**ERASMUS UNIVERSITY ROTTERDAM**

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**Master Thesis Health Economics**

# Multivariate risk attitudes for quality of life and money

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# Abstract

This study attempts to establish the univariate and multivariate risk preferences of individuals for health and wealth. Risk attitudes toward correlation and cross-prudence are measured. An online questionnaire is used to elicit the risk preferences of individuals. Individuals face lotteries regarding different levels of health and wealth using the risk apportionment method. For univariate risk preferences, individuals are risk averse for both wealth and health. For multivariate risk preferences, individuals are correlation averse between health and wealth, cross-prudent for health and show neutrality for cross-prudence for wealth.

# Contents

# 1. Introduction

The Dutch medical insurance system changed drastically in 2006. This institutional reform established that each Dutch resident (with a minimum age of 18 years) is responsible for choosing his or her own health insurance. Dutch residents are obliged to have basic health insurance, which encompasses the minimum health insurance that should be available to every individual. Health insurance companies in the Netherlands also offer supplementary insurance, and individuals can choose supplementary insurance that meets their needs (such as coverage for dentistry, among others). The primary purpose of health insurance is to spread risk, specifically the risk of incurring (unexpected) substantial medical expenses. With risk spreading, individuals will likely not pay the full amount for such expenses (Zeckhouser, 1970). Individuals (i.e., those who are insured) pay for their health insurance (i.e., the premium), which affects their level of wealth, to receive medical care when required (Eeckhoudt et al., 2007). Usually, an individual's health will improve with medical care, but there is also uncertainty. An individual's decision to buy a specific health plan or to undergo, for example, a specific treatment also comes with uncertainty that cannot be eliminated. Uncertainty plays a role in every aspect of health and healthcare. By spending more on health insurance, the individual has less money available to spend on other goods and services. However, the risk of having to pay the full amount for medical care is reduced. These decisions under risk are multidimensional in that the preferences of the individual depend on several attributes, such as the level of wealth and the person's health. The individual is forced to trade-off between wealth and the type of health insurance plan chosen, which could affect his or her health. The individual's risk attitude affects this trade-off when facing uncertainty. Therefore, it is important to investigate the risk preferences of individuals in health-related decisions (Galizzi et al., 2016). According to recent literature on health and healthcare, the decisions made in multidimensional settings are driven by multivariate risk preferences. Decisions to purchase health insurance and many other health-related decisions occur in a multidimensional setting; these decisions are affected by risks and are mostly unexpected and uncontrollable. The decisions are driven by multivariate risk preferences such as correlation aversion and cross-prudence (Eeckhoudt et al., 2007). Individuals who are correlation-averse towards wealth and health prefer to disaggregate certain reductions in wealth and health. Under expected utility (EU), this would mean that the marginal utility of wealth increases when the individuals become unhealthy. Individuals who are cross-prudent for health and wealth can deal better with a health risk when they have more wealth (and vice versa).

As mentioned before, many health-related decisions involve uncertainty and risks. According to the literature, the risk preferences of individuals determine their behaviour. For example, Dardanoni and Wagstaff (1990) observed the role of uncertainty on the demand for medical care.

Bleichrodt et al. (2003a) observed that the willingness to pay (WTP) for health insurance depends on whether individuals are correlation-seeking for health and wealth. Bleichrodt et al. (2003b) also observed that the optimal treatment depends on multivariate risk preferences for wealth and quality of life. Rey and Rochet (2004) concluded in their study that demand for health plan is mostly driven by multivariate risk preferences for wealth and health. Despite its importance, there is little empirical evidence concerning multivariate risk preferences for health-related decisions in the health domain. Furthermore, there is no empirical evidence concerning demographic differences between individuals in health-related decisions. Individual demographic backgrounds could have an effect on risk preferences. In the light of these findings, it is important to investigate multivariate risk preferences. In this study, the univariate and multivariate risk preferences for wealth (money) and health (quality of life) are elicited in an experiment using the risk apportionment method put forward by Eeckhoudt et al. (2007). The risk apportionment method elicits multivariate risk preferences without the assumption that an individual maximises a certain preference using a model such as EU. This is important, because EU often fails in describing risky choices detailed in the health domain (Bleichrodt and Pinto, 2001).

The risk apportionment method elicits the risk preferences in a model-free way. This method is based on choices between pairs of simple lotteries; therefore, it is appropriate for experimentation. This study uses hypothetical outcomes for health (qol) and wealth (money), and, according to the literature, there are no systematic differences between hypothetical outcomes and real incentives for monetary outcomes (Abdellaoui et al., 2013). This study will be a useful contribution to the literature about risk preferences in the health domain by focusing on the univariate and multivariate risk preferences of individuals and determining whether there are differences between individuals based on their demographic backgrounds. This study investigates the risk preferences of individuals for health and wealth. Once the risk attitudes for money on qol and qol on money, cross risk attitude between money and qol and cross-prudence for money and for qol are established, the univariate and multivariate risk preferences of individuals for health and wealth can be determined.

