Reconciling health and wealth background risks: an analysis of risky behavior when higher-order preferences are considered

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This version: December 2018. Very preliminary, please do not circulate

Abstract

Background risks, such as chronic illnesses or financial instability are never independent but come in bundles. We analyse whether the introduction of exogenous financial background risk makes individuals behave in a less risky manner when accounting for the prior level of individual background risk. We focus on the interaction of background and foreground risks, particularly in health and financial risks. Our study relies on a non-parametric methodology to elicit risky decisions and higher order risk preferences, which allows us to have a more detailed individual risk profile. At an individual level, we find that both health and higher-order risk preferences explain the changes in the number of risk averse choices a subject makes once exogenous financial risks have been introduced. Individuals who report having chronic illnesses have a lower degree of riskiness when exposed to potential exogenous losses. However, only health or only higher-order risk preferences cannot explain changes in risky decisions alone, as sick and prudent individuals become riskier when exposed to additional background risk. Temperance also plays a role, in line with the literature on exposure to risks. Finally, we evaluate the idea of how much risk is too much risk, proposed by Quiggin (2003) and argue that there might not be a unique utility function that represents all of our sample, as subjects have different responses when subject to additional exogenous background risk.

JEL codes: C91, D81, I12

Keywords: Risk preferences, health, background risk, higher-order risk preferences, prudence, temperance, risky behavior

Research was approved by the University of Massachusetts Internal Review Board (protocol number 2017-4167).

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1. Introduction

Background risks, such as health status and income instability are pre-existing risks that cannot be avoided and are not under the control of an individual. For background risks, there is no market for directly trading this risk (Franke et al. 2018, Schlesinger and Stapleton 2018). These risks are usually defined as independent from other risks the individual faces (Eeckhoudt et al. 1996). Health status, job, food and environmental insecurity all have an element of risk that is both beyond the individual’s full control. In addition, individuals are in practice almost never faced with one single risk but usually face bundles of risk that might be correlated with each other. These bundles of risk could include the individual’s health status, as well as and the impact health has on job and financial stability (Cardak and Wilkins 2009, Love and Smith 2010, Bressan et al. 2014, Edwards 2008, Pesko 2016). Fully understanding risk preferences requires accounting for background risks (Guiso and Paiella 2008, Berkowitz and Qiu 2006, Fan and Zhao 2009). In this paper, we focus on the intersection of two background risks: health and financial risks.

Prior work has shown that background risk affects economic decisions, both in theory (Gollier and Pratt 1996, Kimball 1993, Eeckhoudt et al. 1996, Pratt and Zeckhouser 1987) and in practice (Deck and Schlesinger 2010, 2014, Ebert and Wiesen 2011, 2014, Tarazona-Gomez 2004, Heinrich and Mayrhofer 2017, Noussair et al. 2014). Recent studies have shown that health status could impact risky decisions and lead to less risky portfolio allocations (Rosen and Wu 2000, Edwards 2008, Coile and Milligan 2009, Bressan et al. 2014). Moreover, models that ignore background risk could generate biased estimates of individual risk preferences (Lusk and Coble 2008). We analyze how risky decisions change when individuals are exposed to increased financial background risk, while accounting for their health status.
Adding background risk usually reduces welfare, as more risk is usually viewed as worse for an individual (Pratt and Zeckhauser 1987, Kimball 1993, Eeckhoudt et al. 1996, Gollier and Pratt 1996). However, some individuals (in particular those who have diminished sensitivity to risk) could become more risk seeking when faced with an additional small background risk (Quiggin and Chambers 1998). This is the principle of “psychological diminished sensitivity”. Rather than being substitutes, risks could be complements for some types of preferences. In this paper, we want to understand if different types of small financial background risks have different effects in the level of individual riskiness when it comes to financial lottery decisions.

Lastly, the analysis of how risk impacts decisions typically focused on examining individual risk attitudes against a wide range of behavioral patterns and economic outcomes, such as trust, self-selection into payment schemes, financial investments and health outcomes (Bohnet and Zeckhauser 2004, Barsky et al. 1997, Riley and Chow 1992, Galizzi et al. 2012, Blais and Weber 2006, Lönnqvist et al. 2015). The analysis of risky decisions has mainly emphasized the measurement of risk aversion (second-order risk preferences). However, risk aversion is just one piece of an individual’s risk-profile (Deck and Schlesinger 2014). An individual’s risk profile is also composed of other higher-order risk aversion measures, such as prudence (third-order) and temperance (fourth-order). We analyze how higher-order preferences interact with risky decisions, depending on the health status of the individual.

As a summary, the focus of our analysis is tri-fold. We first want to examine whether the risky decisions of individuals with different health status differ. Second, we want to analyze whether the introduction of different exogenous financial background risks makes individuals more or less risk averse. Third, we want to understand if the individual’s risk profile (including
higher-order preferences) is a determinant of how risky decisions are affected once background risk increases.

We find that both health and higher-order risk preferences, when considered, explain changes in risky decisions once exogenous financial risks have been introduced. Sick individuals (defined as individuals who report having at least one chronic illness) make less risky decisions when exposed to potential exogenous losses. Healthy subjects become more risk seeking when faced with potential exogenous gains. Higher-order preferences explain part of the changes in risky behaviors. However, they cannot be considered only on their own. Prudence is not enough to explain patterns of risky decisions, as prudent sick individuals make riskier decisions when exposed to exogenous risks, but sick, prudent and temperate individuals make less risky decisions when exposed to potential exogenous losses. Higher-order risk preferences and low income also have a positive impact in the number of risky choices, but in the case where individuals are exposed to a potential gain. Individuals react differently when exposed to exogenous gains, losses and mean-zero lotteries, which is evidence towards the existence of “cross-risk vulnerability”, as one type of background risk, such as health status, could impact decisions on another type of foreground risk – financial decisions - (Malevergne and Ray 2009).

2. Previous literature

There are two main strands of literature relevant to our study. The first one is related to the empirical analysis of background risk, in particular in the case of health and financial decisions. The second one focuses on the experimental analysis of risk and higher-order risk preferences. We discuss both literatures below.

2.1. Empirical analysis of background risk: the case of health
Background risk has been found to affect patterns of individual savings, portfolio allocation decisions, entrance and permanence in the labor market (Heaton and Lucas 2000, Quiggin 2003, Hanaoka et al. 2015, Berkowitz and Qiu 2006). Prior literature on financial risks and portfolio allocation has shown that different background risks, such as income and credit constraints, health status, have an impact on financial-related decisions (Guiso and Paiella 2008, Edwards 2008). In most cases, the presence of background risk has been shown to lead to less risky decisions (Bressan et al. 2014, Guiso et al. 1996, Quiggin 2003, Harrison et al. 2007). This is the basis of our experimental setting.

For our analysis, we focus on two specific risks: financial decisions (as a foreground risk) when health status is considered (as a background risk). Financial and health risks are not independent, and health status could have an effect on financial decisions (Berkowitz and Qiu 2006). In the health domain, health status has both a direct and an indirect effect on risky decisions. Health shocks and the expectation of future health shocks represent a risk for large out of pocket expenses. It affects individual financial planning and planning horizons through its effect on life expectancy. Age (life expectancy) impacts health status by directly affecting survival risk (Love and Perozek 2007).

Individuals with worse health have been found to make less risky decisions and choose safer portfolio allocations (Rosen and Wu 2004, Edwards 2008). This happens particularly in countries where health care systems have less coverage, less protection or supplemental health care insurance (Atella et al. 2012, Bressan et al. 2014, Goldman and Maestas 2013). Poor health also has an impact on labor income risk, as someone with poorer health could reduce the hours of work or not work at all. This could have a negative effect on individual finances and income.
flows. Our focus is on how foreground financial risk, which could be diversified through individual choices, changes when health background risk is considered.

Lastly, there is an additional effect of poor health status. Less healthy subjects have been shown to increase precautionary savings to avoid financial shocks associated with health declines (Edwards 2008, Baptista 2008). The precautionary savings motive is usually associated with the concept of prudence, while making less risky financial choices (discussed above) could be associated with the concept of temperance. Prior studies of financial risky decisions when higher-order risk preferences are considered have heterogeneous results. While some studies find that income uncertainty leads to less risky decisions (Heaton and Lucas 2000, Guiso et al. 1996), some studies find the opposite (Arrondel et al. 1996) or no relationship at all (Alessie et al. 2002). We measure both prudence and temperance in our analysis and provide experimental evidence on the relationship between health and higher-order preferences on financial decisions.

2.2. Experimental analysis of higher-order risk preferences

Measures such as prudence and temperance have been recently used to construct an individual risk profile (Deck and Schlesinger 2014, Ebert and Wiesen 2011). Under the expected utility (EUT) approach, prudence (Kimball 1990) is defined as the (positive) third derivative of the utility function and is equivalent to an aversion to increases in downside risk (Menezes et al. 1980). In a life cycle saving model, the uncertainty of future income only leads to an increase in savings when the individual exhibits prudence (Leland 1968, Noussair et al. 2014). Prudence can also be defined as an aversion to “increases in downside risk”, as it increases the negative skewness of a risky prospect (Deck and Schlesinger 2008, Menezes et al. 1980). Temperance (Kimball 1993, Menezes and Wang 2005) is defined as the (negative) fourth derivative of the
utility function. A temperate individual facing an unavoidable risk would reduce exposure to another, independent risk. Temperate individuals dislike negative kurtosis. Temperance has mostly been linked to behavior under background risk (Gollier and Pratt 1996, Eeckhoudt et al. 1996). In particular, in the presence of future health and financial shocks, subjects who are prudent and temperate save more and invest more in safer assets than those individuals who are not (Leland 1968, Sandmo 1970, Kimball 1990, Gollier and Pratt 1996, Eeckhoudt and Schlesinger 2008, Noussair et al. 2014). To the best of our knowledge, only one paper has incorporated health status as a measure of background risk when examining the prevalence of higher-order risk preferences. Noussair et al. (2014) observes that the majority of individual decisions are consistent with risk aversion, prudence and temperance, and that higher income and better health negatively influence risk aversion. In the analysis of changes in individual riskiness, we include measures of prudence and temperance in our analysis and interact them with individual health.

In the EUT framework, most of the commonly utility functions imply not only risk aversion but also prudence and temperance. Tarazona-Gomez (2004) and Krieger and Mayrhofer (2012) have used approaches in line with EU theory to elicit higher-order risk preferences, finding some evidence for prudence. However, more recently, prudence and temperance have been defined in a non-parametric way (Heinrich and Mayrhofer 2017). This is the approach we take in our study. In this case, preferences are based on 50/50 lottery pairs (Eeckhoudt and Schlesinger 2006). Prudence is defined as a preference for disaggregating a zero-mean risk and a sure reduction in wealth across two equally likely states of nature, while temperance is a preference for disaggregating two independent zero-mean risks across two equally likely states of nature (Ebert and Wiesen 2014). This definition is appealing for experimental purposes and

3. Experimental design and procedures

The experimental design for each treatment consists of two main tasks and one exogenous background risk lottery. In the first task, individuals choose from a series of 16 risk apportionment lotteries to measure risk aversion, prudence and temperance (“Risk apportionment choices”). This set of tasks is repeated after an exogenous background risk lottery has been introduced. In the second task, individuals respond a series of questions related to the different background risks (health, income, job) that could be brought to the experimental session (“Individual background risk elicitation”). This is complemented with a socio-economic survey at the end of the experiment.

