Risk perception, risk attitude and intelligence

An empirical analysis

Master's thesis

MSc. Behavioural Economics

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Abstract

The purpose of this study is to find out whether there is a connection between a person's cognitive abilities and her attitudes toward risk. By means of an experiment we assess that risk neutral subjects seem to be more rational, and more intelligent, than risk averse and seeking individuals. Furthermore, subjects showing an inverse S-shaped probability weighting function are less intelligent than subjects showing an objective perception of probabilities. We also investigated the relationships between intelligence or risk attitudes and other variables: gender, age, education level and field. The correlation between the subject's residence country and both intelligence and risk aversion is analysed: respondents currently living in Italy seem to be more intelligent than subjects living in the Netherlands. The sample of subjects living in the Netherlands and the one of individuals living in Italy show the same risk attitude distribution.

Introduction

The purpose of this study is to find out whether there is a connection between a person's cognitive abilities and her attitudes toward risk. Several previous studies have shown that risk attitudes can be partly elicited from the probability weighting function, and partly from the utility function of the subject. Therefore, in particular, we need to look for connections between a person's intelligence and the way in which she perceives probabilities.

The fact that people usually do not weight probabilities linearly is a known phenomenon. If probabilities were linearly weighted, the objective and the perceived probabilities would coincide, and the probability weighting function w(p) would lie on the 45° line in figure 1. Individuals perceive and weight probabilities in a subjective way.

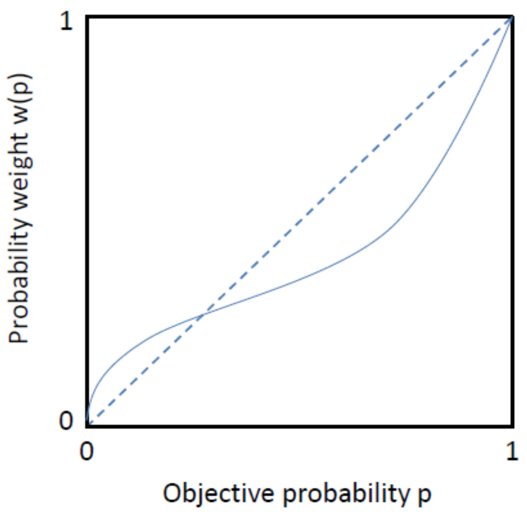

Figure 1

Subjects usually exhibit an inverse s-shaped probability weighting function (Gonzalez & Wu, 1999). This implies an overestimation of small probabilities and an underestimation of big probabilities.

It has already been attested that the inverse s-shaped w(p) has a psychological background. Its first psychological interpretation was given by Kahneman and Tversky (1992), through diminishing sensitivity: subjects feel the changes in probability less as they move away from a reference point (the reference point might be 0; current wealth; expectations). In this case, because we are working with probabilities, the reference points are 0 and 1. Changes in probabilities near these two points will meet with more sensitivity than changes around the middle of the probability function. This may explain the s-shaped curve of w(p).

Wu and Gonzalez (1999) pointed out a related psychological explanation of the inverse-s shape. It is based on two concepts: the discriminability and the attractiveness coefficients. Discriminability refers to the curvature of the weighting function. Discriminability is tightly linked to the diminishing sensitivity concept. Although this coefficient alone gives a proper representation of the curve, it cannot describe all features of function. This is the reason why the authors included a second parameter: the attractiveness coefficient. It gives information about the elevation of the function.

According to Charupat, Deaves, Klotzle, Derouin, & Miu (2012), the w(p) shape can be linked to the subject's degree of emotional balance. For emotional balance, the authors intend the subjective emotions intensity and the degree with which subjects integrate their feeling into judgments and decisions. Consistently with their findings, high emotional balance relates to a lower curvature and a more neutral position of the w(p).

Thanks to previous studies, we already have evidence that the probability weighting function is influenced by psychological factors. With the present study we want to analyse whether there can also be a connection between the subject's intelligence and his probabilities' perceptions, and consequently, his risk attitudes. Other variables will be taken into account: gender, education level and field, age. We will also look for cultural differences across the respondents. More specifically, we are going to analyse any difference in intelligence and risk attitudes between people living in Italy and subjects living in the Netherlands. Several studies have already investigated differences between different nationalities or ethnicities. At the same time, the country of residence has never been considered as a relevant factor. We instead believe that the environment, which the subject is surrounded by, can influence his preferences.

We will investigate the aforementioned relations by running an experiment. The experiment is composed of two sections: in the first section, the cognitive reflection test (Frederick, 2005) is presented (in order to assess the respondent's decision-making intelligence). The second section consists in an estimation of the utility and probability weighting function, according to the Abdellaoui (2000) elicitation procedure, in order to assess the respondent's risk attitudes.

In Chapter 1 a brief history about the introduction and development of w(p) in the preferences analysis is given. In Chapter 2 we present in detail how the questionnaire was designed and distributed over the sample. In Chapter 3 we show and discuss the main findings. Finally, Chapters 4 and 5 are about the main conclusions, limitations and possible future researches.

Chapter 1
Probability weighting function: introduction and development

Expected value

The first method utilized to reveal subjects' preferences is the expected value model. For instance, we could consider rolling a die. This event's outcomes would be obtaining a number from 1 to 6. Each outcome has attached a specific probability to happen. Considering a prospect P defined as follows:

$$P = (p_1: x_1; \dots; p_n: x_n).$$

The expected value of prospect P is computed by multiplying the outcomes times the corresponding probabilities. The expected value of the prospect, EV(P), would then be:

$$\sum_{i=1}^{n} p_i x_i.$$

The EV model implies, first, complete rationality of individuals and, second, maximizing payoffs as final aim. Therefore, if a subject is asked to make a choice between two prospects, he should choose the prospect that offers a higher expected value. This theory does not include any subjective perception of outcomes or probabilities.

Bernoulli (1738) first managed to solve an already known deviation from the EV model: the St. Petersburg paradox. In this game, a coin is flipped until heads shows up. The participant, at the end of the game, wins €2^k. K represents the number of times that the coin is flipped before obtaining heads. The expected value of this game is an infinite amount, but people are usually not willing to pay much to participate.

The main problem of EV, leading to this kind of violation, is that it does not take into account reference points (like the individual's wealth, for instance). In other words, in this model, a raise in wealth from €0 to €1000 is equally felt than a change from €101000 to €102000.

Many researchers tried to solve the aforementioned paradox in many different ways. The first one was Bernoulli. He had the idea of translating monetary amounts into subjective values, called utilities. In doing so, he gave birth to what we call expected utility.

Expected utility

Expected utility was first introduced by Bernoulli, and first axiomatized by von Neumann and Morgenstern (1953). As in EV, the probabilities are assumed to be linearly perceived, but the outcomes are weighted according to a subjective utility function. The expected utility of prospect P, EU(P), is calculated as follows:

$$\sum_{i=1}^{n} p_i U(x_i).$$

Through the respondent's choices, one can elicit his utility function. Consequently, the preferences and risk attitudes of the subject can be defined. If the utility curve is concave, the respondent is risk averse, if it is convex the subject is risk seeking, if it is linear he shows neutrality towards risk.

In order for a utility function to accurately represent the individual's preferences through expected utility, four conditions need to be met: completeness, transitivity, continuity and independence. According to the completeness axiom, for all S and Z prospects, we need to have either S ≥ Z or Z ≥ S. The transitivity axiom states that, for all S, Z and R, if S ≥ Z and Z ≥ R, then S ≥ R. The assumption of continuity requires that, for all S, Z and R with S ≥ Z and Z ≥ R, there must be a probability P such that:

$$(p: S; (1-p): R) \sim Z.$$

The last assumption, the independence axiom, states that, for all S, Z and R outcomes and all probabilities P, if S ≥ Z then:

$$(p: S; (1-p): R) \;\geq\; (p: Z; (1-p): R).$$

Although the expected utility theory has been widely used in the past decades to elicit and study preferences, many researchers demonstrated that its assumptions are often violated under particular circumstances. For instance, already in 1969, Tversky demonstrated that in certain conditions, subject's choices do not follow the transitivity requirement (Tversky, 1969). More specifically, in the present study, we will report the two most relevant violations of the independence axiom: the common consequence effect and the common ratio effect, both called the Allais paradox (Allais, 1953)

According to the Allais paradox, subjects overweight the value of sure outcomes, when those are compared with uncertain outcomes. Consider the following two problems:

PROBLEM 1: Choose between

A:	2,500 with probability	.33,	B:	2,400 with certainty.
	2,400 with probability	.66,		
	0 with probability	.01;		

PROBLEM 2: Choose between

C:	2,500 with probability	.33,	D:	2,400 with probability	.34,
	0 with probability	.67;		0 with probability	.66.

Figure 2

In the first case subjects are asked to make a choice between prospect A and prospect B, in the second case between prospect C and D. In problem 1, prospect A consists of winning 2500 with 33% probability, 2400 with 66% probability or 0 with 1% probability. In prospect B, the subject wins 2400 for sure. Empirically, 82% of the respondents chose option B. In problem 2, the option C presents the possibility to win 2500 with 33% probability and nothing otherwise. Option D offers a gain of 2400 with probability 34% and 0 otherwise. In problem 2, 83% of the subjects chose option C. The choices show that when the probabilities of winning are high, respondents prefer the prospect offering sure gains. However, when both the chances of winning and the difference between the two probabilities are small, subjects choose the prospect that gives a higher chance of winning. In other words, in the first problem respondents chose the safe prospect, while in the second they prefer the more risky one.

The second violation of EU is the common ratio effect. Consider the following prospect R:

$$R = (p, a; (1 - p), b).$$

R gives the possibility of winning outcome a with probability p, and b otherwise. Prospect S, instead, offers outcome c with probability q, and outcome d otherwise

$$S = (q\ c; (1 - q), d).$$

We know the following relationships: outcome a < outcome c and probability p > probability q. We now equally change the probabilities p and q, for instance dividing them for the same positive number x: p/x and q/x. The prospects composed by these two new probabilities are R’ and S’. According to expected utility, if

$$R\ >\ S, then\ R’\ >\ S’.$$

What empirically happens is that:

$$R\ >\ S\ and\ S’\ >\ R’.$$

We observe a preference reversal across the two choices.

In both common consequence and common ratio effects, we observe a kind of behaviour that violates the independence axiom. It therefore violates expected utility theory.

The incompleteness of EU in predicting and analysing subjects' choices lead researcher to find new theories and methods. In order to solve the Allais paradox the rank dependent utility model (Quiggin, 1982) and prospect theory by Kahneman and Tversky (1979) have been developed.

Rank-dependent utility

The rank-dependent utility model uses a subjective perception of probabilities. Before RDU, the outcomes were subjectively weighted according to a utility function and the probabilities were linearly perceived. In RDU, both subjective values of outcomes and probabilities are taken into account.

Before the introduction of RDU, the simple decision weighted utility V(p) was developed, in order to include a subjective view of probabilities in the preferences analysis. According to the subject's choices, it is possible to calculate his preference computing V(p):

$$V(p) = \sum_{i=1}^{n} \pi(p_i) u(x_i),$$

where $\pi(p_i)$ is the probability weighting function. It is strictly increasing and

$$\pi(0) = 0 \; and \; \pi(1) = 1.$$

Although V(p) may give more accurate predictions, it presents a problem: it violates monotonicity as soon as $\pi(p_i)$ is not linear. In order to overcome this issue, John Quiggin (1982) first had the intuition of weighting the probability of getting at least x_i instead of exactly x_i. He developed RDU. Now the π_i function represents the probability of getting at least x_i minus the probability of obtaining more than x_i.

We assume:

$$x_i \geq \cdots \geq x_n.$$

Given this condition, π_i is calculated as follows:

$$\pi_i = w(p_1 + \cdots + p_i) - w(p_1 + \cdots + p_{i-1}),$$
$$with \; \pi_1 = w(p_1).$$

where $w(p)$ is the probability weighting function.

The introduction of the probability weighting function into the study of preferences gave a great help in the understanding the subject personality and psychology. That happens because in RDU the weight attached to an outcome depends on both its probability and on its ranking compared to the other outcomes.

Observing the shape of the probability function we can understand the subject's risk attitudes and his inclination towards optimism or pessimism. For instance, if we worsen the ranking of some outcome, by including in the prospect the possibility of winning higher outcomes, the decision weight attached to the outcome can either increase or decrease. If it decreases, we observe a concave probability weighting function, indicating inclination toward optimism and risk seeking for gains. If, instead, it increases we observe a convex probability weighting function, indicating pessimism and risk aversion for gains.

The inverse-S shape of the probability weighting function is convex near 1 and concave near 0. This suggests risk aversion and pessimism for events happening with high probability. It also shows inclination towards risk seeking and optimism for events happening with small probability.

As mentioned in the introduction, a subject with an objective and precise perception of probabilities would exhibit a probability weighting function coinciding with the 45° degree line. The fact that the majority of the population presents an inverse-S shaped probability function leads us to the conclusion that individuals, generally, are not able to accurately estimate probabilities. Subjects are likelihood-insensitive: they present lack in sensitivity in adapting and facing changes in events' likelihood. They, consequently, tend to estimate the occurrence of all uncertain events as 50-50% (Abdellaoui, Baillon, Placido, & Wakker, 2011). In other words, they overweight too much the likelihood of extreme outcomes. This tendency is called extremity-orientedness and it will be empirically analysed in the next chapters.

Prospect theory

Some years before the RDU discovery, Kahneman and Tversky (1979) were developing an alternative theory: prospect theory. In this Chapter, we decided to present PT after RDU because the idea of including a subjective view of probabilities is the same, but prospect theory presents some further developments. Furthermore, the cumulative version of PT incorporates some basic principle of RDU theory.

First, prospect theory, in comparison with EU, focuses more on the change of wealth from a reference point (that can be current wealth, for instance). Second, it also takes into account the domain of losses; the utility function is concave for gains and convex for losses. Third, it includes the loss aversion concept, which makes the utility function for losses steeper.

