Journal Pre-proofs

Full length article

How Do Subjective Life Expectancies Compare with Mortality Tables? Similarities and Differences in Three National Samples

D .Bell, D .Comerford, E .Douglas

PII: S2212-828X(20)30006-2
DOI: https://doi.org/10.1016/j.jeoa.2020.100241
Reference: JEOA 100241

To appear in: *The Journal of the Economics of Ageing*

Received Date: 15 January 2019
Revised Date: 16 January 2020
Accepted Date: 22 January 2020

Please cite this article as: D. .Bell, D. .Comerford, E. .Douglas, How Do Subjective Life Expectancies Compare with Mortality Tables? Similarities and Differences in Three National Samples, *The Journal of the Economics of Ageing* (2020), doi: https://doi.org/10.1016/j.jeoa.2020.100241

How Do Subjective Life Expectancies Compare with Mortality Tables? Similarities and Differences in Three National Samples

Bell, D., Comerford, D., Douglas, E.*
University of Stirling

* Corresponding author

Abstract

Estimates of personal longevity play a vital role in decisions relating to asset accumulation and decumulation. Subjective life expectancy (SLE) is a measure of individuals' expectation of remaining years of life. Either explicitly or implicitly, it is a key determinant of consumption and savings behaviour, and may be guided by a person's own health and health behaviours. The Gateway to Global Aging, a platform for the Health and Retirement Study's (HRS) family of population surveys, provides harmonised longitudinal datasets for many countries, each based on individual survey responses from respondents aged 50 and above. In this paper, we analyse SLE three of these datasets: the English Longitudinal Study of Ageing (ELSA), The Irish Longitudinal Study of Ageing (TILDA) and Healthy Ageing in Scotland (HAGIS). First, we focus on measurement of SLE, followed by the SLE differential – the discrepancy between SLE and mortality risk indicated by population life tables. One novel finding from our analysis is that the SLE differential is positive for Ireland and is negative for Scotland and England. This difference does not appear to be explained by differences of survey design or population characteristics.

Introduction

Subjective life expectancy (SLE) has attracted the attention of economists since Dan Hamermesh (Hamermesh, 1985) pointed out the absence of any consideration of how long people are expected to live in the life-cycle models of individual consumption and saving that are central to the micro-foundations of macroeconomics. Other social scientists have also researched SLE, seeking to identify its main determinants and consequences, including retirement planning (Griffin, Hesketh, & Loh, 2012; van Solinge & Henkens, 2010), health outcomes and health behaviours (Griffin, Loh, & Hesketh, 2013; Kobayashi, Beeken, & Meisel, 2017).

The SLE literature predominantly involves surveys where respondents are asked to assess their longevity. The Health and Retirement Study (HRS), and those studies deriving from it, now cover more than 70 per cent of the world's population aged 50+. These studies have proven to be useful resources for such analysis. This literature has yielded considerable insights into SLE at the national level, yet the possibilities for cross-country comparative analyses have not been exploited until now. Two possible strategies for eliciting estimates of SLE are (1) a probabilistic method, where individuals are asked to estimate the probability of living to a given age and (2) a point estimate - where individuals are asked how long they expect to live, or when they expect to die.

This paper presents a novel cross-country analysis of SLE using data from three studies from the British Isles that are members of the HRS family: the English Longitudinal Study of Ageing (ELSA), the Irish Longitudinal Study on Ageing (TILDA) and Healthy Ageing in Scotland (HAGIS). England, Ireland and Scotland have broadly similar economic, cultural and social structures, as well as a dominant common language. Actual life expectancy varies moderately across these countries. The most recent estimate of life expectancy at birth for women in Scotland is 81.1 years, in England is 82.9 years and in the Republic of Ireland is 83.4 years.

In this study we seek to answer two core research questions:

1) How do SLE measures compare across these three studies? Given that the probabilistic method of eliciting SLE requires more mathematical skills to answer, we hypothesise that i) respondents who are less numerate will be less likely to answer a probabilistic SLE question than those with greater numeracy and ii) less numerate respondents will be more likely than more numerate respondents to offer a "rounding" response of 50% and 100%.

2) To what extent do differences in relevant population characteristics and elicitation procedures predict differences between objective and SLE measures (calculated as SLE Differential)?

Research question 1 contributes towards the identification of those research questions that can be meaningfully addressed using SLE data. Systematic differences in SLE across cultures could reflect differences in substantive beliefs that may be associated with differential behaviours around health, saving etc. If instead the differences are the result of varying approaches to SLE elicitation across

surveys, then it is important that researchers be aware of these when interpreting their results. This is one of the first papers to discuss these issues using SLE data from several countries. As such, it should provide a fertile base for future inquiry. The question is addressed in Section I: Comparing Subjective Life Expectancy Across Countries and Elicitation Procedures. Here, we introduce SLE and OLE and briefly summarize previous research comparing the two. We observe the measurement of life expectancy in ELSA, TILDA, and HAGIS, and the potential effects of their different elicitation procedures. We observe the distribution of SLE across the countries, and discuss issues of non-response and rounding, and the extent to which these can be explained by differences in numeracy and education.

Research question 2 is important because it addresses the association between the SLE differential and population characteristics. Because we standardise the SLE differential across the three data sets, we can measure the relationships between population characteristics and SLE differentials in each country, and compare these associations across countries. This is only possible when using harmonised survey data like those HRS-derived studies that are available from the Gateway To Global Ageing. The results could be of interest to researchers from a range of disciplines, from demography through epidemiology to economics. This research question is addressed in Section II: Comparing the SLE Differential Across Countries. Here, we concentrate on the SLE differential: the extent to which SLE differs from an objective measure of life expectancy (OLE) – the mortality risk indicated by population life tables. Previous research has tested whether the SLE differential varies across respondents' demographic and socioeconomic characteristics (Griffin et al., 2013; Kobayashi et al., 2017). Our study extends this research by investigating how the SLE differential varies across country: and to what extent this is explained by elicitation procedures and health characteristics.

In the final section, we summarize our key findings, discuss their likely causes and implications. We conclude with some recommendations for data collection practices in longitudinal aging studies.

Section I: Comparing Subjective Life Expectancy Across Countries and Elicitation Procedures

SLE is an individual's expectation of their own longevity. It therefore reflects private knowledge of health status and other risk factors. It should therefore provide information that is implicit in important decisions such as asset accumulation and decumulation. SLE data are especially interesting if they are systematically biased. For example, if people tend to underestimate how long they are likely to live, lifecycle decisions around consumption, saving and investment will be premised on misleading information. O'Dea and Sturrock (2018) suggest that a negative bias in SLE reported in younger middle age explains why annuities are purchased less frequently than expected, given their actuarial value.

The HRS has collected data on SLE since the early 1990s. It asks respondents to estimate the probability that they will live to a certain age. This probabilistic elicitation procedure is also used in ELSA and TILDA. Another way of eliciting life expectancy is to ask people to what age they expect to

live – a point estimate of age of death. This method is used in the Survey of Consumer Finances and has been adopted by HAGIS.

Conceptually, the probabilistic elicitation procedure has several advantages over the point estimate procedure. First, it recognizes that death is a stochastic event – individuals have an implicit distribution of the age at which they may die. Second, it elicits a precise concept – what is meant by a 12 percent chance of living to age X is unambiguous. The point estimate procedure is weaker conceptually because it constrains the respondent to make a statement along the lines of "I believe I will die at age X". The conceptual problem with this statement is that it is unclear whether respondents' point estimates represent a mean, a mode, a median or some hybrid statistic derived from the implicit distribution of expected time to death. One might therefore surmise that inference based on point estimates would be less ambiguous than that based on reported probabilities. However, respondents face practical difficulties with answering probabilistic questions, as set out below, which means that answers to the probabilistic questions that are currently used in surveys are unlikely to deliver accurate measures of respondent's true beliefs (Bago d'Uva, O'Donnell, & van Doorslaer, 2017).

Wu, Stevens and Thorp (2015) test the consistency of life expectancy implied by the point estimate procedure against the probabilistic procedure. They find "very low consistency" across the two measures though they should, in principle, yield similar estimates: mean time to death differed depending on whether it was inferred from a probabilistic estimate or a point estimate.

