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ARE YOU WHAT YOU EAT?
EXPERIMENTAL EVIDENCE ON HEALTH HABITS AND RISK PREFERENCES

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Are you what you eat?

Experimental evidence on health habits and risk preferences[1]

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Abstract: We run an experiment to assess whether preferences for risk significantly differ for individuals with different health habits. We administrate a questionnaire followed by an experimental test to a sample of 120 subjects. The questionnaire measures health characteristics, habits and life style and assesses details about individual nutritional balance , drinking, smoking and physical exercise. We construct a number of individual health and nutritional indexes, including the *Healthy Eating Index* based on the *USDA* guidelines. We elicit preferences for risk using variants of the Holt and Laury (2002) paired lotteries test. Conditional on individual health and life style variables, we estimate the risk preferences for each subject, using Maximum Likelihood estimation. We observe that risk preferences significantly differ for subjects with different health habits and found some evidence of risk aversion. In particular, while smokers do not appear to be significantly more risk seeking, subjects with high scores of the *Healthy Eating Index* are characterized by higher degree of risk aversion.

JEL: Experiments in Health Economics; Healthy Eating Index; Risk Preferences.

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1. Introduction

Behavioural risk factors, such as smoking, heavy drinking and obesity are known causes of a number of chronic health conditions, including cancers, heart diseases, ischemic strokes and type 2 diabetes mellitus (Sturm, 2002), as well as of mental health problems (Sobel, 2004), which, in turn, are primary drivers of health care spending, disability, premature death and decrease in productivity and growth (Sturm 2002, 2004; World Health Organization, 2005a). Despite the widespread information campaigns on such risks, problems related to obesity, smoking and heavy drinking not only seem to persist but are aggravating. This motivates the analysis of the behavioural aspects that might be related to risky health habits. In particular, it is possible that individual health behaviour may be related to individual preferences for risk, and to other attitudes and psychological traits.

The present work reports a laboratory experiment in which we elicit individual risk preferences for a sample of 120 subjects using real monetary payments, and combine these data with information about individual life style and health habits. The work aims at assessing whether subjects with different health habits are characterized by statistically significant differences in their preferences towards risk. The study is part of a wider research project on the interaction between health habits, time and risk preferences and economic behavior whose main results are contained in two companion papers (Galizzi and Miraldo, 2010a, 2010b).

Our work originally contributes to the existing literature as it combines experimental measures of individual risk preferences with a rich original dataset on individual health habits. In particular, we elicit individual risk preferences using the Holt and Laury (2002) paired lotteries test with real payments, that is widely used in the experimental economics literature and allows to estimate individual risk preferences (Andersen, Harrison, Lau and Rutstrom, 2008a; 2008b). We then combine these data with information collected using a detailed questionnaire to assess a wide number of individual health habits, including food intakes, drinking and smoking habits, physical activities. Besides other life style measures, we construct, for each subject in the pool, a *Healthy Eating Index* (*HEI*) according to the latest guidelines by the *US* Department of Agriculture (*USDA*) (Guenther et al. 2006a; 2006b; 2007). The *HEI* index is a global measure of individual nutritional balance adjusted by the total caloric intake of the subject, and complements the traditional measure of the *Body Mass Index* (*BMI*).[3]

[3] For a review on the adequacy of *Body Mass Index* as an indicator of risky health behaviour see Daniels et al. (1997) and Lofgren et al. (2004).

Very few economic studies have already combined experimentally measured risk preferences with information on individual health habits. Three remarkable exceptions are the studies by Lusk and Coble (2005), Blondel et al. (2007) and Anderson and Mellor (2008). While our analysis is related to these studies, it departs from these by providing three important contributions: we consider a sample of subjects with no specific health conditions; we construct an individual *HEI* index and control for a wider set of individual health habits; and we study whether estimated risk preferences differ across subjects with different health habits.

Within our results we show that risk preferences may significantly differ across subjects with different life styles and health habits. In particular, while smokers do not appear to be significantly more risk seeking, subjects with healthier nutritional balance and lower consumption of alcohol are more risk averse. Our results suggest that looking at the interaction among individual preferences and health habits can be a promising line of research with potential policy implications. Indeed a better understanding of the underlying preferences of subjects incurring actions detrimental to their health can inform the design of public policies targeted at reducing behavioural risk factors, such as obesity, smoking and heavy drinking.

This paper is organized as follows. Section 2 discusses the main health policy issues motivating our research, and reviews the previous results from the literature. Section 3 describes the experimental design, the tests and the questionnaire. In Section 4 we describe the data and the way we construct the health habits indexes. In Section 5 we discuss our empirical analysis and present our estimation results. A conclusion follows in Section 6.

2. Motivation and literature review

Obesity is one of the major public health problems in developed countries. Despite the widespread nutritional information campaigns, the problem not only seems to persist but is aggravating. According to the World Health Organization (WHO) there are more than one billion of adults worldwide overweight and 300 million clinically obese (WHO, 2002, 2003, 2005b). In the UK, obesity prevalence has more than tripled in the past 25 years, and obesity among children has tripled in a decade (Foresight, 2007).

In the USA 30% of the Americans are obese (US Department of Health and Social Services, 2000) with diet related illnesses being responsible for four out of the ten leading causes of death (Bush and Williams, 1999; Mokdad et al., 2004) amounting to a death toll of220,000 people a year in the

US and Canada and 320,000 in Europe (Foresight, 2007) while in the UK 30,000 deaths per year are attributed to obesity or obesity related illnesses (House of Commons, 2004). The direct and indirect annual costs of treating obesity in the UK have been estimated at £3.3-3.7 billion (House of Commons Health Committee, 2004) and are estimated to amount £3.6 billion by 2010 (National Audit Office, 2001). In particular the National Audit Office estimated that obesity costs England 18 million sick days and 30,000 excess deaths (National Audit Office, 2001).

In public health agendas, obesity is followed by risky behaviour such as smoking and heavy drinking. Tobacco consumption has reached the proportion of global epidemic. Indeed, even though consumption of cigarettes is levelling down and even decreasing in some countries, worldwide it has been rising (http://www.who.int/tobacco/en/atlas8.pdf), with the total number of tobacco related deaths in 2000 amounting 4.9 million, corresponding to a rise of 25% in a decade, justifying the set of regulations on smoking such as restrictions on youth access to tobacco products, regulation of smoking in public places, increased taxes and advertising campaigns (Mokdad et al 2004; WHO, 2002b).

Even if there is a decreasing trend in the number of smokers in developed countries, for example in the US, the smoking related number of deaths has increased in the last decade (Mokdad et al, 2004) amounting 435,000 deaths per year. The tobacco epidemic has also expanded to the developing world and is responsible for 4% of disease burden in low mortality developing countries (http://www.who.int/mediacentre/news/statements/2008/s07/en/index.html).

Finally, global alcohol consumption has increased in both developed and developing countries in recent decades and is responsible for 1.8 million deaths globally (WHO, 2002). Alcohol consumption is the first cause of death in low mortality developing countries and the third in developed countries contributing, respectively, for 6.2% and 9% of disease burden (WHO, 2002b).

As risky behaviours might be related it is important to analyze them together. Indeed, the literature has often stated that obesity and cigarette consumption may be related. Cigarette smoking may directly impact obesity through biochemical and physical processes such as insulin homeostasis, activity of lipoprotein lipase and sympathetic nervous system, physical activity, preferences in food consumption and appetite reduction (Lundborg and Andersson, 2008; Williamson et al., 1991; Wack and Rodin, 1982; Hofstetter et al., 1986; Stamford et al., 1986;). Moreover, from an economics perspective, cigarette taxes have been associated with obesity prevalence (Chou et al., 2004; Rashad and Grossman, 2004; Gruber and Frakes, 2005).