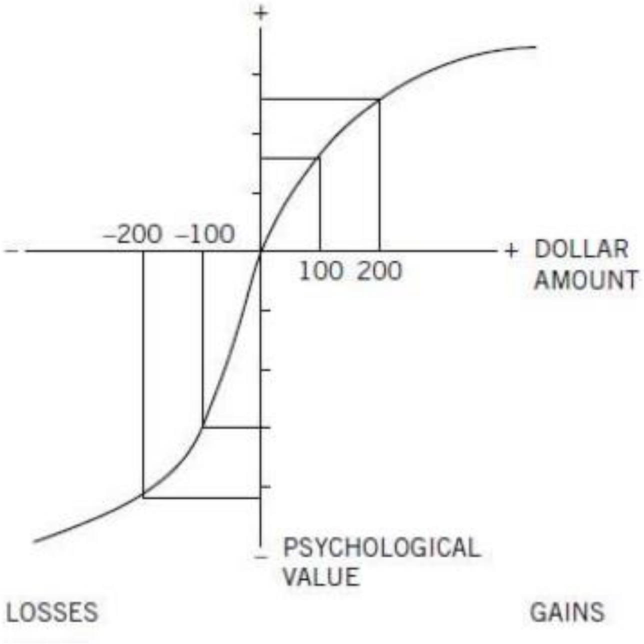

Figure 3

If prospect P is defined as follows:

$$P = (p, x; q, y; (1 - p - q, 0);$$
$$with$$
$$p + q < 1 \; and \; either \; x \geq 0 \geq y \; or \; x \leq 0 \leq y,$$
$$then$$
$$V(p) = \pi(p)u(x) + \pi(q)u(y).$$

This is the original version of prospect theory, designed in 1979. It presents a problematic issue: it violates stochastic dominance. Stochastic dominance implies that, if a certain amount of probability mass passes from a worse outcome to better one, it leads to an improved prospect (Wakker & Fennema, 1997). In order to overcome the problem, Kahneman and Tversky (1992) brought the model to a different level, presenting a cumulative version of the prospect theory. This final version first incorporates the RDU decision weights and, second, differentiates the probability weighting functions for gains and losses:

$$PT(p) = \sum_{i=1}^{k} \pi_i^- \, u(x_i) + \sum_{i=k+1}^{n} \pi_i^+ u(x_i).$$

The procedure used to determine the weights in prospect theory is the same as computed in RDU.
As Fennema and Wakker (1997) pointed out, the prospect theory model overcomes the main violations of EU, such as the Allais paradox. The cumulative prospect theory is not just a mere implementation of PT. In fact, compared to PT, it gives more accurate empirical results.

This section presented a brief overview of the history and development of the probability weighting function across the past decades. We will now proceed with a detailed description of the experiment, run in order to find out any possible connection between the shape of $w(p)$ and the subject's cognitive abilities.

Chapter 2
Theoretical background

In this Chapter, the experiment's theoretical background is introduced. As previously mentioned, the experiment is composed of two parts: a measure of the respondent's intelligence, by mean of the Cognitive Reflection Test, and a particular procedure that aims to elicit the utility and probability weighting functions of the respondents.
The utility and probability weighting functions, combined together, give a precise estimation of the subject's risk attitudes. It is then possible to link risk attitudes and CRT scores, and look for any connection.
In addition, other variables' behaviour will be observed: country of residence, gender, age and education level.

Cognitive reflection Test

The aim of Frederick's Cognitive Reflection Test (2005) is to determine those subject's cognitive abilities related to the decision-making process. Humans, when making choices, can engage two different systems: System 1 and System 2. System 1 is automatic and instinctive, able to compute rapid decisions. In everyday life, it is mainly engaged when the subject is asked to answer rapidly, or to take decisions in unfamiliar fields. System 2 is its counterpart: slow and reflective. If engaged, it allows to give reasoned answers (Sunstein & Thaler, 2008).
The Cognitive Reflection Test is straightforward: it only consists of the following three questions:

(1) A bat and a ball cost $1.10 in total. The bat costs $1.00 more than the ball. How much does the ball cost? _____ cents

(2) If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets? _____ minutes

(3) In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake? _____ days

Figure 4

The structure of the questions is designed in such a way as to suggest, to the responder, a specific answer. These answers, addressed from now on as "automatic", are 10 cents, 100 minutes and 24 days. The correct answers are instead 5 cents, 5 minutes and 47 days.

According to Frederick's findings, the first answer that almost every subject can think of is the automatic one. Respondents who usually engage System 1 will write the automatic answer down. Instead, subjects who are more prone to utilize System 2 will reason more about the answer, with more chances of reaching the correct conclusion. In fact, as the author himself defines it, the CRT measures "*The ability or disposition to resist reporting the response that first comes to mind*". There is a third category of subjects: those who realize that the automatic answer is wrong, but who do not reach the right answer. Those subjects generally write down a wrong answer, but different from the automatic one. Such a behaviour might be not reflective of System 2 engagement, but surely is not entirely System 1. Frederick does not assign a different score for this third category, but we decided to differentiate these subjects from both System 1 and System 2 respondents. 1 point is assigned for each correct answer and 0 point for an automatic (and wrong) answer. We assign 0.25 for a wrong, but not automatic, answer.

In order to demonstrate the accuracy of the Cognitive Reflection Test as intelligence test, the paper showed its consistency with other intelligence measures. A positive and significant correlation was found between the CRT and the WPT[1], the ACT[2] and the SAT[3].

For simplicity, from now on those subjects falling into the System 2 category will be plainly addresses as "smarter".

Abdellaoui's procedure

In order to determine the utility and probability weighting functions, we are going to base our procedure on a parameter-free elicitation proposed by Abdellaoui (2000). The operation is composed of two steps: first, the tradeoff method (Wakker & Deneffe , 1996), and second, the assessment of six equally spaced points in probability weighting units. By means of the tradeoff method, the participants state a certain number of monetary values equally spaced in utility units.

Tradeoff method

First, values for X_0, Y and y need to be assessed. Respondents can then be asked to state a value for X_1 that satisfies the following indifference:

$$Game\ A \sim Game\ B$$

$$X_{1_p}y \sim X_{0_p}Y.$$

[1] Wonderlic Personnel Test. Used from employers to assess the intellectual abilities of the prospective hires.
[2] American College Test.
[3] Scholastic Achievement Test.

The subject needs to be indifferent between the two lotteries, or games. Game A offers X_1 with probability p, and y otherwise. In game B one can win X_0 with probability p and Y otherwise. Once the indifference value of X_1 is established, we ask to choose a value for X_2 that satisfies this second indifference:

$$X_{2_p}y \sim X_{1_p}Y.$$

The tradeoff method requires this relationship to be satisfied:

$$X_2 > X_1 > X_0 > Y > y.$$

The procedure is repeated until the elicitation of the sixth[4] outcome is reached: $(X_1;\ X_2; \dots;\ X_6)$. The method is designed in a way that, according to the respondent preferences, the monetary outcomes are equally spaced in utility units.

In the experiment, the values chosen for X_0, Y and y are 1000. 500 and 0 respectively. A probability p equal to 0.50 has been chosen. It is possible to observe that, in the first indifference, game B ($X_{0p}Y$) is relatively safe, because the respondent wins 1000 with 0.50 probability and 500 otherwise. On the opposite, game A ($X_{1p}y$) is riskier, because the subject can win a specific value X1 with 0.50

probability and 0 otherwise.

These six outcomes, together, lead to the respondent's utility function (Wakker & Deneffe , 1996):

$$U(x_i) = \frac{i}{n},$$

with n equal to 6 and i equal to 0; 1; 2; …; 6. It follows:

$$U(x_0) = 0;$$
$$U(x_6) = 1;$$
and, for example:
$$U(x_1) = \frac{1}{6}.$$

Probability weighting function

The second step requires the assessment of six indifferences, computed from the six values previously elicited:

[4] In deciding the number of outcomes to elicit in order to have precise predictions, we stick with the number of outcomes that Abdellaoui (2000) chose: 6.

$$X_{n_{p_i}}X_0 \sim X_i,$$

where, in our case, X_n corresponds to X_6 and X_i takes value X_1 in the first indifference, X_2 in the second and so on, until X_5. In this step, the subjects are asked to determine the probability p_i in order to satisfy the indifference. In other words, the subjects need to choose a value for p_i[5] that makes them indifferent between playing a risky game $(X_n, p_i; X_0)$ or a safer one $(X_i,\ 1; X_0)$.

These five values, once elicited, give the possibility to draw the probability weighting function by mean of the following formula (Abdellaoui, 2000):

$$w(p_i) = \frac{i}{n},$$

where n is 6 and i is 0; 1; 2; …; 6. With:

$$w(p_0) = 0;$$

$$w(p_6) = 1;$$

and, for instance:

$$w(p_3) = \frac{1}{2},$$

which means that the probability p_3, according to the respondent's preferences, has weight 1/2.

The procedure ends with a sixth, and last, indifference, slightly different from the others:

$$X_{4_{p_3'}}X_2 \sim X_{3_1}.$$

Its aim is to test for consistency. A subject who linearly perceives probabilities would choose p_3' equal to 0.50. At the same time, a subject with consistent preferences would choose for p_3' the same value that is chosen for p_3. In the original Abdellaoui (2000) procedure, if the two values (p_3' and p_3) do not coincide, the subject's data would be discarded, due to lack of coherence. In the present investigation, we will limit ourselves in stating the difference between the two values for completeness in Chapter 4. However, no subject will be rejected.

Abdellaoui, in his paper, does not ask to subjects to state directly outcomes and probabilities that make them indifferent. He rather uses a bisection method. This procedure consists in asking subjects to compute choices between lotteries. From those choices one can assess the exact indifference values. This leads to more accurate findings: subjects find it complicated to state an indifference point precisely.

[5] With $0 \leq p_i \leq 1$.

Because of the length of the bisection method, our experiment consists of simply asking people to state their indifferences. For those readers interested in learning more about it, the bisection method is explained in detail in Appendix A.

Questionnaire design

Respondents are first asked to state some personal characteristics. Then follows an introduction to section 1, in order to make people acquainted with the notation, and an example, in order to make the procedure, that the respondents need to follow, clear. Then section 1 is presented. It consists of obtaining six indifferences. We will elicit here the six monetary outcomes equally spaced in utility units.

Section 2 contains the three question of the Cognitive Reflection Test. The questionnaire then proceeds to section 3, where the subject is asked to choose a probability that, according to his preferences, satisfies 6 indifferences. The values elicited in this final part are equally spaced in terms of probability weighting.

The Cognitive reflection Test is set in section 2 because otherwise the respondent could more easily relate the results of section 1 to the indifferences in section 3. The recognition of such direct relation between the values could lead the subject to understand the purpose of the experiment and to answer accordingly.

A copy of the experiment text is presented in Appendix B.

Main Hypotheses

As mentioned several times, the present study's aim is to investigate the connection between risk attitude and intelligence. According to Burks, Carpenter, Goette, and Rustichini (2009) a relationship between subject's cognitive abilities and his preferences (and choices) exists: subjects characterized by high intelligence are more patient in intertemporal choices and more willing to engage calculated risk. They even can better predict others behaviour in Prisoner's Dilemma-like situations. The study carried out by Dohmen, Falk, Huffman, & Sunde (2010) clearly demonstrates that subjects with higher cognitive skills show a more pronounced willingness to take risk in lotteries and less impatience in intertemporal choice experiments.

Basing our expectations on the scarce literature available about the topic, we believe that subjects engaging system 2, addressed as "smarter", will show themselves as more risk seeking than people engaging system 1.

H_1= Higher scores on the CRT are linked to greater risk seeking.

In addition, subjects' perception of probabilities is analysed. Individuals, usually, do not perceive probabilities linearly. We want to investigate if there is a correlation between having an objective perception of probabilities and intelligence.

H_2= Higher scores on the CRT are linked to a more accurate perception of probabilities

The precision of subject's probability perception will be assessed through the computation of a likelihood insensitivity (or inverse-S shape) index.

Additional Hypotheses

In the experiment, the respondents will be asked to state gender, age, education level and country in which they currently live.

It is worth to mention that we are not going to look for the subjects' nationality or country of origin. Many studies have been already looking for relationships between nationality and intelligence/risk attitudes[6]. Only a few instead controlled for country of residence. We believe that the environment which the subject is surrounded by, even if for short periods, can influence his behaviour and decisions.

Gender and age connected to intelligence/risk attitude

Several studies already proved a strong correlation between gender and both risk attitudes and intelligence. Frederick (2005) himself pointed out that men usually score better than women in the CRT. Generally, women give automatic answers. Men, instead, usually engage more System 2 and, if not, they fall into the third category previously defined. Furthermore, the author points out that women are considerably and consistently more risk averse than men.

Lynn and Kanazawa (2011), in their study, find a connection between smartness, gender and age. They looked for intelligence differences between male and female at different age stages. More specifically, the authors test the subjects' cognitive abilities at age 7, 11 and 16. Their tests, computed from 1965 until 2005, reveals girls to have greater IQ scores at age 7 and 11. The results suggest the opposite result from the age of 16 on: males score better than women.

According to Jackson and Rushton's (2006) study, computed on a sample of 17-18 years old individuals, men IQ's score is, on average, 3.63 points higher than for women. Although the difference is not particularly high, it is confirmed at every socio-economic level and across a wide range of ethnical groups.

Several studies revealed connections between age, sex and different risk attitudes: Dohmen, et al. (2005) found that risk taking behaviours are negatively correlated to being female and age (growing older leads

[6] There are connections between nationality (and ethnicity) and cognitive abilities: Rushton & Jensen (2005) computed a study on the difference in IQ scores between black and white individuals. In addition, a relation between nationality and risk taking behaviours has been computed: Apartsina, Maymona, Cohen, and Singer (2013) analysed behaviour of investors with different origin countries on the stock market.

to the development of aversion toward risk). Dohmen, et al. (2011) finds that women are less willing to take risk than men. This difference is consistent at every age (it narrows down across elderlies).

Education achievements connected to intelligence/risk attitude

Deary, Strand, Smith, & Fernandes (2007) investigate the possible correlations between intelligence and education achievements. They asked 11 years old subjects to undertake intelligence tests, to test any educational achievement for 25 different academic subjects later, when the same subjects reached the age of 16. Their findings are consistent with the hypothesis that education and cognitive abilities are strongly correlated.

