Combining behavioural and health economics: the Allais paradox in the context of health

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Sofie Wouters
311265

Begeleider:
K.I.M Rohde

Abstract

This study is an effort in including the self-reflective view of behavioural economics into the field of health economics. With the use of the 'Allais paradox' modified for health outcomes, it is tested whether expected utility or rather a concept of psychological values should be used in modelling health-related human behaviour. Two experiments are conducted. The first experiment consists of a questionnaire with health-related trade-offs between different prospects, including the 'Allais questions' with health outcomes. With two binomial tests the predictions of both frequent and systematic violations of expected utility theory are confirmed. The second experiment consist of two additional 'treatment' questionnaires including three treatment questions in addition to the five health-related questions of the first experiment's questionnaire. The treatments account for a change of initial state of mind before answering the Allais questions by using the method of 'identity-salience'. A Pearson's chi-square test is used to measure the association between the treatments (gambler and investor) and the choices made in the Allais questions. The results of this experiment are not conclusive yet in confirming the validity of psychological values in the context of health due to a low number of subjects. Therefore the need for further research on the concept of psychological values in the context of health decisions involving risk is emphasized.

1. Introduction

In economics, human rationality is a commonly accepted assumption. Many models assume rational behaviour, and continue on modelling behaviour from this standpoint on. But what is actually meant by rationality? And is it a legitimate assumption? And if it is, how should it be described what a man has to do to be rational? Especially in the context of behaviour under risk, these questions have been raised by many economists over the past centuries.

For a long time, human rationality in the context of risk was explained with the idea of maximizing expected monetary values. In 1738, Daniel Bernoulli used this idea as a basis for his modification of the theory into maximizing expected utility based on his St. Peterburgparadox (Bernoulli, 1738). Expected utility theory has long been a leading theory. And still, many economists believe in the power of its explanation. However, not all do. In 1953 the French economist Maurice Allais published his famous work with many counterexamples against expected utility theory (Allais, 1953). His most famous example, nowadays known as "the" Allais paradox led him to propose a new concept of human decision making under risk: decision making based on the psychological value of a prospects. This concept in turn inspired Daniel Kahneman and Amos Tversky to publish their prospect theory in 1979 (Kahneman & Tvserky, 1979).

A distinguishable trend in this short history of economic theory is the constant search for flaws in the existing theories in order to get a higher understanding of actual behaviour. This trend led to the proposition of new ideas for modelling human behaviour. An important step in this respect is the proposition to include psychological factors into economic modelling. This idea has led to the origination of a new specialism in economics: behavioural economics.

Although this trend accounts for a critical self-reflection upon economic models and the underlying assumptions, it does not account for any final verdict yet. Therefore, it is important to maintain this critical self-reflective view, in order to get a step closer to actual understanding human behaviour. The intention of this study is to put an emphasis on the importance of this self-reflective behaviour in the field of economic research, rather than to come up with a final solution inasmuch which theory to use.

There is more to this intention though. In another upcoming field of economics, health economics, the trend of behavioural economics has not set in yet. In health economics, rational human behaviour is often explained with the use of expected utility theory, while there has not been much (critical, self-reflective) research on the scope of the validity of this

theory in the context of health decisions. The intention of this study therefore becomes to put an emphasis on the importance of self-reflective behaviour in the field of health economics to improve the modelling of human behaviour in the context of health decisions.

The current study will encourage the use of behavioural economics in the field of health economics by using the Allais paradox (an argument against expected utility theory and in favour of psychological values) in the context of health. The original paradox consists of two successive questions each containing two alternatives. Subjects are asked to choose one alternative in both questions. By comparing these choices, Allais' effort is to demonstrate that many subjects make irrational choices, when rationality is defined according to expected utility theory. Important to mention is that the questions are trade-offs between probabilities and particular monetary outcomes in the original Allais paradox. The current study will modify the monetary outcomes into health outcomes (remaining life years).

This study contains two experiments. In the first experiment the Allais paradox on health outcomes is tested. In the second experiment it is tested whether it is possible to manipulate subjects into making a rational or irrational choice (according to expected utility theory) by using the method of 'identity-salience', which will be explained later.

In the next section, a theoretical background of the Allais paradox is presented in order to give a comprehensive overview of the argument Allais presents. Next, the experimental design will make clear how the current study will be conducted. The design and methodology (including the earlier mentioned method of 'identity') of the experiments will be explained there. The section on the results will show whether the results of the two experiments are significant. The discussion is used to interpret the results of the experiments and to shed some light on possible drawbacks of the current study and its implications for future research.

2. Theoretical framework

From maximizing expected value to maximizing expected utility

In the history of economics, the concept of maximizing monetary expected value has long been a leading theory in explaining human rationality. However, in 1738 Daniel Bernoulli proved with his St. Petersburg paradox (Bernoulli, 1738) that people do not actually behave according to this principle. The paradox explains how people are willing to put a limited amount of money at stake in the gamble explained in the paradox, whereas the expected value of that particular gamble is infinite. Maximizing monetary value then would imply that people

are willing to pay an infinite amount of money to play the game. After all, when the expected reward is infinite, the concept of maximizing expected value would lead to an infinite willingness to play this profitable game. However, as Bernoulli proves with his paradox, this is not the case.

Alternatively, Bernoulli gives rise to the so-called 'expected utility theorem'. In short, this theorem states that people do not make decisions based on comparing different expected values of prospects, but rather on the comparison of the expected utilities they receive from values. This modification of expected value theory takes into account the actual satisfaction people get from a particular monetary reward rather than taking the value itself as a criterion for making decisions. For instance, compare a billionaire winning 1000 euro or a student winning 1000 euro. As a student normally does not own a great amount of money, winning a price of 1000 euro adds to his welfare substantially. The billionaire on the other hand probably would not enjoy winning the price as much as the student does, since 1000 euro is not even close to being a substantial amount of money to him. So it can be said that their utility, their pleasure and their joy from winning the 1000 euro differs substantially. Expected utility takes such differences between people in consideration, whereas expected value does not.

Expected utility theory has many proponents since it seems to give a good explanation of human behaviour. Especially with the axiomatic addition (and foundation of Bernoulli's earlier work) of von Neumann and Morgenstern (von Neumann & Morgenstern, 1947), many economists believe in the explanatory power of this theory. The publication led to a fundamental group of proponents of the theory, which believe to have found the once and for all "proof" of expected utility theory in the work of von Neumann and Morgenstern. After all, how could such an axiomatically correct theory not be the best proof of a theory?

Although there are many proponents of expected utility, the theory has not been unchallenged over the years. An important contributor in this respect is the French economist Maurice Allais, who did not believe in the explanatory power of expected utility theory (Allais, 1953). With his counterexamples against expected utility he argued against the theory. In addition, he argued against the ease with which many of his colleagues took the axiomatic foundation of von Neumann and Morgenstern as the once and for all proof of expected utility. Alternatively, he proposed a concept called psychological values, which will be discussed in the next part (Allais & Hagen, 1979).

From maximizing expected utility to maximizing psychological values

In 1953 Maurice Allais published his famous work on random choices involving risk (Allais, 1953). His main purpose was to prove why a theory involving psychological values should be considered instead of the 'neo-Bernoullian formulation' of expected utility theory (a name Allais gave to the formulation proposed by von Neumann and Morgenstern).

He explained his problems with expected utility theory by providing several counterexamples to the theory, which should make clear that expected utility theory is not the best theory for explaining human behaviour. He argued that most people would not obey expected utility theory when they were faced with a decision involving different alternatives to choose from, even though they could be considered quite rational people. As will become clear in what follows, his basic problem with the theory does not stem from the idea of maximizing expected utilities or values in itself, but rather from the interpretation of the values which should be maximized. He favours the concepts of psychological values, which will be discussed later.

