Radboud Universiteit Nijmegen

RADBOUD UNIVERSITY

Nijmegen School of Management

Master Thesis

The Effect of Different Presentation forms of Ambiguous Bets on Ambiguity Attitude

An online experiment is conducted to examine how different presentation forms of ambiguous bets affect ambiguity attitude. Ambiguity aversion was expected for all treatments. However, I find lowest ambiguity aversion for the temperature treatment and the highest ambiguity aversion for the stock price treatment. In addition, it was expected that the urn treatment would provide the highest willingness to pay, due to the illusion of control. Significant ambiguity aversion was found for three of the four treatments, with the exception of the temperature treatment. Ambiguity aversion was highest for the spinner treatment. Significant differences are found in willingness to pay and ambiguity aversion between the stock price treatment and the urn treatment. Furthermore, it was found that risk preferences conducted from the risk preference measure do not affect ambiguity aversion.

Keywords: *ambiguity attitude, willingness to pay, risk preference, presentation forms, financial literacy, understandability*

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Topic: Ambiguity Attitude

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Table of Content

1. Introduction

In the last 60 years the important theories on decision making have been the Expected Utility (EU) theory and the Subjective Expected Utility (SEU) theory. EU assumes that for all outcomes the probabilities are known. However, in many situations the probabilities of events are unknown. Therefore, it is not remarkable that decision making under uncertainty is widely studied in behavioral finance, as uncertainty is a great part of the human decision-making process.

A great deal of empirical evidence against SEU interests specific difference between whether probabilities are unknown or known (Camerer & Weber, 1992). This problem was first addressed by Knight (1921), who separated risk; this could be represented by precise probabilities, and uncertainty which could not be represented by precise probabilities. At the same time Keynes (1921) distinguished between judged probability and weight. The judged probability represents the balance of a proposition. The weight represents the quantity of the evidence supporting a particular balance. He stated that people should prefer bets on probabilities that are backed by a higher weight. Ramsey (1931) argued for measuring subjective probability seeks to use the degree of belief from preference by using expected utility theory. This model was matured by Savage (1954), and determines subjective probability from preferences between bets. The Ramsey (1931) and Savage (1953) model was later challenged by Ellsberg (1961), who found that subjects prefer bets with known probabilities over bets with unknown probabilities. The broadly accepted term for this is ambiguity. The behavior of a known (risky) bet over the ambiguous bet is generally known as ambiguity aversion. Ellsberg used a simple experiment, which is now known as the 'two-colour' problem. This experiment involved two urns which contained black and red balls. For urn one, the distribution was 50 red balls and 50 black balls. For urn two, there were 100 red and black balls in an unknown portion. He found that people have a preference for the known bet rather than the unknown bet, even though the subjects did not have any color preferences. This preference behavior is inconsistent with the subjective expected utility theory; it implies that the subjective probabilities in the known urn is greater. This violation of the subjective expected utility in decision theory is more commonly known as the Ellsberg paradox. Moreover, ambiguity about a probability creates a risk of having a wrong belief. However, SEU theories demands for subjects to be indifferent about this kind of risk.

Ellsberg's work provided interesting new insides for two reasons (Heath & Tversky, 1991). Firstly, it provides an alternative for the subjective expected utility theory using simple games. Secondly, it provides the ambiguity aversion hypothesis. In which people prefer known bets over unknown bets, this is at least true for moderate and large probabilities. For small probabilities, Ellsberg states that subjects could prefer unknown bets. These findings cause problems for the expected utility theory and other risky choice models. If subject's decisions do not only depend on the level of uncertainty but also on the way it is assessed, risky choice models are quite limited as most decision in the real world are based on uncertain events.

Ellsberg's ball example is provided with, although ambiguous, a probability estimate. However, most decisions in the real world are not provided with estimates. Therefore, it is questioned whether ambiguity is only present in an experimental setting (Heath & Tversky, 1991). However, generality is the question in most experimental settings. Nonetheless it is interesting to test for ambiguity because behavior towards uncertain probabilities is present in our daily life. Although, there is criticism on the generality of Ellsberg's model it still provides a lot of information on people's decision making concerning uncertainty. The relevance for this study is therefore justified, that ambiguity and ambiguity aversion are still an issue today. In the past several empirical studies used ambiguity aversion to explain decision behavior in real life. For example, Dimmock et al. (2016) tested the relation between ambiguity aversion and household portfolio puzzles. They tested ambiguity aversion using questions based on Ellsberg urn. They found that most participants are ambiguity-averse, but ambiguity preferences variate considerably. Furthermore, their study showed that ambiguity aversion could be able to explain household portfolio puzzles. These puzzles arise from the fact that a great proportion of the US population does not engage in the stock market. However, standard expected utility theory predicts that all individuals will participate in the stock market (Merton, 1969). Moreover, several studies state that ambiguity aversion can explain these portfolio puzzles. As, stock returns are seen as ambiguous by investors (Bossaerts et al., 2010; Cao, Wang & Zang, 2005; Easley & O'Hara, 2009). In addition, Engle-Warnick, Escobal and Laszlo (2007) conducted a study to distinguish between ambiguity aversion and risk aversion in farmers' technology choice in Peru. Engle-Warnick, Escobal and Laszlo (2007) used a pie-form presentation to mimic ambiguous bets. They found that ambiguity aversion can predict technology choices. Heath and Tversky (1991) used uncertain events on football and politics to mimic ambiguous bets. Muthukrishnan et al. (2009) provide evidence for the external validity of Ellsberg's urn in a marketing environment. They observed ambiguity attitude towards different brands, the brands are perceived as less or more ambiguous with regard to the quality of these brands. Although, they conducted a laboratory experiment studying students behavior, it does show that ambiguity attitude can predict decision-making behavior. Later, Sutter et al. (2013) tried to capture ambiguity attitude amongst children with regards to economic and health behavior. They found that ambiguity-averse children are less likely to smoke, drink, or misbehave. So, it is clear that experimental results can be linked to behavior outside the laboratory, and that the concept of ambiguity aversion is important for the understanding of human decision-making.

Different sources through which uncertainty is presented have been used to investigate ambiguity attitude (Dimmock, 2016; Engle-Warnick, Escobal & Laszlo, 2017; Heath & Tversky, 1991; Muthukrishnan, 2009). However, to my knowledge, it is still unclear whether ambiguity attitude is constant over these different presentation forms. For example, ambiguity attitude could be different in an Ellsberg's urn experiment compared to the pie-form presentation used by Engle-Warnick, Escobal and Laszlo (2007). This research will continue on the study towards ambiguity. More specifically, it will continue on determining whether there is ambiguity aversion in an experimental setting. However, this research will complement existing literature by comparing four presentation forms of ambiguous bets, to test whether ambiguity attitude varies between sources throughout these ambiguous bets are presented. The research question therefore will be:

What is the effect of different presentation forms of ambiguous bets on ambiguity attitude?

This study aims to provide information on the role of presentation forms on ambiguity attitude. It takes in four different presentation forms, discussed in section 3.2. In addition, risk preferences for all respondents will be tested and linked to ambiguity attitude. In an experimental setting, subjects are to complete several tasks. Finally, respondents are to answer several control and financial literacy questions.

Significant results for ambiguity aversion were found for three of the four treatments. Ambiguity aversion was highest for the spinner treatment. Suggesting that the illusion of control plays a role in decision-making. No significant evidence for ambiguity aversion in the temperature treatment was found. The willingness to pay for the risky bet seem to be quite stable, as no significant differences are found between the treatments. Contrary to the expectations no significant differences are found in willingness to pay and ambiguity aversion between the stock price treatment and the urn treatment. However, the willingness to pay for the temperature treatment was significantly higher than the other treatments. Furthermore, risk preferences conducted by the risk preference measure does not affect ambiguity aversion. However, risk taking in general was found to significantly influence ambiguity and willingness to pay. Risk taking by subjects was conducted using a Likert scale, in which the subjects had to indicate how risk taking they are in general. Finally, an interaction effect was found, in which the effect of financial literacy on ambiguity aversion depends on the stock price treatment.

In the next section, a literature overview on ambiguity attitude and ambiguity aversion is presented along with several hypothesis. The third section covers the methodology used for this research. The fourth section covers the experimental results along with the demographic statistics. The fifth section offers a discussion on the results and a comparison with earlier conducted literature. Finally, a conclusion on this study is presented as well as limitations and future research suggestions.

2. Literature Overview

2.1. Definitions of Ambiguity

Before discussing earlier empirical studies on ambiguity attitude, definitions of ambiguity are presented and discussed. De Finetti (1977) stated that there is no such thing as unknown probabilities, so there is no ambiguity. As, all probabilities are equally well known for everybody. However, this approach does not explain the great empirical evidence of ambiguity aversion. Earlier, Ellsberg (1961) stated "*ambiguity is the quality depending on the amount, type, reliability and unanimity of information"*. However, this definition is quite vague and abstract. The definition created by Fellner (1961) and Frisch and Baron (1988) is more clear and will be used as the definition for ambiguity in the remaining of this paper:

"Ambiguity is uncertainty about probability, created by missing information that is relevant and could be known".

Ambiguity attitude therefore is the preference and behavior towards this uncertainty about probabilities. Moving to ambiguity aversion, Frisch and Baron (1988) state that people have the tendency to avoid betting when you lack information that others might have. Moreover, Heath and Tversky (1991) argue that people avoid betting because not knowing all information is unpleasant and frightening. So, ambiguity aversion is the avoidance of making decision under uncertainty. In the next section earlier empirical work on ambiguity and ambiguity aversion is presented and discussed.

2.2. Empirical Studies on Ambiguity

Since Knight (1921) many studies have focused on ambiguity. The preference of the risky bet over the ambiguous bet has been demonstrated in many experiments using alterations of Ellsberg's urn or other sources of presenting uncertainty. In this section numerous empirical studies confirming ambiguity aversion are elaborated.

Ramsey (1931) and Savage (1954) argued for measuring subjective probability by using expected utility theory. As mentioned, this model was later questioned by Ellsberg (1961). The first study that used a Ellsberg urn setting was provided by Becker and Brownson (1964). They criticize Ellsberg (1961) by stating that no framework is provided for making ambiguity operational. In addition, they argue that Ellsberg does not provide a behavior predictor in his model. Becker and Brownson (1964) conducted an experiment to test for subjects' differences in behavior when being confronted with differing degrees of ambiguity. They found that the amounts paid to avoid ambiguity is positively related to the degree of ambiguity provided.