The order of each treatment is shown in Table 1. Individuals start with an endowment of 100 experimental dollars (E$), to avoid negative earnings. Instructions for the choice set tasks and the additional background risk lotteries were recorded as a video, which included examples. We included comprehension questions after the instructions for the first choice set and after the exogenous background risk was introduced. Subjects are paid at the end of the experiment. Participants only received feedback on the tasks paid, but not between experimental tasks.
Table 1: Experimental treatments

<table>
<thead>
<tr>
<th>Treatment</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Background</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>risks</td>
<td>elicitation</td>
<td>first</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$T_1$</td>
<td>Individual</td>
<td>Risk</td>
<td>No BR</td>
<td>Risk</td>
<td>Socio-</td>
<td></td>
</tr>
<tr>
<td>$T_2$</td>
<td>background</td>
<td>apportionment</td>
<td>Mean-zero BR</td>
<td>apportionment</td>
<td>economic</td>
<td></td>
</tr>
<tr>
<td>$T_3$</td>
<td>risk</td>
<td>choices</td>
<td>Upside BR</td>
<td>choices</td>
<td>survey</td>
<td></td>
</tr>
<tr>
<td>$T_4$</td>
<td>elicitation</td>
<td></td>
<td>Downside BR</td>
<td></td>
<td></td>
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<td>last</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>risks</td>
<td>elicitation</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>$T_5$</td>
<td></td>
<td>Risk</td>
<td>No BR</td>
<td>Risk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$T_6$</td>
<td></td>
<td>apportionment</td>
<td>Mean-zero BR</td>
<td>apportionment</td>
<td>individual</td>
<td></td>
</tr>
<tr>
<td>$T_7$</td>
<td></td>
<td>choices</td>
<td>Upside BR</td>
<td>choices</td>
<td>background</td>
<td></td>
</tr>
<tr>
<td>$T_8$</td>
<td></td>
<td></td>
<td>Downside BR</td>
<td></td>
<td>survey</td>
<td></td>
</tr>
</tbody>
</table>

3.1. Task 1: risk apportionment choices

Our elicitation method for higher-order risk preferences is based on the experimental risk apportionment approach developed by Eeckhoudt and Schlesinger (2006) and Eeckhoudt et al. (2009), while following the risk apportionment choice sets of Deck and Schlesinger (2008). The non-parametric concept of risk apportionment defines risk aversion, prudence and temperance over 50-50 lottery pairs (Eeckhoudt et al. 2009, Crainich et al. 2013).

Preferences for risk, prudence and temperance can be defined as follows. Consider an individual with wealth $W > 0$. In risk apportionment tasks, the individual faces a choice to
aggregate or disaggregate two events, $k$ and $\delta$, which can be fixed monetary amounts or independent zero-mean lotteries. Following Deck and Schlesinger (2017) and using the notation $[O_1, O_2]$ to represent the lottery where the outcome is $O_1$ with 50 percent probability and $O_2$ with 50 percent probability, a risk averse person would prefer $[W + k, W + \delta]$ to $[W, W + k + \delta]$, where $k$ and $\delta$ are fixed amounts. A risk averse individual prefers to “disaggregate the harms” (Eeckhoudt and Schlesinger 2006), with the “harms” being the losses of two fixed amounts of money. A risk loving individual would prefer to have both $k$ and $\delta$ together. This also coincides under EU theory with a concave utility function ($u'' < 0$) and a dislike for mean-preserving spreads in the sense of Rothschild and Stiglitz (1971).

A prudent individual would prefer $[W + k, W + \delta]$ to $[W, W + k + \delta]$, where $k$ is a fixed amount and $\delta$ is a zero-mean lottery. An imprudent individual would prefer the opposite. In an EU approach, this is consistent with a convex marginal utility ($u''' > 0$) or with a preference for decreases in downside risk (Menezes et al. 1990). Again, this is still a preference for “disaggregating the harms” (Deck and Schlesinger 2008).

Temperance could also be defined as a preference for $[W + k, W + \delta]$ over $[W, W + k + \delta]$, where $k$ and $\delta$ are independent zero-mean lotteries. Kimball (1993) defines the two harms as “mutually aggravating”, as a temperate individual would prefer to receive only one of these harms (or risks). An intemperate individual would prefer to have both lotteries together. In an EU approach, this is equivalent to $u'' < 0$ or to a preference for decreases in outer risk (Menezes and Wang 2005).

### Table 2: Higher-order risk preferences choice tasks

<table>
<thead>
<tr>
<th>Decision</th>
<th>Preference type</th>
<th>Sure amount</th>
<th>First item $(k, ES)$</th>
<th>Second item</th>
<th>Expected Payoff</th>
<th>Order of tasks</th>
<th>Order of tasks</th>
</tr>
</thead>
</table>


<table>
<thead>
<tr>
<th></th>
<th>(W, ES)</th>
<th>(δ, ES)</th>
<th>Stage 1</th>
<th>Stage 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Risk Aversion</td>
<td>10</td>
<td>[1/1]</td>
<td>[1/1]</td>
</tr>
<tr>
<td>2</td>
<td>Risk Aversion</td>
<td>10</td>
<td>[1/1]</td>
<td>[5/5]</td>
</tr>
<tr>
<td>3</td>
<td>Risk Aversion</td>
<td>10</td>
<td>[1/1]</td>
<td>[9/9]</td>
</tr>
<tr>
<td>4</td>
<td>Risk Aversion</td>
<td>10</td>
<td>[5/5]</td>
<td>[5/5]</td>
</tr>
<tr>
<td>5</td>
<td>Risk Aversion</td>
<td>6</td>
<td>[9/9]</td>
<td>[9/9]</td>
</tr>
<tr>
<td>6</td>
<td>Risk Aversion</td>
<td>50</td>
<td>[5/5]</td>
<td>[45/45]</td>
</tr>
<tr>
<td>7</td>
<td>Prudence</td>
<td>30</td>
<td>[25/-25]</td>
<td>[25/25]</td>
</tr>
<tr>
<td>8</td>
<td>Prudence</td>
<td>12.5</td>
<td>[9/9]</td>
<td>[5/-5]</td>
</tr>
<tr>
<td>9</td>
<td>Prudence</td>
<td>12.5</td>
<td>[5/-5]</td>
<td>[1/1]</td>
</tr>
<tr>
<td>10</td>
<td>Prudence</td>
<td>10.5</td>
<td>[9/9]</td>
<td>[1/-1]</td>
</tr>
<tr>
<td>11</td>
<td>Prudence</td>
<td>12.5</td>
<td>[5/5]</td>
<td>[5/-5]</td>
</tr>
<tr>
<td>12</td>
<td>Prudence</td>
<td>14.5</td>
<td>[9/-9]</td>
<td>[1/1]</td>
</tr>
<tr>
<td>13</td>
<td>Temperance</td>
<td>15</td>
<td>[5/-5]</td>
<td>[5/-5]</td>
</tr>
<tr>
<td>14</td>
<td>Temperance</td>
<td>15</td>
<td>[9/-9]</td>
<td>[1/-1]</td>
</tr>
<tr>
<td>15</td>
<td>Temperance</td>
<td>55</td>
<td>[25/-25]</td>
<td>[25/25]</td>
</tr>
<tr>
<td>16</td>
<td>Temperance</td>
<td>55</td>
<td>[5/-5]</td>
<td>[45/-45]</td>
</tr>
</tbody>
</table>

Note: Tasks are shown in a different order in both choice stages. The order is specified in the last two columns of this table. +/- x denotes the lottery in which the subject can have a 50-50 chance of gaining or losing E$x. 
Based on the definitions of risk apportioning tasks above, subjects start with a fixed amount of money ($W$) in each task. Subjects know that one of two possible states would occur, which is determined by a coin toss flip at the end of the experiment. We denote these states *Heads* and *Tails*. The subject decides for each choice task if she wishes to receive the first additional item ($k$) when the coin flip lands on *Heads* or *Tails* and the second additional item ($\delta$) on the *Same* or *Different* outcome of the coin toss as the first item. There is only one coin toss and the subject decides if she wants the two additional items combined (by choosing *Same* so that she receives both or neither items) or if she wants them separated (by choosing *Different* so that she receives one item or the other). We can measure the individual’s preferences for aggregating or disaggregating $k$ and $\delta$ by examining their choices in each task. In terms of presentation, when items are fixed dollar amounts, they are presented to the experimental subject as $[x / x]$. When items are for zero-mean lotteries, they are presented as $[x / -x]$, where $x$ is the amount that can be won or lost.

In our experimental setup, we present lotteries in a compound format, as this makes the choice whether to aggregate or disaggregate harmful events explicit (Noussair et al. 2014). The way the choice tasks in Table 2 are presented follows the design of Deck and Schlesinger (2010) for prudence and temperance. Risk aversion tasks are defined to be comparable to Deck and Schlesinger (2010) in terms of amounts used and expected values. We defined six risk aversion tasks, six prudence tasks and four temperance tasks. Amounts are defined in terms of experimental dollars (E$) and translated to dollars ($) at a specific exchange rate. An example of the risk aversion task is below (task 2 in Table 2):
You will receive E$10 +
[1 / 1] if the coin lands on Heads or Tails and

[5 / 5] if the coin lands on Same or Different outcome.

In the risk aversion task above, the subject starts with a fixed amount of E$10 and has to identify their preferences regarding receiving two additional fixed amounts, defined as [1 / 1] and [5 / 5]. A risk averse person would prefer having the two items separated, so as to “disaggregate the harms”. For the purposes of measuring higher-order risk preferences, the relevant decision is whether the subject chooses between getting the two items in the Same outcome of the coin toss or to get one or the other when choosing Different. Following Deck and Schlesinger (2010), although the answer to the first additional item is not directly relevant for measuring higher-order risk preferences, the answer is designed to give the subject flexibility and to ensure that the experiment is not rigged.

An example of a prudence choice task is below (task 9 in Table 2):

You will receive E$10.50 +
[9 / 9] if the coin lands on Heads or Tails and

[1 / -1] if the coin lands on Same or Different outcome.

In the example prudence task, the subject starts with a fixed amount of E$10.50 and has to identify their preferences regarding receiving a fixed amount of E$9, defined as [9 / 9] and a zero-mean lottery, where she can win or lose E$5, defined as [5 / -5]. Each zero-mean lottery is a
50/50 lottery which allows the subjects to gain or lose an amount of money. Whether it is a gain or a loss depends on the outcome of a die roll. A prudent person would choose Different in the second additional item, as she would prefer to have the fixed amount and the lottery separated.

Lastly, an example of a temperance choice task is (task 14 in Table 2):

You will receive E$15 +

[9 / -9] if the coin lands on Heads or Tails and

[1 / -1] if the coin lands on Same or Different outcome.

In the temperance task above, the subject starts with a fixed amount of E$10 and has to identify their preferences regarding receiving two mean-zero lotteries. In the first lottery, she can win or lose E$9, so it is defined as [9 / 9]. In the second lottery, she can win or lose E$5, so it is defined as [5 / -5]. A temperate individual would choose to get one lottery or the other, so as to “disaggregate the harms”. Thus, she would choose Different in the second additional item.

Each treatment has two choice sets of 16 risk apportionment tasks, in which subjects revealed their preferred combination of fixed dollar amounts and zero-mean random variables (the “two additional items”). The first choice set takes place before the background risk lottery is introduced, while the second choice set takes place afterwards. Each choice set has the same 16 tasks but is presented in two different orders (see Table 2).

The choice tasks were selected to allow for a variety of comparisons. For the risk aversion tasks, tasks number 1, 2 and 3 have the same initial sure amount, same first fixed and varying second fixed amount. Tasks 3, 4 and 5 have the same expected value. Task 6 has 5 times the amounts as task 3, to account for a stakes effect. Task 4 has 5 times the amount of the
additional items as task 1, to account for a stakes effect. For the prudence tasks, tasks 8, 9 and 11 have the same initial sure amount but different zero-mean lotteries and fixed additional items. Tasks 10, 11 and 12 have equal expected payoff. Tasks 8 and 10 and tasks 9 and 12 have the same fixed amount and different zero-mean lottery. To examine a stakes effect, task 11 has 5 times the amount in the additional items compared to task 7, as well as a larger initial sure amount. The temperance tasks 13 and 14 allow for a relative lottery size comparison, while task 16 has a larger lottery size compared to task 15 to examine a stakes effect.

3.2. Task 2: Individual background risk elicitation

Our questionnaire elicits the different background risks the individual might come to the experiment with. This is independent from the addition of financial background risk in our treatments through the lotteries and the focus of the study on health. For health, our background risk questionnaire incorporates the main categories suggested by Cardak and Wilkins (2009) and Noussair et al. (2014): health risk, labor income risk, committed expenditure risk, liquidity and credit constraints, investment substitutes, mandatory retirement savings, preferences and other factors.

For health risk, we included self-reported measures of health status, number and type of chronic illnesses, private medical insurance, as well as medical coverage of household and family members. For labor income risk, we elicited the subjects’ employment status and employment type, perception of job security in the short and mid-term. For committed expenditure risk, we asked the individual if she has mortgages or pays rent. In the case of liquidity and credit constraints, we measured the liquidity to face financial emergencies, number
of credit cards and credit card debt and income. For investment substitutes, we included a question on house ownership. In the case of mandatory retirement savings, we elicit the subjects’ affiliation to a pension plan. Lastly, for preferences, we include a self-reported measure of risk preferences, a self-reported question on investment behavior as well as questions that help us understand what the individual would do with her spare cash (pay debt, spend, save).

To elicit other factors, we included a short socioeconomic survey at the end of each study that included age, gender, race and ethnicity, State of residence, religion, marital status, educational level, number of children, a self-reported happiness question and a self-reported risk aversion question. The full questionnaire and short survey can be found in Appendix A.