It is most easy to explain the Allais argument with his most famous example, the later called 'Allais-paradox'. He proposes to ask subjects to choose between two alternatives in two successive questions. The alternatives are the following:

(1) Do you prefer Situation A to Situation B

Situation A:

- a 10% chance of winning 500 million dollar
- an 89% chance of winning 100 million dollar
- a 1% chance of winning nothing

Situation B:

- certainty of receiving 100 million dollar

(2) Do you prefer Situation C to Situation D?

Situation C:

- a 10% chance of winning 500 million dollar
- a 90% chance of winning nothing

Situation D:

- a 11% chance of winning 100 million dollar

– an 89% chance of winning nothing

The mathematical expected values of A to D are 139, 100, 50 and 11 dollar respectively. Based on maximizing expected value, it seems obvious a person would choose A over B and C over D. However, as already noted, Bernoulli replaced this concept with maximizing expected utility. This theorem then predicts that a person would prefer C over D if he also prefers A over B, or he would prefer D over C if he also prefers B over A. Different from maximizing expected value, this second option is now (in addition to the first combination of answers), with the modification of expected value into expected utility, possible as well. Dependent on the risk attitude someone has (being risk-averse, risk-neutral or risk-loving), risk-taking reduces, maintains, or enhances utility. Then, someone who is risk averse, corresponding to getting negative utility from taking a risk, may choose B over A, even though the expected monetary value of B is lower than A. In the same way, someone might prefer D over C.

So far in the analysis, there has not been a paradox in the maximization of the expected utility though. To understand the problem Allais faces with expected utility in this example, it is important first to explain what is meant by 'rationality'. In his English translation of his original work Allais explains his view on rationality: "The author considers that a person's conduct can be considered rational if it satisfies the general principle of not being self-contradictory" (Allais, 1979; p. 69). In addition, he claims the so-called 'American School' or the neo-Bernoullian proponents of expected utility do not have such a clear statement on rationality. However, as he then continues, it is considered rational in the American School to behave according to the axioms of the neo-Bernoullian formulation. Basically, this means they as well consider consistency in choices to be rational. So, from here on, acting rationally will be explained as acting consistently, or not self-contradictory.

After this important step of defining rationality, the analysis continues. So again, where does the paradox come in? Allais' important conclusion from the questions above is that when you actually ask these questions to a group of "highly prudent persons" (Allais, 1979; p. 89), a large fraction of the group will choose B over A, but also C over D. He emphasizes how people who should be considered rational (the highly prudent persons), do not act rationally if rationality is defined as behaving according to expected utility. Rather, their behaviour is considered inconsistent and therefore irrational according to expected utility theory. After all, a consistent choice combination would be AC or BD. Allais finds it paradoxical how deliberate and thorough decision-making can be considered irrational, while

these choices do not seem to be hasty and careless at all. This is exactly why expected utility fails to provide a good explanation for human behaviour.

Allais' alternative is a theory of maximizing psychological values. With this concept, he captures the fact that people do not weight all probabilities linearly. So, a 1% difference in probability does not need to have the same value all along the probability distribution. In addition, the value people attach to a possible gain is a diminishing function of that gain. In other words, the marginal psychological value is declining. As the gain becomes bigger, the additional value from one extra 'unit of gain' becomes smaller.

With this concept in mind, the paradox can be solved. According to the concept of psychological values, the inconsistent subjects are now neither inconsistent in their preferences nor irrational. People who prefer B over A, but also C over D apparently attach different values to a 1% chance of winning nothing when they face a 90% chance of winning a great amount of money at the same time, and a 1% (extra) chance of winning nothing when they already face a 89% chance of winning nothing (Allais & Hagen, 1979).

From paradox to theory

The publication of Allais' critique on expected utility theory and his new concept of the psychological values evoked many reactions in the field of economics. Some of the proponents of expected utility theory did not feel comfortable with Allais' ideas. They tried their best effort to explain why Allais must be wrong, and more importantly, why expected utility theory does have the ability to function as a good descriptive theory of human behaviour. An extensive debate is summarized in the contemporary discussions of the expected utility hypotheses and the Allais paradox which Allais and Hagen set out in their 1979 publication (Allais & Hagen, 1979). In his contribution to this publication Yakov Ahimud for instance states that Allais had misinterpreted the necessary conditions for expected utility to hold (Ahimud 1979). He explains how Allais criticises axioms which are not at all necessary to derive expected utility theory from observed behaviour.

Another group of researchers tried to attack the paradox by challenging its settings. By doing so, they examine the robustness of the paradox and its validity as an argument against expected utility theory. MacCrimmon and Larsson (MacCrimmon & Larsson, 1979) changed the probabilities and outcomes, Conlisk (Conlisk, 1989) changed the framing of the questions, Moskowitz (Moskowitz, 1974) changed the representation of the questions into a tree or matrix form and Carlin (Carlin, 1990) changed the formulation of the chances from probabilities to spinning a wheel with 100 numbers. It seemed that some of the changes

reduced the validity of the paradox significantly, but others did not. The fact then remains that in many framings the paradox exists. That seems to be a good argument to at least consider other theories. And that is what many others did.

A third group of researchers got triggered by the idea of psychological values proposed by Allais. Most important in this respect are Daniel Kahneman and Amos Tversky who summarized their ideas on risk and behaviour in prospect theory (Kahneman & Tversky, 1979). They continued with the idea of psychological values and comprehended it into a sophisticated theory.

Prospect theory contains two parts, a value function and a weighting function. To start with the value function, it has two characteristics. Firstly, people are reference dependent. Depending on the initial situation before making a choice among alternatives, one particular alternative is chosen. In this respect, the value of an outcome depends on whether it is a gain or a loss compared to the initial situation. Additionally the value of the outcome depends on its magnitude with regard to the reference point. An example on this point, put forward by the authors themselves, is that a change in temperature from 3 to 6 degrees Celsius is evaluated as a larger difference than the change from 13 to 16 degrees Celsius (Kahneman & Tversky, 1979; p. 278). In this example the reference point is 0 degrees Celsius. Therefore, the closer the difference in degrees to the reference point, the larger the values that are given to the differences. Or, the larger people feel the difference is.

The second aspect of the value function is the difference between the value of a loss and the value of a gain which is just as high. Prospect theory predicts that losses are valued larger than gains, which is called loss-aversion. To put it differently, a 10 euro gain is ‘loved’ less than a 10 euro loss is ‘hated’.

The weighting function of prospect theory describes how people do not weight probabilities linearly in the evaluation of the attractiveness of the different alternatives. Linear weighting corresponds to giving an outcome a weight which is exactly the same as the probability of occurrence for that outcome. In contrast, Kahneman and Tversky explain how people tend to overweight small and moderate probabilities, while they tend to underweight large probabilities. To give an example, they tend to give a prospect with an 89% probability of occurring a smaller than 89% weight, while a prospect with a 1% probability of occurring is given a larger than 1% weight.

It should be clear from the explanation above that prospect theory is an effort of explaining human behaviour with economical, mathematical and most importantly, psychological influences. Not only does this theory challenge expected utility theory, it gives

a good alternative at the same time. With the publication of this theory, behavioral economics became a solid part of economics.

From monetary values to health outcomes

Although prospect theory seems to be a highly sophisticated alternative for expected utility theory incorporating the psychological values proposed by Allais, in the field of health economics expected utility is often still considered a valid theory explaining human behaviour (Oliver, 2003). With the previous information in mind however, it should be considered whether expected utility is able to be a valid descriptive theory in this field of economics.

In his publication, Adam Oliver extends the debate on the descriptive validity of expected utility theory to the field of health economics (Oliver, 2003). Due to the absence of extensive research regarding the validity of expected utility theory in the context of health, he examined the Allais paradox modified with health outcomes. He conducted both qualitative and quantitative research. In his quantitative research he examined his Allais paradox with health outcomes using a questionnaire. Afterwards, he asked his respondents why they made a particular choice.

From his quantitative research he concluded that the violations of expected utility theory are significant and systematically. His qualitative research suggested that most subjects can be considered to have a rational, deliberate thinking process when they make the choice, even when they eventually choose for the Allais combination of answers.

