Individual uncertainty about longevity[*]

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Abstract

This article presents an assessment of individual uncertainty about longevity. A survey performed on 3,331 French individuals enables us to record several survival probabilities per individual. On this basis, we compute subjective life expectancies (SLE) and subjective uncertainty regarding longevity (SUL). SUL is defined as the standard deviation of each individual's subjective distribution of his own longevity. It is large and equal to more than 10 years for men and women. Its magnitude is comparable to the variability of longevity observed in life tables for individuals under 60, but smaller for those older than 60, suggesting use of private information for older respondents. Our econometric analysis confirms that individuals use their private information, mainly their parents' survival and longevity, to adjust their level of uncertainty. Finally, we find that SUL has a sizeable impact, in addition to SLE, on risky behaviors: more uncertainty on longevity decreases significantly the probability of unhealthy lifestyles. Because individual uncertainty about longevity affects prevention behavior, retirement decisions or demand for long-term care insurance, these results have important implications for public health care and retirement policy.

Keywords: Individual Uncertainty; Expectation; Longevity.

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1 Expected longevity: uncertainty matters

For a long time, econometric analysis of choice data has been based on the assumption that decision makers have rational expectations (Manski, 2004). Yet, more accurate information about individual beliefs regarding longevity might provide a better understanding of observed behaviors, in particular, decisions relative to retirement, pension plan choice, demand for long term care insurance, prevention behavior or risky lifestyles. Another argument in favor of eliciting subjective life expectancies is that the information provided by life tables is rather limited, especially because they give little information about individual heterogeneity in beliefs. They provide information about life expectancy by gender and age only, while personal health, parental longevity and lifestyle have an influence on individual life expectancy.

Many papers study survival expectations and subjective survival probabilities. Some of the data used in this literature result from direct questions on expected longevity (Hamermesh and Hamermesh,1983; Hamermesh, 1985; Mirowsky, 1999; Mirowsky and Ross, 2000; Brouwer *et al.,* 2005). Other studies rely on subjective survival probabilities as collected by the Health and Retirement Study (HRS), the Survey of Health, Ageing and Retirement in Europe (SHARE) or other surveys (Hurd and McGarry, 1995; Liu, Tsou and Hammit, 2007; Perozek, 2008; Hurd, 2009; Peracchi and Perotti, 2011; Delavande & Rohwedder, 2011; Kutlu-Koc and Kalwij, 2013; Bissonnette and de Bresser, 2015; Post and Hanewald, 2013; Bago d'Uva *et al.,* 2017; Delavande *et al.,* 2017). Note that the data from HRS contain two questions on subjective survival probabilities, and SHARE only one survival probability for each individual, for a target-age depending on the individual's age. Most studies examining the relation between illnesses and subjective survival probabilities show that individuals make use of the available information in a rational way: illnesses have a negative impact on subjective survival probabilities and subjective survival probabilities are correlated with death rates observed afterwards in longitudinal data. Parental death appears to have an impact on subjective survival probabilities, especially for the parent of the same sex. In most papers, women report smaller survival probabilities than men despite their larger actuarial probabilities. Longitudinal data make it possible to see how probabilities are updated when there is new information (like the onset of an illness), and to examine the correlation between probabilities and corresponding outcomes observed in subsequent waves. Hurd (2009) and Delavande & Rohwedder (2011) show that expectations are well correlated with outcomes.

Most of the existing studies focus on average expectations by subgroup. There are few papers on the inter-individual dispersion of expectations (Post and Hanewald, 2013), and to our knowledge no study on subjective uncertainty at the individual level[1]. In a theoretical paper, Edwards (2013) argued that it is important to know how uncertain individuals are about their longevity because this is a component of well-being alongside subjective life expectancy which is only an expected value. The survey results of Delprat et al. (2015) confirm that individuals are risk averse with respect to the longevity risk. This risk is also likely to be of major

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[1]Post and Hanewald (2013) make an indirect estimation of subjective uncertainty on the basis of saving behavior.

importance to understand, for instance, demand for annuities, prevention behavior and retirement decisions. For instance, in a theoretical paper, Kalemli-Ozcan and Weil (2010) show that if subjective uncertainty about longevity is large enough, an increase in life expectancy may induce people to retire earlier rather than later because they may be sensitive to the increased probability of enjoying retirement.

Our purpose is to focus on individual uncertainty on longevity. We have collected original data through a survey performed in 2009 on a representative sample of 3,331 French people aged 18 or more.

For each individual, the survey design recorded up to five subjective survival probabilities for several target-ages depending on the individual's current age: 50, 60, ..., 90. We use these elicited probabilities to build indicators of subjective life expectancy (SLE) and of individuals' subjective uncertainty regarding their longevity (SUL). SLE is defined as the first moment of each individual's subjective distribution of his or her own longevity. SUL is defined as the standard deviation of this distribution. In addition, the survey provided detailed information about objective health indicators (illnesses and disabilities), and a subjective indicator of self-assessed health (SAH). Like us, Wu et al. (2015) elicited several survival probabilities per individual. However, to the best of our knowledge, it is the first time that direct empirical estimates of individual uncertainty regarding length of life are provided.

This paper (i) provides a measure of individuals' uncertainty on longevity (SUL) and (ii) studies subjective uncertainty on longevity. We address the following questions: is SUL particularly large? Does it vary with private information like diseases and parents' death? Is it correlated with individual risky behaviors?

In section 2, we discuss the meaning of uncertainty in the context of a survey designed to elicit subjective survival probabilities. Our indicator can measure probabilistic risk, but also ambiguity for individuals whose beliefs do not take a probabilistic form. Moreover, the recorded probabilities can be affected by elicitation problems that introduce noise.

We summarize our survey methodology in section 3 and describe the main features of our data in section 4. Our results on subjective life expectancy (SLE) are in accordance with the results of the existing literature, which makes us confident in the quality of our survey.

Together with a noticeable between-individual variability of subjective life expectancy (SLE), we find that individual uncertainty relative to length of life (SUL) is equal on average to more than 10 years for men and women. Comparing the average SUL to the variability of ages at death observed in life tables for the whole population, we find that SUL is of the same magnitude as the population variability of ages at death for people aged 40 to 60. Yet, the result is different for respondents older than 60, who are more certain about their longevity expectations, suggesting use of private information. This finding indicates that subjective uncertainty about longevity provides information that is different from and additional to life tables.

In section 5 we use a simple regression approach examine how subjective life expectancy and uncertainty on longevity vary with indicators of health, socioeconomic characteristics, lifestyles and parents' death. Interindividual heterogeneity in SLE is partly explained by these variables. The estimated impacts of illness and risky behaviors confirm that people are rational in adjusting their expectations to available information. Regarding SUL, the estimates show how individuals use their private information to adjust their uncertainty. One remarkable finding is that the main determinant of SUL are the variables related to parents' - and, more precisely, fathers' survival and longevity. This confirms that part of individual uncertainty is based on the longevity or survival that individuals observe in their group of reference.

In section 6, we examine if uncertainty, i.e. SUL, adds something to subjective life expectancy (SLE) for the understanding of individual behaviors regarding unhealthy lifestyles. We do not intend to make any causal interpretation of our results and analyze them as correlations only. We find that more uncertainty significantly decreases the probability of unhealthy lifestyles, especially for men (and for men and women as concerns tobacco use). These results show that SUL has a sizeable impact, in addition to SLE, on risky behaviors.

In section 7, we conclude by reexamining issues in public health and retirement policies in the light of our results, arguing in particular that they may explain why reforms increasing retirement age may face strong resistance.

2 Probabilistic risk and ambiguity

Our survey enables us to elicit several survival probabilities at the individual level. We use these survival probabilities to build our measure of individual uncertainty regarding length of life.

The term "uncertainty" has several meanings: it can be used for probabilistic risk and for ambiguity. In our framework there can exist three types of uncertainty: (i) Individuals might be quite aware of their survival probabilities and the resulting distributions imply a degree of risk relative to longevity; (ii) Individuals might be ignorant or uncertain about their survival probabilities (ambiguity); (iii) The recorded probabilities are affected by elicitation problems that introduce noise (such as focal points answers).

In our survey, individuals are presented with intervals of probability values. For individuals whose ambiguous beliefs do not take a probabilistic form at all, this is a constraining exercise which forces them to come up with probabilistic ranges on the spot. For individuals whose ambiguous beliefs already take the form of probabilistic ranges, the exercise is easier but may still be difficult if their probability ranges do not coincide with the intervals proposed in the questionnaire. Their choice of a particular interval may involve some noise. Both of these cases suggest that ambiguity in beliefs is likely to be accompanied with greater noise in the answers. In contrast, for individuals with precise probabilistic beliefs, the questionnaire does not constrain their thinking, though their answer may still be subject to noise (e.g., recall problems, focal points). We expect very few respondents, if any, to fall in the third category, but it seems clear to us that noise and ambiguity will be associated in our survey, where we have not tried to directly elicit ambiguity in beliefs. As shown below, we think focal point problems are limited in our context.

Given this clarification, what are the possible drivers of between-individual differences in uncertainty about longevity? Of course, this uncertainty is based on the fact that, in reality, age at death varies widely across people born the same year. People observe in their relatives of the same age and behavior as them a variability of ages at death. They identify with a group of peers, and adjust their beliefs regarding survival probabilities to what they observe in the group. Another source of variability is individual private information about personal characteristics (genes) and behavior (e.g. smoking [2]). Last, there is between-individual variability in uncertainty attributable to the sources of ambiguity: differences in personality and cognitive traits guiding the thought process leading from piecemeal knowledge to the best probability guess for the questionnaire.

The contribution of this paper is to study subjective uncertainty on longevity (SUL), and address the following questions: Is SUL particularly large? Does SUL vary with socioeconomic characteristics, diseases, and parents' death? Is SUL correlated with individual behaviors regarding unhealthy lifestyles or health insurance enrollment?

The survival probabilities elicited by our survey enable us to build indicators of subjective life expectancy (SLE) as well as individuals' subjective uncertainty regarding their longevity (SUL). Whereas our main focus is uncertainty about longevity, we will devote some attention and analysis to subjective life expectancy (SLE) for two reasons: first, a comparison of our results with the existing literature will enable us to validate our approach and survey; second, we are interested in the

[2] Being a smoker increases the risk of lung cancer, which reduces the length of life dramatically. Since the cancer onset is not certain, this may increase personal uncertainty on longevity.

relationship between SUL and SLE.

3 Data

3.1 The survey

Our data come from an original survey, representative of the French population. 3,331 individuals aged 18 or more were interviewed in 2009 using a computer-assisted face-to-face personal interviewing (CAPI) technique.

The questionnaire first contains the usual questions about age, gender and socioeconomic characteristics, such as education, individual and household income, insurance coverage. A lot of attention is devoted to health status, with detailed questions on specific illnesses, on self-assessed health, and on the individual's lifestyle (smoking habits, alcohol consumption, height and weight). The questionnaire then elicits subjective probabilities of survival at different ages and subjective joint distributions of income and health for future decades. The survey provides rich information on individual trade-offs between income and health (equivalent income as in Fleurbaey et al., 2013; Schokkaert et al., 2014; Samson et al., 2017), as well as on individual expectations relative to three dimensions: income, health and longevity. The present paper focuses on subjective expectations and uncertainty relative to longevity. A companion paper (Luchini et al., 2017) studies subjective expectations about future income and future health.

3.2 Elicitation of subjective survival probabilities

Our strategy to elicit subjective survival probabilities follows Hurd and McGarry (1995) and Liu, Tsou and Hammitt (2007). Respondents are asked about their chance of being alive after a given age. For a respondent younger than 51, the first question is as follows:

"In your opinion, what is the percent chance that you will live beyond the age of 50?"

A scale is submitted to the respondent, with 14 values: 0%, 5%, 10%, 15%, 20%, 25%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%. Only one answer is allowed ("don't know" and "refusal" options are offered). To improve our knowledge on subjective survival probabilities at old ages we offer more probabilities at the bottom of the scale, where many individuals will respond for their end-of-life ages.

Once the respondent answered the first subjective survival question, he or she was asked the same question again but for "more than 60", and then for the next decades up to "more than 90". As a result, respondents younger than 51 were asked five subjective survival questions, people between 51 and 60 were asked four questions and people between 81 and 90 one question only. In the survey design, follow-up questions are constrained: probability values strictly greater than the answer given to the previous question are not proposed[3]. Therefore, subjective survival probabilities are weakly decreasing with age by construction.

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[3]This constraint, also imposed in Delavande and Kohler (2009), is not common; for example, it is not found in HRS. However, the main advantage of this contraint is that is allows us to get usable answers for a larger part of the respondents.

Let x_i denote the age at death of respondent i ($x_i = i$'s length of life). For a person under age 51, five probabilities are recorded:

$$\begin{aligned} &p_{50,i} = \Pr(x_i > 50)\,,\ p_{60,i} = \Pr(x_i > 60)\,,\ p_{70,i} = \Pr(x_i > 70)\,, \\ &p_{80,i} = \Pr(x_i > 80)\,,\ p_{90,i} = \Pr(x_i > 90)\,. \end{aligned} \tag{1}$$

For a person aged 75, for instance, only $p_{80,i}$ and $p_{90,i}$ are recorded.

Computing differences between two adjacent probabilities leads to $\widehat{p_{j,i}}$, the subjective probability of death in decade j. Three asumptions are used to compute these probabilities and SLE and SUL for each respondent. More details can be found in section 1 of the online appendix.

Assumption 1: All respondents will live up to 40: $P(x_i > 40) = 1$.

Assumption 2 : No respondent will survive after 100: $P(x_i > 100) = 0$

Assumption 3: If the respondent is supposed to die in a given decade, he/she is supposed to die at the average age of death within the corresponding decade observed for people of the same sex in the population.

The expected value of x_i is defined as:

$$E_i(x_i) = \sum_j \widehat{p_{j,i}}\ x^j \tag{2}$$

where x^j is the average age at death for people who die in decade j, as given in Assumption 3.

The variance is given by:

$$V_i(x_i) = \sum_j \widehat{p_{j,i}}(x^j - E_i(x_i))^2, \quad (3)$$

In summary, subjective life expectancy (SLE_i) and subjective uncertainty about longevity (SUL_i) are defined as follows:

$$SLE_i = E_i(x_i); \quad SUL_i = \sqrt{V_i(x_i)}\ . \quad (4)$$

Note that, because of discretization, (2) and (3) are likely to provide only approximations to the true expectation and variance of individual length of life.

Figure A1 in the appendix gives an intuitive understanding of the relation of our measure of individual uncertainty (SUL) with elicited probabilities. For individuals with similar subjective life expectancy (comprised between 60 and 70), people with high uncertainty declare probabilities of death that are rather even across decades, whereas people that are more certain place a higher probability in one decade.

SLE_i and SUL_i can only be computed for individuals who answered all survival questions. Removing people who refused to answer at least one of the survival questions leads to a sample of 2,856 individuals, i.e. 85.9% of the initial sample[4]. We checked that our conclusions are not affected by a selection bias.

[4] The response rate is very similar between men (86.6%) and women (85.5%) and decreases with age (e.g. 91% for individuals aged 50 versus 79.8% for individuals between 81 and 90). Detailed statistics regarding response rates are given in the Appendix.

3.3 Information about health

Our survey includes detailed questions on specific diseases that the respondent might have experienced in the previous 12 months. The questions concern 45 illnesses grouped into 15 groups of diseases (e.g. respiratory, cardiovascular, ...). In addition, the respondent could add any other illness; the corresponding verbatim were recoded in ICD-10 thanks to expert assessments by a team of three doctors. Given the large number of illnesses observed, we decided to classify them according to two criteria: whether they are chronic or not and whether they might threaten life in the short run or not. As a result, all illnesses were classified by our team of doctors into the following four categories, named hereafter vital risk variables[5]:

- N: Illnesses that do not shorten or threaten life (e.g., lumbago);
- A: Acute illnesses → immediate death risk (e.g., depression);
- C: Chronic condition → reduction in the length of life, but no immediate death risk (e.g., hypertension, diabetes);
- AC: Acute and chronic illnesses → immediate death risk and length of life reduced (e.g., asthma, myocardial infarction).

Our survey also contains questions on disability in the last 12 months, measured by functional limitations. At the end of that section came an overall question on

[5]Their methods and results are described in Bahrami *et al.* (2011). The classification is detailed in Table A.1 in the online appendix.

self-assessed health (SAH_i) on the basis of a visual scale going from 0 to 100. So, we have at our disposal a subjective measure of health and detailed objective indicators relative to illnesses and disabilities.

Our motivation to create the vital risk categories stems from the goal to examine the link between illnesses, SAH, SLE and SUL. SAH is generally considered a good predictor of death risk. But the link between SAH and death risk might be more complex, as shown by Case and Paxson (2005), because some conditions are painful (arthritis, lumbago, anxiety, etc.) but do not threaten life, while other diseases are not so painful, but have a larger impact on death rates (heart diseases).

4 Descriptive analysis

4.1 Basic features of the data

Table 1 displays the means of variables used in our econometric analysis. The means are computed for men and women separately, with the p-value of the test for difference between men and women.

The socio-demographic characteristics confirm that the sample is representative of the French population as concerns education, income and coverage by health insurance[6] (Schokkaert et al., 2014).

Table 1 shows that women are more affected than men by illnesses of type N,

[6]National Health Insurance covers all people in France, but the coverage is partial. In addition, individuals can subscribe to a complementary health insurance, mostly on a voluntary basis. Free complementary health insurance, named CMUC (Couverture Maladie Universelle Complémentaire) is provided to low-income indi-

that spoil life without shortening it: 53 % of them have 3 or more illnesses of type N, in contrast with 36 % of men. Women also have significantly more acute (type A) and acute and chronic (type AC) diseases than men. Otherwise, we do not observe significant difference between men and women in the prevalence of chronic (C) diseases[7]. Regarding functional limitations, all indicators show that women are significantly more affected than men by activity limitations and pain.[8].

Table 1 and Figures A.3 to A.5 (online appendix for the Figures) display information on lifestyles. Women seem to be more "virtuous", showing a significantly smaller proportion of smokers or drinkers than men[9]. On the other hand, the proportion of people who are obese, severely obese, or with normal weight is not

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viduals.