Later, MacCrimmon (1968) conducted an experiment using an Ellsberg-type framework. Merely 10% of the subjects showed behavior according to Ellsberg's results. However, approximately 50% of the subject showed ambiguity aversion when confronted with an investment decision regarding countries with historical information and countries with no historical information. Yates and Zukowski (1976) tested how ambiguity is characterized subjectively. They conducted an experiment in which the subjects were presented with games to test whether the range of possible probabilities is a determinant of ambiguity. The compared a known urn with 5/5 poker chips and an unknown urn with an unknown proportion of red chips between 0 and 10. This latter uniform urn has a greater possible range and was therefore expected to be less preferred. The results confirmed their expectation, the unknown urn was least preferred.

Curley and Yates (1985) constructed thirty lotteries with uncertainty probabilities. They varied the center and the ranges on the intervals within the unknown probabilities of winning could lie. For each respondent, the lotteries were presented in pairs. Each pair presented had the same interval center by the interval ranges varied. They found that ambiguity aversion increased with the center of the interval. Meaning, that when the potential payoff increased, ambiguity aversion increased as well. They found absolutely no evidence for ambiguity seeking behavior whatsoever. Moreover, Curley, Yates and Abrams (1986) examined the psychological sources determining ambiguity avoidance. They found that a decision maker anticipates that other will judge his or her decision. Therefore, makes the decision that is perceived as most acceptable by others, this is usually the choice for the option with the smallest level of ambiguity.

Kahn and Sarin (1998) conducted an experiment in which subjects were to state their ambiguity premium to avoid ambiguity. They found that these ambiguity premiums were almost linear positively related to the probability range. Moreover, they showed that their model is able to predict different decision-making for individuals who exhibit different ambiguity attitude (ambiguity averse, ambiguity seeking, or ambiguity neutral). For example, they found that the subjects showed ambiguity seeking behavior for low probabilities for gains. In a study using descriptive models, Curley and Yates (1989) conducted two studies in which they had subjects rank certain lotteries based on their preferences. In the first study they found that subjects were willing to forsake expected winnings to get rid of ambiguity. Subjects were willing to pay roughly 7,5% of their expected value to avoid ambiguity. However, In line with earlier studies, for lower probabilities a significant percentage of the subjects showed ambiguity seeking behavior, subjects were willing to forfeit expected winnings to be able to pick the more ambiguous option.

Later, Hogarth and Einhorn (1990) created a model of how people assess decision weights. Their model assumes that people anchor their decision on a given probability and then later accommodate this by mentally simulating other possible outcomes. This simulation is affected by the size of the payoff, the variation of the anchor and the level of perceived ambiguity. To measure ambiguity aversion Hogarth and Einhorn (1990) had subjects choose between urns with single outcomes and multiple outcomes, and between urns with known probabilities and unknown probabilities. Roughly all subjects showed ambiguity averse behavior, which was in line with their earlier work (Einhorn & Hogarth, 1986).

In addition, there was some ambiguity seeking behavior for low probabilities of gain and high probabilities of loss. This pattern is found, and discussed before, in earlier empirical studies.

Heath and Tversky (1991) investigated the relationship between the preferences for bets and the perception of probabilities. They conducted a number of experiments comparing subjects' willingness to bet on chance events and their willingness to bet on uncertain events. They found preferences to bet on more familiar sources, for example subjects who knew much about politics, but little about football, were more willing to bet on events regarding politics comparing to football. Even though the probabilities were the same. This is known as the competence hypothesis. However, their findings cannot explain ambiguity aversion, as judgmental probabilities are more ambiguous than the chance events they stated. Therefore, Heath and Tversky (1991) stated that their results suggest that this kind of behavior is the result of the attribution of credit and blame. Because, people perceive the situation differently when they trust in their judgment. For example, if the decision maker has great understanding of certain problem, success will be assigned to their skills. On the other hand, the chance events are attributed to lucky or unlucky in the loss domain. Following the work of Heath and Tversky (1991) on the competence hypothesis. Fox and Tversky (1995) proposed the comparative ignorance hypothesis. Already mentioned by Ellsberg (1961), decisions under uncertainty do not only depend on the level of uncertainty, but also on the source throughout this uncertainty is presented. The comparative ignorance hypothesis assumes that ambiguity aversion follows from a comparison with less ambiguous events or with more knowledgeable individuals. Their findings support this hypothesis, in several studies they showed that ambiguity aversion seems to disappear when these comparisons are not present. They presented ambiguity aversion is a comparative context in which the subject had to evaluate risky and ambiguous prospects. More precisely, Fox and Tversky (1995) argue that the comparative ignorance hypothesis shows that when people are to price uncertain prospects in isolation, they pay little to no attention to the precision of their judgement. For example, they asked subjects how much they were willing to pay a certain game. On one hand they showed an ambiguous urn and a unambiguous earn together. And on the other hand, they stated the same urns separately. For the comparative experiment the amount for the risky bet was significantly higher than for the ambiguous bet. For the non-comparative experiment the amounts were almost equal. This is clear evidence for their comparative hypothesis.

As an expansion to the work of Fox and Tversky (1995), Fox and Weber (2002) extended the comparative ignorance hypothesis by determining four new approaches in which the context of decision can affect the willingness to decide under uncertainty. However, these extensions did not rely on the comparative/non-comparative comparison that is used by Fox and Tversky (1995). They found that subjects find bets with unknown probabilities more attractive when preceded by questions about less familiar aspects than when preceded by questions about more familiar aspects. In addition, they found that comparative ignorance can be affected by providing information that only an expert knows how to use.

Finally, taking in risk attitude and ambiguity attitude. Tversky and Kahneman (1992) stated decision-making as a product of the following four parameters i) attitudes towards risks, ii) attitudes towards ambiguity, iii) sensitivity to losses and gains, and iv) impulsiveness. Going forward on this Tymula et al. (2012) conducted an experiment to test adolescents' risk-taking behavior. They found that adolescents' higher level of risk-taking, in contrast to their older peers, may reflect a higher tolerance for the unknown. Concluding that risk-taking behavior is driven by the tolerance of a certain level of ambiguity. Moreover, earlier research showed that behavior towards risk and ambiguity are compelling factors of choice under uncertainty (Einhorn & Hogarth, 1985; Ghoash and Ray, 1992). Ghosh and Ray (1997) extended this by taking in the roles of risk attitudes and the resistance for ambiguity in predicting people's choices. They conducted an experiment to test this on decisions made in four different scenarios. They found that both risk and ambiguity attitude determine decision-making. In addition, they found that the presence of ambiguity increases the perception of risk for individual subjects. Finally, they found that subjects who are less risk averse have more tolerance for ambiguity and exhibit more confidence in their decisions. Brown et al. (2010) replicated an experiment conducted by Huettel et al. (2006) to test choice under uncertainty with 30 Yale undergraduates, the subjects were to make 200 pair-wise choices between ambiguous and risky lotteries. Their findings suggest that risk and ambiguity cannot be seen separately when making choices under uncertainty. In addition, Ghosh & Ray (1992) conducted a laboratory experiment to analyze the relationship between risk and ambiguity attitudes and the decisions taken by the subjects. The results supported their hypothesis; both ambiguity and risk attitudes affect decision-making behavior.

2.3. Source of Uncertainty

As mentioned, Fox and Tversky (1995) state that decisions under uncertainty do not only depend on the amount of uncertainty, but also on the source through which this uncertainty is presented. This is also known as the source preference hypothesis. Usually, source preference is demonstrated by showing that a subjects prefers to bet on a certain proposition taken from one source than on the same proposition taken from another source. Meaning that the source where the uncertainty comes from (e.g. urn compositions, natural events, spinner compositions) affects ambiguity attitude. Distinct sources of uncertainty, not specifically related to the situations where the information about uncertain probabilities comes from, seems to be affecting decision-making. For example, in casinos bettors seem to prefer betting on their own number rather than having them selected by a computer. Betting on a coin toss, where one may prefer betting on their own coin rather than on someone else's (Chew & Sagi, 2008). In addition, Kilka and Weber (2001) presented a two-stage approach to examine weights for decision-making under uncertainty. They found that probability judgements were somewhat affected by the source of uncertainty. Furthermore, the properties of the probability weighting function were also affected by the source of uncertainty. Therefore, they conclude that the source of uncertainty influences probability judgements. Finally, Trautmann and van de Kuilen (2015) found that ambiguity attitudes depend on the likelihood of happening of an uncertain event, the range of the outcome, and the source trough which this uncertainty is presented. This would suggest that different presentation forms of ambiguous bets have different outcomes in terms of ambiguity attitude. The tasks presented in section 3.2 are in essence the same. However, the different presentation forms could lead to the situation that some presentation forms are perceived as more attractive than the others.

In addition, empirical evidence has shown that task complexity has great influence on decision-making. Payne (1976) conducted an experiment to examine the information processing strategies subjects used to come to a decision. The results showed that the information processing when coming to a decision varies as a function of the complexity of the given task. The same result was later found by Timmermans (1993). Various authors have found that the format in which information is presented affects the processing of that particular information (Russo & Dosher, 1975; Bettman & Kakker, 1977). Moreover, Bettman and Zins (1979) found that information presentation affects consumer information processing. Benbasat and Dexter (1985) conducted an experiment to test for the influence of graphical and color-enhanced information presentation on decision-making. Their experimental design investigated the effects of report format, color and individual differences between subjects. They found that the use of color in reports influenced decision-making in general, and was more beneficial for graphical than tabular reports. The use of colors in reports is, of course, not directly linked to ambiguous bets. However, it does shows that the use of graphical and color-enhanced information presentation does influence decision-making, and this can be linked to the effect of different presentation forms of ambiguous bets.

More recently, Jiangyan et al. (2019) investigated the different Ellsberg urns that are used in experiments to measure ambiguity attitudes. By surveying 41 experimental studies, they differentiate between four different methods of ambiguity production. They found no significant differences in ambiguity attitudes towards these four methods of ambiguity production. Therefore, they suggest the employing method, as it is the least complicated and straightforward production method. The employing method is the most generally used method to produce the Ellsberg two color problem, in which the experimenter chooses the composition of the two colors. This composition is unknown for the participants.

2.4. Hypotheses Development

In this section several hypothesis are developed. Again, for more clarification; willingness to pay is the amount the subject is willing to pay for the particular task. Risk aversion is the difference between the expected value and the willingness to pay for the risky lotteries. Finally, ambiguity aversion is the difference between the willingness to pay for the risky lottery and the ambiguous lottery.