The current study will continue in this line of research that Oliver started with his experiment. The first experiment in this study is an experiment quite similar to that of Oliver's: the Allais paradox modified with health outcomes. In addition, the second experiment tests whether it is possible to manipulate subjects into making the Allais choice. This line of research combines behavioural economics with health economics, using the critical self-reflection of behavioural economics in the field of health economics. This method should be able to get economics a step closer to a good perspective on true human behaviour in health economics.

3. Experimental design

As explained earlier, rationality assumes stable and consistent preference ordering. However, it is still not obvious what the best way of specifying consistency is. As just described,

according to expected utility theory, a prospect is valued based on its mathematical expected utility. However, according to the concept of psychological values and prospect theory, the true value of a prospect depends on psychological factors as well as the expected utility received from the prospect. Especially in the field of health economics, there has been little research on this point so far, whereas this upcoming field of economics should rather be critical upon itself. The current study will continue in the line of work Oliver (Oliver, 2003) has put forward.

Using the paradoxical outcomes of his questions, Allais proposes the concept of psychological values. Therefore, it seems a logical next step to examine the scope of this concept. As Oliver already proves, in the context of health outcomes, the paradoxical answers are chosen frequently as well, implying the validity of psychological values in the health context as well. Going one step further on the concept of psychological values, a change of context then could lead to a large change in psychological value of a prospect, which was also described in prospect theory. If this were true, changing the context of the Allais questions, could lead to a large shift of the subjects' preferences regarding the different options. For instance, a contextual change could lead to a significant increase of the choice for the Allais combination. So, this will be examined. Does the change of context lead to a different answering pattern across subjects? If it does, what are the implications for the on-going debate on which theory should be considered valid? The current study will look into such questions.

This study contains two experiments. In the first experiment, the basic Allais paradox on health outcomes is examined again. This step in the process is quite similar as the earlier test of Oliver. The second part of this study investigates whether it is possible to manipulate a group of subjects in giving the paradoxical answer more or less frequently. It may be clear now that this study does not only try to assess behaviour in situations of risk involving life expectancy, but tries to step up by examining whether particular behaviour can be manipulated through the use of different conceptual framings of the questions. These methods are a mean of getting to a higher understanding of human behaviour in the health context, within the background of behavioural economics.

Experiment 1: the basic Allais paradox on health outcomes

In this first experiment subjects are asked to complete a questionnaire containing five questions. The questions all involve trade-offs between two alternatives with different probabilities and outcomes. All questions involve remaining life expectancy. Subjects are

asked to choose between prospects that yield various outcomes with particular probabilities. The first three questions of this questionnaire are randomly chosen prospects for the subjects to get familiar with the decisions involving trade-offs between probabilities and remaining life years. The last two questions, questions 4 and 5, are the modified Allais questions. Although the outcomes are changed into health outcomes, the probabilities are similar to the original probabilities. In question 4 subjects have to decide to choose for the risky option containing 1% chance of living for 35 years, 10% chance of immediate death and 89% chance of living for 15 years, or the certain option of 100% chance of living for 15 years. These are options 4A and 4B respectively. In question 5 the subjects have to choose between the option containing 90% chance of immediate death and 10% chance of living for 35 years, or 11% chance of living for 15 years and 89% chance of immediate death. These are options 5A and 5B respectively.

In these Allais questions, a subjects answers rationally according to expected utility theory when he chooses either AA or BB (A in questions 4 and A in question 5 or B in question 4 and B in question 5). However, the subject violates expected utility theory when he chooses AB or BA. The second set, BA, is the Allais combination, the combination of answers Allais has predicted many subjects would choose. The complete questionnaire (as well as the questionnaires of experiment 2) can be found in Appendix A.

The most important question of this first experiment is whether this experiment, like the experiment of Oliver, confirms Allais' expectation of most people being irrational according to expected utility theory. Previous studies on the paradox in its basic form with monetary values (Conlisk(1989) and Carlin(1990)) show a specific pattern: the majority of the subjects either choose AA or BA. Options BB and AB are chosen significantly less (in Conlisk (1989) for instance AA and BA are chosen 99 and 103 times respectively, BB and AB are chosen 18 and 16 times respectively). Additionally, the distribution of choices AA and BA is close to fifty-fifty. This pattern is also visible in the earlier study on the Allais paradox with health outcomes of Oliver.

These earlier results suggest that in the current experiment, we could also expect approximately half the subjects to choose for the Allais answer (BA), and the other half to choose AA, one of the two rational combinations of answers, with some exceptions toward the other two combinations. This result would violate expected utility theory. If every subject would be rational according to expected utility theory, all subjects would choose either AA or BB, both combinations confirm expected utility. However, since it is predicted that the Allais

combination is frequently chosen as well, expected utility theory is predicted to be violated many times.

A first test on rationality

The first test that will be conducted is a test on the prediction that the observed distribution of rational and irrational behaviour is close to fifty-fifty. The method used for this test is a binomial test. This test is used to examine whether different categories of a variable account for the same number of observations and it assumes dichotomous variables. The variable that will be used here is the variable 'choice combination', which contains two categories, the irrational choice combinations and the rational choice combinations. So, if a subject chooses AA or BB, the observation will be counted as a rational choice combination and when a subject chooses AB or BA the observation will be counted as a irrational choice combination. Irrational again should be considered in the light of expected utility theory. The number of observations in each category is counted, and in this experiment the rational choice combination will be considered a success. We will test for the following hypothesis:

Ho: The probability of a rational choice occurring is 0,5 ($p = 0,5$)
Ha: The probability of a rational choice occurring is not 0,5 ($p \neq 0,5$)

In these hypotheses p is the probability of success, and as explained above, we test the prediction of a rational choice occurring as often as an irrational choice.

When testing this, it is important to keep in mind that subjects could also choose randomly. In this case, their behaviour is not a deliberate rational or irrational choice, but rather an unintentional one. Therefore, a probability of 0,5 in itself does not prove irrationality, but could also indicate a purely random choice. A second test is needed.

A second test on rationality

In his paper, John Conlisk (Conlisk, 1989) makes a similar statement on this point: "The mere existence of violations is not critical. Economic theories are not expected to work perfectly… If violations of expected utility theory are systematic as well as frequent, then we can easily out-predict the theory; and we are led to suspect a fundamental distortion of the theory." (Conlisk, 1989; p. 393).

To continue from this point of view, it seems logical to conduct a second test in order to check for this systematic and frequent answering (when in the first test the null hypothesis

cannot be rejected and the probability of an irrational choice does not differ from 50% significantly). As the argument above claims, it is not a problem for the theory if the probability of an irrational choice is 0,5 due to the fact that subjects do not always choose deliberately, but rather random. It is, however, a problem when all violations of the theory point towards a single irrational choice combination. Then the argument of random choice does not hold anymore, because choices are not random. Instead, people systematically choose for one of the two irrational combinations. Additionally, when this does not happen once or twice, but rather frequently, there is a violation. As Conlisk explains, such a result is a very strong counterargument against expected utility theory.

In the current study it is examined inasmuch the prediction of Allais known as the Allais paradox is true for health outcomes. Therefore, in the light of the previous argument, it should and will be examined whether the violations of expected utility theory are systematically in the direction of the Allais combination, BA. When this is the case, Allais' original argument against expected utility theory can be accepted in the context of health outcomes as well.

The method for testing this statement is similar to the method above. Again, a binomial test is conducted, now with the variable 'irrational choice combination' containing two categories, 'choice AB' and 'choice BA'. The hypothesis of random violation is tested against an alternative of systematic violations in the direction of the Allais combination:

Ho: The probability of an observation of the choice BA is 0,5 ($p = 0,5$)
Ha: The probability of an observation of the choice BA is larger than 0,5 ($p > 0,5$)

In these hypotheses p is the probability of success, in which success is the combination of choices BA.

