Individual and group preferences over risk: does group size matter?

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Individual and group preferences over risk: does group size matter?

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***Abstract*:** In this paper we investigated group size impact on risk aversion when a majority rule is applied. Drawing on the widely used Holt and Laury's (2002) lottery pairs, we observed a risky shift for both individual and groups regardless of their size. However, groups choices are shown to be closer to the risk-neutrality prediction. More interestingly, whereas smaller groups attitudes can be safely approximated by individual choices, larger groups reveal a statistically different risk-loving attitude. This risky shift becomes more prominent as group size increases.

***Keywords*:** Preferences; Group; Risk Attitude; Majority Rule; Laboratory.

***JEL classification*:** C91; C92; D01.

1. Introduction

In the last decade, several scholars investigated groups risk attitudes. However, they did not achieve a univocal position. Some of them reported that groups are more risk averse than individuals (Ambrus et al., 2015; Baker et al., 2008; Bateman and Munro, 2005; Shupp and Williams, 2008; Masclet et al., 2009). Conversely, other studies show that groups tend to be less risk averse (Rockenbach et al., 2007; Zhang and Casari, 2012). In a recent paper Harrison et al. (2012) studied preferences over social risk. Their main result was that individuals and groups risk attitude was not statistically different.

So far, most studies have tested three-person groups (Baker et al. 2008; Masclet et al., 2009; Harrison et al., 2012; Zhang and Casari, 2012; Brunette et al., 2015), but the size of the group could matter (Sutter, 2005; Charness and Sutter, 2012).

In this work we compare individual preferences with group preferences towards risk when group decision is taken under a majority rule; additionally we studied the impact of the group size on group preferences towards risk.

The remainder of this paper is organized as follows. We first present the experimental design in section 2. Then, we report our results in section 3. Finally, section 4 concludes.

2. Experimental design

Our experiment was conducted on a heterogeneous sample of 300 students. The experiment was programmed in z-Tree (Fischbacher, 2007) and was run at the Universitat Jaume I (Castellón, Spain). Overall, we run the experiment in 10 occasions (30 subjects participated in each occasion). No person took part in the experiment in more than one occasion. Subjects were recruited to participate in the experiment using the ORSEE software (Greiner, 2004). Participants were undergraduate students from different disciplines. Written instructions on the experiment were distributed at the beginning (a translation of the Spanish instructions can be found in Appendix). In all experiments payoff amounts were denoted by ECU (Experimental Currency Unit), where 10 ECU = €1. The average earnings amounted to almost 5 Euro, and the experiment lasted less than 20 minutes.

Participants were presented with 10 binary lottery choices as developed by Holt and Laury (2002) (see Table 1). But differently from Holt and Laury (2002) lotteries were not presented in a classical Multiple Price List format (MPL).

Following Andersen et al. (2014) we used the procedures of Hey and Orme (1994), and presented each choice to the subject as a "pie chart" showing prizes and probabilities (see figure 1A in the Appendix).

TABLE 1 – Binary Lotteries in Multiple Price List format

Lottery A				Lottery B				EV(A)	EV(B)	EPD	Open CRRA interval if subject switches to lottery B
p	ECU	p	ECU	p	ECU	p	ECU				
0.1	50	0.9	40	0.1	96.25	0.9	2.5	41	11.88	29.12	-∞, -1.71
0.2	50	0.8	40	0.2	96.25	0.8	2.5	42	21.25	20.75	-1.71, -0.95
0.3	50	0.7	40	0.3	96.25	0.7	2.5	43	30.62	12.38	-0.95, -0.49
0.4	50	0.6	40	0.4	96.25	0.6	2.5	44	40.00	4	-0.49, -0.15
0.5	50	0.5	40	0.5	96.25	0.5	2.5	45	49.37	-4.37	-0.15, 0.15
0.6	50	0.4	40	0.6	96.25	0.4	2.5	46	58.75	-12.75	0.15, 0.41
0.7	50	0.3	40	0.7	96.25	0.3	2.5	47	68.12	-21.12	0.41, 0.68
0.8	50	0.2	40	0.8	96.25	0.2	2.5	48	77.5	-29.5	0.68, 0.97
0.9	50	0.1	40	0.9	96.25	0.1	2.5	49	86.87	-37.87	0.97, 1.37
1	50	0	40	1	96.25	0	2.5	50	96.25	-46.25	1.37, ∞

We showed all the 10 pairs of lotteries one by one on a computer screen. The pairwise choices were presented in the order shown in Table 1, with increments of the high prize probability of 0.1.