Also in the case of alcohol there is a close relation with the other risk factors. Indeed alcohol consumption has been found to be negatively related with diet quality (Breslow, Guenther and Smothers, 2006) suggesting that alcohol consumption is an important element to be considered in obesity studies.
Clarifying the interaction between alcohol consumption, smoking and diet quality, is therefore a crucial step in determining the extent to which diet may be a confounder in studies of alcohol and smoking habits.

From a health policy perspective, the design of effective preventions campaigns to tackle risky behaviour requires the knowledge of subjects' underlying preferences and attitudes. In fact, even though the explanations for the obesity epidemic and other risky behaviours have often been attributed to genetics (Manson et al., 2003), the biochemical reductionism has been supplemented with a complexity of socio-economic and environmental forces as roots to these types of habits. Indeed, the world health report (WHO, 2002b) has reckoned that risky behaviours are strongly determined by risk perception, which in turn has been found to be linked to preferences as well as to economic, social and cultural factors and to psychological and political attitudes (WHO, 2002b).
Therefore, in order to analyze the behavioural processes inherent to risky behaviours, it is of primary importance to control for the risk preferences, as well as for other psychological traits, of the subjects. The literature on behaviour detrimental to health is vast and spawns across different disciplines such as economics, sociology, psychology and medicine, just to cite some (Rosin, 2008; Philipson, 2001; Philipson and Posner, 2008). Despite advances in each single area, there is still scarce literature combining the different angles of analysis and explicitly investigating the link between risk preferences and risky behaviours. Also, there is far from agreement on how these subjects' preferences should be assessed and measured.

The literature typically uses four methods to measure and control for individual risk preferences. The first method is based on *hypothetical behaviour*. The most common measure of hypothetical behaviour involves hypothetical gambles. Subjects taking part into a survey typically respond to questions in which they are asked to choose between a "safe" job with a certain income, and another "risky" job with higher expected income. The questions vary the probability of getting a lower income in the "risky" job. Based on the observed choices, subjects are then categorized into several types, from the least to the most risk tolerant. Measures based on hypothetical gambles are typically used in surveys on large representative samples of the population, such as the Health and Retirement Study (HRS) and the Panel Study of Income Dynamics (PSID) in United States.

Using data from these surveys, several studies have explored the link between risk attitudes and health behavior. Barsky et al. (1997), for instance, found that subjects with higher risk tolerance are more likely to drink and smoke. Lahiri and Song (2000) and Dave and Saffer (2008) found that more risk averse subjects are less likely to start smoking and consuming alcohol, respectively. Khwaja et al. (2006) found that, compared to subjects that never smoked, current and former smokers are more risk tolerant, and that risk tolerance is a time-invariant characteristic.[4]

The two main advantages of using measures based on hypothetical behaviour are that the questionnaires are easy to implement, and allow checking whether subjects' responses depend on the specific frames and domains within which risk attitudes are assessed. For instance, it is possible to replicate variants of similar questionnaires involving different hypothetical scenarios, in order to assess risk taking in several content domains and to test the consistency of subjects' responses across domains (MacCrimmon and Wehrung, 1990; Weber et al. 2002). This is particularly interesting to analyze to what extent the risk preferences measured by responses to questions on hypothetical monetary payoffs also capture individual attitudes towards health risks. Comparisons between measures of risk preferences for monetary and health-related benefits are clearly possible only within hypothetical scenarios. On the other hand, the main disadvantage of measuring risk attitudes with hypothetical questions is clearly the lack of incentives for subjects to provide responses that genuinely reflect their preferences.

A second method to control for risk preferences is based on *actual behavior*. Rather than directly assessing risk preferences, some studies use a specific observed health behavior as a proxy of subjects' risk attitudes. Following this approach, for instance, Feinberg (1977) used cigarette smoking as one of the indicators of risk aversion, to test the hypothesis that more risk averse workers have shorter duration of unemployment; Viscusi and Hersch (2001) and Hakes and Viscusi (2007) used smoking habits as a proxy for risk preferences in describing individual job and seat belt use decisions, respectively.

While the possibility of using observed health habits to control for unobserved risk attitudes is clearly interesting, it also raises two concerns. First, under this approach the link between risk preferences and health habits is simply based on assumptions, rather than being justified by direct empirical evidence: smokers are assumed to be risk seeking, for instance. Secondly, the approach disregards the possibility that health habits can, actually, be related to other individual attitudes,

4 There are also alternative measures of hypothetical behavior. For instance, rather than hypothetical gambles, Guiso and Paiella (2005) used hypothetical measures for willingness to pay for a risk asset contained in a survey in Italy and found that risk averse subjects were less likely to incur chronic diseases.

such as time preferences (Fuchs, 1982; Bickel et al. 1999; Reynolds, 2005; Galizzi and Miraldo, 2010a) or impulsivity (Mitchell, 1999; Khwaja, et al., 2007), for instance.

An alternative method to control for risk preferences is to use *self-reported attitudes*. In surveys such as the German Socio-Economic Panel (SOEP), for instance, a sample of 22,000 subjects, representative of the German population, are asked a battery of questions to self-assess their risk attitudes. In one question subjects are asked to assess their willingness to take risks "in general", on an 11-point scale. On a a second question respondents are asked to assess their willingness to invest in a hypothetical lottery. Other questions use the same 11-point scale as the general question, but ask subjects to assess their willingness to take risks in five different domains: car driving, financial decisions, sports and leisure, career, health.

Dohmen et al (2010) used the data from the SOEP survey and found that only the self-assessed willingness to take risks in general and in the health domain significantly predict being a smoker or not, while all other self-assessed risk attitudes, including the ones measured by an hypothetical lottery or within a financial domain, were not correlated with the smoker status.

The main advantage of self-reported attitudes contained in surveys is clearly that these measures are assessed for large, representative samples of population, together with a rich set of other socio-demographic and economic variables. On the other hand, self-reported attitudes share with measures based on hypothetical behavior the main disadvantage of lacking incentives for subjects to provide responses that genuinely reflect their preferences. A preliminary answer to this concern comes from the above study by Dohmen et al. (2010), which show that, for a sub-sample of 450 subjects, the self-reported willingness to take risks in general, as assessed by the survey's question, is a good predictor of risky choices observed in a paired-lotteries experimental test with real monetary payments.[5]

The last method to control for risk preferences relies on *incentive-compatible tests* proposed by the experimental economics literature. A number of experimental studies (see, among others, Hey and Orme, 1994; Holt and Laury, 2002; Andersen et al. 2007, 2008a, 2008b; Tanaka et al., 2010) have pointed out that, in order to to truthfully reveal their preferences, subjects should be rewarded with real monetary payments according to their stated choices. Holt and Laury (2002) found that tests with real monetary payments provided better estimates of risk preferences than hypothetical

[5] Dohmen et al. (2010) do not report whether the individual risk aversion elicited by the experimental paired-lotteries test was significantly predicting the fact of being a smoker, alike the self-assessed willingness to take risks in general or in the health domain, or instead was not correlated with the smoker status, alike the self-assessed measures based on the hypothetical lottery, or within the financial domain.

payments, and proposed a paired-lotteries test with real payments that have then been extensively used in the experimental economics literature. The price to be paid in order to guarantee truthful revelation of individual preferences is that, when using experimental tests with real monetary payments, risk preferences can only be elicited within a monetary domain, rather than within specific frames, such as the health-related domain.

