Cognitive abilities and long-term care insurance: Evidence from European data

Abstract

Long-term care (LTC) is one of the largest financial risks faced by the elderly. Yet, it remains largely uninsured. This paper explores the relationship between cognitive abilities and private voluntary or supplementary long-term care insurance (LTCI) ownership as another possible factor contributing to the small size of the market. We used data from a European panel survey, which collects detailed information on both private insurance coverage and three indicators of cognitive abilities: numeracy, verbal fluency and memory skills. We find that memory, but not numeracy or verbal fluency, has a positive and statistically significant effect on the probability of owning private LTCI above and beyond other characteristics such as general education, family, risk factors, income and wealth. Fixed effects estimates show that a one-standard deviation increase in the recall measure score is associated with a 0.5 percentage-point increase of the probability of holding insurance for the baseline sample and a 1 percentage-point increase among the younger cohort. The findings suggest that cognitive limitations in LTCI decision-making are likely to be linked to information processing skills and can be an important factor affecting the expansion of the market that need to be taken into consideration in policy design.

Keywords: long-term care, long-term care insurance, cognitive abilities, ageing

Introduction

The long-term care (LTC) needs of older people have increased in recent years and are projected to rise substantially more over the next few decades due to an ageing population (Colombo, Mercier, 2012). The associated LTC expenditures are highly uncertain and skewed. The probability of a 65 year old person entering a nursing home is estimated over 40% but for about 15%-20% among new entrants stays can last for as long as over 5 years (Kemper, Murtaugh, 1991, Murtaugh et al., 1997, Knight Frank, 2014). At the same time, these services are financially costly with average patient fees for residential or nursing care in Europe ranging between €3,000 and €4,500 per month (Kemper, Murtaugh, 1991, Murtaugh et al., 1997, Knight Frank, 2014). Given this risk distribution, LTC expenditures have the potential to become catastrophic imposing huge financial uncertainty to individuals and their families.

Most people typically manage this risk via self-insurance or reliance on public support and informal care from family members (Costa-Font, Courbage, 2012). The role of private insurance on the other hand has been very limited in financing LTC costs, even in countries where such a market has developed (Colombo et al., 2011). This finding is puzzling. Standard insurance theory predicts that insurance would be optimal for a rational and risk-averse individual in the face of this risk distribution (Brown, Finkelstein, 2008). Furthermore, informal care has become increasingly scarce due to women's participation in the labour market and government budgets around the world are struggling to meet the increasing demand for LTC services because of significant financial constraints (Colombo et al., 2011).

Despite this context being suitable for the expansion of alternative financing arrangements, private insurance has not yet developed substantially neither in a complementary nor in a substitutive way to the traditional financing options. This so-called 'long-term care insurance (LTCI) puzzle' has attracted a lot of attention in the literature. A number of both supply- and demand-side reasons have been offered as potential explanations for the small size of the market. In summary, these include high price policies due to adverse selection, moral hazard and dynamic contracting problems, state-dependent utility and the crowding-out of private demand by public coverage, informal care and home equity (Brown, Finkelstein, 2009, Finkelstein, Luttmer & Notowidigdo, 2013, Brown, Finkelstein, 2008, Pauly, 1990, Costa-Font, Courbage, 2015, Mellor, 2001, Davidoff, 2010). Although these factors shed light on important aspects of the LTCI puzzle, they still do not explain fully the small size of the market particularly from the demand side (Brown, Finkelstein, 2009). Factors like individual decision-making skills and limitations, such as people's cognitive abilities, have not been extensively studied in the context of LTCI.

A number of reasons however suggest that cognitive abilities could influence LTCI demand. First, financial planning for LTC is likely to gradually involve a greater degree of individual responsibility and consequently decision-making, partly due to the declining availability of informal carers and the incompleteness of public coverage (Colombo et al., 2011). Indeed a substantial part of the LTCI market, where it has developed, is characterised by individual as opposed to group contracts (Colombo et al., 2011). Furthermore, decisions about LTC financial security and LTCI more specifically are particularly difficult. Individuals need to understand complicated concepts such as survival probabilities and optimal consumption smoothing, estimate uncertain future expenditures and evaluate the value of LTCI relative to

alternative financing mechanisms, among other things. Even upon deciding that private insurance is desirable, one still needs to navigate a complex landscape of insurance products that require substantial cognitive skills and thorough analysis to understand and decide upon. Lastly, decisions about LTC are usually taken at a relatively later time in life, when cognitive abilities usually start to decline and can thus have a significant impact on optimal decision-making (Agarwal, S. et al., 2009, Banks, 2010).

Despite this backdrop, the evidence base on the effect of cognitive skills on LTCI demand remains very small. On the other hand, a growing body of literature testifies to the importance of cognitive abilities for a broad range of other financial outcomes. A number of studies suggest that higher cognitive skills are associated with greater stock market participation, higher uptake of health insurance, a better understanding of pension arrangements, optimal use of credit cards and higher wealth accumulation to name a few (Christelis, Jappelli & Padula, 2010, Chan, Elbel, 2012, Banks, Oldfield, 2007, Agarwal, Sumit, Mazumder, 2013).

This paper aims at addressing this evidence gap on the role that individual-level cognitive abilities play in LTCI decision-making as an alternative explanation for the small size of the market. Contrary to previous studies that focus only on the role of numeracy and rely on cross-sectional data from the US (McGarry et al., 2016), this study puts the focus on a wider range of cognitive skills and the European market, which remains particularly underdeveloped. We used data from the Survey of Health, Ageing and Retirement in Europe (SHARE) that is uniquely suited for the analysis of the subject matter as it contains information on both LTCI ownership and cognitive skills for 18 countries: Austria, Germany, the Netherlands, Spain, Italy, France, Denmark, Greece, Switzerland, Belgium, Israel, the Czech Republic, Poland, Luxembourg, Portugal, Slovenia, Estonia and Croatia. Measures of cognitive abilities were taken from the

three cognition indicators measured in SHARE and include numeracy, verbal fluency and memory. The analysis was restricted to people aged between 50 and 70 years since this is the prime buying age for LTCI (Goda, 2011) but also to limit the possibility of cohort effects. Furthermore, given the longitudinal nature of the survey, this study used panel data methods to model individual heterogeneity from time-invariant unobserved factors, which has not been taken into account in previous studies (McGarry et al., 2016).

We find that memory, but not numeracy or verbal fluency, has a positive and statistically significant effect on the probability of owning LTCI above and beyond other characteristics including age, general schooling, health, family structure, attitudes towards risk, perception of mortality risk, income and wealth. The estimates from the preferred fixed-effects specification suggest that a one-standard deviation increase in the recall indicator measuring memory is associated with an increase in the probability of having insurance of 0.5 percentage points. This estimate is robust to a number of sensitivity tests and increases to 1 percentage point.

The rest of the paper is organised as follows. Section 2 discusses the conceptual framework. Section 3 provides some background on LTC financing in Europe with a particular emphasis on private insurance. Section 4 outlines the empirical specification. Section 5 describes the data. Section 6 reports and discusses the results and section 7 concludes.

Conceptual Framework

We discuss two contexts within which cognitive abilities may affect the decision to purchase LTCI. The first is that of information costs. The complexity of the decision implies that information barriers can be high and relating to a range of aspects of the decision-making process. The literature suggests that people have a limited understanding of complex price

schedules, eligibility rules, the costs and risks of LTC and the availability of alternative sources of care (Liebman, Zeckhauser, 2004, Currie, Gruber, 1996, Zhou-Richter, Browne & Gründl, 2010, Coe, Skira & Van Houtven, 2015). Such information gaps can often be understood within a bounded rationality framework, according to which heuristics and experience-based decision-making shortcuts are a more rational way of making decisions in a world of computational constraints and information frictions (Simon, 1978, March, 1978). Kunreuther and Pauly (2004) for example, using a model of bounded rationality predict that when the event probability is sufficiently small (as could be the case for catastrophic LTC expenditures) the search costs associated with collecting information about the loss probability outweigh the expected benefits from insurance to the extent that people find it optimal not to purchase insurance. In a context of high information costs due to bounded rationality, higher cognitive abilities can be thought of reducing computational limitations associated with sub-optimal decision-making.

A second channel through which cognitive skills may also affect LTCI coverage is the possible links of cognition with features of the utility function, whether that is parameters characterising time and risk preferences or reference-dependent preferences that give rise to cognitive biases in line with prospect theory (Tversky, Kahneman, 1974, Kahneman, Tversky, 1979). Evidence from the behavioural and experimental economics literature shows that people of higher cognitive ability are more likely to have higher discount rates and often display less risk averse behaviour (Dohmen et al., 2010, Benjamin, Brown & Shapiro, 2013, Frederick, 2005). Concerning possible cognitive biases, framing, whereby people's decisions are affected by whether options are presented with positive or negative connotations can be linked to LTCI decision-making. Gottlieb and Mitchell (2019) show that narrow framers have a substantially lower demand for LTCI and Peters et al. (2006) find that individuals who are more numerate are

also less susceptible to framing effects. Another relevant bias is that of information and choice overload, in the face of which, people become overwhelmed and experience stress (Chernev, Böckenholt & Goodman, 2015), often to the extent of avoiding making a decision altogether (Iyengar, Lepper, 2000). Close to this is the status quo bias. When faced with difficult calculations, people are likely to prefer the default options (Kahneman, Knetsch & Thaler, 1991), which in the case of LTCI would be that of non-purchase.

From the above it occurs that cognitive abilities are likely to affect LTCI demand by overcoming information and/or behavioural constraints, although with the data in hand it is difficult to identify the specific mechanisms that are operating. Furthermore, the direction of the effect is not clear a priori. As LTCI is not generally considered financially reasonable for everyone, particularly those with little wealth to protect from means-tested public programs (Pauly, 1990, Brown, Finkelstein, 2008), better cognitive abilities could be associated with both LTCI ownership and non-ownership depending on the particular individual characteristics and context. Overall, the focus of this paper is on estimating the average effect of cognitive abilities on LTCI coverage independent of the mediating mechanisms and across the wealth and income distribution.