[7]Table A1 and Figure A2 in the online appendix give more details : men and women are not affected by the same illnesses of type AC. Women have more asthma, whereas men have more heart diseases, which is in line with Case and Paxson (2005). Regarding the most prevalent illnesses of type C, except hypertension, we observe that the prevalence of cholesterol, bronchitis and diabetes is not significantly different for men and women. Note that the difference in the prevalence of illnesses between men and women could also arise from the selection effect of mortality, but we cannot observe it.

[8]Note that all variables presented in table 1 are based on self-reporting. In the paper, this information is deemed objective, although we know that it is not always reliable.

[9]An individual is defined as a "smoker" if he/she currently smokes. For alcohol consumption, women belong to the "no risky behaviour" category if they take less than 14 drinks per week. For men the limit is 21 drinks per week.

significantly different between men and women. A significant difference is observed for overweight, which is more frequent for men (34 %) than for women (22 %), and for underweight, which is rare altogether, but more frequent for women (5 % versus 1% for men).

Parental death is an item of information that can influence individual beliefs regarding survival probabilities (Hurd and McGarry, 1995; Liu, Tsou and Hammitt, 2007). The figures in table 4 give a striking picture of the mortality differential between men and women: half of the respondents have lost their fathers, and one third their mothers[10]. Especially, the age at death of fathers is on average lower than the age at death of mothers. Standard errors of the ages of surviving fathers or mothers, or of their age at death show that there is variability, hence individual information that can be useful for our respondents to form their survival expectations.

4.2 Subjective survival probabilities

Figure 1 displays our raw information for men and women, i.e., the distribution of subjective survival probabilities $p_{50,i}, ..., p_{90,i}$ defined by (1) and given by respondents younger than the target (e.g., the distribution of $p_{60,i}$ among people aged 60 and below). These figures are rather similar for men and women and show a noticeable dispersion. While there is a mode at $p_{j,i} = 1$ for younger target ages, the

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[10]This difference in the proportion of deceased fathers and deceased mothers can result also from the fact that, in married couples, men are generally older than their wife.

spread is larger for target ages beyond 70. When people get older than 70, they differ more in their assessments regarding their survival chance[11].

Elicited probabilities may suffer from focal point biases towards 0, 1 or 0.5. Hurd (2009) emphasizes that there might be a tropism of elicited probabilities towards 50 %, resulting in an understatement by respondents when the true probability is greater than 50 %, and an overstatement when it is lower than 50 %. We think focal point problems are limited in our framework because of our formulation of the survival questions, and because of our results. First, the formulation of our questions gives an explicit list of 14 possible probabilities, which limit focal answers. Indeed, contrary to an open question requiring a probability in the interval [0,100], there is no salient option in the middle like fifty/fifty, and whatever attractive position respondents may have in mind is spread among many options. In addition, as stated above, we give more options for low probabilities, which pushes 50% from the middle to the right of the list[12]. Second, our results show indeed a small

[11]Figure A6 in the online appendix shows the distribution of these subjective probabilities for people less than ten years younger than the target age (e.g., the distribution of $p_{60,i}$ among people aged 51-60). Note that the spread in these probabilities is reduced compared to figure 1, but only slightly.

[12]We can compare our distribution of probabilities to the one observed in SHARE, that only proposes one open question about survival, requiring a probability between 0 and 100%. Using SHARE wave 2, we find that only 5% of respondents gave a probability that is not part of our list of 14 values. Restricting the list to 14 probabilities does not constrain too much the respondent compared to what is commonly done in other surveys.

peak around 0.5, especially for target ages beyond 70 (Figure 1). However, we have checked Hurd's hypothesis by comparing average subjective probabilities by age and target age to the life table corresponding survival probabilities (see the online appendix). We find that Hurd's hypothesis does not hold for females, as they systematically underestimate their survival probabilities, even when the true probability is lower than 50 %[13]. Moreover, we do not think our data suffer from focal point biases towards 0 or 1. Figure 1 does not show such focal bias: the proportion of probabilities equal to 1 decreases with the target age, a result that is not induced by any constraint in the survey design.

4.3 Subjective life expectancy and uncertainty

The average values by age of our variables of interest SLE and SUL, and of SAH, are displayed in Figure 2, for men (blue continuous line) and women (red dashed line).[14] Sample means and standard deviations for the three indicators can be found

[13]Elicited probabilities for men might however suffer from a bias towards 0.5, which can induce an overstatement of SUL. A paper by Gan et al. (2005) proposes a Bayesian method for the correction of focal-point biases. We cannot implement this method because it relies on the observation of deaths (which is not possible with our cross section). Anyway, we think that this correction is not pertinent in our case: it implies removing elicited probabilities equal to 0 and 1, ie. exclude answers related to subjective certainty which are precious for our analysis.

[14]The curves derive from locally weighted scatterpoint smoothing, the smoothed values being obtained through a linear regression of our variable of interest on age, giving more weight to the closest observations of each point. For readability of the

at the bottom of Table 1.

As expected, SAH is continuously decreasing with age (figure 2). As in Case and Paxson (2005), women set their SAH at a lower average level than men. However, this difference appears significant only for women younger than 55.

SLE is increasing with age, i.e. individuals update their expectations when they survive to older ages. The dotted lines on Figure 2 give life expectancies (LE) provided by the life tables for year 2009, the year of our survey (French National Institute of Demography) which are based on the mortality rates observed in 2009 for each generation. There is a large gender gap in life table LEs[15]. Yet, this gender gap is not reflected in SLE: male and female SLE are very close at every age, except for a slight but significant difference between 40 and 55 years old (figure 2).

Males and females are both pessimistic: they underestimate their SLE, in comparison with life table LE. The underestimation decreases with age, and becomes non-significant after the age of 70 for men [16]. This pessimism for both genders is often found in the literature but not always.[17] There is no evidence of pessimism

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SLE-LE figure, confidence intervals are only provided for men.

[15]Actually, France is one of the countries with the largest gender gap in LE at birth. It amounts to 6.7 in 2010, to be compared to 3.9 in the United Kingdom, 5 in the USA and 6 in Japan.

[16]Notice that the underestimation might be more important than what appears on the figure: the official statistics are computed on the basis of mortality rates observed in 2009 and do not incorporate future progress in longevity.

[17]To check the robustness of our results, we used French data from SHARE

for US men with HRS data (see Hurd and McGarry (1995)). However, Wu et al. (2015), on a sample of Australians, show that men and women are both pessimistic about survival probabilities, and that this pessimism is attenuated or disappears for men aged more than 70, a result very close to ours. We find that pessimism is much larger for females than for males, a result commonly found in the literature using subjective survival probabilities (Hurd and McGarry, 1995; Liu, Tsou and Hammitt, 2007; Hurd, 2009; Delavande *et al.* (2017)), or direct assessments of longevity (Mirowsky, 1999).

We observe a noticeable between-individual variability in subjective life expectancy, as shown by the standard deviation by age of SLE displayed in Table 2: it is equal to 10.8 years for men aged 40. It is decreasing with age, but still equal to 6.2 years for men aged 60. Actually, this variability is of the same magnitude as the standard deviation of age at death, computed from life tables for 2009.

The subjective uncertainty on longevity SUL is defined as the standard deviation of the individual's subjective distribution of longevity. The sample mean of SUL is around 10 years and is not significantly different between men and women (Table 1). It is close to 12 years for people aged 40 and still equal to 9 years for people aged 60 (Figure 2). Quite logically, SUL is decreasing with the respondent's age: when he/she is getting further on his/her survival curve, the range of pos-

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for the corresponding period, i.e. wave 2. As in our sample, we find that men and women underestimate their survival probabilities with no significant difference between them with respect to their subjective survival probabilities. Detailed results are available on request.

sible values for longevity is indeed decreasing. When it is normalized by remaining life expectancy, however, SUL is increasing with age, then flat after the age of 55 (Figure 2).

How can we appraise the value obtained for SUL? Does it mean that our respondents are subject to a large uncertainty regarding their longevity? To examine this question, we first compare the value of SUL with the standard deviation of age at death, as observed in life tables for the whole population. Table 2 displays the average SUL for men and women aged 40, 50, ...80, and the corresponding standard deviations of age at death computed from life tables in 2009 (we used the same definitions for decades).

We find that the average SUL is of the same magnitude as the population variability of ages at death for people aged 40 to 60. However, the result is different when our respondents get older, reaching the age of 70 or 80. Their uncertainty is then lower than what can be measured from life tables: for men and women aged 80, the average SUL is less than half of the standard deviations of age at death in life tables (table 2). This can be explained by the fact that individuals have better private information about their inherited health, their current health and risky life styles. This information is more likely to come after 60, when parents' or friends' deaths are more frequent, and can be associated with chronic diseases that are diagnosed mostly after 50. On the whole, this result indicates that subjective uncertainty about longevity provides different and additional information to life tables.

These individual SUL might still represent a sizeable amount of uncertainty.

To examine this, we compute individual confidence intervals at 95% for longevity $CI_i = [SLE_i \pm 2SUL_i]$,[18] and look at the values of their lower and upper bounds for individuals of given age groups. For individuals aged 50 and less, the average confidence interval bounds are $[50.1; 101.5]$ Examining the distributions of the CI bounds, we find that the third quartile of the lower bound is equal to 60.0 and that the first quartile of the upper bound is equal to 96.7. Hence 75% of individuals place their lower bound lower than 60 years, and 75 % place their upper bound higher than 96.7 years. These calculations indicate that for young people SUL is on average large enough for these confidence intervals to cover the span of possible lengths of life[19]. This is true for people aged 50 and less, and also for people aged 51 to 60.[20] But when our respondents are older, the uncertainty is reduced and the confidence intervals are more narrow, with for instance average bounds equal to $[86.1; 94.8]$ for people older than 80.

To sum up, we find results that depend on the age of our respondents. People younger than 60 have a subjective uncertainty of the same magnitude as the statistical mortality risk observed in life tables. This uncertainty level can be deemed

[18]The distribution of SLE is close to the Normal distribution, with Skewness equal to - 0.7 and Kurtosis equal to 3.3.

[19]Note that this does not rule out variations accross individuals as regards their level of uncertainty, as shown below.

[20]For people aged 51 to 60 years, the corresponding figures are $[57.9 - 97.1]$ for the average CI bounds, 63.5 for the third quartile of the lower bound and 91.9 for the first quartile of the upper bound.

important by our respondents, since it implies confidence intervals that cover the span of possible lengths of life. On the other hand, older respondents are more certain about their longevity expectations, suggesting the use of private information.

Last, it is interesting to examine the relation between SLE and SUL. Figure 2 (fifth panel) shows that SUL evolves like an inverted U with respect to SLE. We find that pessimistic and optimistic people are characterized by a reduced subjective uncertainty. Conversely, people in the middle are more uncertain[21]. This can be observed also when we look at the distribution of SUL for different levels of SLE, as shown by Figure 3. We observe sizeable variations across individuals as regards their level of uncertainty and we see clearly that pessimistic people (with SLE lower than 60) and optimistic people (with SLE between 80 and 90) have smaller uncertainty, contrary to people with medium subjective life expectancies.

5 Do Subjective life expectancy and Uncertainty on longevity vary with socioeconomic characteristics, diseases, lifestyles and parents' death?

In this section we examine how subjective life expectancy and uncertainty on longevity may vary with indicators of health, socioeconomic characteristics, lifestyles and

[21]This result is not trivial as shown by graph A1 in the appendix, and we can also exhibit graphs of distribution of SUL for a unique level of SLE.

We find the same inverted U shape for the relation between SLE and SUL when we focus on people ages 50 or less, so it is is not due to people's age.

parents' death. As it is the case in research on survival expectations, our estimates cannot be interpreted as measuring causal impacts since subjective expectations are likely to be correlated with behaviors through unobserved variables (Delavande *et al.* (2017)). Causation in multiple directions is likely to occur for lifestyles. For instance, respondents in bad health may smoke or fail to exercise because they are pessimistic about their longevity prospects. In this section we analyze the correlation between of SLE and SUL and several "determinants". In the next section, we will examine how SLE and SUL are associated with unhealthy lifestyles.

Actually, it is possible to formalize these multiple causations by considering that individuals choose between bundles of health and behaviors and have beliefs regarding the probability of various bundles. The interdependence between behaviors (risky lifestyles or insurance and prevention decisions) and beliefs can be explored using the following model[22], where individuals maximize their expected utility :

$$\sum_{(h_i,b_i)\in Z_i} p_i(h_i,b_i)u_i(c_i(h_i,b_i),h_i,b_i)$$

where b_i is a particular behavior (e.g., smoking), c_i is their consumption level and h_i their longevity. The function $p_i(.)$ is the belief function giving the probability of various bundles of health and behavior, and $u_i(.)$ is the utility function bearing on these bundles and the consumption that they make possible. The function $c_i(.)$ depicts the budget possibilities of the individual under a particular combination of health and behavior. Z_i is the set of possible health-behavior bundles that the individual may obtain, and includes both constraints on the choice of behavior b_i,

[22]To simplify, we focus on a one-shot model, which can be easily extended to a life cycle perspective.

and possibilities about health outcomes h_i.

The function $p_i(.)$ reflects how the individual sees the health-behavior possibilities open to her. In particular, adopting a particular behavior b_i alters the probabilities of health outcomes. This function is shaped by two main sets of factors: the objective circumstances of the individual, such as her initial health condition, genetic endowment, environment; the individual's cognitive dispositions such as her information about the incidence of health conditions under various behaviors, optimism, and various cognitive biases.

This simple model shows that beliefs and behaviors are interdependent, and co-determined by the circumstances, the cognitive dispositions, and the preferences of the individual.

5.1 Empirical specification

We estimate separately for women and men a three-equation model "explaining" the individual's SAH_i, SLE_i and SUL_i:

$$\begin{array}{ll} \text{(I)} & SAH_i = \alpha_1' VR_i + \beta_1' X_{1,i} + \delta' Z_i + u_{1,i} \\ \text{(II)} & SLE_i = \gamma_2' SAH_i + \alpha_2' VR_i + \beta_2' X_{2,i} + u_{2,i} \\ \text{(III)} & SUL_i = \gamma_3' SAH_i + \alpha_3' VR_i + \beta_3' X_{2,i} + u_{3,i} \ , \end{array} \quad (5)$$

with $(u_{1,i} \ \ u_{2,i} \ u_{3,i})' \sim N(0, \Sigma)$ where Σ can be a non-diagonal matrix. The vectors $\alpha_1, \beta_1, \delta, \gamma_2, \alpha_2, \beta_2, \gamma_3, \alpha_3$ and β_3 are the parameters to be estimated.

In equation (I), SAH_i is explained by vital risk variables, by $X_{1,i}$, which includes a quadratic function of age, socioeconomic variables (education, income and insurance coverage) and variables characterizing the individual's lifestyle, and by Z_i, the functional limitations experienced by the individual. SLE_i and SUL_i are explained by the subjective and objective indicators of health, SAH_i and VR_i, and by a set of regressors $X_{2,i}$ which contains the variables $X_{1,i}$ and information about the individual's parent death. We introduced four categories for fathers and mothers: alive or dead, with age unknown or not. Moreover, when the age is known, we introduced the age of death (or current age for alive parents) as a cross effect with the death (or with the fact the parent is alive).[23] We supposed that information about parental death and age at death does not influence SAH and this is confirmed by preliminary regressions.

Most variables $X_{1,i}$, $X_{2,i}$, VR_i and Z_i are components of the private information used by the individual to build her beliefs regarding her subjective life expectancy and uncertainty.

The disturbances $u_{1,i}$ $u_{2,i}$ and $u_{3,i}$ between the 3 equations are likely to capture unobserved heterogeneity that might explain SAH_i, SLE_i and SUL_i: individual's information about health (hereditary diseases) or lifestyle not recorded in the survey, heterogeneity in pessimism/optimism or in the personal weights given to vital risks and lifestyle, for instance, to form the subjective assessment of health and survival probabilities. Our specification allows for correlations between the three

[23]Several specifications of the information relative to parents' death were considered, including the use of difference between parents' age of death and respondent's current age, as well as the difference between ages at deaths of parents, when both are dead.

disturbances. Investigations detailed in the appendix section 4 allowed us to reject the possibility of selection bias and not to reject the exogeneity of SAH_i for the SLE_i and SUL_i equations. Hence, we rely on a GLS estimator that allows for heteroskedasticity and correlations between the disturbances of equations (I), (II) and (III) in model (5).

5.2 Results

5.2.1 Self assessed health

Columns 1 of table 3 presents the estimates of equation (I) for women and men. To appraise these estimates, the reader should keep in mind that average SAH is 72 for women and 76 for men on a 0-100 scale. Note that examining the determinants of SAH is not the focus of this study, but it enables us to check the validity of the survey.

The impacts of vital risks are detailed in the appendix, section 4.4. They appear to be significant and quite large. Some are valued similarly by men and women, some others have very different impacts on men and women SAH.

The coefficients of the lifestyle variables show that women and men are aware of the deleterious impacts of smoking, overweight and obesity on health, and value the impact of these lifestyle variables on SAH identically. Men are a bit more aware about smoking: the estimated loss in SAH is 3.3 points for men and 2 points for women. Conversely, women ascribe greater losses in SAH for BMI problems. For alcohol, the only significant impact is a positive one: + 3 points for a non risky alcohol consumption by women (but not men)[24].

Finally, socio-economic variables indicating a low social position are correlated with a significantly lower SAH: having less than a high school diploma for women (-3.9 to -6 points), an income below 875€ for men and women (-2.4 to -4 points) or being CMUC beneficiary for men (-5.2points).

5.2.2 Subjective life expectancy

Results concerning SLE (equation (II)) are presented in columns 2 of table 3. The average SLE is 78.8 years for women and 77.3 years for men with standard deviations equal to 9.7 for both women and men (see table 1). Individuals take SAH into account when determining their survival probabilities: SAH has a significant positive impact on SLE. A 10 point increase in SAH raises SLE by 0.8 year for women and 1.1 year for men.