Very few economic studies have already combined measures of risk preferences elicited by incentive-compatible experimental tests with information on individual health habits. Three remarkable exceptions are the studies by Lusk and Coble (2005), Blondel et al. (2007) and Anderson and Mellor (2008).

Lusk and Coble (2005) elicited risk preferences from 50 undergraduate students using the Holt and Laury (2002) paired-lotteries test and related the observed preferences with the data reported in a survey on the willingness to pay for genetically modified food. Lusk and Coble (2005) found that subjects that, according to the experimental paired-lotteries test, were more risk averse were also significantly less willing to purchase and consume genetically modified food.

Blondel et al. (2007) compared the risk (and time) preferences of 34 drug users taking methadone with a control group of 28 subjects with similar socio-demographic characteristics. Risk preferences were elicited by 14 binary risky choices with real monetary payments. Blondel et al. (2007) found that drug user subjects were significantly more risk-seeking.

Anderson and Mellor (2008) paired for the first time data on individual risk preferences elicited through the Holt and Laury (2002) paired-lotteries method with several questions about risky health behaviour, such as seat belt use, smoking, heavy drinking and being obese. Using a large and heterogeneous sample of 1094 adult subjects, Anderson and Mellor (2008) found that risk aversion as measured by subjects' choices in the experimental lotteries test was negatively and significantly associated with cigarettes smoking, heavy drinking, being overweight or obese, and seat-belt non-use.

Our work is related to these studies to the extent that in the analysis we combine experimental elicitation of risk preferences with a set of variables on individual health habits. However this paper departs from these analysis in several important aspects. First, while Lusk and Coble (2005) and Anderson and Mellor (2008) studied how experimental measures of risk preferences can predict risky health behaviour, the main goal of our study slightly differs as we investigate whether subjects with different health habits exhibit significant differences in risk preferences. With respect to Lusk and Coble (2005), another important difference is that, while not assessing subjects' willingness to pay for specific products, our survey includes a number of questions about a wide set of health habits, food and drinks consumption and weekly nutritional intakes. On the other hand, our work differs from the study by Blondel et al. (2007) in that we consider a sample of subjects with no specific health conditions and we study whether risk preferences differ across subjects with different, but not extreme, health habits.

The design of our experiment is similar to the one by Anderson and Mellor (2008), although there are three main differences between the two studies. First, while Anderson and Mellor (2008) categorized the individual degree of risk aversion based upon the observed switching point between lotteries chosen by subjects, we follow the empirical approach by Andersen et al. (2008a; 2008b) and estimate the shape of individual risk preferences using 40 observations per subject.

Secondly, while our study uses a smaller and more homogeneous sample of subjects, it considers a much richer set of questions on health habits. In particular, while Anderson and Mellor (2008) use a limited number of questions and construct few dummy variables to control for health habits, we rely on a very detailed questionnaire and construct several variables and comprehensive indicators for individual health behaviour. Among other measures, we computed, for each subject in the pool, an individual *Healthy Eating Index* according to the latest guidelines by the nutrition experts of the *US* Department of Agriculture (*USDA*) (Guenther et al. 2006a; 2006b; 2007). The *HEI* index is a global measure of individual nutritional balance adjusted by the total caloric intake of the subject. The construction of the *HEI* index allows us to complement the traditional measure *BMI* with a more accurate and comprehensive indicator of individual diet and nutritional balance.[6] This is potentially an important contribution since Anderson and Mellor (2008) noticed that their results were sensitive to changes in the way risk behaviours were defined from the survey questions. The use of a richer set of discrete variables is likely to produce estimates more robust to changes in the definitions of risky habits than by using few dummy variables.[7]

While making the above new contributions, some of our results are in line with the main results found by Anderson and Mellor (2008). In particular, we find that subjects with a more healthy nutritional balance and with lower weekly consumption of alcohol units exhibit significantly higher degrees of risk aversion, as estimated from the data elicited by the experimental Holt and Laury (2002) lotteries method. However, we do not observe significant differences in the risk preferences between smokers and non smokers. In a companion paper (Galizzi and Miraldo, 2010a) we provide

[6] For some criticisms to the use of *Body Mass Index* as an indicator of risky health behaviour see Daniels et al. (1997) and Lofgren et al. (2004).

[7] This is probably what Anderson and Mellor (2008) meant when observing that *"additional exploration of how risk behaviours are defined may be worthwhile in future studies"*.

a possible explanation for this result, observing that smoking habits may be related to individual time preferences.

3. The experiment

We used the ORSEE online system to invite students in the University of York campus to sign up to one of 6 experimental sessions between the end of April and the beginning of May 2008. All the experimental sessions took place in the EXEC experimental economics laboratory at ARRC building at the University of York. A total number of 120 students showed up. 54 subjects were female. Most subjects were undergraduate students, while 31 were graduate students or members of the staff. Only 7 subjects were economics students. In terms of ethnic composition of our pool, the majority of subjects reported to be white British, while 11 subjects were Chinese, 13 from other Asian origins, 11 not-British white, and 8 from other ethnic origins. All experimental sessions lasted approximately one hour and half, and subjects received an average payment of £ 17.3, not taking into account the fee paid on the basis of the paired-lotteries “random draw prize” described below.[8]

Subjects were given aloud and written instructions on the experiment. They were explicitly told that the experimental session consisted of distinct questionnaires, for each of which they were going to be paid separately.

Subjects were administered a detailed computerized questionnaire designed to control for two main individual dimensions: on the one hand, information about individual life habits, on the other, individual risk preferences. The computerized questionnaire was designed and run with the 3.2.11 version of z-Tree software (Fischbacher, 2007).

The *first* part of the questionnaire focused on the assessment of individual life style and health habits. In particular, we constructed a questionnaire to elicit self-assessed health characteristics and life style, containing detailed qualitative and quantitative questions on health habits and individual behaviour in nutrition, eating, drinking and smoking activities and physical exercise.

The resulting survey had 137 questions assessing, on the top of socio-demographic individual characteristics (age, sex, university degree, height, weight, nationality, ethnicity, religion, political

[8] The same experiment was replicated in two control groups at the University of Brescia in Italy, where we invited 120 undergraduate students and 30 professionals in two experimental sessions. The data collected from the control groups in Italy are not presented here.

orientation, weekly budget, nationality, job and highest level of education of the parents, among others), weekly intakes and portions of different categories of food (including cereals, vegetables, fruits, meat, fish, milk and cheese, sweets) weekly intakes of drinks and alcohol; smoking habits; time spent in sports and physical activities; average sleeping hours; number of sexual intercourses in a month; weekly use of take-away, prepared, canned or frozen food; time spent on cooking and eating; composition of meals out and at home; frequency of visits to the GP, a nurse or a hospital.[9]

In the *second* part of the experiment we elicited individual *risk preferences*.[10] Risk preferences are clearly a central dimension for which it is interesting to control when assessing individual health habits and life style. As discussed in the previous Section, several studies associate individual risk attitude with a number of types of risky behaviour, especially smoking and drinking.