The long-term care insurance market in Europe

The LTCI market is vastly underdeveloped across the industrialised world and especially in Europe. Where the market has been present in Europe the two types of contracts that have developed are those of partial reimbursement and indemnity policies (Colombo et al., 2011).

France is one of the largest LTCI markets in Europe and the world with about 7.1 million in 2017 (FFA, 2017). Indemnity policies are the dominant model and the individual contracts

represent the biggest part of the market (Colombo et al., 2011, Courbage, Roudaut, 2008). In Israel, over 4 million people have some form of private LTCI policy of three types: commercial individual LTCI, commercial collective LTCI and collective LTCI through the health plans. Although the majority of policyholders have collective insurance, mainly through their health plan, approximately 18% have either form of commercial LTCI (Brammli-Greenberg, Waitzberg & Gross, 2012). Germany's private insurance market consists of two types. A compulsory one (reimbursement policy) for individuals who have opted out of the social health insurance (approximately 9% of the population) and a voluntary one (indemnity policies) which insures eligible expenses not covered by the LTC insurance programme (approximately 3.5% of the population). In many other European countries, the market is practically non-existent with private insurance financing only a very small fraction of total LTC expenditure (Colombo, Mercier, 2012). Despite this trend, there is some sluggish market development observed in countries such as Spain and Italy, which is mainly based on indemnity policies (Colombo et al., 2011).

The scope for expansion of a private market in Europe has been shaped over time alongside the development of public insurance schemes that most European countries have put in place to finance LTC. There is big variation across European countries in terms of the available public coverage arrangements. Several countries have universal coverage within a single program, either as part of a tax-funded social care system (e.g. Nordic countries), through dedicated social insurance schemes (e.g. Germany, the Netherlands) or by arranging for LTC coverage mostly within the health system (e.g. Belgium). Other countries have more mixed systems comprising of different benefits and schemes with different degrees of coverage

depending on target groups, specific LTC cost components and jurisdiction (e.g. Austria, France, Italy, the Czech Republic) (Colombo, Mercier, 2012).

Empirical Specification

Previous studies that look at the effect of cognitive abilities on financial decision-making usually rely on cross-sectional data often treating cognitive skills as exogenous (Christelis, Jappelli & Padula, 2010, Banks, Oldfield, 2007, McGarry et al., 2016). A limitation of this literature is that cognitive ability may itself be correlated with other factors that also affect financial decision-making such as unobserved risk factors, risk and time preferences, cautiousness, aptitude for financial matters or parental background which can in turn be correlated with LTCI holding. The literature finds that both genetic variation and shared environment in the form of human capital transfer from parent to child help explain variation in measured cognitive ability (Karagiannaki, 2017) and that cognitive skills are often associated with differences in risk aversion, discount rates and financial skills (Dohmen et al., 2010, Frederick, 2005, Banks, 2010). Furthermore, cognitive function may be measured with substantial error if responses are imprecise and result from guessing or be affected by language and cultural differences across countries (van de Vijver, Fons J.R., 2008). Thus, not accounting for these sources of heterogeneity and possible measurement error may result in biased coefficients from a regression of LTCI holding on measures of cognitive function. To overcome these limitations, the model specification in this paper controls for a wide range of confounding controls including country fixed effects and, taking advantage of the longitudinal aspect of the data, further accounts for individual effects to capture unobserved heterogeneity that can be assumed time-invariant within the three wave period that the data covers.

The latent utility of owning a private LTCI policy for person i at time t can then be modelled as follows

$$y_{it}^{*} = X_{it}'\beta + u_i + \varepsilon_{it} \quad (1)$$

where X_{it}' is the vector of observable variables affecting the utility gain of owning insurance including cognitive abilities, u_i is an individual effect and ε_{it} a zero-mean random term capturing all the unobservable factors affecting latent utility. A person i will decide to own a private insurance policy, $y_{it} = 1$, if the utility from owning insurance is positive, i.e. if $y_{it}^{*} > 0$, suggesting that the probability of observing insurance coverage will be $\Pr(y_{it} = 1) = F(X_{it}'\beta + u_i)$, where $F(.)$ is the c.d.f of ε_{it}. In the empirical application, we employ both linear probability and probit estimators to estimate this probability model.

Data and measures

Data

Data are taken from the last three waves of the Survey on Health, Ageing and Retirement in Europe (SHARE). Waves 5, 6 and 7 of SHARE cover years 2013, 2015 and 2018 respectively and include rich information on health, socio-economic, family and other characteristics for a big cross-national panel sample of individuals aged 50 and over.[1] Importantly for this study, the last

[1] This paper uses data from SHARE Waves 1, 2, 3, 4, 5, 6 and 7 (DOIs: 10.6103/SHARE.w1.700, 10.6103/SHARE.w2.700, 10.6103/SHARE.w3.700, 10.6103/SHARE.w4.700, 10.6103/SHARE.w5.700, 10.6103/SHARE.w6.700, 10.6103/SHARE.w7.700), see (Börsch-Supan et al., 2013) for methodological details. The SHARE data collection has been primarily funded by the European Commission through FP5 (QLK6-CT-2001-00360), FP6 (SHARE-I3: RII-CT-2006-062193, COMPARE: CIT5-CT-2005-028857, SHARELIFE: CIT4-CT-2006-028812) and FP7 (SHARE-PREP: N°211909, SHARE-LEAP: N°227822, SHARE M4: N°261982). Additional funding from the German Ministry of Education and Research, the Max Planck Society for the Advancement of Science, the U.S. National Institute on Aging (U01_AG09740-13S2, P01_AG005842, P01_AG08291, P30_AG12815, R21_AG025169, Y1-AG-4553-01, IAG_BSR06-11, OGHA_04-064, HHSN271201300071C) and from various national funding sources is gratefully acknowledged (see www.share-project.org).

three waves collect measures for both LTCI coverage and levels of cognitive abilities among older Europeans.

The sample was restricted to individuals aged 50-70 since the purchase of LTCI usually takes place before the onset of disability and this constitutes the prime buying age for LTCI (Goda, 2011). To control for any further supply-side effects, whereby older individuals or people who have already developed some limitations with (instrumental) activities of daily living ((I)ADLs) are facing higher premiums or are excluded from the market, we also restricted the sample to people with no ADLs and no IADLs. Sweden was dropped from the sample because the country-specific questionnaire referred to private health insurance instead of LTC. The final sample consisted of 18 countries: Austria, Germany, the Netherlands, Spain, Italy, France, Denmark, Greece, Switzerland, Belgium, Israel, the Czech Republic, Poland, Luxembourg, Portugal, Slovenia, Estonia and Croatia. For individuals whose first interview was taken in a previous wave, information on characteristics that are steady across all waves, such as gender and year of birth, was merged from past waves. There is a degree of item nonresponse for certain variables in SHARE including values in the LTCI cases, education and mortality risk perception, that reduced the regression sample. Where feasible, missing values in the education variables were replaced with information from other variables in the dataset, such as the highest qualification and the number of years of education questions asked in SHARE. The final regression sample was 58,354 observations.

Measures

LTCI Coverage

The SHARE survey asks people whether they have any public or private LTCI of the following types: (i) public, (ii) private mandatory, (iii) private voluntary/supplementary or (iv) none. If the question was not clear, interviewers would follow-up with an explanation about what is usually covered by LTCI, such as home care, assisted living, adult daycare, respite care, hospice care and stays in nursing homes or residential care facilities. The measure of whether a respondent has a private LTCI in the sample is therefore an indicator variable for reporting having private voluntary or supplementary LTCI.

Figure 1 presents the LTCI coverage distribution by country. As expected there is a big variation observed between countries. The highest self-reported coverage rates are from countries with a more developed LTCI market such as Israel (38%), Switzerland (17%), Belgium (17%) and France (17%). LTCI prevalence is also high (above average) in the Netherlands (15%), Luxembourg (14%) and Portugal (12%). Spain, the Czech Republic and Poland report lower average rates of 6%, 5% and 4% respectively. LTCI coverage is lower in the remaining countries. Italy, Croatia, Germany and Denmark have a coverage rate slightly above 2%, while Greece's rate is 1.5%. In Austria and Slovenia the rate is slightly above 1% and in Estonia is a very small 0.2%. The LTCI sample average is 7.8%, indicative of an overall low market development across Europe (**Table 1**).

Due to the nature of survey data and the diverse country-specific institutional LTC arrangements, the self-reported coverage rates found in SHARE were crosschecked with market statistics from other public or industry sources for each country (Table B.1 Appendix B). The underdevelopment of the private market in most European countries however, also implies that

evidence from alternative sources on the exact market size is equally difficult to obtain and rely on. As a result, although there appears to be a degree of discrepancy countries between the survey data and alternative market evidence, we still kept all countries in the baseline sample. Countries for which it is possible there is a degree of overestimation of the true market size, such as Slovenia, Estonia, Croatia, Luxembourg, Belgium, the Czech Republic, Poland and Greece were excluded from the sample as robustness checks.

Cognitive abilities

To measure cognitive abilities we draw on SHARE's special module on cognitive functions and evidence from the cognitive psychology and financial decision-making literature on which types of cognitive abilities are likely to influence LTCI decisions. SHARE has developed a set of measures for cognitive abilities that follows closely its sibling studies HRS (Health and Retirement Study; USA) and ELSA (English Longitudinal Study of Ageing; England) and uses questions that are standardized across countries to allow for consistent international comparisons (Borsch-Supan et al., 2008). There are three measures of cognitive abilities recorded in SHARE that are also relevant for this study: numeracy, verbal fluency and memory. The exact wording of each cognitive measure can be found in Appendix A.