Several researchers found that there is not significant relationship between education levels and risk attitudes. Despite this, a correlation is present between education and risk perception. Pádua, Santos, & Horta (2013) studied the connection between risk attitudes and education in the healthcare fields. More specifically, risky behaviours associated to prevention and cure of diabetes. The findings show that risky behaviours related to diabetes are not associated with educational level, but risk perception is. A different study (Sund & Svensson) shows that highly educated people perceive their risk of having an incident, considering their incidents experience, considerably lower than expected.

According to the literature just reported, we expect to find the following connections between intelligence/risk attitudes and gender, age, education level:

H_3= Men, in general, score better than women in the CRT

H_4= Men are generally more risk seeking than women

H_5 = Young individuals are more risk seeking than older subjects

H_6= Individuals with higher education level score better in CRT

H_7= Education level influences risk perception

The next Chapter presents a description of the sample that undertook the experiment. We briefly explain the procedure used in order to assess the individual risk attitude and we present the results of the most relevant observations.

Chapter 3
Experiment and results

23 subjects in total took part in the experiment. 12 respondents are currently living in Italy and 11 in the Netherlands. 14 of them are men, 9 are women. The individuals are aged between 16 and 59 years-old. This allows us to observe intelligence levels and risk attitudes at different stages of life. However, the majority of the sample is aged between 22 and 26 years old. For what concerns the education level and field, a big part of the respondents obtained a bachelor degree in Economics. Some respondents obtained a bachelor degree in Arts and Culture, some others obtained a master degree in Engineering and, eventually, one respondent obtained a PhD in Physics. A small portion of the sample obtained a middle or high school diploma as highest certificate. Our variables of interest can be tested on a wide range of education level and specialization fields.

Before introducing the results collected, it is worth to briefly explain how curves and risk attitudes of respondents are assessed.

Risk attitudes assessment

In order to determine the respondent's risk attitude, both shape and inclination of the utility and the probability weighting functions have to be taken into account.

The shape of the utility function alone is an incomplete indicator of risk attitude, and the same holds for the probability weighting function. However, the two curves taken together consist in a good index of subject's risk inclination.

As previously specified, the equally spaced outcomes are elicited in the experiment's section 1, by means of the tradeoff method. The points equally spaced in probability weighting units are instead defined in section 3.

According to the subject, and more specifically according to his perception of outcomes or probabilities, the points reported in section 1 present equal distance from each other in terms of utility. This subjective equal division of values may or may not coincide with a linear and objective view of outcomes. If the utility curve is concave or convex, the points elicited in the tradeoff method are not equally spaced from an objective and linear view.

In order to clarify this aspect, we will report an example.

Suppose that a subjects states, in section 1, the six outcomes as:

$$X_0 = 1000;$$
$$X_1 = 5000;$$
$$X_2 = 25000;$$
$$X_3 = 100000;$$

$$X_4 = 500000;$$
$$X_5 = 2500000;$$
$$X_6 = 10000000.$$

According to the subject's perception, these outcomes are equally spaced in utility units. But, if this subject would have had a linear and objective perception of monetary values, these outcomes (maintaining the same values for $X_0 = 1000$ and $X_6 = 10000000$) should instead be:

$$X_0 = 1000;$$
$$X_1 = 1667500;$$
$$X_2 = 3334000;$$
$$X_3 = 5000500;$$
$$X_4 = 6667000;$$
$$X_5 = 83335000;$$
$$X_6 = 10000000.$$

Plotting the utilities on the vertical axis and the normalized monetary outcomes on the horizontal one, we observe that the utility function of this subject is concave. This happens because, for instance, the subject associates utility = 1/6 to a smaller value, compared to the value that he would have associated if he would have had a linear perception. The opposite happens when we observe a convex utility function: the outcomes that the subject chooses are bigger than the ones that he would choose having an objective perception. The same counts for the convexity or concavity of probability weighting function.

As mentioned in the previous paragraph, the monetary outcomes have been normalized, otherwise the findings could be distorted on the base of the magnitude of the outcomes chosen. In order to normalize them on a scale from 0 to 1, we transformed each outcome according to the following rule:

$$\tilde{X}^j = \frac{X^j - X^0}{X^n - X^0}$$

Where $\tilde{X}^j$ refers to the normalized outcome j and X^n is, in our case, X^6.

In order to be defined risk averse it is sufficient, for the subject, to show a concave utility function and a convex probability weighting function. In order to be assessed as risk seeking, it is sufficient, for the subject, to have a convex utility function and a concave probability weighting function.

As one can imagine, the cases in which this distinction is neat and clear are just a few. In the most part of the cases, the curves are partly concave and party convex. We need to design a measure to assess if the curves are more convex than concave or the opposite.

In order to precisely assess the risk attitudes, we are going to measure, first, the direction in which the curves develop (if above or below the neutrality line) and, second, the magnitude of the distance between the neutrality lines (45° degree for w(p) and preferences neutrality for U(x)). In both functions, this distance is measured for each point. The average distance is then computed. From now on, this index will be addressed as "risk aversion index".

In the U(x) graph, the risk aversion index is positive when the curve develops above the neutrality line and negative when it is below. For what concerns the probability weighting function, the index is positive when the curve is convex (below the 45° degrees line), and negative when it is concave. For both graphs, bigger the index, greater the distance from the neutrality line, greater the concavity (or convexity) of the curves. Once both U(x) and w(p) indices are computed, their average is taken. The positive or negative sign of the average index indicates the risk attitude of the individual (negative if risk seeking and positive if risk averse).

The risk aversion index's magnitude gives us relevant information: the greater the index's value, the greater the concavity/convexity of the curve and, consequently, the greater the distance from neutrality. This indicates that high values are associated with a more pronounced inclination towards risk aversion.

The indices are divided into three magnitude-based categories: low (from 0.00 to 0.050); medium (from 0.050 to 0.15) and high (from 0.15 on). These categories allow us to divide the subjects into three groups, based on how much risk averse or risk seeking they are. For instance, a subject with a positive index included in the low category, will be less risk averse than an individual with a positive and high index.

Through this interpretation we can study the connection between, not only intelligence and risk attitude, but even intelligence and the magnitude of risk aversion.

Likelihood insensitivity index

The likelihood insensitivity index indicates how much the subjective view of probabilities is different from an objective perception. It is computed by applying the following formula:

$$\left[w\left(\frac{1}{6}\right) - \frac{1}{6}\right] + \left[\frac{5}{6} - w\left(\frac{5}{6}\right)\right].$$

The index is positive when the weight of probability $\frac{1}{6}$ is perceived as bigger than $\frac{1}{6}$, and when the weight of probability $\frac{5}{6}$ is perceived as smaller than $\frac{5}{6}$. In other words, the coefficient is positive when the subject presents an inverse-S shape function and negative when the curve is instead S-shaped. The value is 0 (or close to 0) when the subject perceives probabilities linearly. The greater the value, the bigger the distance from a rational view.

Subjects showing an inverse-S shape are extremity oriented: they associate more weight to extreme probabilities. For this reason, the probabilities $\frac{1}{6}$ and $\frac{5}{6}$ were chosen because, across the values that the subject is asked to state, they are the extremes.

Results

In this section, we first report the average utility function and probability weighting function, and successively the curves of the most relevant observations, with relative indices.

Average

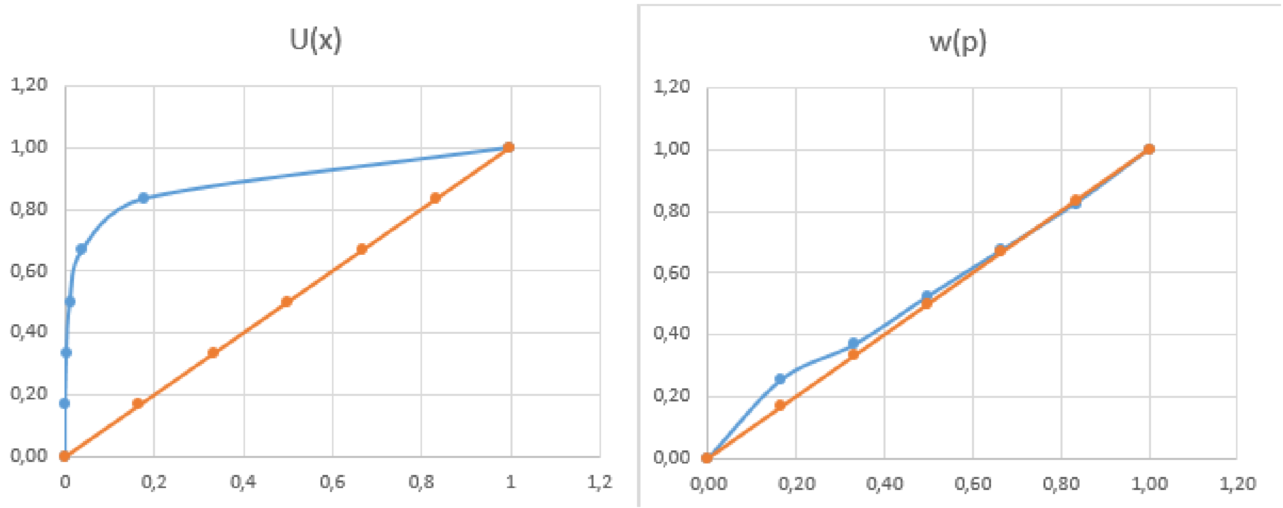

Figure 5

Figure 5 shows the average of utility and probability weighting curves. The index of risk aversion takes value 0.32 for the utility function and −0.020 for w(p). The final coefficient is then 0.15. It shows a moderate inclination towards risk aversion and a strong concavity. Furthermore, the average score of the Cognitive Reflection Test is 2.033 on a maximum of 3. The likelihood insensitivity index is of 0.10, indicating a general slight propensity toward an inverse-S shaped probability weighting function.

Subject 4

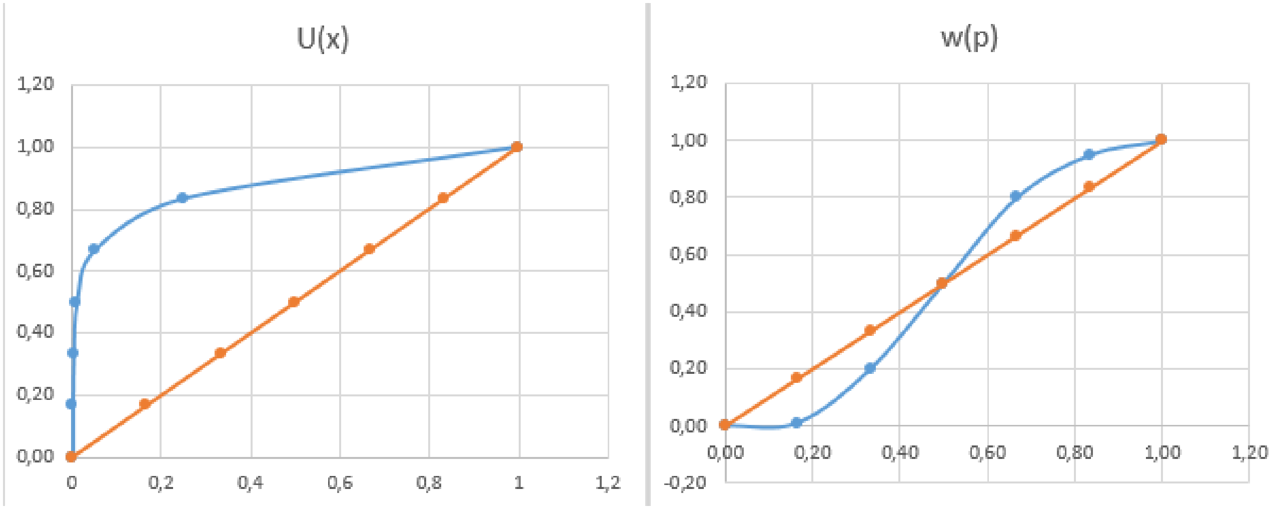

Figure 6

Subject 4 is male, living in Italy and 22 years old. He achieved a Bachelor degree in Economics. His utility function presents a risk aversion index of 0.31. The U(x) is then surely, and strongly, concave. His probability weighting function has a risk aversion coefficient of 0.010. This last value indicates that, despite the underestimation of small and overestimation of large probabilities, the average distance of the curve from linearity is almost 0. The w(p) is slightly more convex than concave. Given the concavity of the U(x) and the convexity of w(p), the subject can be addressed as highly risk averse, with a pronounced average coefficient (0.16). His Cognitive reflection Test score is of 3 on 3. We can define him smarter than the average, or, more properly, more prone to use system 2 in taking decisions. According to his likelihood insensitivity coefficient (−0.27), he is distant both from a neutral perception of probability and from an inverse S-shaped curve: in fact, he underestimates small probabilities and overestimates high probabilities. In experiment's section 3 the subject chose a p_3' equal to p_3, equal to 0.50. His preferences are consistent.

Subject 7

Subject 7 is male, 26 years old. He is currently living in the Netherlands and he obtained a Bachelor Degree in Economics. His utility function is slightly concave at the beginning, to turn convex around the (0.40; 0.40) point. His utility index takes value −0.010, indicating a curve more convex than concave.