One of the main contribution of the present work is that it combines information on health habits with the elicitation of individual risk preferences through incentive-compatible tests used in the experimental economics literature (Hey and Orme, 1994; Holt and Laury, 2002; Andersen et al. 2007, 2008a, 2008b). In particular, we applied the paired lotteries method proposed by Holt and Laury (2002). Briefly, the test consists in presenting the subjects a series of questions, each reproducing a choice between two lotteries. Usually lotteries are binary and give a low payoff with some probability, and a high payoff with the complementary probability. One of the proposed lotteries (say lottery A) is characterized by a lower variance, in terms of smaller difference between monetary payoffs, than the other lottery (say B). The series of proposed pairs of lotteries only differ with respect to the probabilities of occurrence for the high payoff. Thus, for low probabilities, lottery A typically has the higher expected payment, while lottery B gives the higher expected returns for high probabilities. In Table 1, we provide a representation corresponding to the first set of choices we presented to subjects in our experiment.

[Insert Table 1 here]

[9] We also asked subjects to express their evaluation, in a 0-100 grid, for each element of a list of 10 food types and dishes, and 10 daily activities (such as running, trekking, watching TV).

[10] In the sessions, we also elicited time preferences through a paired options experimental test, similar to the one used by Benhabib et al. (2010) and Tanaka, et al.(2010). We used the data collected in the experimental test to estimate a general form of individual time preferences, proposed by Benhabib et al. (2010), encompassing, besides exponential discounting, also hyperbolic and quasi-hyperbolic discounting. The analysis of the relation between individual time preferences and health habits is the focus of a companion paper (Galizzi and Miraldo, 2010a).

In the experimental test, for each question, subjects had to choose from lotteries A and B the lottery they prefered.[11] The idea is that risk-neutral subjects, aiming at maximizing their expected monetary payments, should switch from the "safe" option (lottery A) to the "risky" option (lottery B) only when the expected monetary payment is greater in lottery B than in A. Looking at Table 1, a risk neutral subject should choose A in rows 1-4, before switching to lottery B in row 5, and selecting that lottery in all the remaining rows. A strongly risk averse subject could instead prefer lottery A also in rows after 5, while a strongly risk lover should switch before. Thus, by observing all the choices made by a subject and the lotteries in correspondence of which a switch has occurred, it is possible to measure the individual attitude towards risk.

In our questionnaire, we presented to subjects a total of 40 choices. In each of the 40 situations, subjects were asked to choose between two presented lotteries of the type discussed above. The 40 choices differed with respect to the probabilities of occurrence of the two payoffs, and to the stakes of the lotteries: for instance, we varied the probability and the amount of the maximum win from 10 to 100% and from £2 to £77, respectively. A representation of the 40 choices presented to subjects in our experiment can be found in Appendix 1.1.

As mentioned above, we followed the experimental economics literature in implementing an incentive-compatible experimental test. In particular, in order to guarantee a truthful elicitation of preferences, we implemented a payment mechanism by which at the end of the questionnaire, one of the 40 choices presented to subjects was randomly selected. The two lotteries within that choice were actually played and subjects were then paid cash according to the realized outcome of their preferred lottery.[12]

Following the experimental economics literature (Andersen et al. 2008a, 2008b) we used the 40 observed choices for each subject to estimate the individual relative *rate of risk aversion* σ under the assumption that subjects have a *Constant Relative Risk Aversion* (*CRRA*) utility function of the type $U(x) = x^{\sigma}$, where x is lottery prize and $1\text{-}\sigma$ is the coefficient of *CRRA* to be estimated. Depending on the value of σ subjects have different degrees of risk aversion, among which the three general cases are the ones of risk neutrality ($\sigma=1$), risk aversion ($\sigma<1$) and risk seeking ($\sigma>1$). The empirical estimation of individual risk preference is possible by using maximum likelihood

[11] In the experimental test subjects had to choose either lottery *A* or *B*. Expressing indifference between the two lotteries was not possible in our experiment. This feature of our experimental design does not alter our findings, since in alternative settings where subjects could also express indifference, usually very few subjects used that option, as reported in Andersen et al. (2008b).

[12] At the end of each experimental session, we selected randomly one subject in the lab and ask him/her to draw a ball from an urn that had been prepared for any of the lotteries presented in the selected choice. Each subject was then paid cash the amount corresponding to the realized outcome of his/her preferred lottery in that choice.

methods to estimate the probability of choosing a safer option over a riskier one, as proposed by Andersen et al. (2008a, 2008b) and Harrison (2008) and summarized in Section 5.

In our experimental sessions we assessed and controlled for a number of other individual characteristics. First, we also elicited individual time preferences using a paired options experimental test similar to the one used by Andersen et al. (2002), Benhabib et al. (2010) and by Tanaka et al. (2010). We used the data collected by the experimental test to estimate a general functional form for individual time preferences, proposed by Benhabib et al. (2010), that encompasses, besides exponential discounting, also hyperbolic and quasi-hyperbolic discounting. The analysis of the relation between time preferences and health habits is the focus of our companion paper (Galizzi and Miraldo 2010a).

Secondly, we ran several tests currently used in the experimental psychology and economics literature, in order to control for a number of individual psychological attitudes and behavioural variables, including, among others, cognitive reflection (Frederick, 2005); overconfidence, in terms of both *better-than-average*, *mis-calibration* and *illusion of control* (Glaser and Weber, 2003; Bias et al. 2002, 2005) and self-monitoring (Snyder and Gangestad, 1986).

Furthermore, subjects in our experimental session also played an experimental "*trust game*" (Berg et al., 1995). Each subject was randomly assigned the role of either the Sender or the Receiver, and played a number of rounds of the trust game, each against a different, randomly selected, subject in the lab.[13]

Finally, subjects were also asked to self-assess their health status, relatively to the one of people of their sex and age, choosing one of the following definitions: *"very bad"*, *"bad"*, *"moderate"*, *"good"*, *"very good"*. In particular, subjects were asked to self assess their health status in general and across 5 specific dimensions: pain, mobility, eye-sight and hearing, attention and sleeping, mental health. This allowed us to build several indicators for the self-assessed health status of our subjects.[14]

[13] At each round the Senders were given an amount of 100 points and were asked how many points they wanted to keep for themselves and how many they were willing to send to the matched Receivers. The points sent by Senders were then multiplied by a factor of three and transferred to the Receivers, who were then asked how many of them they wanted to keep for themselves, and how many they were willing to send back to the matched Senders. At the end of the experiment, the points earned by each subjects in each round were summed over all the rounds, converted in pounds using a conversion rate of 150 points = £1, and paid in cash to each subject.

[14] Questions on self-assessed health were complemented by a number of vignettes (King et al. 2004, Tandon et al 2001, 2001b). The use of vignettes allows overcoming issues arising on interpersonal and cross-cultural incomparability in survey data when subjects (or groups of subjects) perceive and use ordinal response categories in different ways due to cultural or even inter-personal differences. The vignettes used in our experiment were an adapted version of the WHO short vignettes questionnaire (WHO, 2002). The interested reader should see http://gking.harvard.edu/vign/ for material on vignettes.

The relations among psychological variables, health habits and economic behaviour are the focus of our companion paper (Galizzi and Miraldo, 2010b).

4. Data and health indexes

Once collected the individual data from the experimental sessions, we worked on the data processing. First, based upon self-assessed data on daily habits and life style, we constructed a number of individual health and nutrition indexes.

The *BMI* has been traditionally used to measure obesity. It is calculated by dividing the weight (in kilograms) by the height (in metres) squared. Despite its widespread use in the assessment of weight status, *BMI* has often been criticized as being a too imprecise measure of healthy weight for several groups of the population, as for example, athletes, children and the elderly (Daniels et al, 1997; Lofgren et al, 2004). This has lead to an increasing number of studies that derive supplementary measures, such as waist circumference measurement, or lean body mass index (Cole, 1991; Nevill 1995; Lean et al 1995; Han et al 2006; Janssen et al, 2004)

Following these suggestions, we decided to complement the *BMI* index computed from the self-assessed weight and height, with a more precise and specific measure that could control for both quantitative and qualitative information on the individual nutritional intake.