The ability to perform mathematical calculations or numeracy, is linked in the literature to a number of information gaps, cognitive biases and financial outcomes. Low numeracy is often associated with a poorer understanding of financial products, distorted perceptions of risks, reduced access to treatment, greater uptake of health insurance policies, framing effects and higher wealth accumulation among other things (Banks, Oldfield, 2007, Chan, Elbel, 2012, Peters et al., 2006, Peters et al., 2007, Reyna, Brainerd, 2007). Due to the complex numerical

calculations necessary when deciding for LTCI, numeracy is therefore likely to affect the probability of having insurance. Verbal fluency involves the executive control over the processes that affect the ability to process written information and retrieve information from memory and it is correlated with decision-making competence between multiple attribute options, such as pension plans, health treatments and consumer products (Rosi et al., 2017). Memory influences the ability to recall facts, compare information at different points in time, understand conditional probabilities and identify relevant pieces of information (Spaniol, Bayen, 2005) and is associated with a number of financial outcomes (Del Missier, Mäntylä & Nilsson, 2015, Rosi et al., 2017). It is therefore likely that both verbal fluency and memory also play an important role in shaping decisions around insurance ownership allowing the better processing of information around financial products and LTC.

The SHARE questionnaire includes two different measures of mathematical performance with basic numerical operations. The first measure is based on percentage calculation questions and the second one on subtractions calculations. Due to the interview structure adopted in the last three waves of the survey, the first numeracy index is only asked to a subsample of the respondents resulting to a high number of missing values for that indicator. As a result, we focused on the second numeracy measure. Respondents are asked, starting from one hundred, to gradually subtract the number seven up to five consecutive times. The numeracy index is the sum of correct calculations. **Figure 2a** plots the numeracy index distribution. The measure ranges from 0 to 5, each score representing the number of correct subtractions. The sample average is 3.8 and the standard deviation is 1.66. Over half of the respondents (55%) were able to answer all five questions correctly and 15% were able to answer correctly four. About 10% gave three correct answers and 5% gave two correct answers. About 15% of the sample only had either one

correct answer (6%) or no correct answer (9%). Thus a significant percentage of respondents performed poorly in this numeracy score.

To measure verbal fluency, respondents are asked to name as many animals as they can in one minute. **Figure 2b** plots the verbal fluency index distribution. The sample average of the verbal fluency score is 19.5 and the standard deviation is 7.8. The bulk of the distribution lies between 14 and 24 words (25^{th} to 75^{th} percentile) while about 10% report over 30 words and 10% report below 10. The vast majority of respondents report a maximum value of 40, although there are a few outlier values (less than 1%) above that.

Memory is measured with a recall question. Respondents are presented with a list of ten words and are then asked to repeat as many as they can remember. The recall indicator ranges from zero to ten, depending on the number of words people can remember. **Figure 2c** plots the recall measure sample distribution. The sample mean is 5.3 and the standard deviation is 1.6. Over 59% of the sample score between 4 and 7, and scores 5 and 6 have the highest frequency. About 16% score above 8 and 7% score below 3.

Figure 3 presents the evolution of cognitive abilities with age. As expected, all cognition measures show a decline over time between ages 50 and 70, with older individuals having a lower level of cognitive abilities compared to younger ones. The mean numeracy index is 4.4, 4.39 and 4.2 at ages 50, 60 and 70 respectively. Similarly, the mean verbal fluency score drops from 22.8 at 50 to 22.3 at 60 and 20.5 at 70 years of age and the mean recall score drops from 6.1 at 50 to 5.9 at 60 and 5.4 at 70 years of age. Overall, the greatest fall in cognitive skills is observed between ages 60 and 70 across all cognitive skills measures.

Table 2 presents the distribution of all three cognitive skills by country. As expected there is variation in cognitive abilities across countries in the sample, which is also consistent

with a North-South gradient. The difference between the largest and smallest average country scores lies within one standard deviation from the sample average.

Cognitive abilities and LTCI

Figure 4 plots the three cognition measures by LTCI status. Across the distribution, we see that the group of people without LTCI perform worse compared to the group of people that hold LTCI in all three cognitive indicators, particularly for verbal fluency and recall. In terms of mean differences, the average numeracy score is 4.4 for people with LTCI versus 4.3 for those without LTCI; the average verbal fluency score is 22.4 for people with LTCI and 21.8 for those without; and the average recall score is 6.05 versus 5.7 for those with and without LTCI respectively.

To explore the dynamics between LTCI ownership and cognitive skills, **Table 3** presents the LTCI transition probabilities by different levels of cognition. To keep the number of transition probabilities manageable, cognition measures were re-categorised. Scores above and below the mean for each cognition measure were grouped as high and low cognitive skills respectively. Overall the default of no LTCI purchase is quite persistent with over 90% of respondents that start without LTCI in one period still being without LTCI in the following period across all skills levels. This persistence to the default of no LTCI between periods however is slightly higher among people with lower cognitive skills compared to people with higher cognitive skills. The transition probability is around 93% from year to year for people with low levels of numeracy and verbal fluency and 92% for people with low levels of recall, but it is closer to 95% for people with above average numeracy, verbal fluency and recall skills. The probability of switching from no LTCI in one period to having LTCI in the next, although small overall, is approximately 5.2% for the low cognition groups, but increases to 7.5% and 8% for

the high cognition groups across all three indicators. The probability of switching from having LTCI in one period to having no LTCI in the next period is higher for the low numeracy and recall groups (approximately 58%-59%) compared to the high numeracy and recall groups (53% and 55% respectively) but it is higher for the high verbal fluency scores (56%) compared to the low verbal fluency group (54%). Similarly, a higher proportion of respondents are likely to continue holding LTCI from one period to the next for the high numeracy and recall groups (45%-46% compared to 41%-42%) but also for the low verbal fluency group (46% compared to 44%).

Table 4 presents the relationship between changes in cognitive skills and changes in LTCI status over time, within individuals observed in the panel for more than one wave. Over 90% of people, whether they had an increase or decrease in their cognitive abilities levels will not change their default LTCI status from one period to the other. There is however higher insurance uptake from one period to the other for people that experienced an increase in their cognitive skills compared to people who experienced a negative change in their cognitive skills over time. In particular, the proportion of people who changed from no LTCI to LTCI between waves was 6.22%, 6.82% and 7.12% for people whose numeracy, verbal fluency and recall scores increased over time, compared to 5.75%, 6.16% and 6.23% for people with decreasing numeracy, verbal fluency and recall scores over time respectively. People with a positive change in recall skills were also less likely to drop a LTCI policy from one wave to the other (2.29%), compared to people with a reduction in recall skills (3.77%) but the opposite was observed for an increase in numerical and fluency skills.

Overall, we observe a positive association between different cognitive skills and LTCI coverage both between individuals but also within individuals over time. In the empirical

analysis, we will explore whether these differences are statistically significant after controlling for a number of observable and time-invariant unobservable factors.

Other controls

All empirical models account for a number of control factors that previous theoretical and empirical work suggest are important predictors of LTCI demand. These include demographic factors such as age and its square, gender, marital status and number of children (Pauly, 1990, Brown, Finkelstein, 2009, Mellor, 2001). To control for one's attitudes towards risk, we control for whether the respondent is currently or has been in the past a smoker and whether s/he has had a visit to the dentist in the past 12 months. We also include an indicator for whether the respondent also stayed overnight in hospital in the past 12 months to capture any information or experience effect from recent ill health and the use of healthcare services on LTCI purchase. Since cognitive ability is highly correlated with education, the models include measures of educational attainment for primary or lower education (base category), secondary, post-secondary and tertiary and post-tertiary education. As with other types of insurance LTCI, coverage is likely to depend on risk factors and health conditions (Finkelstein, McGarry, 2006). We account for a 5-point scale subjective health status ranging from excellent to poor and the presence of two or more chronic diseases, which include heart attack, stroke, cancer, hip fracture, hypertension, diabetes, lung disease, high cholesterol, arthritis and cataracts. We also include a measure of mental wellbeing to account for the possibility that mental health also affects the probability of owning insurance either directly as an additional risk factor or indirectly as a proxy for yet undiagnosed health conditions or unobserved traits such as optimism and perceptions about the future and associated risks. The CASP-12 index is a measure designed specifically to capture subjective mental wellbeing and quality of life in older age and is

composed of four subscales that include items on control, autonomy, self-realization and pleasure. Another factor that is likely to influence LTCI demand is perceptions of mortality risk. Thus, we control for people's expectations of life expectancy using a question that asks people what they think their chances are they will live up to a certain age. The target age varies between five and fifteen years into the future depending on the respondents' age at the time of the interview. Income and assets are also likely to affect LTCI demand (Brown, B. Coe & Finkelstein, 2007). Measures of income and wealth were taken from the detailed financial information available in SHARE. Due to the relatively high rate of nonresponse, the imputed variables were used instead, taking the average of the multiple imputations. To get individual-level measures, total household gross income and total household net wealth were divided by household size. To consider possible nonlinear effects, these measures were split into quartiles. Finally, all models include country fixed effects to account for institutional, cultural or other country variation in the supply of LTCI or LTC arrangements and wave dummies to capture any structural changes in the demand for LTCI over time.

Summary statistics

Table 1 presents the sample summary statistics for the dependent and explanatory variables. The average age is 61 and 55% of the sample are women. A majority of 77% are married or in a partnership, 18% are single or divorced and 0.6% are widowed. The average number of children is 2.1. About 21% are smokers, 61% have seen a dentist or dental hygienist in the last 12 months and 10% have had a hospital stay in the same period. About half of the sample have completed secondary education (55%) and over a quarter (30%) have some post-secondary or tertiary qualification. Around 14% have primary or less education and only 0.1% have had post-graduate training. Most people report a good (41%) or very good level of health

(25%) and 10% and 3% self-assess their health as excellent and poor respectively. On average, 36% of the sample suffer from at least two chronic conditions. The average CASP-12 index is 38.9 and people on average give a 73% probability of living until the target age.

Table 5 presents the sample split by country. Belgium, Germany, Denmark, Italy and Spain have a relatively larger representation in the sample ranging from 10.5% to 8%. Countries such as the Czech Republic, France, Austria, Slovenia, Switzerland and Greece make between 7.6% and 5% each. The Netherlands, Luxembourg, Poland, Israel, Portugal and Croatia have a smaller representation of below 4%. **Table 6** presents the distribution by wave. About 48% of observations are from Wave 4, 44% from Wave 6 and 7% from Wave 7. Similarly, 47.7% of observations are present in one wave, 45% in two waves and 7% in three waves.