In this equation, the estimated impacts of vital risks and lifestyle on SLE are direct effects that come on top of the indirect impacts via SAH in equation (I). For women, having one illness of type AC or at least one illness of type A reduces SLE by 1.3 year. For men, illnesses of type AC have no significant impact on SLE, whereas having at least one illness of type A shortens SLE by 2 years. Interestingly, both women and men ascribe a high loss in life expectancy to having 2 or more illnesses of type C: they respectively associate a loss in SLE equal to 2.7 years and 1.9 year (which appear to be not significantly different). If we compute the total effect of

[24] This result is consistent with the WHO advice relative to the admitted level of alcohol consumption

having 2 or more chronic illnesses (direct effect + indirect effect through SAH) one finds a loss of 3 years for women and men. An interesting result is that illnesses of type N have no impact on SLE for men and women[25]. The fact that individuals do not adjust their survival probabilities (and, accordingly their SLE) with respect to illnesses of type N but expect a sizeable reduction for chronic diseases suggests that they are reasonably well informed regarding the impacts of illnesses on longevity[26].

A similar rational use of information is suggested by the estimated impacts of lifestyles. Individuals believe that smoking reduces life expectancy by 1.9 and 2.3 years, respectively, for women and men. Taking into account the indirect impact through SAH, one finds total reductions in SLE equal to 2.1 and 2.6 years respectively, for women and men. These effects may seem small in comparison to epidemiological results that exhibit a loss in LE equal to 6 years at 50 (and to 3 years at 60). However, in our multivariate analysis, part of the impact of smoking is captured by the impact of education level, income, BMI problems and drinking. Comparing the mean SLE directly between smokers and non smokers, we find significant differences of 5.7 and 5.8 years for men and women, i.e., losses in SLE that are consistent with the epidemiological results. Only men appear to be conscious of the influence of heavy drinking on longevity (2.3 year reduction in SLE), while the

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[25] The categorization of the illnesses in N, C, A or AC has not been communicated to the respondents, nor the information that a given illness does or does not shorten or threaten life.

[26] It also increases our confidence in the self-reported answers given by the respondents.

positive estimated impact of non risky alcohol consumption on expected longevity for men and women suggest that their beliefs are in accordance with epidemiologic results promoted by French wine producers. The results for BMI are striking. As we have seen, BMI problems lead to a much lower SAH - and have through this channel also a negative effect on SLE. On top of that indirect effect, however, individuals are not aware that a high BMI could directly shorten life. On the contrary, after controlling for SAH, obese women expect 1.7 more life years than other women. Although the sum of the direct and indirect effects remains negative, this result suggests that obesity for women has a larger effect on the perceived quality than on the perceived length of life[27].

Some studies have shown that the longevity of same-sex parent has an influence on the individual's perceived survival probabilities (see for instance Liu et al., 2007). We find a different result: the survival and longevity of fathers and mothers are only weakly correlated with the subjective life expectancy of our respondents. Women SLE are not influenced by any of the parent death variables. For men, SLE is positively correlated with theirs fathers' survival (+ 5 years if we consider the average age of surviving fathers of men (63.7, see table 1)) and mothers' survival (but only if their age is unknown, which concerns very few individuals.

Finally, the impacts of socioeconomic variables show that individuals with low education or low social position foresee a shorter life for themselves: women with income below 875 €, or a junior high school diploma, have a reduction in SLE

[27] Once again, endogeneity of lifestyle may also play a role —for instance if some of the less healthy women are more careful about their weight.

equal to -1.2 years; men that are CMUC beneficiaries have a reduction in SLE of - 4.5 years.

On the whole, our respondents have adjusted their survival probabilities in relation to their illnesses, lifestyles and social position. The resulting variations in SLE correspond to the known impacts on actual longevity measured by epidemiological studies. Our results show that people make the difference between illnesses that threaten life and illnesses that do not, and that they form their expectations on the basis of information that is consistent with the observed correlation between social position and longevity.

5.2.3 Subjective uncertainty on longevity

Results concerning SUL are displayed in columns 3 of table 3. On average, SUL is equal to about 10.5 years for men and women. As already explained, age has a mechanical negative impact on SUL. Otherwise, the results show us how individuals use their private information to form their expectations. The fact that some of the regressors have a significant impact suggest that our measure of uncertainty is not only attibutable to ambiguity. Indeed, computing the Fisher statistic to test for the significance of all variables except age, we find small but significant Fisher statistics equal to 1.49 for women ($p=0.029$) and equal to 2.11 for men ($p=0.0001$).

One remarkable result is the fact that the variables that have the highest impact on SUL are the variables related to parents' - and more precisely, fathers' survival and longevity (mothers' survival and longevity have however a very limited impact, which is surprising). They have large impacts of the same signs for men and women:

uncertainty increases when fathers are deceased (+4.8 for women and +2.9 for men). When fathers are alive, uncertainty increases with the age of the parent (at the average ages given in table 1, one obtains + 3.7 for women and + 3.0 for men). This confirms that part of individual uncertainty is based on the longevity or survival individuals observe in their group of reference (as a matter of peers, we observe only the parents here).

There are other explanatory variables that have a significant impact on SUL, although it is smaller. For example, having diseases of type N increases slightly uncertainty for women. Having an income below 875 € decreases uncertainty for men (-1.4). Unhealthy lifestyles can have a negative and significant impact on SUL for men, like obesity, which decreases men's uncertainty by 1.2 for obese and severely obese men. Conversely, we find no correlation between lifestyles and SUL for women.

The estimates of the correlation coefficients between the disturbances of model (5) are displayed at the bottom of table 3. As expected, $\rho_{1,2}$ and $\rho_{1,3}$ are not significantly different from zero, which confirms the exogeneity of SAH. It suggests that unobserved heterogeneity that contributes to the formation of SAH is not correlated with unobserved heterogeneity that influences survival probabilities and hence SLE and SUL. Statements about health seem to be quite separate from statements about longevity: there is no apparent connection between pessimism/optimism for SAH and SLE, or for SAH and SUL[28]. On the other hand, $\rho_{2,3}$ is significant and

[28]This refers to unobserved heterogeneity. Otherwise, individuals use information about their illnesses and SAH to evaluate their survival chances.

negative for women and men, suggesting that a lower SLE for given regressors, that we roughly interpret as pessimism for subjective life expectancy, is correlated with a higher individual uncertainty on longevity. Since estimating $\rho_{2,3}$ entails a monotonic relation, this result seems to contradict the pattern of figure 3, where pessimistic as well as optimistic individuals were more certain. Actually, this is still true on the residuals, i.e. while controlling for all the regressors: SUL residuals are an inversed U shaped fonction of SLE residuals (see figure A9 in the appendix).

6 Risky behaviors and Subjective uncertainty on longevity

As recalled by Delavande (2017), one motivation to collect subjective expectations is to understand individual decisions under uncertainty. In our context, demand for annuities, prevention behavior, as well as retirement decisions are likely to be correlated with individual beliefs regarding longevity. Our purpose is here to examine if uncertainty, i.e. SUL, adds something to subjective life expectancy (SLE) for the understanding of individual behaviors regarding unhealthy lifestyles and complementary health insurance subscription (our survey does not provide information on other financial decisions).

Adopting a simple regression framework, we estimate different linear probability models, where behaviors such as smoking, drinking, being obese (or severely obese) and enrollment in a complementary health insurance are "explained" by SUL and SLE. All regressions include the same socio-demographic characteristics and health variables as before, hence controlling for the circumstances faced by the individual. Regressions are run separately for men and women and results are displayed in table 4. We do not intend to make any causal interpretation of our results and analyze them as correlations only. Indeed, we think that there is reverse causality between beliefs and behaviors and that the appropriate model should consider that individuals choose between bundles of health and behavior, as described in the previous section.

We find that SLE is negatively correlated with all risky behaviors for men, and with being a drinker for women. Interestingly, SUL is also significantly correlated with the decision to be a smoker for men and women: more uncertain men and women are less likely to smoke. Precisely, our results show that one more standard deviation of SUL decreases the probability of smoking by 4.03 percentage points for men and by 2.7 percentage points for women. These impacts are sizeable if we compare them to the proportion of smokers in our sample, i.e. 40 % for men and 32 % for women. They are also non negligible in comparison with the impact of an increase of SLE by one standard deviation: it decreases the probability of smoking by 8.7 percentage points for men and by 6.8 percentage points for women.

Otherwise, we find that more uncertainty (one standard deviation) decreases significantly the probability of being obese or severely obese for men (resp. severely obese only) by 5 percentage points (resp. 2 points). For women, no unhealthy lifestyle is influenced by SUL or SLE, except tobacco use. The results regarding complementary insurance are not conclusive, but there is a small variability in French population regarding enrollment, which is not much a matter of decision:

half complementary insurance plans are provided by the employer and 6 % of plans are provided to low income people for free.

These results show that SUL has an impact, on top of SLE, on decisions regarding risky behaviors. This means that public health messages that focus on life expectancy improvements miss something.

How can we interpret the positive impact of SUL on healthy behaviors? A more formal model with multiple time periods enables us to understand these decisions.

SUL is the standard deviation of the subjective distribution regarding individual's longevity. An exogenous increase in SUL, i.e in this standard deviation SD, means that the relative weight of per-period utility is spread over time, reducing the probability weight of middle-age utility and raising the weight of early-life and old-age utility. If we focus on the trade-off between middle age and old age, this shift in weights induces the individual to shift consumption plans from the middle-age to the old-age periods. This has two effects.

First, interestingly, this shift in utilities (due to consumption plans) makes survival to old age more attractive, which may induce behavioral change shifting the probability of living further, from middle age to old age, triggering a reinforcing mechanism by which both probabilities and utilities are shifted toward the old age. However, there may not be many options for individuals to shift probabilities in this way, since typical healthy behavior raises the survival curve rather than twisting it and transferring probability from one period to another. Secondly, an exogenous spread in probabilities reflecting an increase in SD has no direct impact on precautionary behavior, since this behavior depends on the marginal impact of precautions on the probabilities of survival, not on the absolute level of these probabilities. But there is an indirect impact. A typical healthy behavior has more value if the future periods at which survival chances are increased have greater utility, and this will be the case due to the mechanism described above (a spread in probabilities induces a spread in consumption plans). By this indirect mechanism, greater SD in the individual's expectations, other things equal (in particular keeping life expectancy fixed), induces greater incentives for healthy behavior for individuals who are able to shift consumption plans toward the future.

7 Conclusion

Our results show that French people, both men and women, underestimate their life expectancy, with a larger underestimation for women. The subjective life expectancy (SLE) values are characterized by a large between-individual variability, which seems consistent with the actual inequality in longevity between people, as it can be observed in life tables. Econometric estimations show that individuals are quite rational in adjusting their survival probabilities in relation to their illness, lifestyles and social position.

We find that individual uncertainty relative to length of life (SUL) is equal on average to more than 10 years for men and women. Individual uncertainty may reflect a rational assessment based on the observed variability in longevity between individuals: people might form their expectations observing the variability in age at death around them, although the specific information they have about their own health and their parents longevity enables them to predict less variability for their personal fate. Comparing the average SUL to the variability of ages at death observed in life tables for the whole population, we find that SUL is of the same magnitude as the population variability of ages at death for people aged 40 to 60, but that it is smaller for respondents older than 60. The latter appear to be more certain about their longevity, suggesting use of private information. This finding indicates that subjective uncertainty about longevity provides information that is different from and additional to life tables.

Our econometric analysis confirm that individuals use their private information, mostly their fathers' deaths and fathers' age if alive, to adjust their level of uncertainty. Additional econometric findings show that SUL has a sizeable impact, in addition to SLE, on risky behaviors: more uncertainty on longevity decreases significantly the probability of unhealthy lifestyles.

We find that the average level of SUL, equal to 10, has a magnitude comparable to the variability of longevity observed in life tables for people younger than 60. Nevertheless, this value can be deemed large, even if it is realistic. To examine if our respondents are subject to a large uncertainty we have computed individual confidence intervals at 95% for longevity. Our calculations indicate that for people younger than 60 SUL is on average large enough for these confidence intervals to cover the span of possible lengths of life. These individuals expectations show why it is not that obvious for individuals to buy long term care insurance when they should, i.e. before 60. Similarly, they help understanding why pensions reforms are difficult to justify on the basis of increase in life expectation only.

These results are relevant to issues of public health and retirement policies. Indeed, individual uncertainty about longevity affects prevention behavior, retirement decisions, pension plan choices, and demand for long-term care insurance.

Regarding prevention, people have a good knowledge about the fact that they can lose a few years of life, on average, if they smoke. In a pioneering paper, Hamermesh & Hamermesh (1983) also found that smokers are aware of the detrimental effects of smoking on longevity. They claimed that "the fact that smoking has not ceased entirely reflects people's willingness to take risks, not imperfect information about the effects of smoking." Interestingly, public health advice focuses on life expectancy, but it is not obvious that this is the relevant statistic for individuals concerned about their health and longevity. Our results show a large between-individual variability in SLE, a large SUL, and that risky behaviors are sensitive to SLE and SUL.

What does this imply for individuals' perception of the health benefits of prevention and healthy behavior? Consider a simple model of lifetime utility in which expected utility is equal to

$$U\left(c_1, s_1\right) + \sum_{t>1} p_t\left(s_1, ..., s_{t-1}\right) U\left(c_t, s_t\right),$$

where c_t and s_t are consumption and smoking in period t, and $p_t\left(\cdot\right)$ is the (unconditional) probability to be alive in period t (as a function of smoking in the previous periods). In this model, $SLE = 1 + \sum_{t>1} p_t$, and for a given SLE, maximum SUL obtains when p_t is constant over time (either one dies early or one enjoys the maximum lifespan)[29]. The relevant statistic for the evaluation of improvements in survival probabilities is generally not SLE, but $\sum_{t>1} p_t u_t$, where u_t is the utility enjoyed in t.

Interestingly, in such a context, endogeneity of consumption plans makes the assessment of prevention effects depend on current beliefs. With maximum uncertainty (constant p_t), the optimal consumption plan is quite flat, inducing a rather stable u_t over time, making SLE a reasonable proxy for $u_1 + \sum_{t>1} p_t u_t$. In contrast, with a declining p_t sequence, as in our data (SUL is large but far from maximal), the optimal consumption plan also displays a declining profile, inducing a declining u_t and making p_t less relevant for late periods of life. Such a situation may generate a mismatch between on the one hand public health messages centered on SLE and the improvement of old-age p_t, and on the other hand the strong focus of individuals on earlier risks.

Let us now consider insurance decisions. Income insurance is attractive, but if people are not sure to live long, this uncertainty may justify their apparent myopia. Why save a lot if you may not live to enjoy it? Our results might shed light on the "annuity puzzle", raised by the lack of success of annuities in spite of the fact that they insure individuals against the risk of outliving their savings (and, assuming they are actuarially fair, dominate ordinary bonds, at least under complete mar-

[29] p_t is the probability of being alive at period t. The probability of dying at the end of period t is $p_t - p_{t+1}$, implying that if $p_t = p_{t+1}$, there is no risk of dying in t. So, when the p_t sequence is constant, it means that there are only two periods at which one can die, namely, the first and the last. This gives maximum dispersion to the distribution of ages at death.

kets, as shown in Davidoff et al. 2005). As recalled in Beshears et al. (2014), the literature has found several possible explanations, such as adverse selection, bequest motives, uncertain healthcare expenses, and the presence of a default annuity embedded in Social Security and defined-benefit pension plans. Now, if individuals are strongly uncertain about their longevity, and if income support alleviates the danger of dire poverty after exhaustion of savings, the risk of dying early may loom larger than the risk of living too long. In this context, annuities increase the risk of not being able to take advantage of one's wealth, which may look particularly unappealing when people think that, in case of early health warnings, they would like to consume more than planned in the period in which they can still enjoy certain forms of expensive consumption (e.g., touristic trips). Beshears et al.'s (2014) survey uncovers people's strong desire to remain in control of their wealth, which is completely consistent with their being anxious about an early death.

Decisions about retirement age may also be affected by uncertainty about longevity. As recalled in the introduction, Kalemli-Ozcan and Weil (2010) show that if SUL is sufficiently large, an increase in SLE may have the paradoxical effect of decreasing retirement age. This is due to the fact that the benefits of enjoying retirement loom larger (they have a greater probability) when longevity increases, thereby inducing people to plan an earlier retirement. In contrast, under low SUL, an increase in SLE simply induces a postponement of retirement plans (the probability of enjoying retirement is not affected, only its duration is at stake).

The political economy of pension policy is likely to be affected by a large SUL and a large between-individual dispersion in SLE. Raising the legal age of retirement when LE increases would seem acceptable, even logical, if everyone's expectations coincided with the average LE and if SUL was low. But if a sizable fraction of the population has a low SLE and/or a high SUL, raising the age of retirement reduces the probability of enjoying retirement for these people and may even go directly against their rational wish (per Kalemli-Ozcan & Weil, (2010)) to retire earlier when SLE rises. Therefore, one should not be surprised at the public outrage triggered by pension policies that are based on average LE and ignore the dispersion and uncertainty affecting individual situations.

