UNIVERSITY OF SIENA

LabSi

EXPERIMENTAL ECONOMICS LABORATORY

Enrica Carbone

Gerardo Infante

Are Groups Better Planners Than Individuals? An Experimental Analysis

December 2012

LABSI WORKING PAPERS

N. 42/2012

Are Groups Better Planners Than Individuals? An Experimental Analysis

Enrica Carbone
Seconda Università di Napoli
enrica.carbone@gmail.com

Gerardo Infante
Università degli Studi di Bari
ger.infante@gmail.com

November 2012

Abstract

Over the last ten years the literature in experimental economics has seen a growing interest in groups and how they compare to individuals in different settings. This paper contributes to the literature on this topic by investigating the comparison between groups and individuals with respect to intertemporal consumption problems. Empirical evidence has shown how dynamic optimization problems, representing intertemporal consumption decisions, involve computational difficulties that agents are not always equipped to solve optimally. Several econometric estimations on household and aggregate data seem to show that people do not save enough. Similarly, in many experiments, results suggest that people are very different in how they solve this class of problems and in how they react to changes in the decision environment. We present an experiment comparing group and individual planning under risk and uncertainty. Our study is focussed on investigating how groups perform in intertemporal decision making tasks, in particular observing the significance of group planning compared to individuals when choosing under risk and uncertainty. Results suggest that groups perform better than individuals when planning under risk, while the opposite happens in the case of planning under uncertainty. Interestingly, when comparing the behaviour of our agents in the second lifecycle (denominated "sequence") groups seem to lose all their advantage on individuals (in terms of less deviation from optimum). We interpret this as a "stability effect" caused by the random matching rule adopted during the groups sessions.

Keywords: Collective Decision Making, Intertemporal Consumer Choice, Life Cycle, Risk, Uncertainty, Laboratory Experiments

JEL classification: D12, D91, D81, C91, C92

1 Introduction

Over the last ten years the literature in experimental economics has seen a growing interest in groups and how they compare to individuals in different settings. The main reason is that every day, decisions are taken by groups of different forms and nature (committees, households, boards of directors, groups of advisors and so on) "[...] rather than [by] isolated individuals"[1]. In domains where economic theory is silent about the effect of the type of agents or where experimental research is focussed solely on individuals, the natural question becomes, whether and in which contexts there are significant differences between these decision makers. As remarked in Cooper and Kagel (2005), this silence of economic theory on the "qualitative" difference between groups (of any form) and individuals may constitute a severe problem especially when assuming a substantial equivalence of behaviour between these two types of agents. Although many seem to believe that groups may have an advantage over individuals when it comes to the efficiency of decisions, this is not at all clear. Baker et al. (2008), among others, note that

[1]Bone et al. (1999) p. 63.

in other social sciences, in particular in social psychology, researchers have extensively studied the nature of groups, the dynamics among members, how interactions within a group affect decision making and how it compares with individual decisions[2]. In particular, this literature highlights how the performance of groups may vary significantly in relation to the specific task and describes a number of dynamics (e.g. groupthink) that might undermine the efficiency of group decision making. For these reasons, from the viewpoint of economic policy, it becomes of critical importance to gather evidence on the specific contexts in which groups may outperform individuals and vice versa.

This paper contributes to the literature on this topic by investigating the comparison between groups and individuals with respect to intertemporal consumption problems. The aim of this study is to gather new evidence on group decisions and how they compare to those of individuals, in the contexts of decision making under risk and under uncertainty.

Empirical evidence has shown how dynamic optimization problems involve computational difficulties that agents are not always equipped to solve optimally. For example, empirical analyses on household and aggregate data seem to show that people do not save enough (Browning and Lusardi, 1996). Similarly, in many experiments, results suggest that people are very different in how they solve this class of problems and in how they react to changes in the decision environment. Carbone and Hey (2004) present an experiment on intertemporal decision making in a lifecycle context with risky income. They find that their participants do not optimize and tend to overreact to changes in the employment/unemployment status, also showing that subjects differ substantially in their actual planning horizon. Ballinger et al. (2003) devise an experiment focussed on social learning, in an intertemporal consumption context with risky income. In this study social learning is realized as overlapping generations of participants, so that following players can learn from their predecessors (in groups of three). Results show that although subjects do not optimize, social learning seems to constitute an important force, driv-

[2]For some references on these topics in social psychology, see Baker et al. (2008)

ing planning closer to optimization. A similar result is reported in Brown et. al. (2009) where two studies are presented: the first, a typical intertemporal problem where learning "by repetition" is compared to "social learning"; a second study, where visceral temptations are introduced. The salient difference between these two studies is the use of beverage rewards instead of money rewards introduced in one lifecycle of the second study. Results show that learning has a positive effect on optimization but this effect is smaller than the one produced by social learning. Visceral factors seem to parallel learning from experience. Indeed, when rewards are immediate (instead of delayed), the effect is similar to the case of no experience.

In recent years a significant number of experimental studies have investigated the comparison of groups (or teams) and individuals, with respect to different contexts. Bone et al. (1999) investigate whether groups are more or less consistent to Expected Utility than individuals, finding no significant differences. They also find that individual EU consistency seems not to be improved by repetition, or by previous experience within groups. This latter result is somewhat in contrast with Baker et al. (2008) who focus on lottery-choice experiments using groups composed of three members. In particular, in one of their treatments (called "sequenced"), in which participants first play individually, then in groups and finally again as individuals, results show a significant group effect, in terms of impact on behaviour. Baker et al (2008) also find that risk aversion is not significantly different between groups and individuals, although groups seem to be more consistent with risk-neutral preferences in certain cases. On a different note, Bateman and Munro (2005) investigate conformity to Expected Utility and, similarly to Bone et al. (1999), they find that groups and individuals are not significantly different in how they deviate from EU. Also, in contrast with Baker et al. (2008), groups exhibit a higher risk aversion than individual members. An interesting feature of this study, which might have contributed to the difference in results from Baker et al. (2008), is the fact that groups are established couples in real life and not random subjects matched together during the experiment. In a later study, Bateman and Munro (2009) focus their attention on contingent valuations and, in particular, on the relationship between household and individual stated preferences. In their field experiment, the main question is whether values elicited from a household are significantly different than those elicited by its members taken separately. Their results support the conclusion that valuations are significantly different regardless of whether they are elicited from the household or from one of its members (though it remains unclear which one is more accurate).

A large part of this literature focuses on game theoretical applications where agents are compared with respect to their strategic thinking and learning ability. Cooper and Kagel (2005) explore strategic play in signalling games to investigate the effect of learning across games (transfer). They find that groups are able to develop strategic play significantly faster than individuals, outperforming individuals especially in cases where learning is difficult. Charness and Jackson (2007) focus on the Stag Hunt game, observing whether groups (of two members) play in a significantly different way than individuals. Results support the conclusion that agents are indeed different in how they play the game. Feri et al. (2010) build on Charness and Jackson (2007) using several types of coordination games, teams of three subjects that are allowed to communicate with each other and designing games involving strategic interactions among five players (groups or individuals) instead of two, as in Charness and Jackson (2007). In their experiment they find that teams coordinate more efficiently than individuals. Kocher and Sutter (2005) focus on beauty contest games finding that groups are not necessarily better decision makers than individuals, but they are faster learners. Bornstein and Yaniv (1998), however, find support for the conclusion that groups are strategically more rational than individuals when playing ultimatum games. Moreover, Cason and Mui (1997) investigate group and individual behaviour in dictator games, finding that group decisions seem to be "[...] dominated by the more other-regarding member [...]"[3]. More recent experiments seem

[3]Cason and Mui (1997), p. 1480. The authors also underline that for these teams, their choices tend to be more other-regarding than those of individuals, although this difference is modest

to confirm that groups outperform individuals in strategic settings. Sutter et al. (2010) show that groups play strategically with a higher probability than individuals and more often, in one shot normal-form games. Maciejovsky et al. (2010) study the impact of groups on market behaviour. Their findings confirm that groups are faster learners than individuals and that there seems to be a significant effect of team experience on subsequent individual decisions (as in Baker et al. 2008).

To our knowledge there has not been any attempt to compare the behaviour of individuals and groups in an intertemporal consumption context. The experiment features four treatments: individual and group decision making, under risk and under uncertainty. Four separate samples have been used, two for individuals and two for groups. This means that this experiment does not measure the effect of participating in group planning on subsequent individual tasks. The groups used in the experiment have a single set of preferences (stable and transitive); that is, members do not have individual preferences but operate as part of one common entity[4]. The motivation for this choice is to isolate as much as possible the "pure" effect of group decision making in order to be able to observe whether the interaction in groups improves the intertemporal consumption strategy with respect to individuals both under risk and uncertainty.

The paper proceeds as follows: the theoretical background is described in Section 2; Section 3 presents the experimental design while results are analyzed in Section 4 and discussed in Section 5.

[4]In some ways there is similarity to the "unitary" model of households (see Browning, Chiappori and Lechene, 2006). The use of more complex approaches , although attractive, would have added too many dimensions to the definition and dynamics within groups, which goes beyond the objectives of this study.

2 Theory

This study considers an agent living for a discrete number of periods (T) and having intertemporal preferences represented by the Discounted Utility model with a discount rate equal to zero. In each period, she receives utility from consumption; utility is assumed to have a functional form of the CARA type:

$$U(c) = \left(k - \frac{e^{-\rho c}}{\rho}\right)\alpha,$$

where c is consumption, α and k are scaling factors and the Arrow-Pratt coefficient of (absolute) risk aversion is equal to

$$ARA(c) = -\frac{U''(c)}{U'(c)} = \rho[5].$$

The objective is then to maximize the expected lifetime utility, that is[6]

$$\max E_t \left[\sum_{t=1}^{T} \beta U(c_t)\right] \tag{1}$$

subject to

$$w_{t+1} = a_{t+1} + y = (1+r)(w_t - c_t) + y$$

where w is available wealth, a represents available assets or savings at the beginning of period $t+1$ and y is income. In each period of her lifecycle, the agent receives either a high or a low income, with probabilities $p = q = 0.5$. The rate of return is known and held fixed during the lifecycle. Also, borrowing is not allowed, that is, wealth must always be greater or at most equal to zero. Finally, the agent has no bequest motives, that is, any savings are lost after the last period (T). The problem is then to choose the sequence of consumption (from period 1 to period T) that maximizes (1).

The standard procedure to solve this kind of problems is to use Dynamic

[5] In the experiment parameters were set as follows: $\rho = 0.1$, $k = 10$ and $\alpha = 5$

[6] Having set the discount rate equal to zero, β equals 1, so the same can be expressed by: $E(U(c_t) + U(c_{t+1}) + \cdots + U(T))$.

Programming, through Backward Induction. The Bellman Equation of the problem has been determined as

$$V_t(w_t) = U(c_t^*) + E\left[V_{t+1}(w_{t+1}^*)\right] \tag{2}$$

where V_t is the value function, w_t represents available wealth and E is the expectation operator. Equation (2) may also be expressed as

$$V_t(w_t) = U(c_t^*) + \left[\frac{1}{2}V_{t+1}(w_{t+1}^{*L}) + \frac{1}{2}V_{t+1}(w_{t+1}^{*H})\right] \tag{3}$$

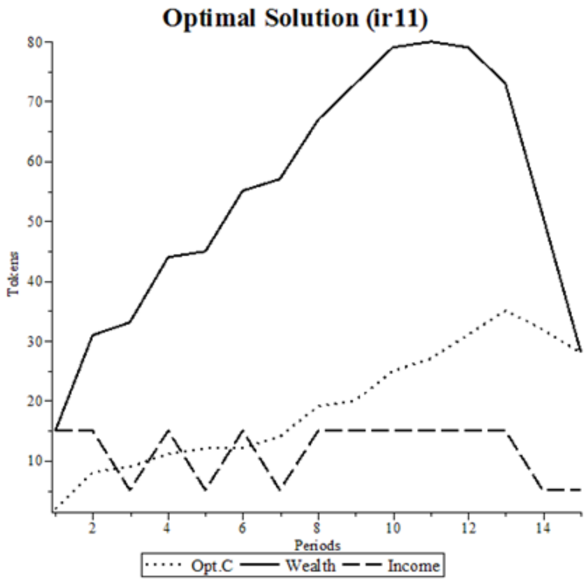
where

$$w_{t+1}^{*L} = (1+r)(w_t - c_t^*) + y^L$$
$$w_{t+1}^{*H} = (1+r)(w_t - c_t^*) + y^H.$$

In other terms, the expectation[7] is resolved by considering the two possible events: low income, y^L, and high income, y^H. Wealth in period $t+1$ is optimal because it is determined by the (optimal) consumption choice in t. The value function establishes a recursive relation between current and future decisions.

In the specific case of this study, some restrictions have been imposed on variables. In particular, as anticipated, borrowing is not allowed $(w_t \geq 0)$ and all variables are rounded to the nearest integer. For this reason a numerical solution of the problem had to be computed. The figure below shows an example of an optimal solution determined by the Maple optimization program.

[7] In the risk case the probabilities of the two possible events are each one-half; in the ambiguity case we assume that the subject works with the same probabilities.



3 Experimental Design

In order to investigate the difference between individual and group planning and the effect of risk and uncertainty on intertemporal decision making, an experiment composed of four treatments has been designed, resulting from the combination of the experimental variables considered. Using a two by two factorial design, it was possible to gather data about individual and group decision making under risk and under uncertainty.

In each session participants played two independent sequences of 15 periods each. The final payoff was calculated on the results of *one* sequence. At the end of the experiment there was a public procedure devised to randomly determine the paying sequence. Instructions provided definition for sequences and periods and also clarified what was meant by "independence" of sequences. In each period of a sequence, participants would receive income, denominated in "tokens" (experimental currency unit), that, together with previous savings would give available wealth[8]. Instructions asked partic-

[8]During the experiment expressions like "income", "wealth", "consumption" or "utility" were carefully avoided.

ipants to decide how many of their available tokens to convert into "points", knowing that, at the end of the experiment, the total points accumulated would be converted into money at a fixed rate (2 Euros per 100 points). Instructions also explained how to use the utility function (called "conversion function"), briefly pointing out some important features, such as the property of decreasing marginal utility[9].

As anticipated in the previous section, participants would receive their income, high (15 tokens) or low (5 tokens), with a probability of 0.5. This probability was public knowledge in the case of risk, and totally unknown in the case of uncertainty. In each period, income was determined by a random draw from a non-see-through bag. In particular, the two events were colour coded such that the bag contained an equal number of balls in both colours. In the case of risk, at the beginning of the experiment, one participant was asked to publicly open the bag and count the balls, so that it would be obvious to all that there was no deception involved. In the case of uncertainty this procedure was simply omitted. When drawing a ball, participants were asked to shuffle the content of the bag and then pick one ball to show to everyone. The ball was then placed back into the bag so as not to alter the probability of future draws.

When making a decision, participants were made aware that tokens saved would produce interest (at a fixed rate of 0.2) which, in the next period, would be summed to savings and income to give the total of tokens available for conversion. Instructions also explained that all variables were integers. In particular, participants were advised that interest would be rounded to the nearest integer, and examples were given to clarify this procedure. Finally, participants were told at different points of instructions that any savings left over at the end of the last period (the fifteenth) would be worthless.

[9] Again, there was no explicit reference to decreasing marginal utility but, rather, to "increments at a decreasing rate"

3.1 Individual Decision Making

In the case of individual planning, participants were randomly allocated to computers. Any contact with others, apart from the experimenters, was forbidden. For each decision participants had *one* minute where they could try different conversions (using a calculator), however they were not permitted to confirm their decision before the end of the minute. This procedure was implemented to induce participants to think about their strategy. The software included a calculator to allow subjects to view the consequences of their decisions (in terms of future interest, savings and utility) and to compare alternative strategies.