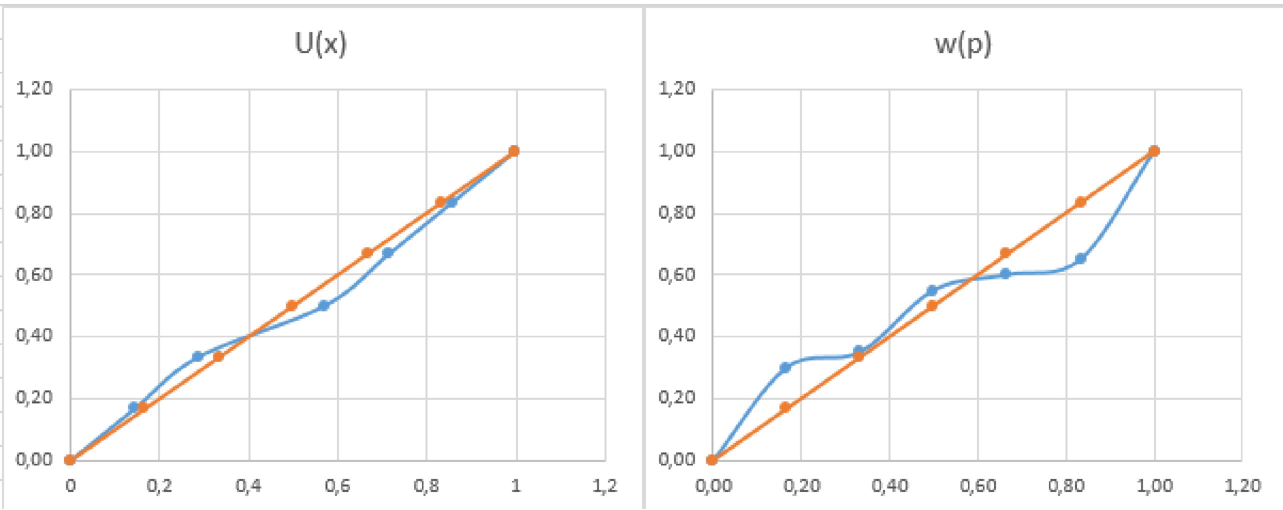

Figure 7

Concerning the probability weighting function, the subject overestimates small probabilities, to turn to underestimation around the (0.60; 0.60) point. His index of 0.010 indicates that the curve is more convex than concave. The average index is exactly 0, suggesting an inclination towards risk neutrality. His CRT score is 1.25. This is because he gave a wrong and automatic answer to the first question, a correct answer to the second one and a wrong, but not automatic, answer to the third question. His index of likelihood insensitivity takes value 0.32, meaning a probability weighting function with a pronounced inverse-S shape. In experiment's section 3 the subject chose a p_3' equal to p_3, equal to 0.55. He shows consistency in his choices.

Subject 8

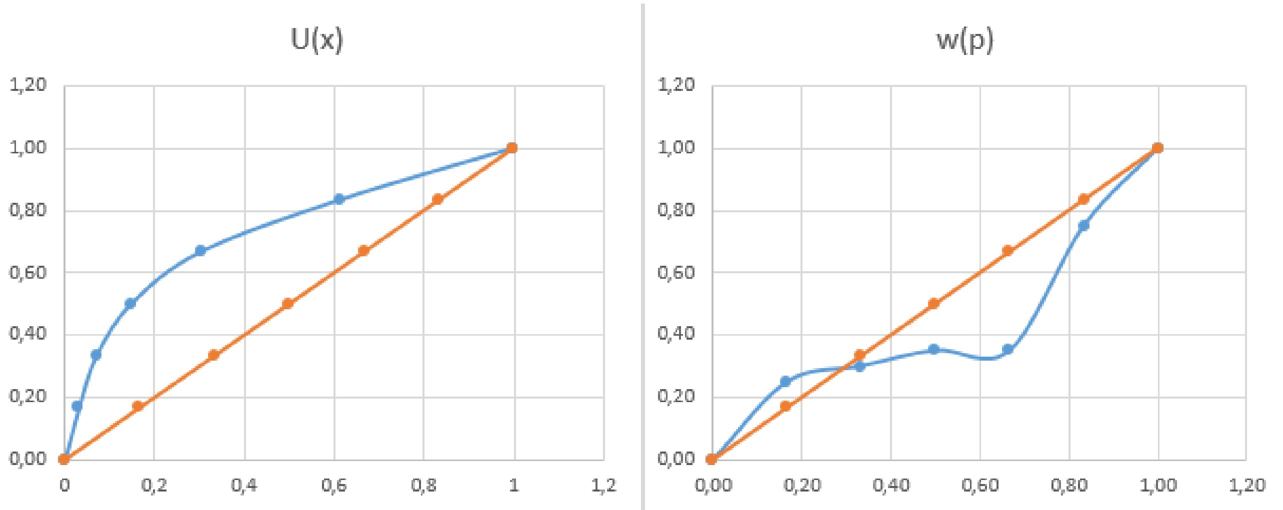

Figure 8

Observation 8 is a 24 years old woman, currently living in the Netherlands, who achieved a Bachelor Degree in Arts and Culture. Her utility function is clearly concave for every outcomes, with an index of 0.19. Her probability weighting function is concave for small probabilities (approximately until the point (0.30; 0.30) and below the 45° degrees line for medium and large probabilities, with an index of 0.070. Her average index is of 0.13, indicating a medium propensity toward risk aversion. She scored 0 on the Cognitive Reflection Test, meaning inclination toward the use of system 1 in the decision making process. Her likelihood sensitivity index is 0.17, indicating an inverse-S shaped curve. In experiment's section 3 the subject chose a p_3' equal to 0.50, different to p_3 (equal to 0.35). She is not coherent in her preferences.

Subject 9

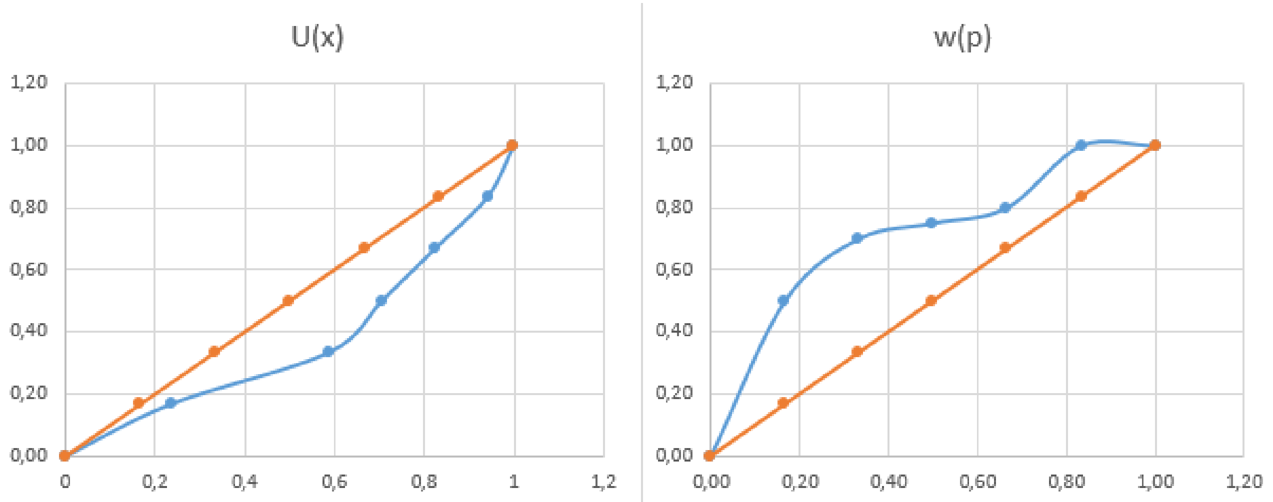

Figure 9

Subject 9 is a 31 years old man, living in Italy. He obtained a master degree in Engineering. His utility function shows clear convexity, with an index of −0.11. His probability weighting function expresses net concavity for every probability weight, showing an index of −0.18. His average risk aversion index is −0.15, the smallest in the entire sample. Its negative sign and magnitude indicate moderate propensity towards risk seeking. His score in the CRT is 1.25, indicating a slight propensity toward the engagement of system 1. His likelihood sensitivity coefficient takes value 0.17. Although the subject does not present an inverse-S shaped curve (he overestimates high probabilities), the value is still positive. This happens because the distance between w($\frac{1}{6}$) and $\frac{1}{6}$ is positive and much more pronounced than the distance between $\frac{5}{6}$ and w($\frac{5}{6}$). In experiment's section 3 the subject chose a p_3' equal to 0.40. different from p_3 (equal to 0.75). He does not show consistency in his choices.

Subject 10

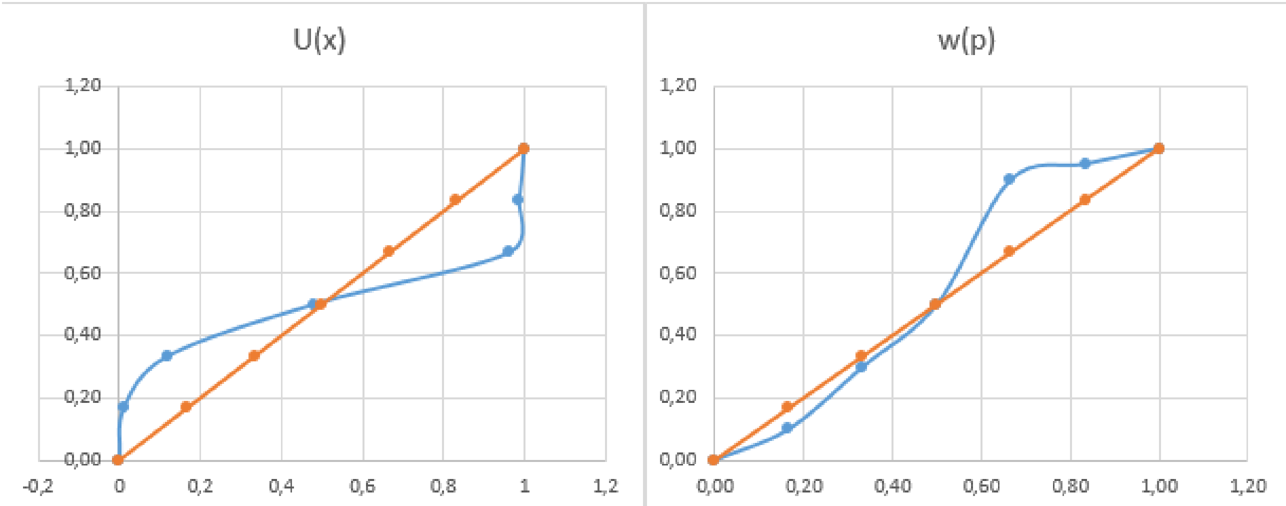

Figure 10

The subject is a 59 years old man, living in Italy. The education level achieved is the High School diploma. He shows an inverse s-shaped utility function: above the linearity until approximately the (0.50; 0.50) point, then below. The utility index is close to the zero: −0.009, indicating almost no inclination. On the other hand, his probability weighting function is slightly below the 45° degrees line until the middle of the curve, then concave. The w(p) risk aversion index is −0.040. The average index of observation 10 is then −0.020, indicating a thin preference toward risk seeking. The subject scored 3 on top of 3 on the Cognitive Reflection Test. This means clear propensity in using the system 2 in the decision making process. His index of likelihood insensitivity is −0.18. In fact, he underestimates small probabilities and overestimates high probabilities. In experiment's section 3 the subject chose a p_3' equal to 0.60. different from p_3 (equal to 0.50). He does not seem to be consistent in his choices.

This chapter only reports the average observation of the sample and four subjects. The remaining 19 are descripted in detail in Appendix C.

In the following Chapter, we will present and discuss the main findings derived from our sample. The validity of the previously specified hypotheses will be tested.

Chapter 4
Conclusions

Main hypotheses

The first main hypothesis is:

H_1= Higher scores on the CRT are linked to being risk seeking

According to our data, on 23 subjects interviewed, 10 are risk seeking, 11 risk averse and 2 risk neutral. Risk seeking subjects have, on average, a Cognitive Reflection Test score of 1.92. Risk averse individuals scored 2.11 and the ones with neutral preferences 2.12.
There is no evidence of a significant difference between the three categories. In fact, the difference between the category that scored the highest and the one that scored the lowest is only of 0.20. However, individuals showing a neutral aversion scored slightly higher, compared to the others, and risk averse respondents scored higher than risk seeking ones. The fact that risk seeking individuals are less likely to score high on the CRT would be supported by the positive correlation between risk aversion index and CRT scores (0.19), but the correlation is found to be not statistically significant (p-value = 0.39).
Additionally, these results suggest that individuals with a propensity toward risk neutrality are more rational than both risk seeking and risk averse subjects.
Those findings directly contradict the main hypothesis. They are consequently in conflict with the previous literature on the topic, except for what regards risk neutrality: their being more rational is consistent with previous findings.

In general, some researchers argued that, wrongly, a correlation between cognitive abilities and risk preferences has been found. The way in which the preference-elicitation task is designed can influence (and bias) the subject’s choices. This phenomenon, combined with mistakes that individuals may make in this kind of experiment, can lead to a noisy, and incorrect, correlation (Wengström, Andersson, Holm, & Tyran, 2013). The same authors demonstrated that modifying the structure of the experiment, or the design of the questions, significantly changes the results. Despite the efficiency of the tradeoff method in avoiding distortions, the use of the bisection method could have been crucial in bypassing biases. The bisection method makes the task easier to solve for individuals who are not acquainted with probabilities and monetary values. Respondents would have not been asked to think about their indifferences, but just to choose between two simple options. However, one cannot exclude the occurrence of biases even if the bisection method is utilized.
Furthermore, in the relationship between intelligence and risk attitudes, much variance cannot be kept under control. Both intelligence and risk attitudes are variables highly influenced by still unknown (or uncontrollable) factors.

The second main hypothesis is:

H_2= Higher scores on CRT are linked to a more accurate perception of probabilities

This hypothesis is tested by investigating a possible correlation between intelligence and the likelihood insensitivity index. The respondents can be divided into three categories. Category 1 is composed by 5 subjects with a likelihood insensitivity index comprehended between −0.50 and −0.050. Category 2 comprehends 5 subjects ranging between −0.050 and 0.050. Category 3 is composed by 13 respondents ranging between 0.050 and 0.50.

Across the individuals in the first category, we count 40% of risk averse and 60% of risk seeking. These subjects scored on CRT, on average, 2.60.

The respondents included in the second category are the ones showing a more accurate perception of probabilities. They are 40% risk averse, 20% risk neutral and 40% risk seeking. Furthermore, these respondents scored on CRT, on average, 2.25.

For what concerns the third category, 38% are risk seeking, 8% are risk neutral and 54% are risk averse. Their CRT scores average is of 1.73.

Our second hypothesis is confirmed: subjects who have a more accurate perception of probabilities are more intelligent than those subjects showing an inverse S-shaped probability curve. In fact, the correlation between the likelihood insensitivity index and the CRT score is negative and high (−0.52). The correlation coefficient is statistically significant: (p-value = 0.011). Subjects showing an inverse-S shaped probability weighting function are generally less intelligent than other ones.

Despite its being statistically non-significant (p-value = 0.41), a negative correlation between the likelihood insensitivity index and the risk aversion index exists (−0.18): an individual showing an inverse-S shaped probability weighting function is more likely to be risk seeking, compared to both individuals perceiving probabilities linearly.