Subjects

All subjects are moderately to highly educated subjects, either studying at a Dutch university (graduation at masters level) or HBO (graduation at bachelors level) or in possession of a degree in either educational type. These subjects are chosen deliberately for their educational level to comply with Allais' idea of 'highly prudent persons' as good as possible. The questionnaire, an online questionnaire, was given to 18 subjects. Subjects were given the instruction that they would have to answer five questions concerning several alternatives with

different chances and outcomes. In addition, to emphasize the health aspect of the questions, they were given the following hypothetical scenario:

" Suppose you are suffering from a particular disease. Your doctor tells you there are several possibilities for treatment. Every treatment involves taking one particular kind of medication. The problem arises when your doctor tells you he cannot accurately predict how your body will respond to the particular drug in the different treatments. However, he is able to predict the chances of responding well or badly to a drug. In each of the following dilemmas, which treatment would you choose? "

Experiment 2: the 'identity' questionnaires

In this second experiment two additional questionnaires are made. Each of these questionnaires accounts for a particular treatment (a research treatment this time, not a treatment in health as was told to the subjects in the introduction of the questionnaire before). Next, it is examined whether these treatments are able to manipulate a subject's choice for the Allais combination of answers. In this experiment, the basic Allais questionnaire on health outcomes of experiment 1 is taken to be the control group for non-treatment answers. When comparing the answers on the Allais questions of the treatment groups and the control group, it can be concluded whether such a treatment influences the decision-making of the subjects.

As already explained in experiment 1, the results of earlier studies show that the combinations AA and BA are most popular whereas the combinations BB and AB are chosen significantly less. It seems to be the case that in the choice corresponding to question 5 of the basic Allais questionnaire, almost all subjects choose 5A, irrespective of their answer in question 4. This implies that the criterion of rationality stems from the answer of question 4 alone. Assuming a subject chooses 5A (neglecting the few that do not), this subject makes a 'rational' choice if he has chosen 4A, but an 'irrational' choice if he has chosen 4B. This second combination is the Allais prediction.

Continuing in this line of thinking, it is quite easy to switch from rational to irrational behaviour, since only one answer needs to be different. A switch of a person's choice from 4A to 4B alone implies him or her becoming irrational (taken his choice for 5A as given), a switch from 4B to 4A is enough to "make" someone rational. In the next part it is explained which method is used to manipulate a person's behaviour into "switching" from rational to irrational or reversed.

Manipulating choices using 'identity'

In their paper, LeBoeuf, Shafir and Bayuk (LeBoeuf et al., 2010; p. 48) state that '…fleeting and logically inconsequential changes in context can greatly alter expressed preferences". So, contextual changes in a situation involving a choice between different alternatives could result in a change of choices as well. In order to examine inasmuch the context is an essential factor in behaviour, the authors tried to alter the so-called 'identity' of a subject when making a choice. They hypothesised that the salience of a particular identity leads to a choice which could be conflicting with preferences when another identity is salient. These contextual changes are precisely the goal of the second experiment in the current study. Therefore, this method of making a particular identity salient, will be used in this second experiment. The concept of identity helps in handing a method for changing the context of the Allais paradox.

As LeBoeuf, Shafir and Bayuk explain, people possess various identities which cannot be all salient at the same time. For instance, a working mother sometimes has the salient identity of 'worker' (when she is at work for instance) while another time the identity of 'mother' is salient. People reflect upon themselves by adopting certain behaviour which fits the salient identity they themselves feel is emphasized at that moment. Therefore, the authors suggest "This view on the self-concept suggests how identity salience might influence decision making."(Leboeuf et al., 2010; p. 49). In the case of the working mother, she might choose differently on a dilemma when she feels the 'worker' identity is salient than when the 'mother' identity is salient.

The method used by Leboeuf, Shafir and Bayuk for making salient the particular identities is giving subjects a survey before answering the "real" questions. In their experiment, the authors used 150 undergraduate students. The identities they wanted to evoke were the scholars identity and the socialite identity. The scholars identity was emphasized with question concerning political issues and world affairs. The socialite identity was evoked with questions concerning social- and campus life. When the identities were supposed to be salient, the students were asked to make a choice between conflicting alternatives. For instance, they had to choose which magazine they would prefer to read if they were in the position to choose either 'The Economist' or 'Cosmopolitan'.

The results of this experiment show that the presence of an identity (as hypothesised by the authors) influences preferences in favour of the alternatives corresponding to that particular identity. In addition to this first experiment, five more experiments were conducted, in order to resolve possible problems with the first test. The basic conclusion of these experiments was that identity does lead to identity-congruent answering, as the first

experiment already made clear. However, in addition to the first experiment it was shown to be of importance that subjects need to be able to identify with an identity in order to actually being influenced by the questions. This last point is very important to keep in mind in the current study, which will be given attention in the discussion.

Two identities: the reckless gambler and the sensible investor

The concept of identities will be used in this second experiment to alter choices from 4A to 4B or reversed. With the use of this concept, a distinct character trait will be used as a trigger for a particular identity. This character trait is thought to be representative for a particular choice (either 4A or 4B), therefore able to trigger the predicted behaviour as a result of the treatment. Both the identity-questionnaires contain 3 identity-related questions additionally to the five questions which are the same questions of the control group. In what follows therefore, question 7 of the identity-questionnaires corresponds to question 4 of the control questionnaire, and question 8 corresponds to question 5.

The first identity that is used to manipulate behaviour is the identity of the reckless gambler. All three questions of this identity involve spending money on bets with a chance of winning some price on the one hand, but a chance of losing money on the other hand. In this way, the subjects have to think about gambling, and whatever the option they eventually choose, all involve the risk of losing money. With the process of weighting different alternatives all involving risk-related gambles, the identity of a gambler should become salient, therefore triggering risk-seeking behaviour (after all, a gambler is supposed to receive utility from taking risk). In question 7, these subjects should then choose for alternative A, the alternative with 10% chance of living for 35 years in full health, but also with 1% chance of immediate death and 89% chance of living for 15 years in full health. This option is riskier than 100% chance of living for 15 years in full health. In this group of subjects therefore, there should be more observations of rational behaviour than in the control group.

With a Pearson's chi-square test, it will be tested whether there is an association between the variable 'treatment' and the variable 'choice'. The variable treatment contains the categories 'control' and 'gambler' and choice contains the categories 'choice BA' and 'all other choices'. The Pearson's chi-square test is a method for testing whether there is an association between two nominal variables. The test does not give much information on the strength or direction of the association though. Therefore, in addition to this chi-square test it is possible to measure the strength of the association with association measure lambda. Lambda takes values from 0 to 1, which is the scale of strength. When lambda takes the value

of 0, there is no association, when it takes the value 1 there is a one on one association. When the chi-square test thus concludes there is a significant association, additionally the strength of this association will be measured with lambda. The direction of the association cannot be concluded directly from the chi-square or lambda. However, the association of the treatments with the choice for BA is tested in twofold. Per treatment it is tested whether there is an association. This individual testing per treatment leaves open the opportunity to analyze the direction of the association using the observations and percentages of both BA and all other choices. This division of choices in BA and all other choices additionally gives a clear view on whether the number of observations BA have increased or decreased in the treatment compared to the control group.

With the Pearson's chi-square test the following hypotheses will be tested:

Ho: There is no association between the variable 'choice' and 'treatment'
Ha: There is an association between the variable 'choice' and 'treatment'

The second identity that will be used is the identity of the sensible investor. In this treatment, the first three questions all involve choosing between different investment options with particular probabilities and outcomes. It is emphasized in the questions that the investments are supposed to be a sensible decision for spending money, in order to make salient the identity of a sensible, deliberate decision maker (someone who does not spend his money right away without thinking it through but rather waits for a sensible alternative to appear). This identity should trigger this well thought through, deliberate behaviour, therefore diminishing risk-taking behaviour. Subjects in this treatment group are predicted to go for the steady intermediate option of 15 years in full health with certainty instead of the risky option with the chance of obtaining 35 years in full health. In question 7, these subjects thus would choose for alternative B. Still assuming most people choose A in question 8, in this group of subjects there should be more irrational behaviour (and in particular the Allais combination) compared to the control group as a result of this treatment.