In line with earlier studies (Curley & Yates, 1985; Kahn & Sarin, 1998; Curley & Yates, 1989), ambiguity aversion is expected. It is expected that ambiguity aversions is shown across all treatments. As, it can be expected that subjects dislike betting on an event for which they do not know the probabilities. However, the work of Fox and Tversky (1995) suggests that decisions do depend on the source throughout uncertainty is presented. Moreover, multiple studies found that the format in which information is presented affects the decision-making process (Russo & Dosher, 1975; Bettman & Kakker, 1977). In addition, Payne (1976) showed that information processing when coming to a decision varies as a function of the complexity of the given task. It is unlikely that all presentation forms, presented in section 3.2, are perceived as equally difficult. This all leads to the following two hypotheses:

H1: There is ambiguity aversion across all treatments

H2: The level of ambiguity aversion varies between the different presentation forms

In a series of studies, investigators have shown a phenomenon later referred as the "illusion of control" (Langer, 1975). Illusion of control is the tendency of believing that people can control or influence outcomes that they demonstrably have no influence over (Langer, 1975). Moreover, when factors from skill situations (competition, choice, involvement) were introduced into chance situations, individuals were overconfident. Due to this phenomenon, it is expected that certain tasks in this study provide a higher willingness to pay compared to the other tasks used. In the Urn task, presented in section 3.2, it is stated that the subjects are to draw without looking a ball from the urn. The fact that the description states that the subjects are to imagine to draw the ball from the urn themselves, gives the respondents some sort of illusion of control. As, the chance of picking the right ball without looking is not higher when you draw the ball yourself. However, it is expected that this illusion of control does influence the willingness to pay. Empirical evidence supports this expectation. Langer (1975) found that subjects who selected a lottery ticket themselves ask higher selling prices than subjects who were assigned a ticket. In addition, Fellner (2004) conducted an experiment in which subjects were to invest in risky lotteries. Subjects invested substantially more in the lottery for which they could roll the die themselves, indicating that they were prone to illusion of control. Moreover, Davis, Sundahl and Lesbo (2000) found that casino bettors place riskier bids on their own dice rolls than on others. So, it is expected that illusion of control influences subjects' behavior. In line with this the following hypothesis is conducted:

H3: The Urn task provides the highest willingness to pay

Lusardi and Mitchell (2011) conducted an experiment in which they tested for financial literacy among Americans. They found that financial illiteracy is widely spread among Americans. This suggest that financial issues are complex for a great deal of the population. As mentioned, information processing when coming to a decision varies as a function of the complexity of the given task. Therefore, it is expected that the stock price movement task is perceived as more difficult in comparison to the other tasks. It is expected that subjects do not like to bet on matters they do not quite understand. Moreover, Heath and Tversky (1991) conducted an experiment comparing subject's willingness to bet on their uncertain beliefs with their willingness to bet on clear situations. They found that subjects were more willing to bet on situations where they felt more competent or knowledgeable. For example, subjects who were selected for their knowledge on politics and lack of knowledge about football, preferred betting on political events rather than on other chance events they considered equally likely to occur. The same subjects preferred betting on chance events rather than on football events that they considered equally likely to occur. So, Heath and Tversky (1991) argue that knowledge about certain events influences the willingness to bet on these ambiguous events. It can be expected that the subjects feel more comfortable with a urn or a spinner than with a stock price movement (Lusardi & Mitchell, 2011). Therefore, it is expected that the stock price movement task provides the lowest willingness to pay. In addition, several studies found that ambiguity aversion could explain portfolio puzzles. As, stock returns are seen as ambiguous (Bossaerts et al., 2010; Cao, Wang & Zang, 2005; Easley & O'Hara, 2009). Moreover, the difference between the stock price movement task and the coin flip is most obvious comparing to the other tasks (Fox & Tversky, 1995). As, the coin flip is extremely clear and the stock price task is most ambiguous. Therefore the following two hypotheses are constructed:

H4: The stock price movement task provides the lowest willingness to pay

H5: The stock price treatment provides the highest ambiguity aversion.

The coin flip used in the temperature task can be regarded as a truly random event. However, betting on tomorrow's temperature can be seen as the same. As, the respondents have absolutely no illusion of control for betting on tomorrow's temperature. Although for all treatments ambiguity aversion is expected. It can be expected that the difference in willingness to pay for bet A (coin flip) and bet B (betting on the temperature) is the smallest across all treatments. Therefore, the following hypothesis is formulated:

H6: The temperature treatment provides the lowest ambiguity aversion.

The correlation between risk and ambiguity attitude is well documented. As, it can provide descriptive modeling of decisions under uncertainty. Tversky and Kahnemann (1992) stated that decision-making is a product of, among other things, of both risk attitudes and ambiguity attitudes. Moreover, Brown et al. (2010) found that risk and ambiguity cannot be separated when making decision under uncertainty. Many studies showed evidence for a positive correlation between risk aversion and ambiguity aversion. Ghosh and Ray (1992) conducted an experiment in which they analyzed the relationship between risk and ambiguity attitudes and the decisions taken by the subjects. The results supported their hypothesis; both ambiguity and risk attitudes affect decision-making behavior. In addition, they found that less risk averse subjects had more tolerance regarding ambiguity. Moreover, Bossaerts et al. (2010) and Charness and Gneezy (2010) report that ambiguity seeking subjects held more risky portfolios. More Specifically, Abdellaoui et al. (2011) and Dimmock et al. (2012, 2013) found evidence for a positive correlation when risk and ambiguity attitude are tested in two different tasks for the same person. This method is similar to the method used in this study to conduct risk and ambiguity attitudes. So, it is hypothesized that subjects who are being less risk averse show a lower ambiguity aversion than subjects who are more risk averse. As, less risk averse subjects had more tolerance for ambiguity. Therefore, the difference between the risky and ambiguous bet should be smaller than for more risk averse subjects. in line with this the following hypothesis is conducted:

H7: Relatively less risk averse subjects provide a lower ambiguity aversion than relatively more risk averse subjects

3. Experimental Design

In this section the research method is presented. The entire survey is constructed and distributed through Qualtrics.

3.1. Risk Preference Measure

The table below shows the risk preference measure that will be used. This measure is based on the work of Eckel and Grossman (2008) and Engle-Warnick et al. (2007). The subjects are instructed to select exactly one of the five options. Each option is characterized by two payoffs with the same probabilities. Choice 1 shows a certain payoff of 26,00 euro. Where choice 5 provides a low payoff of 2,00 euro with a 50% probability and a high payoff of 62,00 euro with a 50% probability. As can be seen, the variance in the payoffs increases as we move from choice 1 to 5. As well as the expected payoff from each option. As, the expected payoff for option 1 is obviously 26 euro. For option 2 it is 27,50 euro, option 3 is 29 euro, option 4 is 30,50 euro and the final option has an expected payoff of 32 euro[1].

Table 1, Gamble options, expected payoffs, and risk

Option	*Event*	*Probability (50%)*	*Payoff*	*Expected payoff*	*Risk*[a]
1	A	50	26	26	0
	B	50	26		
2	A	50	20	27.50	7.50
	B	50	35		
3	A	50	14	29	15
	B	50	44		
4	A	50	8	30.50	22.50
	B	50	53		
5	A	50	2	32	30
	B	50	62		

[a] *Risk is measured as the standard deviation of the expected payoff.*

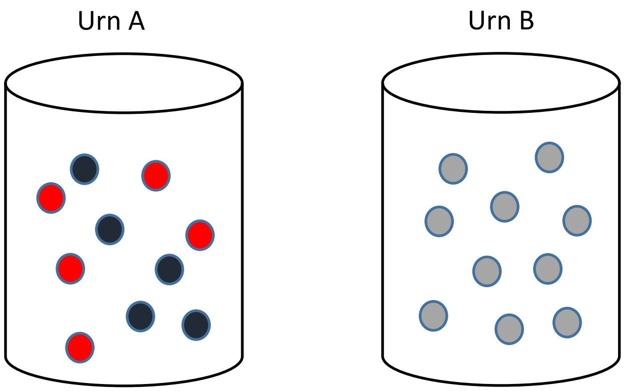
The measure is kept as simple as possible, as complexity could influence the experiment. It is assumed that subjects who would pick the more downwards options are relatively less risk averse. With every step the expected payoff increases with 1,50 euro. In addition, with every step the standard deviation increases with 7,50. Therefore, we can say that the gamble numbers are linearly related to the properties of the gambles (expected return and variance). How the risk task is presented in the survey is shown in Appendix 8.1.5.

[1] Option 2: 0,5*20 + 0,5*35 = 27,5. The same calculation is conducted for every option

3.2. Ambiguity Preference Measure

To investigate whether different presentation forms of ambiguous bets have an effect on decision-making under uncertainty, an experiment is implemented in which the participants will be completing several hypothetical problems. An example of such a task (the Urn task) is provided below. The description of the task is based on the work of Fox and Tversky (1995).

Imagine *the following two Urn (Urn A and Urn B). Urn A is exactly filled with 5 red balls and 5black balls. Urn B is exactly filled with 10 balls that are red or black. However, you do not know the proportion of red and black balls. Suppose that you can play the following game: without looking you are to draw a ball from one of the two urns (again stated below). If you draw a* ***RED*** *ball you will receive* ***1000 euro****. How much are you willing to pay for both Urns (state your answer between 0 – 100 euro).*

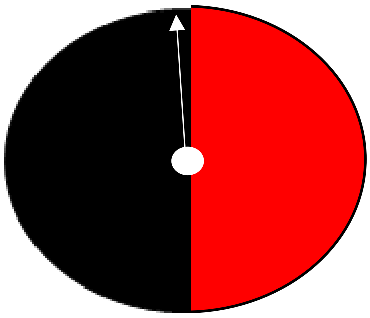


How much are you willing to pay to play for Urn A?……..
How much are you willing to pay to play for Urn B?……..

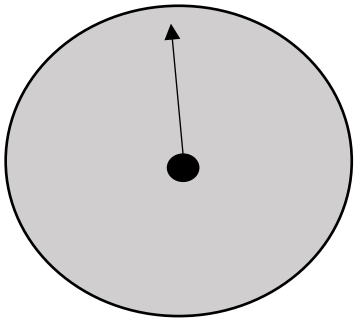
So, the right Urn is ambiguous in the sense that the outcomes of drawing either a red or a black ball is unknown. This paper extends existing literature by taking in different presentation forms within one experiment. Therefore, the same payoffs from the task above are used to construct the task below.