The first row in the Table 1 shows how lottery A has a 10% chance of receiving 50 ECU and 90% chance of receiving 40 ECU. The expected value of each lottery is shown after lotteries payoff matrix. For example, it is 41 ECU for lottery A and 11.88 ECU for lottery B. These two columns were not presented to the subjects. Likewise, lottery B in the first row has a 10% chance of winning 96.25 ECU and a 90% chance of winning 2.50 ECU.

Clearly, the two lotteries have been set up in order to have a large difference between their expected values. Moving down the matrix, we can see that the expected value of both lotteries increases.

However, at a certain point the expected value of lottery B (risky option) becomes greater than the expected value of lottery A (safe option). In the first lottery pair, the probability of getting the higher payoff for both lotteries is 10%. Consequently, only a risk-loving subject would choose B (risky option) in the first row and only a risk-averse subject will choose A (safe option) in the second last row.

The last row provides a simple test to verify that, according to non-satiation assumption, subjects understood the instructions (it was not considered for risk aversion assessment). When the probability of the higher payoff for B increases enough for lower rows in the table, subjects should switch over option B. Now, individuals are expected to cross from A to B at some row in the table. The point at which they switch over lottery B will be used to assess their risk attitude.

According to Harrison et al. (2012) lottery choice data can be analysed in two ways. Since each subject provide a choice for each row of the table, responses can be represented by a single scalar. It will be the number of the lowest row in the Table 1 at which subjects switch to lottery B[1]. A risk neutral subject is expected to switch from A to B when the expected value of both lotteries is about the same therefore he will choose lottery A for the first four rows and lottery B thereafter. If subjects switch to the risky option after the fifth row they will be considered risk-averse whereas if subjects switch to the risky option before the fifth row they will be considered risk-seekers.

Another way to analyse individual risk attitude would be looking for the Constant Relative Risk Aversion (CRRA) interval in which subject fall according to their decision (see last column in Table 1). Now, assuming Constant Relative Risk Aversion, the utility function likely to fit subjects choices will be defined as $U(y) = (y^{1-r})/(1-r)$ where r is no more than the CRRA coefficient. With this parameterization, $r < 0$ will imply risk-seeking behaviours, $r = 0$ risk-neutrality behaviours and $r > 0$ risk-aversion behaviours.

Thus for each row of Table 1, it is possible to infer the implied bounds of the CRRA coefficient when subjects permanently switch to B at that point. This means that if subjects switched to lottery B, let's say at the seventh row, they would reveal a CRRA interval between 0.41 and 0.68. The implied CRRA interval will allow us to use a statistical method able to recognize the presence of an interval-censored response. The interval regression models are essentially Tobit extensions allowing for a dependent variable to be right *or* left censored at some fixed value. Furthermore, these extensions shall properly consider right *and* left censoring which can vary according to subjects' preferences[2].

Now, if we assume monotonic preferences, subjects are expected to choose A in the first decision problem and then switch forever to B at one later decision. Individuals that switch from A to B more than once or that switches back from B to A again would be qualified as non-monotonic. Usually multiple-switch behaviours are said to be sign of indifference (Andersen et al, 2006) or confusion in lotteries choices (Zhang and Casari, 2011). This would imply a problem of inference if it were necessary to impose a certain structure to subjects' preferences that are not justified by the underlying theory. Since some subjects have switched back and forth several times as we move down on Table 1 we could have some problems in inferring their CRRA interval.

According to Andersen et al. (2006), if such behaviour can be safely qualified as sign of indifference between lottery options, then the idea is that on can use a "fatter" interval to represent non-monotonic subjects in the analysis. This "fatter" interval will be defined by the first row that

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[1] This constant will take only integer values ranging from 1 and 10. If the subject switched to lottery B at the first decision problem his scalar will be 1 whereas if the subject switched to lottery B at the last decision problem his scalar will be 10.

