

Nijmegen School of Management
Department of Economics and Business Economics
Master's Thesis Economics (MAN-MTHEC)

RISK PREFERENCES AND THE EFFECT OF A SUBSISTENCE LEVEL

By STEEF BERKELJON (S1028322)

Nijmegen, 30 June 2024

Program: Master's Program in Economics
Specialisation: Financial Economics
Supervisor: Jorgo Goossens

Radboud Universiteit



Risk preferences and the effect of a subsistence level

Steef Berkeljon (s1028322)

Supervisors:

Jorgo Goossens (Radboud University & APG)

Bart Kuijpers (APG)

Rob van den Goorbergh (APG)

June 30, 2024

Abstract

Due to changes in Dutch pension legislation, pension funds are required to elicit risk preferences of participant age cohorts at least every five years. Given the pillars of the Dutch pension system, it brings up the question on how subsistence needs are viewed by individuals. The assumption of CRRA utility suggests that individual subsistence requirements do not affect risk preferences, but we expect that it might. We use an adjusted version of the choice sequence risk elicitation method to test the assumption and identify behaviour contradicting CRRA utility on an individual level. Although we find a deviation from CRRA utility, our findings suggest that it is not due to individuals taking their subsistence needs into consideration during income gambles. These results can have multiple implications for pension funds, including important policy consequences for individual investment strategies.

Acknowledgements

I would like to thank my university supervisor dr. Jorgo Goossens and company supervisors dr. Bart Kuijpers and dr. Rob van den Goorbergh for their support and supervision during this project. I was fortunate enough to be given the opportunity to write my thesis at the Research & Analytics department of APG Asset Management, for which I want to thank my supervisors and APG. Finally, I would like to thank the remaining members of the Research & Analytics team and the other interns for their contributions and feedback.

Summary

In this paper, we test the assumption of CRRA utility and study the correlation between subsistence level and risk preferences using the choice sequence risk elicitation method from Barsky et al. (1997). We conduct an experiment using a student sample and present participants with two different hypothetical incomes to test whether their behaviour follows CRRA utility. Our results show that the majority of respondents do not act according to CRRA utility. We hypothesized that the discrepancy with the literature assumption would be the result of individuals incorporating their subsistence needs in their decisions concerning risk. However, we found no correlation between self-reported required subsistence level and risk aversion. We also did not find a correlation between risk preferences and cognitive uncertainty. Overall, this study provides a practical method of testing the assumption of CRRA utility in an income context. Our findings give new insights into the phenomenon of risk aversion and the subsistence considerations of individuals.

Table of Contents

| | |
|--|----|
| 1. Introduction | 4 |
| 2. Background | 5 |
| 2.1. Institutional landscape | 5 |
| 2.2. Risk elicitation..... | 6 |
| 2.3. Risk aversion | 7 |
| 2.4. Hypotheses | 8 |
| 3. Sample | 9 |
| 4. Method | 10 |
| 5. Univariate analysis | 13 |
| 6. Multivariate analysis | 18 |
| 7. Robustness tests..... | 22 |
| 7.1. Alternative dependent variables | 22 |
| 7.2. Pension professionals | 24 |
| 7.3. Choice sequence | 25 |
| 8. Considerations | 26 |
| 8.1. Subsistence level | 26 |
| 8.2. Status quo bias..... | 28 |
| 9. Discussion and conclusion | 28 |
| References | 30 |
| Appendix A | 33 |
| Appendix B | 35 |
| Appendix C | 47 |
| Appendix D | 50 |

1. Introduction

Following changes in Dutch pension legislation implemented during 2023, pension funds are now required to measure risk attitudes at least every five years and specify the attitude of participants per age cohort to improve the alignment with investment strategy (Pensioen Federatie, 2022). Risk attitude consists of risk capacity and risk preference. Risk capacity is the extent to which individuals can bear investment risks and withstand financial losses without jeopardizing their financial stability. Risk preference is defined as how much financial risk a person is willing to take. In this paper, we will focus only on risk preferences.

To measure risk preferences, pension funds can utilise one of many different risk preference elicitation methods (REM's) in their studies. However, they might run into obstacles when conducting these studies. Dutch retirees do not only build up a pension via their employer and by having private retirement savings, they also receive a guaranteed state pension that serves as a risk-free base income for the elderly. It is unrelated to working years and safe from market fluctuations, as opposed to other forms of pension. This base income can only provide for the bare necessities in life, hereby functioning as a subsistence level¹. Well-known REM's (Barsky et al., 1997; Holt & Laury, 2002; Eckel & Grossman, 2002, 2008) do not take a subsistence level into consideration and it is unknown what effect it would have on the preferences of individuals.

This paper addresses the question: do individuals take a subsistence level into account when declaring risk preferences? Answering this question will add to the literature by improving our understanding of risk preferences, while it can also help pension funds in setting up their risk preference studies. We hypothesize that a subsistence level is not considered in decisions concerning risk based on the assumption in literature that relative risk aversion is constant (Barsky et al., 1997; Holt & Laury, 2002; Eckel & Grossman, 2008; Andreoni & Sprenger, 2012; Crosetto & Filippin, 2013). Constant relative risk aversion (CRRA) indicates that individuals want to take similar percentages of risk for different levels of income. However, individuals may act inconsistent with our hypothesis and display a relative risk aversion that is not constant. If so, we hypothesize that a subsistence level is the cause of this behaviour.

We set up a questionnaire that follows the experimental design from Barsky et al. (1997) by using their choice sequence list (CS) as the method for eliciting risk preferences. We employ the CS approach for several reasons. First, it adheres to all the requirements set by the Dutch financial regulatory authority (AFM, 2023). Second, the method is used in practice since APG (the largest pension provider in the Netherlands) uses it for its risk preference studies. Finally, the method allows for the necessary adjustments needed to conduct this study.

The original CS method presents participants with a question that lets them choose between their current job income and a new job that has a risky income; there is a 50-50 chance that it can either be lower or higher than their current income. After they have picked either of the two jobs, they are asked a follow-up question that is similar to the first. However, the risk level of the new job's income changed and has either increased or decreased, depending on the answer given in the first question. With the final answers, participants can be distributed into four different risk aversion categories and, thus, their willingness to take risk can be approximated.

In our study, we expand the CS setup to three follow-up questions instead of one, resulting in sixteen risk aversion categories instead of four. In the starting question, participants are presented with a hypothetical income that is based on the average income in the Netherlands in 2024. We mainly use a hypothetical income because the survey group consists of students who do not have a full-time job income yet.

¹ We define subsistence level as an income that provides only for the bare necessities in life.

We want to know whether individuals answer differently if the income changes and, thus, the questionnaire also contains another CS set which has doubled the hypothetical income. Similar answers for both levels of income would indicate that individuals act in line with CRRA utility. To test whether potential inconsistencies in answers are the result of a subsistence level, we ask participants about the subsistence level that they require. In addition, after each CS set, participants are asked how confident they are about their final choice. A recent study (Enke & Graeber, 2023) has found that cognitive uncertainty affects economic decision making and following up on their results, this study tests if risk aversion is correlated with cognitive uncertainty.

The complete questionnaire was distributed under students from two university courses, an undergraduate economics and a graduate finance course. The final sample consists of 108 respondents. To test for robustness, another, almost identical, questionnaire was distributed in a course for pension professionals. We use this sample (N=11) to analyse potential differences between the students and professionals in the field.

Our findings seem to suggest that, *on average*, participants answer questions concerning income gambles consistently for different levels of income. However, *on an individual level*, only 20.4% of participants act consistent between both CS sets and give similar answers in both choice sequences. The percentage increases to 41.7% when allowing for a margin of one category. Even then, less than half of the respondents act in line with CRRA utility. This behaviour does not seem to be caused by subsistence level requirements, as we find no correlation between risk aversion and self-reported required subsistence level. Our results also indicate that there is no relationship between risk aversion and cognitive uncertainty. Finally, although we find different risk aversion levels than Barsky et al. (1997), results are similar for the student and professionals sample with statistically insignificantly different risk aversion levels for these two groups. In general, more research is needed to test whether our results are robust and provide evidence opposite to literature assumptions. Still, this paper gives new insights into the phenomenon of risk aversion, in particular regarding the assumption of CRRA and the presence of a subsistence level.

The remaining part of this paper is structured as follows. In section 2, we provide an overview of the Dutch institutional pension landscape, risk elicitation, risk aversion and our hypotheses. Section 3 describes the sample, while we elaborate on the experimental setup in section 4. Section 5 and 6 discuss univariate and multivariate analyses, respectively. Robustness tests are provided in section 7. Finally, section 8 gives some considerations, while section 9 discusses the results and concludes.

2. Background

In this section, we provide a short overview of the institutional pension landscape of the Netherlands and the requirements set by legislators for the risk preference studies of pension funds. After, we discuss the different REM's that adhere to these requirements, elaborate on why we opted for a CS approach and explain the concept of risk aversion. This section concludes with our hypotheses.

2.1. Institutional landscape

In the Netherlands, retirees receive a pension that usually consists of three pillars. The government provides retirees with the first pillar, which is the base pension income. According to the 1956 Dutch law 'Algemene Ouderdomswet', Dutch citizens are entitled to this minimum pension wage, with the amount depending on the number of years lived in the Netherlands. An employer and employee build up the pension that is part of pillar two together. It is a pension income that individuals receive on top of the base pension, given that they had a job. Unlike pillar one, the amount of pillar two depends on the economic situation in the years that a pension was built and the moment of retirement. Pension

funds invest the pension savings in the market, therefore it can always end up being lower or higher than expected. Outcome variance depends on the risk pension funds take when investing, which in turn is determined by the mean risk attitude of pension population cohorts. Finally, pillar three consists of a pension that individuals have saved up privately.

The new pension act implemented on July 1st 2023 has brought considerable changes to the pension landscape in the Netherlands. Before the implementation of the new pension act, pension funds could assume one risk attitude for their whole population and studies for determining and testing risk attitudes were not mandatory (Pensioen Federatie, 2022). With the implementation of the new pension act, pension funds have to conduct a risk preference study at least once every five years, with which they determine their participants' risk preferences per age cohort². Legislation has also set design requirements for the studies. Results must be objective, systematic, reproducible, verifiable and quantitatively interpretable, while the study needs to give a realistic image of the expected pension payments (Pensioen Federatie, 2022). Additionally, the Dutch Authority Financial Markets requires that risk preference studies adhere to the FRAME criteria (Van de Meeren et al., 2019), a framework developed for the Dutch pension industry. The framework states that, in order to be appropriate for assessing willingness to take financial risk, the REM used in a study has to at least be *feasible, rationalising, appropriate, measurable and errable*. More specifically, a REM is *feasible* if it is comprehensible and does not require too much effort from respondents; it should limit the effects of irrational behaviour (*rationalising*); it is *appropriate* for the pension context; results are *measurable* if they are quantitatively and objectively interpretable; the method needs to be able to identify participants who do not understand the questions (*errable*) (AFM, 2023).

In the next part, we go more in depth into REM's and discuss those that adhere to the requirements mentioned above and some that do not.

2.2. Risk elicitation

Risk preference elicitation is not only a relevant topic in the Dutch pension landscape, it is also a much discussed subject in the literature. It is difficult to elicit a person's risk preference as it cannot be directly observed (Van de Meeren et al., 2019). Still, many REM's have been developed to uncover individual preferences. Of the different methods, only a selection adheres to the FRAME-framework, namely the CS approach from Barsky et al. (1997), the multiple choice list (MCL) by Holt & Laury (2002), the convex time budgets method (CTB) by Andreoni & Sprenger (2012) and finally, the distribution builder from Goldstein et al. (2008) and Donkers et al. (2013). The balloon analogue risk task by Lejuez et al. (2002) and the "bomb" risk elicitation task from Crosetto & Filippin (2013), two other well-known REM's, do not adhere to the framework as they are not appropriate for the pension context and outcomes are not quantitatively measurable. The single choice list by Eckel & Grossman (2002, 2008) is appropriate and measurable, but it cannot identify whether participants have understood the questions correctly.

As mentioned in the introduction, we apply CS in this study. A more thorough explanation will be provided in section 4, but in essence, CS requires individuals to answer a sequence of questions where successive questions depend on the answer given in the previous question. Risk preference is determined by the final outcome of an individual.

The MCL method presents individuals with two gambles which have different levels of risk and expected payoffs. Individuals have to choose the gamble they prefer, after which they have to make similar decisions nine more times for a total of ten times. The riskier gamble will become less risky over time with the expected payoff becoming higher, eventually surpassing the expected payoff of the safer

² An age cohort typically consists of five years.

gamble. Risk preferences can be elicited by looking at which gamble pair an individual switches. We do not use this method in our study since the classic MCL approach is more likely to elicit probability weighting (Tversky & Kahneman, 1992) rather than risk preferences when probabilities vary (Drichoutis & Lusk, 2016). Keeping the probabilities constant in CS minimizes the chance that differences in elicited risk aversion are driven by probability weighting. CS also prevents multiple switching points, which can be another issue of the MCL; the switching point of individuals depends on which gamble pairs are shown to them (Bosch-Domènech & Silvestre, 2013).

The CTB method measures risk and time preferences by giving individuals a budget and letting them allocate it between a payment early in the future and at a later point in time. The payment later in the future is always higher, so individuals have to choose between receiving a payment sooner and receiving a higher return. In total, they have to allocate a budget 45 times, with the early payment date, later payment date and the time between these two dates fluctuating. Payments also fluctuate and as a result, the interest rate too. Changing these variables and seeing how individuals respond gives the possibility to calculate risk and time preferences. We do not use the CTB method as it mainly focuses on time preferences and we are not interested in time in this study. Furthermore, participants usually make more decisions, which makes the questionnaire too long for our purpose.