In the process of this determination, the following sub-questions will also be investigated:

- Are the individuals risk averse?
- Are the individuals correlation averse for qol and money?
- Are the individuals cross-prudent for money and for qol?
- Are there differences between individuals based on demographic background?

This master's thesis is further organized as follows: Section 2 provides background information regarding risk attitudes and the risk apportionment method. In Section 3 the research methods are explained. Section 4 presents the main results, and in Section 5 these results are discussed and serves a conclusion to this study.

# 2. Background

## 2.1 Univariate risk preferences

Individuals' risk attitudes influence their decisions when facing uncertainty regarding the outcome. A way to define risk attitudes as described above is through investigating preferences regarding pairs of simple lotteries (Eeckhoudt and Schlesinger, 2006; Chiu et al., 2012). This approach establishes the relation between the risk attitude of the decision-maker and the amount of money and qol (Jouini, Napp and Nocetti, 2013). According to a recent study by Bleichrodt and Van Bruggen (2018), individuals show a trend of being risk-neutral for losses. In this study, the risk attitude for qol and money towards losses will be investigated. The expectation is that the individuals will show a neutral trend for risk attitude towards both qol and money.

To clarify, examples will be provided; these examples also explain the risk apportionment method on how to elicit the risk preferences of individuals. The first example concerns risk aversion for money, followed by an example regarding risk aversion for qol. To clarify, the examples show how to elicit the *univariate risk preferences.* For instance, an individual can choose between two situations, situation A and situation B. The outcome of these situations are imaginary lotteries concerning wealth (W) and health (H). Supposing that w1 and w2 are fixed monetary amounts and h1 and h2 are fixed health reductions, the remaining wealth and health will always be positive.

Risk aversion for wealth can be shown through these two situations:

Situation A

50% chance of living with H and W - w1

50% chance of living with H and W - w2

Situation B

50% chance of living with H and W - w1 - w2

50% chance of living with H and W

If the individual chooses situation A, it means that the individual is risk averse for wealth. If situation B is chosen, it means that the individual is risk-seeking for wealth. The individual combines the fixed monetary reductions and has a convex utility function (Eeckhoudt and Schlesinger, 2006).

Risk aversion for health can be shown through these two situations:

Situation A

50% chance of living with H - h1 and W

50% chance of living with H - h2 and W

Situation B
50% chance of living with H - h1 - h2 and W
50% chance of living with H and W

As explained above, if an individual chooses situation A, it means that the individual is risk averse for health. The individual separates the fixed health reductions and has a concave utility function. If situation B is chosen, it means that the individual is risk-seeking for health. The individual aggregates the fixed health reductions and has a convex utility function according to Eeckhoudt and Schlesinger (2006).

## 2.2 Multivariate risk preferences

It can also be the case that the individual faces reductions in both wealth and health at the same time. This is called *multivariate risk attitude*. For example, when an individual must pay for a particular drug or treatment that can improve his or her condition, the individual has to make a choice between wealth (money) and health (qol) with uncertainty regarding the outcome. The first who introduced this concept (correlation aversion) were Richard (1975) and Epstein and Tanny (1980) and according to Eeckhoudt et al. (2007) is it possible to describe multivariate risk attitudes through the risk apportionment method. To further clarify the risk apportionment method for correlation aversion between wealth and health, another example is provided.
Cross risk aversion for wealth and health can be shown through these two situations:
Situation A
50% chance of living with H and W - w1
50% chance of living with H - h2 and W
Situation B
50% chance of living with H - h2 and W - w1
50% chance of living with H and W

If the individual chooses situation A, the individual separates the losses on wealth and health, which implies that the individual is correlation-averse. A correlation-averse individual would prefer higher wealth in the event of poorer health. If the individual chooses situation B, this implies that the individual is cross-seeking between health and wealth. The individual aggregates the fixed reductions on wealth and health, which implies that the individual is looking for a higher level of wealth in the event of better health. According to Bleichrodt et al. (2003b), individuals are correlation-seeking. Therefore, the expectation in this study is that individuals are correlation-seeking between qol and money.

Another type of multivariate risk attitude is cross-prudence; this is introduced by Eeckhoudt et al. (2007). Cross-prudence depends on the zero-mean risk. According to Eeckhoudt and Schlesinger (2006), for any nth-order risk attitude, it is possible to define the cross-prudence through risk apportionment by considering the apportionment of zero-mean wealth and health risks rather than fixed wealth and health reductions. A cross-prudent individual in wealth and health implies that the individual can deal better with a health risk when he or she has more wealth (and vice versa). To define cross-prudence, the fixed reductions w2 and h2 are replaced by respectively zero mean risk wealth and health namely: $\tilde{w}$ 2 and h̃2.