Imagine *a game with the following two spinners. You will receive* ***100 euro*** *if the spinner stops on* ***Red.*** *For the left spinner the black and red parts are* ***equally*** *big. This means that spinner has the same chance on stopping on the black part and on the red part. The right spinner shows only a grey part. However, below this grey part there are also red and black parts. However, you do not know how big the red or black parts are. This means that you do not know the chance of spinning red or black. Now, Please state how much you are willing pay to play this game. Again, there are no wrong answers, state the answer you are most comfortable with. (state your answer between 0 – 100).*

Spinner A



Spinner B



How much are you willing to pay to play the left game?……

How much are you willing to pay to play the right game?……

In both task 1 and task 2 the probabilities and the payoffs of the gambles are the same. Also, the question "*How much are you willing to pay…"* is exactly the same. The difference between the two tasks lies in the presentation form. With rational subjects one would expect that the amount willing to pay for the gambles is equal. However, it could be the case that the change in presentation does influence the amount willing to pay.

Thirdly, another alternation on task 1 is created. Again the respondent is shown two betting options. Firstly, the respondent is to state how much he/she is willing to pay for betting on a coin flip. Which has by definition a 50/50 probability distribution. This is in line with bet A for both task 1 and 2. Secondly, the respondent is to state how much he/she is willing to pay for betting on tomorrow's temperature. Again. bet A provides a betting game with known probabilities. bet B is ambiguous in the sense that the probabilities of the temperature being an odd/even number are unknown.

Imagine *you can bet on a coin flip* ***(Bet A)****. You will receive* ***100*** *euro if the coin lands on tails. But, you will receive* ***0*** *if the coin lands on heads.*

Now ***imagine****, You can bet* ***(Bet B)*** *on the tomorrow's temperature being an even number (for example, 18,20 or 22) or an odd number (for example, 19,21 or 23). You will receive* ***100*** *euro if the temperature is an even number. You will receive* ***0*** *if the temperature is an odd number. However, the probabilities are unknown. So, the probability of the temperature being an even number tomorrow is unknown. The probability of the temperature being an odd number tomorrow is also unknown.*

Please state how much you are willing pay to play both bets. Again, there are no wrong answers, state the answer you are most comfortable with. (state your answer between 0 – 100).

How much are you willing to pay to play Bet A? ……

How much are you willing to pay to play Bet B?……

Finally, an alteration to task 3 is created. Again, firstly the respondent is to state how much he/she is willing to pay for betting on a coin flip. Secondly, the respondent is to state how much he/she is willing to pay for betting on a stock price movement. In addition, a probability function for both bet A and bet B are provided.

Imagine *you can bet on a coin flip* ***(Asset A)****. You will receive* ***100*** *euro if the coin lands on tails. But, you will receive* ***0*** *if the coin lands on heads.*

Now ***imagine*** *you can bet on a stock price* ***(Asset B)*** *movement. You will receive* ***100*** *euro if the stock price increases. However, you will receive* ***0*** *if the stock price decreases. The stock has an unknown probability to increase and an unknown probability to decrease. This again is shown below, where asset A has a probability of 50% of giving you 100 euro and 50% of giving you 0. Asset B has an unknown probability of giving 100 euro and an unknown probability of giving 0.*

Please state below how much you are willing to pay to play both bets. Again, there are no wrong answers, state the answer you are most comfortable with (state your answer between 0 – 100).

Asset A: (100, 50% ; 0, 50%)
Asset B: (100, ? ; 0, ?)

How much are you willing to pay to play Bet A……?
How much are you willing to pay to play this Bet B……?

Basically, the idea behind this experimental design is that different presentation forms are likely to influence ambiguity attitude, as complexity and personal preferences play a role. Furthermore, it is likely that the willingness to pay differs between the different presentation forms. The difference between the two valuations is used as the ambiguity measure. Meaning that a greater difference between option A and option B within a task, would provide a higher ambiguity aversion.

3.3. Treatment Design

In total four different presentation forms of ambiguous bets are presented. In addition, a risk preference measure is developed. Four treatments are created, one treatment for every presentation form. Firstly, the subjects are confronted with the introduction, providing some general information about the survey. Secondly, the subjects are confronted with one of the ambiguity measure tasks. Then, every subjects, independently of which treatment, is to answer the risk preference task. Finally, all respondents are to answer several control and financial literacy questions. Financial literacy is the ability to understand and solve certain financial problems (Lusardi & Mitchell, 2011). The treatments will be distributed randomly and evenly across the subjects.

Finally, it is also possible to elicit to risk measure from option A from the ambiguity preference measure. As, a willingness to pay below 50 would suggest that the subject is risk averse. The same for a willingness to pay above 50, which suggest risk seeking behavior. However, a separate risk measure is chosen, because it could be possible that the subjects are influenced by the second option in each ambiguity measure (Fox & Tversky, 1995). Therefore, retrieving the risk measure from this task could be biased.

4. Experimental Results

This section will cover the results of this study. Firstly, it will mention some short descriptive statistics on which it will continue on testing for differences in willingness to pay and ambiguity aversion between the treatments. Finally, a regression analysis is performed.

To test for differences between and within treatments. Mostly, a Wilcoxon signed-rank test is used. This is a non-parametric statistical test to compare samples to assess whether their population mean ranks differ. This test is used as an alternative to the paired t-test when the results are not normally distributed (Gehan, 1965). In addition, the Wilcoxon ranksum test ignores outliers, therefore it is extremely useful for data collected from a survey. As, survey results often contain strange values.

4.1. Descriptive Results

A total of 260 subjects participated in the online survey of which 137 are male participants and 123 are female participants. The average age of subjects was 21,3. Almost 65 percent of the subjects were students, being the largest subgroup. The questionnaire was distributed randomly and evenly resulting in a final division of 65 participants assigned treatment 1, 71 assigned treatment 2, 63 assigned treatment 3 and 60 assigned treatment 4. Table 2 shows the proportion and frequencies of the various variables.

Table 2, demographic statistics

	All subjects (N=260)	*Male (N=137)*	*Female (N=123)*
Age	21.3	22.66	19.85
Investment knowledge	3.89	4.52	3.20
Statistical Skills	4.63	4.89	4.33
Employment status			
Employed	83 (31.9%)	55 (40.2%)	28 (22.8%)
Unemployed	3 (1.2%)	2 (1.5%)	1 (0.8%)
Self employed	4 (1.5%)	1 (0.7%)	3 (2.4%)
Student	168 (64.6%)	77 (56.2%)	91 (73.9%)
Retired	2 (0.8%)	2 (1.5%)	0 (0.0%)
Completed education			
No education	0 (0.0%)	0 (0.0%)	0 (0.0%)
Primary education	1 (0.38%)	1 (0.7%)	0 (0.0%)
High school	56 (21.5%)	20 (14.6%)	36 (29.3%)
Bachelor's degree	137 (52.7%)	80 (58.4%)	57 (46.3%)
Master's degree	63 (24.2%)	34 (24.8%)	29 (23.6%)
Doctorate	3 (1.2%)	2 (1.5%)	1 (0.81%)
Risk taking (S.D.)	5.22 (1.94)	5.66 (1.85)	4.72 (1.93)
Understandability (S.D.)	3.72 (0.93)	4.04 (0.80)	3.37 (0.94)

There are little worth mentioning differences between men and women. With the exception that men had a higher understandability of the survey (z = 5.83, p-value < 0,01). In addition, men tend to be more risk taking in general than women (z =3.93, p-value < 0,01). Finally, financial literacy was tested, in total 128 (roughly 49%) subjects answered all three financial literacy questions correctly, 87 (roughly 34%) subjects got 2 correct answers, 39 (15%) subjects got 1 correct answer and only 6 (roughly 2%) subjects answered all three questions incorrectly.

4.2. Risk Preference Measure

The number of subjects choosing the different gamble options is demonstrated in table 3 and figure A1. This task tested the risk preference for the subjects using 5 risky lotteries, 1 being the most risk averse, 5 being the most risk seeking. The mean gamble choice across all subjects is 2,44; the median gamble was 2. Men were significantly less risk averse than women; roughly 26 percent of the men, but only 4 percent of the women, selected the riskiest gamble. Moreover, there were almost twice as much women, 47 vs. 25, who selected option 1. Moreover, men had a significantly higher mean than women (z= 5.44, p-value < 0.01).

Table 3, Gamble choice by sex

Gamble	*All Subjects (%)*	*Male (%)*	*Female (%)*
1	72 (29.0)	25 (18.3)	47 (38.2)
2	94 (37.9)	43 (31.4)	51 (41.5)
3	44 (17.7)	28 (20.4)	16 (13.0)
4	9 (3.6)	5 (3.7)	4 (3.3)
5	41 (16.5)	36 (26.3)	5 (4.1)
Total	260 (100)	137 (100)	123 (100)
Mean (S.D)	2.44 (1.35)	2.88 (1.46)	1.93 (1.01)

In addition, a regression is conducted to understand the effect of various factors to the risk preference measure. Figure 1 shows the results from this particular regression. In section 4.2 it was already mentioned that males and females behave differently in the risk preference task. Following this, from this regression a significant results was found for the independent variable 'sex'. Sex in this regression is used as a dummy variable (male = 0, female = 1). Meaning that a negative significant coefficient suggest that females are relatively more risk averse than males. This result is in line with earlier conducted studies (Powell & Ansic, 1997; Byrnes & Miller, 1999; Charness & Gneezy, 2007). Moreover, it can be seen that only the 'risk taking' variables shows a significant result. This variable was conducted by simply asking how risk averse or risk seeking the subjects are in general, not conducted from the risk measure task. This was expected, as subjects being more risk seeking in general are expected to be less risk averse in the risk preference task.

Table 4, OLS regression on risk preference

	Model
Female	-0.64***
	(0.001)
Age	0.04
	(0.616)
Education	0.14
	(0.254)
Employment	0.01
	(0.829)
Investment know	0.08
	(0.205)
Statistical skills	0.08
	(0.261)
Risk taking	0.08*
	(0.056)
Understanding	0.05
	(0.598)
Financial Literacy	0.03
	(0.840)
_cons	1.34*
	(0.097)
N	260
adj. R^2	0.150

p-values in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

4.3. Testing Hypotheses

The results are organized in different parts in order to structurally test the different hypotheses.