In particular, we computed an individual *Healthy Eating Index* for each subject in the experimental sessions. Following the latest guidelines by the *US* Department of Agriculture (Guenther et al., 2006, 2007), we constructed the updated version of the *HEI*, that is considered to be one of the most advanced and complete measures of an individual nutritional balance. The updated version of the *HEI* index, so-called *HEI-2005*, is a global measure of individual nutritional balance adjusted by the total caloric intake of the subject, and is constructed as a weighted sum of 12 sub-indexes.

The first six sub-indexes assign 5 points each to subjects whose daily intakes are at least equal, or greater, than the recommended quantities for six “healthy” categories of food: total fruit; whole fruit; total vegetables; dark green and orange vegetables, and legumes; total grains; whole grains. Both the intake and the recommended quantities are expressed in cup equivalents (or ounces) for 1000 kcal. Each of these sub-indexes gives 0 points to subjects who do not consume any quantity at all of the food in the corresponding category, and assigns to subjects whose intakes are less than the recommended amounts, a number of points in between 0 and 5, according to a function linearly increasing in the consumed quantities.

The next three sub-indexes assign 10 points each to subjects whose daily intakes are at least equal, or greater, than the recommended quantities for: milk, meat and beans and oils. The intake and the recommended quantities are expressed in cup equivalents (grams or ounces) for 1000 kcal. Each of these sub-indexes gives 0 points to subjects who do not consume any quantity at all of the food in the corresponding category, and assigns to intermediate intakes a number of points between 0 and 10, according to a linear function in the consumed quantities.

One further sub-index assigns 10 and 0 points to subjects to whom the saturated fats represent less than 7%, and more than the 15% of their daily energetic intake, respectively, and assigns points between 0 and 10 to subjects with intermediate proportions. Another sub-index works in a similar way, assigning 10 and 0 points to subjects whose daily intake of sodium is below 0.7 grams, or above 2 grams for 1000 kcal, respectively, and linearly declining points for the intermediate cases. Finally, one sub-index assigns 20 and 0 points to subjects for which the so-called "SoFAAS" discretionary calories, derived from Solid Fat, Alcohol and Added Sugars, represent less than 20%, and more than 50% of their daily energetic intakes, respectively, and linearly declining points for the intermediate cases.

The *HEI* index is computed as the sum of the points assigned by the twelve above sub-indexes, and measures the overall individual nutritional balance. By its construction, *HEI* is a 0-100 score, increasing with the nutritional balance of the individual diet, and assuming value 100 for subjects taking the maximum score in each of the above sub-indexes.[15]

It is important to emphasize that within the revised version of the *HEI* index as all quantities are expressed per 1000 kcal, the nutritional intake is considered in relative, rather than absolute terms, and is therefore adjusted at an individual level, thus making the *HEI* index a global measure of the distance of the daily intake from an "individually" optimal nutritional balance (Guenther et al. 2006a, 2006b)

For the previous version of the *HEI* index, the *USDA* made available anonline software that processed a series of inputs such as age, sex, daily intakes of some categories of food and returned the *HEI* score for the subject. Unfortunately, no such a software or readily available program has yet been released by *USDA*. Therefore, we had to construct our own program to compute the *HEI* score. In writing our own program we closely follow, in every detail, the procedure explained in the manual and the guidelines released by the USDA panel of experts (Guenther et al. 2006a, 2006b, 2007). In particular starting with the weekly intakes of food we expressed all the intakes on a daily intakes and computed the daily energetic intake for each subject, in kcal; we then considered every single intake and computed its nutritional value and contribution to each of the 12 *HEI* sub-indexes;

[15] For the elaboration of the revised version of the HEI index, the USDA has invited a team of qualified experts from many leading US institutions in nutritional studies. The experts have released for the USDA an extremely accurate and helpful manual (Guenther et al 2006a, 2006b, 2007) explaining in every detail how exactly the sub-indexes and the HEI should be computed, and providing guidelines in how to process information and transform data on individual daily intakes.

we summed up the values for all intakes and expressed them in terms of the computed daily energetic intake for each subject; we finally assigned points to each sub-index and computed the *HEI*. We have used Stata 11 for these computations. The program is available on request from the authors.

Besides the *BMI* and the *HEI* indexes, we also computed several other indicators of individual health habits and life style. In particular, we constructed the variables: *SmokeD*, a dummy variable taking value 1 for smokers; *Cigs,* taking values equal to the number of smoked cigarettes per day; *Alcohol* that captures the number of alcohol units drunk per week;[16] *Sport*, that captures the hours of intense physical activities per week; *SexInter*, measuring the average number of sexual intercourse experienced in a month; *Sleep*, that stands for the average sleeping hours per day.
For each subject, we also collected a number of standard socio-demographic characteristics, such as the age (*Age*); gender (*SexD* a dummy taking value 1 for females); the disposable weekly budget in British pounds (*Budget*); the level of instruction of the parents (*DEduc*, an ordered variable taking values between 1 and 5, increasing with the level of instruction of the father, with 1 corresponding to "*have completed the primary school*" and 5 to "*have completed post-graduate degree*"); the ethnicity (the set of dummies *IndiaD, ChinaD, PakistanD, BangladeshD, OtherAsianD, WhiteNotBritD, OtherEthnD*, with *"white British"* taken as reference group).

Although our sample of subjects was mostly formed by undergraduate and graduate students, the data shows significant differences across individual characteristics and sufficient heterogeneity in health habits. The only exception is smoking: only 11 subjects in our pool reported to be smokers. Table 2 shows some descriptive statistics, together with the computed scores for the global *HEI* index and for some of the sub-indexes.

[Insert Table 2 here]

Table 3 shows the pairwise correlations among our variables. As it can be noticed, in general very few variables show strong correlations among them.[17] Some exceptions are represented by the significant positive correlations between number of cigarettes, on one hand, and age and alcohol

[16] According to the UK National Health System an alcohol unit corresponds to 10ml (8grams) of pure alcohol content of a drink. This approximately corresponds to the amount of pure alcohol in a 25ml single measure of spirits (ABV 40%), a third of a pint of beer (ABV 5-6%), or half a 175 ml standard glass of red wine (ABV 12%).
[17] This is consistent with the empirical evidence reported by Cutler and Glaeser (2005) who, using data from the U.S. National Health Interview Survey, also found low correlations among different types of health behaviour.

units on the other; the strong negative correlations between the global *HEI* index and alcohol consumption; and the negative correlations between sleeping hours, on one hand, and age and number of cigarettes on the other.

[Insert Table 3 here]

5. Empirical analysis and estimation results

In this section we directly investigate the issue of whether individuals with different health habits are characterized by significant differences in their preferences for time and risk.

Our empirical strategy for the estimation of individual risk preferences closely follows the analysis by Andersen et al. (2008a; 2008b). In particular, we assume that the utility of income of subject i is a function $U_i(x)$

$$U_i(x) = x^{\sigma i} \quad \text{with } U_i(x)=ln(x) \text{ if } \sigma_i=0 \qquad (1)$$

where x is a monetary payoff and $1- \sigma_i$ is the coefficient of constant relative risk aversion (CRRA). Depending on the value of σ_i subject i shows different degrees of risk aversion, that can be grouped in three general types:

1. If $\sigma_i =1$ risk neutral
2. If $\sigma_i <1$ risk averse
3. If $\sigma_i >1$ risk seeker

The data collected from the above described experimental tests are used to estimate the individual degree of risk aversion. In fact, each subject in the experiment was asked to choose between two lotteries, *A* and *B*, each having two outcomes, say, *1* and *2*. In the 40 pairs of lotteries proposed to subjects in the experiment, we varied both the probabilities p_{kj} and the monetary payoff x_{kj} associated to each outcome of the two lotteries, with $j=A,B$ and $k=1,2$. The probabilities varied from 0 to 100%, while the monetary payoffs varied from £0.1 to £77.