One explanation for this low consistency might be "rounding". This is the tendency to use salient round numbers (often multiples of tens or fives) when asked for a numerical estimate. Two models have been proposed to explain the use of round numbers and both are consistent with the mismatch observed in Wu, Stevens and Thorp (2015). We will now describe these models and their predictions because they offer testable hypotheses to explain differences in SLE across procedures and across surveys.

Manski and Molinari suggest that respondents use round numbers as a proxy for numbers within an interval around the rounded response (Manski & Molinari, 2010). In this view, a respondent who believes that their distribution of life expectancy has a mean of 79 might report a point estimate of 80.

The second model is Hudomiet and Willis' Modal Response Hypothesis (Hudomiet & Willis, 2013). It posits that respondents report the mode of their subjective likelihood distribution rather than its mean. The model offers an attractive account for the prevalence of 100% and 0% responses in SLE data. Where it would be patently incorrect to report a mean of 100% in response to an SLE question, it might be valid to report a mode of 100%. Further, the Modal Response Hypothesis offers a reasonable explanation for the preponderance of 50% responses in SLE data. If subjective likelihood distributions are bimodal (because the respondent can call to mind roughly as many cases of people like them being dead by a given age as being alive by that same age) then respondents summarize

this ambiguous evidence by reporting "50%". We will return to these predictions in our descriptive analysis of SLE data.

For now, this argument is helpful in explaining why Wu, Stevens and Thorp (2015) found discrepancies across point estimate and percentage chance questions. Both models predict that rounding will have a substantively different effect on inferred life expectancy depending on whether one is asked for a probability of living to a given age or whether one is asked for a point estimate of the age at which you will die. Let's consider the Manski and Molinari (2010) model: a respondent who "rounds" her point estimate of SLE from 79 to 80 has an expectation of one extra year of life as a result of rounding in answer to the point estimate question. In contrast, there will be a much smaller gain in life expectancy implied by a rounding from 79% to 80% in response to the question: "what is the percentage chance you will live to be 85?". Now consider the Modal Response Hypothesis. An answer of 100% is interpreted as the mean when inferring life expectancy from the probabilistic SLE data. If a respondent reported 100% as the mode of their distribution and would have reported something less than 100% as the mean of their distribution, then there is a positive bias in life expectancy that occurs specifically because the respondent was asked to report a probability.

Another explanation for the discrepancy across the probabilistic and point estimate measures is that the SLE probabilistic question in the ageing surveys elicits a "percent chance" and people struggle to understand information that is presented in the form of percentages. An experiment that randomly assigned people to view statistical information presented in either percentages or natural frequencies found that people made less logical inferences in the percentage case i.e. people understand 1 in 20 better than they understand a 5% chance (Gigerenzer & Hoffrage, 1995). Lay people tend to put less weight on statistical information when it is presented as a percentage than when it is presented as a natural frequency (Fagerlin, Wang, & Ubel, 2005). A certain level of numeracy (i.e. comfort and competence with processing numerical information) is necessary to provide well-formed responses to questions framed around probabilities (Reyna & Brainerd, 2007).

An indication that there is measurement error in the probabilities reported in SLE data is that around 1 in 5 respondents to the HRS reported a 50% probability of living to age 75 (Hurd, 2009). At follow-up, respondents who had answered 50% were asked if they consider it equally likely that they would die *before* the age of 75. Logically, these respondents should all have reported that they are equally likely to die before age 75 as after age 75 but just 37% did so. Thus, 15 percent of respondents to the life expectancy question reported a 50% probability even though they did not believe that there was a 50% probability of dying at age 75. The "50% blip" is a particularly salient form of misreporting of beliefs. Also, recent research found 7 percent of respondents to ELSA reported a 100% probability of living a decade into the future; given risk of accidental death, these 100% responses could be interpreted as evidence that respondents misunderstand the objective probabilities (O'Dea & Sturrock, 2018). As noted above, however, these response patterns could equally be interpreted as

support for the Modal Response Hypothesis (Hudomiet & Willis, 2013): in this view, survey researchers are wrongly inferring *means* from respondents' *modes*.

Previous research has identified that questions which ask respondents to report percentages are vulnerable to specious 50% responses; respondents who have no idea of the true percentage are more likely to answer 50% (Fischhoff & Bruine De Bruin, 1999). A priori, we would expect less numerate respondents to be less well-informed of the true percentage and so we would expect them to be more likely to respond with a 50% estimate, or to give no response at all.

An additional concern regarding the probabilistic procedure emerged when respondents were asked to report the probabilities of living to 65, 75, 85 and 95. Twelve percent of respondents reported higher probabilities of being alive at older ages than at younger ages, a response that is transparently incorrect (Comerford & Robinson, 2017).

The foregoing suggests that the probabilistic procedure is likely to induce measurement error but it would be a mistake to conclude that point estimates are immune from such problems. Comerford and Robinson (2017) experimented with elicitation procedures that used "live-to" and "die-by" frames. A coherent life expectancy estimate would be insensitive to framing effects: someone who reports a 12% chance of dying by age 75 should also report an 88 % chance of living to age 75 (probabilistic) and someone who expects to live to age 87 should also expect to die at age 87 (point estimate). Coherence was rejected for both procedures. There was a seven-year discrepancy when SLE was elicited by the probabilistic procedure but just a three-year discrepancy when SLE was elicited by the point estimate procedure. Both the point estimate and probabilistic procedures displayed incoherence, although that incoherence was significantly larger for the probabilistic procedure.

In summary, there are two very different formats used in surveys to elicit SLEs and neither is ideal. Researchers should be wary of interpreting at face value difference in SLE across groups because these differences might reflect differences in response bias (Bago d'Uva et al., 2017; Peter Hudomiet, Hurd, & Rohwedder, 2018). In the light of these findings, we now consider SLE responses in our three surveys.

Methods I

Data

The English Longitudinal Survey of Ageing

ELSA is carried out every two years and covers a representative sample of the English household population aged 50 and over. We use Wave 7 fieldwork data which was gathered in 2014-15. 9,666 people participated in ELSA, of whom 9,334 were aged between 50-90 years. ELSA groups people aged 90+ into one age band so these respondents were excluded from the analyses as we could not calculate their current age. Of the 9,334 respondents who were asked questions on SLE, 113 (1.2%) responded 'don't know', and 525 (5.6%) gave answers that were coded as being either

inappropriate, partial or proxy responses and 69 (0.7%) refused to answer. This provides usable SLE data from 8,627 respondents. The SLE questions were asked as part of the Computer Assisted Personal Interview (CAPI).

The Irish Longitudinal Study on Ageing

We use Wave 1 of TILDA, data for which were collected between October 2009 and July 2011. Later waves of TILDA did not elicit SLE. The sample is representative of the Irish household population aged 50 and over (Kearney et al., 2011). 8492 people participated in TILDA Wave 1 during fieldwork when the life expectancy question was last asked, of whom 8163 were aged over 50 years. TILDA groups people aged 80 and over into one age band, so a further 626 were excluded from the analyses because their current age could not be calculated. A further 21 (0.3%) respondents refused and 470 (6.2%) answered 'don't know', leaving 7046 valid responses. The SLE questions were asked as part of the Computer Assisted Personal Interview (CAPI).

Healthy AGeing In Scotland

1,057 people participated in the HAGIS pilot study during its fieldwork phase in 2016-17. Of these, 703 returned the self-completion questionnaire that asked the question on SLE. Of these 703, 7 did not provide sufficient information to determine their current age. A further 7 were excluded, as they were aged over 90 which meant their SLE could not be compared with the OLE estimation. Eight responses were nonsensical (e.g. life expectancy lower than current age). Finally, 37 did not answer the SLE question. This left 644 valid responses.

There were three procedural differences in how SLE data were collected across the three surveys: mode, sample composition and elicitation format. For the mode difference: ELSA and TILDA respondents were asked about SLE as part of an interview, whereas HAGIS respondents provided their response using a self-completion paper questionnaire. The sample composition difference is that all ELSA and TILDA respondents were asked the SLE question as part of the interview, whereas in HAGIS, only those who responded to the self-completion survey encountered the SLE question.