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Figure 1: Distribution of subjective survival probabilities, men and women of all ages below the target

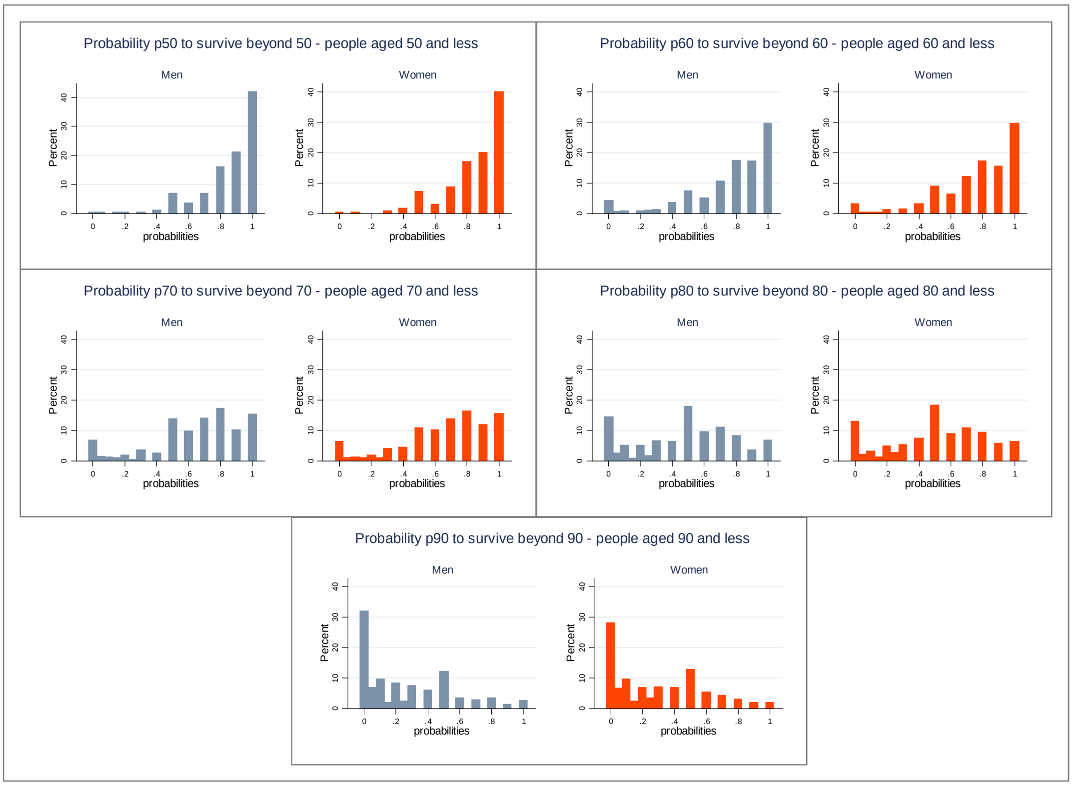

Figure 2: Average self assessed health (SAH), average subjective life expectancy (SLE) and life table LE, average subjective uncertainty on longevity (SUL) by age and relationship between SLE against SUL

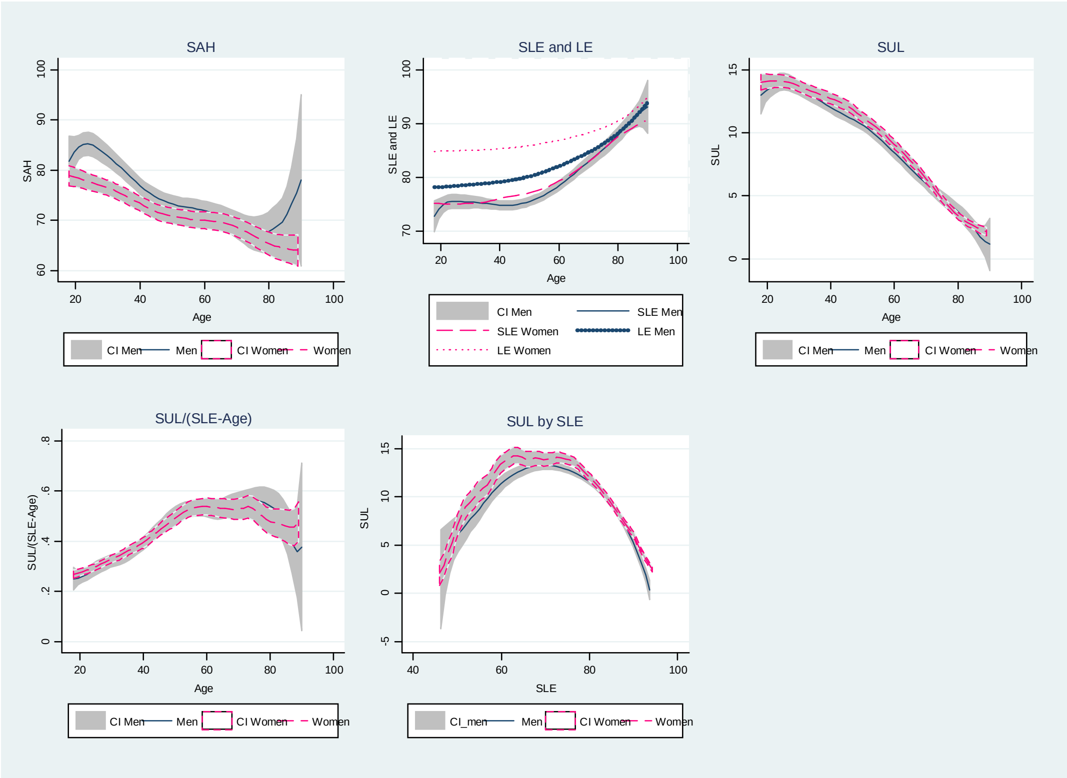

Figure 3: Distribution of SUL by groups of SLE

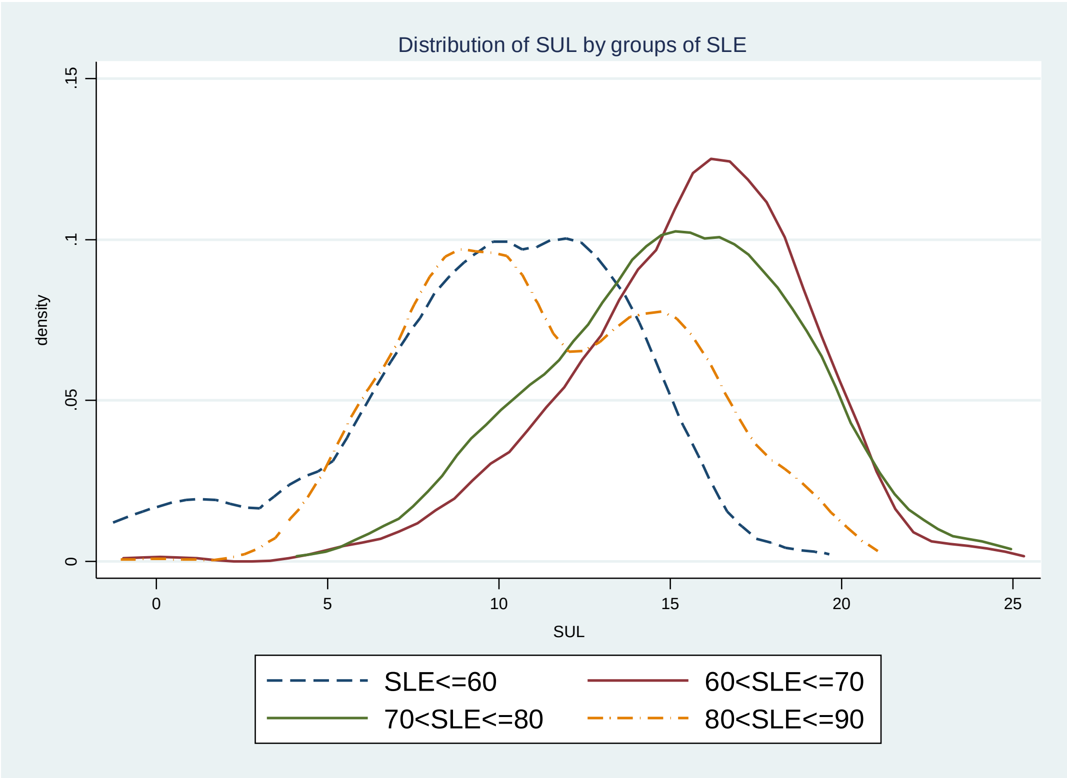

Table 1: Descriptive statistics

		Women	Men	p-value
Socio-economic characteristics				
Age	Age	47.75 (18.56)	46.61 (17.62)	0.116
Gender	Gender	0.52	0.48	0.000
Education	No diploma	0.12	0.08	0.002
	Primary School certificate	0.12	0.09	0.003
	Junior High school diploma	0.34	0.40	0.003
	High school diploma	0.16	0.17	0.769
	University $\leq$ 2 years	0.13	0.11	0.048
	University $\geq$ 3 years	0.13	0.16	0.033
	Other diploma	0.001	0.002	0.426
Income	Income ≤ 875 €	0.29	0.21	0.000
	Income $\in [875 - 1290]$ €	0.26	0.23	0.167
	Income $\in [1290 - 1800]$ €	0.24	0.27	0.056
	Income > 1800 €	0.21	0.28	0.000
Health Insurance	National Health Ins. only	0.05	0.07	0.018
	Complementary Ins.	0.88	0.87	0.323
	CMUC (Comp. Ins. for low-income ind.)	0.06	0.05	0.045
Family Situation	Marital life	0.55	0.62	0.000
	At least one child	0.45	0.35	0.000
Health				
Vital Risks	0 illness of type N	0.14	0.22	0.000
	1-2 illnesses of type N	0.33	0.42	0.000
	$\geq$ 3 illnesses of type N	0.53	0.36	0.000
	0 illness of type AC	0.80	0.83	0.033
	1 illness of type AC	0.16	0.13	0.029
	$\geq$ 2 illnesses of type AC	0.04	0.03	0.794
	0 illness of type A	0.87	0.93	0.000
	$\geq$ 1 illnesses of type A	0.13	0.07	0.000
	0 illness of type C	0.68	0.68	0.934
	1 illness of type C	0.21	0.21	0.728
	$\geq$ 2 illnesses of type C	0.10	0.11	0.520
Functional Limitations	Difficulties to walk	0.17	0.12	0.000
	Bed-ridden	0.12	0.09	0.003
	Difficulties in everyday activities	0.21	0.14	0.000
	Pain	0.39	0.32	0.0008
Lifestyles	Smoker (individual currently smokes)	0.32	0.40	0.000
	Underweight (BMI$\leq$18.5)	0.05	0.01	0.000
	Normal weight(18.5$<$BMI$\leq$25)	0.51	0.49	0.239
	Overweight (25$<$BMI$\leq$30)	0.22	0.34	0.000
	Obese (30$<$BMI$\leq$35)	0.11	0.09	0.251
	Severely obese (BMI$>$35)	0.07	0.06	0.205
	No alcohol	0.34	0.19	0.000
	Alcohol - no risk	0.63	0.75	0.000
	Alcohol - risky behaviour (1)	0.03	0.07	0.000
Parent death and age of death	Father alive (%)	0.47	0.48	0.873
	Father alive (age)	63.4 (11.99)	63.7 (11.88)	0.638
	Father deceased (age at death)	68.7 (15.43)	68.6 (14.67)	0.913
	Mother alive (%)	0.64	0.66	0.335
	Mother alive (age)	64.6 (13.29)	64.7 (12.99)	0.848
	Mother deceased (age at death)	71.6 (17.64)	74.6 (15.67)	0.004
Health and Longevity	*SAH*	72.12 (21.15)	75.85 (18.63)	0.000
	SLE	78.79 (9.72)	77.32 (9.66)	0.0002
	SUL	10.66 (5.48)	10.44 (5.04)	0.316
Number of Observations		1,504	1,292	

Notes: (1) For alcohol consumption, women belong to the "risky behavior" category if they drink more than 14 drinks a week. For men, the limit is 21 drinks per week.

Table 2: Standard deviation of SLE by age, average SUL by age, Standard deviation of age at death by age from life table

	Age	40	50	60	70	80
SD of age at death (Life Table 2009)	Men	12.1	10.9	9.5	9	10.8
	Women	11.1	10.2	9.3	8.7	9.4
Average SUL (Sample)	Men	11.4	11.5	9.0	5.6	4.9
	Women	12.9	11.5	9.4	6.1	3.8
SD of SLE (Sample)	Men	10.8	9.1	6.2	6.6	2.4
	Women	11.5	8.6	7.4	5.1	4.0

Table 3: GLS estimation of the three-equation model, women and men

	Women			Men		
	(1) SAH	(2) SLE	(3) SUL	(1) SAH	(2) SLE	(3) SUL
AGE						
Age	-0.255	-0.281***	0.015	-0.552**	-0.270**	0.031
	(0.222)	(0.104)	(0.053)	(0.216)	(0.115)	(0.057)
Age^2	0.002	0.005***	-0.002***	0.004**	0.005***	-0.002***
	(0.002)	(0.001)	(0.000)	(0.002)	(0.001)	(0.000)
HEALTH						
SAH	-	0.084***	0.008	-	0.114***	-0.005
		(0.012)	(0.006)		(0.014)	(0.007)
Vital Risks:						
0 illness of type N	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
1-2 illnesses of type N	-5.564***	-0.145	0.827**	-2.656**	-0.475	0.133
	(1.426)	(0.671)	(0.345)	(1.118)	(0.593)	(0.292)
$\geq$ 3 illnesses of type N	-9.869***	-0.766	0.744**	-6.059***	-0.976	0.175
	(1.432)	(0.669)	(0.344)	(1.249)	(0.649)	(0.320)
0 illness of type AC	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
1 illness of type AC	-6.890***	-1.344**	-0.103	-3.570***	-0.989	0.318
	(1.250)	(0.592)	(0.304)	(1.286)	(0.684)	(0.337)
$\geq$ 2 illnesses of type AC	-7.488***	1.364	-0.261	-5.708**	-1.466	0.425
	(2.588)	(1.213)	(0.623)	(2.391)	(1.271)	(0.627)
0 illness of type A	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
$\geq$ 1 illnesses of type A	-8.537***	-1.243*	-0.222	-10.568***	-2.115**	-0.028
	(1.424)	(0.666)	(0.342)	(1.680)	(0.904)	(0.446)
0 illness of type C	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
1 illness of type C	-1.820	-0.905	0.309	-3.647***	-0.096	0.535*
	(1.184)	(0.556)	(0.285)	(1.131)	(0.603)	(0.297)
$\geq$ 2 illnesses of type C	-5.022***	-2.681***	-0.609	-8.792***	-1.907**	-0.435
	(1.707)	(0.801)	(0.411)	(1.563)	(0.841)	(0.414)
Functional Limitations:						
Difficulties to walk: Yes	-4.516***	-		-5.972***		
	(1.371)			(1.435)		
Bed-ridden: Yes	-2.292	-		-1.300		
	(1.542)			(1.620)		

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Table 3 – continued from previous page

	Women			Men		
	(1) SAH	(2) SLE	(3) SUL	(1) SAH	(2) SLE	(3) SUL
Difficulties in everyday activities: Yes	-5.506***	-		-5.589***		
	(1.527)			(1.585)		
Pain: Yes	-3.377***	-		-2.329**		
	(1.204)			(1.104)		
PARENT DEATH AND AGE OF DEATH						
Father alive	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Father alive - age unknown	6.558	-1.455	6.265***	7.668	0.153	5.737***
	(6.647)	(3.122)	(1.603)	(6.611)	(3.512)	(1.732)
Father alive - age	0.043	-0.008	0.058***	0.093	0.079*	0.047**
	(0.085)	(0.040)	(0.021)	(0.087)	(0.046)	(0.023)
Father deceased	1.043	-1.382	4.855***	6.970	3.253	2.966*
	(6.493)	(3.046)	(1.564)	(6.560)	(3.488)	(1.720)
Father deceased - age unknown	4.067	1.086	0.066	-0.077	2.243	0.614
	(3.843)	(1.805)	(0.927)	(3.680)	(1.951)	(0.962)
Father deceased - age	0.075	0.003	-0.002	0.006	0.021	0.004
	(0.047)	(0.022)	(0.011)	(0.046)	(0.025)	(0.012)
Mother alive	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Mother alive - age unknown	-9.581	1.758	-2.956*	-5.997	8.359**	-4.778**
	(7.242)	(3.397)	(1.744)	(7.301)	(3.884)	(1.915)
Mother alive - age	-0.128	0.001	-0.024	0.006	0.020	-0.022
	(0.084)	(0.040)	(0.020)	(0.087)	(0.046)	(0.023)
Mother deceased	-8.218	-4.255	-1.956	-2.021	0.117	-1.948
	(6.550)	(3.075)	(1.579)	(7.318)	(3.891)	(1.918)
Mother deceased - age unknown	-3.320	0.493	-0.209	2.275	-1.774	-0.629
	(4.433)	(2.080)	(1.068)	(4.587)	(2.443)	(1.205)
Mother deceased - age	-0.032	0.027	-0.002	-0.008	0.004	-0.003
	(0.050)	(0.023)	(0.012)	(0.053)	(0.028)	(0.014)
LIFESTYLES						
Smoker: Yes	-1.999*	-1.956***	-0.122	-3.332***	-2.289***	-0.432*
	(1.057)	(0.495)	(0.254)	(0.919)	(0.491)	(0.242)
Underweight	-1.186	-1.391	-0.452	-13.561***	4.478**	-1.935*
	(2.098)	(0.985)	(0.506)	(4.024)	(2.147)	(1.059)
Normal weight	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Overweight	-2.839**	0.391	0.164	-1.492	-0.384	-0.006
	(1.117)	(0.525)	(0.270)	(0.977)	(0.521)	(0.257)
Obese	-3.372**	1.698**	0.322	-2.804*	0.022	-1.213***
	(1.510)	(0.708)	(0.363)	(1.528)	(0.814)	(0.401)
Severely obese	-10.606***	-0.177	0.044	-8.701***	-0.806	-1.235**
	(1.832)	(0.865)	(0.444)	(1.867)	(1.001)	(0.493)
No alcohol	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Alcohol - no risk	3.099***	1.123**	-0.181	1.255	1.319**	0.052
	(0.977)	(0.459)	(0.236)	(1.101)	(0.586)	(0.289)
Alcohol - risky behaviour	-1.105	0.475	0.105	-0.390	-2.280**	0.133
	(2.836)	(1.330)	(0.683)	(1.910)	(1.017)	(0.501)
SOCIO-DEMOGRAPHIC						
Education:						
No diploma	-3.909**	-0.541	0.066	-3.160*	-0.811	-0.513
	(1.818)	(0.854)	(0.439)	(1.869)	(0.993)	(0.490)

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Table 3 – continued from previous page

	Women			Men		
	(1) SAH	(2) SLE	(3) SUL	(1) SAH	(2) SLE	(3) SUL
Primary School certificate	-6.060***	-0.342	0.442	-1.953	-1.851*	-0.256
	(1.874)	(0.880)	(0.452)	(1.915)	(1.019)	(0.503)
Junior High school diploma	-4.193***	-1.189*	0.962***	-0.968	-2.622***	-0.595*
	(1.365)	(0.643)	(0.330)	(1.246)	(0.663)	(0.327)
High school diploma	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
University ($\leq$ 2 years)	-0.790	0.920	1.064***	1.105	-1.540*	-0.668
	(1.640)	(0.770)	(0.395)	(1.645)	(0.874)	(0.431)
University ($\geq$ 3 years)	-2.904*	0.945	0.427	0.900	-0.467	0.156
	(1.681)	(0.789)	(0.405)	(1.509)	(0.801)	(0.395)
Other diploma	-29.444**	-3.216	0.701	-12.797	3.629	1.592
	(13.750)	(6.465)	(3.320)	(8.334)	(4.440)	(2.189)
Income:						
Income $\leq$ 875 €	-4.000***	-1.177*	-0.189	-2.425*	-0.714	-1.375***
	(1.383)	(0.651)	(0.334)	(1.315)	(0.700)	(0.345)
Income $\in$ [875 – 1290] €	-3.268**	-0.416	0.036	-0.661	0.070	-0.590*
	(1.277)	(0.601)	(0.309)	(1.188)	(0.630)	(0.311)
Income $\in$ [1290 – 1800] €	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Income > 1800 €	-1.025	-0.054	-0.283	0.441	-1.216*	-0.444
	(1.345)	(0.631)	(0.324)	(1.168)	(0.622)	(0.307)
Health Insurance:						
National Health Ins. only	-1.214	-0.868	1.020*	-2.364	0.815	0.111
	(2.173)	(1.020)	(0.524)	(1.649)	(0.879)	(0.433)
CMUC	2.082	-0.379	0.315	-5.238**	-4.460***	0.237
	(1.987)	(0.930)	(0.478)	(2.189)	(1.168)	(0.576)
Complementary Insurance	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Family Situation:						
Single	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Marital life	0.925	0.607	0.493**	1.328	-0.042	0.061
	(1.029)	(0.482)	(0.248)	(1.026)	(0.546)	(0.269)
No Child	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
At least one child	0.402	-0.098	-0.216	1.197	-0.868	-0.110
	(1.054)	(0.495)	(0.254)	(1.073)	(0.571)	(0.281)
Constant	103.265***	74.918***	11.041***	96.451***	66.306***	13.883***
	(4.199)	(2.321)	(1.192)	(4.086)	(2.560)	(1.262)
$\rho_{1,2}$		-0.002			0.011	
$\rho_{1,3}$		-0.012			-0.014	
$\rho_{2,3}$		-0.293***			-0.235***	
R2	0.353	0.316	0.446	0.359	0.340	0.408
St. Dev of Dependent Variable	21.04	9.61	5.48	18.45	9.69	5.05
RMSE	16.91	7.95	4.08	14.77	7.87	3.88
N		1504			1292	

Note: Standard errors are in parentheses; *** indicates statistical significance at 1%, ** at 5% and * at 10% level.