The distribution builder is an interactive tool that allows individuals to participate in a hypothetical investment task with a trade-off between risk and return (Donkers et al., 2013). In the distribution builder, participants have to allocate probabilities to different income outcomes. They can decide to take no risk and receive the reference income with certainty or to take risk with the potential of receiving a higher income. Participants determine how much risk they want to take; the more risk they are willing to take, the higher the expected income will be. Given a cost constraint, they have to allocate the probabilities in a balanced way as the expected income cannot be unfeasibly high. The final distribution of the probabilities is used to determine an individual's risk preference. Although the distribution builder is a frequently applied REM in the industry, we do not use it as CS is easier to implement. In addition, CS better fits our study as it gives the possibility to add a second, higher income to the analysis.

It is important to note that multiple studies (Crosetto & Filippin, 2016; Pedroni et al., 2017; Holzmeister & Stefan, 2021; Goossens et al., 2023) have found different levels of risk aversion depending on the elicitation method used. This means that the average risk aversion found by Barsky et al. (1997) using CS can be substantially different when using another REM. This phenomenon is still unexplained and is therefore called the risk elicitation puzzle. The elicitation puzzle gives reason to be cautious with interpreting any REM result. However, results prove to be valuable when compared to studies that use the same elicitation approach. It is still unknown which REM is the best for risk preference elicitation due to the puzzle. We opted for CS, but other studies might prefer a different method that better fits their research question.

2.3. Risk aversion

Risk elicitation methods are used to measure risk preferences, more specifically, risk aversion. Risk aversion is the tendency to avoid risks, resulting in individuals preferring sure outcomes over gambles if the expected payment is equal. In other words, risk averse individuals require a risk premium on the expected value of a gamble for them to choose this gamble over the certain equivalent of the expected value (Pratt, 1964). Consequently, more risk averse individuals require a higher premium. Individuals are risk neutral if they do not require a premium and they are risk seeking if they are willing to pay a premium for the gamble.

We use the model of expected utility to capture risk aversion and abstain from using alternative models like loss aversion and probability weighting (Kahneman & Tversky, 1979; Tversky &

Kahneman, 1992; O'Donoghue & Somerville, 2018). According to prospect theory, loss aversion and probability weighting could explain risk aversion.³ Thus, we control, to a large extent, for probability weighting by keeping the probabilities equal in the CS questions of the questionnaire, whilst including a question that controls for loss aversion.

Pratt (1964) and Arrow (1965) combine wealth and the utility stemming from wealth with the expected utility model to quantify risk aversion. They distinguish two forms of risk aversion, absolute and relative. Absolute risk aversion (ARA) indicates that when the wealth of an individual increases or decreases, the absolute amount of wealth invested in risky assets changes. If individuals invest a higher (lower) amount in risky assets when their wealth increases, they exhibit decreasing (increasing) ARA. If the absolute amount of wealth invested in risky assets remains constant after a wealth increase or decrease, individuals exhibit constant ARA. Relative risk aversion indicates that when the wealth of individuals increases or decreases, the percentage of wealth invested in risky assets changes. If individuals invest a higher (lower) percentage of their wealth in risky assets when their wealth increases, they exhibit decreasing (increasing) relative risk aversion (DRRA and IRRA). So with DRRA, individuals are willing to take more relative risk if their wealth increases. If the percentage of wealth invested in risky assets remains constant after a wealth increase or decrease, an individual exhibits CRRA.

We apply risk aversion in the income domain by using income gambles. If individuals are presented with a gamble where the outcomes determine their income, a risk averse individual requires a premium on the expected income of the gamble to prefer it over a certain income. A more risk averse individual would thus also require a higher premium. Put differently, someone with a higher level of risk aversion wants to risk losing a lower percentage of their income. Under CRRA, the percentage of income individuals are willing to put at risk remains constant for different levels of expected income. Under DRRA (IRRA), the percentage of income individuals are willing to put at risk increases (decreases) if income increases. With ARA, the principle is similar, only the percentage of income changes to an absolute amount of income. Hence, under DARA (IARA), the absolute amount of income individuals are willing to put at risk increases (decreases) if income increases.

2.4. Hypotheses

CRRA is often assumed in the literature (Barsky et al., 1997; Holt & Laury, 2002; Eckel & Grossman, 2008; Andreoni & Sprenger, 2012; Crosetto & Filippin, 2013) and thus, we predict that CRRA holds and that individuals exhibit consistent decision making for different levels of income. Considering this expectation, hypothesis 1 is formulated:

H1: Individuals exhibit constant relative risk aversion.

However, individuals may not always act according to CRRA, but display a higher or lower willingness to take risk for a higher level of income. We expect that potential CRRA-inconsistent behaviour can be explained by subsistence level due to the Dutch institutional setting; the government provides citizens with a subsistence level. Individuals might take their required subsistence level s into account during income gambles, resulting in more risk averse behaviour for lower levels of income closer to s . If individuals have a minimum income they require, one would assume that their risk taking behaviour is influenced by it and that they avoid risk if it endangers s . Thus, we hypothesize the following:

³ See O'Donoghue & Somerville (2018) for an extensive analysis of the different risk aversion models.

H2a: Individuals that do not exhibit constant relative risk aversion are willing to take more relative risk for higher levels of income (DRRA).

H2b: Subsistence level is positively correlated with the degree of decreasing relative risk aversion.

Different factors can determine the level of risk aversion of an individual. For example, studies have found that age is positively correlated with risk aversion (Schildberg-Hörisch, 2018). As our sample consists of students, we do not expect an age effect within the sample. But given that the students are on average younger than the general population, we do expect that they exhibit a higher willingness to take risk relative to the population. To test our expectation, another sample consisting of pension professionals (N=11) is used to compare the levels of risk aversion of both the students and professionals. In addition, we compare the mean risk aversion of this study to that of Barsky et al. (1997), who's sample is large enough to consider it a U.S. population benchmark. Furthermore, there is a difference in risk aversion based on gender as women tend to be more risk averse than men (Eckel and Grossman, 2008; Croson and Gneezy, 2009; Noussair et al., 2014). We expect a similar difference within our sample: male students have lower levels of risk aversion than female students.

Enke & Graeber (2023) recently found that cognitive uncertainty can predict behaviour and economic decision making, like choice under risk. Their results indicate that cognitively uncertain individuals, relative to those that are cognitively certain, are less risk averse for low gamble payoff probabilities and more risk averse for high gamble payoff probabilities. Risk aversion is on a similar level for a payoff probability of 50%, indicating that cognitive uncertainty has no effect on risk aversion if probabilities are equal. We develop hypothesis 3 based on these findings:

H3: There is no correlation between willingness to take risk and cognitive uncertainty.

3. Sample

The sample of this study consists of Dutch university undergraduate Economics students and graduate Finance students.⁴ In total, 246 students were invited during two courses to fill in an online questionnaire. It should be noted that most of these students were in class, while some were not. Those in class almost all participated in the survey, the others did mostly not. Still, of all invited students, 115 opened the questionnaire leading to a response rate of 46.7%, as shown in table 1. 171 invitees are undergraduates of which 55 responded, so the response rate of these students is 32.2%. The response rate of the graduate students is 77.3% as 75 were invited to fill in the questionnaire and 58 responded.⁵ Of all respondents, 108 completed the survey, resulting in a completion rate of 93.9%. This is higher compared to another paper performing a risk preference study by way of questionnaire (Goossens et al., 2023). The average completion time was 8.9 minutes. The few that did not complete the questionnaire filled in only 19% of the questions on average, with none of them completing all CS questions, resulting in these responses being left out of the analysis.

⁴ We analyse the pension professionals in section 7.

⁵ Two respondents opened the questionnaire without answering any question, so their gender is unknown.

| | All invitees (N = 246) | Undergrad (N = 171) | Grad (N = 75) |
|-----------------|------------------------|---------------------|---------------|
| Response rate | 46.7% | 32.2% | 77.3% |
| Completion rate | 93.9% | 98.2% | 93.1% |
| Duration | 8.9 min. | 9.6 min. | 8.3 min. |

Table 1: Response rate, completion rate and duration by student type.

Table 2 shows respondent characteristics for the sample. Of the respondents, 78 are male and 29 are female, in percentages 72.2% and 26.9%, respectively. The remaining 0.9% is the result of one respondent preferring not to state their gender. The number of undergraduate or graduate students is exactly the same (54 each). The average age is 22 years (SD = 2.25), which is intuitive for a student sample. There was no monetary incentive for the students to fill in the questionnaire, which, according to some literature, does not result in significant differences in behaviour between and within subjects compared to an incentivized questionnaire (Hackethal et al., 2023).

| | All respondents (N = 108) | Male (N = 78) | Female (N = 29) |
|---------------|---------------------------|---------------|-----------------|
| Age (S.D.) | 22.0 (2.25) | 22.1 (2.18) | 21.9 (2.47) |
| Undergrad (%) | 54 (50%) | 36 (46.2%) | 18 (62.1%) |
| Grad (%) | 54 (50%) | 42 (53.8%) | 11 (37.9%) |

Table 2: Demographic characteristics of respondents. The table displays mean (S.D.) for age and N (%) for student type.

4. Method

We use and expand on the choice sequence risk elicitation method developed by Barsky et al. (1997). Their study presents participants with a choice between a risky and a safe option. More specifically, participants were asked to choose between their current job, the safe option, and a new risky job with a 50 percent chance of doubling the current job's income and a 50 percent chance of decreasing it by 33 percent. Based on the answer given, a participant would then be presented with a similar choice, with only a difference in the percentage decrease of the bad scenario. If a participant accepted the new job in the first question, the potential decrease would be 50 percent in the follow-up question, while it was 20 percent if the new job was rejected. After participants have answered both questions, they can be assigned to one of four risk aversion categories. The new job is preferred to the current job if:

$$\frac{1}{2}U(2c) + \frac{1}{2}U(\lambda c) \geq U(c) \quad (1)$$

Here, c is the consumption stemming from the current job's income (it is assumed that all income is consumed), $1 - \lambda$ is the percentage decrease in the bad scenario and U is the utility function, defined in equation 2. Like with most other REM's, Barsky et al. (1997) use a CRRA power utility function to calculate risk aversion parameters (denoted as γ).

$$U(c) = \frac{c^{1-\gamma}}{1-\gamma} \quad (2)$$

We follow up on Barsky et al. (1997) and expand the original CS setup by adding two additional follow-up questions to increase the number of risk aversion categories from four to sixteen. This does not only make the intervals smaller and create more accurate results, it also allows for the differentiation of risk aversion levels above $\gamma = 3.76$. Barsky et al. (1997) found that roughly 65 percent of respondents have a relative risk aversion above this level. Considering this percentage, the inability to differentiate between higher levels of risk aversion is a shortcoming of the 1997 questionnaire (Hanna & Lindamood,

2004). Hanna et al. (2001) and Hanna & Lindamood (2004) have addressed this shortcoming in a similar way as we do, by including additional categories in their survey. However, they use λ 's that result in similar γ interval widths. The λ 's that we use are more evenly distributed, but as a consequence, γ intervals fluctuate in width. All λ 's used in our study and their matching γ are shown in table 3. The columns with the λ 's and γ 's that coincide with the original CS are marked in bold. A positive γ indicates that individuals are risk averse and a higher γ corresponds to a higher level of risk aversion. An individual is risk neutral if $\gamma = 0$ and risk seeking if $\gamma < 0$. We assume based on literature that individuals are risk averse (Kahneman & Tversky, 1979; Holzmeister & Stefan 2021) and thus, there are only outcomes with $\gamma > 0$.

| | | | | | | | | | | | | | | | |
|-----------|------|------|------|-------------|------|------|------|-------------|------|------|------|-------------|------|------|-------|
| λ | 0.25 | 0.33 | 0.40 | 0.50 | 0.55 | 0.60 | 0.62 | 0.67 | 0.70 | 0.75 | 0.78 | 0.80 | 0.83 | 0.90 | 0.95 |
| γ | 0.31 | 0.48 | 0.65 | 1.00 | 1.23 | 1.51 | 1.68 | 2.00 | 2.31 | 2.91 | 3.35 | 3.76 | 4.57 | 7.53 | 14.51 |

Table 3: λ 's with matching γ 's. These γ 's can be calculated with equation 1 and 2.

Our questionnaire benefits from the considerable testing done on the formulation of the questions asked by Barsky et al. (1997). Although we try to stay as close to the original formulation as possible, we still need to make some adjustments. First, as our sample consists of students and we assume that they are not working full-time, we cannot ask them about their current full-time job income. Therefore, the starting question has been reformulated; participants are asked to imagine having a full-time job with a monthly after-tax income of 2800 euro, which is based on the average income in the Netherlands. Second, another extension of the original CS questionnaire is that participants are presented with a second CS set. They have to answer four additional sequential questions which are almost identical to the previous question sequence. However, there is one major difference as the hypothetical income has doubled from 2800 euro to 5600 euro. By having two substantially different income levels, it gives the possibility to test whether participants display the hypothesized CRRA or not. Additionally, it allows us to answer the research question. In the presence of a subsistence level s , the utility function is the following:

$$U(c) = \frac{(c - s)^{1-\gamma}}{1 - \gamma} \quad (3)$$

This utility function coincides with CRRA if and only if $s = 0$. Moreover, similar γ 's for both levels of income, from now on mentioned as the low and high income, indicate that $s = 0$. We hypothesize that a subsistence level can explain different levels of risk aversion for different levels of income. Put differently, we expect that behaviour might conflict with CRRA due to individuals incorporating their required subsistence level in their decisions, resulting in $s > 0$ and DRRA.