Measures I

Subjective Life Expectancy (SLE)

ELSA and TILDA respondents were asked to provide a probabilistic response as part of the main CAPI questionnaire. In ELSA, respondents were asked '*What are the chances that you will live to be [x_Age] or more*?', and in TILDA '*what is the percent chance that you will live to be [x_Age]*?' The age in years [denoted *x_Age* in the questions above] varied systematically across respondents (see Table 1). It was based on respondents' current age such that they were always asked about the probability of living at least 10 years beyond their current age. HAGIS respondents were asked 'At what age would you expect yourself to live?', and to estimate their response if not sure.

Numeracy

To test the effects of numeracy on SLE response, we construct a binary measure of probability numeracy (Hudomiet et al., 2018) based on the following question from ELSA: 'If 5 people all have

the winning numbers in the lottery and the prize is two million dollars, how much will each of them get?' Using ELSA's numeracy scale we code as high numeracy the 60 percent of respondents who correctly answered this question[1] and coded as low numeracy the remainder.

Education

ELSA and TILDA and respondents were asked to report the highest educational qualification they attained. Given educational qualifications differ across England and Ireland, we pool respondents into comparable categories: those with some higher education (certificate, degree etc.); those with some secondary school qualification (e.g. O-level in England, Intermediate certificate in Ireland); and those with primary school education or less. One respondent, who answered "don't know" was dropped from TILDA. 747 respondents were dropped from ELSA for refusal to answer, "don't know", or for unspecified foreign qualifications.

Table 1. SLE Data from ELSA, TILDA, and HAGIS

	ELSA	**TILDA**
Country	England	Republic of Ireland
Elicitation Procedure	Probabilistic	Probabilistic
Mode	Interview	Interview
Question	*"What are the chances that you will live to be [x_Age] or more*?"	*"What is the percent chance that you will live to be [x_Age]*?"
Age of Respondent (*x_Age* asked about in Probability Question)	50-65‡ (75)	50-64‡ (75)
	66-69‡ (80)	65-69‡ (80)
	70-74 (85)	70-74 (85)
	75-79 (90)	75-79 (90)
	80-84 (95)	80+ *
	85-90 (100)	
	90+ *	

*‡ Minor variation in age bands in ELSA and TILDA. * ELSA and TILDA do not report respondents' current age if respondents are aged over 90 or 80 years respectively*

Statistical Analyses I

We use binary logistic regressions to test the effect of numeracy on:

1) the likelihood of answering the SLE question; and
2) the likelihood of responding 50% or 100%

We report the result of bivariate regressions i.e. we did not include any control variables in our independent hypothesis tests concerning numeracy.

[1] ELSA's numeracy measure differs across respondents, which compromises the ability to make comparisons. It asks respondents one question if they got the previous question correct and a different question if they got it wrong. For the purposes of this analysis, we take the numeracy measure that best splits the sample into correct and incorrect respondents as a crude measure of numeracy. It asked respondents to split a Lottery of win of £2,000 among five people.

Results I

Sample characteristics

Across all three studies, there were similar proportions of men and women (around 45% women and 55% men), see Table 2. The greatest proportion of respondents were in ages 50-65 age bands. For ELSA and TILDA, these are the probabilistic measures (% probability) of SLE and OLE and for HAGIS these are the point estimate (years).

Table 2. SLE (probability) ELSA & TILDA, and SLE (years) HAGIS

	ELSA Mean (SD) **% Probability**		**TILDA** Mean (SD), **probability**		**HAGIS** Mean (SD) **% Years**	
	Men	**Women**	**Men**	**Women**	**Men**	**Women**
Age (years)						
50-65‡ (75 years)	66.7 (23.4)	69.1 (21.5)	76.2 (24.8)	82.6 (23.1)	80.4 (8.2)	80.4 (6.9)
66-69‡ (80 years)	61.3 (23.5)	64.1 (23.9)	67.3 (26.7)	74.3 (27.2)	80.5 (7.1)	81.9 (4.7)
70-74 (85 years)	54.2 (25.9)	57.6 (24.7)	64.3 (30.0)	67.9 (29.6)	83.6 (6.5)	83.2 (4.2)
75-79 (90 years)	45.6 (28.7)	49.2 (27.5)	55.1 (31.2)	54.8 (34.0)	85.9 (6.7)	84.6 (4.5)
80-84 (95 years)	36.9 (29.5)	37.8 (30.1)	-	-	89.5 (5.0)	88.8 (3.9)
85-90 (100 years)	35.3 (32.5)	33.3 (31.2)	-	-	92.7 (4.2)	92.0 (4.5)

N.B.‡ Minor variation in age bands in TILDA.
† Subjective Life Expectancy was asked in a self-completion questionnaire, which was returned by 67% of total sample. Parenthesized figure indicates completion rate relative to that subsample who returned the self-completion questionnaire.

Distribution of SLE

Figure 1 shows the distribution of SLE probabilistic estimates from ELSA (Fig. 1a) and TILDA (Fig. 1b) and in years (point estimate) for HAGIS (Fig. 1c).

Figure 1. Subjective Life Expectancy

Fig. 1a. ELSA

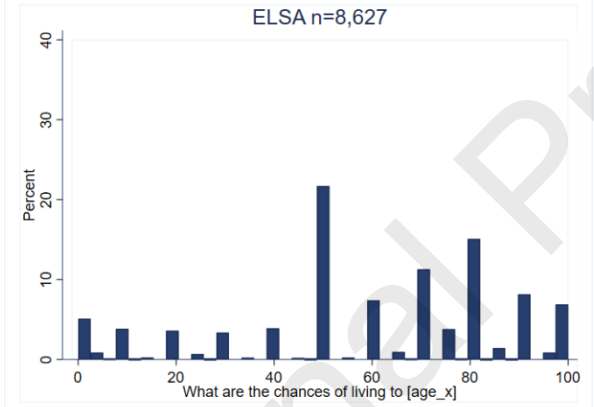


Fig. 1b. TILDA

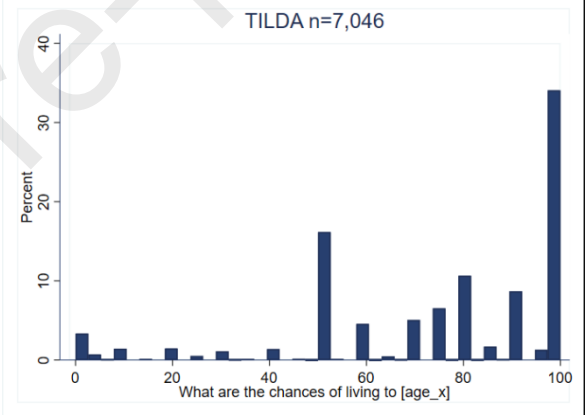
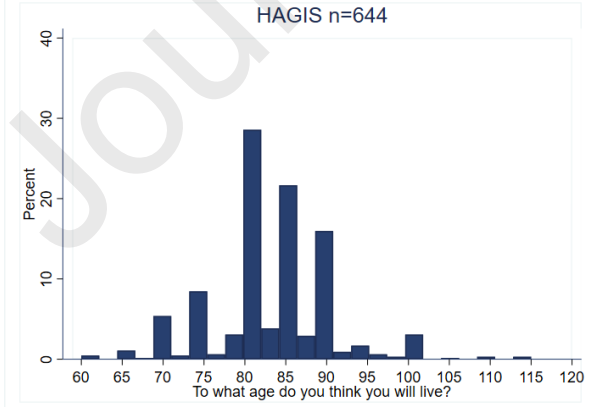


Fig. 1c. HAGIS



Probabilistic Responses & Rounding

One salient result from all three datasets concerns rounding. In ELSA and TILDA respondents report percentages that cluster around values ending in zeros. The HAGIS data also show rounding; respondents' expected age of death tends to cluster at values ending in zeros and fives (see Figure 1c). This trend is evident across the distribution even where there are few respondents, for example those who expect to live to 105, 110, or 115.