Table 4: OLS estimation of the impact of SLE and SUL on risky lifestyles, women and men

	Smoker	Obese+Sev. Obese	Severely Obese	Drinker	Compl. Insurance
Women					
SLE	-0.007***	0.002	-0.001	-0.000	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
SUL	-0.005*	0.002	-0.001	0.000	-0.004*
	(0.003)	(0.002)	(0.002)	(0.001)	(0.002)
Control variables	Yes	Yes	Yes	Yes	Yes
N for $y = 1$	440	187	84	43	882
Men					
SLE	-0.009***	-0.001	-0.002**	-0.004***	-0.000
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
SUL	-0.008**	-0.010***	-0.004**	-0.002	0.001
	(0.003)	(0.003)	(0.002)	(0.002)	(0.003)
Control variables	Yes	Yes	Yes	Yes	Yes
N for $y = 1$	452	156	117	105	753

Notes: Control variables include all variables presented in table 3, except lifestyles variables.

Online Appendix for "Individual Uncertainty about longevity" - Not for Publication

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December 22, 2017

1 Construction of two indicators: the subjective life expectancy (SLE) and the subjective uncertainty about longevity (SUL)

In our survey, depending on the respondent's age, a maximum of five probabilities are recorded.

Let x_i denote the age at death of respondent i ($x_i = i$'s length of life). For a person under age 51, five probabilities are recorded:

$$\begin{aligned} &p_{50,i} = \Pr(x_i > 50)\,,\ p_{60,i} = \Pr(x_i > 60)\,,\ p_{70,i} = \Pr(x_i > 70)\,, \\ &p_{80,i} = \Pr(x_i > 80)\,,\ p_{90,i} = \Pr(x_i > 90)\,. \end{aligned} \tag{1}$$

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For a person aged 75, for instance, only $p_{80,i}$ and $p_{90,i}$ are recorded.

We use the raw information provided by these subjective probabilities to compute $\widehat{p_{j,i}}$, the subjective probability of death in decade j. Three assumptions are needed to compute SLE and SUL for each respondent :

Assumption 1: All respondents will live up to 40: $P(x_i > 40) = 1$.

Assumption 2 : No respondent will survive after 100: $P(x_i > 100) = 0$

Assumption 3: If the respondent is supposed to die in a given decade, he/she is supposed to die at the average age of death within the corresponding decade observed for people of the same sex in the population.

Note that Asumption 3 is more accurate than a linear interpolation, although it does not affect the main results. We used observed average age at death displayed by the French National Demography Institute for the year 2009. This gives for men dying within 41-50: 46.30 years; 51-60: 56.01 years; 61-70: 65.92 years; 71-80: 76.05 years; 81-90: 85.54 years; 91-100: 93.73 years. For women the corresponding figures are: 46.26 years, 55.94 years, 66.07 years, 76.35 years, 86.07 years and 94.22 years. We ignore survival beyond 100, therefore inducing a slight underestimation of subjective uncertainty.

The expected value of x_i is defined as:

$$E_i(x_i) = \sum_j \widehat{p_{j,i}}\ x^j \tag{2}$$

where x^j is the age of death in this decade as given in Assumption 2.

Consider a male respondent i aged between 41 and 50. His SLE is computed as the expected value of x_i:

$$E_i(x_i) = P_i(40 < x_i \leq 50)b_i + P_i(50 < x_i \leq 60)56.01 \\ + P_i(60 < x_i \leq 70)65.92 + P_i(70 < x_i \leq 80)76.05 \\ + P_i(80 < x_i \leq 90)85.54 + P_i(x_i > 90)93.73,$$

where $b_i = (50 - age_i)/2$ and

$$P_i(40 < x \leq 50) = 1 - p_{50,i};\ \ P_i(50 < x \leq 60) = p_{50,i} - p_{60,i};\ \ ...$$

Then, we also compute the variance of this distribution, which provides insight in i's uncertainty about longevity. One has:

$$V_i(x_i) = \sum_j \widehat{p_{j,i}}(x^j - E_i(x_i))^2, \tag{3}$$

For the example considered above (a male between 41 and 50), this variance is given by:

$$\begin{aligned} V_i(x_i) &= P_i(40 < x_i \leq 50)(b_i - E_i(x_i))^2 + P_i(50 < x_i \leq 60)(56.01 - E_i(x_i))^2 \\ &+ \quad P_i(60 < x_i \leq 70)(65.92 - E_i(x_i))^2 + P_i(70 < x_i \leq 80)(76.05 - E_i(x_i))^2 \\ &+ \quad P_i(80 < x_i \leq 90)(85.54 - E_i(x_i))^2 + P_i(x_i > 90)(93.73 - E_i(x_i))^2. \end{aligned}$$

Hereafter, the corresponding standard deviation will be used as an indicator of the individual's uncertainty regarding his/her own longevity.

In summary, we define the two variables subjective life expectancy SLE and subjective uncertainty about longevity SUL as follows:

$$SLE_i = E_i(x_i);\quad SUL_i = \sqrt{V_i(x_i)}\ . \tag{4}$$

Notice that having recorded several subjective probabilities for each individual enables us to compute SLE and SUL indicators with many individual observations, without relying too much on life table statistics.

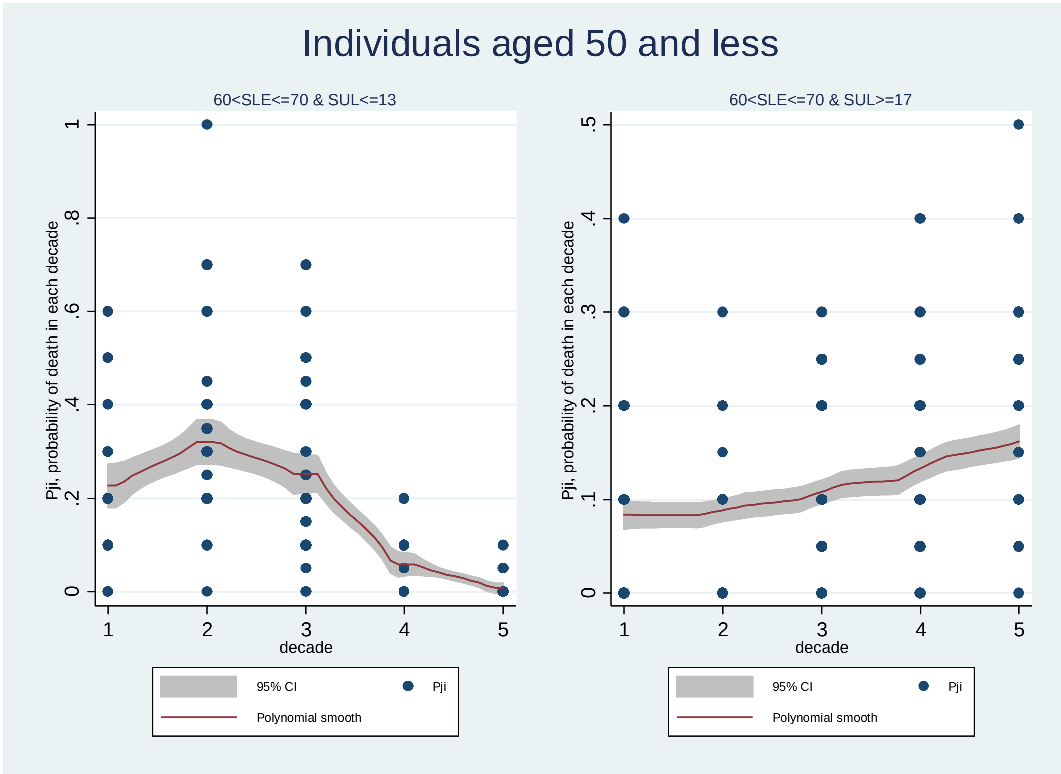
2 Data

2.1 More information on the survey

Our data come from an original survey designed to elicit subjective survival probabilities as well as expectations regarding health and income. 3331 individuals aged 18 or more were interviewed in November and December 2009 using a computer-assisted personal interviewing (CAPI) technique. Each interview took about 45 minutes. A preliminary pilot survey was performed on 30 respondents to remove possible ambiguities and improve the questionnaire wording. Our sample is representative of the corresponding French population, except that we secured an over-representation of people aged 50 and more (we chose to double the proportion of people aged 50 or more). Indeed, we needed enough observations of people affected by illnesses in order to draw relevant statistical inference as concerns the impact of illnesses on self assessed health and expectations regarding survival. All computations and estimations are weighted to obtain results that can be seen as representative of the French population.

2.2 Elicitation of subjective survival probabilities: additional figure

Figure A.1: Relation between SUL and elicited probabilities



2.3 Classification of the main illnesses among the vital risk categories

Table A.1: Prevalence of the main illnesses (women and men) and classification among the vital risk categories

	Women	Men	p-value
Illnesses of type N			
Anxiety	31.86	19.94	0.000
Lumbago	26.3	23.02	0.036
Caries	19.72	22.09	0.131
Nasopharyngitis	18.62	11.36	0.000
Migraine	17.48	7.46	0.000
Gastralgia	15	10.84	0.000
Arthrosis of the knee	14.22	8.92	0.000
Allergic rhinitis	12.66	8.05	0.000
Sinusitis	12.48	8.34	0.000
Acid Reflux	11.6	8.24	0.002
Varicose vein	8.98	3.45	0.000
Colitis	8.97	4.11	0.000
Deafness	8.23	11.02	0.006
Arthrosis of the hip	7.55	5.23	0.005
Urinary infection	7.46	1.27	0.000
Malfunction of thyroid	7.05	0.95	0.000
Eczema	6.68	4.31	0.006
Hemorrhoids	6.6	4.44	0.009
Menstrual disorders	5.96	0.00	0.000
Menopause troubles	4.93	0.00	0.000
Cataract	4.84	2.63	0.000
Psoriasis	4.2	2.91	0.052
Earache	3.28	2.95	0.639
Angina	3.18	1.2	0.000
Ulcer	2.79	2.21	0.299
Handicap	2.06	3.16	0.065
Glaucoma	1.91	0.90	0.008
Infirmity	0.98	1.25	0.485
Epilepsy	0.9	0.75	0.65
Overgrowth of the prostate	0.00	2.63	0.000
Illnesses of type AC			
Asthma	9.38	6.3	0.003
Heart rythm disorder	8.29	5.8	0.004
Cancer	2.68	1.86	0.096
Angina pectoris	1.64	2.23	0.204
Myocardial infarcts	1.53	2.87	0.005
Stroke	1.24	1.21	0.937
Illnesses of type A			
Depression	12.07	5.32	0.000
Illnesses of type C			
Hypertension	17.22	12.99	0.000
Cholesterol	13.26	13.76	0.66
Bronchitis	8.07	7.15	0.338
Diabete	6.2	7.34	0.166
Arteritis	1.28	2.09	0.048
Hepatitis	0.42	0.81	0.158
Parkinson	0.34	0.13	0.169
Alzheimer	0.21	0.04	0.096

Notes: All illnesses resulting from open declarations are also classified into the four vital risk categories. However, as they are numerous, they are not reported in the table in order to improve readability.

