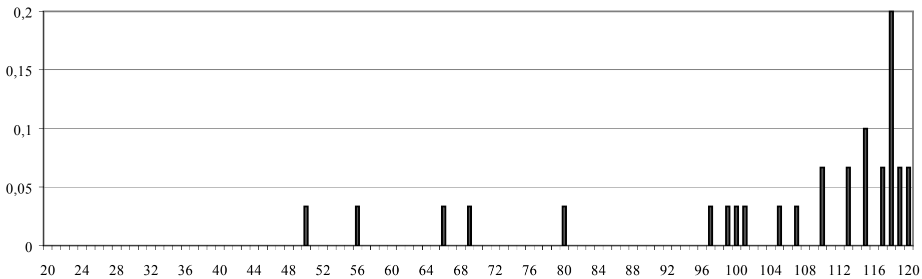
A) No advice
median 100; mode 120; mean 86.21



B) Low advice
median 81; mode 119; mean 87.83

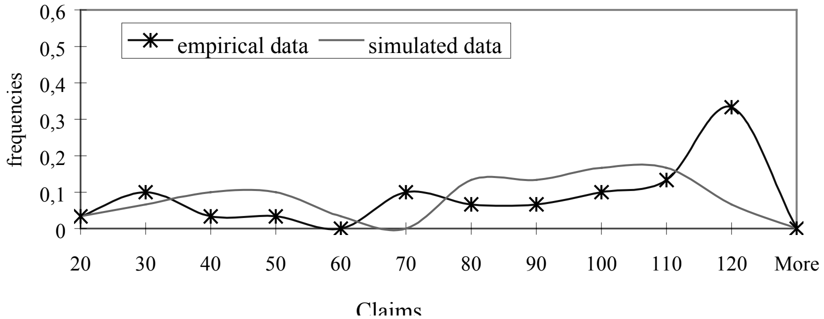


C) High advice
median 114; mode 118; mean 104.81

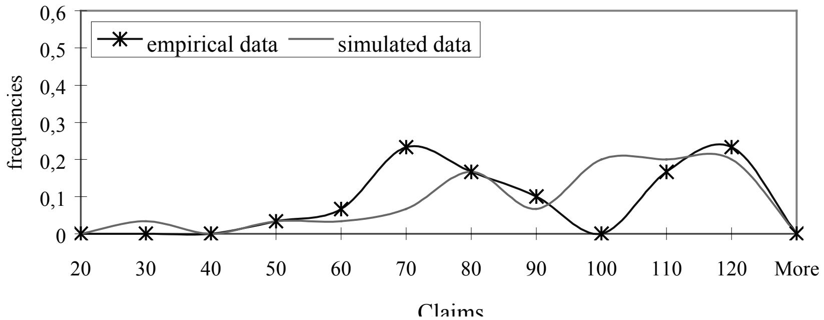


Figures 6: Simulated and Empirical Frequencies

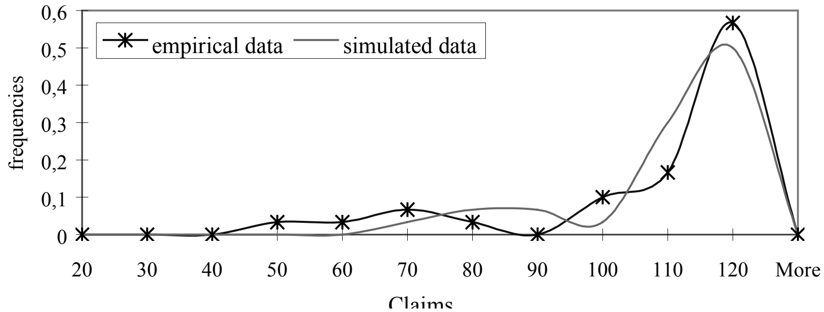
A) No advice μ=22



B) Low advice μ=22



C) High advice μ=8



Endnotes

[1] According to Rubinstein (1998), procedurally rational behavior must be distinguished from irrational behavior. The later is the outcome of impulsive responses without adequate intervention of thought.

[2] In many strategic situations (voting, war, auctions) decision-makers are not as lucky as the main character in the movie "Groundhog's Day"—Camerer, 1997 wittingly calls "Groundhog Day replication" those repeated environments where parameterization does not change—. In this film, the main character lives the same day several times, and each day he faces the exact same situations and decisions, but can remember perfectly what he did previously; thus, his choices have no real consequence on others, but his past experiences help him correct errors. When he finally finds a decision he is happy with, he stops living the same day and moves on.

[3] Equilibrium implications of repeated decision-making processes and learning with errors in specific settings have been explored by Camerer and Ho (1999); Chen, Friedman, and Thisse (1997); Ochs (1995); Roth and Erev,(1995), and Capra *et al.* (1999) and (2002) among others.

[4] The p-beauty contest game is also adequate for the evaluation of "reasoning chains." In this game, players are asked to choose a number between 100 and 0. The choice closest to p ($0<p<1$) times the average of all choices wins a prize. This game was analyzed experimentally by Nagel (1995).