Across the individuals with a linear perception of probabilities, the percentage of risk neutral individuals is higher than in the other categories. This result is consistent with the hypothesis that individuals characterized by an inclination toward risk neutrality are more rational.

Other hypotheses

This section presents findings about the secondary hypotheses, related to gender, age and education.

Gender

Based on the literature, the following two hypothesis have been previously stated:

H_3= Men are generally more risk seeking than women

H_4= Men, in general, score better than women on the CRT

According to our sample, the men divide as follows: 43% risk averse; 43% risk seeking and 14% risk neutral. The women sample, instead, consists of approximately 56% risk averse and 44% risk seeking subjects, with no risk neutral observations. This leads to conclude that women actually are, on average, more risk averse than men, while the percentage of men and women being risk seeking is almost the same. Women seem to be more extreme than men, given that none of them positioned as risk neutral.

Hypothesis 3 can be confirmed, although we reach no significance.

For what concerns the relationship between gender and Cognitive Reflection Test scores (hypothesis 4), men, on average, score significantly higher than women: 2.25 against 1.69. A further observation can be discussed: women have more extreme scores. For instance, in the men sample, only two respondents scored 1 and no one scored 0. Across women, instead, we have many observations scoring 0. and many others 3. Hypothesis 4 is satisfied: men actually scored better than women. We can then assess that, in general, men are more prone to engage System 2 in decision-making process, compared to women.

Men scored better in CRT than women, and women are actually more risk averse than men. This phenomenon may indeed suggest a direct correlation between intelligence and being risk seeking. However, this connection has not been proved by our result. Thus, men being more risk seeking is not driven by their being smarter than women. There have to be some other personal characteristics that drive the difference between men and women in both intelligence and risk attitude.

Age

H_5 = Young individuals are more risk seeking than older ones

We did not find any evidence supporting hypothesis 5. The average age of risk averse individuals is 26.54. Risk seeking subjects are averagely aged 27.10. The difference between the two results, despite its smallness, is in conflict with H_5. In fact, a positive, but small, correlation (0.048) has been found between age and the risk aversion index: older the individual, bigger the chances of being risk seeking. This correlation coefficient is not statistically significant (p-value = 0.83).

It is worth to say that individuals aged between 21 and 26 compose the biggest part of our sample. This distribution might have led to a distorted result. The average age of risk neutral individuals is 30.

The sample has been divided into two categories: individuals aged below 23 (23 included) and subjects older than 23 (where age 23 is the median value). The average CRT score of the first group is 2.020. The second group scored 2.040. The difference is not pronounced enough to assess any relationship, in fact, the positive correlation between CRT scores and age (0.22) is not statistically significant (p-value = 0.31).

Education

- H_6= Education level influences risk perception

H_7= Individuals with higher education level score better on CRT

The sample can be divided into three categories, based on the level of the diploma obtained. 6 subjects achieved middle or high school diploma as latest educational achievement. 13 of them present a bachelor degree; 4 obtained a diploma attesting higher education level (master degree or PhD). The first group is equally divided into risk seekers and risk averters, with no evidence of risk neutral respondents. Across individuals with bachelor-level education, 38% is risk seeking, 54% is risk averse and 8% is risk neutral. The third category is composed by 50% of risk seekers, 25% of risk averse subjects and 25% of risk neutral respondents.

At a first sight, individuals with low education level seem to be slightly less risk averse than subjects who only achieved a bachelor diploma, but sharply more risk averse than individuals with high education level. It is controversial if the education level actually influences the perception of risk.

The first category scored 1.70 on average on the CRT. The second scored 2.19 and the third 2.06. An increase in intelligence from middle/high school to bachelor degree is evident. However, we observe a slight, but clear, decrease from bachelor to higher levels.

In addition, the field of study has been taken into account. Subjects who did not carry on the studies after middle or high school were not included in the present study. The observations' study fields have been divided into: economics, scientific specializations (comprehending informatics, physics and engineering) and humanistic fields (anthropology, arts and culture). Of nine people studying economics, 5 are risk seeking, 3 averse and 1 neutral. The scientific specializations group is composed of 2 risk seeking subjects, 2 risk averse and 1 neutral. The humanistic field is entirely composed by risk averse subjects.

Respondents specialized in economics scored on CRT, on average, 2.36. Subjects involved in scientific studies 2.25. The average score of the humanistic field is sharply lower: 1.42. This could depend on economics student being more acquainted with numerical tests. Despite this, we have clear evidence that people studying economics do not differ much from people studying in scientific fields, both in risk attitudes and in CRT scores. However, economists are more risk seeking and more prone to engage system 2. compared to people studying humanistic subjects.

In conclusion, hypothesis 6 is not satisfied. Hypothesis 7 is confirmed. The study field in which the subject is involved alters both his risk perceptions and his decision-making process.

Conclusions

Respondents showing a propensity toward risk neutrality seem to be more intelligent than both risk averse and risk seeking individuals. At the same time, risk averse people scored better in CRT than risk seeking individuals. It is important to notice that this last correlation between CRT scores and the risk aversion index is not statistically significant.

Women are indeed more risk averse than men. They also seem to be more extreme in their preferences: no risk neutrality has been encountered in women. Men scored much higher than women in CRT.

Despite the small difference, risk averse individuals are, on average, younger than risk seeking ones. It is worth noticing that risk neutral subjects are, on average, slightly older than risk averse and seeking subjects. Differences in age do not lead to any significant differences in intelligence.

It is confirmed that individuals with higher education score better on CRT. Education level does not seem to influence risk perception, but the field of education surely does: economics and other scientific fields of study lead students to be more intelligent and risk seeking than humanistic fields do. In addition, economics student are more risk seeking, and smarter, than other students.

Subjects showing an inverse S-shaped probability weighting function are less intelligent than other ones. Across respondents with an accurate perception of probabilities, a higher percentage of risk neutral individuals can be encountered. The relationship between CRT scores and risk perception is strong and significant. We can firmly assess that intelligence indeed influences the individual's perception of probabilities.

Additional results

Residence country

As mentioned in the previous chapters, we are interested in the possible relationship between country of residence and intelligence/risk attitude. Our results suggest a surprisingly similar risk attitudes distribution across the two countries. 42% of people living in Italy are risk seeking, 50% is risk averse and only 8% is neutral toward risk. The sample collected from people living in the Netherlands shows the following distribution: 45% risk seeking, 45% risk averse, and just 10% risk neutral.

Those individuals show similar attitudes. The only assessable difference is a slightly higher inclination toward risk aversion of people currently living in Italy, compared to people living in the Netherlands. This phenomenon could depend from the fact that the people interviewed from economics, who revealed to be mostly risk seeking, are mainly living in the Netherlands.

There is a difference in intelligence between the two countries: respondents living in Italy have a higher CRT score, on average, compared to people living in the Netherlands (2.27 against 1.77).

It is surprising how subjects living in different countries can show almost identical risk attitudes but significantly different intelligence scores. As previously mentioned, this research has been computed because intelligence and risk attitudes may be influenced by environmental factors. These finding suggest that both countries present the exact same environmental factors that trigger a particular inclination toward risk aversion or risk seeking. At the same time, living in one country or in the other affects the intelligence level of the subject. It would be interesting to expand the research in this direction, in order to investigate which are the environmental factors leading the subjects to have different intelligence levels, depending on the country in which they live, but similar risk attitudes.

Risk aversion index

As previously mentioned, the risk aversion index is split into three categories: low (from 0.00 to 0.050); medium (from 0.050 to 0.15) and high (from 0.15 on). Many observations positioned themselves in the low index range (12 respondents), 7 subjects showed a "medium" index and 4 of them fell into the high values category. We can infer that the majority of our sample has only a slight inclination towards risk aversion or risk seeking. It is more rare to instead have a moderate or high propensity towards risk aversion or seeking. The risk attitudes inside each category are almost equally divided. In other words, each category approximately shows the same number of risk averse and risk seeking individuals. Those subjects falling in the high risk aversion range are more likely to score extreme results in the Cognitive Reflection Test.

Likelihood insensitivity index

As mentioned before, the respondents have been divided into three categories, based on the magnitude of the likelihood insensitivity index: Category 1 is composed of subjects with a likelihood insensitivity index comprehended between −0.50 and −0.050. Category 2 comprehends those subjects ranging between −0.050 and 0.050. Category 3 is composed of those respondents ranging between 0.050 and 0.50.
The categories shows an equal distribution between men and women: each group is composed by 60% of men and 40% of women.
The average age of the subjects in the three categories is 31, 29.80 and 24.50, respectively. In fact, The correlation coefficient between age and the likelihood insensitivity index is negative: −0.20. It is therefore assessable that, in general, younger subjects present an inverse-S shaped probability weighting function. The correlation coefficient is not statistically significant: its p-value takes value 0.35.
Both categories 1 and 2 are composed by 80% of individuals living in Italy and 20% of subjects living in the Netherlands. Category 3 instead comprehends 70% of subjects living in the Netherlands and 30% living in Italy. It is possible to state that subjects living in Italy, in general, show a more accurate perception of probabilities, compared to people living in the Netherlands. Subjects living in the Netherlands are more inclined to have and inverse-S shaped probability function.
Finally, Category 1 is composed by 80% of subjects studying in economics or other scientific fields and 20% of subjects with a middle or high school diploma as highest educational level. Category 2 is composed as follows: 40% of subjects achieved middle or high school, 20% achieved a bachelor in humanistic fields and the final 40% obtained a bachelor in economics or scientific fields. Category 3 presents 61.50% of subjects

who obtained a title in economics or scientific field, 23% with a middle or high school diploma and 15.50% specialized in humanistic fields.

Consistency

Concerning the consistency of respondents' preferences, only 4 subjects on 23 chose the same values for p_3' and p_3. Only 2 of them chose to put the value 0.50 in both probabilities. According to the responses obtained, the average distance between these two probabilities, in absolute value, is 0.22.
The mean of the values chosen for p_3 is 0.526; the mean of p_3' values is 0.53. The difference between the means of the two groups is small (−0.004) and not significant (P-value: 0.94).

Correlations

In this section the correlations between our variables of interest are presented. Several correlations have already been treated in the previous subsections. We are now going to describe the relationships between the value $|p_3'- p_3|$ and the other factors. It is important to say that the correlations between $|p_3'- p_3|$ and the risk aversion index; the relationship between $|p_3'- p_3|$ and age and the correlation between $|p_3'- p_3|$ and the likelihood insensitivity index are all statistically non-significant. The correlation between $|p_3'- p_3|$ and the CRT score is instead statistically significant (p-value = 0.037).

	Score CRT	*Risk aversion index*	*Age*	*Likelihood insensitivity index*	*|p3'-p3|*
Score CRT	1				
Risk aversion index	0,19	1			
Age	0,22	-0,049	1		
Likelihood insensitivity index	-0,52	-0,18	-0,20	1	
|p3'-p3|	-0,44	-0,017	-0,10	0,16	1

Figure 11

As Figure 11 exhibits, there is a high and negative correlation between $|p_3'- p_3|$ and the CRT score. Bigger the difference between p_3' and p_3, lower the consistence in preferences, lower the score on CRT. This means that subjects with higher intelligence are less likely to have inconsistent preferences.

The correlation between the risk aversion index and $|p_3'- p_3|$ is small and negative: more risk seeking the individual is and lower the consistence of his choices.

Age is negatively correlated with the distance between p_3' and p_3: older individuals tend to have more consistent preferences.

The value of $|p_3'- p_3|$ is positively correlated with the likelihood insensitivity index: people showing an inverse-S shaped probability weighting function are more likely to show inconsistent preferences.

Chapter 5
Limitation and further research

With the present study we demonstrated that a significant correlation between intelligence and probabilities perception exists.

In the present chapter, we discuss the main constraints encountered in running the experiment and in interpreting the findings. Finally, ideas for further research are introduced.

Limitations

The biggest problem encountered is the fact that the majority of the correlations found between our variables of interest is not statistically significant. Despite this, we still find significance in the relationship between the Cognitive Reflection Test and the likelihood insensitivity index (significance that helps us to accept and prove one of our main hypotheses) and in the correlation between CRT scores and $|p_3'$- $p_3|$.

The second problems is the small sample. Collecting more observations was unfeasible for several reasons. Firstly, the experiment takes long to be undertaken and it is not straightforward, especially for individuals who are not acquainted with probabilities or lotteries. The use of an experimental laboratory could have allowed us to collect more observations: explaining instructions would have been easier and specific computer programs could have been used. Secondly, we did not provide any monetary incentive for the subjects to participate. This might have led to many participant showing inconsistent preferences, because not incentivized to spend enough time and energies into the experiment.

Furthermore, different respondents undertook the treatment in many different environmental conditions and by means of different devices (computer /paper and pencil). Thus, each respondent could have interpreted the instructions in different ways or have been influenced by different kind of stimuli.

Respondents showing inconsistent preferences have not been discarded. Discarding people that chose different values for p_3' and p_3 would have led to a sample of only four observations. Almost 83% of the observations would have been rejected. We could also have chosen a less strict rule: keeping only those subjects presenting a distance between p_3' and p_3 smaller or equal to 0.10. In this case, our sample would have been composed by 9 subjects.

In looking for differences in risk preferences/intelligence in two different countries, we chose to analyse Italy and the Netherlands for the sake of convenience. Probably, a greater difference in risk attitudes and intelligence would have been found between countries in different continents. The Italian and Dutch public systems present some small disparities, but their environmental conditions are similar. They are both safe and rich countries; their environment does not help developing a particular difference in risk attitudes. This could not be the case for countries showing high criminality rates or low trust level in public and economic institutions. Furthermore, we did not distinguish between long and short period of staying. There could be a difference in risk attitudes between subjects living in a country for many years or only for a few months.

We used a parameter-free method to elicit utility and probability functions. In non-parametric procedures, the values do not need to be fit in predetermined functional forms. In fact, in order to use parametric estimations, a parametric family needs to be chosen, and there is the possibility that the data do not fit properly in it. Furthermore, non-parametric estimations need fewer assumptions. Non-parametric methods have an important drawback: noisy estimations (Gonzalez & Wu, 1999). Thus, parametric assumptions could estimate the functions more accurately.