3 Descriptive analysis: additional figures and results

3.1 Basic features of the data: additional figures

Figure A.2: Vital risks by age for men and women

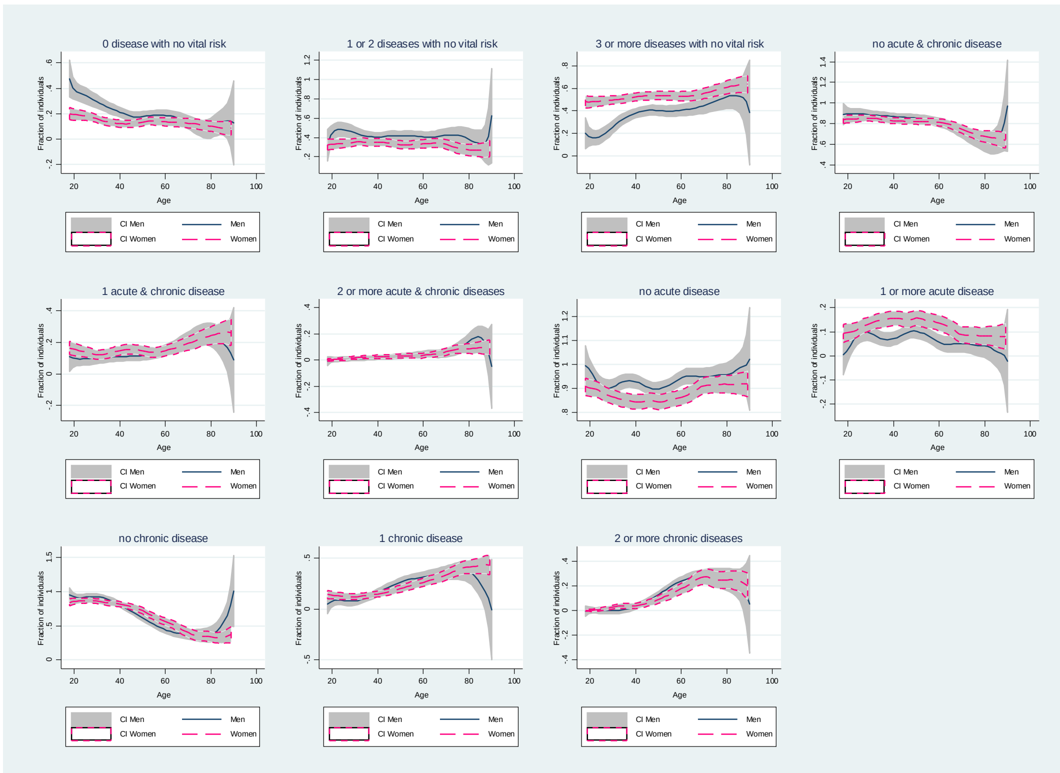


Figure A.3: Proportion of smokers by age and gender

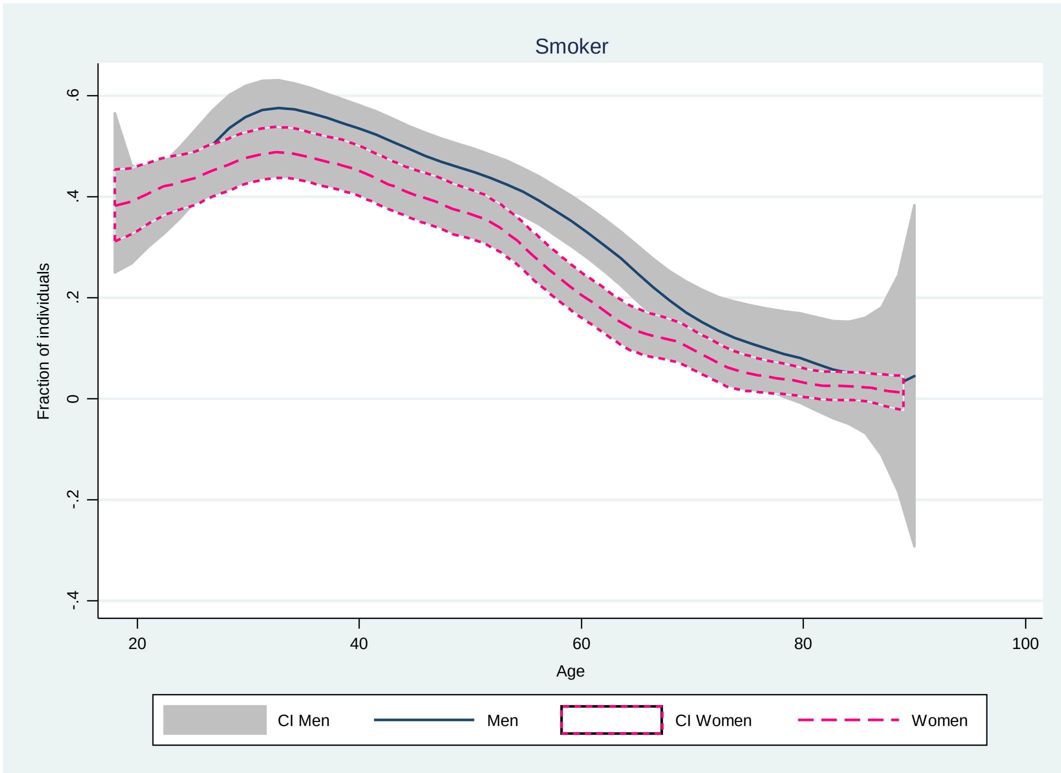


Figure A.4: Alcohol consumption by age for men and women

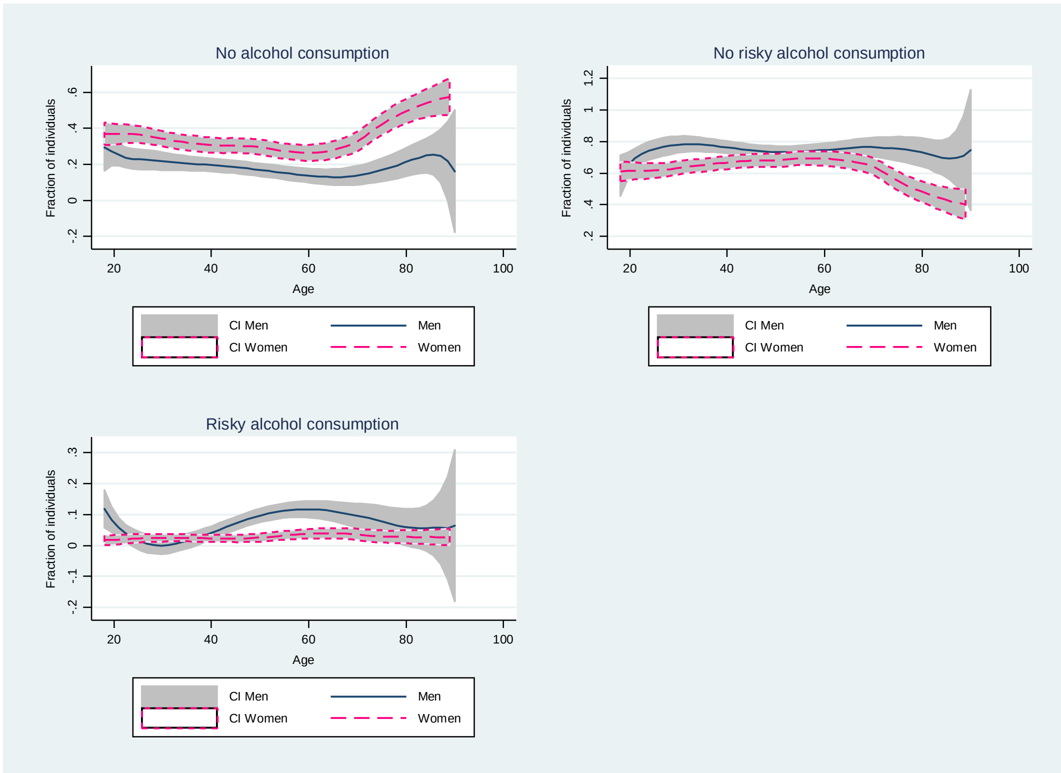
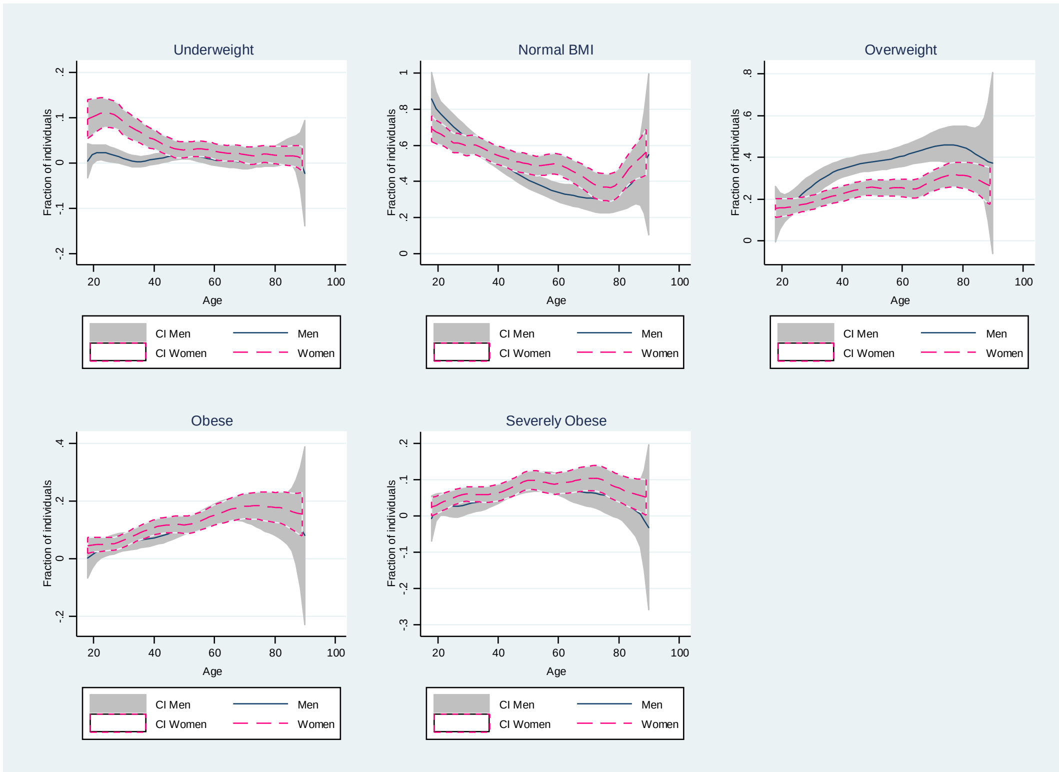


Figure A.5: BMI and obesity problems by age for men and women



3.2 Subjective survival probabilities and focal points

In a survey devoted to the use of subjective probabilities in research, Hurd (2009) emphasizes that many results suggest a response bias towards 50%. If there is a tropism of elicited probabilities towards 50 %, respondents understate the true probability when the latter is greater than 50 % and overstate the true probability when it is lower than 50 %. In figure 1, we observe a small peak around 0.5, especially for target ages beyond 70. In order to examine the average bias, we have computed the differences $p_{j,i} - \overline{p}_{j,a(i)}$, $j = 50, ..., 90$, for each individual i, where $\overline{p}_{j,a(i)}$ is the survival proportion for men and women of the same age as i according to the life tables in 2009[1]. Denoting $\overline{p}_j$ the average probability to live beyond age j, measured from the life tables, we found that the values of $\overline{p}_{50}$ to $\overline{p}_{80}$ are greater than 50 %, whatever the respondent's age or sex. The value of $\overline{p}_{90}$ is much lower. For men it is never greater than 50 %. More precisely, it increases from 18% for men under age 51 to 44 % for men aged more than 80. For women $\overline{p}_{90}$ is rising from 36 % for women under age 51 to 42 % for women whose age is between 71 and 80, and up to 56 % for women aged more than 80.

The average values of $p_{j,i} - \overline{p}_{j,a(i)}$ by age measure the average bias for each probability. They are displayed for men and women in figure A7. For males, the sign of the average bias is consistent with Hurd's suggestion, with an understatement for p_{50} to p_{80} and an overstatement for p_{90}. However, Hurd's hypothesis does not hold for females, as they systematically underestimate their survival probabilities, even for $\overline{p}_{90} < 50\%$. Interestingly, the bias diminishes for all subjective probabilities when the respondent's age approaches the target (except for the male respondents approaching age 50 or 80).

[1] Notice that we have not adjusted the life tables to take into account the likely increase in longevity in the future. Respondents might be aware of this possibility. But we focus mostly on the individual variability in assessments rather than on their accuracy with respect to the "true" future longevity.

Figure A.6: Distribution of subjective survival probabilities, men and women of ages close to the target (max 10 years)

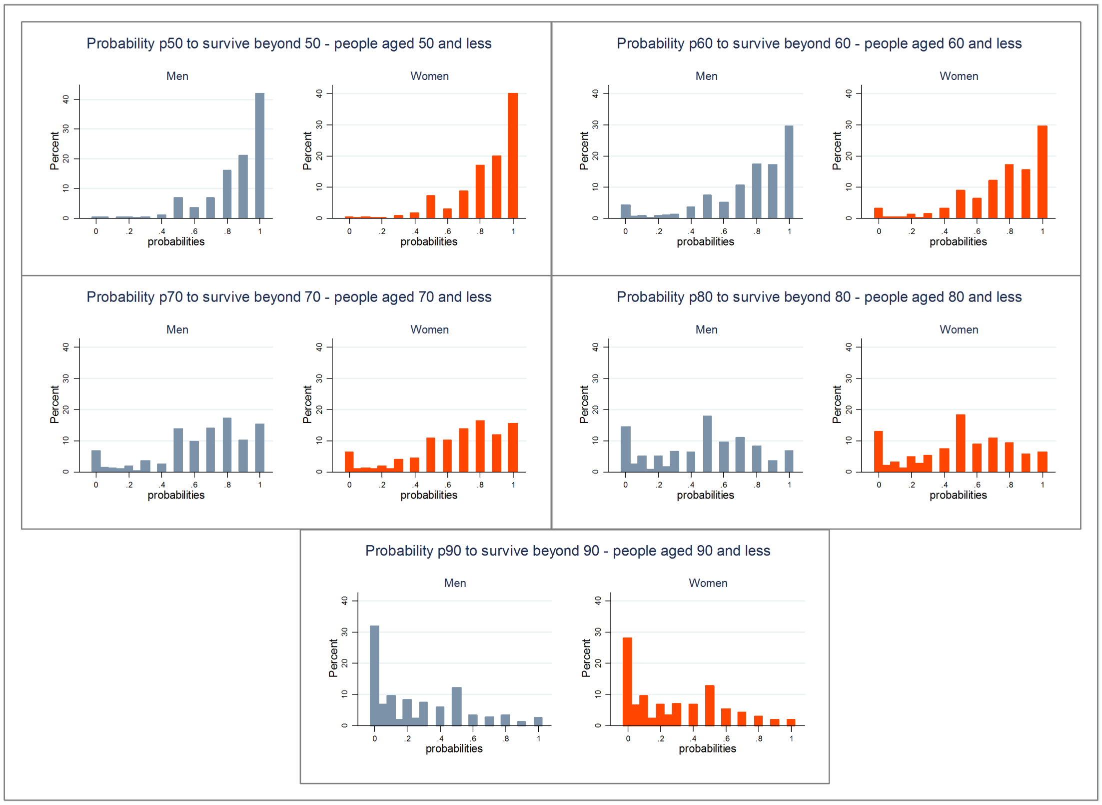
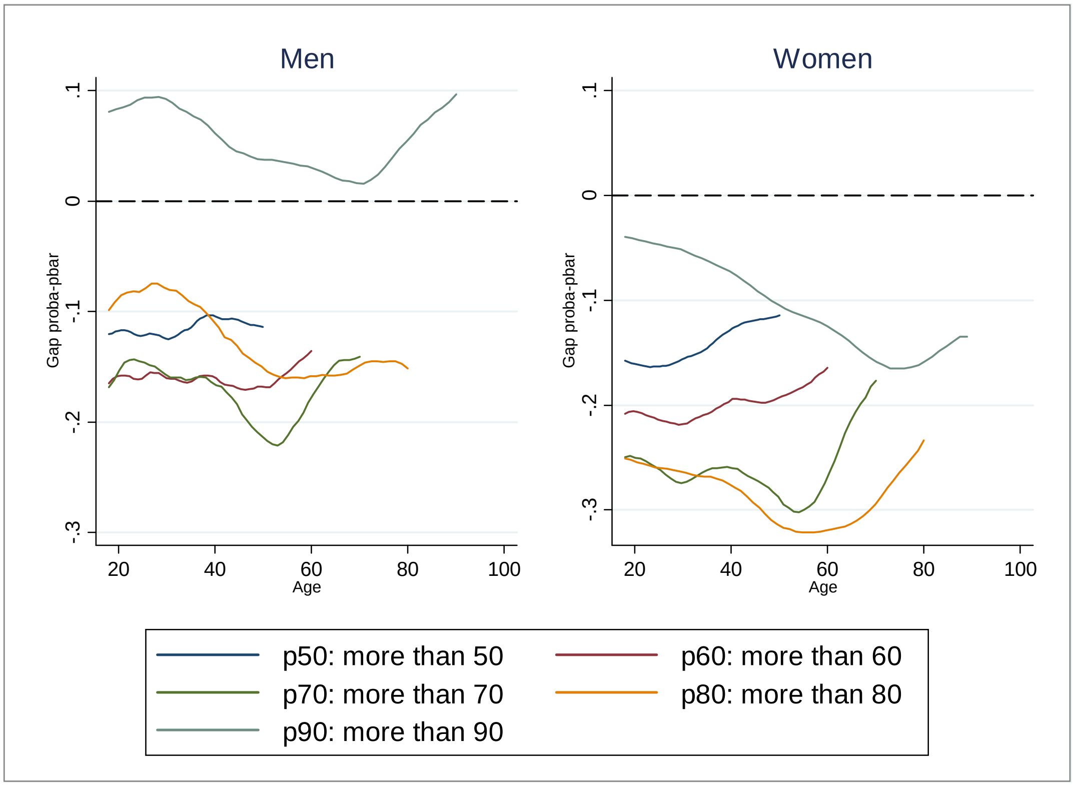
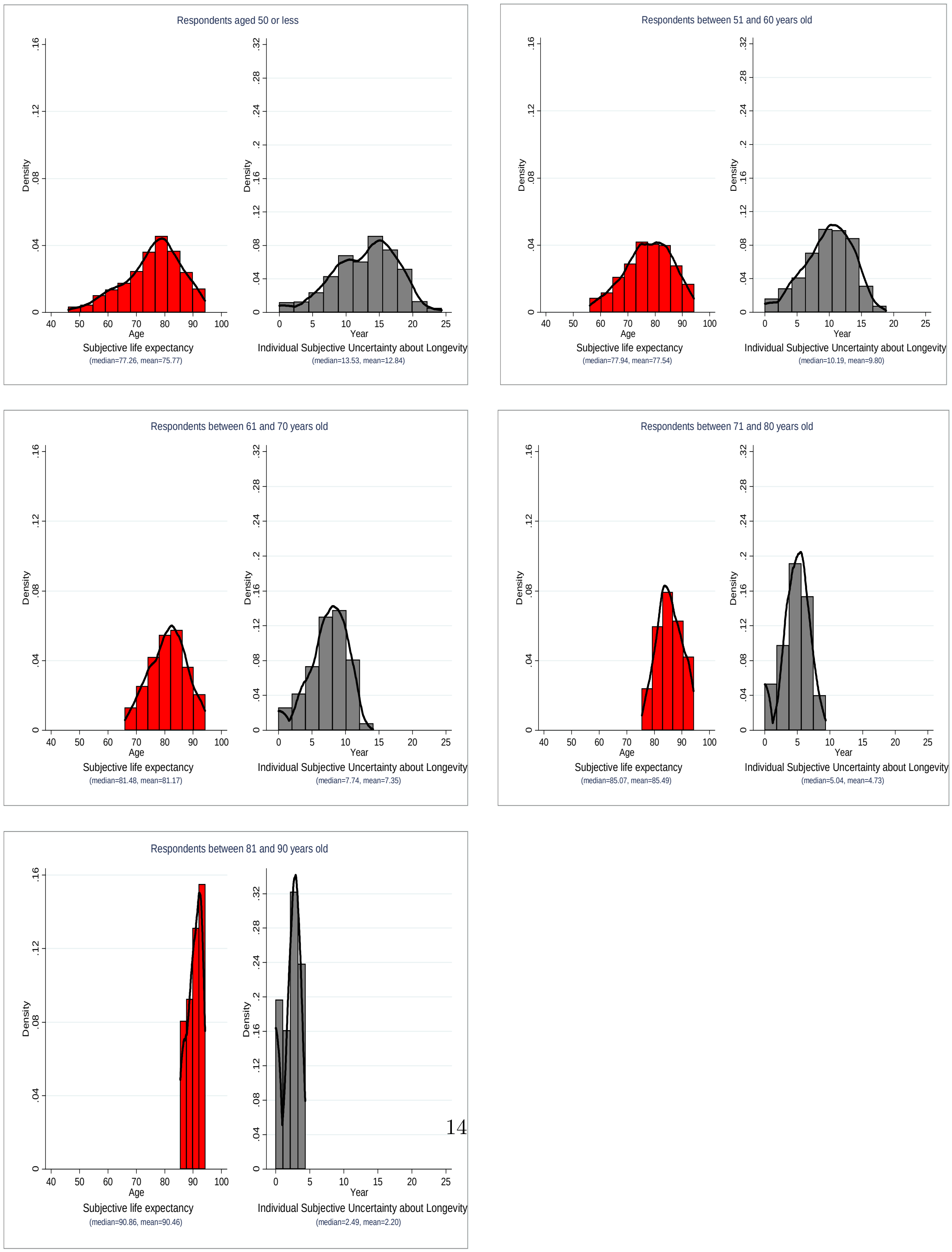


Figure A.7: Average difference by age, between subjective survival probability and life table probability



3.3 Subjective life expectancy and subjective uncertainty about longevity

Figure A.8: Distribution of SLE and SUL by age groups



4 Econometric analysis: additional results

4.1 Additional information on the empirical specification

First we do not consider logarithmic transformations of the dependent variables. Indeed the distributions of SAH_i, SLE_i and SUL_i are rather close to normal distributions, according to the values of their skewness and kurtosis —at least closer than their logarithmic transformations[2].