The starting CS question of the questionnaire has been formulated as follows:

Suppose that you are working a full-time job (40 hours/week) and you have to provide only for yourself. This job is good and guarantees an income after taxes of 2800 (5600) euro per month for the rest of your life. You are given the opportunity to take a new and equally good job, with a 50-50 chance it will double your income and a 50-50 chance that it will cut your income by a third. Would you take the new job?

If a participant answers this question with “yes, take new job”, they are presented with the following second question:

Suppose the chances were 50-50 that the new job would double your income, and 50-50 that it would cut it in half. Would you still take the new job?

If a participant answers the first question with “no, keep current job”, they are presented with the other second question:

Suppose the chances were 50-50 that the new job would double your income, and 50-50 that it would cut it by 20 percent. Would you then take the new job?

Questions following the two above are similar, with variation in the λ and only small differences in the order and formulation of the possible answers; the full questionnaire can be found in appendix B. All final γ intervals are ranked from least to most risk averse in table 4. The lower bound of the least risk averse outcome is $\gamma = 0$ as we assume that individuals are risk averse. The upper bound of the most risk averse outcome is unknown and could theoretically go to infinity. Individuals that are not willing to accept the new job in any situation might be extremely risk averse.

| | Gamble | Relative Risk Aversion (γ) | | |
|----|--------|-------------------------------------|-------------|----------|
| | | Lower bound | Upper bound | Midpoint |
| 1 | AAAA | 0.00 | 0.31 | 0.15 |
| 2 | AAAR | 0.31 | 0.48 | 0.39 |
| 3 | AARA | 0.48 | 0.65 | 0.56 |
| 4 | AARR | 0.65 | 1.00 | 0.83 |
| 5 | ARAA | 1.00 | 1.23 | 1.11 |
| 6 | ARAR | 1.23 | 1.51 | 1.37 |
| 7 | ARRA | 1.51 | 1.68 | 1.59 |
| 8 | ARRR | 1.68 | 2.00 | 1.84 |
| 9 | RAAA | 2.00 | 2.31 | 2.16 |
| 10 | RAAR | 2.31 | 2.91 | 2.61 |
| 11 | RARA | 2.91 | 3.35 | 3.13 |
| 12 | RARR | 3.35 | 3.76 | 3.55 |
| 13 | RRAA | 3.76 | 4.57 | 4.16 |
| 14 | RRAR | 4.57 | 7.53 | 6.05 |
| 15 | RRRA | 7.53 | 14.51 | 11.02 |
| 16 | RRRR | 14.51 | ∞ | ∞ |

Table 4: Lower and upper bounds of risk aversion parameter γ intervals for each CS outcome. Outcomes are ranked from least to most risk averse. The column “gamble” shows the order in which individuals have accepted or rejected the four CS gambles, A is accept and R is reject. The last column shows the midpoint of the interval.

To account for any order effects (Schuman & Presser, 1981), the order in which participants view the CS sets with the low and high income is randomized. The questionnaire also tests for cognitive uncertainty of participants by showing them their final choice outcome after each CS set and asking them about their confidence level of this outcome. This question is based on one used by Enke et al. (2023). To check whether participants are paying attention to the questionnaire, an attention check question used by Chapman et al. (2022) is included in between both CS sets. This question asks participants about their favourite colour, but instructs them in a second sentence to choose specific colours contrary to picking their favourite one. Individuals who are not paying attention to the questionnaire might miss this instruction. After the questions regarding CS, we ask participants about the subsistence level they (think they) require as a monthly after-tax minimum income to make ends

meet. We use their answers to test for potential correlations between risk aversion and self-reported required subsistence level.

We include additional questions in the questionnaire to control for other variables. First, we control for age, gender and type of study. Second, we control for investment behaviour by asking participants in what type of assets they invest. Third, participants are asked what the source of their income is. We control for income in this manner as students often have different and multiple ways of financing their expenses and it might be a relevant indicator for risk aversion. The question is based on one from the LISS panel (Longitudinal Internet studies for the Social Sciences) managed by the non-profit research institute Centerdata (Tilburg University, the Netherlands). Fourth, the questionnaire includes a question from Chapman et al. (2022) that controls for loss aversion. Finally, we include five questions to elicit the financial and numerical literacy of participants to test whether there is a correlation between risk aversion and literacy. The questionnaire tests for financial literacy by way of the “Big Three” financial literacy questions from Lusardi and Mitchell (2011). This short set of questions has proven to be a measure of how well people understand basic financial concepts and it allows for the differentiation between people’s financial knowledge (Lusardi & Mitchell, 2023). Although, in a sample of economics and finance students, differentiation might be low. We test for numerical literacy by including two questions used by Holzmeister & Stefan (2021). All questions can be found in appendix B.

5. Univariate analysis

This section provides an univariate analysis of the CS outcomes and corresponding γ 's. First, we look at the outcome distributions and compare answers for the low and high income. Second, we calculate γ and discuss the value of this parameter for different subsamples.

Figure 1 shows the frequency distribution of outcomes for the low and high income. We assigned ranks to the different CS outcomes, as in the first column of table 4, where the highest rank value corresponds to the highest risk aversion interval. No respondent chose outcome 16, the most risk averse outcome, neither for the low or high income. Based on a visual inspection of these histograms, we determine that both frequency distributions are not normally distributed. This is supported by the Shapiro-Wilk test of normality; the test is significant (at a 1% significance level), indicating that we cannot assume normality.

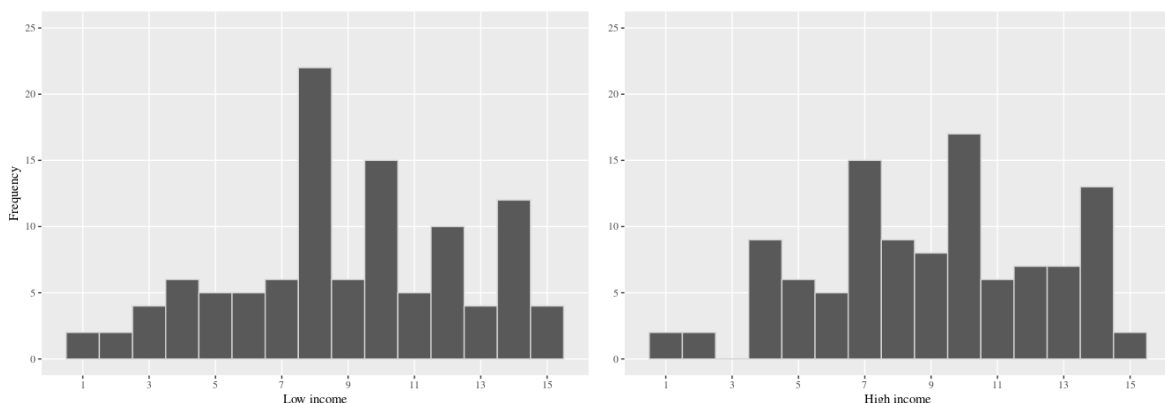


Figure 1: Frequency distributions of CS outcomes for the low income (left) and the high income (right). Outcomes are ranked based on risk aversion level.

The Spearman correlation coefficient of the two rank variables is 0.52, that is, the correlation between the chosen outcome for the low and high income. This is equivalent to the correlation between the midpoint γ 's of the two incomes. The coefficient indicates that there is only a moderate positive

correlation and that most respondents answer the two CS sets differently. Figure 2 shows how risk aversion ranks for the low and high income relate and that answer combinations are widely distributed. Respondents acting according to CRRA utility should have consistent answers and have their observation fall on the diagonal line. We find that only 22 respondents, or 20.4% of the sample, display this behaviour and give similar answers in both choice sequences. Most observations are below or above the line which indicates DRRA and IRRA, respectively. In total, 43 respondents (39.8%) display DRRA and fall below the line, while we observe 43 individuals (39.8%) with IRRA above the line. When we allow for an error margin of one category, the number of respondents that act according to CRRA utility increases to 45, which is still less than half of the sample (41.7%).

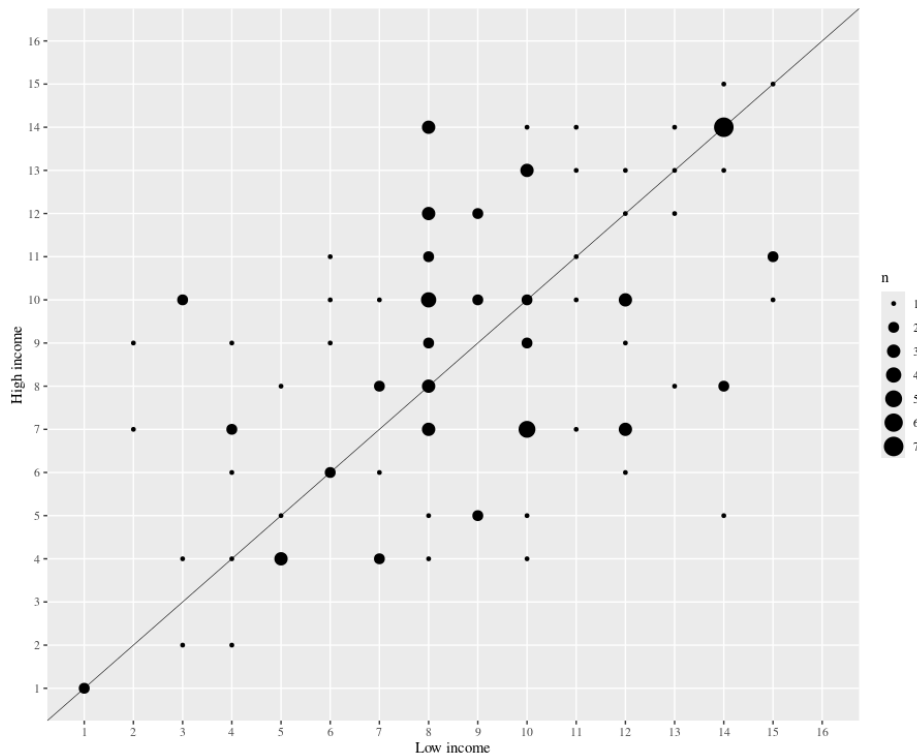


Figure 2: CS outcomes, with the low income on the x-axis and the high income on the y-axis. The diagonal line depicts consistent answers for both levels of income.

These results suggest that on an individual level, respondents are not likely to act in accordance with CRRA utility and thus, we must reject hypothesis 1. Furthermore, we also reject hypothesis 2a as only half of the respondents that do not show CRRA display DRRA.

Table 5 shows the summary statistics of the elicited risk aversion parameters for the low and high income. The statistics are based on the midpoints of each γ category, see table 4 for the exact values used. The table makes separations based on characteristics of respondents and examines how mean risk aversion differs per demographic group.

| Respondent | Relative Risk Aversion (γ) | | | | | | N |
|-----------------|-------------------------------------|--------|------|--------------------|--------|------|-----|
| | Low income (2800) | | | High income (5600) | | | |
| | Mean | Median | S.D. | Mean | Median | S.D. | |
| All respondents | 2.85 | 2.16 | 2.24 | 2.76 | 2.16 | 1.96 | 108 |
| Male | 2.96 | 2.16 | 2.47 | 2.78 | 2.16 | 2.16 | 78 |
| Female | 2.52 | 1.84 | 1.48 | 2.72 | 2.61 | 1.34 | 29 |
| Undergrad | 2.67 | 1.84 | 1.97 | 2.75 | 2.61 | 1.83 | 54 |
| Grad | 3.02 | 2.61 | 2.48 | 2.76 | 2.16 | 2.11 | 54 |

Table 5: Summary statistics of respondents based on demographic characteristics. Statistics are based on elicited γ 's.

For all respondents, we find roughly similar mean risk aversion parameters with an average γ of 2.85 (SD = 2.24) for the low income and 2.76 (SD = 1.96) for the high income. There are no statistically significant differences for any given reasonable significance level. This suggests that on average, respondents seem to act according to CRRA utility. However, we found that this is not supported on an individual level. Female respondents seem to be less risk averse than male respondents for the low income, the means are 2.52 (SD = 1.48) and 2.96 (SD = 2.47), respectively. Yet, we find no statistically significant difference (at a significance level of 10%)⁶. These results are contrary to previous studies that found that women display higher levels of risk aversion compared to men (Barsky et al., 1997; Eckel & Grossman, 2008; Croson & Gneezy, 2009; Noussair et al., 2014). We expect that these contradicting findings might be the result of the low number of female respondents in our sample. Currently, the γ difference is small and statistically insignificant, so a larger sample might bear results more in line with the literature. Undergraduate students have an average γ of 2.67 (SD = 1.97) for the low income, while the graduate students have a γ of 3.02 (SD = 2.48); this difference is not significant (at the 10% significance level). Like with gender, the means are almost identical for the high income.

In the questionnaire, participants were also asked what their source of income was. Students often have different and multiple ways of financing their expenses and thus, it might be a relevant indicator for risk aversion. Table 6 shows summary statistics based on the source of income.