A more unexpected result is that the proportion of 100% responses is much higher in TILDA (32.8%) than in ELSA (6.6%), see Table 3. There are three broad categories of explanation for this novel finding and each has different implications[2]. One potential explanation is that the result stems from differences in survey design; in other words, the effect would disappear were study procedures identical across the Irish and English surveys. The second candidate is differences across Irish and English respondents in the use of round numbers (Manski and Molinari, 2010; Hudomiet and Willis, 2013). In this view, the effect is a manifestation of a country-specific pattern of survey response and so does not necessarily imply any cross-country difference in underlying mortality beliefs. The third is that the Irish have more positive beliefs regarding life expectancy than the English. This consideration is plausible given the Irish also report higher personal well-being than those in the UK (Michaelson, J., Abdallah, S., Steuer, N., Thompson, S., Marks, 2008, Appendix 4) . The contribution of this paper is descriptive – we seek to report similarities and differences in SLE across surveys. We must leave it to future research to explain more fully why 100 percent responses are much more common in TILDA than in ELSA. That said, Table 3 reports some data that is relevant to this question, which we now explore.

In theory, the survey design explanation might account for the observed difference because TILDA and ELSA used different target ages when asking 65 year olds about their SLE, and also because TILDA and ELSA have samples that differ in their age distributions (see Table 2). In practice, when people of the same age were asked virtually identical questions, there remained a difference across datasets in the likelihood of 100 percent responses. This is apparent if we look to the proportion of 100% responses given by 70-74 year olds in Table 3: 23 percent in TILDA compared with only 5 percent in ELSA. So, survey design does not offer a plausible explanation for the difference.

The rounding story makes specific predictions. Both the Manski and Molinari (2010) model of rounding and the Modal Response Hypothesis (Hudomiet and Willis, 2013) predict that round numbers will be used less frequently by more educated respondents. Yet, differences in education level across ELSA and TILDA also fail to account for the difference in 100 percent responses. Table 3 shows that at each level of education, TILDA respondents were substantially more likely than ELSA respondents to answer 100%. Moreover, there was a slight but statistically significant tendency for 100% responses to increase by education level in the TILDA sample (Pearson chi-squared = 15.54, $p <$

[2] Assuming the data has been correctly coded. While there is no way of knowing if there are instances of miscoding in the data – later waves of TILDA did not elicit SLE – the data from Wave 1 do show face validity.

.001), which runs contrary to the rounding hypothesis. Third, both the Manski and Molinari (2010) model of rounding and the Modal Response Hypothesis (Hudomiet and Willis, 2013) predict clustering at other salient round numbers (e.g. 0%, 50%). If rounding were more commonplace in TILDA than in ELSA, then we would expect to see higher response frequencies in TILDA than ELSA at 0% and 50%. Yet figures 1a and 1b show the opposite; ELSA shows slightly higher response frequencies than TILDA at 0% (5.0% in ELSA versus 3.0% in TILDA) and at 50% (21.7% in ELSA versus 16.2% in TILDA).

Lastly, the Manski and Molinari (2010) model explains the use of a round number as a proxy for an interval that is close in value to that round number. If the cluster at 100% is solely explained by rounding being more common in TILDA than in ELSA then, following the Manski and Molinari model, we would expect to observe a substantially higher proportion of responses in the interval 90 – 99% in the ELSA sample than in the TILDA sample. Yet, we do not. In fact, there is a lower proportion of responses in the interval 90 – 99% in ELSA than in TILDA (9.3% in ELSA versus 11.6% in TILDA). For all these reasons, we do not consider rounding to offer a complete explanation for the higher frequency of 100% responses in TILDA than in ELSA.

The third explanation for the high frequency of 100 percent responses in TILDA is that many Irish respondents believe that they will live at least another decade. TILDA included a follow-up question that asked respondents about their health prospects for the future. It asks: "what are the chances that you will move to a nursing home in the next five years?"[3] A helpful feature of this question is that it also asks for a percentage but it is reverse-coded relative to the subjective life expectancy question, i.e. someone who is very confident regarding their health prospects would be expected to report a high percentage in answer to the SLE question but a low percentage in answer to the nursing home question. This pattern of response is supported by the data. A univariate regression shows that those who answered "100%" to the SLE question reported a lower percentage than did other respondents when answering the nursing home question (n = 7,218; t = 10.21, p < .001). In summary, respondents who answered 100% look to be more optimistic than other TILDA respondents regarding their health prospects.

Probabilistic SLE Responses and Numeracy

Our measure of numeracy did not significantly predict the likelihood of giving a usable response to the probabilistic SLE question: 98.5% of less numerate respondents gave usable response to the SLE question in ELSA compared to 99.3 percent of more numerate respondents ($z = 0.90$, $p = .369$). Less numerate respondents were more likely than more numerate respondents to answer 50% as the probability of living to a given target age (26% of low numeracy respondents answered 50% versus 18% of high numeracy respondents, $n = 485$, $z = 1.97$, $p = .049$). We also tested whether numeracy predicts 100% responses and find that here higher numeracy positively predicts using the round

[3] In answer to this question there was a high frequency of 0% responses (85% of those who answered). There was a small frequency of 50% responses (2.3%) and a negligible frequency of 100% responses (0.4% of those who answered).

number. The ELSA data show that 100% was reported as the probability of living to a given age by 6% of low numeracy respondents and by 12% of high numeracy respondents (n = 485, z = 2.22, p = .026).

Table 3. Sample & Response Descriptives of Probabilistic Procedure: ELSA & TILDA

	ELSA 100% (n=8,627)	**TILDA 100% (n=7,046)**
Country	England	Republic of Ireland
Elicitation Procedure	Probabilistic % (n)	Probabilistic % (n)
SLE 0% Response (Total)	5.0% (428)	3.0% (214)
SLE 50% Response (Total)	21.7% (1,869)	16.2% (1,138)
SLE 100% Responses (Total)	6.6 % (573)	32.8% (2,316)
SLE 100% Responses (By Age)		
50-65 (50-64‡) years	8.7% (342)	39.3% (1,752)
66-69 (65-69‡) years	6.7% (92)	25.1% (274)
70-74 years	5.2% (65)	23.4% (202)
75 – 79 years	3.8% (41)	13.9% (87)
80 - 84 years	3.2% (20)	-
65 - 89 years	3.7% (13)	-
SLE 100% Responses (By Education)		
Further/Higher Education	5.9% (166)	34.9% (802)
High School Education	7.9% (231)	33.7% (1038)
Primary School/No Education	7.3% (155)	29.4% (632)
Other Responses		
Don't Know	1.2%	6.2%
Refused	0.7%	0.3%
Proxy or Inappropriate Response	5.6%	-
Usable Data	92.5%	93.5%

*N.B.‡ Minor variation in age bands in TILDA. * p=0.05, ** p=0.01, *** p<0.001*

To conclude, we found that a third of respondents to TILDA reported a 100 percent chance of living to the target age asked used by the survey; a far larger percentage than answered 100% in response to similar questions asked in ELSA. This difference across the English and Irish studies does not appear to be explained by differences across study design or by differences in respondents' propensity to either answer the question or to respond using round numbers.

Section II: Comparing the SLE Differential Across Countries

In this section we examine cross-country differences between subjective and objective life expectancy and to what extent differences between these are explained by elicitation procedures and health characteristics[4].

What is Objective Life Expectancy

Objective Life Expectancy (OLE) is derived from observed population mortality rates. Life expectancy is a measure of how long someone is expected to live, given their birth year, sex and current age (ONS, 2017). This information is summarised in life tables which indicate the probability that someone will die before their next birthday, given their current age and sex. There are two types of life table: cohort and period. A cohort life table gives the probability that people born in the same year have of dying at each single year of age over their life course. These are calculated using actual mortality data from the cohort and include projected mortality rates for the cohort in future years. Period life tables reflect mortality rates at a fixed point in time. Cohort life tables can account for trend changes in life expectancy (i.e. where life expectancy is increasing or decreasing over time). We use cohort life tables to measure OLE, which implies that we assume our survey respondents are aware of trends in life expectancy.

OLE is generally calculated at the national level by gender and birth cohort but we note that it is becoming increasingly fine-grained; in the US OLE is sometimes constructed by race and for sub-national geographies, such as census tracts (Arias, Escobedo, Kennedy, Fu, & Cisewski, 2018).