[2] This statistical approach has been used firstly in Coller and Williams (1999) to elicit subjects' discount rates. The dependent variable in such a kind of model will be the CRRA interval subjects or groups implicitly choose when they switch from lottery A to lottery B.

the subject switched at and the last row that the subject switched at. Theoretically speaking, this would imply that subjects' preferences could be modelled as weakly convex and not strictly convex. We showed all the 10 pairs of lotteries one by one in the same order as depicted in Table 1. Participants were asked to take note of which one they preferred to play on a booklet they were provided in advance.

At the end of the experimental procedure, several random outcomes were generated. We paid only one of the 10 lottery pairs. Firstly one of the rows was randomly selected through a ten-sided die for each subject. Then the lottery was played to determine subjects' payment.

After collecting answers subject by subject, we merged them using the majority rule. In doing so, we exogenously formed two types of groups. The smaller groups were 3-members groups (100 groups) and 5-members groups (60 groups). The larger groups were 15-members groups (20 groups) and 25-members groups (12 groups).

3. Results

Figure 2 displays the proportion of lottery A choices (safe option) as average for each of the ten decision problems listed on the bottom axis. The dashed line shows the predictions under the assumption of risk neutrality. In this reference case, the probability of choosing A will be 1 for the first four decisions and 0 thereafter. As discussed earlier, a risk-neutral subject should take lottery A until its expected value is higher then that of lottery B and then pick lottery B in the remaining decisions. A switch in a later decision would reveal clear risk-aversion behaviour whereas a switch in an earlier decision would reveal clear risk-seeking behaviour.

It is useful to clarify that a rational subject with monotonic preferences should switch from the safer to the riskier option just once and never switch back. Instead, some subjects switched from A to B and *vice versa* more than once. This behaviour can be due to several reasons: either these subjects are genuinely indifferent towards different lotteries (Andersen et al. 2006) or they are not respecting monotonicity (Zhang and Casari, 2011), or it is just a mistake. For our purpose, we consider this behaviour a "mistake" when only one switchback occurred[3]. On the contrary, we labelled as "irrational" those participants who showed multiple switches (they were not monotonic in their preferences).

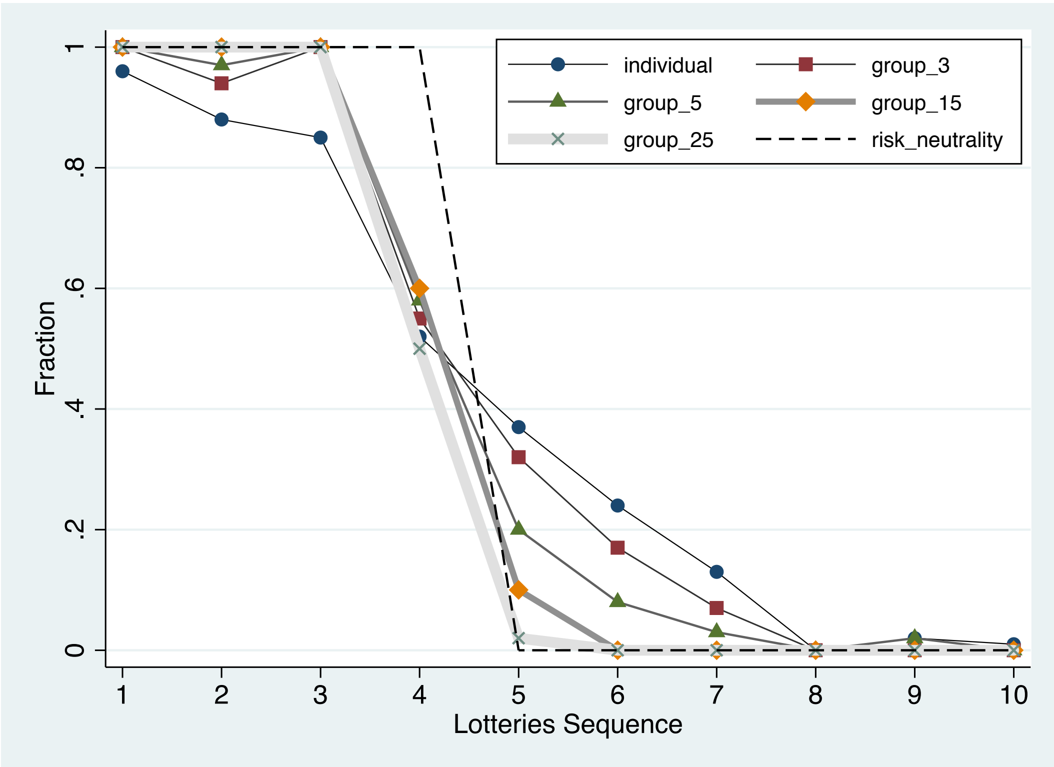
In Table 2A in the Appendix we report counts and percentages for non-monotonic lottery choices across individual and group size treatments. It is noteworthy that the percentage of multiple