Secondly, our simultaneous-equation model is recursive, at least regarding equations (I) and (II) as well as (I) and (III): SAH is an explanatory variable of SLE_i and SUL_i, while these two variables are not supposed to influence SAH. This structure is in line with the survey design, where questions about diseases and SAH are asked before survival probabilities. Moreover, it seemed rather unlikely to us that individual expectations regarding longevity influence SAH.[3] So, it appeared reasonable to adopt a recursive model with SAH explained first. This avoids the identification difficulties that would arise with a non-recursive model.

4.2 Econometric issues

We have to deal with two econometric issues. Firstly, SAH_i can be non-exogenous in equations (II) and (III). Secondly, about 15% of the respondents did not give all the survival probabilities requested to compute their SLE and SUL. Our estimates may suffer from a selection bias.

[2] One has, for SAH_i, SLE_i and SUL_i respectively, skewness = –1.12, 0.7 and 0.14 ; kurtosis = 4.38, 3.2 and 2.37. When taking the log transformations the kurtosis is greater than 20 for $\log(SAH_i)$ and $\log(SUL_i)$ and their skewness is still negative and more distant from 0.

[3] Of course, our cross-sectional dataset makes it impossible to draw conclusions about the direction of the causality between SAH and the subjective survival indicators.

4.2.1 Exogeneity of SAH

SAH_i can be non-exogenous in equations (II) and (III) of model (5). To test for the exogeneity of SAH_i, we performed 3SLS estimations of equations (I),(II) and (III).

Actually, our four indicators of functional limitations Z_i appear to be appropriate excluded instruments for SAH_i. Indeed, they are explanatory variables of SAH_i but have no direct influence on SLE_i and SUL_i —they are not significant when introduced in equations (II) and (III).

Moreover, they are well correlated with SAH_i. We check the weak instrument possibility by computing the Fisher statistics for the significance of Z_i in the first stage regressions. They are equal to 21.4 for women and 17 for men, respectively. Given that we use 4 instruments, we follow the Bound *et al* (1995) criteria and rule out a lack of correlation between them and SAH.

Finally, the exogeneity of these instruments is not rejected by the Sargan test: the p-values for the Sargan statistic are respectively 0.46 and 0.47 for women and men.

The results of first-step estimations and tests for men and women are presented in table A-2. With these instruments, the Hausman tests lead to non-rejection of SAH_i exogeneity for the SLE_i and SUL_i equations. The p-values associated with the Hausman test statistics are, for the SLE equation, 0.768 for women and 0.143 for men; for the SUL equation, they are respectively equal to 0.09 for women and 0.06 for men. Notice also that the exogeneity of SAH in equations (II) and (III) is confirmed by a lack of correlation between the disturbances of equations (I) and (II) and of equations (I) and (III) (see bottom of table 3 in the main text).

The p-value for the Hausman test for exogeneity of SAH in equation (III) being close to 5 %, we provide the 3SLS estimates in table A-3. As expected, they are very close to the GLS estimates. We prefer the latter because of their better precision.

Table A.2: First-stage regressions, women and men

	Women	Men
AGE		
Age	-0.256	-0.552**
	(0.225)	(0.220)
Age^2	0.002	0.004**
	(0.002)	(0.002)
HEALTH		
Vital Risks:		
0 illness of type N	Ref.	Ref.
1-2 illnesses of type N	-5.566***	-2.660**
	(1.448)	(1.138)
$\geq$ 3 illnesses of type N	-9.877***	-6.066***
	(1.453)	(1.271)
0 illness of type AC	Ref.	Ref.
1 illness of type AC	-6.892***	-3.572***
	(1.269)	(1.309)
$\geq$ 2 illnesses of type AC	-7.496***	-5.710**
	(2.626)	(2.433)
0 illness of type A	Ref.	Ref.
$\geq$ 1 illnesses of type A	-8.542***	-10.575***
	(1.446)	(1.709)
0 illness of type C	Ref.	Ref.
1 illness of type C	-1.821	-3.650***
	(1.202)	(1.151)
$\geq$ 2 illnesses of type C	-5.026***	-8.794***
	(1.733)	(1.591)
Functional Limitations:		
Difficulties to walk: Yes	-4.493***	-5.989***
	(1.392)	(1.460)
Bed-ridden: Yes	-2.265	-1.324
	(1.565)	(1.649)
Difficulties in everyday activities: Yes	-5.516***	-5.524***
	(1.550)	(1.613)
Pain: Yes	-3.371***	-2.322**
	(1.222)	(1.123)
PARENT DEATH AND AGE OF DEATH		
Father alive	Ref.	Ref.
Father alive - age unknown	6.561	7.689
	(6.747)	(6.727)
Father alive - age	0.043	0.093

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Table A.2 – continued from previous page

	Women	Men
	(0.086)	(0.088)
Father deceased	1.046	6.981
	(6.590)	(6.675)
Father deceased - age unknown	4.071	-0.067
	(3.900)	(3.744)
Father deceased - age	0.075	0.006
	(0.048)	(0.047)
Mother alive	Ref.	Ref.
Mother alive - age unknown	-9.579	-6.000
	(7.350)	(7.429)
Mother alive - age	-0.128	0.006
	(0.086)	(0.089)
Mother deceased	-8.221	-2.033
	(6.648)	(7.446)
Mother deceased - age unknown	-3.316	2.275
	(4.500)	(4.667)
Mother deceased - age	-0.032	-0.008
	(0.050)	(0.054)
LIFESTYLES		
Smoker : Yes	-2.001*	-3.332***
	(1.073)	(0.935)
Underweight	–1.184	-13.561***
	(2.130)	(4.094)
Normal weight	Ref.	Ref.
Overweight	-2.838**	-1.493
	(1.134)	(0.995)
Obese	-3.375**	-2.807*
	(1.533)	(1.555)
Severely Obese	-10.608***	-8.700***
	(1.859)	(1.900)
No Alcohol	Ref.	Ref.
Alcohol - no risk	3.099***	1.256
	(0.992)	(1.120)
Alcohol - risky behaviour	-1.106	-0.388
	(2.878)	(1.944)
SOCIO-DEMOGRAPHIC		
Education:		
No diploma	-3.907**	-3.155*
	(1.846)	(1.902)
Primary School certificate	-6.057***	-1.951
	(1.902)	(1.948)
Junior High school diploma	-4.193***	-0.966

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Table A.2 – continued from previous page

	Women	Men
	(1.386)	(1.268)
High school diploma	Ref.	Ref.
University (≤ 2 years)	-0.791	1.111
	(1.664)	(1.674)
University (≥ 3 years)	-2.904*	0.904
	(1.706)	(1.536)
Other diploma	–29.435**	-12.790
	(13.956)	(8.479)
Income:		
Income ≤ 875 €	-3.999***	-2.426*
	(1.404)	(1.338)
Income $\in$ [875 − 1290] €	-3.268**	-0.661
	(1.296)	(1.209)
Income $\in$ [1290 − 1800] €	Ref.	Ref.
Income > 1800 €	-1.025	0.440
	(1.365)	(1.188)
Health Insurance:		
National Health Ins. only	-1.216	-2.364
	(2.205)	(1.678)
CMUC	2.079	-5.239**
	(2.017)	(2.227)
Complementary Insurance	Ref.	Ref.
Family Situation:		
Single	Ref.	Ref.
Marital life	0.923	1.330
	(1.045)	(1.044)
No Child	Ref.	Ref.
At least one child	0.402	1.197
	(1.070)	(1.092)
Constant	103.266***	96.452***
	(4.261)	(4.158)
N	1504	1292
Fisher stat. (Weak instruments)	29.25	27.89
Sargan stat.	2.540	2.507
(p-value)	(0.468)	(0.474)
Hausman stat. (SLE)	0.09	2.14
(p-value)	(0.768)	(0.143)
Hausman stat. (SUL)	2.90	3.46
(p-value)	(0.089)	(0.063)

Note: Standard errors are in parentheses; *** indicates statistical significance at 1%, ** at 5% and * at 10% level.

Table A.3: 3SLS estimation of the three-equation model, women and men - SAH instrumented

	Women			Men		
	(1) SAH	(2) SLE	(3) SUL	(1) SAH	(2) SLE	(3) SUL
AGE						
Age	-0.255	-0.277***	0.026	-0.549**	-0.309**	0.055
	(0.222)	(0.106)	(0.054)	(0.216)	(0.121)	(0.058)
Age^2	0.002	0.005***	-0.002***	0.004**	0.005***	-0.002***
	(0.002)	(0.001)	(0.000)	(0.002)	(0.001)	(0.000)
HEALTH						
SAH	-	0.095**	0.042*	-	0.045	0.038
		(0.045)	(0.023)		(0.054)	(0.026)
Vital Risks:						
0 illness of type N	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
1-2 illnesses of type N	-5.585***	-0.070	1.050***	-2.668**	-0.712	0.281
	(1.426)	(0.736)	(0.372)	(1.118)	(0.634)	(0.305)
$\geq$ 3 illnesses of type N	-9.897***	-0.613	1.197***	-6.132***	-1.588*	0.559
	(1.431)	(0.884)	(0.447)	(1.248)	(0.812)	(0.390)
0 illness of type AC	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
1 illness of type AC	-6.882***	-1.248*	0.180	-3.553***	-1.270*	0.494
	(1.250)	(0.697)	(0.352)	(1.286)	(0.734)	(0.352)
$\geq$ 2 illnesses of type AC	-7.511***	1.489	0.109	-5.731**	-1.973	0.742
	(2.588)	(1.315)	(0.664)	(2.390)	(1.360)	(0.653)
0 illness of type A	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
$\geq$ 1 illnesses of type A	-8.531***	-1.111	0.166	-10.540***	-2.893***	0.459
	(1.424)	(0.832)	(0.421)	(1.679)	(1.099)	(0.528)
0 illness of type C	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
1 illness of type C	-1.828	-0.880	0.383	-3.663***	-0.398	0.724**
	(1.184)	(0.572)	(0.289)	(1.131)	(0.660)	(0.317)
$\geq$ 2 illnesses of type C	-5.064***	-2.610***	-0.399	-8.810***	-2.606**	0.003
	(1.707)	(0.854)	(0.432)	(1.563)	(1.012)	(0.486)
Functional Limitations:						
Difficulties to walk: Yes	-4.178***	-	-	-5.717***	-	-
	(1.350)			(1.403)		
Bed-ridden: Yes	-1.957	-	-	-1.184	-	-
	(1.517)			(1.578)		
Difficulties in everyday activities: Yes	-5.922***	-	-	-6.174***	-	-
	(1.505)			(1.548)		
Pain: Yes	-3.396***	-	-	-2.022*	-	-
	(1.185)			(1.076)		
PARENT DEATH AND AGE OF DEATH						

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Table A.3 – continued from previous page

	Women			Men		
	(1) SAH	(2) SLE	(3) SUL	(1) SAH	(2) SLE	(3) SUL
Father alive	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Father alive - age unknown	6.556	-1.551	5.983***	7.552	0.911	5.262***
	(6.647)	(3.188)	(1.612)	(6.610)	(3.651)	(1.753)
Father alive - age	0.044	-0.008	0.056***	0.091	0.089*	0.041*
	(0.085)	(0.041)	(0.021)	(0.087)	(0.048)	(0.023)
Father deceased	1.105	-1.389	4.834***	6.844	3.901	2.560
	(6.493)	(3.092)	(1.563)	(6.560)	(3.614)	(1.735)
Father deceased - age unknown	4.112	1.028	-0.105	-0.061	2.358	0.542
	(3.843)	(1.844)	(0.932)	(3.679)	(2.004)	(0.962)
Father deceased - age	0.075	0.002	-0.005	0.006	0.022	0.003
	(0.047)	(0.023)	(0.011)	(0.046)	(0.025)	(0.012)
Mother alive	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Mother alive - age unknown	-9.518	1.887	-2.572	-5.963	7.751*	-4.398**
	(7.242)	(3.481)	(1.759)	(7.301)	(4.013)	(1.927)
Mother alive - age	-0.128	0.003	-0.019	0.006	0.016	-0.020
	(0.084)	(0.041)	(0.021)	(0.087)	(0.048)	(0.023)
Mother deceased	-8.296	-4.161	-1.678	-2.019	-0.339	-1.663
	(6.550)	(3.141)	(1.587)	(7.318)	(4.008)	(1.925)
Mother deceased - age unknown	-3.244	0.536	-0.083	2.282	-1.614	-0.729
	(4.433)	(2.117)	(1.070)	(4.587)	(2.511)	(1.206)
Mother deceased - age	-0.031	0.028	-0.000	-0.007	0.004	-0.003
	(0.050)	(0.024)	(0.012)	(0.053)	(0.029)	(0.014)
LIFESTYLES						
Smoker: Yes	-2.016*	-1.926***	-0.034	-3.343***	-2.523***	-0.285
	(1.057)	(0.515)	(0.260)	(0.919)	(0.535)	(0.257)
Underweight	-1.171	-1.381	-0.425	-13.507***	3.629	-1.402
	(2.098)	(1.001)	(0.506)	(4.024)	(2.296)	(1.103)
Normal weight	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Overweight	-2.825**	0.423	0.258	-1.502	-0.512	0.075
	(1.117)	(0.546)	(0.276)	(0.977)	(0.543)	(0.261)
Obese	-3.398**	1.750**	0.475	-2.808*	-0.238	-1.051**
	(1.510)	(0.743)	(0.376)	(1.528)	(0.858)	(0.412)
Severely obese	-10.608***	-0.034	0.467	-8.706***	-1.442	-0.837
	(1.832)	(1.025)	(0.518)	(1.867)	(1.134)	(0.545)
No alcohol	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Alcohol - no risk	3.087***	1.081**	-0.305	1.260	1.422**	-0.013
	(0.977)	(0.491)	(0.248)	(1.101)	(0.607)	(0.291)
Alcohol - risky behaviour	-1.119	0.492	0.154	-0.390	-2.272**	0.129
	(2.836)	(1.352)	(0.683)	(1.910)	(1.044)	(0.501)
SOCIO-DEMOGRAPHIC						

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Table A.3 – continued from previous page

	Women			Men		
	(1) SAH	(2) SLE	(3) SUL	(1) SAH	(2) SLE	(3) SUL
Education:						
No diploma	-3.906**	-0.502	0.180	-3.194*	-1.031	-0.375
	(1.818)	(0.879)	(0.444)	(1.869)	(1.033)	(0.496)
Primary School certificate	-6.032***	-0.281	0.621	-1.972	-1.968*	-0.183
	(1.874)	(0.921)	(0.466)	(1.915)	(1.050)	(0.504)
Junior High school diploma	-4.188***	-1.140*	1.107***	-0.987	-2.688***	-0.554*
	(1.365)	(0.677)	(0.342)	(1.246)	(0.682)	(0.328)
High school diploma	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
University ($\leq$ 2 years)	-0.795	0.934	1.103***	1.089	-1.403	-0.754*
	(1.640)	(0.783)	(0.396)	(1.645)	(0.903)	(0.433)
University ($\geq$ 3 years)	-2.889*	0.983	0.540	0.887	-0.397	0.112
	(1.681)	(0.814)	(0.411)	(1.509)	(0.824)	(0.396)
Other diploma	-29.358**	-2.884	1.681	-12.799	2.858	2.075
	(13.750)	(6.675)	(3.374)	(8.334)	(4.595)	(2.206)
Income:						
Income $\leq$ 875 €	-3.987***	-1.127	-0.040	-2.424*	-0.916	-1.249***
	(1.383)	(0.687)	(0.347)	(1.314)	(0.735)	(0.353)
Income $\in [875 - 1290]$ €	-3.262**	-0.378	0.149	-0.679	-0.002	-0.545*
	(1.277)	(0.626)	(0.316)	(1.188)	(0.649)	(0.312)
Income $\in [1290 - 1800]$ €	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Income $>$ 1800 €	-1.025	-0.045	-0.256	0.429	-1.196*	-0.456
	(1.345)	(0.642)	(0.324)	(1.168)	(0.638)	(0.307)
Health Insurance:						
National Health Ins. only	-1.247	-0.851	1.072**	-2.355	0.667	0.204
	(2.173)	(1.037)	(0.524)	(1.649)	(0.909)	(0.436)
CMUC	2.018	-0.407	0.233	-5.253**	-4.829***	0.469
	(1.987)	(0.950)	(0.480)	(2.189)	(1.231)	(0.591)
Complementary Insurance	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Family Situation:						
Single	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Marital life	0.916	0.604	0.483*	1.333	0.079	-0.015
	(1.029)	(0.490)	(0.248)	(1.026)	(0.568)	(0.273)
No Child	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
At least one child	0.403	-0.102	-0.228	1.194	-0.780	-0.165
	(1.054)	(0.503)	(0.254)	(1.073)	(0.590)	(0.283)
Constant	103.223***	73.677***	7.372***	96.462***	72.926***	9.735***
	(4.198)	(5.153)	(2.604)	(4.085)	(5.662)	(2.719)
R2	0.353	0.296	0.447	0.359	0.305	0.409
St. Dev of Dependent Variable	21.04	9.61	5.48	18.45	8.07	3.88
RMSE	16.91	8.06	4.08	14.77	7.87	3.88
N		1504			1292	

4.2.2 Selection bias

Only 86% of the respondents answered all the survival probabilities requested to compute their SLE and SUL. This response rate is very similar between men (86.6%) and women (85.5%) and it decreases with age, as shown in table A-4. This table also displays the pattern of non-responses: whatever their age, about 50% of individuals who did not answer all the survival probabilities did not answer the first question. In that case, these individuals were not asked the subsequent questions. Then, the proportion of individuals who did not answer the second question (conditional on answering the first one), the third question (conditional on answering the first two questions), the fourth question (conditional on answering the first three questions) or the fifth question (conditional on answering the first four questions) is nearly constant.

We used the Heckman two-step approach to deal with a possible selection bias.

In the first step, we estimate the probability to participate separately for men and women, i.e., the probability to answer all the requested survival questions. Age, education and visits to a GP were included as explanatory variables for participation, as well as the information about parental death and a subjective level of happiness in some supplementary regressions (see table A.5). We find that the individuals who did not give complete answers are slightly older, have a low level of education and declare a low level of hapiness in life (they also declare a lower SAH, but this variable is not included in the regression).

When included in model (5), the inverse Mills ratios obtained from these first steps are not significant in equations (I) and (II) and significant at 5% level in equation (III) for males only, see table A.6. This result suggests that there is no selection bias.