Cross-prudence for wealth can be shown through these two situations:
Situation A
50% chance of living with H and W - w1
50% chance of living with H + h̃2 and W
Situation B
50% chance of living with H + h̃2 and W - w1
50% chance of living with H and W

An individual is cross-prudent in wealth if the individual prefers situation A over situation B. An individual who is cross-prudent for wealth prefers to disaggregate the fixed wealth reduction and the zero-mean risk in health in two different states instead of combining them into one state.

Cross-prudence for health can be shown through these two situations:
Situation A
50% chance of living with H - h1 and W
50% chance of living with H and W + $\tilde{w}$ 2
Situation B
50% chance of living with H - h1 and W + $\tilde{w}$ 2
50% chance of living with H and W

The individual is cross-prudent in health if the individual prefers situation A over situation B. An individual who is cross-prudent for health prefers to disaggregate the fixed health reduction and the zero-mean risk in wealth in two different states instead of combining them into one state. According to Edwards (2008), the individuals are cross-prudent for both wealth and health. When the health risks are unclear, the motivation for risk decreases. The expectation in this study is that individuals are cross-prudent for wealth and health.

# 3. Research Methods

## 3.1 Data collection

For this study, a survey designed using thesistoolspro was used. There were two links, one which starts with the less risky option and the other with the riskier option. The reason for this was to randomize the position of the lottery. The links for the survey were distributed through social media, such as LinkedIn and Facebook, and through WhatsApp to those individuals in the author's immediate surroundings. To increase the generalisability, there should be a response to the questionnaire by as many individuals as possible. Therefore, the links were also distributed on random Facebook pages to ensure that the respondents in the survey were not only individuals from the immediate surroundings. The data obtained is completely anonymous, and it is not possible to track down a specific participant. The questionnaire was completed by participants who live in the Netherlands, individuals 18 years or older. In total, 161 respondents finished the survey. Out of the 255 respondents who started the questionnaire, only 167 respondents finished it, and six respondents were below the age of 18. These respondents were removed from the list because only individuals aged 18 and up are obliged to have health insurance in the Netherlands. After this removal, 161 participants remained.

## 3.2 Experiment

The questionnaire started with a written introduction regarding the topic. In the introduction, the purpose of the experiment is explained, general instructions about the experiment are provided, and an example is included to provide a clear idea of the context. Furthermore, the questionnaire consists of two parts. The first part consists of six demographic questions to determine whether the participations are older than 18 years and establish any differences concerning gender, cultural background, socioeconomic status and highest level of education. The numbers obtained could be too low for statistical purposes, but will be used due to time constraints. The second part consists of questions regarding the elicitation of univariate and multivariate risk preferences for money and qol. There were 15 questions concerning this topic. The endowment of the participants was full health and an annual income of 40,000 euro for one year, followed by death. The amount of 40,000 euro was used because this is the average income of a household in the Netherlands. The participants were faced lotteries that only included loss of income and health. The losses in health are shown in percentage of qol. There was no further explanation regarding the reductions in health to keep it as simple as possible for the participants. The participants had to answer a question to continue to the next question; this ensured that they were obliged to answer every question and could not change their answers afterwards.

The questions regarding money and qol consisted of two hypothetical options. Each option was an imaginary lottery. The outcomes of the imaginary lotteries included both money and health status. There is an equal chance for both lotteries to occur. However, one lottery is riskier compared to the other, which made it possible to trace the participant's risk attitude. These questions are reliable because of the solid underlying theoretical framework put forward by Eeckhoudt et al. (2007). To trace the participant's risk attitude, the second part of the survey was divided in five components, as presented in Table 1. The first component of the hypothetical questions measured the univariate risk attitude to money (questions 7 to 9). In this component, the participants had to choose their preferred option between a risky and less risky lottery on money. The qol for this component was full health. The second component measures the univariate risk attitude to qol (questions 10 to 12). A fixed annual income of 40,000 euro was used for this component. The participants had to choose between a risky and a less risky lottery on qol. The third component measures the cross-risk attitude for money and qol (questions 13 to 15). For this component, different levels of money and qol were used to determine whether cross-risk attitudes for money and qol would change for different levels of money and qol. The participants had to choose between a lottery where a low qol was combined with a high level of money and a low level of money combined with a high qol, or a lottery where a low qol was combined with a low level of money and a high qol was combined with a high level of money. The fourth component concerned cross-prudence for money (questions 16 to 18). In this component, a level of money was added to the lotteries. The participant had to choose between a lottery where full health is combined with two levels of money and level of qol is combined with an annual income of 40,000 euro or a lottery where level of qol was combined with two different levels of money and full health is combined with 40,000 euro. The last component concerned cross-prudence of qol (questions 19 to 21). In this case, a level of qol was added to the lotteries.