Results

Baseline results

Table 7 presents the baseline estimation results. A number of different estimators were used including a linear probability, a probit, a random effects probit and a fixed effects specification. Standard errors are clustered at the individual level to account for repeated observations and marginal effects are presented for the probit and random effects probit models.

All three cognition measures have a positive association with the probability of owning private voluntary or supplementary LTCI but only the effect of recall is statistically significant in the OLS model (column 1). A one-standard deviation increase in the recall score is associated with an increase in the probability of insurance ownership of 0.3 percentage points. Concerning the other covariates, age and gender do not have a statistically significant effect. Divorced or never married individuals are significantly less likely to own a private LTCI policy compared to

those married or in a partnership by 0.7 percentage points. The number of children also has a negative and significant effect on the probability of having insurance. Having one more child is associated with a lower probability of insurance by 0.3 percentage points. This is consistent with a substitutive role of informal care from children with respect to insurance coverage for LTC either via the direct provision of care or due to intra-family moral hazard whereby parents may avoid purchasing insurance as an incentive for children to provide informal care. The effect of smoking is negative but not statistically significant while having visited the dentist is associated with an increase in the probability of holding LTCI of 1.3 percentage points, which is statistically significant. Taken as a proxy for risky behaviour and cautiousness this finding is suggestive of an advantageous selection in the European LTCI market taking place on the basis of preference-based characteristics, which are likely to be correlated both with higher investment in prevention activities and higher demand for LTCI (Finkelstein, McGarry, 2006). Hospital stay has an effect of 0.9 percentage point's increase in the probability of insurance coverage, capturing some information effect working through recent experience. Concerning education, in line with previous literature, more educated people are more likely to hold insurance. Having completed secondary, post-secondary and post-tertiary education, have an increasingly positive and statistically significant effect on the probability of owning private LTCI compared to people with just primary or lower education. The effect of education on the probability of insurance is also nonlinear with the effect of having post-tertiary education being a 5-percentage point's increase compared to a 2 percentage points increase from completing tertiary education and a 1.6 percentage points increase from completing secondary education in the probability of owning insurance. With respect to health, there is a negative association between health status and the probability of owning LTCI, again indicative of advantageous selection. Those with increasingly

worse self-reported health status are less likely to own insurance compared to those with excellent health. This relationship is significant when health status is described as fair and is associated with a reduction in insurance probability of 0.9 percentage points. Suffering from at least two chronic conditions is negatively associated with the probability of insurance but is not statistically significant. Worse subjective mental health as measured by a higher CASP-12 score has a positive and statistically significant effect on the probability of insurance. A one-standard deviation increase in the wellbeing index is associated with a 0.1 percentage points increase in the probability of owning insurance. The life expectancy measure is not statistically significant, similar to other findings in the literature that the misperception of the mortality risk and LTC risk cannot alone explain the non-purchase of LTCI (Boyer et al., 2019). There is a positive correlation between income and wealth and insurance demand. Belonging to higher income quartiles has a positive statistically significant effect on the probability of insurance, which is increasing with higher income. Belonging to the second quartile increases the probability of insurance by 0.3 percentage points while belonging to the third and highest ones increase it by 1.3 and 2.2 percentage points respectively, compared to belonging to the bottom income quartile. Higher wealth is also associated with higher insurance coverage, in line with previous evidence that LTCI is frequently purchased as a way of protecting individual wealth against catastrophic expenditures (Finkelstein, McGarry, 2006). Belonging to the second wealth quartile is associated with an increase in the probability of holding insurance by 2.6 percentage points compared to being in the lowest wealth quartile, belonging to the third is associated with an increase of 3 percentage points and belonging to the top wealth quartile is associated with increase in the probability of 2.8 percentage points.

The results from the nonlinear estimators, such as the Probit and random effects Probit models (columns 2 and 3) are very close to the linear probability estimates. The recall measure has a positive and statistically significant effect on the probability of owning LTCI with a one-standard deviation increase in the recall score increasing the insurance probability by 0.25 percentage points and all other covariates having similar effects of the same magnitude and sign.

Lastly, we estimated panel data models. To test whether a random-effects or a fixed-effects model is preferable, we added the mean of the time-varying variables to the model and tested for its significance (Mundlak, 1978, Wooldridge, 2001). If the means are jointly significant then the random-effects specification is preferred. The Mundlak test failed to reject the null hypothesis (chi2 (23) =48.98, p-value=0.0013) suggesting that the time-invariant unobservables are related to the regressors and therefore the fixed-effects model is appropriate. Column 4 presents the estimates from the fixed-effects estimator. Recall still has a positive and statistically significant effect on the probability of owning LTCI. A one-standard deviation in the recall score in this specification is associated with a 0.5 increase in the insurance probability above and beyond other characteristics. With a mean insurance ownership of 7.8%, this estimate suggests a 6% increase in average insurance coverage attributable to better memory skills. Age has a positive but at a declining rate effect on insurance, which is now statistically significant. One more year of age is associated with a 4-percentage points increase in the probability of insurance. Marital status, number of children and having visited the dentist are no longer significant in the fixed effects specification. Hospital stay remains statistically significant and associated with an increase in insurance probability of 1.5 percentage points. Income, health conditions and mental health are no longer significant. Higher wealth still has a positive and significant effect on the probability of insurance as belonging to the second and third wealth

quartiles increase the probability of insurance by 2 and 2.5 percentage points respectively. Belonging to the fourth wealth quartile is no longer significant in this specification, which could be indicative of alternative sources of protection for the very affluent households such as via home equity (Davidoff, 2010). Overall, memory skills as measured by the recall index but not numerical and verbal fluency abilities have a positive and statistically significant effect on the probability of holding insurance above and beyond other characteristics including general schooling, family structure, health, attitudes towards risk, income and wealth.

Robustness checks

We performed a number of robustness checks to investigate the sensitivity of the results to the age cohort, the use of alternative measures of numerical ability, the selection of countries, the exclusion of people with severe cognitive impairments and the inclusion of memory as the sole cognitive measure. The models were estimated with the preferred fixed effects estimator and the results are presented in **Table 8**.

One potential confounder of the relationship between cognition and insurance ownership may be selective mortality and cohort effects. The older cohorts in our sample may be positively selected with respect to their health or their investment in prevention activities since these individuals are still alive and able to participate in the SHARE interviews. Healthier and more cautious individuals are also more likely to have higher cognitive skills and also hold insurance, which may then overestimate the true effect of cognitive abilities on insurance demand. Furthermore, since the LTCI market is a relatively new one, older cohorts are less likely to hold insurance simply because the market was less likely to exist while also having lower levels of cognition due to age-related decline, which is faster in the older cohorts. In the baseline results,

we restricted the sample only to individuals aged between 50 and 70 years old to account for these effects. To control even further for selective mortality and cohort effects we restricted the sample to people aged between 50 and 60 years old since our descriptive analysis of the evolution of cognitive abilities has shown a faster decline in cognitive skills for people belonging in the 60-70 years old age group. If our baseline results of a positive effect of recall on insurance was driven by a selectivity or cohort bias, the estimates of the younger cohorts should be significantly smaller than the baseline results. The estimated coefficients show that this is not the case (column 1). In fact, the effect of recall on the probability of insurance is now larger with a one-standard deviation increase in the measure of memory skills increasing the probability of holding LTCI by 1 percentage point.

It is possible that while our measure of numeracy based on the ability to carry out subtractions is not significant, other aspects of numerical abilities are more relevant for the LTCI decision. Interest rate compounding for example, has been previously used as a measure a financial literacy, a concept capturing people's knowledge and ability of financial matters and has been found to affect a number of other financial outcomes (Banks, 2010, Lusardi, Mitchell, 2014). SHARE includes such an alternative numeracy measure that consists of questions on percentage calculation, price calculation and interest rate compounding (see Appendix A for a description of the measure). There is a large number of missing values in this index due to item non-response and a specific routing filter that was used in waves 5, 6 and 7 of the survey whereby only baseline respondents get to the respective questions. The missing completely at random assumption is likely to be violated in this setting and consequently the analysis based only on observations with complete records can be biased and inconsistent (Rubin, 1987, Little, Rubin, 2002). As a result, the imputed variable was used instead, which is also recommended as

a possible solution by the SHARE survey team (Börsch-Supan, Jürges, 2005). Recall remained the only statistically significant predictor among all cognitive measures in this specification, with an estimated effect on the probability of holding insurance of 0.5 percentage points (column 2). Thus, the baseline results are not sensitive to the specific measure of numeracy and neither numeracy measure has a significant effect on insurance demand.

We next explored whether the results are sensitive to the specific selection of countries included in the sample. We dropped from the sample certain countries for which the reported LTCI coverage rates are possible to overestimate the true conditions of the market. Specifically, we start by excluding Estonia, Slovenia and Croatia, which report very low LTCI coverage rates and evidence from other sources suggested no development of a market (column 3). We further excluded Luxembourg, Poland and Belgium. Although they have higher self-reported rates, we could not find any evidence on private LTCI products available in these countries (column 4). Finally, we dropped additionally Greece and the Czech Republic that report small coverage rates but above 1% but other evidence suggest an even smaller development (column 5). The results remain robust to the alternative country subsamples. The recall measure remained positive and statistically significant, with an average estimated effect ranging from 0.4 to 0.45 percentage points depending on the specific subsample.

Cognitive tests can be affected by specific circumstances at the time of the interview, and particularly cognitive impairment due to health problems such as brain diseases. To test the sensitivity of the results to the presence of outliers we excluded from the sample all individuals who have ever been diagnosed with dementia, Alzheimer's disease, senility, Parkinson's disease or stroke (column 6). Again, numeracy and verbal fluency were not statistically significant while the effect or recall remained statistically significant and close to 0.43 percentage points.

Finally, the effect of recall on the probability of insurance does not mediated by the effect of the other cognitive abilities. The effect remained statistically significant at 0.45 percentage points when included as the sole cognitive measure in the model (column 7).