We did not make use of the bisection method to elicit the functions, because it was too complicated to design. If included, the experiment would have taken too long to be filled in. The procedure would have been feasible by incentivizing respondents and by mean of a computer lab, as Abdellaoui (2000) did in his experiment.

The Frederick's Cognitive Reflection Test was chosen because it is short and straightforward. Different intelligence measures would have been more complete. The CRT only includes logical and mathematical questions. Tests comprehensive of grammar knowledge questions would allow to test for wider and different kinds of intelligence. In this way, for instance, individuals studying in Humanistic fields would have not been penalized.

We limit the study to the gains domain. Generally, the subjects' preferences substantially change whether they are playing with gains or losses. In fact, according to Tversky & Kahneman (1979), the utility curve is concave for monetary values higher than 0 and convex for values smaller than 0. Furthermore, in the losses domain the value function is steeper than the one for gains. It would be interesting to measure subject's preferences both for gain and losses, and then study a more complete connection with cognitive abilities.

Finally, the use of econometric programs would have permit a more accurate analysis. The assessment of all the possible cause-effect connections between our variables of interest could have been more precise. Knowing the magnitude and the significance of these relationships would bring deeper understanding to our research. On the other hand, there are many other uncontrollable (and unknown) factors determining risk attitudes and perception. The presence of these factors can create unexplainable variance.

Further research

The perception of probabilities and, consequently, of risk may be influenced and driven by different kinds of factors: environmental, psychological, physical. Cognitive abilities is only one of its possible causal effects. The present investigation could be expanded by including a measure for emotional intelligence. Emotional intelligence has first been introduced by Salovey an Mayer (1990) and later developed and popularized by Goleman (1995). As Goleman defines it, emotional intelligence is the "understanding one's own feelings, empathy for the feelings of others, and the regulation of emotion in a way that enhances living".

According to Slovic, Finucane, Peters and MacGregor (2002), the way in which own and others emotions are perceived affects judgments and decisions. Similarly, it could affect the subject's risk perception and attitude.

In our experiment, subjects were asked to compute decisions under risk: the probabilities of winning a particular outcome were always known. A further, and interesting, development of research would be the analysis of decisions and preferences under uncertainty. The attitude toward ambiguity can be measured by asking subjects to choose between lotteries where gains are linked to the occurrence of an event. The probability of the event occurring is unknown. In this way, a more precise estimation of uncertainty and risk attitudes could be computed, where attitudes under both risk and uncertainty would be known. Consequently, a more accurate connection with cognitive abilities could be analysed.

Appendix A

Bisection method

		Outcomes (F.F.)			Probabilities (×1%)	
Question	Alternatives †	$x_1 \in$	Choice	Alternatives	$p_1 \in$	Choice
1	A = (x_0, p; R) B = (3,500, p; r)	[1,000; 6,000]	A	A = (x_1, 1) B = (x_6, 50; x_0)	[0, 100]	A
2	A = (x_0, p; R) B = (4,700, p; r)	[3,500; 6,000]	A	A = (x_1, 1) B = (x_6, 75; x_0)	[50, 100]	A
3	A = (x_0, p; R) B = (5,300, p; r)	[4,700; 6,000]	B	A = (x_1, 1) B = (x_6, 87; x_0)	[75, 100]	B
4	A = (x_0, p; R) B = (5,000, p; r)	[4,700; 5,300]	A	A = (x_1, 1) B = (x_6, 81; x_0)	[75, 87]	A
5	A = (x_0, p; R) B = (5,100, p; r)	[5,000; 5,300]	A	A = (x_1, 1) B = (x_6, 84; x_0)	[81, 87]	A
6				A = (x_1, 1) B = (x_6, 85; x_0)	[84, 87]	A
End		[5,100; 5,300]			[85, 87]	

Figure 12

The aim of the bisection method is to elicit both equally spaced outcomes in utility units, and values equally spaced in terms of probability weighting functions.

Subjects are asked to make choices between two lotteries, instead of stating switching outcomes or probabilities. This method provides more consistent results than matching. We are going to describe the procedure followed by Abdellaoui (2000).

5 questions are asked to elicit each outcome X_i (with i = 1; 2; …; 6). 6 questions are asked in order to elicit each probability p_i (with i =1; 2; …; 5).

Figure 12 shows the elicitation of outcome X_1 (first column) and probability p_1 (second column). Through the questions, one can narrow down the interval containing X_1 first, and p_1 then, until a smaller interval is obtained. X_0, R and r must be chosen, according to the following relationship:

$$X_0 > R > r.$$

X_0 takes values \$200. R is equal to \$100. and r is \$0. In addition, a probability p equal to 2/3 is set. These values are kept fixed for all the 5 questions. The subject, in the first column, is asked to choose between lottery A = $(X_0, p; R)$ and lottery B = $(X_i^j, p; r)$. X_i^j is the midpoint of the interval $[b; u]$, defined by Abdellaoui as "the interval of feasible outcomes".

The subject determines choices between lottery A and lottery B, according to his preferences. Based on the choices, the interval (and, consequently, the X_i^j value) of the next question is established. If lottery A is chosen in question 1, then the interval in question 2 is $\left[\frac{b+u}{2}; b\right]$ and, consequently, the X_i^j in question 2 is its midpoint. If lottery B is chosen, the interval in question 2 will instead be $\left[b; \frac{b+u}{2}\right]$.

The procedure is repeated for 5 choices, until a sufficiently small interval is found. The midpoint of this final interval will be X_1.

In the second column, the same procedure is followed in order to elicit p_1. Now, the choice in question 1 is between lottery A = $(X_1, 1)$ and lottery B = $(X_6, p;\ X_0)$. p is the midpoint of the interval $[0; 100]$. According to the subject's choices, the probability interval is narrowed down and p is consequently modified. In question 6, a smaller interval containing p_1 is found. The midpoint of the interval is p_1.

The same method is repeated to find each X_i (i = 1; 2; …; 6) and p_i (i = 1; 2; …; 5).

Appendix B

The experiment's text, as presented to the subjects.

Gender:

Age:

Nationality:

Country of residence:

Education level:

Thank you for deciding to submit this questionnaire.

In this experiment, there is no right or wrong answer. We are only interested in your preferences and beliefs.

This questionnaire is anonymous. Your answers will never be related to your identity.

Introduction to section 1

You can choose between two games. In each game you can randomly pick up a ball from a box. In the box there are 10 balls, 5 blue and 5 red. The probability of picking up a red ball is then 50%.

Game A: (100. 0.5; 50).

In game A, if you pick up a red ball, you win €100. if you pick up a blue ball, you win €50.
In other words, if you choose to play game A, you have 50% probability to win 100 euros, and 50% probability to win 50 euros.

Game B: (150. 0.5; 0).

In game B, if you pick up a red ball, you win €150. if you pick up a blue ball, you win €0.
In other words, if you choose game B, you win 150 with probability 50% and nothing otherwise.

If you choose to play game A, you prefer game A over game B:

Game A > Game B

(100. 0.5; 50) > (150. 0.5; 0)

If you choose to play Game B, you prefer Game B over Game A

Game A < Game B

(100. 0.5; 50) < (150. 0.5; 0)

If for you choosing between A or B is the same, you are indifferent between playing A or B

Game A = Game B

(100. 0.5; 50) = (150. 0.5; 0)

Example

(The instructions in red show what you are supposed to do later, in section 2)

You can choose between two games. In each game you can randomly pick up a ball from a box. In the box there are 10 balls, 5 blue and 5 red. The probability of picking up a red ball is then 50%.

Game A: (100. 0.5; 50).

In game A, if you pick up a red ball you win €100. otherwise you get €50.

Game B: (X1, 0.5; 0).

In game B, if you pick up a red ball, you get a value X1. If you pick up a blue ball you get €0.

Choose a value for X1 that makes you indifferent between playing the two games. In other words, choose a value for X1 for which this indifference is satisfied:

Game A = Game B

(100. 0.5; 50) = (X1, 0.5; 0)

X1= __________ (1)

Example

Let's say that the value that makes you indifferent between playing game A or game B is 200.

Then:

X1= ____200___

This means that you are indifferent between playing game A (100. 0.5; 50) or game B (200. 0.5; 0).

(100. 0.5; 50) = (200. 0.5; 0)

Please note: The value 200 is an example, chosen to show the procedure.
In section 1 you can choose whatever value.

You can choose between two games. In each game you can randomly pick up a ball from a box. In the box there are 10 balls, 5 blue and 5 red. The probability of picking up a red ball is then 50%.

Now game A consists of:

Game A: (X1, 0.5; 50)

In the previous session, you chose a value for X1 (1). Now please write the same number here in game A, in the white gap right below.

Game A: (_______, 0.5; 50)

Example In the previous session you chose X1=200. Now please substitute 200 with X1 in game A: Game A: (_200___, 0.5; 50)

Game B is (X2, 0.5; 0)

In game B, if you pick up a red ball, you get a value X2. If you pick up a blue ball you get €0.

Choose a value for X2 that makes you indifferent between playing the two games. In other words, choose a value for X2 for which this indifference is satisfied.

Game A = Game B

(_______, 0.5; 50) = (X2, 0.5; 0)

X2= _________ (2)

Example Game A = Game B (___200___, 0.5; 50) = (X2, 0.5; 0) Now please choose a value X2 that makes you indifferent between these two games.

Section 1

- Question 1:

You can choose between two games. In each game you can randomly pick up a ball from a box. In the box there are 10 balls, 5 blue and 5 red. The probability of picking up a red ball is then 50%.

Game A: (1000. 0.5; 500)

In game A, if you pick up a red ball you win €1000. otherwise you get €500.

Game B is (X1, 0.5; 0).

In game B, if you pick up a red ball, you get a value X1. If you pick up a blue ball you get €0.

Choose a value for X1 that makes you indifferent between playing the two games. In other words, choose a value for X1 for which this indifference is satisfied.

Game A = Game B

(1000. 0.5; 500) = (X1, 0.5; 0)

X1= _________ (1)

- Question 2:

You can choose between two games. In each game you can randomly pick up a ball from a box. In the box there are 10 balls, 5 blue and five red. The probability of picking up a red ball is then 50%.

Now game A consists of:
Game A: (X1, 0.5; 500)

In the previous session, you chose a value for X1 (1). Now please write the same number here in game A, in the white gap right below.

Game A: (_______, 0.5; 500)

Game B: (X2, 0.5; 0)

In game B, if you pick up a red ball, you get a value X2. If you pick up a blue ball you get €0.

Choose a value for X2 that makes you indifferent between playing the two games. In other words, choose a value for X2 for which this indifference is satisfied.

Game A = Game B

(_______, 0.5; 500) = (X2, 0.5; 0)

X2= _________ (2)

- Question 3

You can choose between two games. In each game you can randomly pick up a ball from a box. In the box there are 10 balls, 5 blue and 5 red. The probability of picking up a red ball is then 50%.

Now game A consists of:
Game A: (X2, 0.5; 500)

In the previous session, you chose a value for X2 (2). Now please write the same number here in game A, in the white gap right below.

Game A: (_______, 0.5; 500)

Game B is (X3, 0.5; 0).

In game B, if you pick up a red ball, you get a value X3. If you pick up a blue ball you get €0.

Choose a value for X3 that makes you indifferent between playing the two games. In other words, choose a value for X3 for which this indifference is satisfied.

Game A = Game B

(_______, 0.5; 500) = (X3, 0.5; 0)

X3= _________ (3)

- Question 4

You can choose between two games. In each game you can randomly pick up a ball from a box. In the box there are 10 balls, 5 blue and 5 red. The probability of picking up a red ball is then 50%.

Now game A consists of:
Game A: (X3, 0.5; 500)

In the previous session, you chose a value for X3 (3). Now please write the same number here in game A, in the white gap right below.

Game A: (_______, 0.5; 500)

Game B is (X4, 0.5; 0)

In game B, if you pick up a red ball, you get a value X4. If you pick up a blue ball you get €0.

Choose a value for X4 that makes you indifferent between playing the two games. In other words, choose a value for X4 for which this indifference is satisfied.

Game A = Game B
(_______, 0.5; 500) = (X4, 0.5; 0)

X4= _________ (4)

- Question 5

You can choose between two games. In each game you can randomly pick up a ball from a box. In the box there are 10 balls, 5 blue and 5 red. The probability of picking up a red ball is then 50%.

Now game A consists of:
Game A: (X4, 0.5; 500)

In the previous session, you chose a value for X4 (4). Now please write the same number here in game A, in the white gap right below.

Game A: (_______, 0.5; 500)

Game B is (X5, 0.5; 0)

In game B, if you pick up a red ball, you get a value X5. If you pick up a blue ball you get €0.

Choose a value for X5 that makes you indifferent between playing the two games. In other words, choose a value for X5 for which this indifference is satisfied.

Game A = Game B

(_______, 0.5; 500) = (X5, 0.5; 0)

X5= _________ (5)

- Question 6

You can choose between two games. In each game you can randomly pick up a ball from a box. In the box there are 10 balls, 5 blue and 5 red. The probability of picking up a red ball is then 50%.

Now game A consists of:
Game A: (X5, 0.5, 500)

In the previous session, you chose a value for X5 (5). Now please write the same number here in game A, in the white gap right below.

Game A: (_______, 0.5; 500)

Game B is (X6, 0.5; 0).

In game B, if you pick up a red ball, you get a value X6. If you pick up a blue ball you get €0.

Choose a value for X6 that makes you indifferent between playing the two games. In other words, choose a value for X6 for which this indifference is satisfied.

Game A = Game B

(_______, 0.5; 500) = (X6, 0.5; 0)

X6= _________ (6)

Please, insert below all the values that you chose previously.

X1 = _____

X2 = _____

X3 = _____

X4 = _____

X5 = _____

X6 = _____

Section 2

Please answer to the following three questions.

(1) A bat and a ball cost €1.10 in total. The bat costs €1.00 more than the ball. How much does the ball cost?

_____ Cents

(2) If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?

_____ Minutes

(3) In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake?

_____ Days.

Section 3

Now you are asked to write down the value of probability P that makes you indifferent between the two games.

In Game A: (Z, 1) in each scenario you have 100% probabilities of winning a value Z. You get the outcome Z for sure.