[5] Nash equilibria are consistent in the sense that a player's prediction of what the other will do is the other's best reply to the player's best response to his prediction.

[6] The initial beliefs represent the starting point of the introspective process.

[7] Recall that in this model beliefs are degenerate distributions that put all the probability mass at a point.

[8] Recall that the stopping rule requires a linked pair of stochastic responses.

[9] Intuitively, the overall probability that a player's decision process stops at an end-node depends on the product of the conditional probabilities. When $\mu \to \infty$ all these probabilities equal 1/2; hence, by replacing the conditional probabilities with 1/2, it is straightforward to

see that $\lim_{\mu\to\infty} Q^{(U,R)} = \lim_{\mu\to\infty} Q^{(U,L)} = \lim_{\mu\to\infty} Q^{(D,R)} = \lim_{\mu\to\infty} Q^{(D,L)} \to 1/4$.

[10] Probabilistic responses become best responses and there is no iteration.

[11] Instead of payoffs of 6 and 2, Cooper *et al.* (1989) use 600 and 200 and Straub (1995) uses 60 and 20.

[12] These data represent the aggregate frequency of D and R choices for the game played several times. However, the one-shot structure of the game was kept in the experiments by matching each player against a different anonymous opponent in each period. In these experiments, no player knew the identity of the player he was matched with or the history of decisions made by any of the other players. Nevertheless, these data do not necessarily equal those would come from a purely one-shot experiment, where repetition and learning are not allowed.

[13] According to Mehta *et al.*, the subjects who reason further have a depth of reasoning of order n. If a strategy is chosen that is the best response to the focal point, the order of the depth of reasoning is 1. Similarly, if one uses a strategy that is a best response of a best response to the focal point, the depth of reasoning has order 2, etc.

[14] As mentioned above, for a two-player/two-strategies game, when the introspective process stops after one cycle, there is one clockwise "cyclical" way in which the same end-node can be reached (see Figure 3). For a two-player/three-strategies game, when the thought process stops after one cycle, there are four possible clockwise cyclical ways that the same end-node can be reached. In the same manner, when the number of strategies is n and the initial prior probabilities are uniformly distributed over all n strategies, there are $\sum_{i=2}^{n} [2(i-1)-1]$ cycles that lead to the same end node.

[15] The discrete version of the Traveler's Dilemma is shown on Table 1.

[16] The subjects who participated in the repeated interaction session made on average 1,364 pesetas. The subjects who participated in the single interaction games made on average 1,271 pesetas.

[17] The advice given by the participants in the repeated Traveler's Dilemma game session was 120, 119, 119, 100, 100, 95, 79, 30, 25, and 24.5.

[18] In the no advice sessions, only one subject chose 20 (the equilibrium strategy); there also

was one subject selecting 20.0001 (almost the equilibrium strategy).

[19] The maximum deviations were 0.533, 0.3 and 0.267 for the high advice, low advice and no advice cases respectively. The critical value of the maximum deviation for 30 observations at a 0.01 level of significance is 0.29. See Siegel and Castellan (1988) for details.

[20] The alternative hypothesis states that most of the numbers chosen in the high advice sessions are higher.

[21] The z-values were –2.5134, -2.0920 and –0.0183 respectively. See Siegel and Castellan (1988) for details of the test. We also applied a Kolmogorov-Smirnov test with the null hypothesis that the claims observed in the low advice session follow the distribution observed in the no advice session. We can not reject the null hypothesis at a 0.01 level of significance.

[22] The experimental studies in which n-level rationality has been tested successfully for one-shot games conclude that depths of reasoning of orders 0, 1 or 2 explain most of the observations. See Mehta *et al*. (1994), Nagel (1995) and Stahl and Wilson (1994).

[23] Capra *et al.* (1999), for data from a Traveler's Dilemma experiment, estimate an error parameter of 8.3 for the equilibrium model and of 10.9 for the dynamic model. Capra *et al.* (2002) obtain an error parameter of 8.4 in an experimental study of imperfect price competition. The estimates for the Anderson and Holt (1997) information cascade experiments imply an error parameter of about 12.5. Finally, McKelvey and Palfrey (1998) estimate an error parameter of 10 for an equilibrium model.

[24] Note that this μ is higher than all those values obtained in an equilibrium context or in a learning environment. This error parameter was estimated in Capra (1999) using data from one-shot games.

[25] The maximum deviations were 0.1, 0.2 and 0.267 for the high, low and no advice cases, respectively. Recall that the critical value at the 1 percent significance level for 30 observations is 0.29.

[26] Comparing the simulated data from the high and low advice cases, we obtained that the maximum deviation between the cumulative frequencies was 0.4, so the null hypothesis of equal distributions can be rejected at the 1 percent significance level. For the high and no

advice cases the maximum deviation is 0.567, so the same conclusion can be reached. Finally, the maximum deviation between the cumulative densities for the low and no advice cases is 0.23. Then, the null hypothesis that distributions are equal cannot be rejected at the 1 percent level of significance.

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