3.2 Group Decision Making

Participants of group sessions were randomly paired at the beginning of each sequence. A random matching rule was enforced, imposing that the same subjects could not be partners more than once. Groups were formed at the beginning of each sequence with the intention of isolating the performance of groups to the greatest extent possible. As in the treatment with individuals, a strict no talking rule was imposed (with the exception of members within the group). Groups had a total of three minutes to discuss and confirm a decision however a choice could only be confirmed after one minute. In order to limit the length of sessions, after the three minutes time, if no decision was confirmed by members, the computer would randomly choose between the last two proposals[10]. To facilitate interactions between members and increase information about groups strategies, an instant messaging system was made available, to chat within the group. Participants were informed about the fact that the software was recording all their messages and that the system was available from the beginning to the end of each period. Par-

[10]The software recorded all proposals. When members did not confirm a decision within 3 minutes, the computer would pick the last proposal of each member and would randomly pick one as representative of the group. This did not happen very frequently. In the case of risk we recorded 58 cases of "disagreement" out of 840 decisions (7%). In the case of uncertainty we had 54 cases out of 900 decisions (6%). Preliminary regressions suggested that disagreement was not a significant regressor.

ticipants could exchange all kind of messages with their partner but they were not allowed to reveal their identity, encourage their partner to share identifying information or use inappropriate language[11]. Instructions provided a detailed explanation of how to interact with one's partner and how to confirm a decision. Partners had to take turns in making proposals as well as take turns as "first proposers", that is, who initiated the exchanges of proposals in a period[12]. The person whose turn it was to make a proposal, selected the available button labeled "Propose" which submitted to their partner. By sending a proposal the turn passed to the other group member, who had to make a counter-proposal. During this process, both partners had a calculator available to try different conversions and check the consequences of each of them. As mentioned above, partners could not confirm a group decision before one minute. For that reason, they could only use the "Propose" button; a "Confirm" button was only available after the one minute time limit. To confirm a proposal, a group member had to press the "Confirm" button, hence confirming her partner's last proposal; otherwise she could still make a counter-proposal and pass the turn to her partner.

After instructions were provided in both individual and group planning sessions, a quiz was distributed to test participants' understanding of the experiment. Afterwards, participants were given some time to practice with the software, in particular with the calculator and the system for group interaction. All sets of instructions included a picture of the utility function and two tables with examples of conversions and of the interest mechanism[13].

3.3 Payment

The final payoff was the conversion into money of the total of points accumulated in one sequence. The computer randomly determined which sequence

[11]After analyzing all messages exchanged, findings suggest that participants largely complied with these rules.

[12]In the first period of a sequence, the computer would randomly determine the "first proposer"; after that, partners would take turns exchanging proposals.

[13]This material is available in the Appendix.

would be considered for payment. Instructions explained that points would be converted into money at a fixed rate of 2 Euros per 100 points. In the case of group decision making, both partners would receive the payoff calculated as described above. This design choice was made so as to not alter the framing of incentives between treatments. Also, the choice of not imposing a sharing rule or letting participants enter into bargaining on how to share the payoff, was motivated by considerations on how this might have altered the behavior of participants during the experiment.

A total of four sessions for groups treatments were run (three sessions for each individual treatment), between the laboratory at Università degli Studi di Salerno and LabSi at Università degli Studi di Siena. Participants were undergraduate students of different disciplines from both universities. Fifty-four participants took part in the sessions for individual decision making; twenty-eight under risk and twenty-six under uncertainty. One hundred and sixteen participants took part in the group sessions (58 groups of two); twenty-eight in sessions with risk and thirty in sessions with uncertainty. The experiment was programmed and conducted with the software z-Tree (Fischbacher 2007).

4 Analysis of results

Results are discussed in four subsections. The first subsection presents a descriptive analysis of data, offering a first comparison between treatments. In the second subsection, group and individual planning as well as decision making under risk and under uncertainty are compared using regression analysis. In the third subsection, as in Ballinger et al. (2003) and Carbone and Hey (2004), treatments are compared with respect to participants' estimated planning horizon. Finally, in the fourth, and last, subsection the content of chat messages recorded during the experiment is discussed. In particular, the analysis will focus on the degree of collaboration within groups and the frequency of strategic talking, alongside a more general investigation of the strategies employed by participants.

4.1 Descriptive Analysis

Table 1 reports a summary of results of the experiment, organized by treatment. In each sub–table sessions and lifecycles are kept separated. The first row is the "Total optimal points", that is, the maximum utility achievable in a sequence, given the actual distribution of income. The second row reports the average total of points accumulated by participants during a sequence (the standard deviation is reported in the third row). Row four shows the deviation from the optimal total, that is, the difference between the second and the first rows. Finally, in the last two rows the total of income actually received in each sequence is reported followed by the number of observations (number of individuals or groups) in the session.

As Table 1 shows, deviations from maximum utility reveal a general pattern of sub-optimal behaviour; in all treatments (all four sub-tables), the average of actual total points is always less than the optimal total points. In many cases participants seem to be able to reduce this deviation in the second sequence. Although this study is *not* focussed on the effect of learning, the regression analysis will further explore how playing a second lifecycle affects individual and group decisions.

Is there any apparent difference between groups and individuals emerging from this first, general look at the data? When comparing agents planning under risk (sub-tables (a) and (c), Table 1), it seems that groups do deviate consistently less from maximum utility. When comparing decision makers in the case of uncertainty, it is not clear who has done better; in the first lifecycle individuals seem to have deviated less than groups, while the opposite appears true for the second lifecycle. Moving to the comparison between decision making under risk and under uncertainty, it seems that differences are not consistent throughout sessions. Indeed, regression analysis will show that there seems to be no significant effect of changing the decision environment (risk to uncertainty).

Table 1: Summary of results

Individual Decision Making Under Risk

(a)	Session 1		Session 2		Session 3	
Lifecycle	*1*	*2*	*1*	*2*	*1*	*2*
Total Opt Pts	576.62	553.89	544.4	465.28	559.17	551.05
AVG Total Pts	475.59	475.17	460.08	383.53	488.42	494.52
Std Dev	77.22	21.39	44.79	18.45	40.54	30.84
Dev. from Opt.	-101.03	-78.72	-84.32	-81.75	-70.75	-56.53
Income	175	145	135	105	165	165
N	7	7	7	7	14	14

Individual Decision Making under Uncertainty

(b)	Session 1		Session 2		Session 3	
Lifecycle	*1*	*2*	*1*	*2*	*1*	*2*
Total Opt Pts	520.64	549.16	523.95	488.87	530.88	491.25
AVG Total Pts	472.26	477.61	460.63	411.60	426.04	397.44
Std Dev	21.65	17.17	23.74	18.37	63.09	70.98
Dev. from Opt.	-48.38	-71.55	-63.32	-77.27	-104.84	-93.81
Income	155	145	145	125	155	125
N	7	7	7	7	12	12

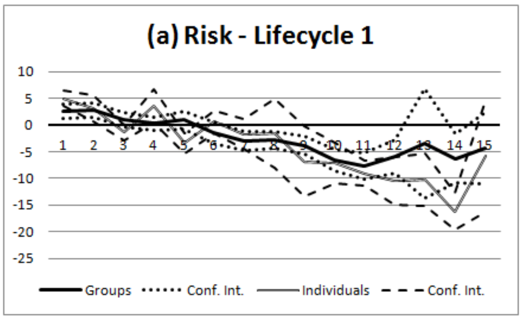
Group Decision Making Under Risk

(c)	Session 1		Session 2		Session 3		Session 4	
Lifecycle	*1*	*2*	*1*	*2*	*1*	*2*	*1*	*2*
Total Opt Pts	491.41	537.77	540.27	538.77	503.28	590.65	553.58	571.96
AVG Total Pts	453.50	508.90	466.80	477.33	451.84	539.58	499.23	490.71
Std Dev	12.93	18.27	17.76	24.75	38.67	20.95	28.30	37.65
Dev. from Opt.	-37.91	-28.87	-73.47	-61.44	-51.44	-51.07	-54.35	-81.25
Income	145	165	145	145	115	175	165	155
N	7	7	7	7	7	7	7	7

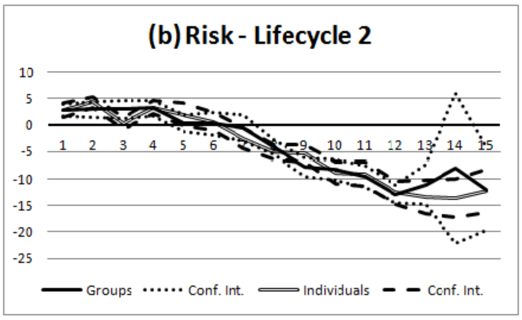
Group Decision Making under Uncertainty

(d)	Session 1		Session 2		Session 3		Session 4	
Lifecycle	*1*	*2*	*1*	*2*	*1*	*2*	*1*	*2*
Total Opt Pts	531.47	557	570.18	566.21	533.47	554.3	514.68	506.24
AVG Total Pts	477.52	528.84	479.27	505.32	459.55	500.25	423.27	463.96
Std Dev	22.97	11.49	54.00	30.08	33.22	22.55	52.47	17.89
Dev. from Opt.	-53.95	-28.16	-90.91	-60.89	-73.92	-54.05	-91.41	-42.28
Income	145	165	165	165	135	175	125	145
N	7	7	7	7	8	8	8	8

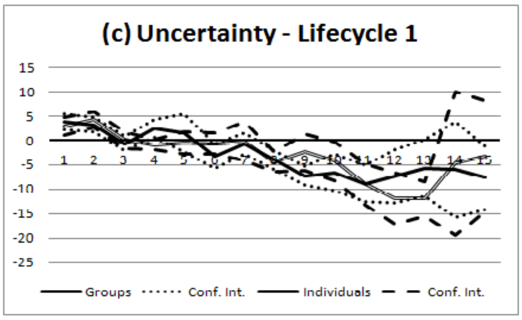
In the following analysis deviations from unconditional and conditional optimum will be considered. While the first measure of optimum is calculated on optimal wealth, assuming optimal behaviour throughout the lifecycle, the notion of conditional optimum is based on *actual* wealth. For this reason, while in the first case deviations from the optimal strategy build up during the lifecycle, the second case incorporates a measure of improvement of behaviour[14].



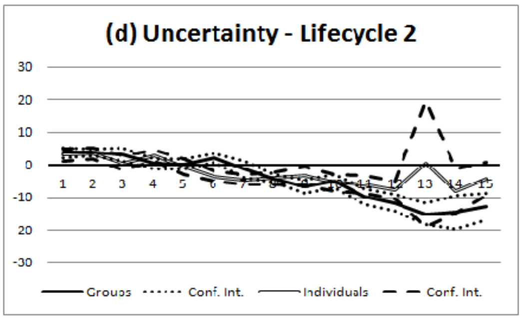
(a)



(b)



(c)



(d)

Figure 1: Individual and Group planning: average deviations from Unconditional Optimum

Figures 1 and 2 show the comparison between group and individual planning, in each of the two lifecycles, in terms of average deviation from *unconditional* and *conditional* optimum. Dotted and dashed lines represent confidence intervals while the x–axis represents optimal behaviour. In both

[14] See also Ballinger et al. (2003) and Carbone and Hey (2004)

figures groups and individuals seem to have very similar patterns. However, some interesting indications may be gathered when looking at unconditional deviations (Figure 1). In particular, in the case of decision making under risk in sequence 1 (Figure 1a), the thick black line, representing groups, seems to be closer to the x–axis than the line representing individual planning[15]. In sequence 2 (Figure 1b), it seems that groups lose their "advantage" on individuals. This time it seems there is no significant or systematic difference between the patterns of deviations. When considering the comparison between individual and group planning in the case of uncertainty (Figures 1c and 1d), the situation seems slightly different. This time, although the patterns are still very similar, it seems that individuals are on average closer to the optimum than groups, in both sequences[16].

When looking at conditional deviations (Figure 2) the graphs do not seem to point to a significant difference, neither between decision makers, nor between lifecycles. Again, the patterns of deviations are very similar although this time there is a visible variability in behaviour, with the lines oscillating significantly, for both types of agents.

Is there any noticeable difference between decision making under risk and uncertainty? The analysis of average deviations from optimum (both definitions)[17] reveals an evident downward shaped pattern, implying over-consumption earlier in the lifecycle and under-consumption later on. In all cases, however, there seems to be no significant difference between risk and uncertainty.

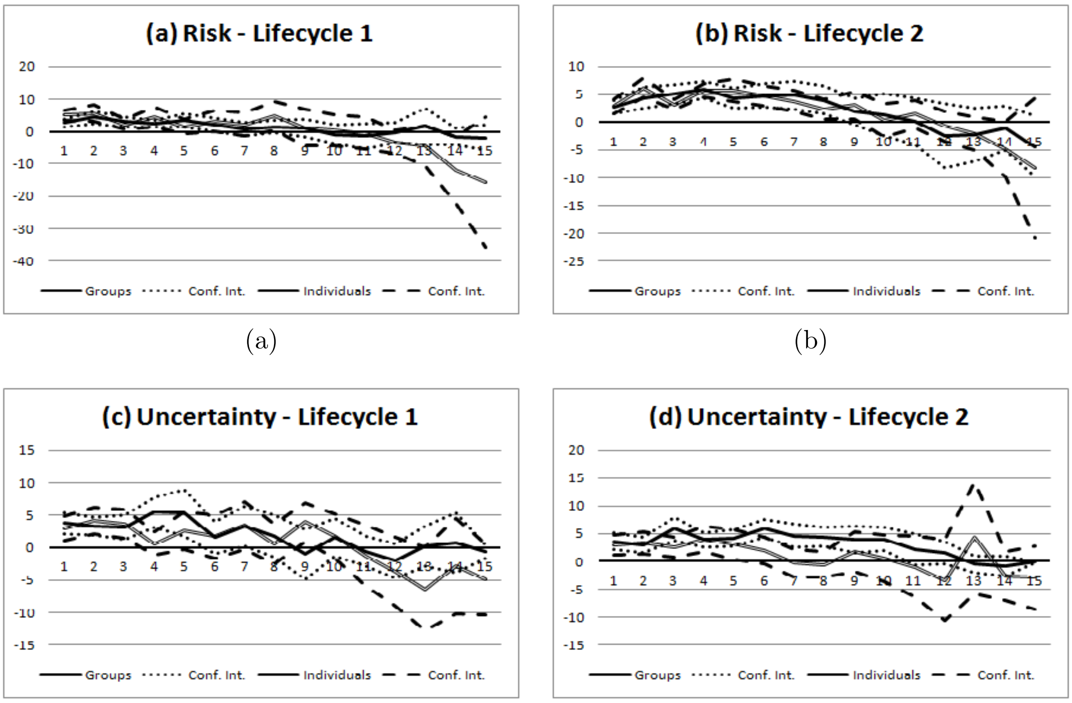
4.2 Regression Analysis

In order to further investigate the effect of group planning (compared to individual decision making) and the effect of uncertainty (compared to risk), the deviation from optimum has been regressed on a number of variables

[15] This is the case between periods 8 and 12, where deviations are significant for both decision makers, but smaller for groups.

[16] See, for example, periods 8 to 11 and periods 3 to 7, in sequence 1

[17] Graphs similar to Figures 1 and 2 can be found in the Appendix



(a) (b) (c) (d)

Figure 2: Individual and Group planning: average deviations from Conditional Optimum

described below. As anticipated, the analysis takes into consideration unconditional and conditional deviations from optimum. Since these two measures differ in their informational content, the comparison of regression results presents interesting insights on the effect of improvement of strategy on deviations. In both cases the dependent variable has been defined as the logarithm of the absolute value of the deviation from optimum[18] ($log(|dev|)$). In this way estimated coefficients can be interpreted in terms of percentage of variation, with positive (negative) signs representing increasing (decreasing) deviations. Finally, the observations of participants who did not consume all their wealth in the last period have been dropped[19].