Discussion

With population ageing and increasing needs for LTC services, understanding the reasons that affect the development of the private LTCI market is important from both an individual welfare and government spending point of view. This paper considered the effect that numerical, verbal fluency and memory abilities have on the probability of owning private voluntary or supplementary LTCI as another factor contributing to the size of the market.

We found evidence that memory but not numeracy or verbal fluency has a positive and statistically significant effect on the probability of owning private LTCI in Europe above and beyond other characteristics including general education, family, risk factors and risk attitudes, income and wealth. The effect was also sizeable. The baseline fixed effects estimates suggest that a one-standard deviation increase in the recall index score is associated with an increase in the probability of insurance of 0.5 percentage points. This effect is comparable or higher to the effect of factors such as age or number of children. For the younger cohorts of people aged 50 to 60 years old, the effect is higher and associated with a change in probability of closer to 1 percentage points. With an average insurance coverage of 7.8% in the overall sample and of 7.3% in the 50-60 subsample, these estimates would correspond to a change in insurance prevalence of 6% and 13% respectively.

The results remained robust even when we accounted for a different aspect of numerical abilities measuring aptitude with percentage calculation and interest rate compounding. Thus

basic numerical skills as are subtractions, but also percentages and interest rate compounding are not likely to affect LTCI decisions at least for the youngest cohorts which are also the prime age group of people who buy insurance. Interest rate compounding furthermore, could also be linked to the concept of financial literacy, which is often associated with a number of financial outcomes and better financial wellbeing (Banks, 2010, Lusardi, Mitchell, 2014). Given the very basic level of financial literacy skills captured by these measures, more research looking into more complex measures of financial literacy that include the understanding of inflation, the stock market and risk diversification is necessary to establish whether more advanced aspects of financial literacy or numeracy are still important in shaping LTCI decisions.

Several study limitations are worth noting. First, our findings are probably best viewed as indicative associations and pointing to future research into the causal effects at work with the use of more experimental data. Identifying an effect as close as possible to causal is always difficult with observational data. To address this issue, this study took into account a long list of possible confounding factors, cohort and selection mortality effects and time-invariant unobserved heterogeneity with the use of fixed effects estimators. Although these methods are an improvement over previous studies that only rely on cross-sectional data (McGarry et al., 2016), we acknowledge that there can still be other sources of endogeneity not accounted for.

Second, although the present study demonstrates a significant average effect of cognition on LTCI ownership, the underlying mechanisms of this effect were not explored due to data limitations. To the extent that memory skills capture the ability to process information faster and more efficiently, the role of cognition on LTCI decisions may be thought to work through reducing information frictions rather than through preferences or cognitive biases. Future research is important to explore which types of information gaps are more relevant and costly

(e.g. whether that is perceptions around LTC risk and alternative sources of protection or the understanding of specific aspects of LTCI products) in order to design more targeted policies.

Lastly, this study did not look into identifying the individuals for whom LTCI is more likely to be an appropriate form of coverage. Due to the high price of LTCI premiums, some people may find it unaffordable to buy such coverage particularly if they have limited accumulated assets to protect. Some experts for example recommend that LTCI premiums should not exceed 5% of household income (National Association of Insurance Commissioners, 2/9/2021). People's willingness to pay for LTCI may also vary in combination with the availability of public programms and their specific characteristics as is the degree of means-testing and coverage or other market characteristics such as the presence of medical underwriting (Pauly, 1990, Brown, Finkelstein, 2008, Cornell et al., 2016). It is thus possible that there are heterogeneous effects of cognitive abilities on the probability of insurance ownership across the wealth and public protection distribution. People particularly with lower income and assets are likely to find LTCI coverage suboptimal and thus better cognitive skills could be associated with non-purchase for this population. Although there is currently some evidence from the US on the wealth thresholds at which LTCI becomes a preferred choice over other consumption smoothing mechanisms such as Medicaid (Brown, Finkelstein, 2008), it is presently unclear what the ideal rate of LTCI ownership should be in the different European countries with their diverse institutional LTC arrangements. In the absence of such evidence, identifying any heterogeneous effects is beyond the scope of this paper. The development however of a similar model for the European population predicting when LTCI becomes desirable depending on individual and market characteristics is a promising avenue for future research.

Despite these limitations, we can expect that for a large part of the population, LTCI is still likely to be optimal, with higher cognitive skills contributing to greater coverage as has been documented in this study. Brown and Finkelstein (2008) estimate that for most of the wealth distribution consumption smoothing without LTCI is inadequate with a significant welfare loss associated with incomplete Medicaid coverage for everyone but the poorest individuals. Suboptimal consumption smoothing under the existing forms of coverage may also be expected in Europe, despite the presence of a more generous welfare state and strong family ties. The existing evidence suggests that the decision to not purchase LTCI is not consistent with intra-family moral hazard and that people who expect public insurance to pay for LTC are not less likely to purchase private insurance(Costa-Font, Courbage, 2015). The latter finding reflects the incompleteness and significant cost sharing associated with public support in Europe, suggesting that there is scope for significant unrealized demand for LTCI coverage.

In this context, the significant and robust effect of cognition and particularly memory on LTCI coverage, suggests that cognitive limitations can be an important factor affecting the expansion of the market that therefore need to be taken into consideration in policy design. Policies to improve the level of memory skills among the general and eldest populations are of a longer horizon and thus less likely to be effective in the shorter term. Strategies to reduce the cognitive load of individual decision-making, such as the availability of simplified information and the standardization of products could be more effective ways of raising insurance coverage, that have been used in the past in the context of health insurance (Rice, Graham & Fox, 1997). However, further investigation is required into the costs and effectiveness of such interventions. There is a lack of quality evidence on the costs of running large education and information campaigns and any existing evidence on such national strategies is mixed (OECD, 2015).

Understanding the costs and effectiveness of raising cognitive skills and/or simplifying information and insurance contracts will allow the cost-effectiveness comparison to alternative polices such as tax-subsidies that have also been shown to have a large impact on insurance coverage and public expenditures (Goda, 2011). Given that memory is the cognitive skill mostly affecting LTCI demand, it is also conceivable that such skills are difficult to change in older ages. With the increasing prevalence of diseases affecting memory such as dementia, it is likely that not all older adults will be able to select their optimal LTC financing arrangement, even in the presence of increased consumer support. Changes therefore to the welfare state with the implementation of a 'fifth pillar' of social insurance with a uniform LTC allowance may be preferable in the case of high costs and ambiguous effectiveness of strategies aiming only at the support of the private market. These questions are left for future research.

Conflict of interest

The corresponding author states that there is no conflict of interest.

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Tables

Table 1 Summary statistics

Variable	Mean	St. Dev.
Long-term care insurance	0.078	0.268
Numeracy score	4.411	1.129
Verbal fluency score	22.194	7.583
Recall score	5.868	1.580
Age	61.18	5.471
Female	0.554	0.497
Married	0.766	0.423
Single	0.177	0.382
Widowed	0.056	0.231
Number of children	2.049	1.231
Smoker	0.208	0.406
Dentist appointment	0.608	0.488
Hospital stay	0.105	0.307
Education: Pre-primary/ primary	0.139	0.346
Education: Secondary	0.547	0.498
Education: post-secondary/tertiary	0.304	0.460
Education: post-tertiary	0.010	0.098
Health: excellent	0.103	0.304
Health: very good	0.245	0.430
Health: good	0.414	0.493
Health: fair	0.204	0.403
Health: poor	0.034	0.181
Chronic diseases (2 or more)	0.362	0.480
CASP-12 index	38.946	5.644
Life expectancy	72.829	23.880
Net per capita income (log)	9.321	1.191
Net per capita wealth (log)	13.519	0.337
Observations	58,354	

Source: SHARE waves 5-7 using calibrated individual weights. People aged 50-70 with no ADLs and no IADLs

Table 2 Cognitive skills by country

Country	Numeracy		Verbal Fluency		Recall	
	Mean	SD	Mean	SD	Mean	SD
Austria	4.64	1.00	25.65	7.32	6.43	1.53
Germany	4.54	0.93	24.16	7.22	6.05	1.55
Netherlands	4.62	0.89	22.86	6.60	5.95	1.51
Spain	3.49	1.78	18.31	6.70	4.95	1.65
Italy	4.12	1.37	17.58	7.02	5.32	1.54
France	4.15	1.34	20.30	6.12	5.84	1.54
Denmark	4.54	0.96	25.96	6.71	6.21	1.50
Greece	4.25	1.36	13.58	4.84	5.50	1.49
Switzerland	4.60	0.92	23.44	6.86	6.38	1.55
Belgium	4.56	0.98	23.23	6.87	6.04	1.58
Israel	4.29	1.24	20.97	7.09	5.81	1.52
Czech Republic	4.56	0.92	25.09	7.29	5.99	1.49
Poland	4.18	1.29	19.47	7.02	5.10	1.45
Luxembourg	4.42	1.15	19.62	6.34	5.84	1.69
Portugal	3.37	1.67	17.29	6.14	4.90	1.52
Slovenia	4.37	1.16	24.49	7.17	5.62	1.56
Estonia	4.53	0.97	23.90	7.60	5.93	1.64
Croatia	4.49	1.06	20.66	7.33	5.72	1.64

Source: SHARE waves 5-7 using calibrated individual weights. People aged 50-70 with no ADLs and no IADLs.