## 3.3 Analysis

The participants were categorized based on their preferences. A participant was categorized to a risk trait if the majority (out of three) of the answers were consistent with that trait. This method allows the ranking of the participants' preferences without the assumption that individuals maximize a certain preference model such as EU. Therefore, this study is model-free and, even when a preference model such as EU fails in describing the chosen behaviour, this study holds validity (Starmer, 2000). Furthermore, at the aggregate level, the mean number and average percentage of choices in the task was presented. One-sided binomial tests were also performed for comparison between the percentage of the participants and 50%. Series of chi-squared tests were performed. To determine whether the observed distribution of preferences diverges from the distribution, the participations were chosen at random.

*Table 1: Choice task*

| Task | Trait | Situation A | Situation B | Choice% |
|---|---|---|---|---|
| 1 | Risk Aversion for Wealth | [(Full Health, 40-5 €); (Full Health,40-10 €)] | [(Full Health, 40-5-10 €); (Full Health, 40 €)] | 65.8% |
| 2 | | [(Full Health, 40-15 €); (Full Health,40-10 €)] | [(Full Health, 40-15-10 €); (Full Health, 40 €)] | 73.5% |
| 3 | | [(Full Health, 40-17 €); (Full Health,40-13 €)] | [(Full Health, 40-17-13 €); (Full Health, 40 €)] | 76.8% |
| 4 | Risk Aversion for Quality of Life | [(90% of Full Health, 40 €); (80% of Full Health,40 €)] | [(70% of Full Health, 40 €); (100% of Full Health,40 €)] | 60.6% |
| 5 | | [(75% of Full Health, 40 €); (70% of Full Health,40 €)] | [(45% of Full Health, 40 €); (100% of Full Health,40 €)] | 80.0% |
| 6 | | [(85% of Full Health, 40 €); (45% of Full Health,40 €)] | [(30% of Full Health, 40 €); (100% of Full Health,40 €)] | 59.4% |
| 7 | Correlation Aversion | [(80% of Full Health, 40 €); (100% of Full Health,40-10€)] | [(80% of Full Health, 40-10 €); (100% of Full Health,40 €)] | 48.4% |
| 8 | | (60% of Full Health, 40 €); (100% of Full Health,40-15€)] | [(60% of Full Health, 40-15 €); (100% of Full Health, 40 €)] | 53.5% |
| 9 | | (45% of Full Health, 40 €); (100% of Full Health,40-23€)] | [(45% of Full Health, 40-23 €); (100% of Full Health,40 €)] | 54.0% |
| 10 | Cross-Prudence for Wealth | [(Full Health, 40+ (-5 or -15) €); (80% of Full Health,40 €)] | [(80% of Full Health, 40+ (-5 or -15) €); (Full Health,40 €)] | 53.5% |
| 11 | | [(Full Health, 40+ (-20 or -30) €); (60% of Full Health,40 €)] | [(60% of Full Health, 40+ (-20 or -30) €); (Full Health,40 €)] | 56.1% |
| 12 | | [(Full Health, 40+ (-12 or -17) €); (60% of Full Health,40 €)] | [(60% of Full Health, 40+ (-12 or -17) €); (Full Health,40 €)] | 55,9% |
| 13 | Cross-Prudence for Quality of Life | [((80% or 40% of) Full Health, 40 €); (Full Health,40-20 €)] | [((80% or 40% of) Full Health, 40-20 €); (Full Health,40€)] | 53.5% |
| 14 | | [((70% or 30% of) Full Health, 40 €); (Full Health,40-25€)] | [((70% or 30% of) Full Health, 40-25 €); (Full Health,40€)] | 59.4% |
| 15 | | [((65% or 45% of) Full Health, 40 €); | [((65% or 45% of) Full Health, 40-10 €); | 68.1% |

| | | | | |
|---|---|---|---|---|
| | | (Full Health,40-10€)] | (Full Health,40€)] | |

*Note: All amounts are in euros x 1,000.*

# 4. Results

## 4.1 Univariate Risk preferences

In Table 2, the univariate risk preferences at the aggregate level are presented. It shows the mean number of choices and also the standard deviation, which was computed over the three choices. The mean number of choices shows a risk averse attitude of the participants for both wealth and health.

*Table 2: Univariate Risk Preferences Aggregate*

| | Mean | Standard deviation |
|---|---|---|
| Risk Aversion, Wealth | 0.86 | 1.36 |
| Risk Aversion, Quality of life | 0.82 | 1.34 |

Table 3 shows the univariate risk preferences at the individual level. The individuals are more risk averse compared to risk-seeking for wealth and health. This is consistent with the results from Table 2. The majority of the participants are risk averse for both money and quality of life on both the aggregated level and individual level. This means that the participants are risk averse for money when qol is kept constant and that they separate the fixed monetary reductions (and vice versa). The individuals do not like taking risks regarding wealth and health and prefer to disaggregate the fixed monetary reductions (and vice versa). The table also shows the p-value of a one-sided binomial test for comparison between the percentage of the participants and 50%. The observation is that there are more risk averters compared to risk seekers and the proportion of risk averts is also significantly different from the 50%.