[18] For a similar approach see Brown, Chua and Camerer (2009)

[19] This occurred 6 times in the case of individual decision making under risk; 7 times in the case of individual planning under uncertainty; 5 times in both treatments with group planning (risk and uncertainty)

4.2.1 Are groups better planners than individuals?

Table 2 below reports the results of regressions estimating the effect of group planning under risk and under uncertainty. "Groups", "Sequence", "Income", "Salerno", "Female" and "Mixed" are dummy variables used to discriminate between treatments[20], lifecycles[21], income draws[22], sessions[23] and gender. As for this last variable, three dummies have been created – male, female and mixed – to accommodate all possible combinations in the experiment[24]. "Period" and "Period Sq." represent planning periods in a sequence; the squared term has been used to detect any non-linearity. "Time" is used to measure the length of time it took participants to make a decision, while "Wealth" has been included in the specifications by taking its natural logarithm ($log(Wealth)$). Regressions also include two variables, used to estimate the effect of past decisions on current ones. In particular past consumption and past utility, lagged one period, are considered. Since this study is not directly focussed on the effects of the other regressors presented in Table 2, the discussion is reported in the Appendix, where they are analyzed in more detail.

All estimations reported in Table 2 include individual random effects and heteroskedasticity robust standard errors. Moreover, residuals have been tested for serial correlation, using the Breusch-Godfrey statistic for higher order autocorrelation and variables have then been transformed accordingly.

Results in Table 2 seem to tell two different stories. In the case of risk, groups deviate on average less than individuals from unconditional optimum (about 11%). Surprisingly, when looking at decision making under uncer-

[20] Groups=1 in case of group planning, 0 otherwise.

[21] Sequence=1 in case of the second sequence, 0 otherwise.

[22] This variable is used to detect the effect of getting high income (15 tokens), compared to low income (5 tokens); therefore, it is equal to 1 in the case of high income and 0 otherwise.

[23] Salerno=1 in the case of sessions run at University of Salerno, 0 for sessions run at University of Siena.

[24] In particular, "male" groups are composed of two male members; "female" groups of two female members, and "mixed" is any group with one male and one female.

Table 2: The effect of Group Planning under Risk and under Uncertainty

	Risk		Uncertainty	
	U.O.	C.O.	U.O.	C.O.
Groups	-0.107*	-0.0418	0.146*	-0.0228
	(-2.50)	(-0.72)	(2.12)	(-0.34)
Sequence	0.0246	0.0129	-0.0460	-0.0193
	(0.69)	(0.32)	(-1.41)	(-0.53)
Period	0.0455**	-0.0256***	0.0409	-0.0344***
	(2.65)	(-4.52)	(1.94)	(-5.94)
Period Sq.	0.00336**		0.00325**	
	(3.24)		(2.73)	
Income		0.140***	-0.0951***	0.227***
		(3.74)	(-3.78)	(5.03)
log(Wealth)	-0.0603	0.696***		0.570***
	(-1.11)	(8.85)		(7.74)
Lagged c	0.00828	0.00737*	0.00965**	0.00679**
	(1.40)	(2.43)	(2.78)	(3.22)
lagged U	-0.00960*		-0.0111***	-0.00748**
	(-2.11)		(-3.77)	(-2.82)
Salerno	0.0367		-0.0881	
	(0.66)		(-1.45)	
Female	0.115*	0.187**		0.140*
	(2.24)	(3.20)		(2.08)
Mixed	0.0428	0.00675		0.0663
	(0.69)	(0.10)		(1.02)
Time			-0.000964*	-0.000618
			(-2.32)	(-1.33)
Constant	0.987***	-0.503**	1.031***	0.0168
	(6.88)	(-2.71)	(15.32)	(0.11)
N	1495	1311	1491	1321
R^2	0.3766	0.282	0.355	0.282
Breusch-Godfrey Test (χ^2_1)	60.12	99.42	65.06	59.10

t statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

U.O. (Uncond. Deviation)= $\log(|c - uo|)$; *C.O. (Cond. Deviation)*= $\log(|c - co|)$

tainty (column 3, table 2), the opposite seem to happen: groups deviate substantially *more* than individuals from *unconditional* optimum (about 15% more). When considering deviations from *conditional* optimum (column 2 and 4, table 2), however, there seems to be no significant difference between decision makers. This result can be interpreted as suggesting that although there is a significant difference in how agents deviate from the solution of the problem (unconditional deviations), this difference seems to be not significant when considering how agents improve their strategy (conditional deviation).

When looking at learning, results suggest that playing a second lifecycle does not cause any significant effect, as summarized results in Table 1 seem to imply. On the other hand however, there is a significant effect of learning *within* the (average) lifecycle[25] represented by the negative coefficient of "Period" in columns 2 and 4 in Table 2 (about 2.5% and 3%).

The discussion above is based on specifications that estimate an average treatment effect through the variable "Groups". However, in light of this, it is not possible to see what really happens during the experiment, that is, across lifecycles. Since participants were matched in new groups at the beginning of the second lifecycle, it seems reasonable to further investigate the performance of groups between lifecycles. This is accomplished by estimating a similar model, where an interaction term between sequences ("Sequence") and treatment ("Groups") is included. Technically, the same estimating strategy described above has been followed and this model has been estimated for all possible cases. Unfortunately, out of the four possible specifications, only in one case the coefficient for the interaction term was significant. This regression is shown in Table 3.

Results confirm that groups deviate from unconditional optimum *less* (by about 27%) than do individuals, *in the first lifecycle*. However, the sit-

[25]Here the effect of planning periods ("Period") is not interacted with any other variables, such as sequence or treatment. For this reason it represents an average effect over the experiment.

Table 3: Interaction term

	Risk
	U.O.
Groups	-0.275***
	(-4.64)
Sequence	-0.114**
	(-2.89)
Groups * Seq.	0.329***
	(4.68)
Period	0.0523**
	(2.91)
Period Sq.	0.00320**
	(2.95)
log(Wealth)	-0.0863
	(-1.60)
Lagged c	0.00835
	(1.47)
Lagged U	-0.0105*
	(-2.40)
Salerno	0.0377
	(0.67)
Female	0.114*
	(2.23)
Mixed	0.0473
	(0.79)
Constant	1.151***
	(7.38)
N	1495
R^2	0.3907
Breusch-Godfrey Test (χ^2_1)	42.8270

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

U.O. (Uncond. Deviation)= $\log(|c - uo|)$

uation changes dramatically when considering the second lifecycle. In this case, groups seem to deviate *more* than individuals, by about 5.5%. This shift might be correlated with the fact that groups were reformed at the beginning of the second lifecycle. If this is true, it is noteworthy how the "continuity" or "stability" of decision makers seem to play an important role on decision making. In other words, while individuals "stay the same" across sequences and appear to improve their decisions[26], groups are not able to do the same and this seems to be due to the variability in the group composition. When looking at the model in Table 3 from the perspective of sequence 2 ("Sequence"=1), the effect of playing a second lifecycle is taken into consideration, in the case of individual ("Groups"=0) and group ("Groups"=1) planning. In particular, results seem to reinforce the finding discussed above; while individuals are able to reduce the deviation from unconditional optimum by roughly 11%, groups do significantly worse, achieving an increase in deviation of about 21%. It is also interesting to note that, from the perspective of the second lifecycle, all participants (individuals and members of groups), should at that stage have the same level of experience.

4.2.2 Comparing Risk and Uncertainty

The same approach used to compare groups and individuals has been followed, estimating models comparing risk and uncertainty in the case of individual decision making and in the case of groups, separately. For each one both unconditional and conditional optimum were used again as benchmarks. Results are shown in Table 4.

The estimations use individual random effects and heteroskedasticy-robust standard errors. As before, residuals have been tested for serial correlation using the Breusch-Godfrey test and variables have been transformed accordingly. The regressors involved in this analysis are the same used in previous estimations. However, this time the treatment dummy variable has been re-

[26] This will be more evident when analyzing individual decision making under risk and uncertainty, which allows individuals to be isolated from groups.

named "Uncertainty" to stress the fact that risk and uncertainty[27] are being compared.

Results in Table 4 show that there seems to be no statistically significant difference between risk and uncertainty for both individuals and groups (with respect to both conditional and unconditional deviations). In the first column, however, the dummy variable "uncertainty" has a p-value of 0.114, which is not dramatically higher than a 10% level of significance. This might be taken as (very) weak evidence of a smaller deviation from unconditional optimum, in the case of uncertainty (about 7%). A possible interpretation is that while individuals deviate from the optimal consumption path in a different way, depending on the environment, their behavior is substantially the same (as suggested by the non-significant coefficient in column 2). Interestingly, results for group decision making (columns 3 and 4, Table 4) seem to match some of the findings from Table 3 illustrated above. In particular, although regressions suggest that there is no significant effect of uncertainty, the coefficient of the treatment variable ("Uncertainty") in column 3, which has a p-value of 0.067, might constitute weak evidence of a worse performance of groups in the case of decision making under uncertainty.

It is also interesting to note that results reported in Table 3 seem also to be confirmed by the estimated effect of playing a second sequence. On the one hand, the average effect of the second lifecycle this time is significant and negative in the case of individual decision making, implying that they seem to do better in the second lifecycle than in the first (of about 8%). On the other hand, however, results show that groups (columns 3 and 4) do remarkably worse in the second lifecycle (about 9.5%). The effect of planning periods is similar to what has been found previously, for both type of decision makers.

[27] "Uncertainty" is 0 in the case of risk, 1 otherwise

Table 4: Comparing Risk and Uncertainty

	Individuals		Groups	
	U.O.	C.O.	U.O.	C.O.
Uncertainty	-0.0767	0.00455	0.0774	0.0401
	(-1.58)	(0.09)	(1.83)	(0.90)
Sequence	-0.0811**	-0.0390	0.0954*	0.00663
	(-2.92)	(-1.15)	(2.29)	(0.15)
Period	0.0319	-0.0182**	0.0552***	-0.0372***
	(1.68)	(-2.93)	(3.46)	(-7.06)
Period Sq.	0.00397***		0.00256**	
	(3.47)		(2.63)	
Income	-0.0955**	0.209***	-0.0366	0.174***
	(-2.60)	(4.44)	(-0.88)	(4.60)
log(Wealth)	0.0311	0.545***	-0.0917	0.658***
	(0.50)	(6.90)	(-1.15)	(9.13)
Lagged c	0.00924*	0.0107**	0.00893	0.00576
	(2.31)	(3.21)	(1.63)	(1.43)
Lagged U	-0.0113***	-0.0120***	-0.00977*	
	(-3.79)	(-5.22)	(-2.36)	
Salerno			-0.0279	
			(-0.72)	
Time				-0.000110
				(-0.33)
Female	0.0783	0.153**	0.0423	0.161*
	(1.56)	(2.86)	(0.79)	(2.33)
Mixed	n/a	n/a	0.0225	0.0362
			(0.54)	(0.73)
Constant	0.985***	0.0115	0.992***	-0.380*
	(6.34)	(0.06)	(6.25)	(-2.46)
N	1442	1270	1544	1362
R^2	0.3649	0.3072	0.3671	0.2512
Breusch-Godfrey Test (χ^2_1)	71.7	72.66	58.23	88.01

t statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

U.O. (Uncond. Deviation)= $\log(|c - uo|)$; *C.O. (Cond. Deviation)*= $\log(|c - co|)$

4.3 Estimated planning horizons

The estimation of the planning horizon used by participants during the experiment is based on the approach described in Ballinger et al. (2003) and Carbone and Hey (2004)[28]. In particular, for each participant the "apparent" planning horizon has been determined as the one in which the mean squared deviation from optimal consumption is *minimized*[29]. These estimations have been carried out with respect to both unconditional and conditional optima.

Results in both cases are very similar. In particular, there seems to be a lot of variability *between* subjects, in all treatments. This is compatible with previous findings from similar experiments, where it has been highlighted that people are very different in how they solve these problems[30]. Also, sequence effects and treatment effects have been analyzed using parametric (t-test) and non-parametric(Wilcoxon-Mann-Whitney and Signed Rank) tests on the average (estimated) planning horizon[31].

Summarizing, when analyzing the difference between sequences, statistical tests suggest that when making decision under risk, both individuals and groups seem to have employed a longer (average) planning horizon in the first lifecycle. The same conclusion is however not supported in the case of decision making under uncertainty, in which the Null Hypothesis of same average horizon across sequences is always accepted.

Statistical tests also reveal that there are no statistically significant differences both between risk and uncertainty and individuals and groups. In-

[28] See Ballinger et al. (2003), p. 934 and Carbone and Hey (2004), p. 678.

[29] Tables showing the estimated planning horizons are reported in the Appendix, along with more details on the procedure followed

[30] See, among others, Carbone and Hey (2004).

[31] The t-test for matched pairs and the signed-rank test have been used, in the case of individual decision making. Since participants were matched in new groups at the beginning of the second lifecycle, the comparison of lifecycles in terms of matched pairs was not appropriate, due to the fact that the samples must be considered as independent (i.e. not related). In this case the t-test (un-matched pairs) and the Wilcoxon-Mann-Whitney test (Ranksum Test) have been used.

terestingly, if the frequencies of longer planning horizons (whose length is greater or equal to 10 periods) are compared, results show that in the case of decision making under risk groups use longer horizons more frequently than individuals (7 times against 2 in sequence 1). However, this difference disappears (8 cases for each treatment) when conditional deviations are considered as well as when comparing frequencies in the second sequence. This might support the findings of the regression analysis, suggesting that groups and individuals differ in how much they deviate from the optimal solution, but not in how they improve their strategy. Previous results also seem to be confirmed when a similar comparison is made in the case of decision making under uncertainty[32].

4.4 Analysis of chat messages

This section will briefly discuss the information gathered through the analysis of messages exchanged by group members using the instant messaging system. The attention has been limited to two aspects: first, the degree of cooperation within groups; second, taking advantage of messages to understand what kind of strategies groups have employed.

Table 5 summarizes chat messages by category. In order to do this, a set of labels had to be created, then all messages had to be read, session by session, and labels applied to each of them. To reduce the complexity and arbitrariness of this procedure, a limited number of categories have been selected. Specifically, chats were labelled according to their content in strategic ("strategy"), collaborative, non collaborative and not related messages[33]. "Strategic" refers to every message related to planning, devising a strategy,

[32] With respect to unconditional optimum, in sequence 1 there are 5 cases of longer horizons for individuals and only 2 for groups; in sequence 2 there are 4 cases for individuals and 1 for groups. With respect to conditional optimum, in sequence 1 there are 3 cases for individuals against 2 for groups; in the second sequence 4 cases for individuals and only 1 for groups.

[33] This last category applies to those messages that are not related to the experiment or the strategy. These chats usually involved small talk or jokes, completely unrelated to the decision making process.

considering the effect and consequences of variables, and so on. "Collaborative" ("non-collaborative") includes messages where agreement (disagreement) between members was expressed. In the case of "non-collaborative" messages, it was decided that "disagreement" was too simplistic a descriptor. In particular, messages representing "non-constructive disagreement" were considered "non-collaborative". In other words, a message has been labelled "non-collaborative" any time a member has expressed disagreement without offering counter-proposals or demonstrating cooperation. Obviously, this procedure necessarily involves a degree of subjectivity intrinsic to the activities of creating categories and labelling messages. For this reason, this summary should be considered as a rough (but nevertheless helpful) representation of what happened during group sessions[34].

Table 5 shows that, apart from session 3 of decision making under risk, participants generally exchanged a similar volume of messages (about 1200 to 1900). As for the frequencies of each category, no formal statistical tests were carried out for two reasons: first, it seems clear from the table that there is no statistically significant difference between treatments, and second, given the unavoidable subjectivity involved in labelling messages, formal testing did not seem useful. However, Table 5 shows that the majority of chat messages are split between strategic and "not related" talking. There seems to be no apparent difference between risk and uncertainty, as well as no significant effect of sessions. In general, it seems that group members attempted to cooperate more than they did challenge each other. In particular, the frequency of non-collaborative messages is significantly smaller than any other category.