[3] In the individual lottery choices mistakes were 31 out of 300 obs (10,33%), in the 3-members groups they were 12 out of 100 (12%), in the 5-members groups 7 out of 60 (11,67%), in the 15-members and 25-members groups only 1/20 (5%) and 1/12 (8,3%). However, we verified that our results would change very little if we drop such observations from our dataset.

switches throughout lottery choices is strictly decreasing when group size increases. It seems that the majority rule makes inconsistent behaviours less likely and more interestingly non-monotonic preferences are absolutely absent in both largest groups.

Figure 2 compares individual choices (circles line), and group choices elicited with majority rule for different group sizes. The two larger groups (15-members groups and 25-members groups) have been identified with a thick line, which become thicker as the group size increases.

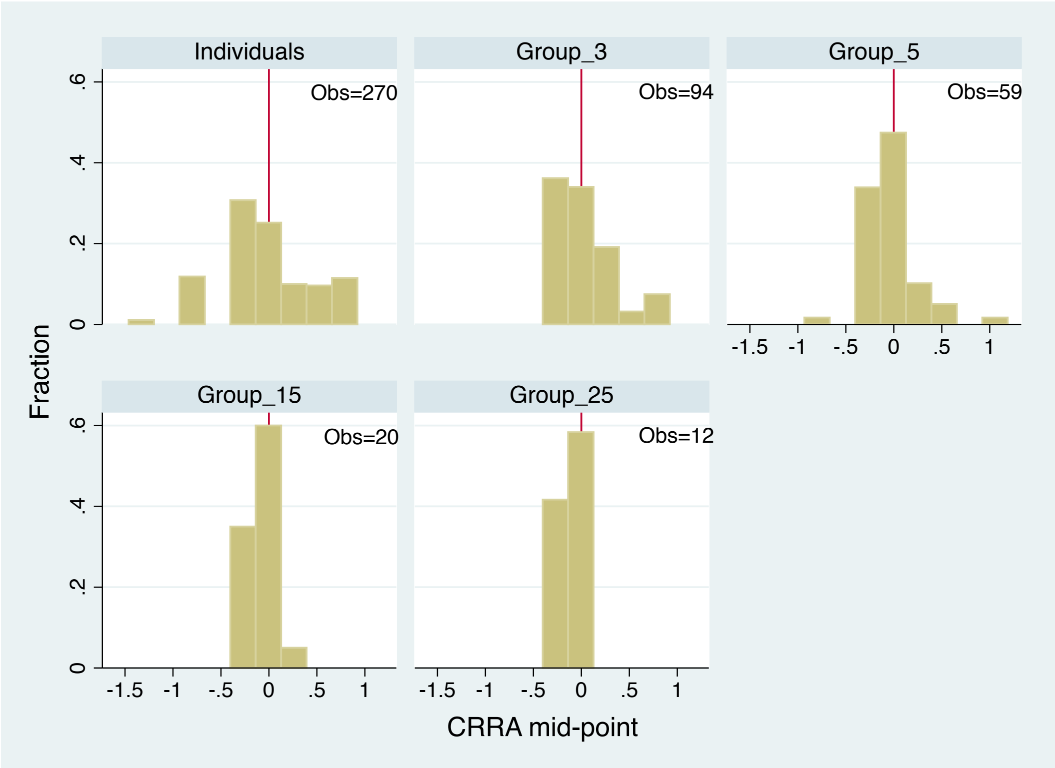
Figure 2 – Fraction choosing the safe choice (lottery A) per individual and group size