Table 3 LTCI transition probabilities by average level of cognitive abilities

	t=no LTCI t+1=no LTCI	t=no LTCI t+1=LTCI	t=LTCI t+1=no LTCI	t=LTCI t+1=LTCI
Numeracy high	92.55	7.45	53.40	46.60
Numeracy low	94.83	5.17	58.78	41.22
Verbal Fluency high	92.41	7.59	55.90	44.10
Verbal Fluency low	94.77	5.23	53.93	46.07
Recall high	92.03	7.97	54.82	45.18
Recall low	94.87	5.13	58.29	41.71

Source: SHARE waves 5-7. People aged 50-70 with no ADLs and no IADLs

Table 4 Change in LTCI status by change of cognitive abilities over time (%)

	Drop LTCI	No change in LTCI status	LTCI take up	Total
Numeracy increase	3.55	90.24	6.22	100
Numeracy decrease	3.34	90.92	5.75	100
Verbal Fluency increase	3.68	89.50	6.82	100
Verbal Fluency decrease	3.44	90.40	6.16	100
Recall increase	3.29	89.59	7.12	100
Recall decrease	3.77	90.00	6.23	100

Source: SHARE waves 5-7. People aged 50-70 with no ADLs and no IADLs

Table 5 Sample split by country

Country	Observations	Percent (%)
Austria	3,536	6.06
Germany	5,861	10.04
Netherlands	2,120	3.63
Spain	4,706	8.06
Italy	4,967	8.51
France	4,392	7.53
Denmark	5,140	8.81
Greece	3,015	5.17
Switzerland	3,080	5.28
Belgium	6,143	10.53
Israel	1,195	2.05
Czech Republic	4,462	7.65
Poland	1,253	2.15
Luxembourg	1,822	3.12
Portugal	618	1.06
Slovenia	3,132	5.37
Estonia	2,840	4.87
Croatia	72	0.12

Source: SHARE waves 5-7. People aged 50-70 with no ADLs and no IADLs

Table 6 Sample split by wave

Wave	Observations	Percent (%)
Wave 5	28,205	48.33
Wave 6	25,876	44.34
Wave 7	4,273	7.32
Present in one wave	26,893	47.77
Present in two waves	25,299	44.61
Present in three waves	4,104	7.29

Source: SHARE waves 5-7. People aged 50-70 with no ADLs and no IADLs

Table 7 Estimation results: probability of owning private voluntary or supplementary LTCI

	OLS	Probit	RE Probit	FE
	(1)	(2)	(3)	(4)
Numeracy	0.000217	0.0000099	-0.000235	0.000743
	(0.00101)	(0.000827)	(0.000833)	(0.00210)
Verbal Fluency	0.000120	0.000154	0.000175	0.000029
	(0.000177)	(0.000135)	(0.000134)	(0.000361)
Recall	0.00295***	0.002434***	0.002536***	0.00458***
	(0.000793)	(0.00061)	(0.000597)	(0.00142)
Age	0.00356	0.003496	0.005039	0.0412***
	(0.00459)	(0.003659)	(0.003718)	(0.0147)
Age square	-0.000024	-.0000263	-0.000039	-0.000220*
	(0.000037)	(0.00003)	(0.000031)	(0.000116)
Female	-0.00357	-0.00323*	-0.000235	
	(0.00238)	(0.00181)	(0.000833)	
Marital status (ref: married/partnership)				
Single	-0.00698**	-0.00414*	-0.005396*	-0.0130
	(0.00309)	(0.002412)	(0.002365)	(0.0211)
Widowed	0.000706	0.001014	0.000552	-0.0247
	(0.00478)	(0.003982)	(0.003866)	(0.0178)
Number of children	-0.00334***	-0.00262***	-0.00283***	0.00139
	(0.000979)	(0.000725)	(0.000732)	(0.00389)
Smoker	-0.00239	-0.004274*	-0.00336	-0.00195
	(0.00256)	(0.002336)	(0.002417)	(0.00534)
Dentist visit	0.0135***	0.01027***	0.00996***	0.00351
	(0.00248)	(0.00192)	(0.001893)	(0.00470)
Hospital stay	0.00919**	0.007317***	0.00696***	0.0146**
	(0.00368)	(0.002752)	(0.00266)	(0.00577)
Education (ref: pre-primary/primary)				
Secondary	0.0157***	0.010263***	0.00998***	
	(0.00378)	(0.002971)	(0.00298)	
Post-secondary/Tertiary	0.0224***	0.016128***	0.016197***	
	(0.00447)	(0.0033302)	(0.003303)	
Post tertiary	0.0450***	0.02622***	0.028814***	
	(0.0149)	(0.008117)	(0.008132)	
Health (ref: excellent)				
Very good	-0.00209	-0.001347	-0.000148	-0.000945
	(0.00436)	(0.002972)	(0.00292)	(0.00699)
Good	-0.00616	-0.003481	-0.0014962	0.00208
	(0.00430)	(0.002951)	(0.002915)	(0.00753)
Fair	-0.00886*	-0.006985*	-0.005964*	-0.000457
	(0.00481)	(0.003642)	(0.0035971)	(0.00907)
Poor	-0.00358	-0.003418	-0.002026	0.00925
	(0.00692)	(0.0061801)	(0.006117)	(0.0147)
Chronic conditions (2+)	-0.000788	-0.000678	-0.001575	0.00635
	(0.00251)	(0.001951)	(0.001913)	(0.00492)

	OLS	Probit	RE Probit	FE
	(1)	(2)	(3)	(4)
CASP-12 index	0.00100***	0.000924***	0.000776***	-0.000106
	(0.000239)	(0.000189)	(0.000186)	(0.000515)
Life expectancy	-0.00005	-.0000486	-0.000049	-0.000103
	(0.000049)	(0.000041)	(0.000038)	(0.000099)
Income quartiles (ref: bottom)				
Second	0.00248	0.005207*	0.00451	-0.000049
	(0.00280)	(0.00312)	(0.003091)	(0.00665)
Third	0.0131***	0.013745***	0.011786***	0.00669
	(0.00367)	(0.003367)	(0.003275)	(0.00764)
Top	0.0222***	0.017366***	0.014699***	0.00359
	(0.00453)	(0.003635)	(0.003474)	(0.00842)
Wealth quartiles (ref: bottom)				
Second	0.0262***	0.017564***	0.015632***	0.0217***
	(0.00322)	(0.002747)	(0.0026738)	(0.00578)
Third	0.0313***	0.012335***	0.010673***	0.0250***
	(0.00599)	(0.003816)	(0.003708)	(0.00760)
Top	0.0278***	0.014957***	0.012001***	0.00568
	(0.00637)	(0.003955)	(0.003797)	(0.00971)
Constant	-0.245*	-0.04534***	-0.0778***	-1.659***
	(0.139)	(0.00119)	(0.001129)	(0.470)
Country fixed effects	Yes	Yes	Yes	Yes
Wave fixed effects	Yes	Yes	Yes	Yes
Observations	58,354	58,354	51,834	58,354
R^2 overall	0.1027			0.0011
R^2 within				0.0171
R^2 between				0.0003
Mundlak Test (Chi2(23))				48.98
(p-value)				0.0013
Wald (chi2 (47))		3879.78	1805.59	

Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust clustered standard errors at the individual level are reported in parentheses. Marginal effects presented in (2).

Table 8 Sensitivity analysis

	Age cohort: 50-60	Alternative numeracy index	Country subsamples			Cognitive impairment outliers	Single cognitive measure
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Numeracy	0.000773	0.00247	0.00150	0.00120	0.00105	0.000141	
	(0.00412)	(0.0195)	(0.00248)	(0.00234)	(0.00256)	(0.00214)	
Verbal Fluency	-0.000375	0.0000242	0.000105	0.000323	0.000129	0.0000305	
	(0.000686)	(0.000360)	(0.000430)	(0.000413)	(0.000455)	(0.000366)	
Recall	0.00962***	0.00454***	0.00456***	0.00380**	0.00432**	0.00431***	0.00452***
	(0.00262)	(0.00142)	(0.00167)	(0.00163)	(0.00177)	(0.00144)	(0.00141)
Age	0.0744	0.0411***	0.0437**	0.0205	0.0176	0.0401***	0.0403***
	(0.0524)	(0.0147)	(0.0174)	(0.0170)	(0.0185)	(0.0150)	(0.0147)
Age square	-0.000509	-0.000219*	-0.000235*	-0.000146	-0.000119	-0.000214*	-0.000213*
	(0.000463)	(0.000116)	(0.000137)	(0.000134)	(0.000146)	(0.000118)	(0.000116)
Female							
Marital status (ref: married/partnership)							
Single	-0.0118	-0.0130	-0.0125	-0.0232	-0.0337	-0.0134	-0.0130
	(0.0330)	(0.0211)	(0.0231)	(0.0217)	(0.0232)	(0.0215)	(0.0211)
Widowed	-0.0377	-0.0247	-0.0259	0.00636	0.00877	-0.0248	-0.0247
	(0.0580)	(0.0178)	(0.0194)	(0.0192)	(0.0218)	(0.0181)	(0.0178)
Number of children	0.00263	0.00137	-0.00292	-0.00492	-0.00535	0.00244	0.00131
	(0.00702)	(0.00388)	(0.00481)	(0.00461)	(0.00491)	(0.00400)	(0.00387)
Smoker	-0.00167	-0.00206	0.00303	-0.00921	-0.00636	-0.00329	-0.00222
	(0.00925)	(0.00533)	(0.00633)	(0.00620)	(0.00685)	(0.00543)	(0.00533)
Dentist visit	-0.000097	0.00353	0.00568	0.00703	0.00608	0.00383	0.00311
	(0.00900)	(0.00470)	(0.00552)	(0.00540)	(0.00605)	(0.00478)	(0.00469)
Hospital stay	0.0213*	0.0145**	0.0168**	0.0111*	0.00671	0.0137**	0.0145**
	(0.0113)	(0.00577)	(0.00668)	(0.00657)	(0.00717)	(0.00597)	(0.00577)
Education (ref: pre-primary/primary)							
Secondary							