As anticipated at the beginning of this section, a second task related to the analysis of chat messages was to try and detect strategies and potential problems faced by groups during the decision making process. Having considered over ten thousand chats, it was clear that, in general, participants understood instructions. There were some instances where participants did not

[34] There are examples, however, of more sophisticated approaches, as in Cooper and Kagel (2005)

Table 5: Summary of chat messages by category

	Groups - RISK							
Sessions	Session 1		Session 2		Session 3		Session 4	
	no.	%	no.	%	no.	%	no.	%
Total Messages	1267		1577		627		1287	
Strategic	447	0.3528	637	0.4039	278	0.4434	525	0.4079
Collaborative	348	0.2747	266	0.1687	153	0.244	385	0.2991
Non-Collaborative	20	0.0158	42	0.0266	13	0.0207	7	0.0054
Not Related	452	0.3567	632	0.4008	183	0.2919	370	0.2875
	Groups - UNCERTAINTY							
Sessions	Session 1		Session 2		Session 3		Session 4	
	no.	%	no.	%	no.	%	no.	%
Total Messages	1888		1341		1449		1525	
Strategic	612	0.3242	549	0.4094	732	0.5052	674	0.442
Collaborative	390	0.2066	324	0.2416	384	0.265	429	0.2813
Non-Collaborative	14	0.0074	22	0.0164	23	0.0159	31	0.0203
Not Related	872	0.4619	446	0.3326	310	0.2139	391	0.2564
	Total							
	no.	%						
Total Messages	10961							
Strategic	4454	0.4063						
Collaborative	2679	0.2444						
Non-Collaborative	172	0.0157						
Not Related	3656	0.3335						

completely understand what was meant by high and low income and some other cases where the rounding mechanism used for interest was not clear enough. In one case there was a misunderstanding about what was meant by "independent" sequences and the difference between tokens and points. In all of these cases, however, initial misunderstandings were corrected by other group members. Only two things were unfortunately not addressed by group cooperation: first, a misunderstanding related to the length of the sequence and, second, some terminology issues. In the first case, observations regarding the last period of a sequence had to be dropped. In the second case, chat messages reveal that there was some confusion between the terms "sequence", "periods", "interest" and "savings". However, this was more a verbal confusion, rather than an actual confusion of concepts[35]. In many cases, strategic talking reveals that decisions were influenced by considerations on savings accumulated, interest earned in the next period, utility gained in the past or associated with current consumption and, finally, by (some) simple forecasting of future income. Some expressed the general strategic idea of accumulating in the first part of the lifecycle (many times just the first three or four periods) in order to build a stock of wealth to be spent in the rest of the sequence. However, group interaction often slowed down strategies; that is, how long to save, when to start spending and so on. In other words, group membership caused a "mediating" effect, by which members were able to move from individual to group strategy[36]. *Group* decision making was many times the result of *active* cooperation, in the sense of active participation to find a common ground. However, although less frequent, there were also examples of group decisions that resulted from *passive* cooperation; in these cases members decided from the beginning, to alternate on decision making as they alternated as first proposers. Another interesting behaviour that emerged from the chat messages (especially in the second sequence) is the *test of reputation*. Very often, in the first couple of periods of the second lifecycle members tested each other to see who had previously received

[35] In other words some participants would use the term period to refer to sequence (or vice versa) but, the meaning of their messages was nevertheless clear when put in context.

[36] This was not always the case, of course. There are records of groups were members were absolutely non-collaborative and unwilling to come to common decisions.

the better result. Sometimes one partner willingly initiated this reputational comparison by communicating to the other member their previous result. Other times, after the first periods, the opposite happened; a member asked the other about previous results. Whoever proved to be a good decision maker, became the leader of the group or, at the very least, became a very influential member. Also, when this comparison or check of reputation did not result in one member becoming influential or leader, members started to question each other to avoid being overcome by their partner. In some cases, deception, lies and exaggeration of one's performance were used[37] to gain the status of "reliable decision maker". This also includes cases where member convinced others that they had technical knowledge in order to build credibility. For example, in one session, in order to support her consumption proposals, a participant used the argument that "[...] from some point onward the utility function gets flatter than the savings line [...]". In another case, the utility function was presented as the function representing the points where "[...] marginal revenue equals marginal cost [...]".

Interestingly, in some cases (especially in the case of planning under risk) a sequence of low (high) income seems to have caused negative (positive) expectations on future income realizations. This is interesting because the probability distribution (in both risk and uncertainty treatments) remained unchanged while drawing income from period to period. This means that there should have been no reason for participants to feel pessimistic (or optimistic), especially in the case of risk where the chances of getting high or low income were well known. In some other cases a pure misconception about probability has been detected. In particular, a participant of a session on decision making under risk believed that since one event (e.g. low income) occurred many times in a row, there was a higher probability for the other (e.g. high income) to occur. In the case of planning under uncertainty, some participants realized, almost at the end of the sequence, that the probability of getting one income or the other was one half. More interestingly, under

[37] In one case a participant stated that he/she gained, in the first sequence, a number of points significantly greater than the maximum achievable.

uncertainty, the more often an event occurred, the more participants believed that its probability was higher than the other's. This seems perfectly normal in a context where there is no information except for direct experience. In addition, in the case of decision making under uncertainty, on several occasions high income was viewed as a bad outcome[38]. In general these were cases where the group was trying to preserve its wealth around a certain number of tokens but, due to poor judgement of probability and poor decision making, when high income occurred, their wealth grew beyond the perceived optimal level.

Looking more closely at the decision making process, messages reveal that some participants tried to compute a level of consumption supposed to be optimal in each period, based on considerations of decreasing marginal utility. Indeed, in many cases this property of the utility function was correctly understood and influenced consumption decisions.

Finally, a summary of the actual strategies employed by groups is reported in Table 6. This analysis suggests that there is great variability between subjects (group members and groups themselves), proof of how people differ in how they tackle these problems. Also, participants displayed a wide array of heuristics that needed to be combined within the group. Messages do not contain precise information about how this combination actually occurred, and this investigation goes beyond the scope of this study. There seems to be no evident difference between strategies devised for decision making under risk and under uncertainty.

5 Discussion

Results suggest that groups and individuals significantly differ in how they deviate from the optimal solution, however they are not different with respect to their ability to improve their strategy. This result is highly interesting be-

[38]Some participants became frustrated while others started wishing for low income.

Table 6: Summary of the strategies extrapolated from chat messages

RISK	UNCERTAINTY
Keep a specific amount of wealth (e.g. 17, 15 or 12 tokens)	Consume a fixed amount of tokens (e.g. 13, 7 tokens)
Consume half of wealth plus one	Consume 2 or 3 tokens in the first periods, then always 3 tokens
Consume half of wealth	Accumulate up to a specific level (20 tokens), then consume half of it and get interest on the half saved
Consume about 70% of wealth	Save always 3 or 8 tokens and take advantage of rounding
Consume 2/5 of wealth	Save when income is low, consume when income is high
Consume 1/5 of wealth (or something very similar)	Consume everything when income is low, save when income is high
Mixed strategy: consume half of wealth but also judge case by case (depending on income draws)	Fixed consumption (15 tokens)
Save when income is high, consume everything when income is low	Always consume half of wealth
Save when income is low, consume when income is high	Keep the wealth always equal to 10 tokens
From some period in the sequence onward (e.g from period 11) start decumulating	Spend everything
Some subjects have a mental ratio between wealth and consumption OR a mental ”optimal” level (e.g. 11, 15, 12 tokens)	Save something in order to spend
Maximize savings or, at least, reach a threshold (e.g. 50 tokens saved) before starting spending	Consume a lot
Save a fixed amount of tokens (e.g. 13 tokens) every period	When wealth is high (not specifically defined) consume half of it. When wealth is low, save.
Consume 1 token every period and then (at period 15) consume everything	
Consume everything in current period	
Accumulate not above 30 tokens of wealth. In period 15 wealth must not be greater than 20 tokens	
Consume 11 tokens when income is high, zero tokens when income is low	
Consume when wealth is smaller than 20 tokens; save when wealth is greater than 20 tokens	
Consume during the lifecycle so that wealth in period 15 is not greater than 50 tokens	

cause it suggests that groups might be more sensitive to the decisional context (in particular, uncertainty) than individuals. It must be noted, however, that these results pool together the two sequences played in the experiment. For this reason the interaction between the treatments (individual/group decision making) and the sequences (Table 3) was analyzed. Interestingly, in the case of decision making under risk, results show that while groups deviate significantly less than individuals in the first sequence (-27.5%), their performance becomes significantly less efficient in the second sequence (+5.4%). When looking at the effect of playing a second sequence, results indicate that while individuals seem to be able to improve their strategy (-11.5%), group performance declines significantly (+21.4%). One possible explanation for this sharp decline of groups is the effect of the re-matching that happened at the beginning of the second sequence. The re-matching procedure was devised to isolate as much as possible the "pure" effect of group planning, to reduce the effect of learning, which was not the objective of this study. This interesting finding suggests that the "stability" of the decision maker might play an important role in the efficiency of decision making. It is also worth noting that at this point of the experiment participants in all treatments (both individuals and group members) had already played one sequence and therefore should have had roughly the same level of experience[39]. Unfortunately, results do not cover all possible cases which limit more thorough analysis. Further investigation of this result might provide more insight into this phenomenon, which could be relevant to real economic settings (i.e. households, committees, etc.).

When analysing the apparent planning horizon used by agents, results suggest that there is no significant difference between individuals and groups, both with respect to decision making under risk and under uncertainty. The frequency of planning horizons (longer than 9 periods) reinforces the results of the regression analysis. In particular, in the case of decision making under risk, groups more frequently use long horizons than individuals (especially

[39] Also, group members should have had a learning advantage, given by the fact of having outperformed individuals

in the first sequence) when the planning horizon is estimated with respect to unconditional optimum. When using the conditional optimum, this difference becomes negligible. Similarly, in the case of decision making under uncertainty, individuals seem to more frequently use long planning horizons than do groups in terms of unconditional optimum while, this difference becomes less evident when considering conditional deviations.

Results also show that there seems to be no statistically significant difference between the effect of risk and uncertainty on the deviation from the optimal strategy. The reason why risk and uncertainty do not seem to be statistically different might lie in how the two environments were designed. As discussed in the experimental design, risk and uncertainty were defined in terms of the knowledge of the probability of receiving a high or low income. This probability was fixed at 0.5 and, although it was unknown by participants when making decisions under uncertainty, it would certainly be a natural reference point. If participants planned as if the probabilities of the two events were equal, then their behaviour would not be statistically different than the condition of risk. Some chat messages recorded during the experiment seem to confirm this hypothesis. An obvious improvement in future experiments will be to find a better representation of uncertainty. It is interesting to note that, once the possible effect of the experimental design is accounted for, results suggest that agents react differently to uncertainty. On the one hand, direct comparison of group and individual planning (Table 2) shows that under uncertainty groups are not able to outperform individuals, as happens when making decision under risk. On the other hand, results in Table 4, although not considered significant at a 5% level of significance, are very close to the 10% and 5% significance threshold. With this limitation in mind, the findings suggest that the effect of uncertainty might have operated in the opposite direction for agents, causing a reduction in deviations from optimum, for the case of individual planning, and an increase of deviation in the case of groups[40].

[40] It is worth stressing that this interpretation cannot and should not be overstretched

Groups and individuals seem to respond in a similar way to an increase of income and to wealth. In both cases these variable cause an increase of deviations from conditional optimum. An interesting finding is related to the effect of lagged variables (consumption and utility). Results show that individuals seem to be more affected by past consumption and past utility, unlike groups. However, their overall effect is very small (around 1%).

The effect of gender on intertemporal planning is very similar for groups and individuals. Males and females (and mixed, in the case of groups) are not significantly different in how they deviate from the optimal consumption path, however, they do differ in how they improve their strategy. Indeed, females deviate more than males from conditional optimum (15.3% in the case of individual planning, 16.1% in the case of groups). The effect of mixed-gender groups is not significant.

Similar to Cooper and Kagel (2005), in this experiment messages exchanged by group members were recorded. The analysis of these messages shows that group members talked more frequently about strategy or of topics not related to the experiment. Moreover, participants usually tried to cooperate with each other in order to reach an agreement on group decisions. This cooperation has also been an important factor of "self-correction" as in many cases members helped each other clarify misunderstandings. Messages also reveal that participants use a great number of strategies or, better, "rules of thumb" to solve the problem. However, many times the interaction within the group slows down the implementation of a strategy or contributes to its inconsistent application throughout a sequence. Interestingly, groups were very different with respect to the dynamics between members. As mentioned, many times group members cooperated to achieve common goals, however, in other cases a form of "delegation" emerged as members agreed to alternate as decision makers during a sequence. Also, usually in the first periods of the second sequence, group members engaged in a "test of reputation", communicating their previous results (sometimes, using deception as well) with the objective of becoming leaders or at least not a subordinate member of the group.

References

[1] Baker, R. J., Laury, S. K., and Williams, A. W. Comparing small-group and individual behavior in lottery-choice experiments. *Southern Economic Journal 75*, 2 (2008), 367–382.

[2] Ballinger, T. P., Palumbo, M. G., and Wilcox, N. T. Precautionary saving and social learning across generations: an experiment. *The Economic Journal 113*, 490 (2003), 920–947.

[3] Bateman, I. J., and Munro, A. An experiment on risky choice amongst households. *The Economic Journal 115*, 502 (2005), C176–C189.

[4] Bateman, I. J., and Munro, A. Household versus individual valuation: Whats the difference? *Environmental and Resource Economics 43*, 1 (2009), 119–135.

[5] Bone, J., Hey, J. D., and Suckling, J. Are groups more (or less) consistent than individuals? *Journal of Risk and Uncertainty 18*, 1 (1999), 63–81.

[6] Bone, J., Hey, J. D., and Suckling, J. A simple risk-sharing experiment. *Journal of Risk and Uncertainty 28*, 1 (2004), 23–38.

[7] Bone, J., Hey, J. D., and Suckling, J. Do people plan? *Experimental Economics 12*, 1 (2009), 12–25.

[8] Bornstein, G., and Yaniv, I. Individual and group behavior in the ultimatum game : Are groups more rational players ? *Experimental Economics 108*, 1 (1998), 101–108.

[9] Brown, A. L., Chua, Z. E., and Camerer, C. F. Learning and visceral temptation in dynamic saving experiments. *Quarterly Journal of Economics 124*, 1 (2009), 197–231.

[10] Browning, M., Chiappori, P. A., and Lechene, V. Collective and unitary models: A clarification. *Review of Economics of the Households 4*, 1 (2006), 5–14.

[11] Browning, M., and Lusardi, A. Household saving: Micro theories and micro facts. *Journal of Economic Literature 34*, 4 (1996), 1797–1855.

[12] Carbone, E. Understanding intertemporal choices. *Applied Economics 38*, 8 (2006), 889–898.

[13] Carbone, E., and Hey, J. D. A test of the principle of optimality. *Theory and Decision 50*, 3 (2001), 263–281.

[14] Carbone, E., and Hey, J. D. The effect of unemployment on consumption: an experimental analysis. *The Economic Journal 114*, 497 (2004), 660–683.

[15] Cason, T., and Mui, V. A laboratory study of group polarization in the team dictator game. *The Economic Journal 107*, 444 (1997), 1465–1483.

[16] Charness, G., and Jackson, M. O. Group play in games and the role of consent in network formation. *Journal of Economic Theory 136*, 1 (2007), 417–445.

[17] Cooper, D. J., and Kagel, J. H. Are two heads better than one? team versus individual play in signaling games. *American Economic Review 95*, 3 (2005), 477–509.

[18] Cubitt, R. P., and Sugden, R. Dynamic decision-making under uncertainty: an experimental investigation of choices between accumulator gambles. *Journal of Risk and Uncertainty 22*, 2 (2001), 103–128.

