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Longevity Risk, Subjective Survival Expectations, and Individual Saving Behavior

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Abstract Theoretical studies suggest that unexpected changes in future survival probabilities (longevity risk) are important determinants of individuals' decisions about consumption, saving, asset allocation, and retirement timing. This study provides empirical evidence that individuals are indeed aware of longevity risk and that this awareness affects their savings decisions. These results are based on a data set that matches subjective survival expectations and savings indicators from the Survey of Health, Ageing and Retirement in Europe (SHARE) with life table data from the Human Mortality Database.

Keywords longevity risk, subjective survival expectations, forecast dispersion, saving behavior

JEL classifications D14, D84, D91, H31, J11

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For the past several decades, the industrialized world has experienced rapid improvements in life expectancy and mortality rates. The annual rates of these improvements exhibit considerable variations, as illustrated in Figure 1 for the mortality rates of males and females aged 65 and 85. The erratic paths of the mortality rates reflect the underlying complex interaction of external drivers, such as medical innovation, whose overall impact is clearly non-deterministic. The resulting unexpected changes in mortality are commonly referred to as "longevity risk," "stochastic mortality" or "aggregate mortality risk."

-- *Figure 1 here* --

Theoretical studies suggest that longevity risk is an important determinant of individual consumption and saving decisions (Levhari and Mirman, 1977; Davies, 1981; Cocco and Gomes, 2009; De Nardi, French, and Jones, 2009), individual asset allocation decisions regarding annuities and longevity bonds (Albis and Thibault, 2008; Menoncin, 2008; Cocco and Gomes, 2009; Post, 2009; Stevens, 2009; Horneff, Maurer, and Rogalla, 2010; Schulze and Post, 2010), and retirement timing decisions (Cocco and Gomes, 2009), as well as for equilibrium annuity prices (Van de Ven and Weale, 2008). In these models, like in the classical life-cycle model with lifespan uncertainty (Yaari, 1965), individuals integrate into their decision-making process a prognosis of mean survival probabilities. In addition, these models incorporate uncertainty with respect to actual future survival rates. The presence of this longevity risk is shown to increase individuals' savings for self-insurance against longevity shocks (Cocco and Gomes, 2009), induce the use of longevity bonds as hedging instruments (Menoncin, 2008; Cocco and Gomes, 2009), and increase investment in deferred annuities (Post, 2009; Stevens, 2009; Horneff, Maurer, and Rogalla, 2010).

In this article, we empirically test whether individuals are aware of longevity risk and, if so, whether this awareness affects their actual saving behavior. To this end, we analyze survey data on subjective survival expectations and savings elicited from more than 30,000 individuals in the Survey of Health, Ageing and Retirement in Europe (SHARE) and corresponding life table data from the Human Mortality Database (University of California; Berkeley, and Max Planck Institute for Demographic Research, 2009).

The SHARE survey contains subjective point forecasts of individuals' survival probabilities. Such estimates have been shown to be informative with respect to the mean of objective survival probabilities. Similar to their objective counterparts, subjective survival estimates exhibit differentials according to, for example, age, gender, health, and socioeconomic status (Hamermesh, 1985; Hurd and McGarry, 1995; Mirowsky and Ross, 2000; Khwaja, Sloan, and Chung, 2007; Popham and Mitchell, 2007; Delavande and Rohwedder, 2008). Subjective estimates are found to match the shape of survival functions of actual life tables, although they exhibit some underestimation at younger ages and some overestimation at older ages (Hamermesh, 1985; Elder, 2007; Hurd, Rohwedder, and Winter, 2009).[1] Furthermore, subjective estimates have predictive power for individuals' actual survival (Hurd, McFadden, and Gan, 1998; Hurd and McGarry, 2002; Siegel, Bradley, and Kasl, 2003; Winter, 2008), for the development of aggregate survival rates (Hamermesh, 1985; Perozek, 2008), and for economic decisions regarding consumption, savings, bequests, and the timing of claiming retirement benefits (Coile et al., 2002; Gan et al., 2004; Hurd, Smith, and Zissimopoulos, 2004; Bloom et al., 2007; Delavande and Willis, 2008, Salm, 2010).

To study individuals' awareness of longevity risk, we test whether subjective survival probabilities elicited in SHARE are also informative with respect to the uncertainty surrounding the development of objective survival rates. For this, we relate the dispersion in individuals' point forecasts to the uncertainty observed in objective mortality data.[2] A similar approach is found in a large number of empirical studies that use the dispersion of point forecasts as a proxy for uncertainty regarding economic variables. These include macroeconomic variables such as inflation, unemployment, and GDP growth rates (Cukierman and Wachtel, 1979; Levi and Makin, 1979, 1980; Mullineaux, 1980; Makin; 1982; Brenner and Landskroner, 1983; Zarnowitz and Lambros, 1987; Rich, Raymond, and Butler, 1992; Bomberger, 1996; Hahm and Steigerwald, 1999; Hayford, 2000; Giordani and Söderlind, 2003; Vuchelen, 2004; Rich and Tracy, 2006; Bloom, Floetotto, and Jaimovich, 2009; Engelberg, Manski, and Williams, 2009; Bachmann, Elstner, and Sims, 2010; Lahiri and Sheng, 2010), financial analyst forecast variables such as such as firm earnings, stock returns, corporate bond spreads, and real estate performance (Ajinkya and Gift, 1985; Imhoff and Lobo, 1992; Barron et al., 1998; Gebhardt, Lee, and Swaminathan, 2001; Doukas, Kim,

[1] The evidence for specific causes of death is mixed: some studies find that individuals misperceive the risks related to specific causes of death (e.g., Lichtenstein et al., 1978; Morgan et al., 1983; Viscusi, 1990; Hakes and Viscusi, 2004; Armantier, 2006; Andersson and Lundborg, 2007; Bhattacharya, Goldman, and Sood, 2009). Other studies report opposite results (Benjamin and Dougan, 1997; Viscusi, Hakes, and Carlin, 1997; Benjamin, Dougan, and Buschena, 2001).