	Age cohort: 50-60	Alternative numeracy index	Country subsamples			Cognitive impairment outliers	Single cognitive measure
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Post-secondary/Tertiary							
Post tertiary							
Health (ref: excellent)							
Very good	-0.000267	-0.000525	0.00417	0.00229	0.00206	-0.000862	-0.000472
	(0.0119)	(0.00699)	(0.00801)	(0.00774)	(0.00818)	(0.00704)	(0.00698)
Good	-0.00161	0.00260	0.0116	0.00652	0.00432	0.00147	0.00273
	(0.0132)	(0.00752)	(0.00866)	(0.00842)	(0.00895)	(0.00759)	(0.00751)
Fair	0.00694	0.000345	0.00692	0.00107	0.00527	0.000911	0.0000642
	(0.0168)	(0.00906)	(0.0105)	(0.0102)	(0.0111)	(0.00922)	(0.00905)
Poor	0.0397	0.00994	0.0164	0.00840	0.0255	0.00783	0.0111
	(0.0280)	(0.0147)	(0.0173)	(0.0167)	(0.0183)	(0.0153)	(0.0147)
Chronic conditions (2+)	0.00612	0.00630	0.00718	-0.000498	0.00405	0.00555	0.00605
	(0.00994)	(0.00492)	(0.00570)	(0.00562)	(0.00616)	(0.00502)	(0.00491)
CASP-12	0.000740	-0.0000773	-0.0000542	0.000178	0.000170	-0.0000025	-0.0000629
	(0.000954)	(0.000515)	(0.000608)	(0.000591)	(0.000655)	(0.000525)	(0.000514)
Life expectancy	0.000127	-0.000107	-0.0000382	-0.000144	-0.000109	-0.0000936	-0.000107
	(0.000190)	(0.000099)	(0.000117)	(0.000115)	(0.000128)	(0.000101)	(0.0000989
Income quartiles (ref: bottom)							
Second	0.00380	-0.000083	0.00480	0.00495	0.0177**	0.00135	-0.0000409
	(0.0119)	(0.00664)	(0.00784)	(0.00745)	(0.00800)	(0.00677)	(0.00663)
Third	-0.00679	0.00663	0.0137	0.0218**	0.0220**	0.00579	0.00655
	(0.0134)	(0.00764)	(0.00902)	(0.00871)	(0.00895)	(0.00776)	(0.00763)
Top	0.000659	0.00352	0.0166*	0.0190**	0.0191*	0.00283	0.00378
	(0.0147)	(0.00842)	(0.00982)	(0.00968)	(0.00980)	(0.00857)	(0.00841)
Wealth quartiles (ref: bottom)							

	Age cohort: 50-60	Alternative numeracy index	Country subsamples			Cognitive impairment outliers	Single cognitive measure
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Second	0.0187*	0.0218***	0.0203***	0.00236	0.00268	0.0215***	0.0217***
	(0.00992)	(0.00578)	(0.00660)	(0.00625)	(0.00653)	(0.00589)	(0.00577)
Third	0.0291**	0.0252***	0.0217**	-0.0162*	-0.0113	0.0243***	0.0250***
	(0.0140)	(0.00759)	(0.00862)	(0.00850)	(0.00877)	(0.00771)	(0.00759)
Top	0.00179	0.00579	-0.000200	-0.0162	-0.0206*	0.00433	0.00571
	(0.0181)	(0.00971)	(0.0113)	(0.0109)	(0.0114)	(0.00986)	(0.00971)
Constant	-2.605*	-1.663***	-1.749***	-0.00992**	-0.576	-1.612***	-1.625***
	(1.497)	(0.475)	(0.553)	(0.00486)	(0.589)	(0.478)	(0.469)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wave fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	21,609	58,384	46,496	38,065	31,105	57,158	58,434
R^2 overall	0.0000	0.0011	0.0014	0.0031	0.0015	0.0011	0.0010
R^2 within	0.0221	0.0171	0.0202	0.0052	0.0049	0.0169	0.0170
R^2 between	0.0000	0.0003	0.0005	0.0033	0.0016	0.0003	0.0003

Notes: *** p<0.01, ** p<0.05, * p<0.1. Fixed effects estimates. Robust clustered standard errors at the individual level are reported in parentheses. Model (3) excludes Estonia, Slovenia and Croatia. Model (4) excludes Estonia, Slovenia, Croatia, Luxembourg, Poland and Belgium. Model (5) excludes Estonia, Slovenia, Croatia, Luxembourg, Poland, Belgium, the Czech Republic and Greece. Model (6) excludes individuals who have been diagnosed with dementia, Alzheimer's disease, senility, Parkinson's disease or stroke.

Figures

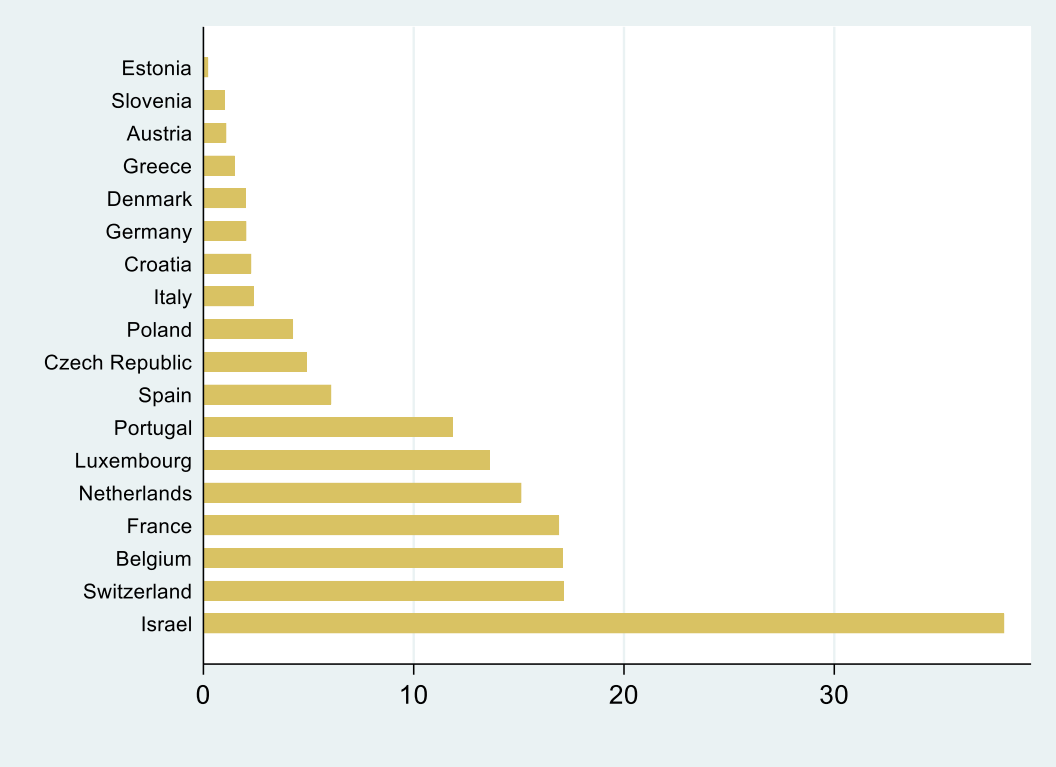
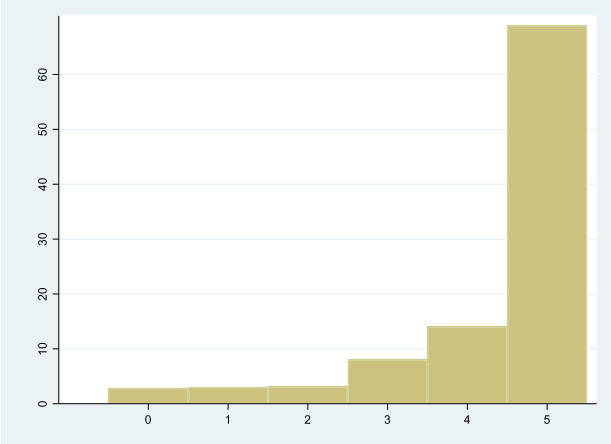
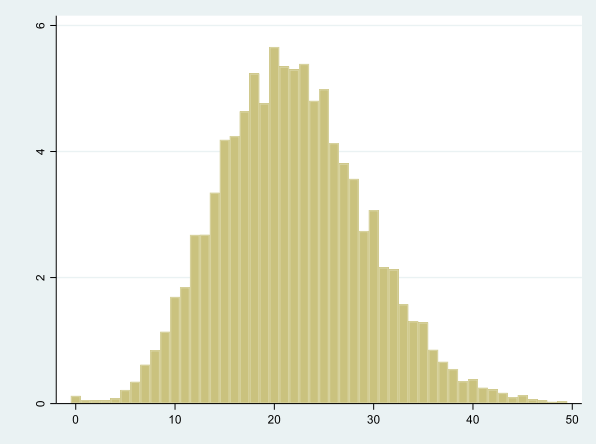


Figure 1 Private voluntary or supplementary LTCI, share of valid answers in per cent by country.

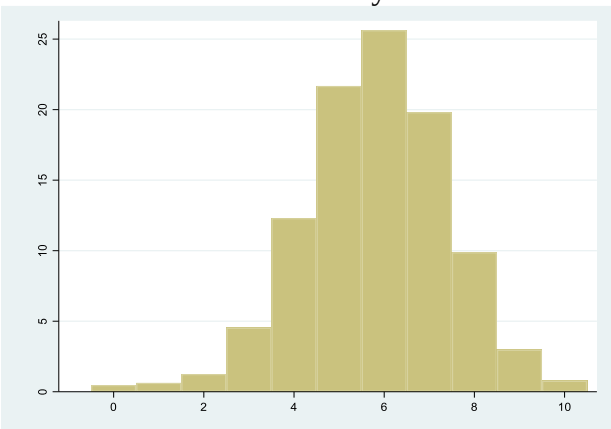
Source: SHARE waves 5-7 using calibrated individual weights. People aged 50-70 with no ADLs and no IADLs