⁶ We ran a Welch two-sample t-test. Even though our data is not normally distributed, a t-test can still be used given that our sample size is large enough.

| Respondent | Relative Risk Aversion (γ) | | | | | | N |
|----------------------|-------------------------------------|--------|------|--------------------|--------|------|----|
| | Low income (2800) | | | High income (5600) | | | |
| | Mean | Median | S.D. | Mean | Median | S.D. | |
| Loan | 3.19 | 2.61 | 2.64 | 3.06 | 2.61 | 2.62 | 31 |
| No loan | 2.71 | 1.84 | 2.06 | 2.63 | 2.16 | 1.63 | 77 |
| Parents allowance | 2.79 | 1.84 | 2.09 | 2.97 | 2.61 | 2.10 | 43 |
| No parents allowance | 2.89 | 2.16 | 2.34 | 2.62 | 2.16 | 1.87 | 65 |
| Grant | 2.86 | 1.84 | 2.27 | 2.56 | 1.84 | 1.65 | 31 |
| No grant | 2.84 | 2.16 | 2.24 | 2.83 | 2.16 | 2.08 | 77 |
| Job income | 2.81 | 2.00 | 2.12 | 2.74 | 2.16 | 1.90 | 78 |
| No job income | 2.93 | 2.39 | 2.55 | 2.81 | 2.61 | 2.14 | 30 |

Table 6: Summary statistics of respondents based on type of income. Subgroups are made based on whether students borrow money from the government (loan), if they get financial support from their parents (parents allowance), if someone receives a grant (grant) and if they have a job income or not (job income).

We find no statistically significant differences at any given reasonable significance level for all four types of income. There seems to be barely any difference in γ means for students who get financial support from their parents and those that receive a grant. It also does not seem to matter whether they have a job or not. The only noticeable, though not statistically significant, difference we find is for students who have a loan versus those that do not. Borrowers display a higher level of risk aversion with a γ of 3.19 (SD = 2.64) for the low income and a γ of 3.06 (SD = 2.61) for the high income. Intuitively, one might think this does not make sense as you would expect someone who borrows money, a risky activity, to be less risk averse than those who do not borrow. On the contrary, they might act more risk averse because they need a higher guaranteed income in order to pay back their debt.

Investment behaviour might be correlated with risk preferences, so participants were asked what type of assets they possess. The questionnaire differentiated between bank and savings accounts, conventional investments (stocks, bonds, funds, options, etc.), cryptocurrency and real estate including land. Participants could select multiple answers. Table 7 presents summary statistics based on assets owned. As all respondents but two have a bank or savings account and it is considered standard to have in the Netherlands, we do not make a distinction between those who do or do not have such accounts.⁷

⁷ Additionally, we leave real estate out of the table as only 7 respondents invest in real estate, while the majority of 101 respondents does not. We do not find a noteworthy or statistically significant difference at a reasonable significance level.

| Respondent | Relative Risk Aversion (γ) | | | | | | N |
|----------------|-------------------------------------|--------|------|--------------------|--------|------|----|
| | Low income (2800) | | | High income (5600) | | | |
| | Mean | Median | S.D. | Mean | Median | S.D. | |
| Investments | 3.18 | 2.61 | 2.64 | 2.77 | 2.16 | 2.20 | 57 |
| No investments | 2.47 | 1.84 | 1.63 | 2.74 | 2.61 | 1.68 | 50 |
| Crypto | 2.50 | 1.84 | 1.60 | 3.01 | 2.16 | 2.25 | 31 |
| No crypto | 2.99 | 2.16 | 2.44 | 2.65 | 2.16 | 1.84 | 77 |

Table 7: Summary statistics of respondents based on the type of assets owned. Subgroups are made based on whether students own conventional investments and cryptocurrency, or not.

From the total sample, more than half owns conventional investments. These 57 respondents are on average more risk averse for the low income compared to those that do not invest in stocks, bonds, funds, options, etc. However, the difference is not statistically significant at a sensible significance level. This result contradicts that of Dohmen et al. (2011) as they found that the willingness to take financial risk is positively correlated with investment in stocks. We do find a positive correlation for respondents who invest in cryptocurrency; the 31 respondents that own crypto are less risk averse than the 77 individuals that do not. These findings follow our expectation that owners of cryptocurrency would be more willing to take risk, which is based on a previous study that found that crypto investors take more trade risk on average (Hackethal et al., 2022). However, there is an opposite, though again insignificant, result for the high income: crypto owners are less willing to take risk relative to those that do not own cryptocurrency. For investments, we find no difference in mean γ for the high income. Overall, although we do not find statistically significant differences, our findings suggest that investment behaviour does seem to result in different levels of risk aversion, more so for the low income. Furthermore, it is interesting to observe that a high percentage of respondents own conventional investments and cryptocurrency.

Finally, the order in which respondents saw the CS sets with the low and high income was randomized to account for potential order effects. Table 8 shows summary statistics based on order.

| Respondent | Relative Risk Aversion (γ) | | | | | | N |
|----------------|-------------------------------------|--------|------|--------------------|--------|------|----|
| | Low income (2800) | | | High income (5600) | | | |
| | Mean | Median | S.D. | Mean | Median | S.D. | |
| Order low-high | 2.92 | 1.84 | 2.63 | 2.68 | 2.16 | 1.90 | 50 |
| Order high-low | 2.78 | 2.16 | 1.85 | 2.82 | 2.16 | 2.02 | 58 |

Table 8: Summary statistics based on questionnaire order.

From the total sample, 50 respondents saw the low income before the high income, while 58 respondents were shown the high income first. There seems to be no order effect as for both levels of income, the difference in mean γ is nihil and not statistically significant for any given reasonable significance level.

To summarize this section, we do not find a statistically significant difference in mean γ for the low and high income, indicating behaviour that is consistent with CRRA utility. However, there are opposing results on an individual level as only roughly 20% of the respondents act CRRA consistent. When dividing the respondents into subsamples, we find some variance in average risk aversion levels. That said, all differences in mean were again not statistically significant.

6. Multivariate analysis

The main goal of this study is to test whether individuals take their required subsistence level into consideration in decisions concerning risk. In this section, we analyse the correlation between risk aversion and self-reported subsistence level and run multiple regressions to test our hypotheses.

We use the following regression model:

$$\gamma_i = \beta_0 + \beta_1 s_i + \beta_2 c_i + \beta_3 x_i + \varepsilon_i \quad (4)$$

Here, γ_i is the elicited individual risk aversion parameter, s_i the self-reported required subsistence level (in after-tax euro's per month, divided by thousand) and c_i the level of confidence about the outcome (from 0 to 10). The control variables are denoted as x_i . First, we control for age, which is defined as the age of students in full years ranging from 18 to 27 years old⁸. Second, we added dummies to control for gender (1 = male, 0 = female), education (1 = undergrad, 0 = graduate), order (1 = low-high, 0 = high-low) and loss aversion (1 = loss averse, 0 = not loss averse). We left out the respondent that did not answer the gender question to avoid complications.

Table 9 shows OLS regression results for the low and high income γ . We ran a third regression on the difference between the γ 's of the two incomes (γ high income – γ low income). Respondents have a negative difference value if they act in accordance with DRRA. That is, they are more risk averse for the low income than for the high income. We find no statistically significant effects (at the 10% significance level) for regressions 2 (high income γ) and 3 (γ difference) and both have a negative adjusted R-squared, indicating that these models have no predictive power. In contrast, regression 1 (low income γ) does have predictive value, although low; the adjusted R-squared is 0.069.

⁸ A frequency distribution table for age can be found in appendix A.

| | <i>Dependent variable:</i> | | |
|-------------------------|----------------------------|--------------------|-------------------|
| | Low income | High income | High - Low |
| | (1) | (2) | (3) |
| Subsistence | 0.080 (0.285) | -0.025 (0.262) | -0.098 (0.273) |
| Confidence low income | 0.053 (0.120) | | |
| Confidence high income | | 0.026 (0.114) | |
| Age (years) | -0.380*** (0.134) | -0.203 (0.123) | 0.173 (0.128) |
| Gender | 0.088 (0.509) | -0.100 (0.462) | -0.224 (0.471) |
| Education | -1.355** (0.575) | -0.595 (0.527) | 0.762 (0.552) |
| Order | -0.050 (0.436) | -0.256 (0.416) | -0.198 (0.416) |
| Loss aversion | 1.407** (0.705) | 0.840 (0.651) | -0.571 (0.677) |
| Constant | 10.121*** (3.230) | 6.859** (2.957) | -3.331 (3.090) |
| Observations | 107 | 107 | 107 |
| R ² | 0.130 | 0.050 | 0.042 |
| Adjusted R ² | 0.069 | -0.017 | -0.015 |

Note:

*p<0.1; **p<0.05; ***p<0.01

Table 9: OLS regression results for the low income γ (1), high income γ (2) and the γ difference (3) as dependent variables. Subsistence is self-reported required monthly subsistence level in euro's, divided by thousand. Confidence is confidence level from 0 to 10. The control dummy variables are gender (1 = male, 0 = female), education (1 = undergrad, 0 = grad), order (1 = low-high, 0 = high-low) and loss aversion (1 = loss averse, 0 = not loss averse). Standard errors are reported in parentheses.

We find a statistically significant negative correlation between age and risk aversion; if age goes up by one year, risk aversion parameter γ decreases by 0.380. This does not support literature that found that risk aversion increases with age (Schildberg-Hörisch, 2018). That said, Schildberg-Hörisch (2018) also describes that there can be temporary fluctuations in risk preferences. Given the small age range of the students, the negative correlation might be a result of temporary fluctuations. Consequently, we anticipate that the correlation reverses with a higher age range. We will test this with the pension professionals sample in section 7.2. The negative correlation could also have been a result of education. However, we find that undergraduates are less risk averse than the graduate students, even though they are on average 21 and 24 years old, respectively. Surprisingly, this contradicts the age effect. The opposing effects might be because education captures part of the age effect, or vice versa. This seems not to be the case though as we found no interaction between age and education when including an interaction term in the regression analysis.

We again find no statistically significant effect for order, but we do for loss aversion; regression 1 indicates that loss averse individuals are more risk averse too. Of all respondents, 97 chose the loss

averse option, while the remaining 11 respondents chose the risk seeking option. The estimated coefficient is 1.407, so the loss averse individuals have a substantially higher average γ value. These results suggest that loss aversion captures risk aversion, which is in line with prospect theory (Kahneman & Tversky, 1979). However, we do not find complementary results in regression 2 as there does not appear to be a statistically significant effect for the high income.

Figure 3 shows the frequency distribution of self-reported required subsistence level. On average, respondents require 1718 (SD = 809) euro per month after-tax. The maximum required subsistence level is 4000 euro per month after taxes, while some only require a minimum income of 200 euro per month. We discuss in section 8.1 why this minimum amount is lower than expected. As shown in table 9, there is no statistically significant effect for subsistence level at any given reasonable significance level. We ran another set of regressions, conditional on the 42 respondents that display DRRA, to test the hypothesis that subsistence level is positively correlated with the degree of DRRA. Table 10 presents the results of these conditional regressions. Again, we do not find any statistically significant effects for subsistence and for that reason, we must reject hypothesis 2b. For clarity, we would not have been able to reject hypothesis 2b if we found a significantly negative coefficient for subsistence level in regression 3 of table 10.

We observe that the DRRA conditional regressions in table 10 all have explanatory power. Age and education now also have significant coefficients in regression 2 and 3. However, we do not find statistical significance for loss aversion anymore in regression 1.

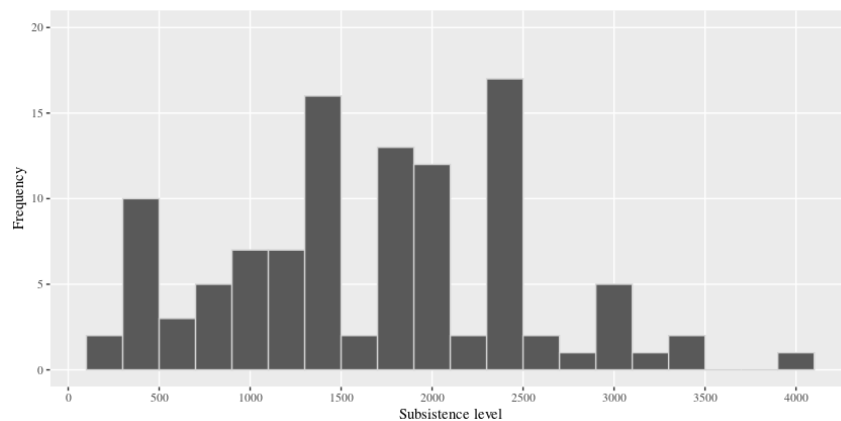


Figure 3: Frequency distribution of subsistence level.

| | <i>Dependent variable:</i> | | |
|-------------------------|----------------------------|----------------------|----------------------|
| | Low income | High income | High - Low |
| | (1) | (2) | (3) |
| Subsistence | 0.143 (0.583) | 0.103 (0.200) | -0.014 (0.500) |
| Confidence low income | 0.259 (0.209) | | |
| Confidence high income | | 0.015 (0.071) | |
| Age (years) | -0.654*** (0.225) | -0.209*** (0.075) | 0.423** (0.192) |
| Gender | -0.629 (0.941) | -0.594* (0.310) | -0.211 (0.789) |
| Education | -2.558*** (0.889) | -0.650** (0.300) | 1.903** (0.762) |
| Order | 0.380 (0.838) | 0.149 (0.284) | -0.232 (0.718) |
| Loss aversion | 1.092 (1.421) | 0.550 (0.474) | -0.809 (1.203) |
| Constant | 16.624*** (5.344) | 6.268*** (1.820) | -11.076** (4.548) |
| Observations | 42 | 42 | 42 |
| R ² | 0.299 | 0.284 | 0.211 |
| Adjusted R ² | 0.155 | 0.136 | 0.075 |

Note:

*p<0.1; **p<0.05; ***p<0.01

Table 10: OLS regression results for the low income γ (1), high income γ (2) and the γ difference (3) as dependent variables, conditional on DRRRA respondents. Subsistence is self-reported required monthly subsistence level in euros, divided by thousand. Confidence is confidence level from 0 to 10. The control dummy variables are gender (1 = male, 0 = female), education (1 = undergrad, 0 = grad), order (1 = low-high, 0 = high-low) and loss aversion (1 = loss averse, 0 = not loss averse). Standard errors are reported in parentheses.