*Table 3: Classification of individuals by trait based on univariate risk preferences*

| | % of individuals | p-value |
|---|---|---|
| Risk Averse, Wealth | 71.4% | 0.001 |
| Risk Averse, Quality of life | 72.7% | 0.001 |

A chi-squared test was performed to determine whether the observed distribution of preferences diverge from the distribution that would be observed if the participants were to choose at random. This test showed that the participants' responses were not randomly chosen (p-value = 0.001). There is an association between risk averse for money and risk averse for qol.

## 4.2 Multivariate Risk preferences

In Table 4, the multivariate risk preferences at aggregated level are presented. The table shows the mean number of choices and also the standard deviation, which was computed over the three choices. The mean number of choices shows a cross-prudence neutrality for money, correlation aversion for money and qol and cross-prudence for qol.

*Table 4: Multivariate Risk Preferences Aggregate*

| | Mean | Standard deviation |
|---|---|---|
| Correlation aversion | 1.45 | 1.50 |
| Cross-Prudence, Wealth | 1,49 | 1.50 |
| Cross-Prudence, Quality of life | 1.27 | 1.49 |

In Table 5, the multivariate risk preferences at the individual level are presented. The table presents the p-value of a one-sided binomial test comparison between the percentage of the participants and 50%. The results are consistent with the risk preferences at aggregated level. The participants seem to be correlation averse between qol and money, this proportion of correlation averts is not different form the 50%. The participants disaggregate the fixed health and wealth reductions rather than aggregating the fixed health and wealth reductions.

The participants seem to be cross-prudent neutral for wealth and they seem to be cross-prudent for health, which means that the participants disaggregate the fixed health reduction and the zero-mean risk in wealth in two different states instead of combining them into one state. This implies that the participants can deal better with a wealth risk when they have higher qol. Furthermore, the proportion of participants who are cross-prudence for qol are significantly different from the 50% in either case.

*Table 5: Classification of individuals by trait based on multivariate risk preferences*

| | % of individuals | p-value |
|---|---|---|
| Correlation Aversion | 51.6% | 0.37 |
| Cross-Prudence, Wealth | 50.3% | 0.50 |
| Cross-Prudence, Quality of life | 57.8% | 0.03 |

Series of chi-squared tests were performed. These tests show that the participants' responses were not randomly chosen. There is significant association between cross-prudence for money and cross-prudence for qol (p-value = 0.001), correlation aversion and risk aversion for money (p-value = 0.002), correlation aversion and cross-prudence for qol (p-value = 0.001) and correlation aversion and cross-prudence for money (p-value = 0.001). There was no significant association found for correlation between aversion and risk aversion for qol (p-value = 0.192).

## 4.3 Demographics

### *4.3.1 Gender*

Sixty-three percent of the participants were female, and 37% were male. In Table 6, the univariate and multivariate risk preferences for male and female at the individual level are presented. The table presents the p-value of the one-sided binomial test comparison between the percentage of the participants and 50%. The difference between female and male is that male participants are cross-prudent for qol, while female participants are cross-prudent neutral for qol. This means that, compared to females, males can better deal with wealth risk when they have more health. Another difference is that males are correlation-seeking, while female participants show neutrality when it comes to correlation aversion. This implies that male participants disaggregate the fixed reductions in wealth and health more compared to the female participants. Furthermore, both risk averse males and females are, for both qol and money, significantly different from the 50%. The proportion of male participants who are cross-prudent for qol are also significantly different from the 50%.

*Table 6: Classification of individuals for male and female by trait based on univariate and multivariate risk preferences*

| | Male | | Female | |
|---|---|---|---|---|
| | % of the individuals | p-value | % of the individuals | p-value |
| Risk Averse for wealth | 72% | 0.001 | 71% | 0.001 |
| Risk Averse for qol | 72% | 0.001 | 73% | 0.001 |
| Correlation Averse | 57% | 0.183 | 49% | 0.421 |
| Cross-prudence for wealth | 53% | 0.350 | 49% | 0.421 |
| Cross-prudence for qol | 70% | 0.003 | 50% | 0.5 |

### *4.3.2 Cultural background*

Thirty-two percent of the participations were Dutch, 37% Turkish and 31% had different cultural backgrounds, such as Moroccan and Indonesian. In Table 7, the univariate and multivariate risk preferences for individuals with Dutch, Turkish and other backgrounds at the individual level are presented. The table presents the p-value of the one-sided binomial test comparison between the percentage of the respondents and 50%. The differences between the participants with different cultural background were that the participants with Turkish background are correlation-seeking, while the participants with Dutch cultural background are correlation averse between wealth and qol. Another difference is that participants with Dutch and other cultural backgrounds are cross-prudent for wealth and health compared to the participants with a Turkish background. This indicates that participants with Dutch and other cultural backgrounds can better deal with a health risk when the participants have a better wealth compared to the participants with Turkish background and that they can also deal better with a wealth risk when they are healthier compared to the participants with Turkish cultural background. Moreover, the proportion of the participants with Dutch, Turkish and other cultural backgrounds are significantly different from the 50% for risk aversion for both qol and money. Participants with Dutch cultural background are also significantly different for cross-prudence for qol from the 50%.