What is the SLE Differential

The SLE differential is SLE minus OLE. At the individual level, SLE will normally diverge from OLE for the simple reason that OLE is an average for the cohort and does not take account of private information held by the individual. Private information may include longevity of parents, genetic inheritance, current health status, health behaviours etc. (ONS, 2017). Note that life tables implicitly take account of "unexpected" causes of death, such as road traffic accidents or other relatively low probability causes of death which individuals may not incorporate in their SLE assessment because they are not regarded as significant potential causes of their own mortality. Unforeseen causes of deaths are, by definition, outside the individuals' information set and will therefore tend not to be incorporated into SLE, especially if the associated probabilities are small.

In various populations SLE has been found to be positively associated with OLE, though the two do not always correlate perfectly. The general approach in the literature has been to test whether known mortality risks explain SLE (for the US, see Hurd and McGarry (1995, 2002), (Schoenbaum, 1997); for the UK see Kobayashi, Beeken and Meisel, 2017; for Australia see Griffen, Loh and Hesketh, 2013). For instance, Griffen et al. (2013) categorized some respondents as being in a longer SLE group (those

[4] We do not include education in our models of the SLE differential because we do not have OLE data by education level.

whose SLE was at least 5 years longer than the OLE predicted by age and sex) and others as being in a shorter SLE group (those whose SLE was at least 5 years shorter than their OLE). Those in the shorter SLE group were more likely to be smokers and to have poorer subjective health status; those in the longer SLE group drank less alcohol. The authors concluded that people take many of the factors that predict actual mortality into account when estimating their own mortality, but that not all factors are weighted appropriately. This may be because it is a complex mental task to weight all the factors that predict life expectancy as well as all of their potential interactions.

A related approach to testing the validity of SLE is to test whether SLE reported by a respondent in a longitudinal study predicts that respondent's actual mortality. This approach has been applied to the HRS, where SLE has been found to forecast respondents' deaths even after controlling for subjective health (Smith, Taylor and Sloan, 2001; Siegel, Bradley and Kasl, 2003). The data to use this approach is only available when a longitudinal study which, like HRS, has been running for some time.

Another approach to assessing the validity of SLE data is to test for a systematic SLE differential: predictable differences between a population's SLE and OLE. If estimates of SLE match OLE estimates, then the mean SLE differential should be zero: there would be no difference between the average SLE of a representative sample of the population and the OLE revealed in population life tables.

Evidence suggests that SLE differentials may be robust across countries by age and gender. SLE generally underestimates OLE in the "young" old, but this effect disappears around age 85; this pattern has been reported for the US (Elder, 2013) ; Australia (Wu, Stevens and Thorp, 2015) and the UK (O'Dea & Sturrock, 2018). The second is that women tend to underestimate their longevity more than men: this finding is common across the UK (e.g. Kobayashi et al., 2016; O'Dea and Sturrock, 2018), the US (Bissonnette, Hurd, & Michaud, 2017) and Australia (e.g. Griffin et al., 2013).

Recent analyses have used longitudinal surveys to estimate OLEs by socioeconomic characteristics. Of relevance to the current research, there are differences across countries in the observed results. In a US sample, the better educated showed a positive SLE differential: they predict longer survival than OLE (Bissonnette et al., 2017). In the UK, those with higher education had a negative SLE differential (O'Dea and Sturrock, 2018). This difference across countries raises the possibility that cultural differences play a role in SLE differentials. It could also be, however, that variation in the SLE differential derive from differences in the procedures used to elicit SLE, which we now consider.

Objective Life Expectancy (OLE)

To derive OLE for Scotland and England, we used the ONS National Life Tables 2014-16 (ONS, 2019)[5] and, for the Republic of Ireland, the Irish Life Tables 2010-2012 (CSO, 2019)[6]. For all countries OLE is

[5] English and Scottish life tables sourced from https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/lifeexpectancies/datasets/nationallifetablesunitedkingdomreferencetables

[6] Irish Life Tables 2010-12 sourced from https://www.cso.ie/en/releasesandpublications/er/ilt/irishlifetablesno162010-2012/

taken from cohort life tables. For HAGIS we derive a point estimate of OLE, conditional on survival up to the respondents' current age and sex. For both ELSA and TILDA, we use the life tables to calculate an OLE Probability (OLEP) for comparison with the recorded SLE probability. The coverage dates in the life tables are matched as closely as possible to the respective ageing studies' fieldwork.

SLE Differential

The SLE differential was estimated by subtracting the SLE from the OLE measure for each responding individual. This resulted in a positive or negative outcome: positive for those who expect to live longer than indicated by the life tables; and negative for those who predict shorter lives.

Health Variables

Across all three surveys, we also collected data on the subjective general health of the respondent, which was measured on a five-point scale - excellent, very good, good, fair and poor - in each of the surveys. Responses of "don't know", "refused" or by proxy were coded as missing. We also gathered data on whether respondents reported that they had ever smoked, suspecting that smoking behaviour may affect SLE, given the publicity surrounding the adverse effects of smoking on health. This question was present in all three surveys. Those who responded 'no' were coded as having never smoked. Those who answered 'yes' were subsequently asked if they currently smoked for whom those who answered 'no' were coded as ex-smokers and those who answer 'yes' as current smokers.

Statistical Analyses II

Testing differences between OLE and SLE estimates

We compare SLE with estimates of life expectancy based on relevant life tables across the three surveys and observe such patterns by population characteristics, including age, gender, subjective health and smoking behaviour. This allows us to explore the population characteristics of those who predict that they will live shorter or longer than the objective measures of life expectancy. We called this variable the SLE Differential.

The SLE Differential was estimated by subtracting the SLE from the OLE measure. This resulted in a positive or negative outcome: positive for those who expect to live longer than the indicated by the life tables; and negative for those who predict shorter lives. For ELSA and TILDA these were the probability measures, and for HAGIS it was the point estimate measure in years. We created standardised variables to facilitate comparison of the regression results across the studies. We subsequently use regression models to test the association between the standardised SLE Differential and i) age, subjective health and smoking status, and ii) the interaction between age and health.

Results II

The population characteristics of the samples are reported in Table 4. ELSA and TILDA respondents were broadly similar in terms of subjective health although a higher proportion of TILDA respondents reported excellent health (15% men, 17% women in TILDA vs. 12% men, 12% women in ELSA) and fewer reported poor health (5% men and women in TILDA vs. 7.8% men, 7.5% women in ELSA). HAGIS respondents reported the poorest health with only 7% of men and 9% of women reporting excellent health and approximately 12% of both men and women reporting poor health.

A smaller proportion of ELSA respondents have never smoked. The highest proportion of never smokers were found in HAGIS. Across all three studies, women were more likely than men to have never smoked. This gender differential is vaguely discernible for current smokers, however, where only HAGIS report proportionally greater male than female smokers.

Table 4. Sample Descriptives for ELSA, TILDA, and HAGIS

	ELSA		**TILDA**		**HAGIS**	
Country	England		Republic of Ireland		Scotland	
No of observations	100% (n=8,627)		100% (n=7,046)		100% (n=644)	
Age	67.2 (9.3)		61.9 (8.1)		67.7 (9.5)	
Mean (Std.D), Min-Max	50-90 yrs		50-80 yrs		50-90 yrs	
% (n)	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**
	44.4 (3832)	55.6 (4795)	46.1 (3472)	53.9 (4065)	45.0 (290)	55.0 (354)
Age (years)						
50-65 (50-64‡)	44.3 (1696)	46.7 (2240)	61.2 (1999)	65.2 (2464)	43.1 (125)	45.2 (160)
66-69 (65-69‡)	16.7 (638)	15.2 (730)	16.7 (546)	14.5 (5548)	13.5 (39)	13.6 (48)
70-74	15.0 (575)	14.3 (684)	13.3 (433)	11.4 (430)	16.2 (47)	16.7 (59)
75-79	12.8 (490)	12.3 (591)	8.9 (291)	8.9 (335)	14.1 (41)	12.7 (45)
80-84	7.3 (278)	7.3 (351)	-	-	6.7 (28)	7.3 (26)
85-90	4.0 (155)	4.2 (199)	-	-	3.5 (10)	4.5 (16)
Subjective Health						
Excellent	11.7 (455)	11.9 (584)	14.7 (512)	17.1 (695)	7.1 (32)	9.0 (52)
Very good	29.5 (1150)	28.9 (1416)	29.4 (1020)	28.2 (1145)	25.6 (116)	26.8 (155)
Good	33.0 (1289)	32.9 (1612)	32.7 (1135)	32.3 (1313)	35.1 (159)	31.6 (183)
Fair	18.2 (709)	18.8 (924)	18.1 (628)	17.4 (708)	20.5 (93)	20.4 (118)
Poor	7.7 (299)	7.5 (368)	5.1 (176)	5.0 (204)	11.7 (53)	12.3 (71)
Smoking Status						
Never	30.7 (1263)	43.2 (2194)	35.9 (1247)	49.8 (2026)	40.7 (184)	54.8 (318)
Ex-smoker	57.7 (2372)	45.4 (2307)	45.3 (1574)	30.9 (1256)	39.8 (180)	28.6 (166)
Smoker	11.6 (479)	11.5 (584)	18.8 (651)	19.3 (783)	19.5 (88)	16.6 (96)

N.B.‡ Minor variation in age bands in TILDA.