We measured cognitive uncertainty by asking respondents about their confidence level of their final outcome of each CS set, ranging from 0 (not confident at all) to 10 (very confident). On average, respondents have the same level of confidence for the low and high income, with a value of 6.46⁹. Table 9 and 10 show that we do not find a statistically significant correlation between γ and confidence level, both for the low and high income. We fail to reject hypothesis 3 as this study does not provide evidence that suggests that confidence or cognitive uncertainty plays a substantial role in determining risk preferences. In addition, the highest and lowest quintile of confidence do not result in different levels of risk aversion.

In the questionnaire, we tested for financial literacy and find that 93.5% of respondents answer all three questions correctly, with no individual making a mistake in more than one question. The financial literacy rate we find does not compare with that of studies with samples more representative of the general population. Van Rooij et al. (2011) used data from the 2005 DNB Household Survey and

⁹ Frequency distribution tables for confidence can be found in appendix A.

found that only 40.2% of respondents ($N = 1508$) answered all financial literacy questions correctly. It is important to note that they used five questions instead of three. Still, 27% of respondents made more than one mistake. Another study used a Dutch online household panel from the LISS panel ($N = 2341$) and asked the first two of the “Big Three” financial literacy questions¹⁰ from Lusardi and Mitchell (2011). They found that 70.4% of respondents answered both questions correctly. The discrepancy in literacy rates was to be expected as university students do not represent the general population: economics and finance students are expected to be more financially and numerically literate than the average population. We also tested for numerical literacy and find that 89.8% of respondents correctly answer both questions. Again, no respondent has more than one wrong answer. This is also true when looking at both financial and numeracy literacy combined. Overall, we did not add financial or numerical literacy as control variables in our regressions because of the high percentage of respondents that answered all questions correctly.

Concluding, we find that self-reported required subsistence level is not statistically significantly correlated with risk aversion or the degree of DRRA. We also found no effect for cognitive uncertainty, which follows our hypothesis. Unexpectedly, there is no statistically significant effect for gender at the 5% significance level, while the correlation between age and risk aversion is negative instead of positive. In the following section, we conduct multiple regression analyses to test for the robustness of the results.

7. Robustness tests

7.1. Alternative dependent variables

To test for robustness of our results, we ran additional regressions with risk tolerance ($1 / \gamma$) and λ as dependent variables instead of γ . Table 11 shows OLS regression results for risk tolerance as dependent variable.

¹⁰ See appendix B for (the order of) the financial literacy questions.

| | <i>Dependent variable:</i> | | |
|-------------------------|----------------------------|---------------------|---------------------|
| | Low income | High income | High - Low |
| | (1) | (2) | (3) |
| Subsistence | −0.011 (0.111) | −0.121 (0.115) | −0.112* (0.058) |
| Confidence low income | 0.017 (0.046) | | |
| Confidence high income | | −0.008 (0.050) | |
| Age (years) | 0.153*** (0.052) | 0.150*** (0.054) | −0.006 (0.027) |
| Gender | 0.327 (0.198) | 0.422** (0.202) | 0.067 (0.100) |
| Education | 0.382* (0.224) | 0.482** (0.231) | 0.095 (0.117) |
| Order | 0.272 (0.170) | 0.168 (0.182) | −0.120 (0.088) |
| Loss aversion | −1.094*** (0.274) | −0.728** (0.285) | 0.380*** (0.143) |
| Constant | −2.349* (1.256) | −2.364* (1.295) | −0.083 (0.654) |
| Observations | 107 | 107 | 107 |
| R ² | 0.233 | 0.151 | 0.143 |
| Adjusted R ² | 0.179 | 0.091 | 0.092 |

Note:

*p<0.1; **p<0.05; ***p<0.01

Table 11: OLS regression results for risk tolerance ($1/\gamma$) as dependent variable, with low income tolerance (1), high income tolerance (2) and tolerance difference (3). Subsistence is self-reported required monthly subsistence level in euro's, divided by thousand. Confidence is confidence level from 0 to 10. The control dummy variables are gender (1 = male, 0 = female), education (1 = undergrad, 0 = grad), order (1 = low-high, 0 = high-low) and loss aversion (1 = loss averse, 0 = not loss averse). Standard errors are reported in parentheses.

It is robust to take risk tolerance as dependent variable for the low income. The model even has more predictive power for risk tolerance, the adjusted R-squared is 0.179 instead of 0.069. The model has no predictive power when using the γ of the high income or the high income γ minus the low income γ as dependent variables, but it does when using risk tolerance, as shown in table 11. Most notably, there is an increase in significant variables for the high income compared to the regression in table 9. This might be due to the value distributions of γ and $1/\gamma$ as risk tolerance values are more closely distributed.

We find roughly similar coefficients for age, education and loss aversion for the high income relative to the low income. In contrast, there is a positive correlation between gender and risk tolerance for the high income while not for low income. Male respondents have a 0.422 higher average risk tolerance than female respondents, which is in line with previous studies. We also find a statistically significant effect, albeit at the 10% significance level, for subsistence level when running the regression model on the risk tolerance difference of the low and high income. The negative coefficient indicates a negative correlation between self-reported required subsistence level and the degree of DRRA, which

opposes hypothesis 2b. Based on these findings, we again have to reject the hypothesis. That said, we do not draw conclusions out of caution as we find no significant coefficients in the other regressions.

We replaced γ with λ as dependent variable as a second robustness test. The advantage of using λ is that no assumptions about utility have to be made. As a reminder, $1 - \lambda$ is the percentage of income individuals can potentially lose when accepting the new job, so they would be left with λ multiplied by the current job's income. We find regression results similar to those in table 11, thus it is robust to take λ as dependent variable, relative to risk tolerance. The regression model seems to provide more predictive power for both risk tolerance and λ compared to γ . It might therefore be preferable to follow Barsky et al. (1997) in future studies and use risk tolerance in analyses.

7.2. Pension professionals

We conducted a second survey among a group of pension professionals to test the expectation that students exhibit a higher willingness to take risk compared to the general population due to their age. Formulated differently, we expect that age is positively correlated with γ for a large age range.

The pension professionals are individuals who currently work and have many years of experience in the Dutch pension sector. During a pension event, they were invited to fill in the online questionnaire, which was adjusted to make it suitable for this sample. The adjustments can be found in appendix D. Of the 11 professionals present, all have opened the questionnaire and all but one finished it. However, this respondent filled in 89% of the questionnaire, including the questions regarding CS, and thus, we include the individual in our analysis. Consequently, the response and completion rate are 100% and 91%, respectively. It took the professionals 8.7 minutes on average to complete the questionnaire, which is similar to the students.

| | All respondents (N = 11) | Male (N = 7) | Female (N = 4) |
|---------------|--------------------------|--------------|----------------|
| Age (S.D.) | 46.5 (9.3) | 44.9 (11.5) | 49.5 (2.9) |
| Income (S.D.) | 5100 (800) | 5157 (943) | 5000 (577) |

Table 12: Characteristics of the pension professionals. Age is in years and income is monthly after-tax income in euro's.

Table 12 shows respondent characteristics. The average age of the pension professionals is 46.5, which is expectedly higher than the average age of the students. It is important to note that the professionals were shown age cohorts of 5 years, so the mean age we find is not exact. Income was also elicited in intervals, of thousands of euro's, to preserve privacy and increase the response rate of the question regarding income. Similar to age, we took the midpoint of the interval and calculated the mean, resulting in an average after-tax monthly income of 5100 euro.

We compare the risk aversion levels of the professionals with those of the students in table 13 and find that there are no statistical significant differences for any given reasonable significance level¹¹ for both the low and high income. Although, we find that the professionals have a mean γ of 3.28 (SD = 3.25) for the low income, which is higher than the 2.85 (SD = 2.24) average γ of the students. The small, statistically insignificant difference might be explained by the relatively high level of financial knowledge of the professionals, which could have resulted in less risk averse behaviour. However, we cannot test this hypothesis and thus need to be careful with drawing conclusions.

¹¹ We ran a Mann-Whitney U test (Wilcoxon rank-sum test). Our data is not normally distributed and due to the sample size of the pension professionals, we cannot use a t-test.

| Respondent | Relative Risk Aversion (γ) | | | | | | N |
|-----------------|-------------------------------------|--------|------|--------------------|--------|------|-----|
| | Low income (2800) | | | High income (5600) | | | |
| | Mean | Median | S.D. | Mean | Median | S.D. | |
| All respondents | 2.89 | 2.16 | 2.33 | 2.77 | 2.16 | 2.06 | 119 |
| Students | 2.85 | 2.16 | 2.24 | 2.76 | 2.16 | 1.96 | 108 |
| Professionals | 3.28 | 1.84 | 3.25 | 2.87 | 1.84 | 2.96 | 11 |

Table 13: Summary statistics of students, pension professionals and these two samples combined.

The professionals require a subsistence level of 2582 (SD = 627) euro per month after taxes on average. We ran a Mann-Whitney U test and found that this mean is significantly higher (at the 1% significance level) than the 1718 euro average of the students. We expect that this difference might be due to different income reference points. The professionals have an average after-tax monthly income of 5100 euro, which is almost twice the average net income in the Netherlands. The average confidence level of the professionals is 6.82 for the low income and 6.73 for the high income, which is slightly higher than the 6.47 confidence level of the students for both levels of income.

Overall, we find no different average γ 's. Given the sample size, we ran no separate regressions for the pension professionals.

7.3. Choice sequence

The questionnaire of this study was different than that of Barsky et al. (1997), mainly due to the additional two follow-up questions that resulted in sixteen different outcomes instead of four. Using our setup, we found risk aversion parameters of 2.85 and 2.76 for the low and high income, respectively. In contrast, Barsky et al. (1997) found that respondents had an average risk aversion of 4.1¹², which is evidently higher. However, it might not be accurate to compare these parameters because of two reasons. First, Barsky et al. (1997) calculate the γ value of each outcome category in a different way than we do. They use means of category ranges that depend on the γ distribution of their sample, while we use the midpoint of the category range. Second, we use more categories which can affect final results. To solve these issues, we look at how our respondents answered the first two CS questions. By using their answers of the first two questions, we can divide them into the four risk aversion categories used by Barsky et al. (1997). In addition, we use the percentage distributions of the four categories so no assumptions about utility or parameter values have to be made.

Table 14 shows percentage distributions of the four risk aversion categories for the low income, high income and the results of Barsky et al. (1997). The categories are ranked from most (1) to least (4) risk averse. More information about these categories and its γ bounds can be found in appendix A.

¹² Hanna & Lindamood (2004) ran a student survey in two finance courses at the Ohio State University and found a mean relative risk aversion of 4.4.

| Respondent | Percentage choosing response | | | | N |
|---------------|------------------------------|------|------|------|-------|
| | 1 | 2 | 3 | 4 | |
| Low income | 18.5 | 33.3 | 35.2 | 13.0 | 108 |
| High income | 20.4 | 35.2 | 32.4 | 12.0 | 108 |
| Barsky et al. | 64.6 | 11.6 | 10.9 | 12.8 | 11707 |

Table 14: Percentage distributions of the different risk aversion categories.

We observe that the most risk averse option was chosen most often in the 1997 experiment, 64.6% of respondents rejected both income gambles. The majority of respondents from our sample chose one of the two middle outcomes; they accepted (rejected) the first income gamble and rejected (accepted) the second. The difference in percentage distributions of the low and high income is in line with our previous findings; there are only minor differences. We ran a Pearson's Chi-squared test and found a p-value of 0.96, suggesting that there is no statistically significant difference between the percentage distributions of the low and high income. In other words, there is an association between these distributions. If we run the same test to compare the low or high income with the results from Barsky et al. (1997), we do find a statistically significant difference (at the 1% significance level) between the distributions. Thus, we can conclude that we found different risk aversion parameter distributions compared to Barsky et al. (1997).

We expected that students would be less risk averse relative to the general population. However, Barsky et al. (1997) conducted a pilot study using a student sample and they found that these students had an average γ of 3.85. Furthermore, the pension professionals, a sample with a mean age of 46.5, had similar average levels of risk aversion as our student sample. Hence, we cannot conclude that the differences in risk aversion found are a result of age or student samples versus non-student samples.

8. Considerations

8.1. Subsistence level

In the questionnaire, students were asked what level of subsistence they require. More specifically, they were asked what amount of income after taxes per month they considered the absolute minimum for them to be able to make ends meet. We found that 12 respondents stated that they need only 500 euro per month or less, with the minimum amount as low as 200 euro. This is far below the current minimum income of around 2000 euro. The average self-reported required subsistence level of 1718 euro per month is reasonably close to the minimum net income in the Netherlands.

We expect that some respondents require a low subsistence level because of different reference points. The questionnaire presented participants with a hypothetical situation for the CS questions and we intended the subsistence level question to be answered from the same perspective. However, it was not clearly mentioned that students had to imagine the same situation for this question and thus, some students might have answered from the perspective of their current (financial) situation. It is likely that several students still live with their parents and therefore have no rent and grocery expenses. Moreover, students have different types of income and might exclude this in their subsistence level consideration. For example, a student receives an allowance from their parents and has to work a part-time job to cover all of their expenses. When considering what minimum income they would need to make ends meet, they might deem the allowance as a baseline and only include the income needed on top of this allowance.