As we can notice, we observe a risky shift for both individuals and groups. More specifically, the switching point occurs at lottery 4. However, groups seem to be closer to the risk-neutrality prediction respect to individuals. Here it is useful to distinguish between lotteries 1-4 from lotteries 5-10. As commented before only a risk-loving individual will choose B in lotteries 1 through 4. For this range of lotteries we observe that both smaller and larger groups were less-risk seeking than individuals. Differently, if we move our attention on lotteries 5 through 10 we detect that the difference between group sizes becomes relevant. Particularly, 15-members and 25-members groups lines depict a lower proportion for lottery A choices thus revealing a clear risk-seeking trend. Hence, for these lotteries lager groups seem to be more risky than individuals.

As far we analysed only average choices across lotteries. A second step in our breakdown would be using the CRRA intervals subjects choose in each decision problem. In Figure 3 we start by presenting the graphical distribution of elicited CRRA interval midpoints for individuals and groups[4] and in Table 2A in the Appendix some descriptive statistics on them.

Figure 3 – Elicited CRRA interval midpoints for individuals and groups



From Table 2A we note that the average CRRA midpoint for individuals is negative as expected (risk-seeking behaviours) and progressively decreases as the group size increases. While individuals and smaller groups distributions seem to be statistically indistinguishable, for larger groups (15 and 25 members) the standard error is relatively small respect to samples mean. This is clearly noticeable in the last two histograms in Figure 3 where there is not a great variability around the mean as midpoints become concentrated on the left of the zero-reference line.

To provide a more formal test of our experimental framework we employ an Interval Regression Model (Coller and Williams, 1999; Andersen et al., 2006; Harrison et al., 2012). Our dependent variable will be the elicited CRRA interval that subjects and exogenously formed groups implicitly choose when they cross over the risky option B in Table 1. Estimates of the CRRA for

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4 In the individuals', 3-members and 5-members groups panels, the sample size is less than their total observations (300 for individuals, 100 for groups of three persons and 60 for groups of 5 persons) since some subjects provided choices that led their CRRA interval being $(-\infty; +\infty)$ making midpoints computation impossible. According to Harrison et al. (2012) in the presence of multi-switching behaviours a bounded interval cannot be properly defined. In Figure 3A of the Appendix we report the distribution of CRRA midpoints when "fatter" intervals are considered according to Andersen et al. (2006).

different group sizes are displayed in Table 2 where we consider individual choices as our reference agents.

Table 2: Interval Regression Model of elicited CRRA interval

VARIABLES	Estimate	Standard Error	Z-statistic	P-value	Lower 95% C.I.	Upper 95% C.I.
Group 3	0.033	0.045	0.749	0.454	-0.054	0.121
Group 5	-0.028	0.048	-0.596	0.551	-0.122	0.065
Group 15	-0.082*	0.048	-1.713	0.087	-0.176	0.012
Group 25	-0.118**	0.054	-2.198	0.028	-0.223	-0.013
Constant	-0.014	0.028	-0.500	0.617	-0.070	0.041
Observations	456					

Notes: Dependent variable being elicited CRRA interval. Reference dummy being Inividuals. Log-likelyhood value is -773.87711, Wald test for the null hypothesis that all coefficients are zero has a Chi-squared value of 10.01 with 4 degree of freedom and a p-value of 0.0403. Standard errors are robust to heteroskedasticity.

We notice that for both smaller groups of 3 members and 5 members the estimates are far to be significant. As previously showed in graphical analysis, smaller groups are not statistically different from individuals (standard errors are even larger than estimated coefficients). Differently, we prove that, as hypothesized, larger groups reveal negative and significant estimates. Particularly, we detect very sizable marginal effects. Groups with 15 subjects have a CRRA estimate being 8.2 percentage points lower than the omitted category whereas groups with 25 subjects present a far more prominent difference of almost 12 percentage points.