[19] Deaton, A. *Understanding Consumption (Clarendon Lectures in Economics)*. Oxford University Press, 1992.

[20] Fehr, E., and Zych, P. K. Intertemporal choice under habit formation. *Handbook of Experimental Economics Results 1* (2008), 923–928.

[21] Feri, F., Irlenbusch, B., and Sutter, M. Efficiency gains from team-based coordinationlarge-scale experimental evidence. *The American Economic Review 100*, 4 (2010), 1892–1912.

[22] Fischbacher, U. z-tree: Zurich toolbox for ready-made economic experiments. *Experimental Economics 10*, 2 (2007), 171–178.

[23] Frederick, S., Loewenstein, G., and O'donoghue, T. Time discounting and time preference: A critical review. *Journal of Economic Literature 40*, 2 (2002), 351–401.

[24] Guariglia, A., and Rossi, M. Consumption, habit formation, and precautionary saving: evidence from the british household panel survey. *Oxford Economic Papers 54*, 1 (2002), 1.

[25] Hall, R. E. Stochastic implications of the life cycle-permanent income hypothesis: Theory and evidence. *The Journal of Political Economy 86*, 6 (1978), 971–987.

[26] Hey, J. D. Exploring the experimental economics approach in pensions. Working Paper 43, Department for Work and Pensions, 2008.

[27] Hey, J. D., and Dardanoni, V. Optimal consumption under uncertainty: An experimental investigation. *The Economic Journal 98*, 390 (1988), 105–116.

[28] Kocher, M. G., and Sutter, M. The decision maker matters: Individual versus group behaviour in experimental beauty-contest games. *The Economic Journal 115* (2005), 200–223.

[29] Loewenstein, G., and Prelec, D. Anomalies in intertemporal choice: Evidence and an interpretation. *The Quarterly Journal of Economics 107*, 2 (1992), 573–597.

[30] Loewenstein, G., and Thaler, R. H. Anomalies: intertemporal choice. *The Journal of Economic Perspectives 3*, 4 (1989), 181–193.

[31] Maciejovsky, B., Sutter, M., Budescu, D. V., and Bernau, P. Teams make you smarter: Learning and knowledge transfer in auctions and markets by teams and individuals. IZA Discussion Paper no. 5105, 2010.

[32] Mazzocco, M. Saving, risk sharing, and preferences for risk. *American Economic Review 94*, 4 (2004), 1169–1182.

[33] Meghir, C., and Weber, G. Intertemporal nonseparability or borrowing restrictions? a disaggregate analysis using a us consumption panel. *Econometrica 64*, 5 (1996), 1151–1181.

[34] Naik, N. Y., and Moore, M. J. Habit formation and intertemporal substitution in individual food consumption. *The Review of Economics and Statistics 78*, 2 (1996), 321–328.

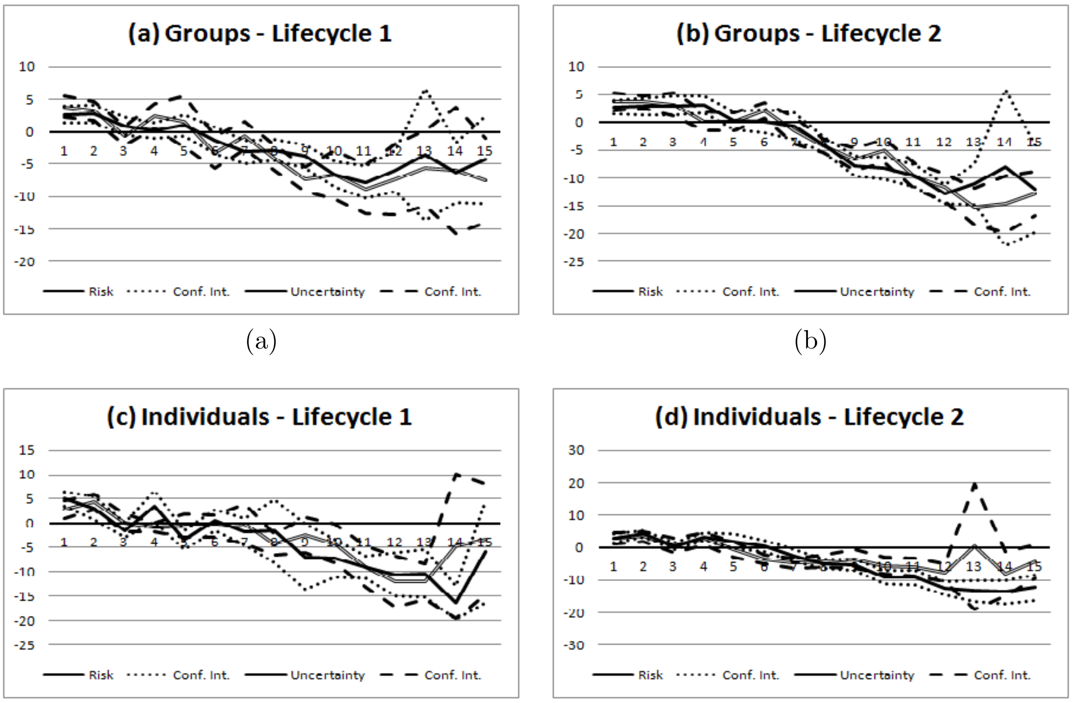
[35] Rossi, M. Households' consumption under the habit formation hypothesis. evidence from italian households using the survey of household income and wealth (shiw). Economics Discussion Papers, University of Essex, Department of Economics, 2005.

[36] Sutter, M., Czermak, S., and Feri, F. Strategic sophistication of individuals and teams in experimental normal-form games. IZA Discussion Paper no. 4732, 2010.

Appendices

Appendix A Comparing Risk and Uncertainty - Figures

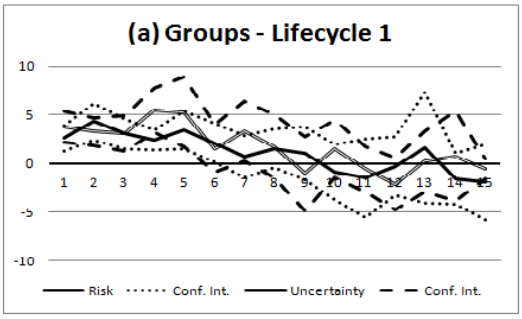
This section presents the graphs of average deviations from optimum when risk and uncertainty are compared. Figures 3 and 4 show these comparisons in the case of unconditional and conditional optimum, respectively.



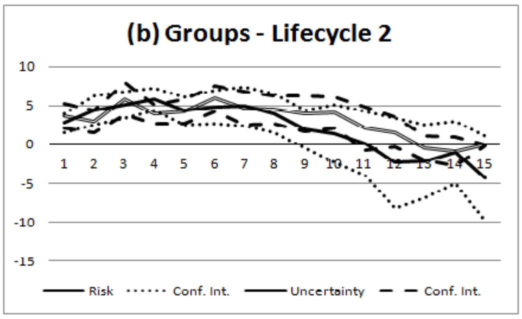
(a) (b)

(c) (d)

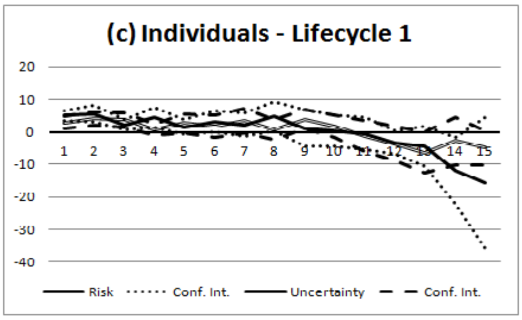
Figure 3: Risk and Uncertainty: average deviations from Unconditional Optimum



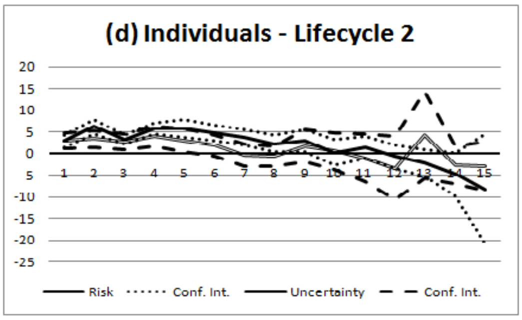
(a)



(b)



(c)



(d)

Figure 4: Risk and Uncertainty: average deviations from Conditional Optimum

Appendix B Other regressors

This section reports on the other regressors that have been included in all estimations, focussing in particular on those reported in Table 4, where decision makers are separated. This way any potential differences in the effect of a variable can be observed separately for individuals and groups.

The dummy variable "Income" measures the effect of a change of income from a low (5 tokens) to a high (15 tokens) level. Results show that high income causes an increase of the conditional deviation of about 21% for individuals and 17% for groups. The change of income seems to cause an excessive increase of consumption, with respect to the conditional optimum (that is calculated on available wealth, which includes current income). In other words, participants over-responded to the increase of income although group interaction seems to have mildly mitigated this effect. At the same time, Table 4 shows that, in the case of deviations from unconditional optimum, the effect of income is negative and significant only for individuals. The apparent contradiction is due to the different definition of the dependent variable. In particular, Figure 3 shows how the pattern of average deviations from unconditional optimum decreases and is below zero for approximately half of a sequence. If participants consume more following an increase of income, this higher consumption will reduce the (negative) deviation, in absolute terms.

Wealth has been defined in terms of its logarithm. This implies that in all estimations the coefficient of this variable is an elasticity. Nevertheless, results in Table 4 suggest that an increase of wealth causes an increase of the deviation from (conditional) optimum. The effect of wealth seems to also confirm the effect of income, discussed above.

Estimations include two variables to measure the effect of past decisions on the current one and, consequently, on the deviation from optimum. Past consumption, in various forms, is typically used when studying habits; in the specifications used in this study only one lag of this variable has been included, "Lagged c". Results suggest that, although lagged consumption is statistically significant and positive, implying an increasing effect on deviations, the magnitude of this effect is usually very limited. In this case, it is interesting to look at all comparisons to see if there are any significant differences between treatments. Table 2 suggests that the significance and size of the effect of lagged consumption on *conditional* deviations is approximately the same for risk and uncertainty. When looking at the same effect on deviations from unconditional optimum, however, regressions show that past consumption is significant only in the case of decision making under uncertainty. Taken together, these results suggest that past decisions of consumption might have been more conditioning in the case of uncertainty[41].

[41] This is a speculation, mainly based on the fact that the lagged consumption is highly significant in the case of uncertainty (both in the case of deviations from unconditional

Table 4 offers a different point view, giving the possibility of comparing individuals and groups. Interestingly, results show that lagged consumption seems to have played a significant role only in the case of individual decision making, causing an increase of deviations from optimum, with a similar size and significance of the coefficients of Table 2 (about 1%). A question remains: why were groups not affected by lagged consumption?

A second, related measure of the influence of past decisions on current ones is lagged utility ("Lag U"). Results in Tables 2 and 4 show that the effect of this variable on deviations from optimum is *negative*, roughly around 1%. It is clear that lagged utility significantly influences decision making, both under risk and under uncertainty and, as Table 2 shows, it seems that planning under uncertainty is affected more greatly. Also, Table 4 suggests that this variable has a significant effect on both individuals and groups, although in the latter case lagged utility seems to play a role only with respect to deviations from unconditional optimum[42]. A very puzzling result is that the effect of past utility is always *negative*, implying a reduction of deviations from optimum, moving in the opposite direction of lagged consumption. This may be explained by the dynamics of the variables involved (actual consumption, utility and deviations from optimum). On average participants over-consumed early in the lifecycle and under-consumed in the last half (relative to the optimal solution). In this part of a sequence, if one looks only at consumption, an increase in deviation is detected due to the fact that optimal consumption steadily increases, while actual consumption is constrained by actual wealth, which is significantly lower than optimal . At the same time, the size of actual wealth is large enough to allow participants to make consumption decisions in the "flatter" part of the utility function, where greater variations in consumption produce smaller variations of utility (due to the effect of decreasing marginal utility). Hence, the negative coefficient of lagged utility might have been caused by the weak responsiveness of

and conditional optimum). However in the case of risk, statistical significance is lower (only in case of conditional optimum).

[42] In the case of conditional optimum lagged utility is not significant and dropped (Table 4, column 4).

this variable to the changes in consumption.

"Salerno" and "Time" are two variables designed to capture the effect of where the experimental sessions were run (Salerno or Siena) and the effect of the time used to make a decision. The latter variable is defined as the seconds used in the period to confirm one's decision. Results show that the effect of both these variable is not significant[43].

In order to estimate the effect of gender on planning, the traditional dummy variable approach has been followed. Since the experiment involved groups, the category "Mixed" was created, to include all cases of mixed-gender groups, while the traditional "Male" and "Female" categories applied to groups with two males and two females. Results in Table 4 show that in the case of individual decision making females deviate more than males from *conditional* optimum (about 15%) while this difference is not significant when looking at deviations from *unconditional* optimum. This result might imply that while males and females deviate substantially in the same way from the optimal path of consumption, males might improve their strategy more effectively than females. A very similar result is obtained when looking at group planning (columns 3 and 4, Table 4). Again, there seems to be no statistical difference between males and females in terms of deviations from *unconditional* optimum. However, when taking *conditional* optimum as a benchmark, females seem to deviate more than males (about 16%). Also, results show that mixed groups do not differ significantly from "male" groups.

[43]"Time" is significant only in one case, Table 2, column 3. However, its effect amounts to a reduction of deviation from unconditional optimum of about 0.1%, which is almost negligible.

Appendix C Technical details on regression analysis

Regressions are based on datasets obtained by pooling together the observations of the treatments to be compared[44]. Moreover, since groups changed from one sequence to the next, the dataset has been organized to reflect this. Specifically, Group "1" in the first sequence is not the same as in the second sequence and estimations need to take this into account.

As a brief explanation of the lagged variables used in the estimations, "Utility" in the last period is used mainly because it might represent an alternative reference point for how current decisions are made, especially in a life cycle experiment. This is merely an alternative view of habitual consumption or, better, temporal dependence. This approach is used to explore the idea that participants might use past utility as a reference point for their decisions rather than past consumption, which would, in a sense, make current welfare depend in some ways on past welfare. However, it should be noted that the objective is not to propose any new theoretical approach to habits; although past consumption and past utility are of course related[45], the objective is merely to consider a potential alternative reference point for current decisions.

Regressions reported in Table 2 include individual random effects. The Breusch-Pagan LM test for random effects (B-P) rejects the Null Hypothesis in all cases. Column (1): B-P= 74.77 (p-value= 0.0000); column (2): B-P= 101.71 (p-value= 0.0000); column (3): B-P= 56.15 (p-value= 0.0000); column (4): B-P= 114.47 (p-value= 0.0000). Also, all estimations include heteroskedasticity-robust standard errors. Residuals have been tested for se-

[44]For example, when comparing individual and group decision making under risk, the dataset contains the observations of those two treatments.

[45]Models in Tables 2, 3 and 4 have been estimated using both variables, dropping both of them and using just one of them alternatively. Results do not change substantially; for each estimation the Variance Inflation Factor (VIF) has been calculated and it is always well below the values usually considered critical for multicollinearity.

rial autocorrelation, using the Breusch-Godfrey test (reported in the last row of the Table); the coefficient of autocorrelation has been estimated using the Cochrane-Orcutt iterative procedure. Variables have then been tranformed accordingly. In the case of Risk (first two columns of Table 2), $\hat{\rho} = 0.2166$ (6th iteration) and $\hat{\rho} = 0.2906$ (4th iteration) were estimated. In the case of Uncertainty (third and fourth column of Table 2), the estimated coefficients are $\hat{\rho} = 0.2258$ (6th iteration) and $\hat{\rho} = 0.2304$ (4th iteration).