3.3. Exogenous background risk lottery

As background risks should be pre-existing and uninsurable for individuals, we set up four treatments to reflect these three characteristics. Three of the treatments involve a lottery which differs on its expected value. The background risk lottery is introduced between the two sets of risk apportionment lotteries. The subject knows that the lottery will affect her payoff but she will not make any decisions regarding the lottery. Hence, this risk is uninsurable and also pre-existing before the second set of choices. Although the lotteries introduced are financial background risks, this background risk lottery is independent from other background risks the individual might have. The background risk lottery is also introduced exogenously, being explicitly imposed to the individual. The outcome of the lottery is realized after the end of the experiment.

The four treatments are: no lottery (No BR treatment), a mean-zero lottery (mean-zero BR treatment), a negative expected value lottery (downside BR treatment) and a positive expected
lottery (upside BR treatment). The No BR treatment involves no lottery and the subject makes the two sets of choices back to back. The mean-zero and downside background risk treatments follow the logic of Lusk and Coble (2008) as a point of comparison for changes in risky decisions. However, we changed the value of the positive and negative outcomes of the lotteries to match our choice set payments. The mean-zero lottery has a 50 percent chance of winning E$50 and a 50 percent chance of losing E$50. The downside risk lottery has a 50 percent chance of winning E$0 and 50 percent chance of losing E$50. The upside risk lottery has a 50 percent chance of winning E$50 and 50 percent chance of losing E$0. In the Mean-zero and downside treatments, the risk is pre-existing, uninsurable and also undesirable, as it could lead to losses.

A distinction should be made between the zero-mean lotteries which are part of the choice set decisions and the additional background risks introduced in our treatments. Examining preferences for disaggregating sure losses and zero-mean lotteries (prudence) and preferences for disaggregating two independent zero-mean lotteries (temperance) in our choice sets could help us explain reductions in exposures to background risks (Mayrhofer 2017). These zero-mean lotteries could be thought of in these choice sets as background risks. The background risks in our choice sets are avoidable (based on the choices the individual makes) and are not pre-existing. However, our additional (treatment) background risks are unavoidable, uninsurable and pre-existing in the case of our second set of choices. Subjects are not allowed to make choices on the additional background risk lotteries, while they could avoid unfair or zero-mean lotteries of the choice sets based on their own decisions. Both types of background risks in our experiment are independent from each other, which allows us to examine the impact of one type of background risk on the other and vice versa.
3.4. Implementation and payment

Our experiment is computerized and run online in Amazon Mechanical Turk (MTurk) with an adult population. This allows us to have as much variability in pre-existing risks as possible, which could be more difficult with a population of undergraduate students. Each individual experimental session lasts around 30 minutes. Based on the way the MTurk platform works, individuals work on their experiment independently, once they agree to take part of our experiment and sign off on the consent page. The experiment is run in Qualtrics, which allows for an easy assignment of the treatments to each person. Each treatment is assigned 80 subjects, for a total of 640 individuals participating in our experiment.

Total payment includes a base fee of $0.5 for participation in the experiment. Bonus payment consists in one of the choice task decisions and the outcome of the background risk lottery. This is done at an exchange rate of E$80:$1. From the choice tasks, one decision will be selected to be paid as bonus, by drawing a random number from 1 to 32 (corresponding to the 32 higher-order risk preference choice tasks the individual makes). Regardless of whether it is a risk, prudence or temperance task, for the task chosen for payment the subject always gets the initial sure amount in the risk apportionment lottery. In addition, if based on the subject choices and the outcome of the coin toss the subject gets the first additional item, we roll a red six-sided die to determine the payoff from this lottery. If the first additional item is a fixed amount, the subject receives the amount regardless of the die roll (whether it is an odd or an even number). If the first additional item is a zero-mean lottery, the payoff of this lottery depends on the die roll. If the die roll is odd, the subject receives the first outcome of the lottery and gains the amount specified. If the die roll is even, the subject receives the second outcome of the lottery and loses the amount specified. If the subject gets the second additional item, we roll a blue six-sided die
to determine the payoff from this lottery. The payoffs for the second additional item work the same way as for the first additional item. If based on the choices and the outcome of the coin toss the subject does not get an additional item, she gets E$0 for that item.

The outcome of the background risk lottery in the treatments where additional background risk is introduced is determined by rolling a purple six-sided die. If the die roll is odd, the subject receives the first outcome of the lottery, which could be positive, negative or zero. If the die roll is even, the subject receives the second outcome of the lottery, which could be positive, negative or zero.

4. Results

For the following analysis, we define individuals as sick if they reported that they had at least one chronic illness. Healthy individuals are those who reported that they had no chronic illnesses. We first examine differences in overall risky behavior between sick and healthy subjects. Second, we focus on the impact of the different treatments on risky behavior, accounting for individual health. Third, we introduce higher-order preferences to the analysis, specifically prudence and temperance. Treatments yield the same results regardless of the position of the background risk elicitation survey so we pool them together. Table 3 presents the number of subjects per treatment and health status.

<table>
<thead>
<tr>
<th>Table 3: Number of subjects by treatment and self-reported health status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>No BR</td>
</tr>
<tr>
<td>Mean-zero BR</td>
</tr>
<tr>
<td>Upside BR</td>
</tr>
<tr>
<td>Downside BR</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>
4.1. Aggregate behavior: sick versus healthy

First, we measure the overall incidence of riskiness in our sample as well as for sick and healthy individuals. We define the level of individual riskiness, prudence and temperance as the number of binary decisions consistent with risk aversion, prudence and temperance. These definition measures of the strength of these attitudes and has been previously used by Deck and Schlesinger (2010, 2014), Ebert and Wiesen (2011) and Noussair et al. (2014). We initially focus on the number of risk averse choices (that is the number of times individuals choose to disaggregate the harms and choose to receive both additional items separately).

We expect sick individuals to be less risky in their choices when compared to healthy subjects, both pre- and post-treatment. What we find is that pre-treatment, sick subjects make on average the same number of risk averse choices compared to healthy subjects (p<0.001). The distribution of the number of risk averse choices pre-treatment is also the same for sick and healthy individuals (Kolmogorov-Smirnov test p=0.75, Figure 1). But post-treatment, sick subjects make a significantly higher number of risk averse choices than healthy subjects (p<0.001).

In our experiment, sick and healthy individuals seem to react differently when exposed to the treatments, which is consistent with the prior literature findings. When taking all subjects in our sample, the average number of risk averse choices pre- and post-treatments is the same (2.85 choices p=0.03). However, this hides two different behaviors. Sick individuals overall make more risk averse choices when comparing pre- and post-treatments (2.90 versus 3.02 choices, p=0.03) while healthy individuals overall make a lower number of risk averse choices (2.77 versus 2.58 choices, p=0.01). When we compare sick and healthy individuals post-treatment, the distribution of the number of risk averse choices is different from each other (Kolmogorov-
Smirnov test p=0.002). Therefore, there is a change in the distribution of the number of risk averse choices and that sick and healthy behave differently after treatment. The shifts in the distributions can be clearly seen in Figure 1 when distributions are split by health status.

4.2. Impact of treatment and health status

To examine the risky behavior of our experimental subjects by treatment, we split the sample into those who change their behavior (CB) pre- and post-treatment and those who do not change their behavior in terms of the number of risk averse choices (DCB). Those individuals who CB are the ones who have a different number of risk averse choices pre- and the post-treatment, regardless of whether they make more risky decisions post-treatment or not. Those who DCB have the same number of risk averse choices in the pre- and post-treatment. We focus our analysis on those individuals who CB and initially compare the three treatments with background risk lotteries against the treatment with no additional background risk.

In addition to the number of risk averse choices, we also define three categories to place individuals in terms of the number of choices they make. Individuals have a low degree of riskiness (LR) if they made four, five or six risk averse choices. Individuals are classified as having a mild degree of riskiness (MR) if they made three risk averse choices and as having a high degree of riskiness (HR) if they made two or less risk averse choices.

As a check against the results of the prior literature, we analyze the number of risk averse choices pre-treatment. The results are in Appendix B.
4.3. *Downside BR* treatment (only potential losses)

Theoretically, the anticipated effect of background risk outcomes on individual riskiness is not completely clear, as most of the literature focuses on negative outcomes or losses. For the case of a negative outcome (a financial loss) we would expect that if the individual is “risk vulnerable”, adding background risk to wealth would decrease the level of individual riskiness to other independent risks (Eeckhoudt et al. 1996, Guiso and Paiella 2008). Quiggin (2003) has an opposing argument: if the individual has diminished sensitivity to risk, adding extra risk would make her behave in a riskier manner.

In practice, most of findings show some degree of risk vulnerability, but there is evidence of the opposite behavior as well. For example, Lusk and Coble (2008) analyze individuals’
choices over a series of lottery choices in a laboratory setting in the presence and absence of uncorrelated (financial) background risk. They find that adding an unfair background risk lottery similar to our *Downside BR* treatment reduces individual riskiness, although the effect is not quantitatively large. Cameron and Shah (2015) find that after experiencing a natural disaster (additional exogenous background risk), individuals exhibit a lower degree of riskiness. However, Eckel et al. (2009) and Page et al. (2014) find the opposite result, which would be in line with Quiggin’s (2003) and with prospect theory predictions, particularly regarding a higher degree of riskiness after a loss. In the financial realm, Heaton and Lucas (2000) find that higher levels of background risk are associated with a lower degree of riskiness in individual financial portfolios.

In our experiment, we find that only individuals who are sick respond to exogenous potential losses. This is consistent with the health literature on risky financial decisions and on background risk addition (Heaton and Lucas 2000, Lusk and Coble 2008). On average, when sick individuals are exposed to the *Downside BR* lottery, the number of risk averse choices significantly increases (from an average of 2.96 choices to 3.20, p=0.035). There is no significant change in the number of risk averse choices for healthy individuals. In addition, not only average choices change but the distribution of the number of risk averse choices as well. Comparing the pre-treatment choices of sick subjects exposed to the *Downside BR* treatment, there is a shift of the distribution post-treatment to the right (towards less riskiness) in the number of risk averse decisions (Kolmogorov-Smirnov test p=0.04, Figure 2). The shift in the *Downside BR* treatment distribution can be attributed to MR individuals who become LR. This means that on average, individuals could be defined as risk vulnerable, as adding exogenous risk
with the potential for losses reduces the level of riskiness (the number of risk averse choices made).

Table 4: percentages of individuals with different degrees of riskiness

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Sick</th>
<th>Healthy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-treatment</td>
<td>Post-treatment</td>
</tr>
<tr>
<td>No BR</td>
<td>32.2</td>
<td>41.5</td>
</tr>
<tr>
<td></td>
<td>36.8</td>
<td>29.2</td>
</tr>
<tr>
<td>Upside BR</td>
<td>30.4</td>
<td>33.3</td>
</tr>
<tr>
<td></td>
<td>47.7</td>
<td>38.5</td>
</tr>
<tr>
<td>Mean-zero BR</td>
<td>29.2</td>
<td>40.6*</td>
</tr>
<tr>
<td></td>
<td>42.2</td>
<td>34.4</td>
</tr>
<tr>
<td>Downside BR</td>
<td>33.7</td>
<td>52.5**</td>
</tr>
<tr>
<td></td>
<td>40.0</td>
<td>34.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Sick</th>
<th>Healthy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-treatment</td>
<td>Post-treatment</td>
</tr>
<tr>
<td>No BR</td>
<td>23.7</td>
<td>16.9</td>
</tr>
<tr>
<td></td>
<td>24.5</td>
<td>22.8</td>
</tr>
<tr>
<td>Upside BR</td>
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<td>28.4</td>
</tr>
<tr>
<td></td>
<td>13.9</td>
<td>23.1</td>
</tr>
<tr>
<td>Mean-zero BR</td>
<td>27.4</td>
<td>25.5</td>
</tr>
<tr>
<td></td>
<td>23.4</td>
<td>20.3</td>
</tr>
<tr>
<td>Downside BR</td>
<td>32.7</td>
<td>13.9**</td>
</tr>
<tr>
<td></td>
<td>21.4</td>
<td>25.7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Sick</th>
<th>Healthy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-treatment</td>
<td>Post-treatment</td>
</tr>
<tr>
<td>No BR</td>
<td>44.1</td>
<td>41.5</td>
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<tr>
<td></td>
<td>38.6</td>
<td>47.4</td>
</tr>
<tr>
<td>Upside BR</td>
<td>40.2</td>
<td>38.2</td>
</tr>
<tr>
<td></td>
<td>38.5</td>
<td>38.5</td>
</tr>
<tr>
<td>Mean-zero BR</td>
<td>43.4</td>
<td>33.9</td>
</tr>
<tr>
<td></td>
<td>34.8</td>
<td>45.3</td>
</tr>
<tr>
<td>Downside BR</td>
<td>33.7</td>
<td>33.7</td>
</tr>
<tr>
<td></td>
<td>38.5</td>
<td>40.0</td>
</tr>
</tbody>
</table>

Notes: *p=0.10  **p=0.010 for test of difference between percentage of individuals pre- and post-treatment in each category.
4.4. *Upside BR* (only potential gains) and *Mean-zero BR* (potential gains and losses) treatments

To the best of our knowledge, there is no experimental evidence for the case of background risk lottery with potential gains only. In our experiment, the behavior of subjects exposed to exogenous potential gains depends on their health status. For sick individuals in the Upside BR treatment we do not see a change in the number of risk averse decisions pre- and post-treatment (average 2.82 risk averse choices pre-treatment versus to 3.03 post-treatment, p=0.38, Table 5). However, on average, healthy individuals become riskier. We find a reduction in the number of risk averse choices after being exposed to the exogenous background risk lottery with potential gains (average 3.11 risk averse choices pre-treatment versus to 2.79 post-treatment, p=0.097). From Table 4, this change in riskiness is a movement from individuals who are LR in the pre-treatment and are MR post-treatment. However, these changes are not significant. A reason for this finding could be that subjects start with an endowment of E$100, thus are playing with house money, which might tend to encourage more risky behavior, particularly when additional gains are involved (Deck and Schlesinger 2010, Thaler and Johnson 1990). In addition, MTurk workers have been sometimes found to make riskier decisions (Lian et al. 2018).