It is unknown how the respondents interpreted the subsistence level question. Fortunately, the questionnaire asked for source of income and thus, we can test whether this affects required subsistence

level or not. If the students answered the question from the hypothetical situation, no correlation should be found. But if they answered it from their current perspective i.e. they use different reference points, we can find potential correlations.

We ran an OLS regression with self-reported required subsistence level as dependent variable and the different sources of income as independent variables. More specifically, we included dummies controlling for loan (1 = student has a loan, 0 = no loan), allowance parents (1 = student receives allowance from parents, 0 = no allowance), grant (1 = student receives a grant, 0 = no grant) and job income (1 = student has job income, 0 = no job). Additionally, we added age as independent variable because the personal situation of a student is likely to be correlated with age. Table 15 shows the regression results.

| | <i>Dependent variable:</i> | | |
|-------------------------|----------------------------|---------------------|---------------------|
| | Subsistence | | |
| | (1) | (2) | (3) |
| Age | 0.120*** (0.040) | | 0.126*** (0.033) |
| Loan | -0.164 (0.191) | -0.062 (0.196) | |
| Allowance parents | -0.247 (0.173) | -0.367** (0.174) | |
| Grant | -0.049 (0.190) | -0.313* (0.175) | |
| Job income | -0.155 (0.174) | -0.111 (0.180) | |
| Constant | -0.651 (0.928) | 2.049*** (0.216) | -1.066 (0.726) |
| Observations | 107 | 107 | 107 |
| R ² | 0.146 | 0.071 | 0.124 |
| Adjusted R ² | 0.104 | 0.034 | 0.115 |

Note:

*p<0.1; **p<0.05; ***p<0.01

Table 15: OLS regression results for self-reported required subsistence level as dependent variable. Independent variables are age (in years) and dummy variables loan (1 = yes, 0 = no), allowance parents (1 = yes, 0 = no), grant (1 = yes, 0 = no) and job income (1 = yes, 0 = no). Standard errors are reported in parentheses.

We find that age is positively correlated with self-reported required subsistence level at a statistical significance level of 1%, indicating that older respondents require a higher income to make ends meet. Furthermore, we find, if we leave out age as independent variable, that there is a significantly negative correlation (at the 5% significance level) between subsistence level and receiving an allowance from parents. It suggests that students require roughly 367 euro per month less on average if they get financial aid from their parents, relative to the students that do not. These findings signal that it is likely that at least some students used the perspective of their current situation to answer the question concerning subsistence level. To prevent misunderstandings about reference points and freedom of interpretation in future research, questions need to clearly state if it should be answered from a hypothetical situation or not.

8.2. Status quo bias

A second consideration is the status quo bias. In their paper, Barsky et al. (1997) address a potential status quo bias participants have as they might value their current job for other reasons than income. The status quo bias is a bias that results in individuals wanting to maintain the current state of affairs and valuing it more than a new situation. If participants display this bias, they are less likely to switch to the new job, hereby overestimating risk aversion parameters. Barsky et al. (1997) could not test the presence of the status quo bias in their main study due to the experimental setup. However, they ran a pilot study containing two treatments, which was conducted using a student sample. The first group was presented with questions that followed the original wording; they were given the choice between a hypothetical current job and a risky new job. The second group was presented with adjusted questions that are status quo bias free; they were given the choice between a new job with a safe income and a new job with a risky income.

Barsky et al. (1997) found that the first group exhibits higher levels of risk aversion than the second group, indicating a presence of the status quo bias. Samuelson and Zeckhauser (1988) also found the presence of the status quo bias in a sample with a hypothetical situation and the results of a more recent study support the correlation between the status quo bias and risk preferences (Bekir & Doss, 2020).

Similar to Barsky et al. (1997), we cannot estimate the status quo bias in our sample. It is possible that risk aversion levels would have been lower if the questionnaire accounted for this bias. However, the potential presence of a status quo bias does not have to be problematic considering that we focus on the outcomes of the low income relative to the high income and the correlation with a subsistence level, not the exact levels of risk aversion. Nevertheless, it is still important to mention this phenomenon and the limitation of this study considering it is unknown if and to what extent there is a status quo bias present. Following up on the suggestion of Barsky et al. (1997) to stay clear from the bias, future studies using a similar experimental setup should use two new jobs instead of a current and new job.

9. Discussion and conclusion

Due to the new pension act, pension funds are now required to conduct a risk preference study at least every five years. The requirements set by the AFM give funds the opportunity to choose from a selection of risk elicitation methods for their risk preference study. However, none of these REM's are developed in an institutional setting similar to that of the Netherlands. Dutch retirees receive a risk-free base pension provided by the government, which serves as a retiree's subsistence level. It is unknown whether individuals take a subsistence level into consideration when declaring risk preferences and thus, the main goal of our study was to test this.

We invited undergraduate and graduate students to fill in an online questionnaire that contained an adjusted version of the Barsky et al. (1997) CS approach for eliciting risk aversion. The students were presented with two CS sets, with different levels of hypothetical income, to test whether their risk preference would depend on the income level. Given the assumption within the literature that individuals exhibit CRRA, we hypothesized that the low and high income would result in a similar level of risk aversion. *On average*, we found comparable γ values that are insignificantly different from each other for any given reasonable significance level, hereby providing support for our hypothesis. However, *on an individual level*, approximately 80% of respondents did not act in line with CRRA utility and answered the CS questions in a different manner for the two levels of income. Thus, our findings oppose the assumption of CRRA utility.

In addition, we hypothesized that respondents who do not act according to CRRA utility would exhibit DRRA as a result of them incorporating their subsistence needs in their CS decisions. We found that an equal number of respondents exhibit DRRA and IRRA and that there is no statistically significant correlation between self-reported required subsistence level and risk aversion or the degree of DRRA. These results suggest that respondents did not take their subsistence requirements into consideration when answering the questions.

The findings of this study have multiple implications for the Dutch pension sector. First, the individual violation of CRRA has important policy consequences for investment decisions for individual life cycle investments of insurers or the flexible pension scheme ('flexibele premieregeling'). For collective investments, like the solidarity pension scheme ('solidaire premieregeling') or pension funds, we can still work with the assumption of CRRA, as it holds in the aggregate. Second, as we find that self-reported subsistence level requirements are not correlated with risk aversion (suggesting $s = 0$), pension funds can calculate γ values including the risk-free base pension. In other words, they can assume that participants do not treat pillar 1 differently from pillar 2. Naturally, more research is needed to support our findings and test the robustness. Still, this study gives insight into a way of testing CRRA utility assumptions and the analysis of the correlation between risk aversion and subsistence needs.

This study has several limitations. First, the sample consists of students only, hereby not giving a good representation of the population. Students might have a hard time imagining what level of income they need and studies focusing on the pension sector should therefore use a more age diverse sample. Although we provide another sample with pension professionals, this group only consists of 11 individuals. Second, the formulation of the subsistence question might have been ambiguous; the question could have been more clear as to whether it applied to the current (financial) situation of the respondents or to the hypothetical situation presented in the CS questions, thereby leaving less room for interpretation by the respondents. Also, the subsistence question was presented after they answered the CS questions. Alternatively, it can be asked before to look at nudging effects. Third, the elicitation of cognitive uncertainty was not extensive. As expected, we found no correlation between choice confidence and risk aversion. To shed more light on this result, asking for choice confidence after each single CS question might have proven to be more insightful. This would also give the opportunity to test whether confidence drops when outcomes get closer to each other. However, it was purposively chosen to not ask these eight questions about confidence of outcome, given that it would have increased the length of the questionnaire. Finally, although finding exact γ values was not the goal of this study, we are unable to test whether there is a status quo bias present. If so, we overestimate risk aversion levels, but there is no reason to believe that the difference in risk aversion between the low and high income will be affected.

A potential extension of our study would be to show participants their outcome of the first CS set when answering the second set, as it is likely that this would serve as a nudge. Furthermore, to get a better understanding of the rationale behind their decisions, showing participants the outcomes of both sets side by side and asking about the reasoning for their choices including the confidence of it might prove insightful. Regardless, future research on the topic of CRRA utility and subsistence needs is desirable to test whether our results are stable across different studies.

References

- AFM. (2023). *Randvoorwaarden voor de uitvoering van het risicopreferentieonderzoek*.
- Andreoni, J., & Sprenger, C. (2012). Estimating Time Preferences from Convex Budgets. *American Economic Review*, 102(7), 3333-3356.
- Arrow, K. J. (1965). *Aspects of the Theory of Risk Bearing*. Helsinki: Yrjö Jahnssonin Säätiö.
- Barsky, R. B., Juster, F. T., Kimball, M. S., & Shapiro, M. D. (1997). PREFERENCE PARAMETERS AND BEHAVIORAL HETEROGENEITY: AN EXPERIMENTAL APPROACH IN THE HEALTH AND RETIREMENT STUDY. *The Quarterly Journal of Economics*, 112(2), 537-579.
- Bekir, I., & Doss, F. (2020). Status quo bias and attitude towards risk: An experimental investigation. *Managerial & Decision Economics*, 41(5), 827-838.
- Belot, M., Duch, R., & Miller, L. (2015). A comprehensive comparison of students and non-students in classic experimental games. *Journal of Economic Behavior and Organization*, 113, 26–33.
- Bosch-Domènech, A., & Silvestre, J. (2013). Measuring risk aversion with lists: A new bias. *Theory and Decision*, 75(4), 465–496.
- Chapman, J., Snowberg, E., Wang, S., & Camerer, C. (2022). Looming Large or Seeming Small? Attitudes Towards Losses in a Representative Sample. *CESifo Working Paper No. 9820*.
- Crosetto, P., & Filippin, A. (2013). The “bomb” risk elicitation task. *Journal of Risk and Uncertainty*, 47, 31-65.
- Crosetto, P., & Filippin, A. (2016). A theoretical and experimental appraisal of four risk elicitation methods. *Experimental Economics*, 19(3), 613–641.
- Crosan, R., & Gneezy, U. (2009). Gender differences in preferences. *Journal of Economic Literature*, 47(2), 448–474.
- Dohmen, T., Falk, A., Huffman, D., Sunde, U., Schupp, J., & Wagner, G. G. (2011). Individual risk attitudes: measurement, determinants, and behavioral consequences. *Journal of the European Economic Association*, 9(3), 522-550.
- Donkers, B., Lourenço, C., Goldstein, D., & Dellaert, B. (2013). Building a distribution builder. *Netspar Design Paper 20*.
- Drichoutis, A. C., & Lusk, J. L. (2016). What can multiple price lists really tell us about risk preferences? *Journal of Risk and Uncertainty*, 53(2–3), 89–106.
- Eckel, C. C., & Grossman, P. J. (2002). Sex differences and statistical stereotyping in attitudes toward financial risk. *Evolution and Human Behavior*, 23(4), 281-295.
- Eckel, C. C., & Grossman, P. J. (2008). Forecasting risk attitudes: An experimental study using actual and forecast gamble choices. *Journal of Economic Behavior and Organization*, 68(1), 1–17.
- Enke, B., & Graeber, T. (2023). Cognitive Uncertainty. *Quarterly Journal of Economics*, 138(4), 2021–2067.
- Enke, B., Graeber, T., & Oprea, R. (2023). COMPLEXITY AND TIME. *NBER Working paper*.

- Goldstein, D. G., Johnson, E. J., & Sharpe, W. F. (2008). Choosing Outcomes versus Choosing Products: Consumer-Focused Retirement Investment Advice. *Journal of Consumer Research*, 35, 440-456.
- Goossens, J., Knoef, M., Kuijpers, B., Potter van Loon, R., Ponds, E., Riedl, A. & Vos, S. (2023). A comparison of risk preference elicitation methods and presentation formats. *Netspar Design Paper 233*.
- Hackethal, A., Hanspal, T., Lammer, D. M., & Rink, K. (2022). The characteristics and portfolio behavior of bitcoin investors: evidence from indirect cryptocurrency investments. *Review of Finance*, 26(4), 855-898.
- Hackethal, A., Kirchler, M., Laudenbach, C., Razen, M., & Weber, A. (2023). On the role of monetary incentives in risk preference elicitation experiments. *Journal of Risk and Uncertainty*, 66(2), 189–213.
- Hanna, S. D., Gutter, M. S., & Fan, J. X. (2001). A measure of risk tolerance based on economic theory. *Journal of Financial Counseling and Planning*, 12(2), 53-60.
- Hanna, S. D., & Lindamood, S. (2004). An Improved Measure of Risk Aversion. *Journal of Financial Counseling and Planning*, 15(2), 27-45.
- Holt, C. A., & Laury, S. K. (2002). Risk Aversion and Incentive Effects. *The American Economic Review*, 92(5), 1644-1655.
- Holzmeister, F., & Stefan, M. (2021). The risk elicitation puzzle revisited: Across-methods (in)consistency? *Experimental Economics*, 24(2), 593–616.
- Kahneman, D., & Tversky, A. (1979). Prospect Theory: An Analysis of Decision under Risk. *Econometrica*, 47(2), 263-292.
- Lejuez, C. W., Read, J. P., Kahler, C. W., Richards, J. B., Ramsey, S. E., Stuart, G. L., Strong D. R., & Brown, R. A. (2002). Evaluation of a Behavioral Measure of Risk Taking: The Balloon Analogue Risk Task (BART). *Journal of Experimental Psychology*, 8(2), 75-74.
- Lusardi, A. & Mitchell, O. S. (2011). Financial Literacy and Planning: Implications for Retirement Wellbeing. *NBER Working Paper*.
- Lusardi, A., & Mitchell, O. S. (2023). The Importance of Financial Literacy: Opening a New Field. *Journal of Economic Perspectives*, 37(4), 137–154.
- Noussair, C. N., Trautmann, S. T., & Van De Kuilen, G. (2014). Higher order risk attitudes, demographics, and financial decisions. *Review of Economic Studies*, 81(1), 325–355.
- O'Donoghue, T., & Somerville, J. (2018). Modeling risk aversion in economics. *Journal of Economic Perspectives*, 32(2), 91–114.
- Pedroni, A., Frey, R., Bruhin, A., Dutilh, G., Hertwig, R., & Rieskamp, J. (2017). The risk elicitation puzzle. *Nature Human Behaviour*, 1(11), 803–809.
- Pensioen Federatie. (2022, June). *Van risicopreferentieonderzoek naar risicohouding en beleggingsbeleid*.
- Pratt, J. W. (1964). Risk Aversion in the Small and in the Large. *Econometrica*, 32(1), 122-136.