SLE Differential

Figures 2 and 3 depict SLE and OLE for each age band and gender separately for the Irish and English surveys. Figure 2 shows that among the English samples, younger age groups tend to report SLEs

that are lower than the OLEs recorded in ONS life tables. In their seventies, respondents tend to report SLEs that match OLEs. From then on, English respondents tend to report SLEs that exceed their OLE. A second pattern of results that emerges from Figure 2 concerns the role of sex. In their 50s and 60s, males and females report SLEs that are similarly distant from OLEs but as respondents grow older, males report more optimistic SLEs than do females. Figure 3 depicts the Irish data. Here, respondents in their 50s and 60s report SLEs that converge with OLEs. Older respondents then go on to report SLEs that are more optimistic than OLEs. As with the English sample, males and females look similar to one another in their 50s and 60s but males become even more optimistic than females in later life. The distribution of SLE differential across studies is available in the Appendix (Figure 5).

Figure 2. ELSA: SLE v OLE (probabilities) by age and sex

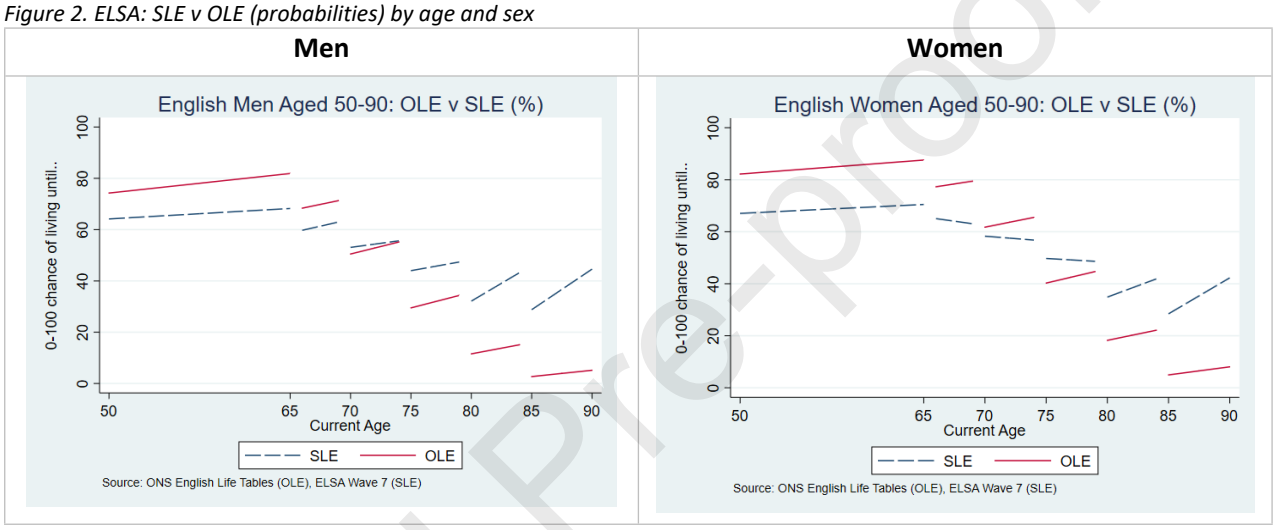
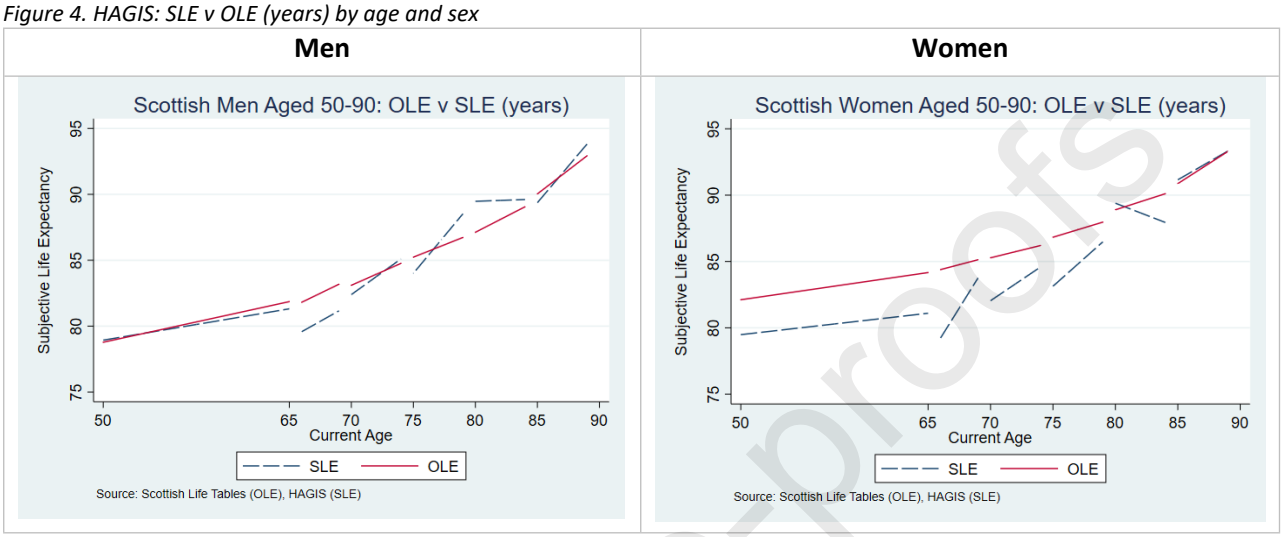


Figure 3. TILDA: SLE v OLE (probabilities) by age and sex

Figure 4 demonstrates comparisons of subjective and objective life expectancy in men and women in HAGIS. While these data represent the responses in years (point estimate procedure) they have been categorised according to the age groupings used in the probabilistic questions for comparison

across equivalent age groups. When the mean SLE is compared to the OLE drawn from the Scottish Life Tables we found that prior to age 85, women tended to predict shorter lives than indicated by OLE, and thereafter their estimates were more aligned with the life table estimates. Overall, the SLE responses in men were similar to the life table estimates with the exception of those aged 60-65, where SLE was lower than OLE.

Figure 4. HAGIS: SLE v OLE (years) by age and sex



We created standardised variables to facilitate comparison of the regression results across the studies. The mean ELSA SLE differential indicates that the English sample overestimated their life expectancy by 4.79 percentage points than the life tables predict for the average English person of their age and gender (CI: -4.81— -4.76, $z(8,627) = -4.40$, $p<0.001$). If the subjective and objective measures of life expectancy produced the same results, then the SLE differential should be close to zero because the characteristics of the average respondent to ELSA are representative of the characteristics of the average member of English households[7]. For TILDA, the SLE differential is also significantly different from zero. Like the ELSA SLE differential, it is also sizable (more than three percentage points in absolute terms). However, the direction of the SLE differential is positive in the Irish case (SLE differential: 3.39, CI: 3.36 — 3.41, $z(7,045) = 284.28$, $p<0.001$).