For mixed gains and losses, Lusk and Coble (2008) find that when a mean-zero background risk lottery is introduced, subjects’ riskiness is reduced. From the Lusk and Coble (2008) findings, we would expect that when exogenous potential losses are involved, subjects

\footnote{In terms of variability of responses, although our subjects are HR, our standard deviation (s.d.) is similar to the prior literature for the number of risk averse choices (Heinrich et al. 2017). Heinrich et al. (2017) have an average of 1.63 average risk tolerant choices with a s.d. of 1.96 for subjects in the U.S. We have an average of 3.15 risk tolerant pre-treatment with a s.d. of 1.92 and an average of risk tolerant choices of 2.85 post-treatment with a s.d. of 1.99, also using subjects in the U.S.}
make less risky choices. However, in our case, adding a zero-mean background risk lottery does not have any significant average effects in terms of the number of risk averse choices, regardless of the health of the individual (Sick: average 2.84 risk averse choices pre-treatment versus to 2.91 post-treatment, p=0.17, Healthy: average 3.29 risk averse choices pre-treatment versus to 2.94 post-treatment, p=0.12, see Table 5). Although there is a marginally significant increase in the percentage of individuals who are LR, there are no major changes in the distribution of the number of risk averse choices pre- and post-treatment (Kolmogorov-Smirnov test for sick p=0.44, for healthy p=0.34). One reason why the mean-zero treatment might not be significant is that our stakes are small compared to the decisions subjects make outside the laboratory (Maier and Rüger 2012). Higher stakes outside the laboratory could lead to more speculative behavior, particularly to cover for potential losses, where subjects’ might aggregate different risks to have one positive outcome.

As a summary, we find that individuals respond differently depending on their health status and the treatment they are exposed to. The degree of individual riskiness changes following potential exogenous gains and losses, but it does not change when a mixed prospect is exogenously introduced. These changes also depend on health: sick subjects reduce their riskiness when exposed to exogenous losses (Rosen and Wu 2004, Edwards 2008, Fan and Zhao 2009), while healthy subjects increase their riskiness following the introduction of exogenous gains. Individuals with health issues have been usually found to be less risky than healthy subjects, particularly when it comes to financial decisions (Bressan et al. 2014).

One potential explanation for the difference found between sick and healthy subjects could be related to reference-dependence. Prospect theory predicts that individuals' risk attitudes may be reference-dependent, in that individuals are riskier when considering losses to a reference
point and less risky when considering gains (Kahneman and Tversky 1979, Thaler and Johnson 1990, Kahneman 2003). We find the opposite result. Individuals who are sick (self-report at least one chronic illness) become less risky when exposed to exogenous potential financial losses, while healthy subjects become riskier when exposed to exogenous potential financial gains. In our study, individuals who are chronically sick might be more sensitive to potential losses, as poor health affects both current and future income and health-related expenditures. Thus, chronically sick subjects might be averse to losses (Kőszegi and Rabin 2006). Being prudent and temperate in financial decisions could be another explanation why sick individuals make a higher number of risk averse choices when facing potential losses. We explore this next.

Table 5: Average number of risk averse choices pre- and post-treatment, by health status and treatment

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Sick Pre-treatment</th>
<th>Sick Post-treatment</th>
<th>Healthy Pre-treatment</th>
<th>Healthy Post-treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>No BR</td>
<td>2.85 (1.55)</td>
<td>2.94 (1.65)</td>
<td>3.04 (1.68)</td>
<td>2.45 (1.61)</td>
</tr>
<tr>
<td>Upside BR</td>
<td>2.82 (1.56)</td>
<td>3.03 (1.75)</td>
<td>3.11 (1.50)</td>
<td>2.79 (1.79)</td>
</tr>
<tr>
<td>Mean-zero BR</td>
<td>2.84 (1.56)</td>
<td>2.91 (1.52)</td>
<td>3.29 (1.60)</td>
<td>2.94 (1.66)</td>
</tr>
<tr>
<td>Downside BR</td>
<td>2.96 (1.53)</td>
<td>3.35 (1.70)</td>
<td>2.97 (1.67)</td>
<td>2.93 (1.99)</td>
</tr>
</tbody>
</table>

Notes: Standard deviation between parentheses. b=significant at 5% for increase in the number of risk averse choices. c=significant at 5% for decrease in the number of risk averse choices.

4.5. Higher order preferences and health
As risk is not the only part of an individual’s risk profile, we explore whether higher-order preferences play a role in risky decisions when exogenous risk is added. One of the reasons why analyzing higher-order risk preferences in this context is relevant is related to the impact on health on future risks. In particular, future health shocks can trigger out-of-pocket expenditures, which absorbs financial wealth and raises its marginal utility (Edwards 2008). So being exposed to risks not only affects individual riskiness but their behavior in terms of risky decisions and tolerance to risks. The precautionary saving motive, or “prudence” (Kimball 1990), prompts individuals to acquire more wealth to offset the background risk. Any risk that leads to precautionary savings should also lower the demand for risky assets, which results in “temperance” (Kimball 1992). When faced with potential income losses and increased risks, prudent and temperate individuals aim at saving more in less risky investments.

We begin by examining the correlation between the number of risk averse, prudent and temperate choices by health status and treatment (Table 6). On the aggregate, we observe a positive relationship between the number of risk averse choices pre- and post-treatment with the initial number of prudent and temperate choices, which is the typical pattern found in the literature (Ebert and Wiesen 2011, Noussair et al. 2014, Maier and Rüger 2012). This result holds regardless of the health status and treatment. Additional analysis of the average individual risk profile can be found on Appendix C.

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2 We focus on the higher-order risk preferences pre-treatment, as our focus is not on the change in higher-order preferences but to look at the individual risk profile itself and analyze how individual riskiness changes.

3 The correlation values are in line with Ebert and Wiesen’s (2014) experimental results for the three measures and the results of Deck and Schlesinger (2017) for risk aversion and temperance. Our overall correlations are 0.48, 0.29 and 0.52 for our pre-treatment measures and our 0.42 and 0.26 for the risk aversion correlations with prudence and temperance in the post-treatment. In addition, the correlation between risk aversion and prudence is higher than between risk aversion and temperance.
Although we do not directly measure health expenditures after a health shock, we do have a financial shock with potential losses in the Downside BR treatment and a mean-zero lottery with potential losses in the Mean-zero BR treatment. In our experiment, we cannot measure the precautionary savings motive directly, but following the prior literature, we would expect that individuals who are at least temperate and sick should behave in a less risky manner when exposed to a background risk lottery that involves potential financial losses (Heaton and Lucas 2000).

To analyze the average number of risk averse choices by degrees of prudence and temperance, we define a high degree of prudence if the subject made 4 prudent choices or more
and a low degree if the subject made 2 prudent choices or less. For the case of temperance, an individual has a high degree of temperance if she made 3 temperate choices or more, and a low degree of temperance if she made one or no temperate choices. Table 7 presents the average number of risk averse choices by health status, treatment and the different degrees of higher order preferences. We find that for sick individuals, in the case of additional exogenous financial lotteries, the degree of prudence (or precautionary savings) does not matter, while the degree of temperance (or avoidance of other risks) does, as expected. Subjects with a high degree of temperance increase their average number of risk averse choices after being exposed to a background risk lottery with potential losses (Downside BR treatment). This could be explained as a strategy to reduce their exposure to risks and compensate for potential future losses coming from the background risk lottery. Those subjects who are sick and exhibit a low degree of temperance show the same behavior when exposed to treatments that include a gain, although this effect is marginally significant. This increase in the number of risk averse choices can be explained as a way to increase potential gains instead of hedging risks, compared to their high temperate counterparts. For the case of healthy subjects, those who show a low degree of prudence significantly reduce their average number of risk averse choices after exposed to the treatments, as we would expect (Upside BR treatment is marginally significant). Less prudent subjects care less about precautionary income, hedging risks or avoiding losses (or no gains at all) and are therefore riskier in their choices.

Therefore, behavior towards risky choices and exogenous background risks does not only depend on the degree of individual riskiness but also on the level of higher-order risk preferences of the individual. An individual risk profile should incorporate not only riskiness, but also prudence and temperance (and other higher-order risk preferences if available, Deck and
Schlesinger 2014). Risk also comes in many forms, not only financial, and we can argue that prior background risks, such as health, also play a part in the individual’s risk profile, as sick and healthy individuals with the same degree of prudence and temperance behave differently when it comes to their riskiness.

4.6. Between-subject analysis: exposure versus no exposure to background risk

To explain individual changes in the number of risk averse choices when exposed to the background risk lotteries compared to the No BR treatment, we run ordered logit models for each sub-sample. In each specification, the dependent variable is the number of risk averse choices made post-treatment. The dependent variable ranges from 0 choices for an individual who made no risk averse choices to 6 choices for an individual who made 6 risk averse choices. Table 8 presents the results of the ordered logit specifications. The relevant variables in the model are related to the health of the individual, gender, income and higher-order risk preferences (and their interactions).

Subjects with poor health have been found to be less risky in their decisions and choose safer financial portfolio allocations to avoid potential declines in wealth (Rosen and Wu 2008, Baptista 2008). Therefore, compared to healthy individuals, we expect sick subjects to make more risk averse choices when exposed to losses. In line with our aggregate analysis (section 4.1.), subjects who self-reported having at least a chronic illness (Sick) make an average of 1.5 more risk averse choices after being treated. This is in comparison to subjects who do not report having chronic illnesses and were not exposed to additional background risk lotteries. The effect is (marginally) significant when potential losses are introduced in the exogenous background risk lottery (Mean-zero BR and Downside BR). In the case of subjects with health risks, the higher
number of risk averse choices after being treated could be a strategy to counteract the potential losses from the exogenous background risk, since the *Downside BR* and the *Mean-zero BR* treatments both have loss scenarios. This is also evidence towards cross-risk vulnerability (Malevergne and Rey 2009). Economic decisions take place in the context of multiple and correlated risks, and decisions about endogenous risks, such as our choice tasks are usually taken while facing exogenous background risks, such as our background risk lotteries or the individual’s health status. Our finding agrees with the literature that finds that health risks and poor health prompts less risky financial decisions (Edwards 2008, Heaton and Lucas 2000, Rosen and Wu 2004, Cardak and Wilkins 2009) but takes into consideration that both health and financial risks are related. Edwards (2008) argues that similar findings in the context of expected utility theory (EUT) coincides with a negative cross partial derivative for health and consumption, with sick individuals demanding more funds to make up for the lost non-market production of essential goods and services. In our case, this would be translated in a higher number of risk averse choices.