Define $U_i(x_{kj})$ as the utility that subject i perceives from getting a monetary payoff x_{kj}. As discussed above, the utility of subject i is assumed to be of the *CRRA* type $U_i(x_{kj})= x_{kj}^{\sigma i}$, where σ_i is the individual parameter for risk aversion to be estimated. Under Expected Utility Theory (*EUT*), the expected utility by subject i of a given lottery $j=A,B$ is just the utility of each outcome in that lottery, weighted by the probability of the outcome:

$$EU_{ij} = \sum_{k=1,2} (p_{jk} * U_i(x_{kj})) \qquad (2)$$

with $j=A,B$ and $k=1,2$. Clearly the expected utility depends on the subject's risk aversion parameter σ_i, the variable that we want to estimate. Based on a candidate value of σ_i, an index $\Delta_i(EU)$ is constructed, as the difference between the expected utilities perceived by subject i, from the two lotteries A and B:

$$\Delta_i(EU) = EU\, i_A - EU\, i_B \qquad (3)$$

The index depends on the subject's latent risk preferences and takes positive values when subject i assigns higher expected utility to lottery A than B, and vice versa.

This latent index is then linked to the observed binary choices, by using a standard cumulative density function (*CDF*). In particular, assume that the latent index $\Delta_i(EU)$ is distributed according to a normal distribution. Therefore, like in a probit, a normal *CDF* $\Phi(\Delta_i(EU))$ takes any argument $\Delta_i(EU)$ and transforms it into a number between 0 and 1:

$$Prob\ (choosing\ lottery\ A) = \Phi(\Delta_i(EU)) \qquad (4)$$

This probit function thus links the latent individual risk preferences with the choices observed in the experiment: any time $\Phi(\Delta_i(EU))>1- \Phi(\Delta_i(EU))$, the subject chooses lottery A.

Therefore, under the assumptions of Expected Utility Theory and of utility functions of the *CRRA* type defined above, the likelihood of observing a specific choice depends on the individual risk preference σ_i, given the assumed normal *CDF* linking the latent index to the observed choices. Since indifference responses were explicitly ruled out, the individual log-likelihood conditional to the observed choices y_{in}, with $n=1,...,40$, is given by:

$$Ln\ L_i\ (\sigma_i; y_i) = \sum_n ((ln\ \Phi(\Delta_i(EU))|\ y_{in} =1\ ) + ((ln\ \Phi(1 - \Delta_i(EU))|\ y_{in} =0\ ) \qquad (5)$$

where $y_{in} =1(0)$ denotes the choice of lottery $A(B)$ in the proposed pair of lotteries $n=1,...,40$. Notice that the main difference between the above estimation procedure and a standard probit model is that in the former case, given the above assumptions and our experimental design, the exact form of the latent index is perfectly known with the only exception of the individual parameter σ_i. While a typical probit model would estimate the change in probability of observing a given outcome following a change in the value of a specific explanatory variable, in the above estimation procedure the values of the latent index induced by the experimental lotteries, together with the observed choices by the subject, are used to estimate the individual risk aversion parameter σ_i.

Our estimation procedure follows Andersen et al. (2008a; 2008b) and Harrison (2008). In particular, we pooled all the observations together: as our questionnaire collected 40 responses on risk preferences for subject, the resulting dataset comprised 4800 observations, that reduced to 4650 once the missing responses were dropped. The log-likelihood function at the sample level is thus:

$$Ln\ L\ (\sigma; y) = \sum_i \sum_n ((ln\ \Phi(\Delta_i(EU))|\ y_{in} = 1\ ) + ((ln\ \Phi(1 - \Delta_i(EU))|\ y_{in} = 0\ ) \qquad (6)$$

We corrected for heteroskedasticity and autocorrelation of observations within the same subject, by treating the residuals from the same subject as potentially correlated, and by computing cluster-robust standard errors of estimates.

Using Stata 11, we wrote a program to compute the expected utilities by the subjects and the latent index $\Delta_i(EU)$ and to construct the above log-likelihood function. The program passed into the log-likelihood function the data on the probabilities and monetary payoffs of the experimental lotteries and the observations on the preferred choices by the subjects. The log-likelihood function was then read and evaluated by Stata maximum likelihood routine and maximized using Newton-Raphson optimization technique.[18]

The results of the estimation of the individual degree of risk aversion σ_i based upon the above log-likelihood function are presented in Table 4, as *Model I*. As it can be seen, the maximum likelihood estimate returned a value for the parameter of risk aversion of $\sigma\hat{} = 0.5015$, along with its standard error. The estimate clearly indicates that subjects in our pool are risk averse. The estimate is generally consistent with the commonly produced estimates by the experimental economics literature (see for instance Hey and Orme, 1994; Holt and Laury, 2002; Andersen et al. 2007, 2008a; 2008b).

We then turned to the main objective of our estimation. Following Andersen et al. (2008b) and Harrison (2008), we allowed the *CRRA* coefficient to depend on a set of individual observed characteristics. In particular, we allowed the parameter of risk aversion to depend on the individual

[18] For a discussion on maximum likelihood estimation using Stata, see Gould et al. (2006).

health habits and on a set of socio-demographic control variables. Define X a vector of individual observed characteristics, including a set of socio-demographic controls, such as age, sex, ethnicity, parental education, weekly budget and similar, and, possibly, the above set of health habits variables *HEI, BMI, Cigs, Sport and Alcoh*. If we also condition on the vector X of individual observed characteristics, the above log-likelihood function becomes:

$$Ln\ L\ (\sigma; y, X) = \sum_i \sum_n ((ln\ \Phi(\Delta_i(EU))|\ y_{in} = 1; X_i) + ((ln\ \Phi(1 - \Delta_i(EU))|\ y_{in} = 0; X_i) \qquad (7)$$

We adjusted our Stata program to include the individual characteristics in vector X among the explanatory variables for the estimate of the individual parameter of risk aversion. In *Models II-VI* the *CRRA* coefficient is estimated as a function:

$$\sigma = \alpha_0 + \sum_m \gamma_m X_m \qquad (8)$$

where X contains a number m of different socio-demographic characteristics and individual health habits. The results of estimation of *Models II-VI* are reported below. When looking just at the effect of socio-demographic characteristics (*Model II*), it can be seen that, in our pool, individual risk preferences differ only across subjects of different ethnicity and socio-economic background, as reflected by relatives' education.[19]

Concerning health habits, results show that, whether is included on its own (*Model III*), or together with other health habits variable (*Model IV*), *BMI* is never significantly related to risk preferences. On the other hand, the inclusion of other health habits variables show some results of interest. First, smokers do not appear to be characterized by significantly different preferences in terms of risk. In fact we do not find any statistically significant association between smoking habits and risk preferences. While our finding is robust across different specifications of the model, it should be noticed that, in our pool, only 11 subjects (less than 10% of the sample) reported to be smokers. While clearly based on very few observations, this result seems to bring some more evidence of the weak association between risk attitudes and smoking status found in Dohmen et al. (2010). Notice that our result differs from the experimental evidence by Anderson and Mellor (2008) and is also in contrast with the correlation between risk tolerance and smoking typically found in studies that use

[19] We do not find any evidence that female, or older subjects, tend to be more risk averse. On this point, for instance, Andersen et al. (2008b) report evidence that females are more risk averse; while Tanaka et al. (2010) find that older subjects are more risk averse. The lack of evidence on the second effect is probably due to the relatively small heterogeneity of our sample in terms of age.

hypothetical measures to control for risk attitudes (Barsky et al. 1997; Lahiri and Song, 2000; Khwaja et al. 2006).