These findings are robust to the alternative specification where “fatter” intervals are considered for some multi-switching behaviours. In Table 3 of the Appendix we report regression results with “fatter” CRRA intervals. The estimates appear to be stable and consistent though the marginal effects for 15-members group are only very close to the statistical significance.

4. Conclusions

In this paper we investigated group size impact on risk attitude when a majority rule is applied. Particularly, we aimed to compare smaller-sized groups of 3 and 5 subjects with larger-sized groups of 15 and 25 subjects being randomly and exogenously formed departing from individual choices.

Drawing on the widely used Holt and Laury's (2002) lottery pairs we elicited individuals and groups risk attitudes. We observed a risky shift for both individual and groups regardless of their size. However, groups choices are shown to be closer to the risk-neutrality prediction. More interestingly, whereas smaller groups attitudes can be safely approximated by individual choices, larger groups reveal a statistically different risk-loving attitude. This risky shift becomes more prominent as group size increases.

Now, classical economics textbook models individual choices being independent from other people choices. However, social and political decision-making processes imply some aggregation of individual preferences with a variety of risk attitudes. This means that when a majority rule is likely to work at some social level, in presence of some degree in individual risk-seeking behaviours the social decision will undoubtedly be a more risky one.

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Appendix

FIGURE 1A – Lottery pairs in a pie-chart display

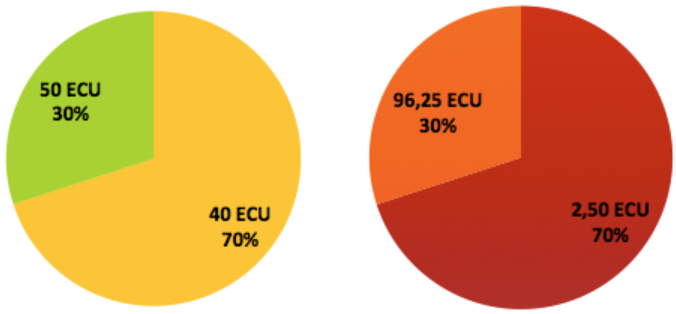


FIGURE 2A - Elicited CRRA interval midpoints for individuals and groups ("fatter" intervals)