Figure 1 shows the distribution of the number of risk averse choices, where we can compare healthy subjects exposed to *No BR* and sick subjects post-treatment (*No BR, Mean-zero BR, Upside BR, Downside BR*). Compared to healthy subjects not exposed to additional background risk, the sick *Mean-zero BR* and the sick *Downside BR* seem to have a difference when behaviors are low risk (5 and 6 risk averse decisions). This is what the regression shows at the individual level. At the aggregate level, the comparison of the whole distributions of the number of risk averse choices from the healthy *No BR* treatment and sick subjects is only marginally significant for the *Downside BR* treatment (Kolmogorov-Smirnov test p=0.096).
A similar effect, albeit smaller is found for the *Number of prudent choices*. A prudent agent is one who increases his savings when uncertainty affects her future income (Tarazona-Gomez 2004). In our case, prudent subjects could be insuring themselves against the uncertainty coming from the potential losses of the exogenous background risk lottery, when compared to imprudent subjects who are not exposed to extra exogenous risk. We find that subjects who are more prudent and who are exposed to potential exogenous losses (*Downside BR* or *Mean-zero BR* treatments) make more risk averse choices compared to subjects not exposed to additional background risk. The effect is smaller compared to the impact of health status and marginally significant. This behavior is relevant when individuals try to offset the potential loss of the background risk lottery (Kimball 1990, Carroll 1994, Merrigan and Normandin 1996, Dynan 1993). In addition, for the case of an exogenous mean-zero risk, this is evidence towards the concept of “risk vulnerability”, in which additional background risk could induce less risky behavior towards any other risk (Gollier and Pratt 1996, Edwards 2008). There is no significant effect of prudence when subjects are exposed to an exogenous background risk with potential gains only (*Upside BR*).
Table 6: Correlations between risk (pre- and post-treatment) and baseline (pre-treatment) higher-order preferences

<table>
<thead>
<tr>
<th></th>
<th>Pre-treatment number of risk averse choices, pre-treatment higher order risk measures</th>
<th>Post-treatment number of risk averse choices, pre-treatment higher order risk measures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Overall</td>
<td>No BR Sick</td>
</tr>
<tr>
<td>Number of risk averse choices - Number of prudent choices</td>
<td>0.48**</td>
<td>0.48**</td>
</tr>
<tr>
<td>Number of risk averse choices - Number of temperate choices</td>
<td>0.29**</td>
<td>0.35**</td>
</tr>
<tr>
<td>Number of prudent choices - Number of temperate choices</td>
<td>0.52**</td>
<td>0.46**</td>
</tr>
</tbody>
</table>

Notes: *p=0.10 *p=0.05 **p=0.010 for a Spearman correlation test.
Table 5: Average number of risk averse choices, by degree of prudence and temperance, health status and treatment

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Sick Pre-treatment</th>
<th>Sick Post-treatment</th>
<th>Healthy Pre-treatment</th>
<th>Healthy Post-treatment</th>
<th>Sick Pre-treatment</th>
<th>Sick Post-treatment</th>
<th>Healthy Pre-treatment</th>
<th>Healthy Post-treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High degree of prudence</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No BR</td>
<td>3.20</td>
<td>3.24</td>
<td>3.36</td>
<td>2.40*</td>
<td>2.59</td>
<td>2.76</td>
<td>2.66</td>
<td>2.5</td>
</tr>
<tr>
<td>Upside BR</td>
<td>3.10</td>
<td>2.92</td>
<td>3.33</td>
<td>3.26</td>
<td>2.84</td>
<td>2.87</td>
<td>2.61</td>
<td>1.94*</td>
</tr>
<tr>
<td>Mean-zero BR</td>
<td>3.06</td>
<td>2.87</td>
<td>3.00</td>
<td>3.15</td>
<td>2.36</td>
<td>2.77</td>
<td>3.52</td>
<td>2.35**</td>
</tr>
<tr>
<td>Downside BR</td>
<td>3.16</td>
<td>3.50</td>
<td>3.07</td>
<td>3.33</td>
<td>3.00</td>
<td>2.86</td>
<td>3.76</td>
<td>3.04*</td>
</tr>
<tr>
<td>Low degree of prudence</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No BR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upside BR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean-zero BR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Downside BR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>High degree of temperance</th>
<th>Low degree of temperance</th>
</tr>
</thead>
<tbody>
<tr>
<td>No BR</td>
<td>3.00</td>
</tr>
<tr>
<td>Upside BR</td>
<td>2.85</td>
</tr>
<tr>
<td>Mean-zero BR</td>
<td>3.18</td>
</tr>
<tr>
<td>Downside BR</td>
<td>3.03</td>
</tr>
</tbody>
</table>
However, we find the opposite effect on subjects who are sick and more prudent than their healthy, imprudent counterparts ($\text{Sick} \times \text{Number of prudent choices}$). These individuals make a smaller number of risk averse choices when exposed to the exogenous lotteries, regardless of whether the background risk lottery contains gains, losses or is a mixed gamble. The effect is small and marginally significant for skewed background lotteries ($\text{Upside BR}$ and $\text{Downside BR}$) and significant when an exogenous mean-zero lottery is introduced ($\text{Mean}-\text{zero BR}$). Quiggin (2003) argues that although adding an independent risk reduces welfare, some individuals could have diminished sensitivity to risk, which might not make them particularly concerned with the addition of a small risk. This might be the case for this subsample of sick, prudent subjects, who although display prudent behavior, having additional background risk added to their risk pool might make them behave in a riskier manner. These are individuals who, according to Quiggin (2003) might display constant risk aversion with linear utility functions (risk neutral individuals) and whose premium for risk could be reduced by the presence of an independent background risk. Following Edwards (2008), this result could also be evidence that our sample has individuals who have a positive cross partial between health and consumption in the EUT framework.

In line with the results in our within-subject analysis, there is a positive relationship between health status, riskiness, prudence and temperance. When subjects are sick and make more prudent and temperate choices ($\text{Sick} \times \text{Prudence} \times \text{Temperance}$) they make more risk averse choices when exposed to potential exogenous losses ($\text{Downside BR}$, compared to healthy subjects with low degrees of prudence and temperance). In our case, the effect of the introduction of exogenous background risk affects subjects with a high degree of temperance in an indirect manner. Nevertheless, the effect is in line with the literature stating that background risks should lower the demand for risky assets (Kimball 1993, Elmendorf and Kimball 2000). This also is the effect we find between the pre- and post-treatment number of
risk averse choices when sick individuals who are temperate are exposed to an unfair exogenous background risk. In particular, sick individuals who are temperate might be less risky in their choices as they have stronger preference to disaggregate two (in our case, independent) background risks. So intuitively, an individual facing an unavoidable background risk (potential negative health shocks) will seek to reduce exposure to another background risk (our exogenous unfair lottery, Mayrhofer 2017). The differential impact of sick (prudent and temperate) subjects when exposed to potential exogenous losses could also be evidence towards loss aversion as these subjects make less risky decisions when facing potential exogenous losses (Kahneman and Tversky 1979).

An indirect way health status can impact the degree of individual risk aversion is through the subject’s wealth. Poorer health status negatively impacts individual finances, so we would expect that subjects who are exposed to high levels of background risk (in terms of income instability) and have a higher degree of prudence make more risk averse choices than those with higher levels of wealth (Cardak and Wilkins 2009, Edwards 2008). In our case we focus on one of the possible measures of wealth, the subject’s income. We find that low income\(^4\), prudent subjects (Low Income * Number of prudent choices) become significantly more risk averse when exposed to potential exogenous gains. Guiso and Paiella (2008) and Noussair et al. (2014) find that lower wealth subjects are more risk averse only. However, Noussair et al. (2014) finds that lower income has a negative impact on prudence. Our result pools these two findings together. The increase in risk aversion for low income and prudent subjects could be associated with the concept of precautionary savings. When faced with a potential exogenous gain, low income, prudent individuals would tend to make more risk averse choices to potentially increase their income.

\(^4\) Low income subjects are defined as those subjects who earn $35,000 or less per year. Mid income subjects earn between $35,000 and $75,000 per year and high income subjects earn over $75,000 a year.
As a check of the individual findings, we also find that at the aggregate level the distribution of the number of risk averse choices between low and higher income subjects who are prudent are significantly different only for those subjects exposed to the Upside BR treatment (Wilcoxon rank sum test \( p = 0.01 \)). In particular, low prudent subjects seem to be make more risk averse choices (mean test for the number of risk averse choices, low versus mid-high income \( p\)-value=0.006).

5. Discussion

From the aggregate correlation analysis of risky behaviors of different orders, we cannot discard the possibility that some of our subjects fit under common EUT specifications. There are overall similar patterns of riskiness, prudence and temperance among the four treatments for sick and healthy individuals. In addition, there is evidence that some of our subjects (those who are prudent) could be risk vulnerable, which fits the EUT setup. However, when it comes to individual characteristics, sick, prudent and low income individuals seem to react differently when exposed to exogenous gains and losses. Low income and low degrees of riskiness are positively related, in our case for prudent individuals (Guiso and Paiella 2008). The positive correlation between a low level of riskiness, prudence and temperance would discard constant absolute risk aversion for these individuals (CARA) as well as constant absolute risk aversion (CRRA) but not for those who are sick, prudent and temperate. Other studies have also discarded other EUT specifications as well (Trautmann and van de Kuilen 2018, Deck and Schlesinger 2008, Guiso and Paiella 2008).

The different behavior of individuals when facing exogenous gains, losses and mean-zero lotteries could be evidence towards the existence of a reference point or loss aversion (PT - Kahneman and Tversky 1979). The heterogeneous behavior in these risky choice tasks could be evidence towards the idea of a mixture-model as well, where some individuals fall
under EUT and some under PT, depending on the domain the subjects are exposed to (exogenous gains, losses or mean-zero, Harrison and Rutström 2009). Imposing a single functional form on the utility function would not properly explain the changes we see in individual behavior during this experiment.

Analysing the links between health and risky choices is an extension of the literature on portfolio choice in the presence of background risk (Edwards 2008). We can think of health as a background risk with the potential for a loss (either a decline in health, an increase in health expenditures or just aging, which increases the risk of health complications). Adding an independent exogenous (financial) risk with the potential of a loss seems to reduce the risky behavior of sick individuals depending on the type of risk introduced, which would imply a state dependent utility function (Finkelstein et al. 2013). In particular, there is an increase in number of risk averse choices for sick individuals who are prudent and temperate when facing the potential of a loss instead of a mixed-gamble. This means that prudent behavior alone (and precautionary savings-related behavior) is not enough to ensure the reduction in risk averse choices. The patterns in the data reveal that the impact of being prudent on the number of risk averse choices depends on whether subjects have a prior health-related background risk.

Therefore, incorporating higher order preferences is relevant for the analysis of risky decisions (Ebert and Wiesen 2011). Temperance appears to be less pervasive than prudence, (Trautmann and van de Kuilen 2018, Eeckhoudt and Schlesinger 2006, Crainich et al. 2013) as it but has a significant impact for sick individuals when exposed to a potential exogenous loss. Although it has been already shown that undesirable risks increase the level of individual riskiness (Lusk and Coble 2008), our results show that undesirable risks change the level of individual riskiness depending on the individual’s higher-order preferences profile and individual characteristics. Thus, the analysis of risk and higher-order preferences
should take into account individual characteristics and the case of health is one of many examples: there is no one-size-fits-all approach to examine risky decisions.