4.3.1. Ambiguity Aversion

Finding the possibility of ambiguity aversion, the subjects were to state their willingness to pay for both the risky and ambiguous bet. To determine any difference in willingness to pay between the risky and the ambiguous bet multiple Wilcoxon ranksum tests have been conducted. This leads to the results presented in the following table:

Table 5, mean willingness to pay

	Risky Bet	*Ambiguous Bet*	*Difference*
Urn Treatment	€ 37.89	€ 21.74	€ 16.15 (1.98**)
Spinner Treatment	€ 39.21	€ 19.15	€ 20.06 (7.64***)
Temperature Treatment	€ 33.95	€ 32.92	€ 1.03 (0.24)
Stock price Treatment	€ 35.25	€ 20.73	€ 14.52 (2.84***)
All treatments	€36.58	€23.64	€12.94 (5.78***)

z statistics in parentheses

*Note: * p < 0,1; ** p < 0,05; *** p < 0,01*

From table 5 we can conclude that ambiguity aversion, although not significant for the temperature treatment, is found for all treatments. The mean willingness to pay for all treatments is presented in table 5. The right column shows the difference between the risky bet and the ambiguous bet per treatment. With the z-value in the parentheses. On average the subjects were willing to pay €36.58 for the clear bets and €23.64 for the ambiguous bets. When averaging all treatments, there is strong evidence for ambiguity aversion: subjects were willing to pay on average €12.94 more for the risky bet than for the ambiguous bet ($z = 5.78$, p-value $< 0{,}001$). Therefore, we cannot reject our fist hypothesis. This results is in line with earlier studies (Ellsberg, 1961; Curley & Yates, 1985; Hogart & Einhorn, 1990; Pulford & Colman, 2008), who all found ambiguity aversion in an experimental setting. More specifically, for the urn treatment subjects were willing to pay € 16.15 more for the risky bet than for the ambiguous bet. Comparing this results to Fox and Tversky (1995), who conducted a similar study; the difference is higher. Fox and Tversky (1995) found a difference of € 9.51. In addition, Fox and Tversky (1995) found a substantially lower willingness to pay, for both the risky and the ambiguous bet. Looking at the subject's preference, regardless of the willingness to pay, in total 85 (roughly 33%) subjects showed behavior suggesting ambiguity neutrality. Meaning, the willingness to pay was equal for the risky and ambiguous bet. 152 (roughly 58%) subjects showed ambiguity aversion, and only 23 (roughly 9%) subjects showed ambiguity seeking behavior. For the urn, spinner an stock price treatment only four subjects exhibited ambiguity seeking behavior; the willingness to pay for the ambiguous bet was higher than for the risky bet. This is in line with earlier studies, founding absolutely no evidence for ambiguity seeking behavior, for medium and large probabilities (Curley & Yates, 1985; Curley & Yates, 1989; Einhorn & Hogarth, 1986). However, for the temperature task 11 subjects, roughly 17%, of the subjects showed ambiguity seeking behavior. This result is quite surprising as earlier literature only found evidence for ambiguity seeking behavior for low probabilities in the gain domain (Einhorn & Hogarth, 1986; Kahn & Sarin, 1998; Curley & Yates, 1989).

It can be seen that there is quite some variation between the treatments in terms of willingness to pay between the risky bet and the ambiguous bet. These differences will be tested in the next section. The first results indicate that there are some differences in ambiguity aversion between the different treatments. Especially the temperature treatment shows different results.

4.3.2. Presentation Forms

As explained, this thesis complements existing literature by taking in different presentation forms of ambiguous bets. However, first of all the difference in willingness to pay for the risky bet is examined. Across all treatments, the willingness to pay for the risky bets is seems to be roughly the same (S.D. = 2.4). Furthermore, every treatment shows an average below €50, which suggest that on average the subjects are risk averse. A willingness to pay of €50 exactly suggest that a subject is risk neutral. As, the expected payoff of the risky bet is also €50. However, as mentioned, conducting the risk measure form this task could be biased. As, subjects are likely to compare the risky bet with the ambiguous bet. Comparing the different treatments in terms of willingness to pay for the risky bet leads to the results shown in the following table:

Table 6, willingness to pay, risky bet

	Urn Treatment	*Spinner Treatment*	*Temperature Treatment*	*Stock price Treatment*
Urn Treatment				
Spinner Treatment	0.26			
Temperature Treatment	-0.36	-0.76		
Stock price Treatment	-0.66	-1.01	0.28	

Wilcoxon ranksum tests to compare the different treatments in terms of willingness to pay for the risky bet

*Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$*

Table 6 shows multiple Wilcoxon ranksum tests to compare the different treatments. Z statistics are provided in the table. The hypothesis is that the urn treatment provides the highest willingness to pay. Already shown in table 5, the willingness to pay for the risky bet in the urn treatment was €37.89. In addition, table 5 showed that the willingness to pay for the spinner treatment was € 39.21. Suggesting that the spinner treatment provides the highest willingness to pay. However, table 6 shows no significant difference between the different treatments. Therefore we should reject the hypothesis.

Table 5 shows that the mean willingness to pay for the risky bet in the temperature task is lowest; € 33.95. Assuming that the subjects behave according to the comparative ignorance hypothesis, in which the subjects evaluate risky and ambiguous bets together (Fox & Tversky, 1995). The risky bet in the temperature task is valued as least attractive compared to the other treatments. The risky bet in the stock price treatment is similar to the temperature treatment, a coin flip. Therefore, the coin flip compared to betting on a stock price movement is perceived as more attractive than betting on tomorrow's temperature. However, the willingness to pay for the risky bet for the stock price treatment and temperature treatment show no significant difference ($z = 0.28$, p-value > 0.1, Ns.). Moreover, the mean willingness to pay for the risky bet for the temperature treatment is not significantly lower than the other treatments combined ($z = - 0.37$, p-value > 0.1, Ns.).

So, there is no significant difference between the highest willingness to pay and the lowest willingness to pay for the risk bet. Suggesting that the mean willingness to pay for the risky bets seems to be stable across all treatments. It is quite surprising that the willingness to pay for the risky bet is stable across the different treatments. It was expected that due to illusion of control the urn treatment would provide a higher willingness to pay. However, although not explicitly stated, the illusion of control in the spinner treatment is likely to had a great influence. Moreover, the small difference in willingness to pay could suggest that illusion of control does not have a great influence in an experimental setting.

In line with the willingness to pay for the risky bet, the willingness to pay for the ambiguous bet is likely to be different between treatments. It was expected that the stock price movement task would provide the lowest willingness to pay (Bossaerts et al., 2010; Cao, Wang & Zang, 2005; Easley & O'Hara, 2009). Again, for comparing the different treatments in terms of willingness to pay for the risky bet. Multiple Wilcoxon ranksum tests have been conducted, leading to the following results:

Table 7, willingness to pay, ambiguous bet

	Urn Treatment	*Spinner Treatment*	*Temperature Treatment*	*Stock price Treatment*
Urn Treatment				
Spinner Treatment	-1.3			
Temperature Treatment	2.94***	3.86***		
Stock price Treatment	-0.43	0.60	-3.15***	

Wilcoxon ranksum tests to compare the different treatments in terms of willingness to pay for the ambiguous bet

*Note: * p < 0.1; ** p < 0.05; *** p < 0.01*

Table 7 shows Wilcoxon ranksum tests to compare the different treatments. Z statistics are provided in the table. Firstly, we should reject the hypothesis. As was uncovered in table 5, the spinner treatment provides the lowest willingness to pay for the ambiguous bet. Table 5 shows that the mean willingness to pay for the ambiguous for the spinner treatment is € 19.15. Comparing the spinner treatment to the other treatments, only a significant difference was found to the temperature treatment (z = 3.86, p-value < 0.01).

Table 5 already showed that the willingness to pay for the ambiguous is highest for the temperature treatment; € 32.92. This is a significantly higher mean willingness to pay than for the other treatments combined (z = 4.055, p-value < 0.01). Moreover, table 7 shows that the willingness to pay for the ambiguous bet in the temperature treatment is significantly higher than the willingness to pay in the other treatments separately. These results suggest that the ambiguous bet in the temperature treatment is perceived as more attractive than the ambiguous bet in the other treatments. Again, illusion of control could play a role in this matter. Betting on tomorrow's temperature and a coin flip could be perceived as equally attractive, as illusion of control plays no role in both situations. This could explain the fact that the willingness to pay for the ambiguous bet is significantly higher in the temperature treatment than in the stock price treatment. The coin flip in the stock price treatment could provide a higher illusion of control than betting on a stock price movement. Whereas, betting on a coin flip or tomorrow's temperature could be seen as equally random. Overall, the results show that especially the temperature treatment shows a significantly higher willingness to pay for the ambiguous bet. For the other treatments no significant differences are found.

Both willingness to pay for the risky bet and willingness to pay for the ambiguous are researched separately in previous sections. Now, ambiguity aversion as the difference between the willingness to pay for the risky bet and willingness to pay for the ambiguous bet is evaluated. It was hypothesized that the stock price treatment would provide the highest ambiguity aversion. As, the difference between the stock price movement task and the coin flip is most obvious, comparing to the other tasks. Assuming that the subjects behave according the comparative ignorance hypothesis (Fox & Tversky, 1995), comparing the extremely clear coin flip to the highly ambiguous stock task would provide the highest ambiguity aversion. In addition, it was expected that the temperature treatment would provide the lowest ambiguity aversion. Again, multiple Wilcoxon ranksum tests have been conducted, the z statistics are provided in the following table:

Table 8, ambiguity aversion

	Urn Treatment	*Spinner Treatment*	*Temperature Treatment*	*Stock price treatment*
Urn Treatment				
Spinner Treatment	1.97**			
Temperature Treatment	-4.82***	-6.44***		
Stock price treatment	-0.01	-1.99**	4.61***	

Wilcoxon ranksum tests to compare the different treatments in terms ambiguity aversion

*Note: * p < 0.1; ** p < 0.05; *** p < 0.01*

Table 8 shows that ambiguity is highest for the spinner treatment. The spinner treatment shows a significantly higher ambiguity aversion compared to the other treatments combined (z = 4.32, p-value < 0.01). In addition, the results uncover that the spinner treatment has a significantly higher ambiguity aversion compared to the other treatments separately. Therefore, we should reject the hypothesis that the stock price treatment would provide the highest ambiguity aversion. The fact that the spinner treatment shows the highest willingness to pay for the risky bet and the lowest willingness to pay for the ambiguous. Indicates that the risky bet in this treatment is perceived as most attractive compared to the ambiguous bet. If the subjects behave according the comparative ignorance hypothesis (Fox & Tversky, 1995). Reasoning could be that the perception of illusion of control is highest in this treatment. However, if this was entirely the case one would expect that the ambiguous spinner would still provide a higher willingness to pay, than for example the stock price task.