- Samuelson, W., & Zeckhauser, R. (1988). Status Quo Bias in Decision Making. *Journal of Risk and Uncertainty*, 1(1), 7-59.
- Schildberg-Hörisch, H. (2018). Are Risk Preferences Stable? *The Journal of Economic Perspectives*, 32(2), 135–154.
- Schuman, H., & Presser, S. (1981). *Questions and Answers in Attitude Surveys: Experiments on Question Form, Wording, and Context*. New York: Academic Press, Inc.
- Tversky, A., & Kahneman, D. (1992). Advances in Prospect Theory: Cumulative Representation of Uncertainty. *Journal of Risk and Uncertainty*, 5, 297-323.
- Van der Meeren, G., De Cloe-Vos, H. & Van Geen, A. (2019). Meet risicobereidheid met een kwantitatieve methode. *ESB 4773*. 222-225.
- Van Rooij, M., Lusardi, A., & Alessie, R. (2011). Financial literacy and stock market participation. *Journal of Financial Economics*, 101(2), 449-472.

Appendix A

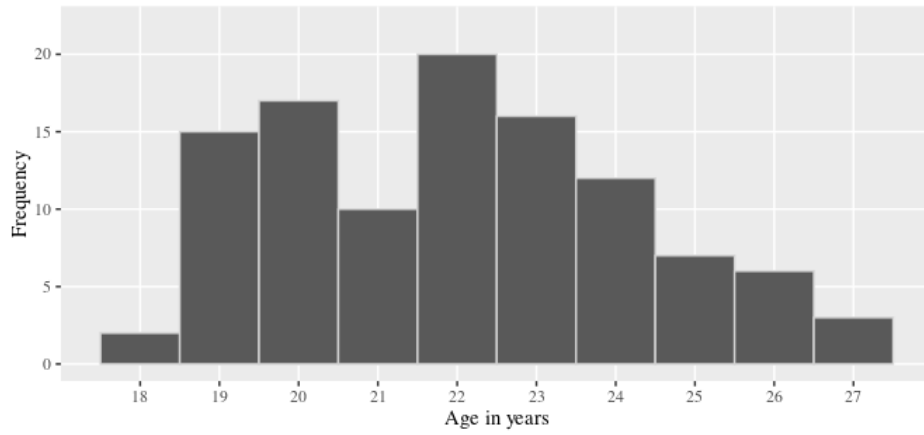


Figure 4: Frequency distribution of age.

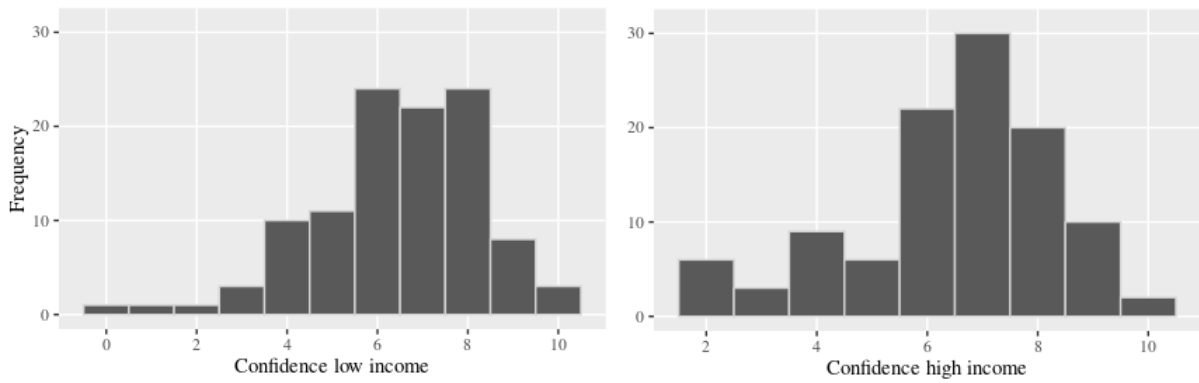


Figure 5: Frequency distribution of confidence levels for the low income (left) and high income (right).

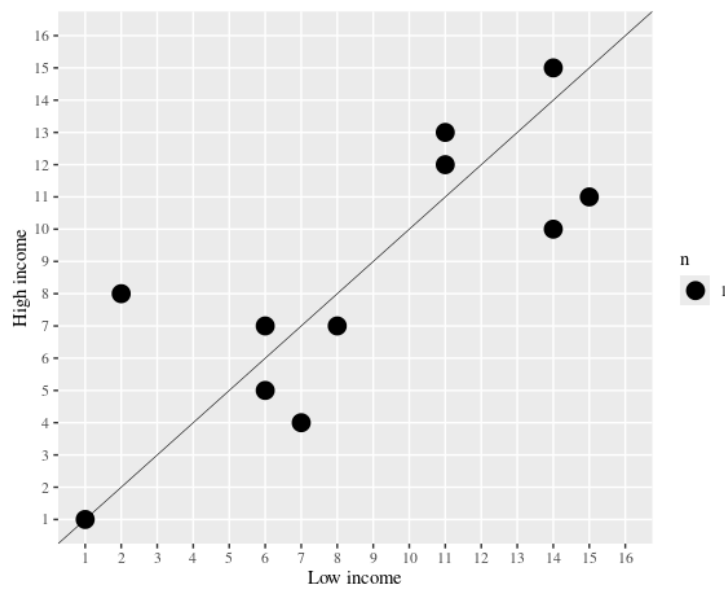


Figure 6: CS outcomes of the pension professionals ($N = 11$), with the low income on the x-axis and the high income on the y-axis. The diagonal line depicts consistent answers for both levels of income.

| | Gamble | Relative Risk Aversion (γ) | |
|---|--------|-------------------------------------|-------------|
| | | Upper bound | Lower Bound |
| 1 | RR | ∞ | 3.76 |
| 2 | RA | 3.76 | 2 |
| 3 | AR | 2 | 1 |
| 4 | AA | 1 | 0 |

Table 16: Choice sequence outcome categories used by Barsky et al. (1997) and their respective relative risk aversion upper and lower bounds. Categories are ranked from most to least risk averse. The column "gamble" shows the order in which individuals have accepted or rejected the two gambles, A is accept and R is reject.

Appendix B

Introduction text (new page):

Introduction

The following pages contain an anonymous questionnaire, which we invite you to complete. This questionnaire has been developed as part of a research project at Radboud University.

The purpose of the questionnaire is to understand your preferences for job decisions in particular situations. Your answers provide important information for policymakers. Your answers will be used as research data.

There is no time limit for completing the questionnaire, but it will take approximately 10 minutes. There are no wrong or right answers as the questions concern your own individual preferences. While answering the questions, pretend that prices in the future will stay the same as prices now, meaning there won't be any increase in prices (no inflation).

Consent

The information collected will be anonymous and will remain strictly confidential, meaning that it is impossible to trace the answers back to you. We do this by removing all information leading to you as an individual from the survey data. The anonymous responses are analyzed by the researchers and may be used for other studies, for the advancement of knowledge, and for the dissemination of the overall results in scientific articles and presentations.

You decide whether to participate in this study. Your participation is voluntary. You may say no at any time. You do not have to answer questions you would rather not answer, and you can stop your participation at any time during the study. You do not have to indicate why you are stopping.

By proceeding to the next page, you will be considered as having given your consent to participate in this research project. You agree that you have been informed about the purpose of the study and you understand that you may stop at any time during the study if you wish. Since the questionnaire is anonymous, you will no longer be able to withdraw from the study once you have completed the questionnaire because it will be impossible to determine which of the answers are yours. Your consent indicates that you have understood the information and that you agree to participate in the study voluntarily.

This study has been approved by the Ethics Assessment Committee Faculty of Law and Nijmegen School of Management EACLM-LT-036.

Questions

If you have any questions about this research, please contact one of the researchers indicated below. Thank you for your valuable cooperation!

Steef Berkeljon
Master's student
Radboud University Nijmegen, The Netherlands
steef.berkeljon@ru.nl

Jorgo Goossens
Assistant Professor
Radboud University Nijmegen, The Netherlands
jorgo.goossens@ru.nl

Characteristics questions (new page):

Please answer the following general questions about yourself:

What is your gender?

- Male
- Female
- Other
- Prefer not to say

What is your age?

- <18
- 18
- 19
- 20
- 21
- 22
- 23
- 24
- 25
- 26
- >26

Are you a Bachelor's or Master's student?

- Bachelor's
- Master's

How do you mainly finance your monthly expenses? More than one answer is permitted.

- Student grant or allowance
- Student loan (student finance)
- Study allowance from parents or other family
- Job income

Choice sequence low income:

Question 1 (new page):

Suppose that you are working a full-time job (40 hours/week) and you have to provide only for yourself. This job is good and guarantees an income after taxes of **2800 euro** per month* for the rest of your life.

You are given the opportunity to take a new and equally good job, with a 50-50 chance it will double your income and a 50-50 chance that it will cut your income by a third. Would you take the new job?

- Yes, take new job
- No, keep current job

*Average net income in the Netherlands (2024).

If selected “new job”, then question 2 (new page):

Suppose the chances were 50-50 that the new job would double your income, and 50-50 that it would cut it **in half**. Would you still take the new job?

- No, keep current job
- Yes, take new job

If selected “current job”, then question 2 (new page):

Suppose the chances were 50-50 that the new job would double your income, and 50-50 that it would cut it **by 20 percent**. Would you then take the new job?

- No, keep current job
- Yes, take new job

If selected “new job” + “new job”, then question 3 (new page):

Now suppose the chances were 50-50 that the new job would double your income, and 50-50 that it would cut it **by 66.7 percent**. Would you then keep your current job?

- No, take new job
- Yes, keep current job

If selected “new job” + “current job”, then question 3 (new page):

Now suppose the chances were 50-50 that the new job would double your income, and 50-50 that it would cut it **by 40 percent**. Would you again keep your current job?

- No, take new job
- Yes, keep current job

If selected “current job” + “new job”, then question 3 (new page):

Now suppose the chances were 50-50 that the new job would double your income, and 50-50 that it would cut it **by 25 percent**. Would you still take the new job?

- Yes, take new job
- No, keep current job

If selected “current job” + “current job”, then question 3 (new page):

Now suppose the chances were 50-50 that the new job would double your income, and 50-50 that it would cut it **by 10 percent**. Would you still keep your current job?

- No, take new job
- Yes, keep current job
-

If selected “new job” + “new job” + “new job”, then question 4 (new page):

Finally, suppose the chances were 50-50 that the new job would double your income, and 50-50 that it would cut it **by 75 percent**. Would you now keep your current job?

- Yes, keep current job
- No, take new job

If selected “new job” + “new job” + “current job”, then question 4 (new page):

Finally, suppose the chances were 50-50 that the new job would double your income, and 50-50 that it would cut it **by 60 percent**. Would you again keep your current job?

- Yes, keep current job
- No, take new job

If selected “new job”+ “current job” + “new job”, then question 4 (new page):

Finally, suppose the chances were 50-50 that the new job would double your income, and 50-50 that it would cut it **by 45 percent**. Would you take the new job?

- No, keep current job
- Yes, take new job

If selected “new job” + “current job” + “current job”, then question 4 (new page):

Finally, suppose the chances were 50-50 that the new job would double your income, and 50-50 that it would cut it **by 37.5 percent**. Would you now take the new job?

- No, keep current job
- Yes, take new job

If selected “current job” + “new job” + “new job”, then question 4 (new page):

Finally, suppose the chances were 50-50 that the new job would double your income, and 50-50 that it would cut it **by 30 percent**. Would you now keep your current job?

- Yes, keep current job
- No, take new job

If selected “current job” + “new job” + “current job”, then question 4 (new page):

Finally, suppose the chances were 50-50 that the new job would double your income, and 50-50 that it would cut it **by 22.2 percent**. Would you again keep your current job?

- Yes, keep current job
- No, take new job

If selected “current job” + “current job” + “new job”, then question 4 (new page):

Finally, suppose the chances were 50-50 that the new job would double your income, and 50-50 that it would cut it **by 16.7 percent**. Would you again take the new job?

- No, keep current job
- Yes, take new job

If selected “current job” + “current job” + “current job”, then question 4 (new page):

Finally, suppose the chances were 50-50 that the new job would double your income, and 50-50 that it would cut it **by 5 percent**. Would you now take the new job?