As well as in the first treatment, the Pearson's chi-square will be used to test the relation between variables 'choice' and 'treatment'. The design of this test is the same as the design of the test on the association of the first treatment. Again, the association is tested with the Pearson's chi-square test, the strength of the association (whenever the chi-square concludes with a significant association) will be measured with association measure lambda

and the direction of the association will be observed with checking the frequencies and percentages of 'choice BA' in the observed counts. There will be a minor change though. The categories of the variable 'treatment' will be 'control' and ' investor' rather than 'control' and 'gambler'.

Subjects

In the second experiment, similar subjects to the first experiment are used. The three treatment samples therefore can be considered to belong to the same population. The subjects of both treatments were given the instruction to answer 8 questions, involving several alternatives with particular probabilities and outcomes. In order to make the questionnaires as coherent as possible, some transitional information was given between the first three treatment questions and the latter five health outcome questions. In addition, all treatment questions are formulated in such a manner that they involve particular probabilities and outcomes. In this way, all questions look alike, both treatment and health outcome questions. Again, the health outcome questions consist of three basic questions for the subjects to get used to the questions, continued by the Allais questions, which are then easy to understand.

For this second experiment, 22 subjects participated in addition to the 18 which already participated in the first experiment. The subjects of the first experiment are taken to be the control group in the second experiment. The gambler treatment consisted of 12 subjects. The investor treatment consisted of 10 subjects.

4. Results

General

Table 1, which is shown below, summarizes the overall choice distribution of the Allais questions for both experiments 1 and 2. A total of 40 subjects participated in this study. In the first experiment 18 subjects participated. In the second experiment these 18 subjects were taken to be the control group. Therefore, the distribution of choice combinations in experiment 1 is equal to the distribution of choices in the control treatment of experiment 2. The results of experiments 1 therefore are headed under the control-treatment of experiment 2 in table 1. The gambler-identity questionnaire was answered by 12 subjects, the investor-identity questionnaire by 10 subjects.

In what follows, the null hypothesis will be tested against the alternative with a significance of $\alpha = 0{,}05$. When the p-value is smaller than 0,05 the null hypothesis will be rejected.

		Treatment			
Choice		Control	Gambler	Investor	Total
	AA	**9** (50,0%)	**5** (41,7%)	**4** (40,0%)	**18** (44,0%)
	BB	**1** (5,6%)	**1** (8,3%)	**0** (0,0%)	**2** (4,9%)
	AB	**0** (0,0%)	**2** (16,7%)	**1** (10,0%)	**3** (7,3%)
	BA	**8** (44,4%)	**4** (33,3%)	**5** (50,0%)	**17** (44,0%)
	Total	**18** (100%)	**12** (100%)	**10** (100%)	**40** (100%)

Table 1, observations per combination of answers and treatment

Experiment 1

In the first experiment the basic Allais questionnaire with health outcomes is examined. As discussed in the experimental design, based on earlier experiments conducted with monetary gambles (for instance Conlisk (1989) and Carlin (1990)), there was a hint that only half the subjects would choose for a "rational" choice combination. Based on table 1, there seems to be such a pattern in the results of this experiment as well (10 irrational observations versus 8 rational observations). However, the existence of any pattern must be tested before giving it any significance. To test the hypothesis whether the probability of a subject choosing a rational combination of alternatives is 50%, the first test on rationality was proposed.

The first test on rationality

The first test on rationality is a binomial test on the probability of a rational choice combination to occur. Below, the hypotheses of this first test are repeated:

Ho: The probability of a rational choice occurring is 0,5 ($p = 0{,}5$)
Ha: The probability of a rational choice occurring is not 0,5 ($p \neq 0{,}5$)

The results of this test are shown in table 1 of Appendix B. The variable 'choice combination' takes two values, 1 whenever AA or BB is chosen and 2 whenever AB or BA is chosen. Based on these numerical codes, with a binomial test the number of observations of each code is counted. The category 'AB or BA' contains 8 observations. The category 'AA or BB' contains 10 observations. The observed proportions of these two categories are 0,44 and 0,56

respectively. The binomial test with tested proportion p = 0,5 results in a p-value of 0,815. Therefore, with this test containing 18 observations the null hypothesis cannot be rejected.

The second test on rationality

The second test on rationality is a binomial test on the probability of the choice BA to occur, when comparing only the two irrational choice combinations. It is tested whether the violations of expected utility theory are systematically towards the Allais combination. The hypotheses are:

Ho: The probability of an observation of the choice BA is 0,5 (p = 0,5)
Ha: The probability of an observation of the choice BA is larger than 0,5 (p > 0,5)

The results of this test can be found in table 2 of Appendix B. The variable 'choice combination' takes values of 1,2 and 9. When the variable takes a value of 1, the respondent has chosen AB. Value 2 corresponds to BA being chosen. When the variable takes a value of 9, either AA or BB is chosen, both rational choices. This value is turned into a (user) missing value, and therefore is not counted as an observation in the test.

The category BA contains 8 observations, while category AB contains 0 observations. The observed proportions therefore are 1,00 and 0,00 respectively. Due to the one-sided alternative hypothesis, the p-value with a total of 8 observations is 0,004. Based on this value the null hypothesis can be rejected.

Experiment 2

In experiment 2 the results of the two treatment groups are tested against the control group, which is taken to be the group of subjects from experiment 1. It is tested whether there is a significant association between the variable 'treatment' and 'choice BA'. The method is a Pearson's chi-square statistic.

The overall pattern of table 1 above shows the frequencies and percentages per treatment and choice combination. Comparing the results of the gambler treatment with the control treatment, there seems to be a small change in pattern. As intended with the gambler treatment, the number of observations BA decreased (from 44,4% to 33,3%). However, not all predictions are confirmed in these results. In the section on the experimental design it is explained how subjects normally (i.e. in earlier research on the paradox with monetary outcomes) choose AA and BA quite often, while BB and AB are chosen significantly less.

Based on these earlier experiments, it was predicted that a reduction of the choice for BA would imply an increase in the choice for AA. This amounts to a change in the answer of the first Allais question, since it was explained how almost all people chose 5A (control questionnaire) or 8A (treatment questionnaire) in the earlier experiments. Although predicted, the reduction in the number of observations of the choice BA does not seem to result in an increase in the choice for AA. Rather, BB and AB are chosen more frequently than in the control group.

The test results must point out whether the decrease of BA in the gambler treatment is significant. As already mentioned in the experimental design, the Pearson's chi-square test does not take into account the direction of change. Due to the fact that both BB and AB are chosen instead of BA, rather than AA being chosen (as predicted), this result is not conclusive in the question whether rationality has increased. However, the test is still able to provide information on the frequency of the choice for BA. Any significant (and systematic) change in the number of observations of BA still is an indication for psychological values to be in place. That is, by only changing someone's initial state of mind with the treatment, behaviour is changed. Expected utility theory does not capture these changes, whereas psychological values and prospect theory do.

Next, consider the pattern of the investor treatment in table 1. When the treatment influences decisions as intended, BA should be chosen more frequently while AA should be chosen less frequently. In table 1 of the results both these changes are visible: the choice for AA reduces from 50% to 40%, the choice for BA increases from 44,4% to 50%. However, with ten subjects this result does not seem to be very conclusive. The chi-square test must point out whether there is enough reason to reject the null hypothesis. When the Pearson's chi-square does give reason to reject the null hypothesis, table 1 additionally gives reason to believe the direction of change is as predicted: the investor treatments leads to "irrational" behaviour; BA is chosen more frequently while AA is chosen less frequently.

The treatments are tested individually, since they are designed to alter the choice for BA in the opposite direction (as told in the previous paragraphs). The variable 'choice' takes a value of 1 when BA is chosen and takes a value of 2 when either one of the other combinations is chosen. The variable 'treatment' takes values 1,2 and 3 for control, gambler and investor treatment respectively. The treatment which is not relevant in the particular test (either gambler or investor) is turned into a (user) missing value. Therefore, the observations of that particular treatment are not included in the crosstab and Pearson's chi-square statistic.