Furthermore, our estimates show that subjects with healthier nutritional habits, as reflected by higher values of the *HEI* index, and subjects with lower consumption of alcohol units tend to be characterized by more risk averse profiles. Both results are robust across alternative specifications of *Models III-VI* in terms of socio-demographic characteristics included as determinants and controls. The finding of a significant, negative relation between risk aversion and alcohol consumption is in line with the experimental evidence by Anderson and Mellor (2008) and with the results by Barsky et al. (1997) and Dave and Saffer (2008) using hypothetical gambles measures from HRS and PSID surveys in the US. Results are summarized in Table 4.

[Insert Table 4 here]

6. Conclusions

We have presented the results of a laboratory experiment in which we elicit individual risk preferences for a sample of 120 subjects using real monetary payments, and combine these data with information on individual life style and health habits. The aim of the analysis is to assess whether subjects with different health habits are statistically different with respect to preferences towards risk.

Our work originally contributes to the existing literature as it combines experimental measures of individual risk preferences with a rich original dataset on individual health habits. In particular, we elicit individual risk preferences to estimate individual risk preferences. We then combine these data with information from a detailed questionnaire assessing a wide number of individual health habits, including food intakes, drinking and smoking habits, physical activities. Besides other life style measures, we construct, for each subject in the pool, an *Healthy Eating Index* as a global measure of individual nutritional balance adjusted by the total caloric intake of the subject, that complements the traditional measure of the *Body Mass Index*.

Very few economic studies have already combined experimentally measured risk preferences with information on individual health habits. Our analysis adds to the literature the following major contributions: we consider a sample of subjects with no specific health conditions; we construct an individual *HEI* index and control for a wider set of individual health habits; and we study whether estimated risk preferences differ across subjects with different health habits.

Our main result is that we find evidence that risk preferences significantly differ across subjects with different life style and health habits. In particular, while smokers do not appear to be significantly more risk seeking, subjects with more healthy nutritional balance and lower consumption of alcohol seem to be more risk averse.

The fact that the questionnaires and experimental tests were administered just at one point in time clearly makes difficult to properly deal with the causality and endogeneity issues between individual preferences on the one hand, and health habits on the other. We also reckon that our results need to be validated by a larger-scale analysis on a more heterogeneous and representative sample of subjects. Another limitation of the present experimental design is that, in order to guarantee incentive-compatible elicitation through real payments, we could only elicit time and risk preferences in a monetary domain, rather in health-related framings. Moreover, our results, and in particular the finding that smoking habits are not significantly related to risk preferences, suggest that it may be worthwhile to explicitly investigate the link between time preferences and health habits, and to also control for other, potentially relevant, individual traits and psychological attitudes, such as over-confidence and impulsivity, for instance. These are indeed the objectives of some companion work (Galizzi and Miraldo, 2010a, 2010b).

Nevertheless, our results suggest that looking at the interaction between experimentally measured risk preferences and health habits can be a promising and challenging area of investigation. Our work, for instance, seems to suggest that, once the individual risk preferences are elicited through incentive-compatible experimental tests with real payments, the often assumed correlation (Viscusi and Hersch, 2001; Hakes and Viscusi, 2007) between smoking habits and risk tolerance may not be supported by direct empirical evidence. This line of research is also susceptible of interesting policy implications. In fact, it may allow a better understanding of the underlying preferences of subjects incurring actions detrimental to their health and, therefore, help the analysis of public policies targeted at the reduction of obesity incidence, smoking and binge drinking.

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Appendix 1. Tables

Table 1: An example of choices between binary lotteries

ID	*Lottery A*				*Lottery B*				*Your Choice*	
	P	*£*	*P*	*£*	*P*	*£*	*P*	*£*	*A*	*B*
1	10%	**20**	90%	**16**	10%	**38.5**	90%	**1**	A	B
2	20%	**20**	80%	**16**	20%	**38.5**	80%	**1**	A	B
3	30%	**20**	70%	**16**	30%	**38.5**	70%	**1**	A	B
4	40%	**20**	60%	**16**	40%	**38.5**	60%	**1**	A	B
5	50%	**20**	50%	**16**	50%	**38.5**	50%	**1**	A	B
6	60%	**20**	40%	**16**	60%	**38.5**	40%	**1**	A	B
7	70%	**20**	30%	**16**	70%	**38.5**	30%	**1**	A	B
8	80%	**20**	20%	**16**	80%	**38.5**	20%	**1**	A	B
9	90%	**20**	10%	**16**	90%	**38.5**	10%	**1**	A	B
10	100%	**20**	0%	**16**	100%	**38.5**	0%	**1**	A	B

Table 2. Descriptive statistics for the health habits and socio-demographics variables across the 120 subjects

Variable	***Mean***	***Std. Dev***	***Min***	***Max***
Age	21.017	3.879	18	43
SexD	0.45	0.497	0	1
BMI	22.351	4.562	14.916	48.949
Budget	73.817	45.197	0	350
DEduc	3.466	1.079	1	5
Alcohol	2.044	2.604	0	20.357
SmokeD	0.9166	0.288	0	1
Cigs	1.916	6.832	0	60
Sleep	7.767	1.153	5	12
Sport	1.309	2.003	0	18.571
SexInter	5.192	6.829	0	30
Fruit HEI	5.652	3.07	0	10
Veg HEI	6.89	4.568	0	10
Grains HEI	2.955	3.356	0.538	10
Milk HEI	3.069	4.537	0	10
Meat HEI	9.199	2.654	0.093	10
Oils HEI	9.359	1.404	3.276	10
Sat Fat HEI	4.245	3.329	0	10
SoFAAS HEI	11.909	6.151	0	20
Tot HEI	53.182	11.336	28.409	75.254

Table 3. Correlation matrix between the health habits and socio-demographics variables across the 120 subjects.

	Age	*BMI*	*Budget*	*DEduc*	*Alcoh*	*Cigs*	*Sleep*	*Sport*	*SexIn*	*HEI*
Age										
BMI	0.114									
Budget	0.327	-0.083								
DadEduc	-0.02	-0.082	0.019							
Alcohol	-0.103	-0.028	0.001	-0.088						
Cigs	0.439	0.066	0.052	-0.039	0.135					
Sleep	-0.257	0.084	-0.166	0.004	0.130	-0.198				
Sport	0.142	0.115	0.214	0.139	-0.049	-0.011	-0.118			
SexInt	0.039	-0.099	0.027	-0.031	0.045	0.214	0.014	-0.059		
HEI	0.043	0.068	0.005	0.120	-0.458	-0.139	-0.048	0.001	0.034	

Table 4: Estimated risk preferences and effects of health habits.