- No, keep current job
- Yes, take new job

If selected “new job” + “new job” + “new job” + “new job”, then question 5 (new page):

You are willing to take the new job if the chances were 50-50 that it would double your current after-tax income of 2800 euro per month, and 50-50 that it would cut it by 75 percent.

On a scale from 0 (not at all confident) to 10 (very confident): How confident do you feel about this?

| | | |
|----------------------|--|----------------|
| Not at all confident | | Very confident |
| 0 | 1 2 3 4 5 6 7 8 | 9 10 |

If selected “new job” + “new job” + “new job” + “current job”, then question 5 (new page):

You are willing to take the new job if the chances were 50-50 that it would double your current after-tax income of 2800 euro per month, and 50-50 that it would cut it by 66.7 percent, but you would not if the cut were 75 percent.

On a scale from 0 (not at all confident) to 10 (very confident): How confident do you feel about this?

| | | |
|----------------------|--|----------------|
| Not at all confident | | Very confident |
| 0 | 1 2 3 4 5 6 7 8 | 9 10 |

If selected “new job” + “new job” + “current job” + “new job”, then question 5 (new page):

You are willing to take the new job if the chances were 50-50 that it would double your current after-tax income of 2800 euro per month, and 50-50 that it would cut it by 60 percent, but you would not if the cut were 66.7 percent.

On a scale from 0 (not at all confident) to 10 (very confident): How confident do you feel about this?

| | | |
|----------------------|--|----------------|
| Not at all confident | | Very confident |
|----------------------|--|----------------|

0 1 2 3 4 5 6 7 8 9 10

If selected “new job” + “new job” + “current job” + “current job”, then question 5 (new page):

You are willing to take the new job if the chances were 50-50 that it would double your current after-tax income of 2800 euro per month, and 50-50 that it would cut it by 50 percent, but you would not if the cut were 60 percent.

On a scale from 0 (not at all confident) to 10 (very confident): How confident do you feel about this?

Not at all confident

Very confident

0 1 2 3 4 5 6 7 8 9 10

If selected “new job” + “current job” + “new job” + “new job”, then question 5 (new page):

You are willing to take the new job if the chances were 50-50 that it would double your current after-tax income of 2800 euro per month, and 50-50 that it would cut it by 45 percent, but you would not if the cut were 50 percent.

On a scale from 0 (not at all confident) to 10 (very confident): How confident do you feel about this?

Not at all confident

Very confident

0 1 2 3 4 5 6 7 8 9 10

If selected “new job” + “current job” + “new job” + “current job”, then question 5 (new page):

You are willing to take the new job if the chances were 50-50 that it would double your current after-tax income of 2800 euro per month, and 50-50 that it would cut it by 40 percent, but you would not if the cut were 45 percent.

On a scale from 0 (not at all confident) to 10 (very confident): How confident do you feel about this?

Not at all confident

Very confident

0 1 2 3 4 5 6 7 8 9 10

If selected “new job” + “current job” + “current job” + “new job”, then question 5 (new page):

You are willing to take the new job if the chances were 50-50 that it would double your current after-tax income of 2800 euro per month, and 50-50 that it would cut it by 37.5 percent, but you would not if the cut were 40 percent.

On a scale from 0 (not at all confident) to 10 (very confident): How confident do you feel about this?

Not at all confident

Very confident

0 1 2 3 4 5 6 7 8 9 10

If selected “new job” + “current job” + “current job” + “current job”, then question 5 (new page):

You are willing to take the new job if the chances were 50-50 that it would double your current after-tax income of 2800 euro per month, and 50-50 that it would cut it by 33.3 percent, but you would not if the cut were 37.5 percent.

On a scale from 0 (not at all confident) to 10 (very confident): How confident do you feel about this?

Not at all confident Very confident

0 1 2 3 4 5 6 7 8 9 10

If selected “current job” + “new job” + “new job” + “new job”, then question 5 (new page):

You are willing to take the new job if the chances were 50-50 that it would double your current after-tax income of 2800 euro per month, and 50-50 that it would cut it by 30 percent, but you would not if the cut were 33.3 percent.

On a scale from 0 (not at all confident) to 10 (very confident): How confident do you feel about this?

Not at all confident Very confident

0 1 2 3 4 5 6 7 8 9 10

If selected “current job” + “new job” + “new job” + “current job”, then question 5 (new page):

You are willing to take the new job if the chances were 50-50 that it would double your current after-tax income of 2800 euro per month, and 50-50 that it would cut it by 25 percent, but you would not if the cut were 30 percent.

On a scale from 0 (not at all confident) to 10 (very confident): How confident do you feel about this?

Not at all confident Very confident

0 1 2 3 4 5 6 7 8 9 10

If selected “current job” + “new job” + “current job” + “new job”, then question 5 (new page):

You are willing to take the new job if the chances were 50-50 that it would double your current after-tax income of 2800 euro per month, and 50-50 that it would cut it by 22.2 percent, but you would not if the cut were 25 percent.

On a scale from 0 (not at all confident) to 10 (very confident): How confident do you feel about this?

Not at all confident Very confident

0 1 2 3 4 5 6 7 8 9 10

If selected “current job” + “new job” + “current job” + “current job”, then question 5 (new page):

You are willing to take the new job if the chances were 50-50 that it would double your current after-tax income of 2800 euro per month, and 50-50 that it would cut it by 20 percent, but you would not if the cut were 22.2 percent.

On a scale from 0 (not at all confident) to 10 (very confident): How confident do you feel about this?

Not at all confident Very confident

0 1 2 3 4 5 6 7 8 9 10

If selected “current job” + “current job” + “new job” + “new job”, then question 5 (new page):

You are willing to take the new job if the chances were 50-50 that it would double your current after-tax income of 2800 euro per month, and 50-50 that it would cut it by 16.7 percent, but you would not if the cut were 20 percent.

On a scale from 0 (not at all confident) to 10 (very confident): How confident do you feel about this?

Not at all confident Very confident

0 1 2 3 4 5 6 7 8 9 10

If selected “current job” + “current job” + “new job” + “current job”, then question 5 (new page):

You are willing to take the new job if the chances were 50-50 that it would double your current after-tax income of 2800 euro per month, and 50-50 that it would cut it by 10 percent, but you would not if the cut were 16.7 percent.

On a scale from 0 (not at all confident) to 10 (very confident): How confident do you feel about this?

Not at all confident Very confident

0 1 2 3 4 5 6 7 8 9 10

If selected “current job” + “current job” + “current job” + “new job”, then question 5 (new page):

You are willing to take the new job if the chances were 50-50 that it would double your current after-tax income of 2800 euro per month, and 50-50 that it would cut it by 5 percent, but you would not if the cut were 10 percent.

On a scale from 0 (not at all confident) to 10 (very confident): How confident do you feel about this?

Not at all confident

Very confident

0 1 2 3 4 5 6 7 8 9 10

If selected “current job” + “current job” + “current job” + “current job”, then question 5 (new page):

You are **not** willing to take the new job if the chances were 50-50 that it would double your current after-tax income of 2800 euro per month, and 50-50 that it would cut it by 5 percent.

On a scale from 0 (not at all confident) to 10 (very confident): How confident do you feel about this?

Not at all confident

Very confident

0 1 2 3 4 5 6 7 8 9 10

Attention check question (new page):

People like many different colors. What about you? To demonstrate that you are reading this question, please select purple and yellow from the list below. That's right, just select these two options, no matter what your favorite color is.

- Blue
- Red
- Green
- Purple
- Black
- Orange
- Yellow
- Gold

Choice sequence high income:

Question 1 (new page):

Suppose that you are working a full-time job (40 hours/week) and you have to provide only for yourself. This job is good and guarantees an income after taxes of **5600 euro** per month* for the rest of your life.

You are given the opportunity to take a new and equally good job, with a 50-50 chance it will double your income and a 50-50 chance that it will cut your income by a third. Would you take the new job?

- Yes, take new job
- No, keep current job

*Twice the average net income in the Netherlands (2024).

(Follow-up questions are similar to those above. See appendix C for an example of the choice sequence questions in the questionnaire.)

Subsistence level question (new page):

What amount of income after taxes per month would you consider the absolute minimum for you? This means that, if you had any less than this amount, you would not be able to make ends meet, even if you cut your expenses as much as possible. Omit the € sign in your answer.

Financial literacy and investment questions (new page):

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

- More than €102
- Exactly €102
- Less than €102
- Do not know

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

- More than today
- Exactly the same
- Less than today
- Do not know

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

- True
- False
- Do not know

Do you currently possess one or more of the following assets? More than one answer is permitted.

- Bank accounts or savings accounts
- Investments (stocks, bonds, funds, options, etc.)
- Bitcoin or other cryptocurrency
- Real estate (including land), not used as one's own, second or holiday home
- None of the above

Loss aversion and numerical literacy questions (new page):

Which option do you prefer?

- A sure financial amount of €0
- A lottery between a financial gain of €1000 and a financial loss of €1200, each with 50% probability

In a lottery, the chance of winning a car is 1 in 1000. What percent of tickets of the lottery win a car?
Omit the % sign in your answer.

If the chance of getting a disease is 10%, how many people would be expected to get the disease out of 1000?

Feedback questions (new page):

Finally, what did you think of this questionnaire?

The questions were difficult to answer.

- Strongly disagree
- Disagree
- Neither agree or disagree
- Agree
- Strongly agree

The questions were sufficiently clear.

- Strongly disagree
- Disagree
- Neither agree or disagree
- Agree
- Strongly agree

The questionnaire was too long.

- Strongly disagree
- Disagree
- Neither agree or disagree
- Agree
- Strongly agree

It was an interesting subject.

- Strongly disagree
- Disagree
- Neither agree or disagree
- Agree
- Strongly agree

I enjoyed answering the questions.

- Strongly disagree
- Disagree
- Neither agree or disagree
- Agree
- Strongly agree

Do you have any comments or feedback about this questionnaire?

Appendix C

Question 1 (new page):

Suppose that you are working a full-time job (40 hours/week) and you have to provide only for yourself. This job is good and guarantees an income after taxes of **5600 euro** per month* for the rest of your life.

You are given the opportunity to take a new and equally good job, with a 50-50 chance it will double your income and a 50-50 chance that it will cut your income by a third. Would you take the new job?

- Yes, take new job
- No, keep current job

*Twice the average net income in the Netherlands (2024).

Question 2 (new page):

Suppose the chances were 50-50 that the new job would double your income, and 50-50 that it would cut it **by 20 percent**. Would you then take the new job?

- No, keep current job
- Yes, take new job

Question 3 (new page):

Now suppose the chances were 50-50 that the new job would double your income, and 50-50 that it would cut it **by 25 percent**. Would you still take the new job?

- Yes, take new job
- No, keep current job

Question 4 (new page):

Finally, suppose the chances were 50-50 that the new job would double your income, and 50-50 that it would cut it **by 30 percent**. Would you now keep your current job?

- Yes, keep current job
- No, take new job

Question 5 (new page):

You are willing to take the new job if the chances were 50-50 that it would double your current after-tax income of 5600 euro per month, and 50-50 that it would cut it by 25 percent, but you would not if the cut were 30 percent.

On a scale from 0 (not at all confident) to 10 (very confident): How confident do you feel about this?

Not at all confident

Very confident

0 1 2 3 4 5 6 7 8 9 10

Attention check question (new page):

People like many different colors. What about you? To demonstrate that you are reading this question, please select purple and yellow from the list below. That's right, just select these two options, no matter what your favorite color is.

- Blue
- Red
- Green
- Purple
- Black
- Orange
- Yellow
- Gold

Question 1 (new page):

Suppose that you are working a full-time job (40 hours/week) and you have to provide only for yourself. This job is good and guarantees an income after taxes of **2800 euro** per month* for the rest of your life.

You are given the opportunity to take a new and equally good job, with a 50-50 chance it will double your income and a 50-50 chance that it will cut your income by a third. Would you take the new job?

- Yes, take new job
- No, keep current job

*Average net income in the Netherlands (2024).

Question 2 (new page):

Suppose the chances were 50-50 that the new job would double your income, and 50-50 that it would cut it **by 20 percent**. Would you then take the new job?

- No, keep current job
- Yes, take new job

Question 3 (new page):

Now suppose the chances were 50-50 that the new job would double your income, and 50-50 that it would cut it **by 25 percent**. Would you still take the new job?

- Yes, take new job
- No, keep current job

Question 4 (new page):

Finally, suppose the chances were 50-50 that the new job would double your income, and 50-50 that it would cut it **by 22.2 percent**. Would you again keep your current job?

- Yes, keep current job
- No, take new job

Question 5 (new page):

You are willing to take the new job if the chances were 50-50 that it would double your current after-tax income of 2800 euro per month, and 50-50 that it would cut it by 20 percent, but you would not if the cut were 22.2 percent.

On a scale from 0 (not at all confident) to 10 (very confident): How confident do you feel about this?

Not at all confident

Very confident

0 1 2 3 4 5 6 7 8 9 10

Appendix D

Removed questions:

Are you a Bachelor's or Master's student?

- Bachelor's
- Master's

How do you mainly finance your monthly expenses? More than one answer is permitted.

- Student grant or allowance
- Student loan (student finance)
- Study allowance from parents or other family
- Job income

Adjusted question:

What is your age?

- <25
- 25-29
- 30-34
- 35-39
- 40-44
- 45-49
- 50-54
- 55-59
- 60-64
- 65-69
- >69

New question:

What is your current after-tax income per month?

- <€2000
- €2000-€3000
- €3000-€4000
- €4000-€5000
- €5000-€6000
- €6000-€7000
- €7000-€8000
- €8000-€9000
- €9000-€10,000
- >€10,000
- Prefer not to say