Table 4 already showed that the ambiguity aversion for the temperature treatment is the lowest. Table 8 shows that this is significant when comparing to the other treatments. In addition, the temperature treatment was tested against all other treatments combined (z = -6.34, p-value < 0.01). So, There is sufficient evidence to reject to null hypothesis. Although it was expected that the temperature treatment would provide the lowest ambiguity aversion, it is surprising that there is no significant evidence for ambiguity aversion at all. Earlier studies using different presentation forms of ambiguous situations all found evidence for ambiguity aversion. Curley and Yates (1985) found ambiguity aversion using paired lotteries. Hogarth and Eindhorn (1990) found ambiguity aversion using ambiguous urns. Further, Fox and Tversky (1995) found ambiguity aversion, in a comparative situation, for natural events. Similar to Heath and Tversky (1991). So, it is remarkable that the temperature treatment shows no evidence for ambiguity aversion.

4.4. Regression Analysis

To determine which variable demonstrate the most influence on ambiguity aversion. A regression was conducted using the risk preference measure and the control variables as independent variables; model 1 in the regression. For the second and third regression an interaction term has been included.

Firstly, an interaction variable on investment knowledge is included. As mentioned before stock returns are seen as ambiguous (Bossaerts et al., 2010; Cao, Wang & Zang, 2005; Easley & O'Hara, 2009). Therefore, it was expected that the stock price treatment would show the highest ambiguity aversion. In addition, Heath and Tversky (1995) argue that subjects are willing to pay more for matters they feel more comfortable with. So, although investment knowledge does not have a significant coefficient for the whole sample. It could be that investment knowledge does have a significant coefficient for the stock price treatment. Therefore, an interaction term is created, 'investment knowledge*stock price treatment'. This regression is shown as model 2 in table 10.

Secondly, an interaction variable on financial literacy is included. Again, it is likely that investment knowledge influences willingness to pay for the stock price treatment. However, the first interaction term was created self-stating investment knowledge. Now, financial literacy is used as a more objective way to capture investment knowledge. The interaction term created is "Financial literacy * stock price treatment". The regressions are shown in the following results shown in table 9.

Table 9, OLS regression on ambiguity aversion

	Model 1	Model 2	Model 3
Risk preference	0.18	0.14	0.23
	(0.875)	(0.902)	(0.846)
Female	1.66	1.28	1.13
	(0.628)	(0.709)	(0.742)
Age	0.26	0.08	0.17
	(0.871)	(0.960)	(0.914)
Education	3.46	3.71*	3.56
	(0.117)	(0.094)	(0.106)
Employed dummy	-6.22*	-6.29*	-6.33*
	(0.099)	(0.095)	(0.092)
Investment know	1.83	1.54	1.71
	(0.132)	(0.214)	(0.158)
Statistical skills	-0.25	-0.34	-0.34
	(0.850)	(0.795)	(0.797)
Risk taking	2.46***	2.55***	2.48***
	(0.002)	(0.001)	(0.002)
Understanding	-2.55	-2.70	-2.77
	(0.174)	(0.151)	(0.140)
Financial literacy	-3.41	-3.71	-5.35*
	(0.253)	(0.214)	(0.094)
Interaction variable 1		0.99	
		(0.217)	
Interaction variable 2			7.92*
			(0.095)
_cons	-10,02	-8,94	-7.93
	(0.468)	(0.517)	(0.565)
N	260	260	260
adj. R^2	0.048	0.049	0.054

p-value in parentheses

*Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$*

First of all, we should reject the hypothesis; relatively less risk averse subjects provide a lower ambiguity aversion than relatively more risk averse subjects. As, the regression shows a non-significant positive coefficient, suggesting that relatively less risk averse subjects show a higher ambiguity aversion. So, no clear correlation between risk attitude and ambiguity attitude is found. However, earlier literature found a positive correlation between risk aversion and ambiguity aversion when risk and ambiguity attitudes are tested in different tasks for the same person (Abdellaoui et al., 2011; Dimmock et al., 2012). In addition, Ghosh and Ray (1992) found that less risk averse subjects had more tolerance regarding ambiguity. The results are in line with Hogarth and Einhorn (1990), who found no correlation between ambiguity attitude and risk attitude.

In contrast to the risk preference measure, general risk taking is found significant. Risk taking shows a positive significant coefficient. Suggesting that subjects who are willing to take more risk in general show a higher ambiguity aversion. This is quite surprising, as earlier literature found that less risk averse subjects are more tolerant towards ambiguity (Ghosh & Ray, 1992; Abdellaoui et al., 2011; Dimmock et al., 2012). However, additional regressions on willingness to pay show that less risk averse subjects are willing to pay more for both the risky and the ambiguous bet. The regression is presented in the appendix; table A1. So, the significant positive coefficient of risk taking on the willingness to pay for the ambiguous bet shows that less risk averse subjects do have more tolerance for ambiguity. However, given the fact that the coefficient is stronger and of greater significance for the willingness to pay for the risky bet. Ambiguity aversion is greater for less risk averse subjects. However, it is remarkable that risk preference conducted from a risk measure task using risky lotteries shows a factor that is far from significant. And that asking for risk taking in general provides a highly significant coefficient.

Although not significant, the gender variable suggest that women show a higher ambiguity aversion than men. As mentioned, it is well documented that men are in general more risk seeking than women (Powell & Ansic, 1997; Byrnes & Miller, 1999; Charness & Gneezy, 2007). In addition, Charness and Cneezy (2007) found that women invest less, and thus seem to be more financially risk averse than men. Furthermore, Schubert et al. (2000) found that women tend to be more ambiguity averse than men in an investment context. The same result was found by Powell et al. (2002). So, our results are not in line with earlier conducted studies.

A dummy has been made to capture the ‘employment’ variable in the regression (employed = 1, unemployed = 0). A significant negative coefficient is found for the dummy variable. Indicating that employed subjects exhibit a lower ambiguity aversion. A reasoning could be that employed subjects have a higher income and are therefore willing to take more risks when betting on an ambiguous event. In addition, relatively speaking 100 euro is less for the employed subjects than for the unemployed subjects. However, it must be said that this willingness to pay is set in an experimental setting. So, it is hard to determine whether having an actual higher income is linked to the willingness to pay in this experiment.

We can speak of an interaction effect when the effect of an independent variable on the dependent changes, when considering the values of another independent variable. So, in this regression an interaction effect would occur if the effect of investment knowledge on ambiguity aversion changes when we only consider the stock price treatment. Model 2 shows that the interaction term has a positive sign, suggesting that subjects who rated their investment knowledge higher than the average population showed a higher ambiguity aversion. However, the interaction does not provide a significant coefficient and therefore the effect of investment knowledge on ambiguity aversion does not depend on the stock price treatment. A significant negative effect was expected as subjects who feel more comfortable with financial matters were willing to pay more for the stock price task (Heath and Tversky, 1995) and therefore exhibit a lower ambiguity aversion.

Financial literacy in model 1 shows no sign of significance. It was expected that the effect of financial literacy on ambiguity aversion depends on the stock price treatment. Model 3 shows that the interaction term, "financial literacy * stock price treatment" does show a positive significant coefficient. Implying that financial literate subjects exhibit a higher ambiguity aversion when considering the stock price treatment. This results suggest that more financial literate subjects are either willing to pay more for the risky bet and/or are willing to pay less for the ambiguous bet. To check for this, an additional regression on the willingness to pay with the interaction term is conducted and presented in the appendix. The interaction term shows no significant results in the regressions. However, the coefficients suggest that financial literate subjects are willing to pay more for the risky bet and less for the ambiguous bet when considering the stock price treatment. So, the results are contrary to our expectations; that financial literate subjects are willing to pay more for the stock price task.

Finally, financial literacy was not significant in model 1, but converts to a slightly significant variable in model 3. This is due to the inclusion of the interaction term, in which financial literacy is captured. The change in significance is probably due to the correlation between 'financial literacy' and the interaction term 'financial literacy * stock price treatment'.

5. Discussion

The preceding results have shown that there is evidence for ambiguity aversion in three of the four treatments that were distributed; the urn, spinner and stock price treatment all show evidence for ambiguity aversion. These findings are line with earlier conducted research (Curley & Yates, 1985; Kahn & Sarin, 1998; Hogarth & Einhorn, 1990; Fox & Tversky, 1995; Pulford & Colman, 2008). Overall, there is no prove that the subjects did perform the comparison between the clear bet and the ambiguous bet. However, comparing the results to earlier conducted work by Fox and Tversky (1995); the results do suggest that the risky bet was compared to the ambiguous bet.

The urn treatment shows a mean willingness to pay of € 37.89 for the risky bet and € 21.74 for the ambiguous bet. Fox and Tversky (1995) conducted a similar study, but found considerably lower willingness to pay for both the risky bet and the ambiguous bet ($24.34 for the risky bet and $14.85 for the ambiguous bet). The description of the game is highly similar. However, there some differences. Firstly, the subjects were to guess a color themselves. Where as in this study, the subjects were given with a winning color. However, the illusion of control hypothesis (Langer, 1975) would suggest that choosing your own color would increase the willingness to pay. Secondly, the presentation of the urn itself differs in both. This study uses a graphical illustration of the urns, whereas Fox and Tversky (1995) use a table from to present the chips distribution. The difference in presentation could be the reason for the higher willingness to pay. Finally, the number of balls/chips is different. Fox and Tversky (1995) use a bag with 100 chips. Whereas this study uses an urn with 10 balls. According to Einhorn and Hogarth (1985), the amount of ambiguity is an increasing function of the number of distributions of the ambiguous bet. For example, for an ambiguous urn containing 100 red and black balls in an unknown distribution, there are 101 possible distributions possible, 0 red balls to 100 red balls. For an urn with 10 balls there are only 11 distributions possible. This suggest that the amount of perceived ambiguity is much lower. Although Pulford and Colman (2008) found similar levels of ambiguity aversion across different urn sizes, suggesting that ambiguity aversion is robust for urn size. The great difference in urn size between this study and the study conducted by Fox and Tversky (1995) could be the reason for the difference in willingness to pay.