In Game B: (X, P; Y), instead, you have a probability P of getting outcome X, and 1-P of getting outcome Y.

The task, in this section, is to write down the probability that makes you indifferent between playing game A or game B.

Example If, for example, Game A is (100. 1), choosing this game means that you will win €100 for sure. If Game B is (200. P, 0), choosing this game means that you win €200 with probability P, and €0 with probability (1-P). Please state P, such that for you is the same between playing A or B. (100. 1) = (200. P; 0)

What is the probability that makes you indifferent between playing Game A or Game B in the following scenarios?

	Game A	Game B	Probability
Scenario 1	(X1, 1) (____, 1)	(X6, P; 1000) (____, P; 1000)	(X1, 1) = (X6, P; 1000) (___, 1) = (___, P: 1000) If P= _____

Scenario 2	(X2, 1) (____, 1)	(X6, p; 1000) (____, P; 1000)	(X2, 1) = (X6, P; 1000) (___, 1) = (___, P; 1000) If P= _____
Scenario 3	(X3, 1) (____, 1)	(X6, p; 1000) (____, P; 1000)	(X3, 1) = (X6, P; 1000) (___, 1) = (___, P; 1000) If P= _____
Scenario 4	(X4, 1) (____, 1)	(X6, p ; 1000) (____, P; 1000)	(X4, 1) = (X6, P; 1000) (___, 1) = (___, P; 1000) If P= _____
Scenario 5	(X5, 1) (____, 1)	(X6, p; 1000) (____, P; 1000)	(X5, 1) = (X6, P; 1000) (___, 1) = (___, P; 1000) If P= _____
Scenario 6	(X3, 1) (____, 1)	(X4, p; X2) (____, P; ____)	(X3,1) = (X4, P; X2) (___, 1) = (___, P; X2) If P= _____

Appendix C

Subjects’ characteristics, functions and values are presented here.

Subject 1

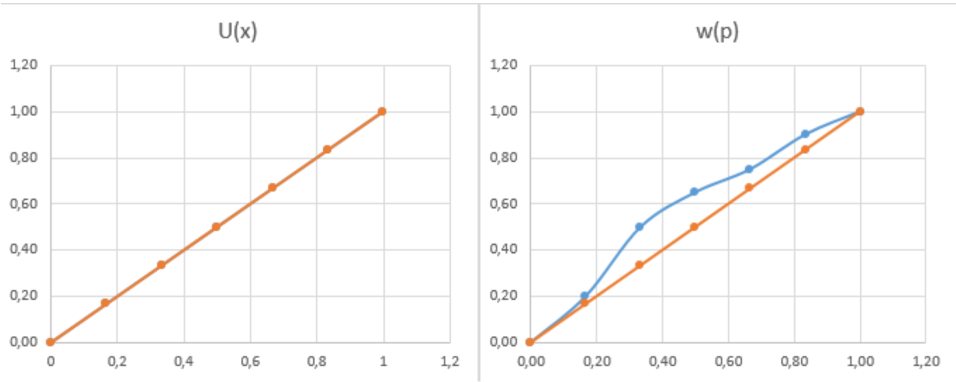

Figure 13

Gender: M	Age: 16
Country: IT	CRT: 2
Education: Middle School	Risk Attitude: Seeking
Risk aversion index: −0.040	$|p_3' - p_3|$: 0.20
Likelihood insensitivity index: −0.030	

Subject 2

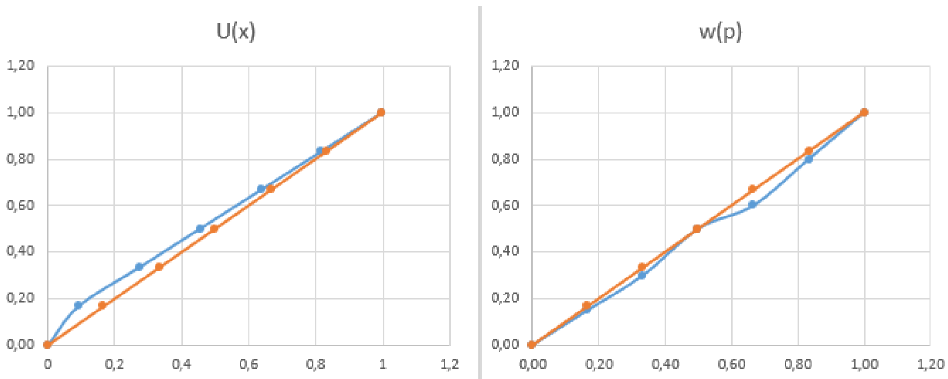

Figure 14

Gender: F	Age: 55

Country: IT	CRT: 2
Education: High School	Risk Attitude: Averse
Risk aversion index: 0.030	$\lvert p_3' - p_3 \rvert$: 0.50
Likelihood insensitivity index: 0.017	

Subject 3

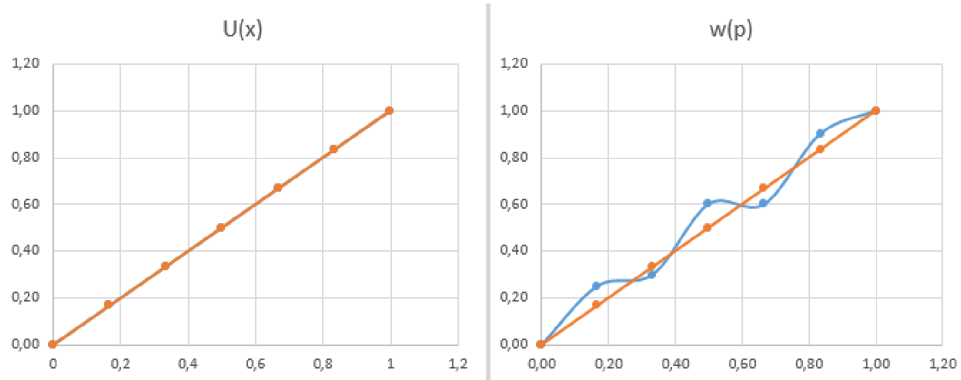

Figure 15

Gender: M	Age: 22
Country: IT	CRT: 2
Education: Bachelor in Economics	Risk Attitude: Seeking
Risk aversion index: −0.010	$\lvert p_3' - p_3 \rvert$: 0.10
Likelihood insensitivity index: 0.017	

Subject 5

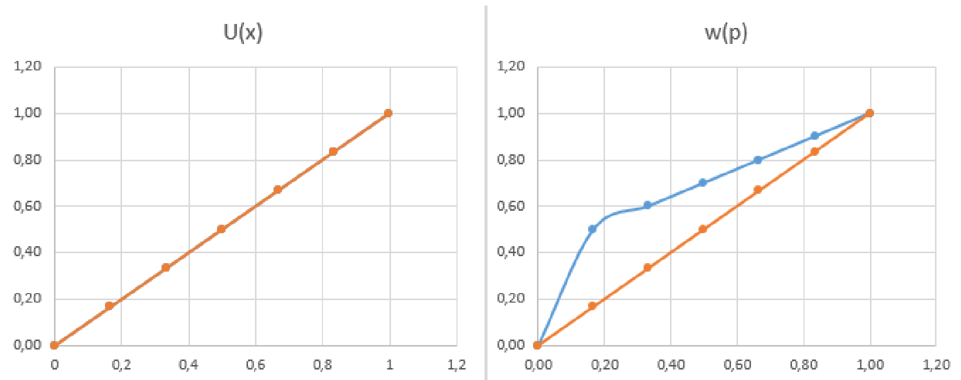

Figure 16

Gender: F	Age: 23

Country: NL	CRT: 2
Education: Bachelor in Economics	Risk Attitude: Seeking
Risk aversion index: −0.070	$\lvert p_3' - p_3 \rvert$: 0.20
Likelihood insensitivity index: 0.27	

Subject 6

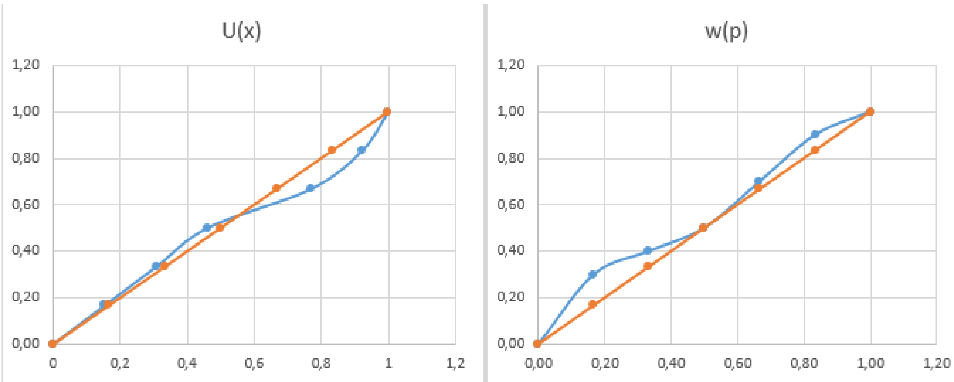

Figure 17

Gender: M	Age: 24
Country: NL	CRT: 2
Education: Bachelor in Economics	Risk Attitude: Seeking
Risk aversion index: −0.030	$\lvert p_3' - p_3 \rvert$: 0.20
Likelihood insensitivity index: 0.070	

Subject 11

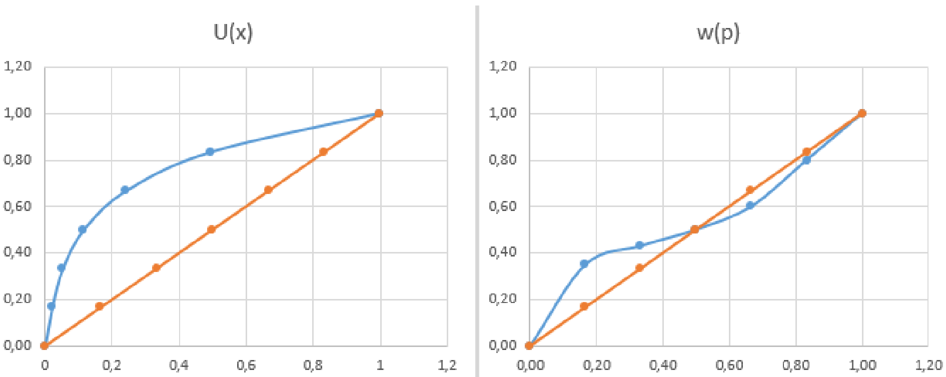

Figure 18

Gender: M	Age: 22

Country: IT	CRT: 3
Education: Bachelor in Informatics	Risk Attitude: Averse
Risk aversion index: 0.10	$\lvert p_3' - p_3 \rvert$: 0.20
Likelihood insensitivity index: 0.22	

Subject 12

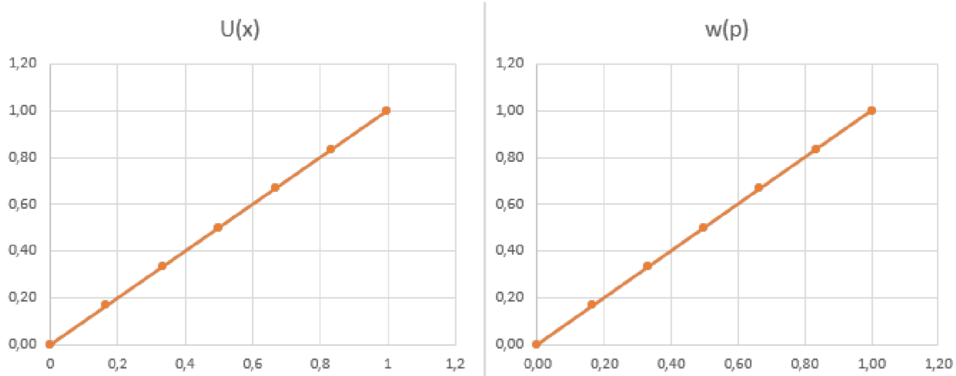

Figure 19

Gender: M	Age: 34
Country: IT	CRT: 3
Education: PhD Physics	Risk Attitude: Neutral
Risk aversion index: 0	$\lvert p_3' - p_3 \rvert$: 0
Likelihood insensitivity index: 0	

Subject 13

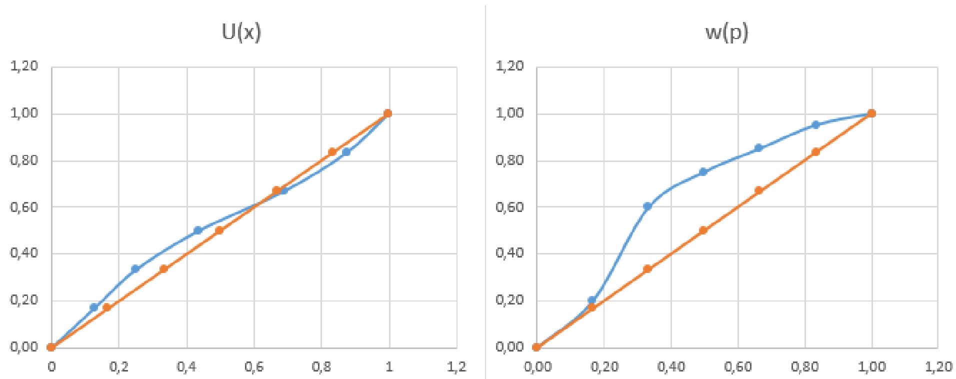

Figure 20

Gender: F	Age: 30
Country: IT	CRT: 1

Education: Master Degree in Engineering	Risk Attitude: Seeking
Risk aversion index: −0.050	$|p_3' - p_3|$: 0.25
Likelihood insensitivity index: −0.080	