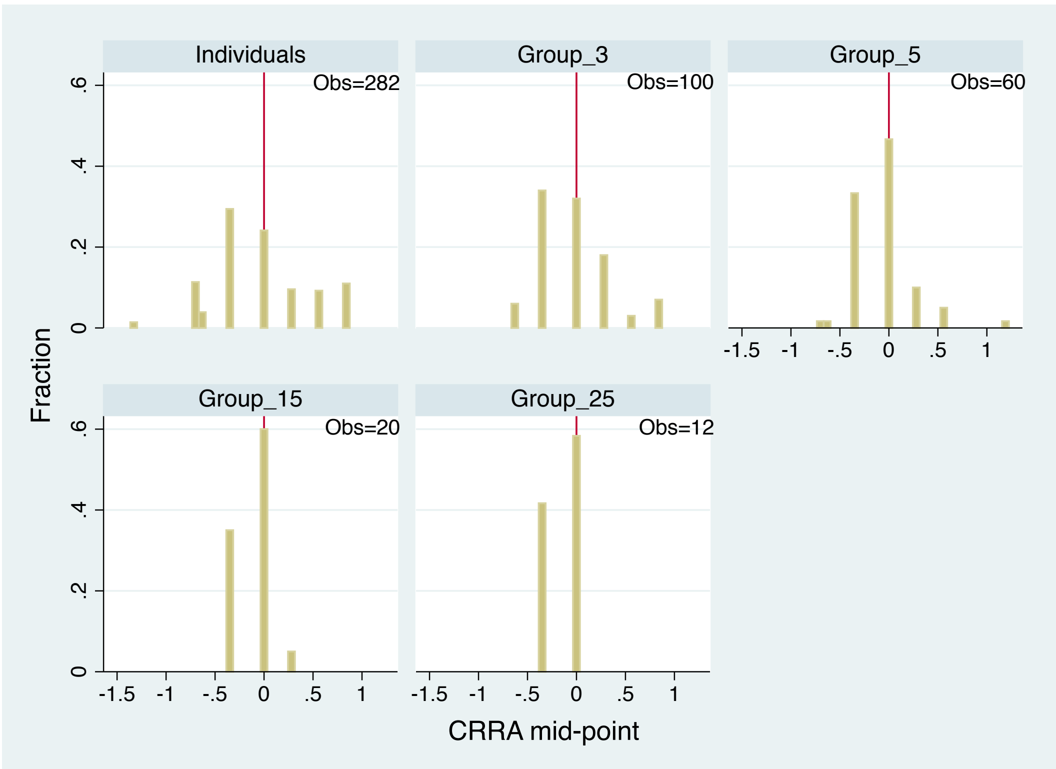


TABLE 1A – Non-monotonic preferences in lotteries choices

	Total observations	Observations with multiple switch-back	%
Individuals	300	30	10%
Group3	100	6	6%
Group5	60	1	1.67%
Group15	20	0	0%
Group25	12	0	0%

TABLE 2A – CRRA midpoints descriptive statistics

Variables	Mean	Standard Error
Individuals	-0.0233	0.0290
Group_3	0.0167	0.0347
Group_5	-0.0447	0.0389
Group_15	-0.0980	0.0398
Group_25	-0.1330	0.0476
Observations	455	

TABLE 3A: Interval Regression Model of elicited CRRA interval with "fatter" intervals

VARIABLES	Estimate	Standard Error	Z-statistic	P-value	Lower 95% C.I.	Upper 95% C.I.
group3	0.031	0.044	0.718	0.473	-0.054	0.117
group5	-0.025	0.047	-0.523	0.601	-0.117	0.068
group15	-0.077	0.048	-1.617	0.106	-0.170	0.016
group25	-0.112**	0.053	-2.114	0.035	-0.216	-0.008
Constant	-0.019	0.028	-0.705	0.481	-0.074	0.035
Observations	491					

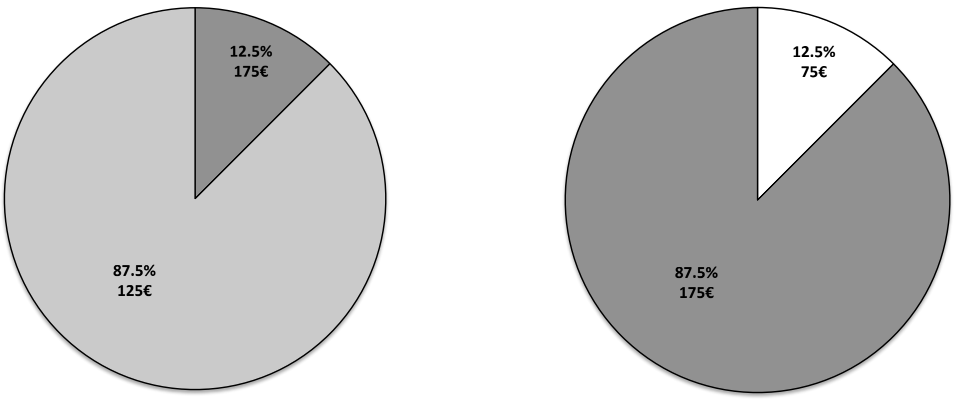
Notes: Dependent variable being elicited CRRA interval. Reference dummy being Inividuals. Log-likelyhood value is -777.90577, Wald test for the null hypothesis that all coefficients are zero has a Chi-squared value of 9.13 with 4 degree of freedom and a p-value of 0.0579. Standard errors are robust to heteroskedasticity.

Experiment instructions (translated into English):

Welcome to the Experiment

This is an experiment to investigate your evaluation of lotteries. At the end of the experiment you will receive a payoff based on the decisions you make according to the rules set out at the end of the experiment. Please read the instructions very carefully before starting the experiment. In particular, make sure that you have understood the payoff procedure before starting.

You will face 10 pairs of lotteries. For each pair you will be asked to choose the lottery that you prefer the most. Below is an example of the pairs of lotteries you can face:



Lottery A Lottery B

You will have to choose between Lottery A and Lottery B. Once you complete this task, one out of the 10 pairs of lotteries will be randomly chosen. The lottery that you stated as the most preferred will then be played for real.