It was expected that the urn treatment would provide the highest willingness to pay. As, the illusion of control (Langer, 1975) of picking a ball from the urn yourself was expected to influence the willingness to pay. However, although not significant, the results show that the risky bet for the spinner treatment is highest. Again, illusion of control (Langer, 1975) could play a role in these results. In the description of the spinner treatment it was not explicitly stated that the subjects were to imagine to play the spinner themselves. However, it could be interpret that the subjects were to imagine to play the spinner themselves. Then again illusion of control (Langer, 1975) could be the reason for the higher willingness to pay. The interpretation of playing the spinner themselves was probably high. In addition, it could be the case that playing a spinner would provide a higher illusion of control than picking a random ball from a urn. However, no significant results were found, therefore further research could provide more exclusion on this matter.

Furthermore, it was expected that the ambiguous bet for the stock price treatment would provide the lowest willingness to pay. As, stock returns are seen as ambiguous (Bossaerts et al., 2010; Cao, Wang & Zang, 2005; Easley & O'Hara, 2009). However, the results show that there is no significant difference between the willingness to pay for the ambiguous bet between the different treatments, the temperature treatment disregarded. The reason for the insignificant differences in willingness to pay for the ambiguous bet could be due to the comparative ignorance hypothesis (Fox & Tversky, 1995). This hypothesis states that ambiguity aversion occurs when subjects evaluate risky and ambiguous bets together, but diminish or even disappears when subjects evaluate those bets separately. Ambiguity aversion is almost always found in a within-subjects design, in which subjects are to compare risky and ambiguous bets, rather than a between-subjects design in which subjects evaluated each bet. So, it could be that the subjects in the within-subjects design do no pay great attention to the actual bets, but they compare the risky and ambiguous bet and base their willingness to pay on this comparison. However, if this was solely the case the temperature treatment should have behaved similar, and it is clear that this treatment provides significantly different results. Furthermore, although there is no significant difference in terms of willingness to pay, for both the risky and the ambiguous bet, between the spinner treatment and the stock price treatment. The spinner treatment provides a significantly higher ambiguity aversion. So, the within-subjects and between-subjects explanation could be reason for the small differences in willingness to pay, it does not explain the difference in ambiguity aversion.

The temperature treatment does not provide any significant evidence for ambiguity aversion. It was expected that the level of ambiguity aversion was lowest for this treatment. As, both a coin flip and betting on tomorrow's temperature could be seen as truly random events. In contrast to the other treatments, in which illusion of control could play a role, betting on a temperature is likely to be seen as completely random. On the other hand, one could argue that due to this complete randomness of betting on a temperature, this could be seen as more ambiguous, and that the difference between the risky and the ambiguous is more obvious compared to the other treatments. Therefore, it should be expected that the ambiguity aversion is highest for this treatment. Comparing the stock price treatment and the temperature treatment, the risky bet is the same for both treatments and the ambiguous bet differs. Following the comparative ignorance hypothesis, it is likely that the difference in ambiguity aversion is due to the comparison between the risky and the ambiguous bet. This does suggest that the subjects evaluate both the coin flip and betting on the temperature as roughly equal. Moreover, the willingness to pay for the risky bet in the stock price treatment is, although not significant, higher in the stock price treatment than in the temperature treatment. Suggesting that the coin flip in the stock price treatment is perceived as more attractive in comparison to the stock price bet, than the coin flip compared to the temperature task.

Due to earlier literature (Tversky & Kahneman, 1992; Tymula et al., 2012; Brown et al., 2010) it was expected that more risk averse subjects showed a higher ambiguity aversion than less risk averse subjects. Risk preference conducted from the risk preference measure had absolutely no significant effect on both the willingness to pay and ambiguity aversion. This results is quite remarkable, as it was expected that subjects who selected a more risky lottery would be willing to pay more for the risky bet. However, in addition to the risk preference task subjects were asked to state how risk taking they are in general. For this variable a highly significant positive coefficient was found for both willingness to pay for the risky bet and the ambiguous bet. In addition, more risk taking subjects exhibited higher ambiguity aversion. Although ambiguity aversion was positively related to more risk taking subjects. Subjects who are more risk taking were willing to pay for more the ambiguous bet. Which is in line with earlier literature (Ghosh & Ray, 1992), who found that less risk averse subjects had more tolerance for ambiguity. So, taking the risk preference from two separate tasks provides contrasting results. Reasoning could be that asking for risk taking in general and conducting the risk preference from a task would provide different results. As, risk attitude is proven to be different across domains (Weber, Blaus & Betz, 2002). However, one could argue that conducting risk preference from a lottery game would provide a closer related risk preference to the later presented risky and ambiguous bets, than just asking for risk taking in general. Overall our results show contracting evidence for the relationship between risk attitude and ambiguity attitude. In line with Hogarth and Einhorn (1990) no correlation between risk attitude and ambiguity attitude was found using the risk preference task. However, in line with Ghosh and Ray (1992) less risk averse subjects had more tolerance for ambiguity, when just asking for risk taking behavior in general.

6. Conclusion

Ramsey (1931) stated that measuring subjective probability seeks to use the degree of belief from preference by using expected utility theory. Later, Savage (1954) determined subjective probability from preferences between bets. The accepted term for this is ambiguity. These models were later challenged by Ellsberg (1961). He found that people have a preference for the known bet rather than the unknown bet. This behavior is inconsistent with the subjective expected utility theory. This phenomenon is now known as ambiguity aversion. This anomaly is later tested and found by several studies (Einhorn & Hogarth, 1985; Heath & Tversky, 1991; Bernasconi and Lommes, 1992; Fox and Tversky, 1995; Pulford & Colman, 2007).

This study continued on the work on ambiguity attitude by taking in different presentation forms of ambiguous bets. Finding differences between different presentation forms of ambiguous bets have been the main goal of this thesis. In this way, this study contributes to already existing by taking in different presentation forms of risky and ambiguous bets. In addition, the influence of risk preferences on willingness to pay and ambiguity attitude was tested. An online survey was distributed among 260 subjects. The survey confronted the subjects with a risk preference measure. Followed by the ambiguity attitude measure, where willingness to pay for risky and ambiguous lotteries had to be indicated.

The results showed a general tendency for ambiguity aversion. For three out the four treatments a significant difference was found between the willingness to pay for the risky bet and the willingness to pay for the ambiguous bet; ambiguity aversion. Firstly, the willingness to pay for the risky bet showed no significant differences across the treatments. Suggesting that the willingness to pay for the risky bet is quite robust. Contrary results were found for the willingness to pay for the ambiguous bet. Compared the other treatments, the willingness to pay for the ambiguous bet was significantly higher in the temperature treatment. Finally, different presentation forms of ambiguous bets do influence ambiguity attitude. The spinner treatment provides a significantly higher ambiguity aversion when being compared to the other treatments. Whereas for the temperature treatment no evidence for ambiguity aversion is found. The urn and stock price treatment seem to be quite similar in terms willingness to pay for the risky bet, willingness to pay for the ambiguous bet and ambiguity aversion.

This study holds limitations in generalizability. In total 260 participants were confronted with the investment tasks. So, on average only 65 subjects per treatment filled out the survey. In addition, the number of subjects was not evenly distributed among the four treatments. Furthermore, decision-making studies mainly focus on the behavior of individuals or multiple individuals in an experimental setting. This survey used can only cover a limited part of decision-making under uncertainty outside of an experimental setting. Therefore, a certain consideration has to be made when reflecting subjects behavior inside this survey to behavior in real life. Further, it could be argued that the different presentation forms did not differ enough to really test for variations in ambiguity attitude between different treatments. Furthermore, only around 50% of the subjects were able to answer all three literacy question correctly. Suggesting that the level of financial knowledge was not very high. Therefore, the survey could be too difficult for a great deal of the subjects. This is likely to have influenced the results. As, information processing is influenced by the complexity of the given task. For the spinner treatment it was not stated clear enough whether the subjects were to play the spinner themselves or that somebody else did it for them. This could have an influence on the willingness to pay. As, illusion of control could play a role in this. In addition, only preferences for 50-50 known risk urns with ambiguous urns with unknown numbers between 0 and 100 percent were tested in this study. Also other winning percentages could be used in comparing different treatments.

Uncertainty about the composition of an urn of balls or about the composition of a spinner is just one kind of missing information. This are just games in an experimental setting. It would be more interesting to test ambiguity attitude in other, more closely related to real world, domains. Some studies suggest that these other kinds of missing information about events make people hesitant to bet on the events (Weber, 2002). Furthermore, to really test for differences between different presentation forms, the comparative ignorance hypothesis has to be taken in. Fox and Tversky (1995) found ambiguity aversion in a comparative situation but this effect diminished or disappeared in a non-comparative situation. In addition, it could be interesting to combine the different presentation forms with the fact that the subjects are able to pick their own colors or stock. Therefore, it could be tested whether the illusion of control has a greater effect in certain presentation forms of ambiguous bets.

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8. Appendix

8.1. Survey

In this section screenshots of the actual survey are presented.

8.1.1. Introduction

Welcome!

First of all thank you for taking time to participate in this survey. Currently I am working on my thesis for the master Financial Economics at Radboud University. For my thesis I am conducting a study concerning investment decision-making. In this survey you will examine and judge 2 investments tasks. After, you will answer several general questions about age, gender, education etc.

This survey will take around 5 minutes. Your answers are important and strictly anonymous! In addition, there are no wrong answers, pick the answer you feel the most comfortable with.

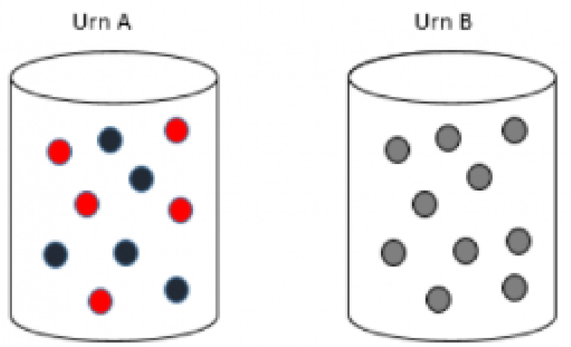
Again, thank you for your participation!

Kind regards,
Wouter Arts

8.1.2. Urn Treatment

Imagine you can play with the following two Urns (Urn A and Urn B). Urn A is exactly filled with 5 red balls and 5 black balls. Urn B is exactly filled with 10 balls that are red or black. However, you do not know the proportion of red and black balls. Suppose that you can play the following game: without looking you are to draw a ball from one of the two urns (again, stated below). If you draw a **RED** ball you will receive **100 euro**. However, you will receive **0** if you draw a black ball.