Subject 14

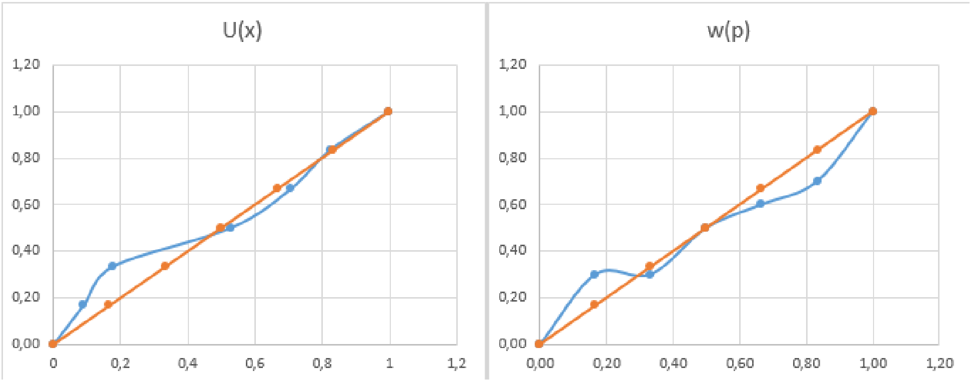

Figure 21

Gender: M	Age: 29
Country: IT	CRT: 3
Education: Master Degree in Engineering	Risk Attitude: Averse
Risk aversion index: 0.020	$|p_3' - p_3|$: 0.10
Likelihood insensitivity index: 0.27	

Subject 15

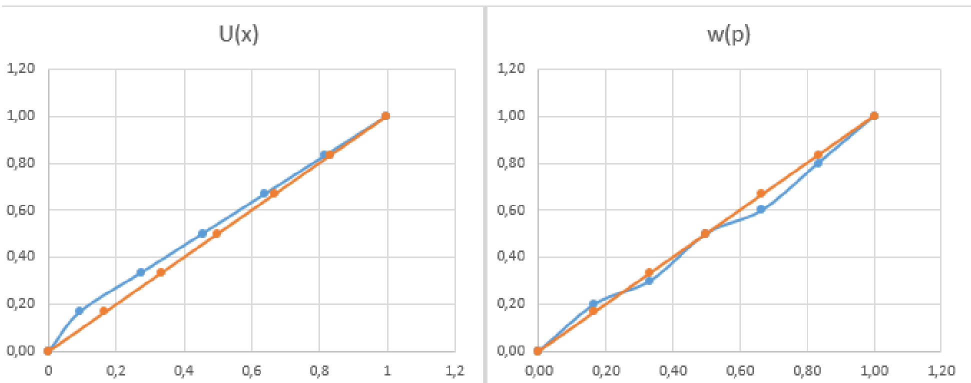

Figure 22

Gender: M	Age: 17
Country: IT	CRT: 2

Education: Middle School	Risk Attitude: Averse
Risk aversion index: 0.020	$\lvert p_3' - p_3 \rvert$: 0.20
Likelihood insensitivity index: 0.070	

Subject 16

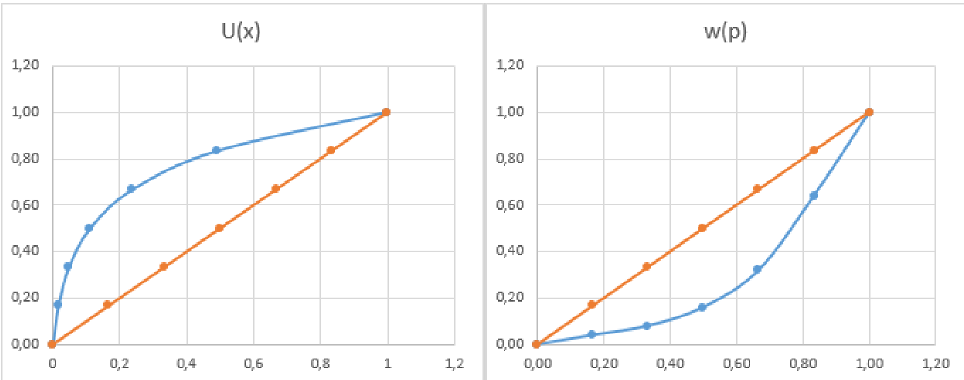

Figure 23

Gender: M	Age: 22
Country: IT	CRT: 2
Education: Bachelor in Anthropology	Risk Attitude: Averse
Risk aversion index: 0.20	$\lvert p_3' - p_3 \rvert$: 0.34
Likelihood insensitivity index: 0.070	

Subject 17

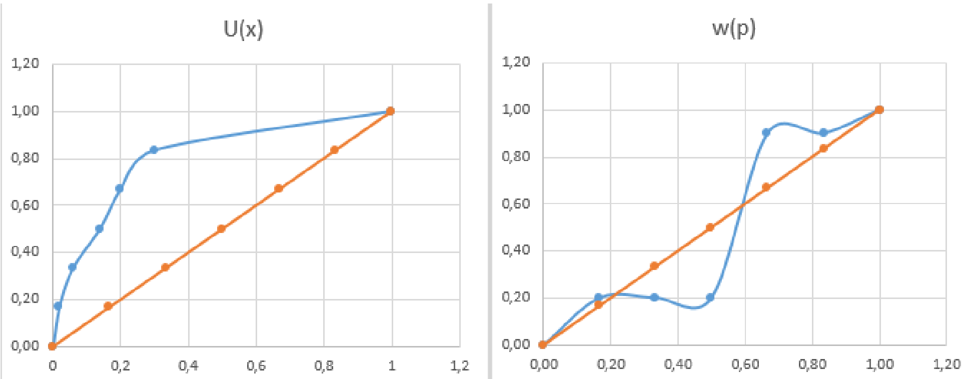

Figure 24

Gender: F	Age: 22
Country: NL	CRT: 2.25

Education: Bachelor in Arts and Culture	Risk Attitude: Averse
Risk aversion index: 0.13	$\lvert p_3' - p_3 \rvert$: 0.80
Likelihood insensitivity index: −0.030	

Subject 18

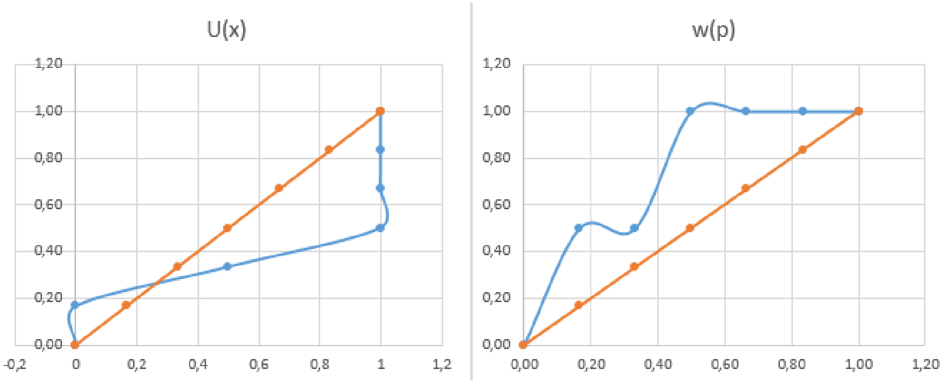

Figure 25

Gender: M	Age: 21
Country: NL	CRT: 1
Education: High School	Risk Attitude: Seeking
Risk aversion index: −0.18	$\lvert p_3' - p_3 \rvert$: 0.50
Likelihood insensitivity index: 0.17	

Subject 19

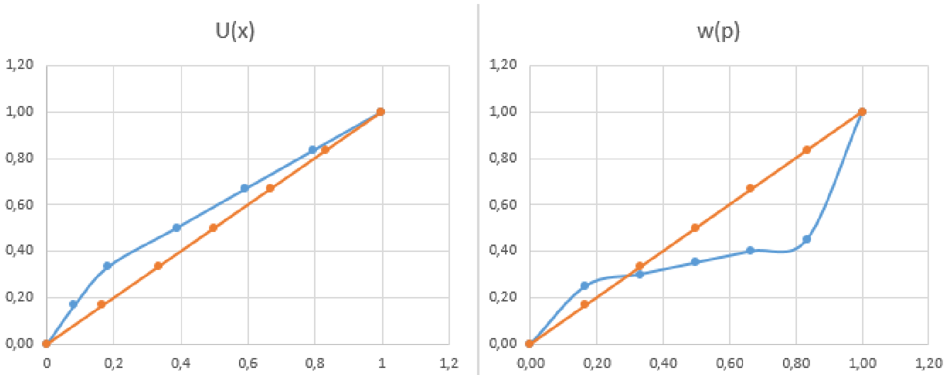

Figure 26

Gender: F	Age: 21
Country: NL	CRT: 0

Education: High School	Risk Attitude: Averse
Risk aversion index: 0.090	$\lvert p_3' - p_3 \rvert$: 0.65
Likelihood insensitivity index: 0.47	

Subject 20

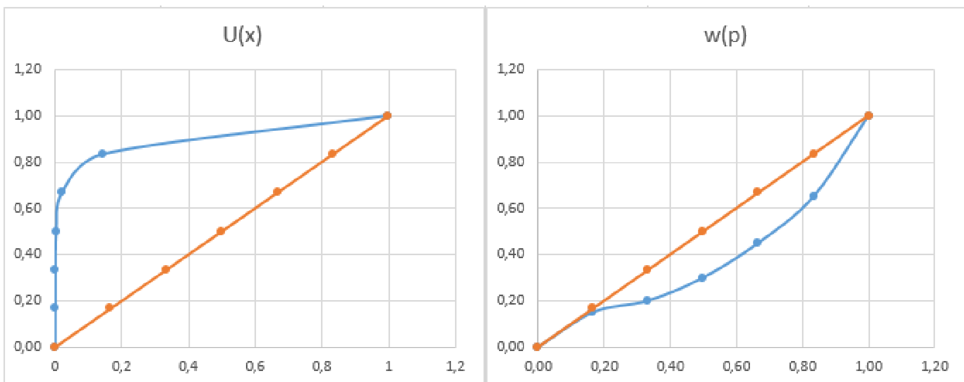

Figure 27

Gender: F	Age: 32
Country: NL	CRT: 3
Education: Bachelor in Economics	Risk Attitude: Averse
Risk aversion index: 0.22	$\lvert p_3' - p_3 \rvert$: 0
Likelihood insensitivity index: 0.17	

Subject 21

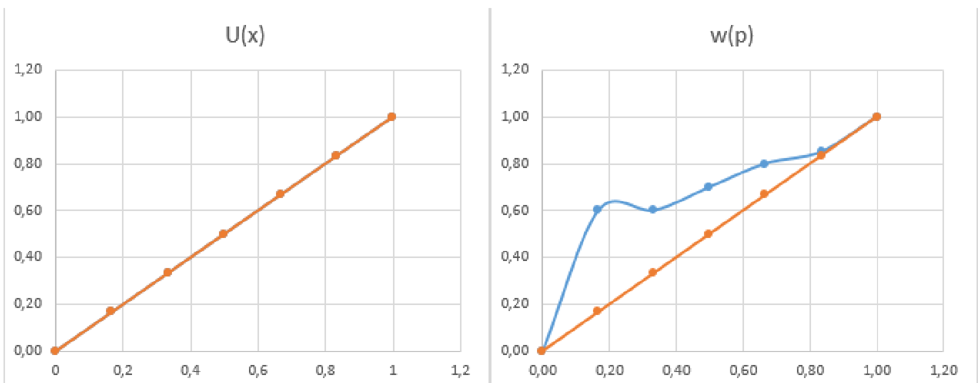

Figure 28

Gender: F	Age: 23
Country: NL	CRT: 2

Education: Bachelor in Economics	Risk Attitude: Seeking
Risk aversion index: −0.080	$\lvert p_3' - p_3 \rvert$: 0.10
Likelihood insensitivity index: 0.42	

Subject 22

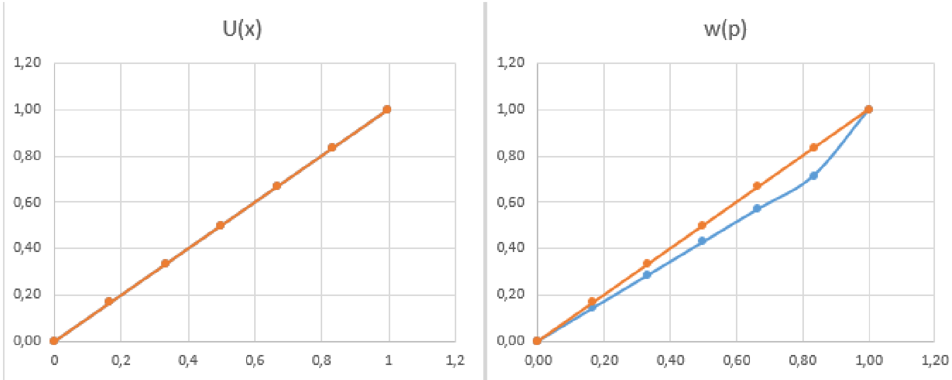

Figure 29

Gender: M	Age: 26
Country: NL	CRT: 3
Education: Bachelor in Economics	Risk Attitude: Averse
Risk aversion index: 0.030	$\lvert p_3' - p_3 \rvert$: 0.23
Likelihood insensitivity index: 0.10	

Subject 23

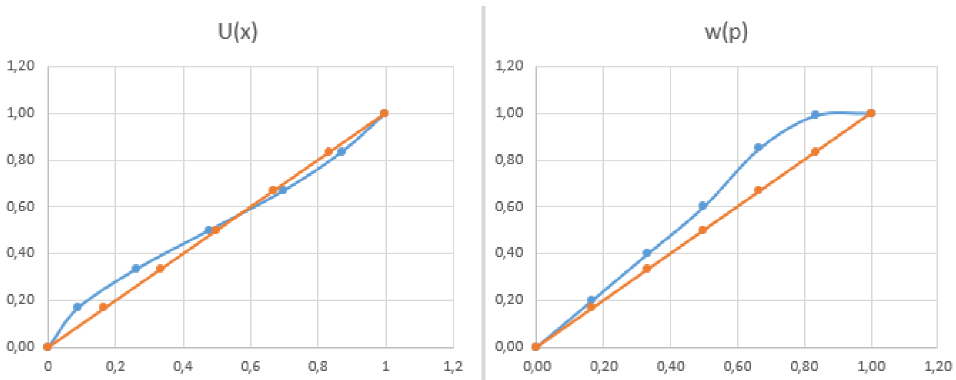

Figure 30

Gender: F	Age: 22
Country: NL	CRT: 3

Education: Bachelor in Economics	Risk Attitude: Seeking
Risk aversion index: −0.030	$\|p_3' - p_3\|$: 0.10
Likelihood insensitivity index: −0.12	

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