Table 8: Ordered logit models for post-treatment risk aversion, by treatment

<table>
<thead>
<tr>
<th>D.V.: Number of risk averse choices (post-treatment)</th>
<th>No BR Mean-zero BR</th>
<th>Upside BR Mean-zero BR</th>
<th>Downside BR Mean-zero BR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of risk averse choices (pre-treatment)</td>
<td>0.079 (0.091)</td>
<td>0.117 (0.093)</td>
<td>0.051 (0.096)</td>
</tr>
<tr>
<td>Health survey first</td>
<td>0.147 (0.287)</td>
<td>0.025 (0.284)</td>
<td>0.113 (0.289)</td>
</tr>
<tr>
<td>Sick</td>
<td>-0.578 (0.844)</td>
<td>1.107 (0.790)</td>
<td>1.478 (0.816)</td>
</tr>
<tr>
<td>Female</td>
<td>-0.378 (0.430)</td>
<td>0.066 (0.410)</td>
<td>0.192 (0.451)</td>
</tr>
<tr>
<td>Number of prudent choices</td>
<td>-0.005 (0.213)</td>
<td>0.102 (0.188)</td>
<td>0.312 (0.172)</td>
</tr>
<tr>
<td>Number of temperate choices</td>
<td>-0.321 (0.269)</td>
<td>-0.044 (0.244)</td>
<td>-0.067 (0.221)</td>
</tr>
<tr>
<td>Sick * Number of prudent choices</td>
<td>0.119 (0.239)</td>
<td>-0.376 (0.226)</td>
<td>-0.471 (0.274)</td>
</tr>
<tr>
<td>Sick * Number of temperate choices</td>
<td>0.319 (0.318)</td>
<td>-0.266 (0.348)</td>
<td>0.382 (0.326)</td>
</tr>
<tr>
<td>Prudence * Sick * Female</td>
<td>0.092 (0.182)</td>
<td>0.143 (0.223)</td>
<td>-0.014 (0.222)</td>
</tr>
<tr>
<td>Temperance * Sick * Female</td>
<td>0.034 (0.248)</td>
<td>0.151 (0.307)</td>
<td>-0.422 (0.299)</td>
</tr>
<tr>
<td>Prudence * Temperance * Sick</td>
<td>0.684 (0.660)</td>
<td>0.550 (0.677)</td>
<td>1.444 (0.697)</td>
</tr>
<tr>
<td>Low Income</td>
<td>0.240 (0.750)</td>
<td>-1.082 (0.720)</td>
<td>-0.346 (0.753)</td>
</tr>
<tr>
<td>Low Income * Number of prudent choices</td>
<td>-0.022 (0.189)</td>
<td>0.502 (0.198)</td>
<td>0.022 (0.192)</td>
</tr>
<tr>
<td>Low Income * Number of temperate choices</td>
<td>0.224 (0.250)</td>
<td>0.248 (0.250)</td>
<td>-0.003 (0.263)</td>
</tr>
<tr>
<td>cut1</td>
<td>-2.209 (0.870)</td>
<td>-1.633 (0.862)</td>
<td>-1.089 (0.637)</td>
</tr>
<tr>
<td>cut2</td>
<td>-0.890 (0.844)</td>
<td>-0.558 (0.835)</td>
<td>-0.339 (0.625)</td>
</tr>
<tr>
<td>cut3</td>
<td>-0.089 (0.845)</td>
<td>0.484 (0.833)</td>
<td>0.593 (0.627)</td>
</tr>
<tr>
<td>cut4</td>
<td>0.713 (0.850)</td>
<td>1.706 (0.843)</td>
<td>1.422 (0.635)</td>
</tr>
<tr>
<td>cut5</td>
<td>2.007 (0.864)</td>
<td>2.777 (0.863)</td>
<td>2.371 (0.656)</td>
</tr>
<tr>
<td>cut6</td>
<td>3.463 (0.911)</td>
<td>4.653 (0.960)</td>
<td>3.230 (0.682)</td>
</tr>
<tr>
<td>N</td>
<td>175</td>
<td>170</td>
<td>167</td>
</tr>
</tbody>
</table>
6. Conclusion

In this study, we set up an online experiment with the aim of understanding how health and financial background risks, risk aversion and higher-order preferences are related. Given that in practice individuals face bundles of risk that might be correlated, we focus on the interaction of two background risks: health and financial (Malevergne and Ray 2009). We incorporate exogenous background risks with potential gains, losses and a mixed-gamble and measure changes in risky decisions through a risk apportionment choice set (Eeckhoudt and Schlesinger 2006). We aim to examine the degree of riskiness of subjects who reported having chronic illnesses (have health background risks), including the interaction with the degrees of prudence and temperance. Our experiment allows us to focus on the number of risk averse choices individuals make after being exposed to the exogenous background risks, as they cannot be avoided or insured against. We also measure the potential determinants of the number of risk averse choices before background risks are introduced, as a measure of behavior before the increase of financial risk.

On the aggregate level, we find that sick subjects react differently to additional background risk compared to healthy subjects and make a lower number of risk averse decisions. This is in line with the health and financial risks literature, which states that subjects with poorer health tend to be less risky when it comes to financial decisions and portfolio allocations (Edwards 2008, Cardak and Wilkins 2009, Bressan et al. 2014). This is also evidence towards the existence of “cross-risk vulnerability” (Malevergne and Rey 2009), which incorporates risk vulnerability (Gollier and Pratt 1996) into a multivariate background risk setting and shows that having one type of background risk can reduce the level of riskiness of other risky individual decisions. However, not all treatments have the same impact on the level of individual riskiness. we find when sick individuals are exposed to a background risk lottery with potential losses, the number of risk averse choices significantly
increases compared to healthy subjects (Rosen and Wu 2004, Edwards 2008, Fan and Zhao 2009). However, healthy subjects increase their riskiness following the introduction of exogenous gains (Bressan et al. 2014). Extensions of this work include examining how adding health risk impacts financial risk, which is the other side of “cross-risk vulnerability” proposed by Malavergne and Rey (2009). In addition, analyzing the changes in higher order risk preferences when financial risk is introduced is another avenue of research, which would be an extension of the experimental work by Deck and Schlesinger (2010, 2014) and Noussair et al. (2014).

Our findings indicate that the empirical relationship between health and financial risks is not a linear one. At the individual level, subjects behave differently depending on the exogenous background risk introduced. Sick individuals become make a higher number of risk averse choices when exposed to potential exogenous losses. However, changes in individual riskiness are also partly explained by higher-order risk preferences once the background risk lotteries have been introduced. Nevertheless, higher-order risk preferences cannot be considered only on their own. Prudence is not enough to explain risky decisions, as prudent sick individuals make riskier decisions when exposed to exogenous risks. As expected, sick, prudent and temperate individuals behave in a less risky manner when exposed to potential exogenous losses. Our results also suggest that low income has a positive impact on the degree of individual riskiness, but only in the case where individuals are exposed to a potential gain. This could be an indirect measure of health risks, as declining health increases the probability of health expenditures and of substituting labor (lower income) for time caring for an illness. Although the effect is not direct, more analysis is needed in order to clarify the impact of health shocks through changes individual wealth (out-of-pocket medical expenses) in the case exogenous financial background risk is added.
References


Appendix A: Written Instructions and questionnaires

General Instructions

Welcome to this study in decision making.

By signing the consent form in the previous screen you agreed to participate in this study. Remember, your participation is completely voluntary. If you choose to leave before finishing the study, you will forfeit any amount you may have earned. You must be at least 18 to participate in this study.

The study will take about 30 minutes during which you will make a series of decisions and answer a series of questions. All your answers will remain confidential. You will be paid according to the instructions, which will be explained in a moment. You will receive the HIT payment after you complete the study. Any bonuses you receive will be paid in the next 48 hours. Please complete the tasks on your own.

During this study, we will talk about all decisions using Experimental Tokens (E$). You will start with an endowment of E$100.

Your payoffs will be calculated in terms of Experimental Tokens and then translated at the end of the experiment into dollars at the following rate:

\[
80 \text{ E$} = 1 \text{ U.S. Dollar}
\]

Instructions

[This is the script of the instructions video. Video can be seen here]

On the following screens, there will be a series of tasks. Once you have completed all the tasks in the experiment, the program will randomly choose one task for payment. Since we do
not know which task will be chosen for payment, you should make each decision as if it will
determine how much you will earn. Please note that you cannot lose your own money.

This is an example of what one of the tasks looks like:

“You will receive E$10 +

[10 / -10] if the coin lands on Heads or Tails and [5 / -5] if the coin lands on Same or
Different outcome.”

Each task starts with you receiving a fixed amount of cash (show only first part of task), and
the ability to make choices about two additional items that could alter your payment (show
the two parts of the task). The two additional items are lotteries. As an example, [10 / -10] in
the first lottery represents the lottery in which you could have E$10.00 added to or subtracted
from your payoff, depending on the outcome of the die roll. I will explain how the lottery
outcomes are determined soon.

In each task, we will decide what lotteries you end up getting by tossing a coin. For each task,
you first will have to decide if you prefer to receive the first additional lottery when the coin
toss lands on Heads or Tails. You will also determine if you prefer to receive the second
lottery on the Same or Different outcome of the coin toss as the first item. There is only one
coin toss and you are deciding if you want the two lotteries combined (so that you receive
both or neither) or if you want the two lotteries separated (so that you receive one or the
other). If you do not get a lottery, that means that you get E$0 for that lottery.

Suppose you choose to receive the first lottery of the example task when the coin lands on
Tails. You also choose to receive the second lottery on the Same outcome of the coin toss.
This means that if the coin lands on tails, you get the first lottery and because you chose the
same outcome, you also get the second lottery. If the coin lands on Heads, given your
choices, you would get neither of the lotteries, because you chose to get the first lottery on Tails and the second lottery on the same outcome.

Suppose you now choose to receive the first lottery of the example task when the coin lands on Tails. You also choose to receive the second lottery on the Different outcome of the coin toss. In this case, you would get one lottery or the other based on the coin toss. If the coin lands on Tails, you get the first lottery but not the second one, as you chose to get the second lottery on the Different outcome. If the coin landed on Heads, you would not get the first lottery because you chose Tails, but you would get the second lottery, because you chose to receive it in a different outcome.

As a summary, choosing Same means that you will get both lotteries if the coin toss matches what you chose. If the coin toss does not match your choice, you do not get any of the lotteries. Choosing Different means that you will get one of the lotteries depending on the coin toss outcome. If your choice matches the coin toss and you chose Different in the second lottery, you only get the first lottery. If your choice does not match the coin toss and you chose Different, you only get the second lottery but not the first one. Remember that lotteries you do not get mean that you get E$0 from that lottery.

The outcomes of the lotteries you receive based on your decision will be determined as follows. For lotteries you receive in the Heads/Tails decision, we will roll a red six-sided die. For lotteries you receive in the Same/Different decision, we will roll a blue six-sided die. In our example, if you get the first lottery and the red die roll is odd (1, 3, 5), the first outcome of the lottery will occur and E$10 will be added to your payoff. If the red die roll is even (2, 4, 6), the second outcome of the lottery will occur and E$10 will be subtracted from your payoff. Following the example, our second lottery is [5/-5]. If you get the second lottery and the blue die roll is odd (1, 3, 5), the first outcome of the lottery will occur and E$5 will be
added to your payoff. If the blue die roll is even (2, 4, 6), the second outcome of the lottery will occur and E$5 will be subtracted from your payoff. Some of your tasks have a [5 / 5] instead of a [5 / -5]. This means that instead of the lottery adding or subtracting money from your payoff, the lottery adds E$5 regardless of the outcome of your die roll.

To summarize, first you will choose the outcome of your coin toss for your first lottery, either Heads or Tails. You will then choose whether you want to receive your second lottery on the same or different outcome as your coin toss choice. We will toss a coin and determine which lotteries you will receive. Remember, based on your choices and the coin toss, you could receive the first lottery, the second lottery, both or neither of the lotteries. If you do not get a lottery, you receive E$0 from that lottery. If you get the first lottery, we will roll a red die to determine the outcome. If you get the second lottery, we will roll a blue die to determine the outcome. After this, we will calculate your payoffs, which consist of the sure amount and the outcomes of the lotteries, if you received any.

Let’s go through some examples to calculate the final payoffs and to explain how you will make your choices in each of the tasks. In the first example,

You will receive E$10 +

[10 / -10] if the coin lands on Heads or Tails and [5 / -5] if the coin lands on Same or Different outcome.

Suppose you made the following responses. You clicked on and chose Tails and Same. This means you choose to receive both lotteries if the coin lands on tails or neither if it comes up heads. If your coin toss landed on Heads, your total payoff will be E$10, the sure amount. If your coin toss landed on Tails, that means that you get both lotteries. If the red die roll lands odd you get E$10 added to your payoff from the first lottery. If the blue die roll lands odd, you get E$5 added to your payoff from the second lottery. That means that your final payoff
will consist of E$10 from the sure amount plus E$10 from the first lottery plus E$5 from the second lottery, for a total payoff of E$25.

If your coin toss landed on *Tails*, that means that you get both lotteries. If the red die roll lands even, you get E$10 subtracted from your payoff from the first lottery. If the blue die roll lands odd, you get E$5 added to your payoff from the second lottery. That means that your final payoff will consist of E$10 from the sure amount, minus E$10 from the first lottery plus E$5 from the second lottery, for a total payoff of E$5.

Following the example,

You will receive E$10 + 

[10 / -10] if the coin lands on *Heads* or *Tails* and [5 / -5] if the coin lands on *Same* or *Different* outcome.

Suppose you made the following responses. You clicked on and chose Heads and Different. This means you choose the receive the first lottery if the coin toss comes up heads, and the second lottery if the coin toss comes up tails. If your coin toss landed on *Heads*, you get the first lottery but not the second. If the red die roll lands odd you get E$10 added to your payoff from the first lottery. You get E$0 from the second lottery. That means that your final payoff will consist of E$10 from the sure amount plus E$10 from the first lottery for a total payoff of E$20.