To test for the extent to which this difference in SLE differentials across TILDA and ELSA may be driven by 100% responses, we excluded 100% responses from both TILDA and ELSA. When we do so, we still find that the TILDA sample exhibits a more positive SLE differential than the ELSA sample (TILDA: -6.89 percentage points; ELSA: - 7.12 percentage points) though the difference across TILDA and ELSA is not statistically significant (unpaired t-test: $df = 12,782$; $t = 0.47$, $p = .637$). Note, however, that the test we have just reported biases TILDA's SLE differential downwards relative to ELSA's SLE differential. This occurs because we have dropped the most positive 32.8% of the TILDA sample in terms of SLEs whereas we have only dropped the most positive 6.6% of the ELSA sample. A

[7] The bias induced by the exclusion of the institutionalised population from the ELSA sample cannot account for this negative SLE differential. That bias implies that the SLE differential would be slightly positive st (O'Dea and Sturrock, 2018).

second approach is to drop the most positive 32.8% of both samples in terms of SLEs. Doing so, we find that the SLE differential is significantly more positive in TILDA than in ELSA (TILDA: -6.89 percentage points; ELSA: -19.10 percentage points; unpaired t-test: df = 10,525; t = 27.50, p < .001).

For HAGIS, the SLE differential is significantly different from zero and, like ELSA, is negative (-1.43, CI: -1.50—-1.35, z(650) = -36.53, p<0.001). We do not compare the SLE differential across HAGIS and the other two surveys because of the difference in their units of measurement (years in HAGIS versus probabilities in ELSA and TILDA).

SLE Differential and Population Characteristics

Table 5 reports the results of the linear regression of the SLE Differential and the population characteristics of each study. There are five columns in Table 5 to aid comparison across studies. The first and last columns report the regression results from the full samples of ELSA and HAGIS respectively. The three shaded columns in the centre of the table report regression results from ELSA, TILDA and HAGIS with the sample restricted to respondents under the age of 80. This is because TILDA's full sample only includes 50-80 year olds.

Across all studies, women were more likely to think they would live shorter lives than predicted by the relevant life tables. Anticipation of living longer than the objective expectation increase with age, with the greatest effect in the oldest old. However, the strength of the association is more evident in ELSA and less so in HAGIS, even where age groups are comparable. The same association was evident in TILDA despite it only including those aged up to 79.

Those who reported poorer health status (in comparison with excellent health) were more likely to anticipate shorter lives than the life expectancy calculated by life tables for people of their age and gender. This is not surprising and reflects private information which they hold on the effects of health status on their life expectancy. Across all studies, this was evidenced as a clear health gradient where the effect size and significance in association increased with poorer health status. For similar reasons, smokers were more likely to anticipate shorter lives than those who never smoked.

Table 5. Population Characteristics of Standardised SLE Differential

Variable	ELSA		TILDA	HAGIS	
	SLE Differential Full sample	**SLE Differential <80 years**	**SLE Differential <80 years**	**SLE Differential <80 years**	**SLE Differential Full sample**
Sex (Male)					
Women	-0.189***	-0.192***	-0.185***	-0.333***	-0.329***
Age (50-65 years)	-	-	-	-	-
66-69	0.118***	0.118***	0.045	-0.047	-0.052
70-74	0.464***	0.464***	0.485***	0.046	0.047
75-79	0.936***	0.936***	0.884***	0.077	0.072
80-84	1.366***	n/a	n/a	n/a	0.336*
85-90	1.650***	n/a	n/a	n/a	0.391*
Subjective Health (Excellent)	-	-	-	-	-
Very Good	-0.218***	-0.203***	-0.156***	-0.306*	-0.338*
Good	-0.436***	-0.431***	-0.341***	-0.484**	-0.459***
Fair	-0.669***	-0.666***	-0.659***	-0.725***	-0.733***
Poor	-0.971***	-0.997***	-1.187***	-1.136***	-1.105***
Smoke (non-smoker)	-	-	-	-	-
Ex-smoker	-0.017	-0.026	-0.033	-0.088	-0.049
Smoker	-0.211***	-0.227***	-0.216***	-0.439***	-0.412***
_cons	0.168***	0.172***	0.334***	0.717***	0.697***
r^2	0.300	0.220	0.165	0.152	0.154
bic	21512.417	18415.543	18816.235	1565.39	1752.767
N	8625	7642	7045	559	637†

** p=0.05, ** p=0.01, *** p<0.001 † n does not add up to full sample due to missing values*

The novel results from our analysis concern the differences in SLE Differential across the ageing studies. The effect of age on the SLE differential is weaker in HAGIS than it is in the two studies that elicited SLE using a probabilistic procedure. For instance, relative to the base category of 50-65 year olds, the average person in the 70-74 age band has an SLE differential that is 0.485 standard deviations higher in TILDA, 0.464 standard deviations higher in ELSA, but just .046 higher in HAGIS. It is not clear why the scale of the age effect in HAGIS is just a tenth as large as it is in the other two surveys. Whatever the cause, it looks to be specific to the effect of age on the SLE differential; for smoking status and subjective health, the coefficients are of broadly similar size in all three datasets.

Interaction Effects of Age & Health on SLE Differential

Though subjective health is always positively associated with the SLE differential, the two outermost columns of Table 5 demonstrate that the scale of this effect is larger among the over 80s than it is among younger age groups. For the full sample, this coefficient is less negative than it is for the

under 80s in ELSA (-.971 versus -.997) and in HAGIS (-1.105 versus -1.136). We conducted OLS regressions of the standardized SLE differential that controlled for main effects of age and subjective health (both coded as continuous variables) and their interaction. The interaction was a statistically significant predictor of the SLE differential in both datasets (ELSA: $t = 5.99$, $p < .001$; HAGIS: $t = 3.31$, $p = .001$).

Conclusion

Our goal in this paper was to characterise the life expectancy of three populations using data from longitudinal surveys of ageing. We focused particularly on the SLE differential, the difference between SLE and OLE. Comparing data from three different studies revealed two points of difference: i) the SLE differential is positive in the Irish data but is negative in the two UK studies, and ii) the effect of age on the SLE differential is weaker in HAGIS than it is in the two studies that elicited SLE using a probabilistic procedure.

The difference in sign of the SLE differential (positive for Ireland, negative for the two UK studies) is not easily explained by survey procedures. Both the Irish and English surveys collect their SLE measures through in-person interviews and both use probabilistic questions that are worded similarly. Nor is the more positive SLE differential in Ireland relative to England entirely explained by the remarkably high proportion of 100 percent responses in the Irish data. When we dropped the 33 percent who reported 100 percent from the TILDA sample and the most positive 33 percent from the ELSA sample, we still found that the remaining TILDA sample had a higher SLE differential than the remaining ELSA sample.

We find it difficult to explain the other novel result i.e. why the effect of age on the SLE differential is smaller in HAGIS than in the other two surveys. It may be that HAGIS respondents more readily take into consideration their health status (subjective health and/or smoking status) when calculating their life expectancy. We find a more negative SLE differential is associated with being a smoker, a woman or reporting worse subjective health. These results are consistent with the previous literature (Griffin et al., 2013; Kobayashi et al., 2017). However, the results are unlikely to explain the differences found in the HAGIS sample. Alternatively, it may be attributable to the mode of data collection: SLE data were collected in a self-completion survey in HAGIS but through interviews in the other two studies. Or, it may be a result of difference in the elicitation procedure: SLE was elicited as a point estimate in HAGIS but by a probabilistic procedure in ELSA and TILDA. This question merits future research.

ELSA, TILDA, and HAGIS recruit a representative sample of private households in their respective countries; this sampling procedure will not include people living in institutions (e.g. care homes,

prisons etc.)[8]. O'Dea and Sturrock (2018; Fig. 3.4) exploit the longitudinal dimension of ELSA to test the degree to which this sampling bias leads OLE in ELSA to deviate from population measures of OLE. They compare the mortality of ELSA respondents to the mortality in the wider population and find that ELSA respondents are slightly less likely to be dead by any given age. In other words, sampling bias in ELSA has been shown to (slightly) overestimate life expectancy relative to the population as a whole.