For both treatments, the hypotheses are:

Ho: There is no association between the variable ‘choice’ and ‘treatment’
Ha: There is an association between the variable ‘choice’ and ‘treatment’

The results of the first test (regarding the gambler treatment), are shown in tables 3 and 4 of Appendix B. Table 3 gives the cross tabulation of treatment and choice, showing the counts and the percentages of a combination of the different treatment and choice categories. Table 4 gives an overview of the Pearson’s chi-square test statistics.

With a decrease in the number of counts in the category BA from 44,4% to 33,3% and an increase in the category all other combinations from 56,6% to 66,7%, the Pearson’s chi-square value is 0,370. With 1 degree of freedom and a p-value of 0,543 the null hypothesis cannot be rejected. The assumption of the chi-square test of cell frequencies being 5 at least is not met since one cell frequency is smaller than 5.

The results of the second test (regarding the investor treatment), are shown in tables 5 and 6 of Appendix B. Table 5 shows the cross tabulation of treatment and choice. Table 6 gives an overview of the Pearson’s chi-square test results.

With an increase in choosing for BA from 44,4% to 50% and a decrease of choosing all other choices from 56,6% to 50%, the value of the Pearson chi-square is 0,080. With 1 degree of freedom and a p-value of 0,778, the null hypothesis cannot be rejected. All cell frequencies are at least 5, so this assumption of the chi-square test is met.

5. Discussion

Results

Experiment 1

This experiment tested the Allais paradox on health outcomes. It was examined whether the paradoxical combination of answers would be observed with the modification of the original paradox into health outcomes. Based on table 1 of the result section, it was predicted that the outcomes indeed violated expected utility theory. There was an hint for both frequent and systematic violations of expected utility.

The results of the first test on rationality confirmed the frequent violation of expected utility theory. The null hypothesis of the probability of the occurrence of a rational choice

combination to be 50% could not be rejected. This result shows frequent violation of expected utility theory. Specifically, the proportion of the irrational choices does not differ from 0,5 significantly. However, as pointed out in the experimental design, the result of frequent violation in itself does not lead to problems with the validity of expected utility theory. If it were true subjects chose randomly, they would haven chosen for an irrational combination in 50% of the cases, because the probability of an irrational combination to occur is 50% with random answering. Therefore, not rejecting the null hypothesis in itself does not provide enough evidence to conclude with violation of expected utility theory in the direction of irrationality (while the subjects are considered rational). The second test does provide this evidence though.

The second test on rationality examined the occurrence of systematic violations in the direction of the Allais combination of answers. Evidence for systematic violation eliminates the possibility of random answering, since random answering would lead to a fifty-fifty distribution of both irrational combinations. Systematic violation in the direction of one single choice combination therefore does lead to problems with expected utility theory. The second test on rationality confirmed the prediction of systematic violations in the direction of BA. BA was chosen 8 times, whereas AB was not chosen at all. The null hypothesis was rejected with a very low p-value of 0,004, therefore confirming the systematic violations of expected utility theory.

With the combined results of both tests (the violations are both frequent and systematic), a strong violation of expected utility theory is confirmed. The logical next step is to question whether expected utility is still a valid descriptive theory. Similarly to earlier research on the Allais paradox with monetary outcomes, this experiment implies inadequacy of expected utility theory in explaining health-related behaviour, at least for a significant amount of people (almost half the subjects).

It is important in the field of health economics to take notice of such results. The important step that needs to be taken is a critical assessment of expected utility theory. The extent to which expected utility theory is a valid descriptive theory should be examined. Furthermore, there should be given attention to alternatives for expected utility, which possibly are less sensitive for paradoxical situations. Most prominent in this respect is prospect theory, which is an application of Allais' concept of psychological values. The concept of psychological values will be used as the starting point for experiment 2.

Experiment 2

Although supported in behavioural economics, the concept of psychological values has not gained much support in the field of health economics yet. In the second experiment it is tried to include this concept in the context of health decisions, in order to get a better perspective on whether such a concept could be applicable in this context.

Unfortunately it cannot be concluded directly from this experiment that health economics should rely on the concept of psychological values. Since neither null hypothesis in this second experiment can be rejected (both tests result in very high p-values) it is possible to draw the conclusion that there is not reason to believe in the validity of psychological values in the context of health. However, this conclusion would not be justified. At least, not yet.

That is, the second experiment had a very low number of subjects. Because the Pearson's chi-square test is more sophisticated than the simple binomial test of the first experiment, there cannot be any conclusions from 10 or 12 subjects per treatment, whereas the first experiment did show a clear pattern with only 18 subjects. The chi-square was used to examine whether there was a changing pattern in responses, rather than a pattern in itself. With only 10 or 12 subjects, any change in pattern could be random, or based on coincidence. This test thus could never be significant with such a small number of subjects. Furthermore, a basic assumption of the chi-square statistic is a frequency of more than 5 counts per cell. In the gambler treatment, this assumption was not met, since there was one cell with only 4 observations. In the investor treatment two cells contained 5 observations. Although the assumption is met in this second treatment, half the cells containing 5 counts does not lead to a very strong chi-square statistic. Based on the results of this experiment it is therefore impossible to draw strong conclusions in favour or against psychological values. Rather, the experiment must be conducted again with many more subjects, in order to draw any justified conclusion.

The most important implication from the statements above is that even though the hypotheses cannot be rejected, the predictions of this study cannot be rejected either. Only when this experiment is conducted again with a reasonable amount of subjects, any conclusion on whether the predictions are correct can be made. Up until that point, there is no reason to reject the idea of psychological values in the context of health. Rather, there should be more research on the concept of psychological values with health outcomes. After all, the results of experiment 1 seem to give rise to a credible problem with expected utility theory.

Therefore, there seems to be enough reason to search for alternatives in explaining health-related human behaviour such as psychological values and prospect theory.

Design

The most important flaw in this study is the small number of subjects, as already noted. Although this does not lead to a problem in the first experiment, it is a big problem for the second experiment. However, besides this problem with the number of subjects, the subjects themselves are well-chosen. As explained in the experimental design, all subjects are well educated people, underlining the argument of Allais that (even) highly prudent persons violate expected utility theory.

Apart from the number of subjects, some things still need to be taken into consideration about the method of identity-salience. LeBoeuf, Shafir and Bayuk (LeBoeuf et al., 2010) argue that it is important for people to be able to identify with the evoked identity for the method to be actually accurate. The identities of this experiment, the reckless gambler and the sensible investor, are chosen such that every subject is able to identify with either one. Although not every subject may identify with 'his' evoked identity with the same intensity, every person is, at least for a minimal degree, familiar with a situation of gambling or saving. Therefore, there is enough reason to believe the identities are actually able to trigger identification with particular behaviour.

Another remark has to be made on the identities. Although it is very unusual for a person to think of either context while making a health decision in real life, it does not reduce the significance of this study. The second experiment is not directly designed to assess true decision making in a real-life situation, but rather to assess whether psychological factors could be influential in the decision-making process. The use of the identities are examples of contextual changes, which could indicate validity of psychological values when behavioural patterns change.

The last remark in this section will be about the use of questionnaires. It is important to ask whether a questionnaire is the best way of evoking an identity. It is possible to imagine that a real life simulation of gambling or investing may result in a stronger salience of the identities. On the other hand, it must not be obvious to the subjects that a specific identity is evoked. The knowledge of receiving a particular treatment might influence decisions, leading to dishonest results. By using a questionnaire, this danger can be reduced quite easily. In the current study, the similar formulation of all questions, treatment as well as health related questions including the Allais questions, led to a coherent questionnaire, while the questions

themselves asked the subjects to make decisions on very different topics. The subjects did not give the impression of understanding that their choice in the first 3 or 6 questions (in the basic Allais questionnaire and the treatment questionnaires respectively) did not matter in the study. The purpose for these questions was to get the subjects thinking about the topics, rather than to examine their choices in themselves. The method of using questionnaires seems to be quite efficiently and reliable, and especially with a limited budget for research, it seems to be a good alternative. For a possible re-examination of the second experiment, the arguments above should be taken into consideration though.