If your coin toss landed on *Tails*, that means that you get the second lottery but not the first one. If the blue die roll lands odd you get E$5 added to your payoff from the second lottery. You get E$0 from the first lottery. That means that your final payoff will consist of E$10 from the sure amount plus E$5 from the second lottery for a total payoff of E$15.
Please click next to go through some comprehension questions. These will not impact your payoff in any way.

Comprehension questions

The comprehension questions will not impact your payoff in any way.

You will receive E$10 + [10 / -10] if the coin lands on Heads or Tails and [5 / -5] if the coin lands on Same or Different outcome.

Suppose you made the responses marked in red.

If your coin toss landed on Heads and the red die lands in 3, your total payoff will be

E$_____ (answer: E$10 (sure amount) = E$10 (from Heads) + E$0 (from Different outcome) = E$20)

If your coin toss landed on Tails and the blue die lands in 6, your total payoff will be: E$

E$5

= E$5)

Please click next to continue and make your choices.

Your choices

Remember: You will have to make two choices. Your first choice is whether you want the first lottery when the coin lands on Heads or Tails. Your second choice is whether you want the second lottery in the Same or Different outcome as the result of the coin toss.
Please click on your choices.

If you want to review the instructions, you can do so here.

**Choice #1.**

You will receive E$30 +

[25 / -25] if the coin lands on *Heads or Tails* and

[25 / 25] if the coin lands on *Same or Different* outcome.

**Choice #2.**

You will receive E$15 +

[5 / -5] if the coin lands on *Heads or Tails* and

[5 / -5] if the coin lands on *Same or Different* outcome.

**Choice #3.**

You will receive E$10 +

[1 / 1] if the coin lands on *Heads or Tails* and

[1 / 1] if the coin lands on *Same or Different* outcome.

**Choice #4.**

You will receive E$12.50 +

[9 / 9] if the coin lands on *Heads or Tails* and

[5 / -5] if the coin lands on *Same or Different* outcome.
Choice #5.

You will receive E$15 +

\[9 / -9\] if the coin lands on Heads or Tails and

\[1 / -1\] if the coin lands on Same or Different outcome.

Choice #6.

You will receive E$10 +

\[1 / 1\] if the coin lands on Heads or Tails and

\[5 / 5\] if the coin lands on Same or Different outcome.

Choice #7.

You will receive E$12.50 +

\[5 / -5\] if the coin lands on Heads or Tails and

\[1 / 1\] if the coin lands on Same or Different outcome.

Choice #8.

You will receive E$10 +

\[1 / 1\] if the coin lands on Heads or Tails and

\[9 / 9\] if the coin lands on Same or Different outcome.

Choice #9.

You will receive E$55 +

\[25 / -25\] if the coin lands on Heads or Tails and

\[25 / -25\] if the coin lands on Same or Different outcome.
Choice #10.

You will receive €10.50 +

[9 / 9] if the coin lands on Heads or Tails and

[1 / -1] if the coin lands on Same or Different outcome.

Choice #11.

You will receive €10 +

[5 / 5] if the coin lands on Heads or Tails and

[5 / 5] if the coin lands on Same or Different outcome.

Choice #12.

You will receive €55 +

[5 / -5] if the coin lands on Heads or Tails and

[45 / -45] if the coin lands on Same or Different outcome.

Choice #13.

You will receive €6 +

[9 / 9] if the coin lands on Heads or Tails and

[9 / 9] if the coin lands on Same or Different outcome.

Choice #14.

You will receive €50 +
[5 / 5] if the coin lands on Heads or Tails and

[45 / 45] if the coin lands on Same or Different outcome.

**Choice #15.**

You will receive E$12.50 +

[5 / 5] if the coin lands on Heads or Tails and

[5 / -5] if the coin lands on Same or Different outcome.

**Choice #16.**

You will receive E$14.50 +

[9 / -9] if the coin lands on Heads or Tails and

[1 / 1] if the coin lands on Same or Different outcome.

Please click next to continue.

**Additional earnings**

*This is the script of the additional earnings video. Videos can be seen here for Mean Zero, Upside and Downside*.

Please make sure you carefully follow and understand the instructions for this stage.

Independent from the decisions you make throughout the experiment, you will participate in a lottery in which you could have the chance to get additional earnings. The outcome of the lottery will be revealed when your bonus is paid and it can impact your final payoff. You do
not have to make any decisions in this stage but we ask you to pay close attention to how the lottery you will participate in might affect your final payoff.

[Mean-zero risk] In the lottery you will participate in today, you will have a 50% chance of winning E$50 and a 50% chance of losing E$50.

[Upside risk] In the lottery you will participate in today, you will have a 50% chance of winning E$50 and a 50% chance of losing E$0.

[Downside risk] In the lottery you will participate in today, you will have a 50% chance of winning E$0 and a 50% chance of losing E$50.

The outcome of the lottery is determined by a six-sided die at the end of study. If the die roll is odd, your outcome is the first one. If the die roll is even, your outcome is the second one. The outcome of the lottery will be added to your final payoff. Remember you cannot lose your own money.

[Mean-zero risk] As an illustration, if the die roll is 1, this means that you would win E$50, the first outcome of the lottery. If the die roll is 6, you would lose E$50, the second outcome of the lottery.

[Upside risk] As an illustration, if the die roll is 1, this means that you would win E$50, the first outcome of the lottery. If the die roll is 6, you would lose E$0, the second outcome of the lottery.

[Downside risk] As an illustration, if the die roll is 5, this means that you would win E$0, the first outcome of the lottery. If the die roll is 6, you would lose E$50, the second outcome of the lottery.

Remember:
[Mean-zero risk] In the lottery you will participate in today, you have a 50% chance of winning E$50 and a 50% chance of losing E$50.

[Upside risk] In the lottery you will participate in today, you have a 50% chance of winning E$50 and a 50% chance of losing E$0.

[Downside risk] In the lottery you will participate in today, you have a 50% chance of winning E$0 and a 50% chance of losing E$50.

Please answer the following comprehension questions to continue:

1. When will the outcome of this lottery be revealed?
   Now/At the end of the study

2. What will we draw to determine your lottery outcome?
   A 6-sided die / A 10-sided die / A 20-sided die

3. If your die roll is 4 you get the:
   First outcome of the lottery / Second outcome of the lottery

4. Although you will not have to make any choices in this lottery, will this lottery impact your payoffs?
   Yes / No

**Instructions**

In this task, you will be asked again to make a new series of choices. The instructions are the same as before. You can go over the instructions again as well as the examples by watching the video if you want to do so.
Please remember that you cannot lose your own money.

Please click next to continue and make your choices.

**Your choices**

Remember: You will have to make **two choices**. Your first choice is whether you want the first lottery when the coin lands on *Heads* or *Tails*. Your second choice is whether you want the second lottery in the *Same* or *Different* outcome as the result of the coin toss.

Please click on your choices.

If you want to review the instructions, you can do so [here](#).

**Choice #1.**

You will receive E$30 +

\[ 25 / -25 \] if the coin lands on *Heads* or *Tails* and

\[ 25 / 25 \] if the coin lands on *Same* or *Different* outcome.

**Choice #2.**

You will receive E$15 +

\[ 5 / -5 \] if the coin lands on *Heads* or *Tails* and

\[ 5 / -5 \] if the coin lands on *Same* or *Different* outcome.
Choice #3.

You will receive E$10 +

[1 / 1] if the coin lands on Heads or Tails and

[1 / 1] if the coin lands on Same or Different outcome.

Choice #4.

You will receive E$12.50 +

[9 / 9] if the coin lands on Heads or Tails and

[5 / -5] if the coin lands on Same or Different outcome.

Choice #5.

You will receive E$15 +

[9 / -9] if the coin lands on Heads or Tails and

[1 / -1] if the coin lands on Same or Different outcome.

Choice #6.

You will receive E$10 +

[1 / 1] if the coin lands on Heads or Tails and

[5 / 5] if the coin lands on Same or Different outcome.

Choice #7.

You will receive E$12.50 +

[5 / -5] if the coin lands on Heads or Tails and
[1 / 1] if the coin lands on *Same or Different* outcome.

**Choice #8.**

You will receive E$10 +

[1 / 1] if the coin lands on *Heads or Tails* and

[9 / 9] if the coin lands on *Same or Different* outcome.

**Choice #9.**

You will receive E$55 +

[25 / -25] if the coin lands on *Heads or Tails* and

[25 / -25] if the coin lands on *Same or Different* outcome.

**Choice #10.**

You will receive E$10.50 +

[9 / 9] if the coin lands on *Heads or Tails* and

[1 / -1] if the coin lands on *Same or Different* outcome.

**Choice #11.**

You will receive E$10 +

[5 / 5] if the coin lands on *Heads or Tails* and

[5 / 5] if the coin lands on *Same or Different* outcome.

**Choice #12.**

You will receive E$55 +

[5 / -5] if the coin lands on *Heads or Tails* and
[45 / -45] if the coin lands on *Same or Different* outcome.

**Choice #13.**

You will receive E$6 +

[9 / 9] if the coin lands on *Heads or Tails* and

[9 / 9] if the coin lands on *Same or Different* outcome.

**Choice #14.**

You will receive E$50 +

[5 / 5] if the coin lands on *Heads or Tails* and

[45 / 45] if the coin lands on *Same or Different* outcome.

**Choice #15.**

You will receive E$12.50 +

[5 / 5] if the coin lands on *Heads or Tails* and

[5 / -5] if the coin lands on *Same or Different* outcome.

**Choice #16.**

You will receive E$14.50 +

[9 / -9] if the coin lands on *Heads or Tails* and

[1 / 1] if the coin lands on *Same or Different* outcome.

Please click next to continue.
Questionnaire

Please answer the following questions:

1. How would you describe your current health? Very good/good/satisfactory/poor/bad

2. Compared to one year ago, how would you rate your health in general now? Much better now than a year ago / Somewhat better now than a year ago / About the same as one year ago / Somewhat worse now than one year ago / Much worse now than one year ago

3. Do you have any long-term health conditions, impairments or disabilities that restricts you in your everyday activities, and has lasted or is likely to last, for 6 months or more? Yes / No

4. Do(es) your condition(s) limit the type of work or the amount of work you can do? Yes/No

5. Has a doctor ever diagnosed you to have one or more of the following conditions? Sleep disorder / Diabetes / Asthma / Cardiac disease (cardiac insufficiency, weak heart) / Cancer / Stroke / Migraine / High blood pressure / Depression / Anxiety / Joint diseases (including arthritis, rheumatism) / Chronic back trouble / Other illness (please specify) / No illness diagnosed

6. Are you currently covered by private health insurance? Yes/No

7. Do you take regular medication? Yes/No

8. If you take regular medication, is it covered by your health plan or do you pay for it out of pocket? Yes, it is covered fully / Yes, it is covered partially/ No, it is not covered and I pay for the medication fully

9. How TRUE or FALSE is each of the following statements for you?

<table>
<thead>
<tr>
<th>Definitely True</th>
<th>Mostly True</th>
<th>Don’t know</th>
<th>Mostly False</th>
<th>Definitely False</th>
</tr>
</thead>
</table>
a. I seem to get sick a little easier than other people
b. I am as healthy as anybody I know
c. I expect my health to get worse
d. My health is excellent

10. Do you have any household members who are currently suffering from a long-term disability or chronic illness? Yes, my wife (husband) / Yes, one of my children / Yes, another family member I have to take care of / No

11. If yes, are the expenses related to taking care of the sick household member(s) covered by your health plan or do you pay for it out of pocket? Yes, it is covered fully / Yes, it is covered partially / No, it is not covered and I pay for the expenses fully

12. Given your current needs and financial responsibilities, would you say that you and your family are ... Prosperous / Very comfortable / Reasonably comfortable / Just getting along / Poor / Very poor

13. Are you the chief wage earner in your household? Yes / No

14. If No, is the chief wage earner of your household employed now? Yes/ No

15. If Yes, which of the following categories best describes your employment status? Employed, working 1-20 hours per week / Employed, working 21-39 hours per week / Employed working 40 or more hours per week / Not employed, looking for work / Not employed, not looking for work / Retired / Student / Disabled, not able to work / Homemaker / Unpaid family worker
16. If you are employed, are you self-employed? Yes / No

17. The organization you work for is in which of the following: Public sector (e.g. government) / Private sector (e.g. most businesses and individuals) / Not-for-profit sector / Other

18. What is the total number of people employed in your household? 0 / 1 / 2 / more than 2

19. How much money did you personally earn last year? This includes money from jobs, net income from business, farm or rent, dividends or interest, social security payments or any other income received by any household member over 18 years old. Please report the total amount earned. Do not subtract taxes or deductions listed on your tax return

Less than $10,000

$10,000 to $19,999

$20,000 to $29,999

$30,000 to $39,999

$40,000 to $49,999

$50,000 to $59,999

$60,000 to $69,999

$70,000 to $79,999

$80,000 to $89,999

$90,000 to $99,999

$100,000 to $149,999

$150,000 or more
20. How much money did all members of your household earn last year? This includes money from jobs, net income from business, farm or rent, dividends or interest, social security payments or any other income received by any household member over 18 years old. Please report the total amount earned. Do not subtract taxes or deductions listed on your tax return.