*Table 7: Classification of individuals with Dutch, Turkish and other cultural backgrounds by trait based on univariate and multivariate risk preferences*

| | Dutch background | | Turkish background | | Other | |
|---|---|---|---|---|---|---|
| | % of the individuals | p-value | % of the individuals | p-value | % of the individuals | p-value |
| Risk Averse for wealth | 73% | 0.001 | 71% | 0.001 | 68% | 0.0065 |
| Risk Averse for qol | 74% | 0.001 | 71% | 0.001 | 72% | 0.001 |
| Correlation Averse | 55% | 0.161 | 48% | 0.448 | 49% | 0.5 |
| Cross-prudence for wealth | 58% | 0.161 | 36% | 0.024 | 58% | 0.136 |
| Cross-prudence for qol | 68% | 0.008 | 48% | 0.448 | 58% | 0.136 |

### *4.3.3 Socio-economic status*

Fifty percent of the participants were students, 48% were employed, 2% were unemployed and none were retired. In Table 8, the univariate and multivariate risk preferences for individuals who are students and employed at individual level are presented. The table presents the p-value of a one-sided binomial test comparison between the percentage of the respondents and 50%. The differences between employed participants and students are that the employed participants are cross-prudent for qol, whereas students have a neutral attitude for cross-prudence for qol. This indicates that employed participants can deal better with wealth risk when they have more health. Moreover, both employed participants and students for risk averse both qol and money are significantly different from the 50%. Employed participants for cross-prudence for qol are significantly different from the 50%.

*Table 8: Classification of individuals by trait based on univariate and multivariate risk preferences*

| | Employed | | Student | |
|---|---|---|---|---|
| | % of the individuals | p-value | % of the individuals | p-value |
| Risk Averse for wealth | 69% | 0.001 | 75% | 0.001 |
| Risk Averse for qol | 68% | 0.002 | 78% | 0.001 |
| Correlation Averse | 58% | 0.1 | 44% | 0.184 |
| Cross-prudence for wealth | 50% | 0.50 | 48% | 0.411 |
| Cross-prudence for qol | 66% | 0.004 | 49% | 0.5 |

### *4.3.4 Education*

Twenty-five percent of the participations had an MBO, 39% had an HBO and 36% had university as highest level of education. In Table 9, the univariate and multivariate risk preferences for individuals with MBO, HBO and university as highest level of education at individual level are presented. The table presents the p-value of the one-sided binomial test comparison between the percentage of the participants and 50%. Participants with university as highest education are cross-prudent for wealth, while the participants with HBO as highest education are cross-imprudent for wealth. This implies that the participants with university as highest education can deal better with a health risk when the they have more wealth. Furthermore, participants with MBO, HBO and University as highest education level for risk aversion for both qol and money are significantly different from 50%. This is also the case for the participants with MBO as highest education level for cross-prudence for qol; they are also significantly different from 50%.

*Table 9: Classification of individuals with MBO, HBO and University background by trait based on univariate and multivariate risk preferences*

| | MBO | | HBO | | University | |
|---|---|---|---|---|---|---|
| | % of the individuals | p-value | % of the individuals | p-value | % of the individuals | p-value |
| Risk Averse for wealth | 68% | 0.019 | 69% | 0.002 | 76% | 0.001 |
| Risk Averse for qol | 70% | 0.001 | 73% | 0.001 | 75% | 0.001 |
| Correlation Averse | 55% | 0.318 | 53% | 0.352 | 54% | 0.3 |
| Cross-prudence for wealth | 50% | 0.5 | 44% | 0.187 | 58% | 0.149 |
| Cross-prudence for qol | 65% | 0.04 | 56% | 0.187 | 54% | 0.3 |

# 5. Discussion and conclusion

## 5.1 Discussion

This study has shown how univariate and multivariate risk preferences for health and wealth are measured in a direct way without modelling assumptions. Concerning univariate risk preferences, it shows that the participants are risk averse for losses of wealth and health. This implies that the participants do not like taking risks regarding wealth and health and prefer to disaggregate the fixed monetary reductions (and vice versa). These results are not in line with the study of Bleichrodt and Van Bruggen (2018); they found risk neutrality for losses for monetary outcomes.

Concerning multivariate risk preferences, the participations tend to be correlation averse between health and wealth. These results are also not in line with the results of the study of Bleichtodt et al. (2003). According to that study, individuals are correlation-seeking, while in this study, the participations seem to disaggregate fixed losses in wealth and health. Regarding demographics, the students and the participants with Turkish cultural background are cross-seeking between wealth and health, which is in line with the results of the study Bleichtodt et al. (2003).