Please state how much are you willing to pay for both Urns. Again, there are no wrong answers, state the answer you are most comfortable with (state your answer between 0 – 100).



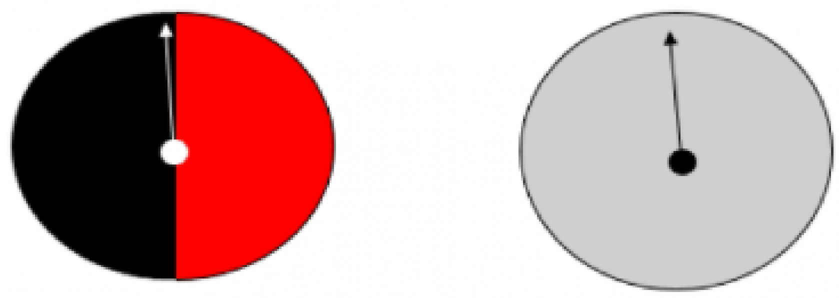
How much are you willing to pay to play for Urn A?

How much are you willing to pay to play for Urn B?

8.1.3. Spinner Treatment

Imagine a game with the following two spinners. You will receive **100 euro** if the spinner stops on **Red.** For the left spinner the black and red parts are **equally** big. This means that spinner has the same chance on stopping on the black part and on the red part. The right spinner shows only a grey area. However, below this grey area there are also red and black parts. However, you do not know how big the red or black parts are. This means that you do not know the chance of spinning red or black.

Please state how much you are willing pay to play this game. Again, there are no wrong answers, state the answer you are most comfortable with (state your answer between 0 – 100).



How much are you willing to pay to play the left game?

How much are you willing to pay to play the right game?

8.1.4. Temperature Treatment

Imagine you can bet on a coin flip **(Bet A)**. You will receive **100** euro if the coin lands on tails. But, you will receive **0** if the coin lands on heads.

Now **imagine**, You can bet **(Bet B)** on the tomorrow's temperature being an even number (for example, 18,20 or 22) or an odd number (for example, 19,21 or 23). You will receive **100** euro if the temperature is an even number. You will receive **0** if the temperature is an odd number. However, the probabilities are unknown. So, the probability of the temperature being an even number tomorrow is unknown. The probability of the temperature being an odd number tomorrow is also unknown.

Please state how much you are willing pay to play both bets. Again, there are no wrong answers, state the answer you are most comfortable with. (state your answer between 0 – 100).

How much are you willing to pay to play Bet A?

How much are you willing to pay to play Bet B?

8.1.4. Stock Price Treatment

Imagine you can bet on a coin flip **(Asset A)**. You will receive **100** euro if the coin lands on tails. But, you will receive **0** if the coin lands on heads.

Now **imagine** you can bet on a stock price **(Asset B)** movement. You will receive **100** euro if the stock price increases. However, you will receive **0** if the stock price decreases. The stock has an unknown probability to increase and an unknown probability to decrease.This again is shown below, where asset A has a probability of 50% of giving you 100 euro and 50% of giving you 0. Asset B has an unknown probability of giving 100 euro and an unknown probability of giving 0.

Please state below how much you are willing to pay to play both bets. Again, there are no wrong answers, state the answer you are most comfortable with (state your answer between 0 – 100).

Asset A:	(100, 50% ; 0, 50%)
Asset B:	(100, ? ; 0, ?)

How much are you willing to pay to play bet for asset A?

How much are you willing to pay to play bet for asset B?

8.1.5. Risk Preference Measure

Examine the following tables below. The tables show different investment payoffs with corresponding probabilities. Look at the 50% probability for the investment as a coin flip. For example for the **second** table shows a 50% probability of getting €20,00 and a 50% probability of getting €35,00. For a coin flip this would mean that you would receive €20,00 if it is, for example, heads and €35,00 if it is tails.

Pick the table/investment you would feel most comfortable with.

○

payoff		probability
€	26,00	50%
€	26,00	50%

○

payoff		probability
€	20,00	50%
€	35,00	50%

○

payoff		probability
€	14,00	50%
€	44,00	50%

○

payoff		probability
€	8,00	50%
€	53,00	50%

○

payoff		probability
€	2,00	50%
€	62,00	50%

8.1.6. Control Questions

What is your gender?

- Male
- Female

What is your age?

- under 18
- 18-24 years
- 25-34 years
- 35-44 years
- 45-54 years
- 55-64 years
- 65 years or older

What is your highest level of education you have **completed?**

- No education
- Primary education
- High school
- Bachelor's degree
- Master's degree
- Doctorate

What is your employment status?

- Employed
- Unemployed
- Self employed
- Student
- Retired

Rate your own knowledge in investment, compared to the average population

- Far below average
- Moderately below average
- Slightly below average
- Average
- Slightly above average
- Moderately above average
- Far above average

Rate your own statistical skills, compared to the average person

- Far below average
- Moderately below average
- Slightly below average
- Average
- Slightly above average
- Moderately above average
- Far above average

How willing are you to take risks?

Completely unwilling 0 1 2 3 4 5 6 7 8 9 10 Completely willing

Suppose you had $100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow?

- More than $102
- Less than $102
- Exactly $102
- Do not know
- Refuse to answer

Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year how much would you able to buy with the money in this account

- More than today
- Less than today
- Exactly the same
- Do not know
- Refuse to answer

Please tell me whether this statement is true or false. 'Buying a single company's stock usually provides a safer return than a stock mutual fund'

- True
- False
- Do not know
- Refuse to answer

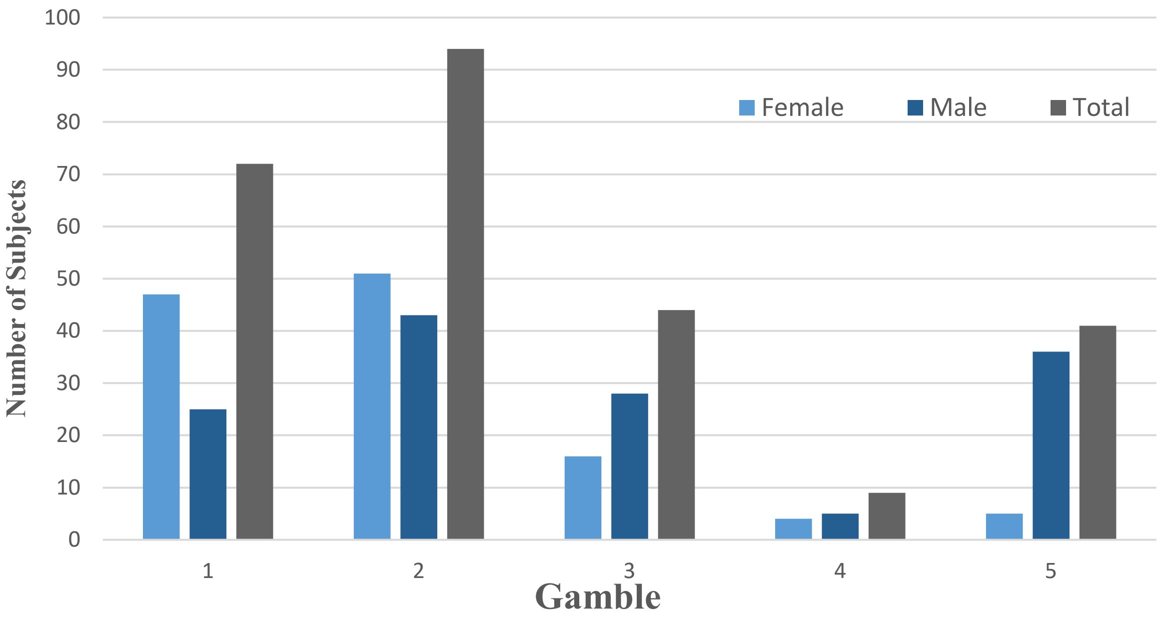
How well did you understand what to do and how to answer this survey?

- Did not understand at all
- I had quite some difficulties
- Understood somehow
- Understood well
- Everything was very clear

8.2. Additional tables

In this section additional tables are presented.

8.2.1. Figure A1, graphical illustration gamble choice by sex



8.2.2. Table A1, OLS regression on willingness to pay

	(1) Risky Bet	(2) Ambiguous Bet
Risk preference	-0.18	-0.42
	(0.894)	(0.719)
Female	-1.54	-2.91
	(0.699)	(0.395)
Age	-2.42	-2.75*
	(0.191)	(0.085)
Education	3.25	-0.19
	(0.199)	(0.930)
Employed dummy	1.17	-1.15
	(0.416)	(0.350)
Investment knowledge	1.63	-0.10
	(0.246)	(0.934)
Statistical skills	0.19	0.47
	(0.899)	(0.717)
Risk taking	4.11***	1.67**
	(0.000)	(0.033)
Understanding	-1.91	0.61
	(0.378)	(0.743)
Financial literacy	1.65	5.17*
	(0.630)	(0.080)
_cons	6.41	24.69*
	(0.710)	(0.097)
N	260	260
adj. R^2	0.091	0.020

OLS regression on both the risky bet and the ambiguous bet. p-value in parentheses

*Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$*

8.2.3. Table A2, OLS regression on willingness to pay with interaction term

	(1) Risky Bet	(2) Ambiguous Bet
Risk preference	-0.17	-0.39
	(0.900)	(0.735)
Female	-1.86	-2.99
	(0.641)	(0.384)
Age	-2.55	-2.73
	(0.174)	(0.093)
Education	3.33	-0.23
	(0.192)	(0.917)
Employed dummy	-3.13	3.20
	(0.472)	(0.393)
Investment knowledge	1.58	-0.13
	(0.261)	(0.915)
Statistical skills	0.14	0.47
	(0.929)	(0.718)
Risk taking	4.14***	1.65*
	(0.000)	(0.036)
Understanding	-2.12	0.65
	(0.330)	(0.730)
Financial literacy	-0.02	5.33
	(0.996)	(0.095)
Interaction variable 2	7.02	-0.90
	(0.201)	(0.849)
_cons	12.45	20.39
	(0.436)	(0.140)
N	260	260
adj. R^2	0.093	0.016

OLS regression on both the risky bet and the ambiguous bet (including interaction term). p-value in parentheses

*Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$*