Suggestions for further research

As already stated a few times, it is in the best interest of the field of health economics to continue on using the methods of behavioural economics to examine basic assumptions of the economics models used. As the first experiment makes clear quite convincingly, there are frequent and systematic violations of expected utility theory, also in the context of health outcomes. At least based on this particular paradox, there seems to be a good reason to examine other models for predicting human behaviour. It is not said expected utility should not be used anymore. Rather, it is proposed to conduct thorough investigation before making essential assumptions in modelling human behaviour.

For the current study to be more convulsive on the applicability of psychological values in the context of health, it is important to re-examine the predictions and statements with a larger group of subjects. Although it is not essential for the first experiment (the predicted behaviour already is observed with a small group of subjects), it is essential for the second. Once the predictions are examined with a larger group of subjects, it is truly possible to say whether conceptual changes actually do play an important role in decision making in the health context. Such a conclusion contributes to the question whether psychological values are in order in explaining human behaviour in the context of health.

Concluding remarks

The current study tried to shed a new light on the Allais paradox. Following Adam Oliver (Oliver, 2003) in his experiment, the Allais paradox was modified into health outcomes. It was examined whether the violations of expected utility theory are both frequent and systematic, and they appeared to be. The Allais argument therefore is applicable to health outcomes as well. Additionally, it was examined whether a change in the context of the paradox could alter behaviour. The change of context was interpreted in this study by making

a particular identity salient in order to manipulate behaviour. A changing pattern in choice combinations could have given a clue for the concept of psychological values to be of importance in decision making concerning health. Unfortunately, the second experiment did not give a significant result due to the size of this experiment.

It is strongly argued that a self-reflective critical view is essential in the field of health economics in order to improve economic models involving human behaviour in the context of health. The methods of behavioural economics are a good starter for this suggested research. It is in the interest of health economics to continue in this line of research, in order to make economic models more and more reliable. Especially keeping in mind the focus on policymaking in the field of health economics, the combination with behavioural economics is an important next step for this specialism in economics.

Appendix A: questionnaires

Questionnaire Experiment 1: Health outcome questions and the Allais paradox with health outcomes

Suppose you are suffering from a particular disease. Your doctor tells you there are several possibilities for treatment. Every treatment involves taking one particular kind of medication. The problem arises when your doctor tells you he cannot accurately predict how you body responds to these particular drugs in the different treatments. However, he is able to predict the chances of responding good or bad to a drug. In each of the dilemmas below, which treatment would you choose?

Question 1
Consider the choice between treatment A and B. Which treatment would you choose?

A. 10% chance of living for 10 years in full health, followed by immediate death
   90% chance of living for 30 years in full health followed by immediate death

B. 100% chance of living for 20 years in full health followed by immediate death

Question 2
Alternatively, suppose you had the choice between the following two treatments. Which treatment would you choose in this scenario?

A. 80% chance of living for 20 years in full health, followed by immediate death
   15% chance of living for 50 years in full health, followed by immediate death
   5% chance of immediate death
B. 60% chance of living for 20 years in full health, followed by immediate death
   25% chance of living for 50 years in full health, followed by immediate death
   15% chance of immediate death

Question 3
Alternatively, suppose you had the choice between the following two treatments. Which treatment would you choose?

A. 40% chance of immediate death
   60% chance of living for 60 years in full health, followed by immediate death
B. 100% chance of living for 25 years in full health, followed by immediate death

Question 4
Alternatively, suppose you had the choice between the following two treatments. Which treatment would you choose?

A. 1% chance of living for half a year in full health, followed by immediate death
   10% chance of living for 35 years in full health, followed by immediate death
   89% chance of living for 15 years in full health, followed by immediate death

B. 100% chance of living for 15 years in full health, followed by immediate death

Question 5
Alternatively, suppose you had the choice between the following two treatments. Which treatment would you choose?

A. 90% chance of living for half a year in full health, followed by immediate death
   10% chance of living for 35 years in full health, followed by immediate death
B. 89% chance of living for half a year in full health, followed by immediate death
   11% chance of living for 15 years in full health, followed by immediate death

Questionnaire 2: Gambler treatment, experiment 2

Question 1
The last couple of months your department at work has had a rough period. In order to bring in an important client into the company, you and your colleagues have worked overtime for many hours. Since your boss has noticed this hard work, and wants to thank you for your many hours put into the job, you get a small bonus of 100 euro. Suppose you have to choose between the following options for spending this bonus, which option would you choose?

A. You go to a casino and spend the 100 euro on a few gambles:
   50% chance of winning 100 euro
   50% chance of winning nothing at all

B. You buy 10 lottery tickets each worth 10 euro:
   0,01% chance per ticket of winning the jackpot of 10000 euro
   99,9% chance of winning nothing.

Question 2
Another time, you and your friends decide to go to the casino. Suppose you could only choose between the slot machine and a poker game. You have got 200 euro to spend. Which option would you prefer?

A. You will go for the slot machine and take 200 bets of 1 euro:
   1% chance of winning 100 euro for every bet of 1 euro
   99% chance of losing the 1 euro you put at stake every bet

B. You will go for the poker game with a stake of 200 euro:
   20% chance of winning against the other 4 players, therefore getting their stakes of 200 euro each and keeping your own stake as well
   80% chance of losing against the other players. You lose your stake and you end up with nothing at all

Question 3
Suppose you are a contestant in a television game show. It is your lucky day, because you have just survived the first and second round, and you are now a finalist. In the first two rounds you have already won a 1000 euro. However, in the finale you need to play another game before you can be sure of any price. There are three options for you and either one of the options must be chosen. If the following three options are available, which option would you prefer?

A. You spin the special 'winners wheel of fortune':
   25% chance of doubling your price
   25% chance of splitting your price in half
   50% chance of losing your entire price and ending up with nothing at all

B. You roll a dice:
   If you throw the number 1, you have a chance of winning 3000 euro instead of the initial 1000 euro.
   If you throw 2, you will receive the initial 1000 euro in cash.
   If you throw 3,4, 5 or 6, you lose your money and you end up receiving nothing at all.

C. You draw a ball out of an urn containing 10 white balls and 60 red balls:
   If you draw a red ball, you lose your initial price. If, on the other hand, you draw a white ball, you win 5000 euro instead of the initial 1000 euro.

In the previous scenarios you were asked to choose one of the two or three options in a gamble. Each gamble involved taking the risk of either winning a great deal of money or losing a substantial amount of money. Although these scenario's were all hypothetical, in real life we could face similar situations. The common characteristic of the previous questions was that they all dealt with monetary gambles. However, life is not all about money. For instance, when it comes to health, there are situations involving risk as well. Consider the next scenario:

Suppose you are suffering from a particular disease. Your doctor tells you there are several possibilities for treatment. Every treatment involves taking one particular kind of medication. The problem arises when your doctor tells you he cannot accurately predict how your body will respond to the particular drug in the different treatments. However, he is able to predict the chances of responding well or badly to a drug. In each of the dilemmas below, which treatment would you choose?

<u>Question 4</u>
Consider the choice between treatment A and B. Which treatment would you choose?

A. 10% chance of living for 10 years in full health, followed by immediate death
   90% chance of living for 30 years in full health, followed by immediate death

B. 100% chance of living for 20 years in full health, followed by immediate death

<u>Question 5</u>
Alternatively, suppose you had the choice between the following two treatments. Which treatment would you choose in this scenario?

A. 80% chance of living for 20 years in full health, followed by immediate death
   15% chance of living for 50 years in full health, followed by immediate death
   5% chance of immediate death
B. 60% chance of living for 20 years in full health, followed by immediate death
   25% chance of living for 50 years in full health, followed by immediate death
   15% chance of immediate death

Question 6
Alternatively, suppose you had the choice between the following two treatments. Which treatment would you choose?

A. 40% chance of immediate death
   60% chance of living for 60 years in full health, followed by immediate death
B. 100% chance of living for 25 years in full health, followed by immediate death

Question 7
Alternatively, suppose you had the choice between the following two treatments. Which treatment would you choose?