Further research is required to verify the multivariate risk preferences between health (qol) and wealth (money). For example, this research could be extended by adding a stimulus and context to the risk preferences. Regarding wealth, this study involved only losses but could be expanded by also involving improvements in wealth. A context could also be added to this research to verify whether the risk attitude between health (qol) and wealth (money) depend on stimuli and the context of the risk preferences. A risk apportionment method can be used to test whether correlation attitudes between wealth and health depend on stimuli or that correlation attitudes between wealth and health are domain specific. According to Attema et al. (2019), has the sign of the outcomes a large impact on the choices that individuals made. Framing and sign-dependence are therefore more important in studies of higher order risk attitudes compared to what was previously thought. If an individual behaves differently for gains and losses, it is difficult to tell which preferences should be taken into consideration. Therefore, further research in sign effect is important while measuring multivariate risk preferences.

As discussed above, the risk apportionment method and hypothetical outcomes for health and wealth were used for this experiment. According to recent literature, there are no differences in the results of the hypothetical and the real-life outcome methods (Abdellaoui et al, 2013; Cohen

et al, 2016). Despite the advantages of this method, such as no need of assumption that individuals maximize a preference model such as EU and that the results of this method are easily comparable to existing literature. The risk apportionment method is a new elicitation method. There is a disadvantage, namely that the information which is elicited regarding the amount of risk aversion is limited. Future research could be done by using this method with a sample which is more representative of the public.

An implication of this study is that approximately 100 of the respondents who started the online questionnaire did not finish it. Most of the participants stopped responding to the online questionnaire after the first few questions regarding the risk preferences. If these participants had finished the online questionnaire, the sample would be more representative of the general public. A few explanations for this could be that the participants did not understand the questions, that it took too much time or the participants did not take it seriously. To prevent this from happening in future research, it can be explained at the start of the questionnaire that it is very important, and, once started, the questionnaire should be completed. A motivation for the participants could be to link it with a reward. Another approach to ensure that the participants understand the questionnaire would be to change the language to Dutch, since the participants could also have problems understanding the questions due the language and may have stopped responding for that reason.

## 5.2 Conclusion

This study used the risk apportionment technique put forward by Eeckhoudt et al. (2007) to measure the univariate and multivariate risk preferences for health (qol) and wealth (money) of individuals in order to answer the stated research question. Concerning univariate risk preferences for health and wealth, it can be concluded from this study that individuals are risk averse for both, which indicates that the individual does not like to take risks for health and wealth and prefers to separate the fixed reductions in both wealth and health. Concerning multivariate risk preferences, it can be concluded that individuals seem to be correlation averse between health (qol) and wealth (money). In this aspect, the students and participants with Turkish cultural background were cross-seeking. The participants were cross-prudent for health and neutral for cross-prudence for wealth. Regarding the demographic differences, male participants were more cross-prudent for health compared to female participants. The differences between the participants with different cultural background were that the participants with Turkish background were correlation-seeking, while the participants with Dutch cultural background were correlation averse between wealth and qol. Another difference among cultural background is that participants with Dutch and other cultural background were cross-prudent for wealth and health compared to the participants with Turkish background. The

difference between the employed participants and students was that the employed participants were cross-imprudent for health, while students were not. Last, the participants with university as highest education were cross-prudent for wealth, while the participants with HBO as highest education were cross-imprudent for wealth.

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# 7. Appendices: Questionnaire

**1.How old are you**

A. <18
B. 18 - 25
C. 26 – 35
D. 36 – 45
E. 46 – 55
F. 56 – 65
G. 65+

**2. What is your social economic status?**

A. Student
B. Employed
C. Unemployed
D. Retired

**3. What is your gender?**

A. Female
B. Male

**4. What is yout religion?**

A. Islam
B. Christianity
C. Atheist
D. Other

**5. What is your highest level of education?**

A. MBO
B. HBO
C. University

**6. What is your cultural background?**

A. Dutch
B. Turkish
C. Maroccan
D. Indonesian
E. Other

**7. What is your most preferred option?**

Assume you were able to choose between 2 situations.

Situation A:
50% chance of living with full health with an income of 35.000 euro
50% chance of living with full health with an income of 30.000 euro
or
Situation B:
50% chance of living with full health and an income of 25.000 euro
50% chance of living with full health and an income of 40.000 euro

A. Situation A
B. Situation B

**8. What is your most preferred option?**

Assume you were able to choose between 2 situations.

Situation A:
50% chance of living with full health with an income of 25.000 euro
50% chance of living with full health with an income of 30.000 euro
or
Situation B:
50% chance of living with full health and an income of 15.000 euro
50% chance of living with full health and an income of 40.000 euro

A. Situation A
B. Situation B

**9. What is your most preferred option?**

Assume you were able to choose between 2 situations.

Situation A:
50% chance of living with full health with an income of 23.000 euro
50% chance of living with full health with an income of 27.000 euro
or
Situation B:
50% chance of living with full health and an income of 10.000 euro
50% chance of living with full health and an income of 40.000 euro

A. Situation A
B. Situation B

**10. What is your most preferred option?**

Assume you were able to choose between 2 situations.