The model reported in Table 3 includes individual random effects. The Breusch-Pagan Lagrangian Multiplier test for Random Effects (B-P) rejects the Null Hypothesis (B-P= 61.36; p-value= 0.0000). Standard errors are robust to heteroskedasticity and residuals have been tested for serial correlation. The Breusch-Godfrey test for serial correlation rejects the null hypothesis of no autocorrelation ($\chi^2(1) = 42.827$). The Cochrane-Orcutt iterative procedure has been used to estimate the coefficient of autocorrelation ($\rho = 0.1935$) after eight iterations.

Regressions reported in Table 4 include individual random effects. The Breusch-Pagan Lagrangian Multiplier test for Random Effects (B-P) rejects the Null Hypothesis in all cases. Column 1: B-P= 74.57, p-value= 0.0000; column 2: B-P= 115.80, p-value= 0.0000; column 3: B-P= 102.64, p-value= 0.0000; Column 4: B-P= 92.26, p-value= 0.0000. Also, all estimations include heteroskedasticity-robust standard errors. Residuals have been tested for serial autocorrelation, using the Breusch-Godfrey test (reported in the last row of the Table); the coefficient of autocorrelation has been estimated using the Cochrane-Orcutt iterative procedure. Variables have then been tranformed accordingly. The estimated coefficients of correlation are the following: Model (1), $\rho = 0.2233$, 6th iteration; model (2), $\rho = 0.2539$, 4th iteration; model (3), $\rho = 0.2212$, 7th iteration; model (4), $\rho = 0.2736$, 4th iteration.

Appendix D Estimated Planning Horizon

To compute the "apparent" planning horizon used by participants, the approach described in Ballinger et al. (2003) and Carbone and Hey (2004)[46] has been followed. Employing the optimal plan implies using a T-periods planning horizon, where "T" is the real number of periods composing the lifecycle. However, due to the complexity of the problem, some agents tend to use simplifying rules, such as "using a shorter horizon which is then rolled forward"[47] to cover the (real) length of the lifecycle[48]. As noted in Ballinger et al. (2003) and Carbone and Hey (2004), this leads to dynamic inconsistency and sub-optimal choices. In particular, a subject using this kind of strategy (having a subjective horizon of τ) will behave in period "t" as if period "$t + \tau - 1$" were the last one (except for the last period, T, that will be correctly recognized as the end of the lifecycle). For example, a person with a two periods planning horizon, will behave as if each period is the last-but-one, except for the last-but-one and last periods which are correctly recognized as the last two of the lifecycle. Hence, this strategy implies that in period "t" the subject will not use the relevant optimal consumption function (that is, the one of period "t"). Instead, she will use the consumption function of period "$T+1-\tau$" if t is smaller or equal to "$T+1-\tau$", otherwise she will use the correct one[49]. Following this reasoning, for each possible length of the planning horizon ($1 \leq \tau \leq T$)[50], the optimal solution has been computed, using the optimal consumption functions. The "apparent" planning horizon has been determined as the one in which the mean squared deviation from optimal consumption is *minimized*.

Tables 7 and 8 show the estimated planning horizons for each participant, with respect to both definitions of optimum that have been used in this study.

[46] See Ballinger et al. (2003), p. 934 and Carbone and Hey (2004), p. 678.

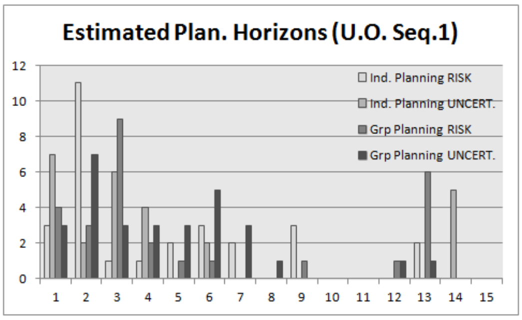
[47] Carbone and Hey (2004), p. 678.

[48] It is important to note that subjects might also be unaware of the fact that they are using a shorter planning horizon.

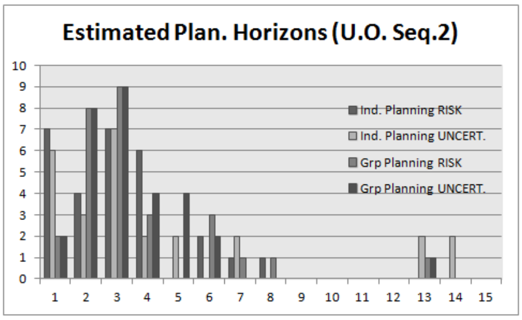
[49] Carbone and Hey (2004), p.679.

[50] In this specific case, potential actual planning horizons range from 1 (extreme myopic behaviour) to 15 periods (optimal behaviour).

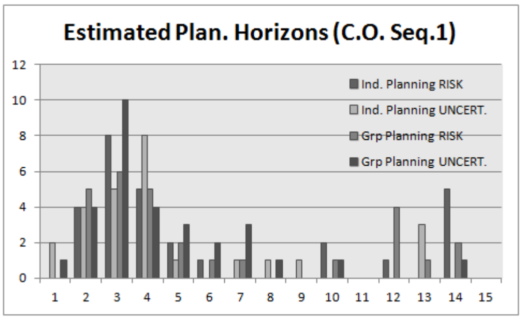
Figures 5a, 5b, 5c and 5d report the frequency of each planning horizon, in each treatment (unconditional and conditional optimum). These graphs show how participants seem to have used mostly short (or very short) planning horizons, with interesting high frequencies, particularly in lifecycle 1, for horizons of 12, 13 and 14 periods.



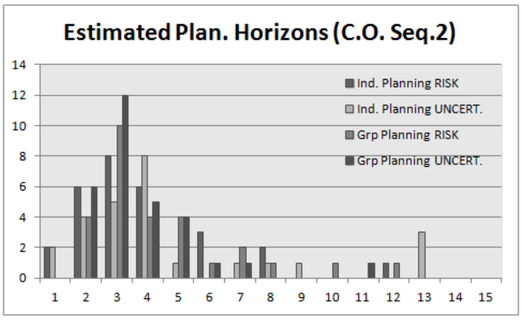
(a)



(b)



(c)



(d)

Figure 5: Individual and Group planning: average deviations from Unconditional Optimum

D.1 Statistical Tests

Is there any difference between sequences? The last row of Table 7 reports the average of estimated planning horizons for each lifecycle. Although this measure is not precise, it provides a useful indication of participants' decisions. In order to detect any statistically significant difference between lifecycles, the t-test for matched pairs and the signed-rank test have been used, in the

Table 7: Estimated Planning Horizons (Unconditional Optimum)

Individuals						Groups			
Risk			Uncertainty			Risk		Uncertainty	
Lifecycles *1*	Lifecycles *2*	*Diff*	Lifecycles *1*	Lifecycles *2*	*Diff*	Lifecycles *1*	Lifecycles *2*	Lifecycles *1*	Lifecycles *2*
Session 1			*Session 1*			*Session 1*		*Session 1*	
1	1	0	2	2	0	3	3	2	3
2	2	0	1	2	1	1	3	7	2
13	2	-11	3	4	1	4	6	7	3
2	1	-1	6	2	-4	2	2	2	4
2	3	1	3	3	0	13	1	1	5
2	4	2	6	5	-1	3	2	3	2
6	4	-2	2	3	1	1	6	5	5
Session 2			*Session 2*			*Session 2*		*Session 2*	
5	2	-3	1	1	0	6	8	3	4
5	3	-2	1	1	0	3	4	2	2
2	3	1	1	1	0	3	3	6	2
6	4	-2	3	3	0	9	2	2	2
2	6	4	4	7	3	3	3	6	6
4	1	-3	4	3	-1	3	2	1	1
7	4	-3	3	4	1	3	3	6	3
Session 3			*Session 3*			*Session 3*		*Session 3*	
6	3	-3	3	3	0	13	4	6	1
1	1	0	4	3	-1	4	3	4	6
7	4	-3	4	5	1	2	3	13	2
2	1	-1	14	13	-1	12	3	1	5
9	1	-8	1	1	0	3	6	6	2
13	8	-5	3	1	-2	13	2	2	3
9	7	-2	14	13	-1	13	2	5	3
2	6	4	1	1	0	*Session 4*		12	5
2	3	1	14	14	0	3	3	*Session 4*	
9	4	-5	1	3	2	1	7	5	3
1	2	1	14	7	-7	2	2	4	13
2	1	-1	14	14	0	13	2	3	2
2	3	1				13	13	2	4
3	3	0				1	4	7	3
						5	1	2	4
								8	3
								4	3
AVG			AVG			AVG		AVG	
4.54	3.11	-1.43	4.88	4.58	-0.31	5.54	3.68	4.57	3.53

Table 8: Estimated Planning Horizons (Conditional Optimum)

Individuals						Groups			
Risk			Uncertainty			Risk		Uncertainty	
Lifecycles		*Diff*	Lifecycles		*Diff*	Lifecycles		Lifecycles	
1	*2*		*1*	*2*		*1*	*2*	*1*	*2*
Session 1			*Session 1*			*Session 1*		*Session 1*	
3	2	-1	4	4	0	4	3	3	4
2	3	1	2	2	0	2	3	7	3
14	2	-12	3	4	1	3	5	6	4
3	2	-1	4	3	-1	2	3	2	3
2	3	1	4	4	0	10	2	2	5
4	4	0	9	5	-4	3	3	3	3
5	6	1	4	5	1	2	7	4	5
Session 2			Session 2			Session 2		Session 2	
6	3	-3	2	2	0	7	8	3	3
5	4	-1	2	2	0	3	7	3	3
3	3	0	1	1	0	5	3	4	2
4	2	-2	4	3	-1	14	5	2	2
3	8	5	4	5	1	3	3	4	5
4	1	-3	4	4	0	4	4	1	2
12	4	-8	2	2	0	5	3	5	3
Session 3			Session 3			Session 3		Session 3	
4	3	-1	3	5	2	12	4	5	2
2	1	-1	3	3	0	6	5	3	7
14	4	-10	4	4	0	3	5	8	3
3	3	0	13	10	-3	12	3	3	6
10	3	-7	3	2	-1	4	10	6	2
14	8	-6	3	2	-1	13	2	3	4
14	12	-2	13	12	-1	14	3	4	3
3	6	3	1	1	0	Session 4		10	5
3	3	0	13	13	0	4	4	Session 4	
14	4	-10	5	9	4	2	6	7	3
4	2	-2	8	8	0	2	2	3	11
2	2	0	7	13	6	12	3	3	3
10	6	-4				12	12	2	4
3	4	1				3	4	7	2
						4	2	3	4
								14	3
								5	3
AVG			AVG			AVG		AVG	
6.07	3.86	-2.21	4.81	4.92	0.12	6.07	4.43	4.5	3.73

case of individual decision making. Since participants were matched in new groups at the beginning of the second lifecycle, the comparison of lifecycles in terms of matched pairs was not appropriate, due to the fact that the samples must be considered as independent (i.e. not related). In this case the t-test (un-matched pairs) and the Wilcoxon-Mann-Whitney test (Ranksum Test) have been used.

In all tests the Null Hypothesis is that the average length of the planning horizon is the same in both sequences ($H_0 : mean(Seq1) = mean(Seq2)$). Since when running the t-test Stata reports all three possible alternative hypotheses, only the relevant one will be reported. When running the Signed Rank and the Wilcoxon-Mann-Whitney tests the same Null Hypothesis and the two-tailed alternative hypothesis ($H_1 : mean(Seq1) \neq mean(Seq2)$) are used.

Table 7 shows that individuals, in the case of decision making under risk seem to have on average implemented longer planning horizons in the first sequence as opposed to the second[51]. However, the same is not true in the case of decision making under uncertainty; both the t-test and the signed-rank test accept the null hypothesis of no difference between the mean lengths in sequences 1 and 2[52]. Similar conclusions apply to group decision making. In the case of group planning under risk, the Wilcoxon Ranksum Test accepts the Null Hypothesis of no difference in the underlying distributions of the estimated planning horizon in the first and second sequence[53], although the sum of ranks for the first lifecycle is slightly higher. However, the t-test suggests that the difference between the mean planning horizons of the two samples is statistically significant (t= 1.8707, p=0.0334). In the case of decision making under uncertainty, both the t-test and the Wilcoxon Ranksum test accept the Null Hypothesis[54].

[51] t-test: t= 2.3355; p-value= 0.0136 ($H_1 : mean(Seq1) > mean(Seq2)$). Signed Rank test: z= 2.142; p-value= 0.032

[52] t-test: t= 0.829; p-value= 0.2075 ($H_1 : mean(Seq1) > mean(Seq2)$). Signed Rank test: z= 0.36; p-value= 0.7185

[53] Wilcoxon-Mann-Whitney: z= 1.107; p-value= 0.2685.

[54] t-test: t= 1.4716; p-value= 0.0759. Wilcoxon-Mann-Whitney test: z= 1.365; p-value= 0.1722

Results in Table 8 suggest that individuals planning under risk seem to use significantly longer planning horizons in the first lifecycle than in the second[55]. Similar to what discussed above, this is the only case of a statistically significant difference between sequences. In the case of individual planning under uncertainty, average horizons (last row of the table) are very close; indeed, the t-test (t= -0.3124; p-value= 0.3787[56]) and the Signed Rank test (z= 0.137; p-value= 0.8911[57]) do not reject the Null Hypothesis of no difference between sequences. As anticipated, in the case of group planning results are very similar to those in Table 7. When planning under risk, groups in the first sequence seem to employ a longer horizon, as weakly suggested by the t-test (t= 1.7627; p-value= 0.0418[58]). As before, however, the Wilcoxon Ranksum test accepts the Null Hypothesis of no significant difference of the distributions of mean planning horizons (z= 0.983; p-value= 0.3254[59]). Also, the t-test (t= 1.2694; p-value= 0.1047[60]) and the Wilcoxon-Mann-Whitney test (z= 1.029; p-value= 0.3036) suggest that there seem to be no statistical difference between sequences in the case of group decision making under uncertainty.

Is there any difference *between* treatments? Do participants employ longer or shorter planning horizons when making decisions under risk, with respect to the case of uncertainty? Is there any difference between individuals and groups? When running the t-test (un-matched pairs) and the Wilcoxon-Mann-Whitney test (Ranksum Test) for all possible cases[61] the Null Hypothesis is always accepted, in both cases of unconditional and conditional optimum, suggesting that there is no statistical difference between treat-

[55] t-test: t= 2.887; p-value= 0.0038 ($H_1 : mean(Seq1) > mean(Seq2)$). Signed Rank: z= 2.628; p-value= 0.0086 ($H_1 : mean(Seq1) \neq mean(Seq2)$)

[56] Here the alternative hypothesis is $H_1 : mean(Seq1) < mean(Seq2)$

[57] Here the alternative hypothesis is $H_1 : mean(Seq1) \neq mean(Seq2)$

[58] $H_1 : mean(Seq1) > mean(Seq2)$

[59] $H_1 : mean(Seq1) \neq mean(Seq2)$

[60] $H_1 : mean(Seq1) > mean(Seq2)$

[61] Each lifecycle has been compared for individual planning under risk and under uncertainty, group planning under risk and under uncertainty, decision making under risk, and decision making under uncertainty.

ments.

Appendix E Instructions

E.1 Individual Decision Making Under Risk

Welcome!

This is an experiment on decision making. The experiment will last about 1 hour and a half. Please read these instructions carefully as you have the chance to earn money depending on your decisions. If you have any questions please raise your hand. The experimenter will answer in private. You are not allowed to talk to other participants to the experiment.

The experiment consists of 2 independent ”sequences”, each one composed of 15 periods. Sequences are independent because there is no relation between them. This means that your choices in one sequence will not influence future sequences. However, please note that, within one sequence, your decision in each period will influence subsequent periods (for example, your decision in period 1 will have consequences for period 2 and so on).