A. 1% chance of living for half a year in full health, followed by immediate death
   10% chance of living for 35 years in full health, followed by immediate death
   89% chance of living for 15 years in full health, followed by immediate death

B. 100% chance of living for 15 years in full health, followed by immediate death

Question 8
Alternatively, suppose you had the choice between the following two treatments. Which treatment would you choose?

A. 90% chance of living for half a year in full health, followed by immediate death
   10% chance of living for 35 years in full health, followed by immediate death
B. 89% chance of living for half a year in full health, followed by immediate death
   11% chance of living for 15 years in full health, followed by immediate death

Questionnaire 3: Investor treatment, experiment 2

Question 1
The last couple of months your department at work has had a rough period. In order to bring in an important client into the company, you and your colleagues have worked overtime for many hours. Since your boss has noticed this hard work, and wants to thank you for your many hours put into the job, you get a bonus of 1000 euro. Since a 1000 euro is a lot of money, you want to spend this money wisely. Rather than spending the money right away, you decide to invest the money in stocks. Although investing money on the stock exchange always comes with some risk, an investment gives you a good chance on making some profit as well. In this way, your 1000 euro today could be worth much more in one year, giving you the opportunity to benefit from this profit. Consider the following two alternatives with the following chances. Which option would you prefer?

A. You invest the money in ten stocks of company A worth 100 euro each at the moment:
   75% chance of the stocks being worth 150 euro each in one year
   25% chance of the stocks being worth 50 euro each in one year

B. You invest the money in 4 stocks of company B worth 250 euro each at the moment:
   50% chance of the stocks being worth 350 euro each in one year
   50% chance of the stocks being worth 150 euro each in one year

Question 2

Now consider the stocks of two different companies. This time, you are sure that you want to hold the stocks for five years. Additionally, you are sure you will be able to sell the stocks with a profit of 250 euro in total, because you are able to commit to a forward contract to sell the stocks for a pre-arranged amount of money in five years. However, what you do not know, is whether the companies will payout dividend, and if they do so, how much it will be. Your choice will be between investing in 8 stocks of company A, each worth 125 euro at the moment or 2 stocks of company B, each worth 500 euro at the moment. Which portfolio would you choose?

A. 20% chance of company A paying out a dividend of 12,50 euro per stock each year
   80% chance of company A not paying out any dividend the next five years

B. 70% chance of company B paying out 30 euro per stock each year
   30% chance of company B not paying out any dividend the next five years

Question 3

Alternatively, consider now a situation where both the market price of the stocks in two years and the dividend payout in the next two years are uncertain. Because you still want to invest your money wisely, you compare two fairly similar portfolios of stocks, either 10 stocks worth 100 euro each of company A, or 10 stocks worth 100 euro each of company B. Additionally, you are sure of making some profit by holding either investment. However, the chances and the amounts of the dividend payout and the market price in two years is not certain yet. Consider the following two possibilities. Which option would you choose?

A. 90% chance of the stocks of company A being worth 125 euro each in two years
   10% chance of the stocks still being worth 100 euro
   &
   40% chance of a dividend payout of 15 euro per stock in the next two years.
   60% chance of no dividend payout at all the next two years

B. 60% chance of the stocks of company B being worth 150
   40% chance of the stocks still being worth 100 euro
   &
   70% chance of a dividend payout of 5 euro per stock in the next two years
   30% chance of no dividend payout at all the next two years

In the previous scenarios you made an investment decisions on how to spend your money. You considered the trade-offs between different investment opportunities. In these scenarios all portfolios differed from each other in their expectations on the profit from the portfolio. In the first question, the market price of stocks in one year was unknown, in the second question the dividend payout was uncertain and in the third question both the market prices and the dividend were variable. Although all questions were different, they had in common their emphasis on monetary gains. In real life however, the trade-offs we sometimes face do not only stress out to financial situations. For instance our health is another topic on which we have to make decisions involving different alternatives with different outcomes. Choosing one way to deal with a situation directly eliminates the possibility to deal with the issues in another way. Your choice of actions then could have substantial consequences for your life. Therefore, in the next questions, you are asked how you would act in a situation involving

competing health alternatives, all influential for your future life, all with different chances and outcomes. Consider the next scenario:

Suppose you are suffering from a particular disease. Your doctor tells you there are several possibilities for treatment. Every treatment involves taking one particular kind of medication. The problem arises when your doctor tells you he cannot accurately predict how your body will respond to the particular drug in the different treatments. However, he is able to predict the chances of responding well or badly to a drug. In each of the dilemmas below, which treatment would you choose?

Question 4
Consider the choice between treatment A and B. Which treatment would you choose?

A. 10% chance of living for 10 years in full health, followed by immediate death
   90% chance of living for 30 years in full health, followed by immediate death

B. 100% chance of living for 20 years in full health, followed by immediate death

Question 5
Alternatively, suppose you had the choice between the following two treatments. Which treatment would you choose in this scenario?

A. 80% chance of living for 20 years in full health, followed by immediate death
   15% chance of living for 50 years in full health, followed by immediate death
   5% chance of immediate death
B. 60% chance of living for 20 years in full health, followed by immediate death
   25% chance of living for 50 years in full health, followed by immediate death
   15% chance of immediate death

Question 6
Alternatively, suppose you had the choice between the following two treatments. Which treatment would you choose?

A. 40% chance of immediate death
   60% chance of living for 60 years in full health, followed by immediate death
B. 100% chance of living for 25 years in full health, followed by immediate death

Question 7
Alternatively, suppose you had the choice between the following two treatments. Which treatment would you choose?

A. 1% chance of living for half a year in full health, followed by immediate death
   10% chance of living for 35 years in full health, followed by immediate death
   89% chance of living for 15 years in full health, followed by immediate death

B. 100% chance of living for 15 years in full health, followed by immediate death

Question 8

Alternatively, suppose you had the choice between the following two treatments. Which treatment would you choose?

A. 90% chance of living for half a year in full health, followed by immediate death
   10% chance of living for 35 years in full health, followed by immediate death
B. 89% chance of living for half a year in full health, followed by immediate death
   11% chance of living for 15 years in full health, followed by immediate death

Appendix B: tables 1 to 6

Choice combination	N	Observed proportion	Test proportion	Two-sided p-value	α
AB or BA (irrational)	**8**	0,44	0,5	**0,815**	0,05
AA or BB (rational)	**10**	0,56			
Total	18	1,00			

Table 1. Results of binomial test on the variable 'choice combination'

Irrational choice combination	N	Observed proportion	Test proportion	Two-sided p-value	One-sided p-value	α
BA	**8**	1,00	0,5	0,008	**0,004**	0,05
AB	**0**	0,00				
Total	8	1,00				

Table 2. Results of binomial test on the variable 'irrational choice combination'

		Choice		
Treatment		BA	All other choices	Total
Control	Count	8	10	18
	%	**44,4%**	**56,6%**	100%
Gambler	Count	4	8	12
	%	**33,3%**	**66,7%**	100%
Total	Count	12	18	30

Table 3. Crosstab on choice per treatment with treatments 'control' and 'investor'

	χ^2	Degrees of freedom	Two-sided p-value	α
Pearson chi-square	0,370	1	**0,543**	0,05

Table 4. Results of Pearson chi-square test on treatments 'control' and 'gambler' and choice 'BA' and 'all other choices'

		Choice		
Treatment		BA	All other choices	Total
Control	Count	8	10	18
	%	**44,4%**	**56,6%**	100%
Investor	Count	5	5	10
	%	**50,0%**	**50,0%**	100%
Total	Count	13	15	28

Table 5. Crosstab on choice per treatment with treatments control and investor

	χ^2	Degrees of freedom	Two-sided p-value	α
Pearson chi-square	0,080	1	**0,778**	0,05

Table 6. Results of Pearson chi-square test on treatments 'control' and 'investor' and choice 'BA' and 'all other choices'

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