Situation A:
50% chance of living with 90% of full health with an income of 40.000 euro
50% chance of living with 80% of full health with an income of 40.000 euro
or
Situation B:
50% chance of living with 70% of full health and an income of 40.000 euro
50% chance of living with 100% of full health and an income of 40.000 euro

A. Situation A
B. Situation B

**11. What is your most preferred option?**

Assume you were able to choose between 2 situations.

Situation A:
50% chance of living with 75% of full health with an income of 40.000 euro
50% chance of living with 70% of full health with an income of 40.000 euro
or
Situation B:
50% chance of living with 45% of full health and an income of 40.000 euro
50% chance of living with 100% of full health and an income of 40.000 euro

A. Situation A
B. Situation B

**12. What is your most preferred option?**

Assume you were able to choose between 2 situations.

Situation A:
50% chance of living with 85% of full health with an income of 40.000 euro
50% chance of living with 45% of full health with an income of 40.000 euro
or
Situation B:
50% chance of living with 30% of full health and an income of 40.000 euro
50% chance of living with 100% of full health and an income of 40.000 euro

A. Situation A
B. Situation B

**13. What is your most preferred option?**

Assume you were able to choose between 2 situations.

Situation A:
50% chance of living with 80% of full health with an income of 40.000 euro
50% chance of living with 100% of full health with an income of 30.000 euro
or
Situation B:
50% chance of living with 80% of full health and an income of 30.000 euro
50% chance of living with 100% of full health and an income of 40.000 euro

A. Situation A
B. Situation B

**14. What is your most preferred option?**

Assume you were able to choose between 2 situations.

Situation A:
50% chance of living with 60% of full health with an income of 40.000 euro
50% chance of living with 100% of full health with an income of 25.000 euro
or
Situation B:
50% chance of living with 60% of full health and an income of 25.000 euro
50% chance of living with 100% of full health and an income of 40.000 euro

A. Situation A
B. Situation B

**15. What is your most preferred option?**

Assume you were able to choose between 2 situations.

Situation A:
50% chance of living with 45% of full health with an income of 40.000 euro
50% chance of living with 100% of full health with an income of 16.000 euro
or
Situation B:
50% chance of living with 45% of full health and an income of 17.000 euro
50% chance of living with 100% of full health and an income of 40.000 euro

A. Situation A
B. Situation B

**16. What is your most preferred option?**

Assume you were able to choose between 2 situations.

Situation A:
50% chance of living with 100% of full health with an income of 35.000 or 25.000 euro
50% chance of living with 80% of full health with an income of 40.000 euro
or
Situation B:
50% chance of living with 80% of full health and an income of 25.000 or 35.000 euro
50% chance of living with 100% of full health and an income of 40.000 euro

A. Situation A
B. Situation B

**17. What is your most preferred option?**

Assume you were able to choose between 2 situations.

Situation A:
50% chance of living with 100% of full health with an income of 20.000 or 10.000 euro
50% chance of living with 60% of full health with an income of 40.000 euro
or
Situation B:
50% chance of living with 60% of full health and an income of 20.000 or 10.000 euro
50% chance of living with 100% of full health and an income of 40.000 euro

A. Situation A
B. Situation B

**18. What is your most preferred option?**

Assume you were able to choose between 2 situations.

Situation A:
50% chance of living with 100% of full health with an income of 28.000 or 23.000 euro
50% chance of living with 60% of full health with an income of 40.000 euro
or
Situation B:
50% chance of living with 60% of full health and an income of 28.000 or 23.000 euro
50% chance of living with 100% of full health and an income of 40.000 euro

A. Situation A
B. Situation B

**19. What is your most preferred option?**

Assume you were able to choose between 2 situations.

Situation A:
50% chance of living with 80% or 40% of full health with an income of 40.000 euro
50% chance of living with 100% of full health with an income of 20.000 euro
or
Situation B:
50% chance of living with 80% or 40% of full health and an income of 20.000 euro
50% chance of living with 100% of full health and an income of 40.000 euro

A. Situation A
B. Situation B

**20. What is your most preferred option?**

Assume you were able to choose between 2 situations.

Situation A:
50% chance of living with 70% or 30% of full health with an income of 40.000 euro
50% chance of living with 100% of full health with an income of 15.000 euro
or
Situation B:
50% chance of living with 80% or 40% of full health and an income of 15.000 euro
50% chance of living with 100% of full health and an income of 40.000 euro

A. Situation A
B. Situation B

**21. What is your most preferred option?**

Assume you were able to choose between 2 situations.

Situation A:
50% chance of living with 65% or 45% of full health with an income of 40.000 euro
50% chance of living with 100% of full health with an income of 30.000 euro
or
Situation B:
50% chance of living with 65% or 45% of full health and an income of 30.000 euro
50% chance of living with 100% of full health and an income of 40.000 euro

A. Situation A
B. Situation B