Less than $10,000
$10,000 to $19,999
$20,000 to $29,999
$30,000 to $39,999
$40,000 to $49,999
$50,000 to $59,999
$60,000 to $69,999
$70,000 to $79,999
$80,000 to $89,999
$90,000 to $99,999
$100,000 to $149,999
$150,000 or more

21. If you are employed or self-employed, how much do you agree or disagree with the following statements:
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a. I have a secure future in my job</td>
<td>nor agree</td>
</tr>
<tr>
<td>b. I worry about the future of my job</td>
<td></td>
</tr>
<tr>
<td>c. The company/business I work for (I own) will still be in business 5 years from now</td>
<td></td>
</tr>
</tbody>
</table>

22. Are you currently enrolled in a pension plan (401 K)? Yes / No

23. Do you own a credit card? (Do not include debit cards) Yes / No

24. How many credit cards do you own? (Do not include debit cards) 1, 2, 3, more than 3

25. How often is the entire balance on all of your credit cards paid off each month? Hardly ever or never / Not very often / About half of the time / Most months / Always or almost always

26. Suppose you had only one week to raise $2000 for an emergency. Which of the following best describes how hard it would be for you to get that money? I could easily raise the money / I could raise the money, but it would involve some sacrifices (e.g., reduced spending, selling a possession) / I would have to do something drastic to raise the money (e.g., selling an important possession) / I don’t think I could raise the money

27. Imagine you unexpectedly receive $1000. How much of it would you save, how much would you spend, and how much of it would you use to pay off debt (for example,
on a mortgage, other loans or credit cards)? Spending amount / Saving amount / Paying off debt amount (in whole $)

28. What if this amount was $10,000? Spending amount / Saving amount / Paying off debt amount (in whole $)

29. Do you own the home you are living now? Yes / No, but I own other properties / No, I do not own any properties

30. If Yes, did you (or other members of your household) take out mortgages or home loans from a bank, (credit union, or some other financial institution) to help pay for your home or the properties you own? Yes / No

31. Has your household paid off the loan(s) completely now? Yes / No

32. In what year do you expect the loan(s) to be fully paid off?

33. If No, do you pay rent for the property you live in now? Yes / No

34. Which of the following statements comes closest to describing the amount of financial risk that you are willing to take with your spare cash? That is, cash used for savings or investment. I take substantial financial risks expecting to earn substantial returns / I take above-average financial risks expecting to earn above-average returns / I take average financial risks expecting to earn average returns / I am not willing to take any financial risks / I never have any spare cash

Survey

Please answer the following questions:
1. What sex were you assigned at birth, on your original birth certificate: Male / Female / Other / Prefer not to answer

2. Your age: [] years

3. Which U.S. State do you live in?

5. Select the racial category that best describes you: White / Black or African American / American Indian or Alaska Native / Asian / Hawaiian/Pacific Islander / Other

6. What is your ethnicity? Hispanic or Latino / Not Hispanic nor Latino

7. Are you currently: Married / Living together as married / Divorced / Separated / Widowed / Single, never married

8. Do you have children? If so, how many?

9. What is the highest educational level that you have completed? Less than high school degree / High school degree or equivalent (e.g., GED) / Some college but no degree / Associate’s degree / Bachelor's degree / Master’s degree / Doctorate degree / Professional degree beyond a bachelor’s degree / Other

11. Do you belong to a religion or religious denomination? If yes, which one? Roman Catholic / Protestant / Orthodox / Jewish / Muslim / Hindu / Buddhist / Other / No, I do not belong to any denomination

12. Apart from weddings and funerals, about how often do you attend religious services these days? Never / Less than once a year / About once or twice a year / Several times a year / 2-3 times a month / Nearly every week / Every week / Several times a week / Don’t know
13. How do you see yourself: are you generally a person who is fully prepared to take risks or do you try to avoid taking risks? Please choose a value on the scale, where the value 1 means ‘not at all willing to take risks’ and the value 10 means ‘very willing to take risks’.

14. Taking all things together, would you say you are: Very happy / Rather happy / Not very happy / Not at all happy

Please click next to continue.

**Appendix B: Pre-treatment behavior**

In this section, we analyze the determinants of the number of risk averse choices pre-treatment as a way of checking the influence of different variables in risky behavior. Table 9 presents ordered logit regressions for the number of risk averse choices in the pre-treatment with our relevant variables (gender, health status and higher order preferences) as explanatory factors. Females are always less risky than men (Eckel and Grossman 2008, Croson and Gneezy 2009) and this result has been found in the non-parametric higher-order risk apportionment literature (Ebert and Wiesen 2014, Noussair et al. 2014). In this case, females make a higher number of risk averse choices pre-treatment. Individuals who make more prudent choices are always less risky (make a higher number of risk averse choices). However, there is no effect of temperance on the number of risk averse choices, which is in line with prior studies which show that temperance is less prevalent than prudence (Deck and Schlesinger 2008, Baillon et al 2017, Bleichrodt and van Bruggen 2018). Lastly, subjects who CB and are sick initially have a higher degree of riskiness, which is opposite to the usual findings in prior studies (Cardak and Wilkins 2009, Edwards 2008). A reason for this finding could be related to the fact that health changes might matter for the (static) analysis of
riskiness, but the effect of health on risky decisions might not be contemporaneous with changes in health itself (Love and Smith 2010). In particular, individuals who reported having a chronic illness might have adjusted their level of riskiness in the past, once they learned of their expected health outcomes. Thus, playing with house money would incentivize making less risk averse choices (a higher level of riskiness), even for those who are expected to be riskier. We find no effect of health on the number of risk averse choices pre-treatment for those who DCB.

Table 9: Ordered logit models for pre-treatment levels of risk aversion, by behavior

<table>
<thead>
<tr>
<th>D.V: Number of RA choices (pre-treatment)</th>
<th>Change Behavior</th>
<th>Do not change behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>0.963*</td>
<td>0.816*</td>
</tr>
<tr>
<td></td>
<td>(0.38)</td>
<td>(0.35)</td>
</tr>
<tr>
<td>Number of prudent choices</td>
<td>0.708**</td>
<td>0.181*</td>
</tr>
<tr>
<td></td>
<td>(0.12)</td>
<td>(0.09)</td>
</tr>
<tr>
<td>Number of temperate choices</td>
<td>0.247</td>
<td>0.015</td>
</tr>
<tr>
<td></td>
<td>(0.16)</td>
<td>(0.12)</td>
</tr>
<tr>
<td>Female*Number of prudent choices</td>
<td>-0.073</td>
<td>-0.048</td>
</tr>
<tr>
<td></td>
<td>(0.13)</td>
<td>(0.10)</td>
</tr>
<tr>
<td>Female*Number of temperate choices</td>
<td>-0.113</td>
<td>-0.168</td>
</tr>
<tr>
<td></td>
<td>(0.18)</td>
<td>(0.12)</td>
</tr>
<tr>
<td>Sick</td>
<td>0.066</td>
<td>-0.965**</td>
</tr>
<tr>
<td></td>
<td>(0.39)</td>
<td>(0.36)</td>
</tr>
<tr>
<td>Sick*Number of prudent choices</td>
<td>0.159</td>
<td>0.122</td>
</tr>
<tr>
<td></td>
<td>(0.13)</td>
<td>(0.10)</td>
</tr>
<tr>
<td>Sick*Number of temperate choices</td>
<td>-0.091</td>
<td>0.167</td>
</tr>
<tr>
<td></td>
<td>(0.18)</td>
<td>(0.13)</td>
</tr>
<tr>
<td>cut1</td>
<td>1.760**</td>
<td>-2.213**</td>
</tr>
<tr>
<td></td>
<td>(0.36)</td>
<td>(0.36)</td>
</tr>
<tr>
<td>cut2</td>
<td>2.132**</td>
<td>-0.956**</td>
</tr>
<tr>
<td></td>
<td>(0.36)</td>
<td>(0.34)</td>
</tr>
<tr>
<td>cut3</td>
<td>2.721**</td>
<td>0.127</td>
</tr>
<tr>
<td></td>
<td>(0.37)</td>
<td>(0.34)</td>
</tr>
<tr>
<td>cut4</td>
<td>3.633**</td>
<td>1.201**</td>
</tr>
<tr>
<td></td>
<td>(0.39)</td>
<td>(0.34)</td>
</tr>
<tr>
<td>cut5</td>
<td>4.312**</td>
<td>2.163**</td>
</tr>
<tr>
<td></td>
<td>(0.40)</td>
<td>(0.34)</td>
</tr>
<tr>
<td>cut6</td>
<td>4.715**</td>
<td>3.307**</td>
</tr>
<tr>
<td></td>
<td>(0.42)</td>
<td>(0.37)</td>
</tr>
</tbody>
</table>

| N                                         | 418             | 683                    |


Appendix C: Additional analysis of higher-order risk preferences

Table 10 shows the number of prudent and temperate choices by number of risk averse choices, pre- and post-treatment. On average, the subjects who make the highest number of risk averse choices also make the highest number of prudent and temperate choices (Noussair et al. 2014, Maier and Rüger 2012). Subjects who are HR make the highest number of imprudent and intemperate choices. The positive correlation holds when comparing HR subjects pre- and post-treatment with their baseline numbers of prudent and temperate choices, but it mostly happens at the extremes. This happens regardless of the health status of the subject. Average increases in the number of prudent and temperate choices mostly happen when comparing extreme riskiness levels with MR subjects. From Table 6, moderately HR and LR individuals do not behave differently from MR individuals in terms of higher-order preferences. These MR subjects are moderately prudent and moderately temperate in terms of their number of choices compared to the extreme HR and LR subjects.
Table 10: Prudence and temperance by number of risk-averse choices, pre- and post-treatment.

<table>
<thead>
<tr>
<th></th>
<th>SICK</th>
<th>HEALTHY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of risk averse choices (pre-treatment)</td>
<td>Number of prudent choices (pre-treatment)</td>
<td>Number of temperate choices (pre-treatment)</td>
</tr>
<tr>
<td>0 (n=111, HR)</td>
<td>1.32**</td>
<td>1.32**</td>
</tr>
<tr>
<td>1 (n=60, HR)</td>
<td>2.83</td>
<td>2.07a</td>
</tr>
<tr>
<td>2 (n=115, HR)</td>
<td>2.97</td>
<td>1.93</td>
</tr>
<tr>
<td>3 (n=148, MR)</td>
<td>2.72a</td>
<td>1.82+</td>
</tr>
<tr>
<td>4 (n=87, LR)</td>
<td>3.08</td>
<td>1.93</td>
</tr>
<tr>
<td>5 (n=57, LR)</td>
<td>3.04</td>
<td>2.09</td>
</tr>
<tr>
<td>6 (n=100, LR)</td>
<td>5.07**</td>
<td>3.10**a</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>SICK</th>
<th>HEALTHY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of risk averse choices (post-treatment)</td>
<td>Number of prudent choices (post-treatment)</td>
<td>Number of temperate choices (post-treatment)</td>
</tr>
<tr>
<td>0 (n=114, HR)</td>
<td>1.56**</td>
<td>1.46**</td>
</tr>
<tr>
<td>1 (n=60, HR)</td>
<td>3.08a</td>
<td>1.85a</td>
</tr>
<tr>
<td>2 (n=97, HR)</td>
<td>2.78</td>
<td>1.91</td>
</tr>
<tr>
<td>3 (n=118, MR)</td>
<td>2.89</td>
<td>1.89</td>
</tr>
<tr>
<td>4 (n=112, LR)</td>
<td>2.87</td>
<td>1.99</td>
</tr>
<tr>
<td>5 (n=70, LR)</td>
<td>3.30a</td>
<td>1.99</td>
</tr>
<tr>
<td>6 (n=107, LR)</td>
<td>4.51**a</td>
<td>2.91**a</td>
</tr>
</tbody>
</table>

Notes: † p=0.10 * p=0.05 ** p=0.010 for test against random behavior (3 choices for prudence, 2 choices for temperance).

= category value is different from the prior category level value at 10% significance or less (Mann-Whitney test).