Table A.4: Response rates by gender and age

	Response rate	pct who did not answer the first question	pct who did not answer the 2nd question	pct who did not answer the 3rd question	pct who did not answer the 4th question	pct who did not answer the 5th question
female	85.5	65.53	12.12	10.98	6.82	4.55
male	86.6	55.67	18.23	12.32	8.87	4.93
<50	91.02	45.97	5.65	15.32	15.32	17.74
51-60	86.04	48.45	14.43	19.59	17.53	-
61-70	83.81	59.41	24.75	15.84	-	-
71-80	75.35	78.30	21.70	-	-	-
81-90	79.79	100	-	-	-	-

Table A.5: Heckman two-step selection model: First step estimates for men and women, using different sets of variables

	Women			Men		
	Probit (1)	Probit (2)	Probit (3)	Probit (1)	Probit (2)	Probit (3)
Age 18-50	0.240**	0.144	0.237**	0.241**	0.207*	0.258**
	(0.108)	(0.121)	(0.109)	(0.115)	(0.126)	(0.116)
Age 51-60	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Age 61-70	-0.120	-0.046	-0.148	-0.025	0.003	-0.018
	(0.120)	(0.129)	(0.121)	(0.126)	(0.131)	(0.127)
Age 71-80	-0.396***	-0.309**	-0.413***	-0.274*	-0.227	-0.269*
	(0.124)	(0.135)	(0.125)	(0.140)	(0.148)	(0.142)
Age 81-90	-0.279*	-0.190	-0.291*	0.042	0.095	0.053
	(0.163)	(0.172)	(0.163)	(0.199)	(0.206)	(0.202)
No Diploma	-0.262*	-0.237	-0.191	-0.324*	-0.319*	-0.273
	(0.147)	(0.148)	(0.150)	(0.173)	(0.173)	(0.175)
Primary School certificate	-0.315**	-0.297**	-0.256*	-0.027	-0.025	0.004
	(0.141)	(0.142)	(0.143)	(0.168)	(0.169)	(0.171)
Junior High school	-0.158	-0.151	-0.129	-0.056	-0.055	-0.054
	(0.125)	(0.126)	(0.126)	(0.133)	(0.134)	(0.135)
High school diploma	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
University $\leq$ 2 years	0.186	0.168	0.168	0.120	0.115	0.072
	(0.168)	(0.169)	(0.169)	(0.189)	(0.189)	(0.190)
University $\geq$ 3 years	-0.066	-0.081	-0.083	0.233	0.231	0.174
	(0.159)	(0.160)	(0.160)	(0.170)	(0.170)	(0.173)
No answer to WTP question	-0.477***	-0.471***	-0.479***	-0.589***	-0.591***	-0.606***
	(0.085)	(0.085)	(0.085)	(0.089)	(0.090)	(0.090)
GP consult:Yes	-0.006	0.001	0.006	0.378***	0.380***	0.362***
	(0.158)	(0.158)	(0.158)	(0.119)	(0.119)	(0.120)
Father alive	-	0.131	-	-	-0.020	-
		(0.111)			(0.116)	
Mother alive	-	0.128	-	-	0.120	-
		(0.111)			(0.111)	
Low hapiness	-	-	-0.268***	-	-	-0.371***
			(0.093)			(0.103)
High hapiness	-	-	-0.031	-	-	-0.065
			(0.094)			(0.106)
Constant	1.338***	1.222***	1.404***	0.946***	0.890***	1.094***
	(0.200)	(0.212)	(0.207)	(0.173)	(0.184)	(0.184)
N		1814			1509	

Note: Estimation of a probit model, where Y=1 if the individual gave all requested probabilities requested to compute SLE and SUL. Value of the coefficients; standard errors are in parentheses; *** indicates statistical significance at 1%, ** at 5% and * at 10% level.

Table A.6: Three-stage least squares estimation of the three-equation model, women and men

	Women			Men		
	(1) SAH	(2) SLE	(3) SUL	(1) SAH	(2) SLE	(3) SUL
Mills ratio	11.637	10.184	-2.073	11.613	-5.070	-12.021***
	(22.373)	(10.497)	(5.392)	(15.966)	(8.484)	(4.170)
AGE						
Age	-0.246	-0.272***	0.013	-0.553**	-0.269**	0.033
	(0.223)	(0.104)	(0.054)	(0.216)	(0.115)	(0.056)
Age^2	0.002	0.005***	-0.002***	0.004**	0.005***	-0.002***
	(0.002)	(0.001)	(0.000)	(0.002)	(0.001)	(0.000)
HEALTH						
SAH	-	0.083***	0.008	-	0.114***	-0.004
		(0.012)	(0.006)		(0.014)	(0.007)
Vital Risks:						
0 illness of type N	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
1-2 illnesses of type N	-5.517***	-0.105	0.818**	-2.508**	-0.540	-0.022
	(1.429)	(0.672)	(0.345)	(1.136)	(0.603)	(0.296)
$\geq$ 3 illnesses of type N	-9.809***	-0.711	0.733**	-5.915***	-1.041	0.020
	(1.436)	(0.672)	(0.345)	(1.264)	(0.659)	(0.324)
0 illness of type AC	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
1 illness of type AC	-6.886***	-1.340**	-0.104	-3.585***	-0.982	0.334
	(1.250)	(0.592)	(0.304)	(1.286)	(0.684)	(0.336)
$\geq$ 2 illnesses of type AC	-7.423***	1.423	-0.273	-5.651**	-1.493	0.362
	(2.591)	(1.214)	(0.623)	(2.392)	(1.271)	(0.625)
0 illness of type A	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
$\geq$ 1 illnesses of type A	-8.505***	-1.215*	-0.228	-10.522***	-2.131**	-0.066
	(1.426)	(0.667)	(0.343)	(1.681)	(0.905)	(0.445)
0 illness of type C	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
1 illness of type C	-1.791	-0.881	0.304	-3.616***	-0.109	0.504*
	(1.185)	(0.556)	(0.286)	(1.132)	(0.604)	(0.297)
$\geq$ 2 illnesses of type C	-5.028***	-2.689***	-0.608	-8.753***	-1.923**	-0.472
	(1.707)	(0.801)	(0.411)	(1.564)	(0.841)	(0.413)
Functional Limitations:						
Difficulties to walk: Yes	-4.522***	-	-	-5.932***	-	-
	(1.371)			(1.435)		
Bed-ridden: Yes	-2.297	-	-	-1.248	-	-
	(1.542)			(1.622)		
Difficulties in everyday activities: Yes	-5.493***	-	-	-5.627***	-	-
	(1.528)			(1.586)		
Pain: Yes	-3.355***	-	-	-2.307**	-	-
	(1.205)			(1.104)		

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Table A.6 – continued from previous page

	Women			Men		
	(1) SAH	(2) SLE	(3) SUL	(1) SAH	(2) SLE	(3) SUL
PARENT DEATH AND AGE OF DEATH						
Father alive	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Father alive - age unknown	6.641	-1.385	6.250***	7.945	0.026	5.434***
	(6.648)	(3.122)	(1.604)	(6.621)	(3.518)	(1.729)
Father alive - age	0.044	-0.006	0.058***	0.096	0.078*	0.044**
	(0.085)	(0.040)	(0.021)	(0.087)	(0.046)	(0.023)
Father deceased	1.097	-1.334	4.845***	7.075	3.203	2.848*
	(6.493)	(3.046)	(1.564)	(6.561)	(3.489)	(1.715)
Father deceased - age unknown	4.078	1.097	0.063	-0.054	2.232	0.587
	(3.843)	(1.804)	(0.927)	(3.679)	(1.950)	(0.959)
Father deceased - age	0.075	0.003	-0.002	0.007	0.020	0.003
	(0.047)	(0.022)	(0.011)	(0.046)	(0.025)	(0.012)
Mother alive	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Mother alive - age unknown	-9.407	1.912	-2.988*	-6.260	8.472**	-4.510**
	(7.249)	(3.399)	(1.746)	(7.308)	(3.888)	(1.911)
Mother alive - age	-0.126	0.003	-0.025	0.005	0.020	-0.022
	(0.085)	(0.040)	(0.020)	(0.087)	(0.046)	(0.023)
Mother deceased	-8.159	-4.208	-1.966	-1.961	0.086	-2.020
	(6.551)	(3.075)	(1.579)	(7.317)	(3.890)	(1.912)
Mother deceased - age unknown	-3.261	0.545	-0.220	2.148	-1.719	-0.499
	(4.434)	(2.080)	(1.068)	(4.589)	(2.445)	(1.202)
Mother deceased - age	-0.032	0.028	-0.002	-0.009	0.005	-0.001
	(0.050)	(0.023)	(0.012)	(0.053)	(0.028)	(0.014)
LIFESTYLES						
Smoker : Yes	-1.989*	-1.948***	-0.124	-3.329***	-2.289***	-0.433*
	(1.057)	(0.495)	(0.254)	(0.918)	(0.491)	(0.241)
Underweight	-1.157	-1.366	-0.457	-13.518***	4.469**	-1.957*
	(2.099)	(0.985)	(0.506)	(4.023)	(2.147)	(1.055)
Normal weight	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Overweight	-2.860**	0.372	0.168	-1.489	-0.385	-0.009
	(1.118)	(0.525)	(0.270)	(0.977)	(0.520)	(0.256)
Obese	-3.382**	1.689**	0.324	-2.811*	0.024	-1.207***
	(1.510)	(0.708)	(0.363)	(1.528)	(0.814)	(0.400)
Severely Obese	-10.645***	-0.214	0.052	-8.735***	-0.789	-1.193**
	(1.833)	(0.866)	(0.445)	(1.868)	(1.001)	(0.492)
No Alcohol	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Alcohol - no risk	3.113***	1.136**	-0.184	1.210	1.338**	0.098
	(0.977)	(0.459)	(0.236)	(1.102)	(0.587)	(0.288)
Alcohol - risky behaviour	-1.086	0.493	0.101	-0.421	-2.266**	0.166

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Table A.6 – continued from previous page

	Women			Men		
	(1) SAH	(2) SLE	(3) SUL	(1) SAH	(2) SLE	(3) SUL
	(2.836)	(1.330)	(0.683)	(1.910)	(1.017)	(0.500)
SOCIO-DEMOGRAPHIC						
Education:						
No diploma	-4.164**	-0.766	0.112	-3.503*	-0.663	-0.161
	(1.883)	(0.885)	(0.455)	(1.927)	(1.024)	(0.503)
Primary School certificate	-6.437***	-0.674	0.510	-1.985	-1.836*	-0.223
	(2.009)	(0.944)	(0.485)	(1.915)	(1.020)	(0.501)
Junior High school diploma	-4.334***	-1.314**	0.988***	-1.029	-2.596***	-0.532
	(1.392)	(0.655)	(0.337)	(1.248)	(0.664)	(0.326)
High school diploma	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
University ($\leq$ 2 years)	-0.699	0.999	1.047***	1.139	-1.556*	-0.707
	(1.649)	(0.774)	(0.398)	(1.645)	(0.874)	(0.430)
University ($\geq$ 3 years)	-2.959*	0.896	0.437	1.029	-0.524	0.021
	(1.684)	(0.791)	(0.406)	(1.520)	(0.806)	(0.396)
Other diploma	-29.389**	-3.180	0.693	-13.096	3.766	1.916
	(13.749)	(6.463)	(3.319)	(8.342)	(4.445)	(2.185)
Income:						
Income $\leq$ 875 €	-4.010***	-1.188*	-0.187	-2.382*	-0.733	-1.420***
	(1.383)	(0.651)	(0.334)	(1.316)	(0.701)	(0.344)
Income $\in [875 - 1290]$ €	-3.255**	-0.406	0.034	-0.682	0.077	-0.572*
	(1.277)	(0.601)	(0.309)	(1.188)	(0.630)	(0.310)
Income $\in [1290 - 1800]$ €	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Income $>$ 1800 €	-1.048	-0.075	-0.279	0.422	-1.208*	-0.426
	(1.346)	(0.631)	(0.324)	(1.168)	(0.622)	(0.306)
Health Insurance:						
National Health Ins. only	-1.196	-0.853	1.017*	-2.370	0.819	0.121
	(2.173)	(1.019)	(0.524)	(1.649)	(0.879)	(0.432)
CMUC	2.139	-0.330	0.305	-5.319**	-4.424***	0.324
	(1.990)	(0.931)	(0.478)	(2.191)	(1.169)	(0.575)
Complementary Insurance	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Family Situation:						
Single	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Marital life	0.899	0.585	0.498**	1.355	-0.054	0.032
	(1.030)	(0.483)	(0.248)	(1.026)	(0.546)	(0.269)
No Child	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
At least one child	0.436	-0.068	-0.223	1.237	-0.886	-0.151
	(1.056)	(0.496)	(0.255)	(1.075)	(0.571)	(0.281)
Constant	99.269***	71.453***	11.747***	92.589***	67.961***	17.805***
	(8.756)	(4.268)	(2.192)	(6.699)	(3.780)	(1.858)
R2	0.353	0.317	0.446	0.359	0.341	0.412

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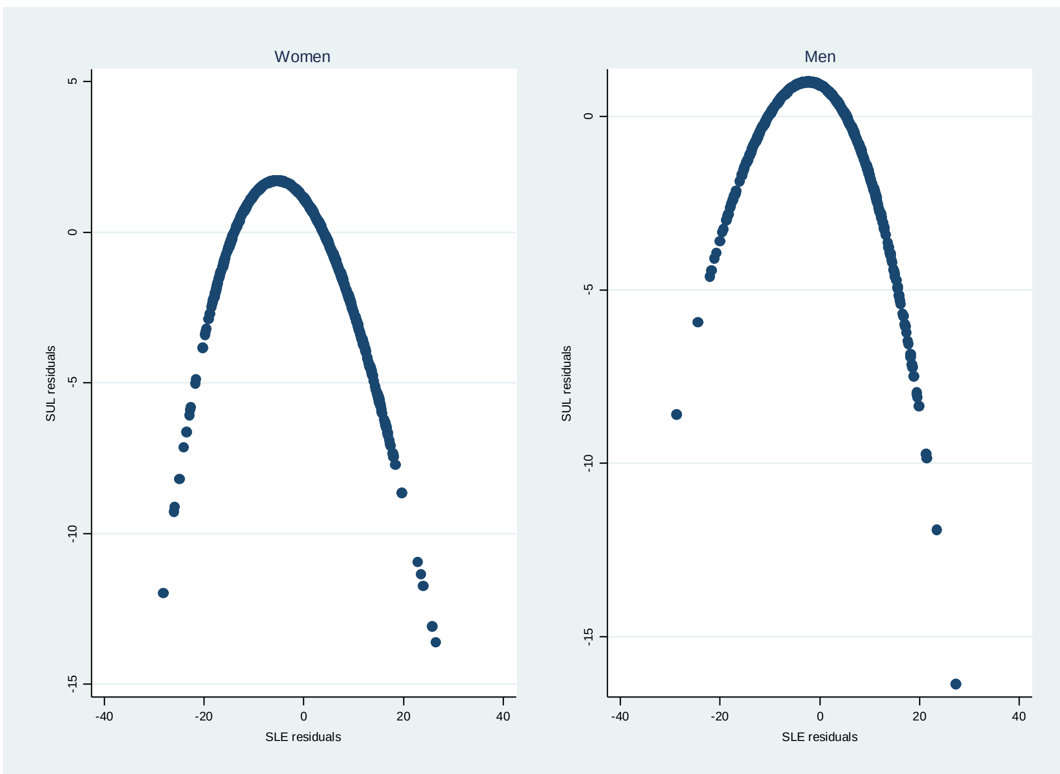
Table A.6 – continued from previous page

	Women			Men		
	(1) SAH	(2) SLE	(3) SUL	(1) SAH	(2) SLE	(3) SUL
N		1504			1292	

Note: Standard errors are in parentheses; *** indicates statistical significance at 1%, ** at 5% and * at 10% level.

4.3 Distribution of SUL residuals by SLE residuals

Figure A.9: Distribution of SLE residuals by SUL residuals - results of the estimates of model (5)



4.4 Impact of vital risks on SAH

The impacts of vital risks on SAH (equation (I) of model (5)) appear to be significant and quite large. Some are valued similarly[4] by men and women, some others have very different impacts on men and women SAH. : having 2 or more illnesses of type AC (Acute and Chronic, such as myocardial infarction or tumor) "costs" 7.5 points for women and 5.7 points for men; having at least one illness of type A (Acute, such as depression, phlebitis or pulmonary embolism) "costs" 8.5 points for women and 10.6 points for men. It is worth noticing that functional limitations have a significant negative influence on SAH (except being bed-ridden), even in a regression where vital risks are controlled for. Women and men evaluate the impact of functional limitations, i.e. disability and pain, similarly.

More differences appear between women and men for illnesses of type N (do not shorten or threaten life, such as migraine, lumbago or arthritis): having 1 or 2 of such illnesses decreases the assessment by women of their own health by 5.6 points, having 3 or more by 9.9 points. The corresponding values are significantly lower for men: 2.6 and 6 points. There is also a difference between women and men in the valuation of illnesses of type C (Chronic, such as hypertension or diabetes). In this case, men ascribe a higher cost than women do: having 1 illness of type C decreases SAH for men by 3.6 points, having 2 or more by 8.8 points. The corresponding values are much lower for women: 1.8 (not significant) and 5 points. These differences in assessments by men and women might derive from three factors: gender differences in the "pricing" of illnesses, unobserved differences in the seriousness of illnesses, or, more simply, differences in the prevalence of specific illnesses within the same vital risk category (within category AC, men have more heart attacks and women more asthma). Detailed regressions including illnesses instead of vital risk variables show that they are many differences between men and women in the impacts of illnesses on SAH. So, the three factors are likely to contribute to these gender differences.

[4] In the whole of this section, the differences in coefficients between men and women that are commented on are significant (5 %).

5 References

Bound, J., Jaeger, D. A., Baker, R. (1995). Problems with Instrumental Variables Estimation When the Correlation Between the Instruments and the Endogenous Explanatory Variables is Weak, *Journal of the American Statistical Association*, vol. 90, pp. 443–450.