At the beginning of each period you will receive an amount of tokens that will be available to you. You have to decide how many tokens you want to convert into points. You can convert a number of tokens between 0 and the amount available to you. The conversion function of tokens to points is reported in Figure 1 (Appendix). This figure shows graphically the conversion of tokens to points in a continuous interval. You may also look at Table 1 (Appendix) where some examples of conversions are provided. Please note that that the number of points obtained from the conversion increases as the number of tokens converted increases; however, increments are realized at a decreasing rate, that is, the difference in points obtained by converting 6 tokens rather than 5 is bigger than the difference between converting 16 tokens rather than 15. Finally, please note that the more tokens are converted in each period, the less tokens are saved for conversion in future periods. Please note that, before period 15 (the last period) is reached, tokens not converted will be saved for the next period. Savings will earn interest, thus increasing the amount of tokens available in the following period. When period 15 (the last period) is reached, any tokens left (that is, not converted) will be worthless.

Your payoff, at the end of the experiment, will be calculated on the decisions you have made in ONE of the above mentioned "sequences". This sequence will be randomly selected among the 2 played. This means that your payment will be calculated based on the decisions you made during the 15 periods composing the randomly selected sequence. In particular, your payment will be the conversion in Euros of the total amount of points earned in the selected sequence, using a conversion rate of 2 Euros each 100 points.

Periods and Decision Making

At the beginning of each period, you will be randomly assigned a number of tokens. This number may be "high" (15 tokens) or "low" (5 tokens). You have 50% chance of receiving one of the two. It is important to note that the amount of tokens received in one period does not affect the chances of getting the same or the other amount in any following period.

From period 1 to period 14, if you have any tokens saved, they will earn interest, at the rate of 20% ($r = 0.2$). Savings plus interest accumulated will increase the number of tokens available to you in the following period. Please remember that tokens not converted at the end of period 15 will be worthless. Table 2 (Appendix) is available to you, reporting some examples of calculation of interest.

At the beginning of each period you will be showed on the computer screen the total of tokens available, consisting in:

1. Tokens earned in the period: 15 or 5

2. Tokens saved in the previous period (S)

3. Interest earned on savings: S x 0.2 (not rounded)

4. Tokens available for conversion rounded to the nearest integer (for example, 3.4=3; 3.5=4 or 3.6=4): Tokens earned in the period (1.) + Tokens saved in the previous period (2) + Interest earned on savings (3.)

5. Total of points earned: sum of the points earned starting from period 1

Of course, in period 1 there will be no savings and no interest received, so the number of tokens available to you will be equal to 15 or 5 tokens.

Within this screen you will be asked to enter the number of tokens you wish to convert into points. You may change your decision in any moment before pressing the "confirm" button. When this button is pressed your decision will become irrevocable. You cannot move to the next decision before one minute from the beginning of the current period. To make your decision you may use a calculator to observe the consequences of your choice. Depending on the number entered, it is possible to see the related savings, interest earned on savings in the next period and the number of points earned from conversion. The use of the calculator will not make your choice final.

Once the first 15-period sequence has been completed, the following sequence will start. As explained above, the experiment involves making decisions through 2 sequences.

At the end of each sequence a summary of the choices made during the 15 periods will be provided.

Earnings

When the 2 sequences have been completed, your payment will be determined. One sequence will be randomly selected and you will receive the conversion in Euros of the total amount to points earned in the selected sequence.

If you have any questions, please raise your hand and an experimenter will be happy to assist you.

Right after these instructions a short quiz testing your comprehension of the experiment will take place followed by 3 minutes practice with the conversion function.

Appendix

Figure 1 - Conversion Function:

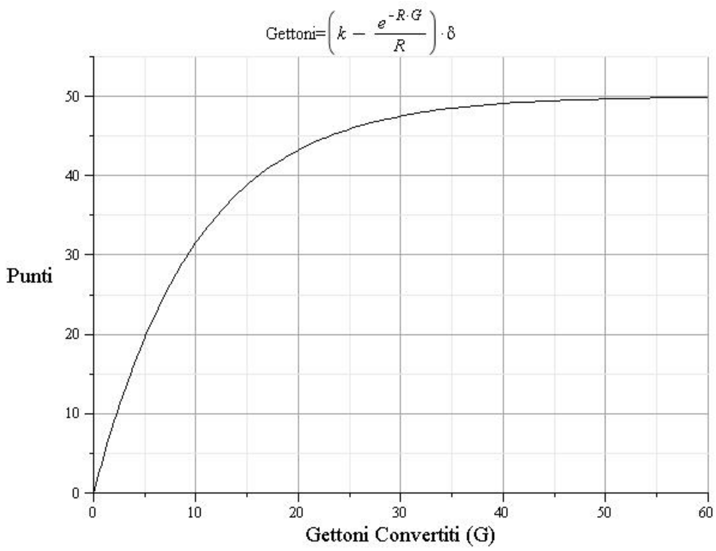


TABLE 1

Tokens Converted (G)	Points Earned
0	0
1	4.758129098
2	9.063462346
3	12.95908897
4	16.4839977
5	19.67346701
6	22.5594182
7	25.17073481
8	27.53355179
9	29.67151701
10	31.60602794
11	33.35644582
12	34.9402894
13	36.37341035
14	37.6701518
15	38.84349199
16	39.9051741
17	40.8658238
18	41.73505559
19	42.52156904
20	43.23323584
⋮	⋮
50	49.66310265
⋮	⋮
100	49.99773
⋮	⋮
150	49.9999847
⋮	⋮
200	49.9999999

$Punti = 50 - 50 * e^{-0.1*G}$

G = Tokens Converted

TABLE 2

Tokens Saved	**Interest on saved Tokens**	**Tokens Saved + Interest**
0	0	0
1	0.2	1.2
2	0.4	2.4
3	0.6	3.6
4	0.8	4.8
5	1	6
6	1.2	7.2
7	1.4	8.4
8	1.6	9.6
9	1.8	10.8
10	2	12
11	2.2	13.2
12	2.4	14.4
13	2.6	15.6
14	2.8	16.8
15	3	18
16	3.2	19.2
17	3.4	20.4
18	3.6	21.6
19	3.8	22.8
20	4	24
⋮	⋮	⋮
50	10	60
⋮	⋮	⋮
100	20	120
⋮	⋮	⋮
150	30	180
⋮	⋮	⋮
200	40	240

Interest = 0,2 * S

S = Tokens Saved

E.2 Individual Decision Making under Uncertainty[62]

Welcome!

This is an experiment on decision making. The experiment will last about 1 hour and a half. Please read these instructions carefully as you have the chance to earn money depending on your decisions. If you have any questions please raise your hand. The experimenter will answer in private. You are not allowed to talk to other participants to the experiment.

The experiment consists of 2 independent "sequences", each one composed of 15 periods. Sequences are independent because there is no relation between them. This means that your choices in one sequence will not influence future sequences. However, please note that, within one sequence, your decision in each period will influence subsequent periods (for example, your decision in period 1 will have consequences for period 2 and so on).

At the beginning of each period you will receive an amount of tokens that will be available to you. You have to decide how many tokens you want to convert into points. You can convert a number of tokens between 0 and the amount available to you. The conversion function of tokens to points is reported in Figure 1 (Appendix). This figure shows graphically the conversion of tokens to points in a continuous interval. You may also look at Table 1 (Appendix) where some examples of conversions are provided. Please note that that the number of points obtained from the conversion increases as the number of tokens converted increases; however, increments are realized at a decreasing rate, that is, the difference in points obtained by converting 6 tokens rather than 5 is bigger than the difference between converting 16 tokens rather than 15. Finally, please note that the more tokens are converted in each period, the less tokens are saved for conversion in future periods. Please note that, before period 15 (the last period) is reached, tokens not converted will be

[62]The material referred to in the "Appendix" is the same for all sets of instructions and can be consulted in subsection 1 (Individual Decision Making under Risk).

saved for the next period. Savings will earn interest, thus increasing the amount of tokens available in the following period. When period 15 (the last period) is reached, any tokens left (that is, not converted) will be worthless.

Your payoff, at the end of the experiment, will be calculated on the decisions you have made in ONE of the above mentioned "sequences". This sequence will be randomly selected among the 2 played. This means that your payment will be calculated based on the decisions you made during the 15 periods composing the randomly selected sequence. In particular, your payment will be the conversion in Euros of the total amount of points earned in the selected sequence, using a conversion rate of 2 Euros each 100 points.

Periods and Decision Making

At the beginning of each period, you will be randomly assigned a number of tokens. This number may be "high" (15 tokens) or "low" (5 tokens). The probability of getting either of the two is unknown. It is important to note that the amount of tokens received in one period does not affect the chances of getting the same or the other amount in any following period. The number of tokens will be determined by a draw from a non-see-through bag containing coloured balls. There are only two colours, however the number of balls of either colour is unknown. A number of tokens (high or low) will be attributed to each of the two colours. The draw will determine the number of tokens for all participants in that period.

From period 1 to period 14, if you have any tokens saved, they will earn interest, at the rate of 20% ($r = 0.2$). Savings plus interest accumulated will increase the number of tokens available to you in the following period. Please remember that tokens not converted at the end of period 15 will be worthless. Table 2 (Appendix) is available to you, reporting some examples of calculation of interest.

At the beginning of each period you will be showed on the computer screen the total of tokens available, consisting in:

1. Tokens earned in the period: 15 or 5
2. Tokens saved in the previous period (S)
3. Interest earned on savings: S x 0.2 (not rounded)
4. Tokens available for conversion rounded to the nearest integer (for example, 3.4=3; 3.5=4 or 3.6=4): Tokens earned in the period (1.) + Tokens saved in the previous period (2) + Interest earned on savings (3.)
5. Total of points earned: sum of the points earned starting from period 1

Of course, in period 1 there will be no savings and no interest received, so the number of tokens available to you will be equal to 15 or 5 tokens.

Within this screen you will be asked to enter the number of tokens you wish to convert into points. You may change your decision in any moment before pressing the "confirm" button. When this button is pressed your decision will become irrevocable. You cannot move to the next decision before one minute from the beginning of the current period. To make your decision you may use a calculator to observe the consequences of your choice. Depending on the number entered, it is possible to see the related savings, interest earned on savings in the next period and the number of points earned from conversion. The use of the calculator will not make your choice final.

Once the first 15-period sequence has been completed, the following sequence will start. As explained above, the experiment involves making decisions through 2 sequences.

At the end of each sequence a summary of the choices made during the 15 periods will be provided.

Earnings

When the 2 sequences have been completed, your payment will be determined. One sequence will be randomly selected and you will receive the conversion in Euros of the total amount to points earned in the selected sequence.

If you have any questions, please raise your hand and an experimenter will be happy to assist you.

Right after these instructions a short quiz testing your comprehension of the experiment will take place followed by 3 minutes practice with the conversion function.

E.3 Group Decision Making under Risk[63]

Welcome!

This is an experiment on decision making. You will be making decisions in cooperation with another participant whose identity will be unknown to you. The experiment will last about 1 hour and a half. Please read these instructions carefully as you have the chance to earn money depending on your decisions. If you have any questions please raise your hand. The experimenter will answer in private. You are not allowed to talk to other participants to the experiment.

The experiment consists of 2 independent "sequences", each one composed of 15 periods. Sequences are independent because there is no relation between them. This means that your choices in one sequence will not influence future sequences. However, please note that, within one sequence, your decision in each period will influence subsequent periods (for example, your decision in period 1 will have consequences for period 2 and so on).

During this experiment you will be part of a group composed of two individuals. The section "Groups and Decisions" explains how groups will be formed, how to interact within a group and reach a decision.

At the beginning of each period your group will receive an amount of tokens that will be available to you. You have to decide how many tokens you want to convert into points. You can convert a number of tokens between 0 and the amount available to you. The conversion function of tokens to points is reported in Figure 1 (Appendix). This figure shows graphically the conversion of tokens to points in a continuous interval. You may also look at Table 1 (Appendix) where some examples of conversions are provided. Please note that that the number of points obtained from the conversion increases as the

[63] The material referred to in the "Appendix" is the same for all sets of instructions and can be consulted in subsection 1 (Individual Decision Making under Risk).

number of tokens converted increases; however, increments are realized at a decreasing rate, that is, the difference in points obtained by converting 6 tokens rather than 5 is bigger than the difference between converting 16 tokens rather than 15. Finally, please note that the more tokens are converted in each period, the less tokens are saved for conversion in future periods. Please note that, before period 15 (the last period) is reached, tokens not converted will be saved for the next period. Savings will earn interest, thus increasing the amount of tokens available in the following period. When period 15 (the last period) is reached, any tokens left (that is, not converted) will be worthless.

Your payoff, at the end of the experiment, will be calculated on the decisions you have made in ONE of the above mentioned "sequences". This sequence will be randomly selected among the 2 played. This means that your payment will be calculated based on the decisions you made during the 15 periods composing the randomly selected sequence. In particular, your payment will be the conversion in Euros of the total amount of points earned in the selected sequence, using a conversion rate of 2 Euros each 100 points.

Each member of the group will receive this payoff.

Periods

At the beginning of each period, you will be randomly assigned a number of tokens. This number may be "high" (15 tokens) or "low" (5 tokens). You have 50% chance of receiving one of the two. It is important to note that the amount of tokens received in one period does not affect the chances of getting the same or the other amount in any following period.

From period 1 to period 14, if you have any tokens saved, they will earn interest, at the rate of 20% ($r = 0.2$). Savings plus interest accumulated will increase the number of tokens available to the group in the following period. Please remember that tokens not converted at the end of period 15 will be worthless. Table 2 (Appendix) is available to you, reporting some examples of calculation of interest.

Groups and Decisions

During each sequence you will be paired with another participant but you will not know his/her identity. This matching will be random. At the end of the first sequence, of 15 periods, new groups will be composed for the second sequence, using again random matching.

Participants matched with you in a group will never have the opportunity to know your identity. During the experiment is absolutely forbidden to reveal your identity to the other group member (or try to know the identity of other participants).

At the beginning of each period you will be showed on the computer screen the total of tokens available, consisting in:

1. Tokens earned in the period: 15 or 5
2. Tokens saved in the previous period (S)
3. Interest earned on savings: S x 0.2 (not rounded)
4. Tokens available for conversion rounded to the nearest integer (for example, 3.4=3; 3.5=4 or 3.6=4): Tokens earned in the period (1.) + Tokens saved in the previous period (2) + Interest earned on savings (3.)
5. Total of points earned: sum of the points earned starting from period 1

Of course, in period 1 there will be no savings and no interest received, so the number of tokens available to you will be equal to 15 or 5 tokens.

In the same screen described above you will be asked to interact with the other member of your group in order to make a decision. To do this the following procedure will be employed:

1. You will have to take turns interacting with the other member
2. In the first period, one of the members of the group will be randomly selected to start the interaction. In the periods following the first, members will take turns initiating the interaction.
3. By pressing the button "PROPOSE", the member of the group who begins the interaction will send his/her proposal to the other member and conclude his/her turn. After this, he/she will have to wait the other member of the group to send his/her decision (accept the proposal or make a new one)
4. It will not be possible to make a group decision before 1 minute. However, during this time group members will be able to exchange proposals of conversion. At the end of the 1 minute time limit, each member of the group, during his/her turn, will also have the opportunity to confirm the proposal received, hence turning it into the group decision, which is irrevocable. The period is concluded when one of the group members confirms a proposal. Hence, the approval of the other member is not required.
5. Members will be able to keep interacting up to a time limit of 3 minutes. After this limit, if a group decision has not been made, the computer will randomly select one of the two members making his/her proposal the final decision of the group.
6. When the minimum time to make a group decision is over (1 minute), if the member whose turn it is to start interacting has not sent any proposal to his partner, the turn will automatically pass to the other member of the group.

<u>Rules of Group Interaction</u>

1. A group decision cannot be made before 1 minute since the start of the current period. This means that even if an agreement is reached, this decision cannot be confirmed before the minimum time limit of 1 minute is over.

2. On the screen used for group interaction, a calculator will be available to you to verify the consequences of your choice. Depending on the number of tokens entered, it is possible to see the related savings, interest earned on savings in the next period and the number of points earned from conversion.