	Model I	Model II	Model III	Model IV	Model V	Model VI
Constant	0.50148*** (0.01136)	0.45193*** (0.06358)	0.45262*** (0.1044)	0.45223*** (0.12932)	0.50707*** (0.0793)	0.5355*** (0.0589)
SexD		-0.00952 (0.01927)	-0.0114 (0.01953)	-0.02344 (0.02017)	-0.01754 (0.0198)	-0.01878 (0.01964)
Age		-0.000928 (0.00271)	-0.00141 (0.00286)	0.00221 (0.0031)	0.00199 (0.00297)	
BMI			0.00235 (0.00387)	0.00225 (0.0040)		
Alcohol				0.00861** (0.00412)	0.00865** (0.00388)	0.00833** (0.00361)
Sport				0.0023 (0.0036)	0.00199 (0.00355)	
Cigs				-0.0025 (0.0015)	-0.0022 (0.0015)	-0.00163 (0.00147)
HEI				-0.00156* (0.0008)	-0.00158** (0.00064)	-0.00157** (0.00061)
White-noBrit		-0.04097 (0.02878)	-0.0425 (0.02872)	-0.03687 (0.02939)		-0.0325 (0.0276)
IndianD		-0.14965*** (0.02399)	-0.14299*** (0.02674)	-0.17252*** (0.02791)	-0.16504*** (0.0238)	-0.1618*** (0.02154)
PakistaniD		0.10889* (0.05649)	0.10047* (0.05963)	0.11086* (0.05768)	0.1205* (0.05448)	0.12302* (0.05519)
OtherAsian		0.10428*** (0.04015)	0.103** (0.0405)	0.12362*** (0.04554)	0.1289*** (0.0462)	0.1251*** (0.0475)
Mixed		-0.10359 (0.10992)	-0.1190 (0.11729)	-0.11049 (0.10654)	-0.09449 (0.0979)	-0.0971 (0.0973)
OtherEthn		-0.1877** (0.08912)	-0.22452* (0.13384)	-0.27498* (0.1554)	-0.2201* (0.0994)	-0.1904** (0.0782)
Budget		0.00029 (0.00021)	0.00032 (0.00022)	0.00029 (0.0002)	0.00022 (0.0002)	0.00032* (0.00018)
DEduc		0.0187** (0.0086)	0.01807** (0.0094)	0.01677* (0.0094)	0.01545* (0.00817)	0.01862** (0.00887)
No. of obs		4650	4570	4570	4650	4650
Clusters		120	118	118	120	120

Appendix 2. Test for risk aversion as presented to subjects in the experiment.

Please, in any of the four following tables, for each row containing a pair of alternative lotteries, choose the lottery that you prefer between option A and option B.

A lottery is intended to give you an amount of pounds with some probability and some other amount with the complementary probability.

For instance, in row 1 of table 1, lottery A gives you 20 £ with probability 10% and 16 £ with probability 90%, while lottery B gives you 38.5 £ with probability 10% and 1 £ with probability 90%.

Notice that, at the end of the experiment, one of the 4 tables will be extracted, and, within the selected table, one of the 10 rows/pairs of lotteries will be selected.

One among all the participants will be randomly selected to get paid for this question.

If you will be the subject randomly drawn to get paid, you will be paid according to the actual outcome of the lottery corresponding to the option (either A or B) you have chosen within the selected row/pair in the extracted table.

Please, in each table, make your choice for each row/pair, by putting a circle around either A or B in the last columns.

Table 1

ID	*Lottery A*				*Lottery B*				*Your Choice*	
	p	*£*	*p*	*£*	*p*	*£*	*p*	*£*	*A*	*B*
1	10%	**20**	90%	**16**	10%	**38.5**	90%	**1**	A	B
2	20%	**20**	80%	**16**	20%	**38.5**	80%	**1**	A	B
3	30%	**20**	70%	**16**	30%	**38.5**	70%	**1**	A	B
4	40%	**20**	60%	**16**	40%	**38.5**	60%	**1**	A	B
5	50%	**20**	50%	**16**	50%	**38.5**	50%	**1**	A	B
6	60%	**20**	40%	**16**	60%	**38.5**	40%	**1**	A	B
7	70%	**20**	30%	**16**	70%	**38.5**	30%	**1**	A	B
8	80%	**20**	20%	**16**	80%	**38.5**	20%	**1**	A	B
9	90%	**20**	10%	**16**	90%	**38.5**	10%	**1**	A	B
10	100%	**20**	0%	**16**	100%	**38.5**	0%	**1**	A	B

Table 2

ID	*Lottery A*				*Lottery B*				*Your Choice*	
	p	*£*	*p*	*£*	*p*	*£*	*p*	*£*	*A*	*B*
1	10%	**6**	90%	**4.80**	10%	**11.55**	90%	**0.30**	A	B
2	20%	**6**	80%	**4.80**	20%	**11.55**	80%	**0.30**	A	B
3	30%	**6**	70%	**4.80**	30%	**11.55**	70%	**0.30**	A	B
4	40%	**6**	60%	**4.80**	40%	**11.55**	60%	**0.30**	A	B
5	50%	**6**	50%	**4.80**	50%	**11.55**	50%	**0.30**	A	B
6	60%	**6**	40%	**4.80**	60%	**11.55**	40%	**0.30**	A	B
7	70%	**6**	30%	**4.80**	70%	**11.55**	30%	**0.30**	A	B
8	80%	**6**	20%	**4.80**	80%	**11.55**	20%	**0.30**	A	B
9	90%	**6**	10%	**4.80**	90%	**11.55**	10%	**0.30**	A	B
10	100%	**6**	0%	**4.80**	100%	**11.55**	0%	**0.30**	A	B

Table 3

ID	*Lottery A*				*Lottery B*				*Your Choice*	
	p	*£*	*p*	*£*	*p*	*£*	*p*	*£*	*A*	*B*
1	10%	**2**	90%	**1.60**	10%	**3.85**	90%	**0.10**	A	B
2	20%	**2**	80%	**1.60**	20%	**3.85**	80%	**0.10**	A	B
3	30%	**2**	70%	**1.60**	30%	**3.85**	70%	**0.10**	A	B
4	40%	**2**	60%	**1.60**	40%	**3.85**	60%	**0.10**	A	B
5	50%	**2**	50%	**1.60**	50%	**3.85**	50%	**0.10**	A	B
6	60%	**2**	40%	**1.60**	60%	**3.85**	40%	**0.10**	A	B
7	70%	**2**	30%	**1.60**	70%	**3.85**	30%	**0.10**	A	B
8	80%	**2**	20%	**1.60**	80%	**3.85**	20%	**0.10**	A	B
9	90%	**2**	10%	**1.60**	90%	**3.85**	10%	**0.10**	A	B
10	100%	**2**	0%	**1.60**	100%	**3.85**	0%	**0.10**	A	B

Table 4

ID	*Lottery A*				*Lottery B*				*Your Choice*	
	p	*£*	*p*	*£*	*p*	*£*	*p*	*£*	*A*	*B*
1	10%	**40**	90%	**32**	10%	**77**	90%	**2**	A	B
2	20%	**40**	80%	**32**	20%	**77**	80%	**2**	A	B
3	30%	**40**	70%	**32**	30%	**77**	70%	**2**	A	B
4	40%	**40**	60%	**32**	40%	**77**	60%	**2**	A	B
5	50%	**40**	50%	**32**	50%	**77**	50%	**2**	A	B
6	60%	**40**	40%	**32**	60%	**77**	40%	**2**	A	B
7	70%	**40**	30%	**32**	70%	**77**	30%	**2**	A	B
8	80%	**40**	20%	**32**	80%	**77**	20%	**2**	A	B
9	90%	**40**	10%	**32**	90%	**77**	10%	**2**	A	B
10	100%	**40**	0%	**32**	100%	**77**	0%	**2**	A	B