The only state of the world in which this sampling bias could explain why the Irish sample have a positive SLE differential and the English have a negative SLE differential is if the average member of the institutionalised population in Ireland lives longer than the average member of the rest of the population. We consider this state of the world implausible. Similarly, on the question of how respondent characteristics explain the SLE differential, we see no grounds for concern. The institutionalised population is a small fraction of the total population. The weighted average of the institutionalised and non-institutionalised population is therefore close to that of the non-institutionalised population on its own. Even if the parameter estimates revealed in our regressions are wildly different from those that would be found in the institutionalised population, it is implausible that population-level parameters would differ directionally from what we find our regression results.

SLE is important. It should be an input to many decisions and behaviours that have substantial consequences for wellbeing in later life e.g. lifetime asset accumulation and decumulations, health behaviours, decisions around living arrangements etc. In order to predict, and perhaps nudge, decision making regarding the ageing process, it is important to understand how people form their subjective life expectancies.

The immediate contribution of our research is to inform micro-economists' interpretation of the results of analyses that control for SLE. Future research should investigate whether the extremely high probabilities reported by the Irish sample are reporting errors that only arise in surveys or whether they reflect unrealistic expectations that also inform respondents' behaviour. If they are merely a survey artefact then, all else being equal, the reporting bias might lead economists to incorrectly infer that the Irish population is investing less in their remaining years of life than the English population. On the other hand, if the higher proportion of 100 percent responses among the Irish population turn out to represent a considered belief that respondents are certainly going to live to a ripe old age, then this cultural difference in expectations would be expected to have a substantive impact on investment decisions (financial, health and human capital) in Ireland. It will be interesting and important to test whether these results are merely survey artefacts or whether they inform lifecycle decision making.

[8] Note that this exclusion only applies at the stage that respondents are being initially recruited to the survey. Extant participants who move from a household into care homes or other institutions are followed up. ELSA may now include respondents in care homes, as Wave 7 data are used in this research. TILDA and HAGIS use Wave 1 data and therefore will only include respondents living within households.

A broader contribution of the current research is to highlight that effects of the procedural differences when eliciting measures of SLE in ageing studies. Point estimate procedures may be less cognitively demanding and therefore could be more useful in ageing populations. Further research in this area is also recommended.

Funding

This work was supported by the National Institute of Aging (RAG044535A) and the Nuffield Foundation (OPD/42197) who had no involvement in the design of the study, the collection, analysis and interpretation of data, or in the writing of the manuscript.

Acknowledgements

The authors would like to thank participants and especially our discussant Jürgen Maurer for insightful feedback when we presented this work at the Gateway to Global Aging Data Research Conference, funded by the National Institute on Aging (2R01 AG030153). We also thank the coordindating editor Alfonso Sousa-Poza and anonymous reviewers for helpful feedback.

References

Arias, E., Escobedo, L. A., Kennedy, J., Fu, C., & Cisewski, J. A. (2018). *U.S. small-area life expectancy estimates project : methodology and results summary*. Retrieved from https://stacks.cdc.gov/view/cdc/58853

Bago d'Uva, T., O'Donnell, O., & van Doorslaer, E. (2017). Who can predict their own demise? Heterogeneity in the accuracy and value of longevity expectations☆. *The Journal of the Economics of Ageing*. https://doi.org/10.1016/j.jeoa.2017.10.003

Bissonnette, L., Hurd, M. D., & Michaud, P.-C. (2017). Individual survival curves comparing subjective and observed mortality risks. *Health Economics*, *26*(12), e285–e303. https://doi.org/10.1002/hec.3506

Comerford, D. A., & Robinson, J. (2017). Die-by Framing both Lengthens and Shortens Life: Further Evidence on Constructed Beliefs in Life Expectancy. *Journal of Behavioral Decision Making*, *30*(5), 1104–1112. https://doi.org/10.1002/bdm.2027

Elder, T. E. (2013). The Predictive Validity of Subjective Mortality Expectations: Evidence From the Health and Retirement Study. *Demography*, *50*(2), 569–589. https://doi.org/10.1007/s13524-012-0164-2

Fagerlin, A., Wang, C., & Ubel, P. A. (2005). Reducing the Influence of Anecdotal Reasoning on People's Health Care Decisions: Is a Picture Worth a Thousand Statistics? *Medical Decision Making*, *25*(4), 398–405. https://doi.org/10.1177/0272989X05278931

Fischhoff, B., & Bruine De Bruin, W. (1999). Fifty-Fifty=50%? *Journal of Behavioral Decision Making*, *12*(2), 149–163. https://doi.org/10.1002/(SICI)1099-0771(199906)12:2<149::AID-BDM314>3.0.CO;2-J

Gigerenzer, G., & Hoffrage, U. (1995). How to improve Bayesian reasoning without instruction: Frequency formats. *Psychological Review*, *102*(4), 684–704. https://doi.org/10.1037/0033-295X.102.4.684

Griffin, B., Hesketh, B., & Loh, V. (2012). The influence of subjective life expectancy on retirement transition and planning: A longitudinal study. *Journal of Vocational Behavior*, *81*(2), 129–137. https://doi.org/10.1016/J.JVB.2012.05.005

Griffin, B., Loh, V., & Hesketh, B. (2013). A mental model of factors associated with subjective life expectancy. *Social Science & Medicine*, *82*, 79–86. https://doi.org/10.1016/J.SOCSCIMED.2013.01.026

Hamermesh, D. S. (1985). Expectations, Life Expectancy, and Economic Behavior. *The Quarterly Journal of Economics*, *100*(2), 389. https://doi.org/10.2307/1885388

Hudomiet, Peter, Hurd, M., & Rohwedder, S. (2018). *Measuring Probability Numeracy*. https://doi.org/10.7249/WR1270

Hudomiet, Péter, & Willis, R. J. (2013). Estimating second order probability beliefs from subjective survival data. *Decision Analysis*, *10*(2), 152–170. https://doi.org/10.1287/deca.2013.0266

Hurd, M. D. (2009). Subjective Probabilities in Household Surveys. *Annual Review of Economics*, *1*(1), 543–562. https://doi.org/10.1146/annurev.economics.050708.142955

Kearney, P. M., Cronin, H., O'Regan, C., Kamiya, Y., Savva, G. M., Whelan, B., & Kenny, R. A. (2011). Cohort profile: The Irish Longitudinal Study on Ageing. *International Journal of Epidemiology*, *40*(4), 877–884. https://doi.org/10.1093/ije/dyr116

Kobayashi, L. C., Beeken, R. J., & Meisel, S. F. (2017). Biopsychosocial predictors of perceived life expectancy in a national sample of older men and women. *PLOS ONE*, *12*(12), e0189245. https://doi.org/10.1371/journal.pone.0189245

Manski, C. F., & Molinari, F. (2010). Rounding Probabilistic Expectations in Surveys. *Journal of Business & Economic Statistics*, *28*(2), 219–231. https://doi.org/10.1198/jbes.2009.08098

Michaelson, J., Abdallah, S., Steuer, N., Thompson, S., Marks, N. (2008). *National Accounts of Well-being: bringing real wealth onto the balance sheet*. Retrieved from www.nationalaccountsofwellbeing.org

O'Dea, C., & Sturrock, D. (2018). *Subjective expectations of survival and economic behaviour*. https://doi.org/10.1920/wp.ifs.2018.W1814

ONS. (2017). Period and cohort life expectancy explained: December 2017 - Office for National Statistics. Retrieved January 13, 2019, from https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/lifeexpectancies/methodologies/periodandcohortlifeexpectancyexplained

Reyna, V. F., & Brainerd, C. J. (2007). The importance of mathematics in health and human judgment: Numeracy, risk communication, and medical decision making. *Learning and Individual Differences*, *17*(2), 147–159. https://doi.org/10.1016/J.LINDIF.2007.03.010

Schoenbaum, M. (1997). Do smokers understand the mortality effects of smoking? Evidence from the Health and Retirement Survey. *American Journal of Public Health*, *87*(5), 755–759. https://doi.org/10.2105/AJPH.87.5.755

van Solinge, H., & Henkens, K. (2010). Living longer, working longer? The impact of subjective life expectancy on retirement intentions and behaviour. *The European Journal of Public Health*, *20*(1), 47–51. https://doi.org/10.1093/eurpub/ckp118

Appendix

Figure 5. Distribution of SLE Differential across studies