3. A table, denominated "Group decision: current proposals" will be shown on screen. This table is composed of two rows containing the conversion proposals of each member of the group together with the related consequences. Your row is indicated by blue coloured characters.

4. Below this table a box will be available to enter your proposal of conversion, which may be confirmed by pressing the button "PROPOSE".

5. After 1 minute, that is, the minimum time allowed to make a group decision, at each turn a button labeled "CONFIRM" will be available. By pressing this button the group decision will be recorded (becoming irrevocable)

6. An instant messaging (IM) system will also be available and operative from the beginning to the end of the period. To use the chat simply write your message and press enter on the keyboard. This way, your message will be sent to your partner. Each message will be recorded. While using the chat system it is absolutely forbidden to:

   (a) Communicate one's identity in any way (name, student number, nicknames, etc.)

   (b) Ask other participants questions that could lead to the disclosure of identifying information

   (c) Use inappropriate language (insults, etc.)

> The experimenter will make sure that all the rules of chat usage are respected. A violation of one of these rules will cause the cancellation of the final payoff of the participant who committed the violation.

When the group decision has been made, the current period ends and a new period begins.

Once the first 15-period sequence has been completed, the following sequence will start. As explained above, the experiment involves making decisions through 2 sequences.

At the end of each sequence a summary of the choices made during the 15 periods will be provided.

Earnings

When the 2 sequences have been completed, your payment will be determined. One sequence will be randomly selected and you will receive the conversion in Euros of the total amount to points earned in the selected sequence.

If you have any questions, please raise your hand and an experimenter will be happy to assist you.

Right after these instructions a short quiz testing your comprehension of the experiment will take place followed by 3 minutes practice with the conversion function and 3 minutes practice with the group-interaction system.

E.4 Group Decision Making under Uncertainty[64]

Welcome!

This is an experiment on decision making. You will be making decisions in cooperation with another participant whose identity will be unknown to you. The experiment will last about 1 hour and a half. Please read these instructions carefully as you have the chance to earn money depending on your decisions. If you have any questions please raise your hand. The experimenter will answer in private. You are not allowed to talk to other participants to the experiment.

The experiment consists of 2 independent ”sequences”, each one composed of 15 periods. Sequences are independent because there is no relation between them. This means that your choices in one sequence will not influence future sequences. However, please note that, within one sequence, your decision in each period will influence subsequent periods (for example, your decision in period 1 will have consequences for period 2 and so on).

During this experiment you will be part of a group composed of two individuals. The section ”Groups and Decisions” explains how groups will be formed, how to interact within a group and reach a decision.

At the beginning of each period your group will receive an amount of tokens that will be available to you. You have to decide how many tokens you want to convert into points. You can convert a number of tokens between 0 and the amount available to you. The conversion function of tokens to points is reported in Figure 1 (Appendix). This figure shows graphically the conversion of tokens to points in a continuous interval. You may also look at Table 1 (Appendix) where some examples of conversions are provided. Please note that that the number of points obtained from the conversion increases as the

[64] The material referred to in the ”Appendix” is the same for all sets of instructions and can be consulted in subsection 1 (Individual Decision Making under Risk).

number of tokens converted increases; however, increments are realized at a decreasing rate, that is, the difference in points obtained by converting 6 tokens rather than 5 is bigger than the difference between converting 16 tokens rather than 15. Finally, please note that the more tokens are converted in each period, the less tokens are saved for conversion in future periods. Please note that, before period 15 (the last period) is reached, tokens not converted will be saved for the next period. Savings will earn interest, thus increasing the amount of tokens available in the following period. When period 15 (the last period) is reached, any tokens left (that is, not converted) will be worthless.

Your payoff, at the end of the experiment, will be calculated on the decisions you have made in ONE of the above mentioned "sequences". This sequence will be randomly selected among the 2 played. This means that your payment will be calculated based on the decisions you made during the 15 periods composing the randomly selected sequence. In particular, your payment will be the conversion in Euros of the total amount of points earned in the selected sequence, using a conversion rate of 2 Euros each 100 points.

Each member of the group will receive this payoff.

Periods

At the beginning of each period, you will be randomly assigned a number of tokens. This number may be "high" (15 tokens) or "low" (5 tokens). The probability of getting either of the two is unknown. It is important to note that the amount of tokens received in one period does not affect the chances of getting the same or the other amount in any following period. The number of tokens will be determined by a draw from a non-see-through bag containing coloured balls. There are only two colours, however the number of balls of either colour is unknown. A number of tokens (high or low) will be attributed to each of the two colours. The draw will determine the number of tokens for all participants in that period.

From period 1 to period 14, if you have any tokens saved, they will earn interest, at the rate of 20% ($r = 0.2$). Savings plus interest accumulated will increase the number of tokens available to the group in the following period. Please remember that tokens not converted at the end of period 15 will be worthless. Table 2 (Appendix) is available to you, reporting some examples of calculation of interest.

Groups and Decisions

During each sequence you will be paired with another participant but you will not know his/her identity. This matching will be random. At the end of the first sequence, of 15 periods, new groups will be composed for the second sequence, using again random matching.

Participants matched with you in a group will never have the opportunity to know your identity. During the experiment is absolutely forbidden to reveal your identity to the other group member (or try to know the identity of other participants).

At the beginning of each period you will be showed on the computer screen the total of tokens available, consisting in:

1. Tokens earned in the period: 15 or 5
2. Tokens saved in the previous period (S)
3. Interest earned on savings: S x 0.2 (not rounded)
4. Tokens available for conversion rounded to the nearest integer (for example, 3.4=3; 3.5=4 or 3.6=4): Tokens earned in the period (1.) + Tokens saved in the previous period (2) + Interest earned on savings (3.)
5. Total of points earned: sum of the points earned starting from period 1

Of course, in period 1 there will be no savings and no interest received, so the number of tokens available to you will be equal to 15 or 5 tokens.

In the same screen described above you will be asked to interact with the other member of your group in order to make a decision. To do this the following procedure will be employed:

1. You will have to take turns interacting with the other member
2. In the first period, one of the members of the group will be randomly selected to start the interaction. In the periods following the first, members will take turns initiating the interaction.
3. By pressing the button "PROPOSE", the member of the group who begins the interaction will send his/her proposal to the other member and conclude his/her turn. After this, he/she will have to wait the other member of the group to send his/her decision (accept the proposal or make a new one)
4. It will not be possible to make a group decision before 1 minute. However, during this time group members will be able to exchange proposals of conversion. At the end of the 1 minute time limit, each member of the group, during his/her turn, will also have the opportunity to confirm the proposal received, hence turning it into the group decision, which is irrevocable. The period is concluded when one of the group members confirms a proposal. Hence, the approval of the other member is not required.
5. Members will be able to keep interacting up to a time limit of 3 minutes. After this limit, if a group decision has not been made, the computer will randomly select one of the two members making his/her proposal the final decision of the group.
6. When the minimum time to make a group decision is over (1 minute), if the member whose turn it is to start interacting has not sent any

proposal to his partner, the turn will automatically pass to the other member of the group.

Rules of Group Interaction

1. A group decision cannot be made before 1 minute since the start of the current period. This means that even if an agreement is reached, this decision cannot be confirmed before the minimum time limit of 1 minute is over.

2. On the screen used for group interaction, a calculator will be available to you to verify the consequences of your choice. Depending on the number of tokens entered, it is possible to see the related savings, interest earned on savings in the next period and the number of points earned from conversion.

3. A table, denominated "Group decision: current proposals" will be shown on screen. This table is composed of two rows containing the conversion proposals of each member of the group together with the related consequences. Your row is indicated by blue coloured characters.

4. Below this table a box will be available to enter your proposal of conversion, which may be confirmed by pressing the button "PROPOSE".

5. After 1 minute, that is, the minimum time allowed to make a group decision, at each turn a button labeled "CONFIRM" will be available. By pressing this button the group decision will be recorded (becoming irrevocable)

6. An instant messaging (IM) system will also be available and operative from the beginning to the end of the period. To use the chat simply write your message and press enter on the keyboard. This way, your message will be sent to your partner. Each message will be recorded. While using the chat system it is absolutely forbidden to:

(a) Communicate one's identity in any way (name, student number, nicknames, etc.)

(b) Ask other participants questions that could lead to the disclosure of identifying information

(c) Use inappropriate language (insults, etc.)

The experimenter will make sure that all the rules of chat usage are respected. A violation of one of these rules will cause the cancellation of the final payoff of the participant who committed the violation.

When the group decision has been made, the current period ends and a new period begins.

Once the first 15-period sequence has been completed, the following sequence will start. As explained above, the experiment involves making decisions through 2 sequences.

At the end of each sequence a summary of the choices made during the 15 periods will be provided.

<u>Earnings</u>

When the 2 sequences have been completed, your payment will be determined. One sequence will be randomly selected and you will receive the conversion in Euros of the total amount to points earned in the selected sequence.

If you have any questions, please raise your hand and an experimenter will be happy to assist you.

Right after these instructions a short quiz testing your comprehension of the experiment will take place followed by 3 minutes practice with the conversion function and 3 minutes practice with the group-interaction system.

LabSi Working Papers

ISSN 1825-8131 (online version) 1825-8123 (print version)

Issue	Author	Title
n. 1/2005	Roberto Galbiati Pietro Vertova	Law and Behaviours in Social Dilemmas: Testing the Effect of Obligations on Cooperation (April 2005)
n. 2/2005	Marco Casari Luigi Luini	Group Cooperation Under Alternative Peer Punishment Technologies: An Experiment (June 2005)
n. 3/2005	Carlo Altavilla Luigi Luini Patrizia Sbriglia	Social Learning in Market Games (June 2005)
n. 4/2005	Roberto Ricciuti	Bringing Macroeconomics into the Lab (December 2005)
n. 5/2006	Alessandro Innocenti Maria Grazia Pazienza	Altruism and Gender in the Trust Game (February 2006)
n. 6/2006	Brice Corgnet Angela Sutan Arvind Ashta	The power of words in financial markets:soft versus hard communication, a strategy method experiment (April 2006)
n. 7/2006	Brian Kluger Daniel Friedman	Financial Engineering and Rationality: Experimental Evidence Based on the Monty Hall Problem (April 2006)
n. 8/2006	Gunduz Caginalp Vladimira Ilieva	The dynamics of trader motivations in asset bubbles (April 2006)
n. 9/2006	Gerlinde Fellner Erik Theissen	Short Sale Constraints, Divergence of Opinion and Asset Values: Evidence from the Laboratory (April 2006)
n. 10/2006	Robin Pope Reinhard Selten Sebastian Kube Jürgen von Hagen	Experimental Evidence on the Benefits of Eliminating Exchange Rate Uncertainties and Why Expected Utility Theory causes Economists to Miss Them (May 2006)
n. 11/2006	Niall O'Higgins Patrizia Sbriglia	Are Imitative Strategies Game Specific? Experimental Evidence from Market Games (October 2006)
n. 12/2007	Mauro Caminati Alessandro Innocenti Roberto Ricciuti	Drift and Equilibrium Selection with Human and Virtual Players (April 2007)
n. 13/2007	Klaus Abbink Jordi Brandts	Political Autonomy and Independence: Theory and Experimental Evidence (September 2007)
n. 14/2007	Jens Großer Arthur Schram	Public Opinion Polls, Voter Turnout, and Welfare: An Experimental Study (September 2007)

n. 15/2007	Nicolao Bonini Ilana Ritov Michele Graffeo	When does a referent problem affect willingness to pay for a public good? (September 2007)
n. 16/2007	Jaromir Kovarik	Belief Formation and Evolution in Public Good Games (September 2007)
n. 17/2007	Vivian Lei Steven Tucker Filip Vesely	Forgive or Buy Back: An Experimental Study of Debt Relief (September 2007)
n. 18/2007	Joana Pais Ágnes Pintér	School Choice and Information. An Experimental Study on Matching Mechanisms (September 2007)
n. 19/2007	Antonio Cabrales Rosemarie Nagel José V. Rodrìguez Mora	It is Hobbes not Rousseau: An Experiment on Social Insurance (September 2007)
n. 20/2008	Carla Marchese Marcello Montefiori	Voting the public expenditure: an experiment (May 2008)
n. 21/2008	Francesco Farina Niall O'Higgins Patrizia Sbriglia	Eliciting motives for trust and reciprocity by attitudinal and behavioural measures (June 2008)
n. 22/2008	Alessandro Innocenti Alessandra Rufa Jacopo Semmoloni	Cognitive Biases and Gaze Direction: An Experimental Study (June 2008)
n. 23/2008	Astri Hole Drange	How do economists differ from others in distributive situations? (September 2008)
n. 24/2009	Roberto Galbiati Karl Schlag Joël van der Weele	Can Sanctions Induce Pessimism? An Experiment (January 2009)
n. 25/2009	Annamaria Nese Patrizia Sbriglia	Individuals' Voting Choice and Cooperation in Repeated Social Dilemma Games (February 2009)
n. 26/2009	Alessandro Innocenti Antonio Nicita	Virtual vs. Standard Strike: An Experiment (June 2009)
n. 27/2009	Alessandro Innocenti Patrizia Lattarulo Maria Grazia Pazienza	Heuristics and Biases in Travel Mode Choice (December 2009)
n. 28/2010	S.N. O'Higgins Arturo Palomba Patrizia Sbriglia	Second Mover Advantage and Bertrand Dynamic Competition: An Experiment (May 2010)
n. 29/2010	Valeria Faralla Francesca Benuzzi Paolo Nichelli Nicola Dimitri	Gains and Losses in Intertemporal Preferences: A Behavioural Study (June 2010)

n. 30/2010	Angela Dalton Alan Brothers Stephen Walsh Paul Whitney	Expert Elicitation Method Selection Process and Method Comparison (September 2010)
n. 31/2010	Giuseppe Attanasi Aldo Montesano	The Price for Information about Probabilities and its Relation with Capacities (September 2010)
n. 32/2010	Georgios Halkias Flora Kokkinaki	Attention, Memory, and Evaluation of Schema Incongruent Brand Messages: An Empirical Study (September 2010)
n. 33/2010	Valeria Faralla Francesca Benuzzi Fausta Lui Patrizia Baraldi Paolo Nichelli Nicola Dimitri	Gains and Losses: A Common Neural Network for Economic Behaviour (September 2010)
n. 34/2010	Jordi Brandts Orsola Garofalo	Gender Pairings and Accountability Effect (November 2010)
n. 35/2011	Ladislav Čaklović	Conflict Resolution. Risk-As-Feelings Hypothesis. (January 2011)
n. 36/2011	Alessandro Innocenti Chiara Rapallini	Voting by Ballots and Feet in the Laboratory (January 2011)
n. 37/2012	Alessandro Innocenti Tommaso Nannicini Roberto Ricciuti	The Importance of Betting Early (January 2012)
n. 38/2012	Azzurra Ruggeri Konstantinos V. Katsikopoulos	More Does Not Always Lead to Better: Mothers, Young Women, and Girls Generating Causes of a Baby Crying (February 2012)
n. 39/2012	Lory Barile	Does tax evasion affect firms’ internal control? Some evidence from an experimental approach (February 2012)
n. 40/2012	Luigi Luini Annamaria Nese Patrizia Sbriglia	Social Influence in Trustors’ Neighborhoods (July 2012)

n. 41/2012	Simon Halliday	Taking, Punishment and Trust (August 2012)
n. 42/2012	Enrica Carbone Gerardo Infante	Are Groups Better Planners Than Individuals? An Experimental Analysis (December 2012)

LABSI WORKING PAPERS
ISSN 1825-8131 (ONLINE VERSION) 1825-8123 (PRINT VERSION)

LABSI EXPERIMENTAL ECONOMICS LABORATORY
UNIVERSITY OF SIENA
PIAZZA S. FRANCESCO, 7 53100 SIENA (ITALY)
http://www.labsi.org   labsi@unisi.it