a. Numeracy



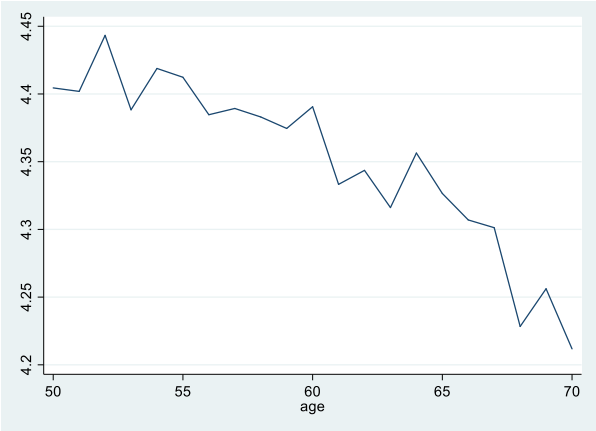
b. Verbal fluency



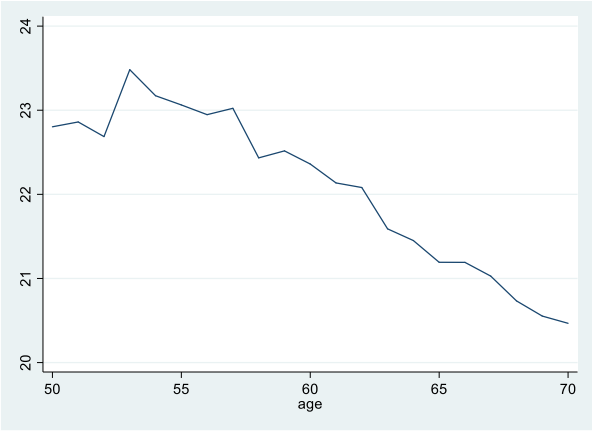
c. Recall

Figure 2 Sample distribution of cognitive indicators

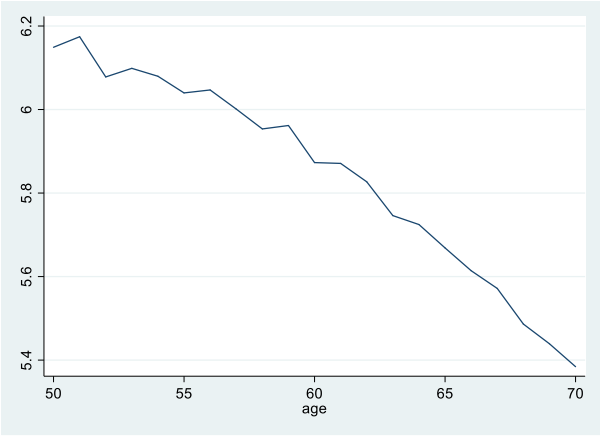
Notes: Fraction of sample reported. (a) Numeracy indicator measures the number of correct subtractions performed; (b) Verbal fluency indicator measures the number of animals named in one minute; (c) Recall indicator measures the number of words recalled out of a list of ten.
Source: SHARE waves 5-7 using calibrated individual weights. People aged 50-70 with no ADLs and no IADLs



a. Numeracy



b. Verbal fluency

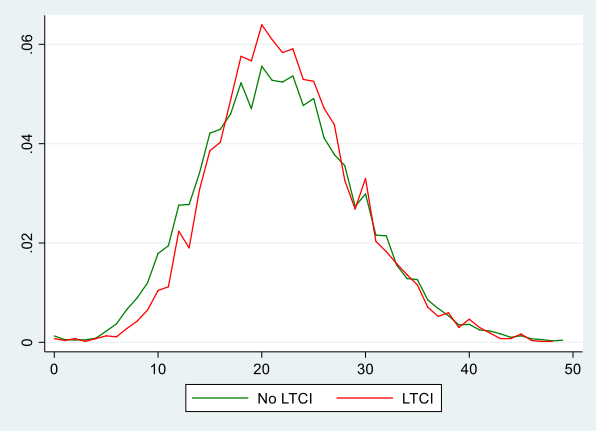


c. Recall

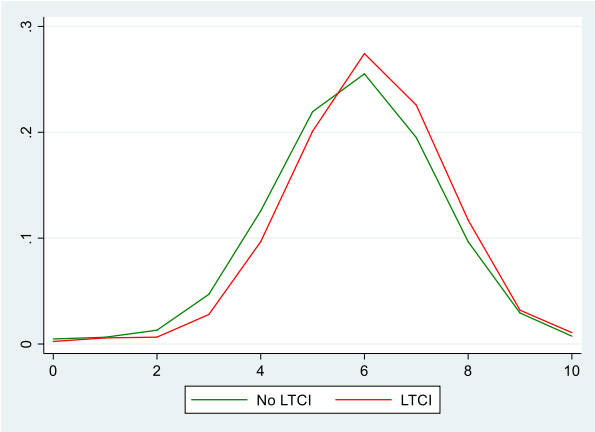
Figure 3 Cognitive indicators by age

Notes: Fraction of sample reported. (a) Numeracy (mean), (b) verbal fluency (mean), (c) recall (mean).
Source: SHARE waves 5-7 using calibrated individual weights. People aged 50-70 with no ADLs and no IADLs.

a. Numeracy



b. Verbal Fluency



c. Recall

Figure 4 Sample distribution of cognitive indicators by LTCI status

Notes: Fraction of sample reported. (a) Numeracy indicator measures the number of correct subtractions performed; (b) Verbal fluency indicator measures the number of animals named in one minute; (c) Recall indicator measures the number of words recalled out of a list of ten.
Source: SHARE waves 5-7 using calibrated individual weights. People aged 50-70 with no ADLs and no IADLs

Appendix A

A.1. Measures of LTCI and cognitive abilities in SHARE

A.1.1 LTCI

The generic question on long-term care insurance is: ‘Do you have any of the following public or private long-term care insurances?’ If the question is unclear interviewers are instructed to provide a follow-up explanation: ‘Long-term care insurance helps covering the cost of long-term care. It generally covers home care, assisted living, adult daycare, respite care, hospice care and stays in nursing homes or residential care facilities. Some of the long-term care services might be covered by your health insurance’. Respondents are provided with a list of possible answers and can report one or more of the following answer categories: ‘Public’, ‘Private mandatory’, ‘Private voluntary/ supplementary’, ‘None’.

A.1.2 Cognitive abilities

A.1.2.1 Numeracy

SHARE includes a series of five sequential subtractions for respondents to ask. The question is as follows: ‘Now let’s try some subtraction of numbers. One hundred minus 7 equals what? And 7 from that?’. The question ‘and 7 from that?’ is repeated up to the fifth subtraction. The numeracy indicator is the sum of the correct number of subtractions.

A.1.2.2 Verbal Fluency

The verbal fluency indicator is based on the following question: ‘I would like you to name as many different animals as you can think of. You have one minute to do this.’ The verbal fluency score then is the sum of acceptable animals. Any member of the animal kingdom, real or mythical is scored correct, except repetitions and proper nouns. Specifically each of the

following gets credit: a species name and any accompanying breeds within the species as well as any male, female and infant names within the species.

A.1.2.3 Recall

To measure memory SHARE includes the following question: 'Now, I am going to read a list of words from my computer screen. We have purposely made the list long so it will be difficult for anyone to recall all the words. Most people recall just a few. Please listen carefully, as the set of words cannot be repeated. When I have finished, I will ask you to recall aloud as many of the words as you can, in any order. Is this clear?'. The memory indicator is the sum of all words recalled within a minute. In waves 5, 6 and 7 respondents were randomly assigned to one of four sets of "ten words list learning". A delayed recall question is also asked whereby the interviewer comes back to the recall question after a while asking respondents to list any of the words they can still remember.

A.1.2.4 Alternative numeracy measure

The SHARE survey asks the following questions that are used to construct the second numeracy index:

1. If the chance of getting a disease is 10% how many people out of 1,000 would be expected to get the disease? Possible answers: 100; 100; 90; 900 and another answer.
2. In a sale, a shop is selling all items at half price. Before the sale a sofa costs 300 euro. How much will it cost in the sale? The possible answers: 150; 600 and another answer.
3. A second hand car dealer is selling a car for 6,000 euro. This is two-thirds of what it costs new. How much did the car cost new? Possible answers: 9,000; 4,000; 8,000; 12,000, 18,000 and another answer.

4. Let's say you have 2,000 euro in a savings account. The account earns 10% interest each year. How much would you have in the account at the euro of two years? Possible answers: 2,420; 2,020; 2,100; 2,400 and another answer.

The way the final numeracy measure is constructed is the following. If question (1) is answered wrongly then respondents are asked question (2) while if it is answered correctly respondents are directed to question (3). If both questions (1) and (2) are wrong then the numeracy score is 1, which is the lowest possible. If question (1) is wrong while question (2) is correct then the score is 2. Those respondents that answer question (1) correctly are taken to questions (3) and (4). If question (3) is wrong then the score is 3. If questions (1) and (3) are correct but (4) is wrong then the score is 4. If all questions (1), (3) and (4) are correct then the score is 5, which is the highest possible score.

Appendix B

Table B.1

Market statistics on LTCI across countries

Country	Information on the LTCI market	Source
Austria	60,000 LTCI insured	Kern & Lammer (2011)
	Private insurance schemes are under development and the contract volume is quite moderate	Trukeschitz and Schneider (2012)
Germany	1.3 million supplementary policies	AXA (2012)
Netherlands	No supplementary LTCI market. Past attempts have failed because of a lack of demand	Schut and van den Berg (2012)
Spain	The private market remains limited to date	AXA (2012)
	Several products have been launched but the penetration of this insurance is low. Estimated 17,453 insured people	SCOR Global Life (2012)
Italy	Private insurance market is emerging in Italy, predominantly based on indemnity policies	OECD (2011)
France	7.1 million people have a LTCI contract	FFA (2017)
	The market is estimated to cover 5.5 million individuals	AXA (2012)
Denmark	Private Health Insurance: 1.614.181 number of insured persons of which 2% are personally signed contracts and of those 70% are care insurances	Danish Insurance Association (2013)
Switzerland	Private insurance is not a success in Switzerland	SCOR Global Life (2012)
Israel	Private LTCI reaches a high market penetration with over 4 million insured	SCOR Global Life (2012)
	Over 4 million people have some form of private LTCI insurance policy	Brammli-Greenberg et al. (2012)
Czech Republic	"[…] no experience with private voluntary or compulsory long-term care insurance. There have not been any attempts of introducing private long-term care insurance neither in the past nor in the future […]"	ÖSB Consulting (2014)
Poland	No mention of private long-term care insurance. Only private financing is out-of-pocket payments.	Golinowska (2010)
Portugal	Private LTCI spending at 1.1% of total LTC spending (2006)	OECD (2011)
Greece	Private spending on LTC at 0.01% of GDP consisting of private insurance, out-of-pocket expenditure and co-payments to private insurance	Greve (2017)