[2] Results of Hill, Perry, and Willis (2004) indicate that subjective survival probability estimates contain information on respondents' uncertainty regarding these rates; however, they do not relate this uncertainty to the stochastic process driving actual mortality rates.

and Pantzalis, 2006; Zhang, 2006a, 2006b; McAllister, Newell, and Matysiak, 2008; Barron, Stanford, and Yu, 2009; Güntay and Hackbarth, 2010), and demand for consumer goods (Fisher and Raman, 1996; Gaur et al., 2007; Fuss and Vermeulen, 2008). Generally, these empirical studies find a positive relationship between the volatility of a forecast variable and the dispersion in the point forecasts. Experimental studies confirm this result (Harvey, 1995; Harvey, Ewart, and West 1997; Du and Budescu, 2007).

The successful application in a large number of studies and research fields of forecast dispersion as a proxy for the uncertainty of an underlying forecast variable provides the foundation for our first research hypothesis:

> *Hypothesis 1*: If individuals are aware of longevity risk, the dispersion of subjective survival forecasts should be wider when uncertainty of the underlying survival rates is higher.

We test this hypothesis by checking whether the survival rate dispersion found in actual life table data from the Human Mortality Database corresponds to the forecast dispersion observed in responses elicited in SHARE.[3] Based on this analysis, we use data on SHARE respondents' savings to study behavioral implications of longevity risk awareness and to assess whether awareness is driven by forecaster uncertainty or forecaster disagreement.

Our results show that the dispersion of subjective estimates of survival probabilities is indeed positively linked to the dispersion of objective survival rates, indicating an awareness of longevity risk among SHARE respondents. The related analysis of respondents' saving behavior provides evidence that respondents also act on their awareness of longevity risk. However, the impact on saving behavior is mostly due to forecaster disagreement effects and does not result in a clear increase in precautionary savings. The savings reaction thus differs from what theory suggests being an optimal response.

[3] Ideally, we would like to have a data set that includes direct responses regarding subjective mortality uncertainty and contains information from a sample of individuals who exhibit considerable heterogeneity with respect to objective mortality uncertainty. We are not aware of data having the first property, but SHARE meets the second property very well. It covers a large number of countries with heterogeneous objective mortality uncertainty and provides key control variables. Survey design and sampling methods are harmonized across all countries, guaranteeing reliable cross-country comparisons.

The findings of this large-sample study provide first empirical evidence for the growing theoretical literature that analyzes individual decision making under longevity risk. Our findings also have policy and regulation implications. Many developed countries have undergone a shift from pay-as-you-go to individually managed defined contribution pension plans. The success of plans that emphasize individual responsibility for retirement savings crucially depends on individuals making informed decisions based on a correct assessment of the involved risks, for example, longevity risk. Our findings on awareness of longevity risk and saving behavior, which indicate mostly disagreement effects among respondents, highlight that communication and education regarding this risk should be improved.

The remainder of the article is structured as follows. Section 1 describes the data from the SHARE survey and the Human Mortality Database. Calculation of dispersion measures and descriptive results are contained in Section 2. Awareness of longevity risk is formally analyzed in Section 3, followed by an analysis of estimation errors in Section 4. In Section 5, we link awareness of longevity risk to saving behavior. Section 6 provides robustness checks; in Section 7 we summarize our findings and conclude.

1. Data, Sample Selection, and Generated Variables

1.1. Subjective Survival Expectations—SHARE

The Survey of Health, Ageing and Retirement in Europe (SHARE) is a rich micro-level data set covering a large number of European countries. We use Wave 2 of SHARE, which includes data collected in 2006 and 2007 for Austria, Belgium, Czechia, Denmark, France, Germany, Greece, Ireland, Italy, the Netherlands, Poland, Spain, Sweden, and Switzerland. We omit Greece and Ireland from our analysis because the Human Mortality Database does not contain data for Greece, and SHARE is missing wealth and income variables for Ireland (as of March 2011). The resulting sample is comprised of 30,038 individual cases.

To elicit survival expectations, individuals in SHARE are asked the following question: "What are the chances that you will live to be age T or more?" The target age T is chosen conditional on the respondent's current age, x, as given in Table 1 (Hurd, Rohwedder, and Winter, 2009) and the response range is between 0 and 100. Due to this survey design, individuals are asked for age-specific survival probabilities referring to different forecast horizons ($T - x$).

-- *Table 1 here* --

We rescale the responses so that they range from 0 to 1 and treat them as probabilities (Hurd and McGarry, 2002). After removing those respondents who did not answer the survival expectation question, as well as those cases where the target age variable given in the data set did not comply with the definition given in Table 1, 26,497 valid cases remain for analysis.

An overview of demographic and economic characteristics of the selected respondents is given in Table 2; all variables are defined in Table 3.

-- *Table 2 here* --

-- *Table 3 here* --

1.2. Objective Mortality Data—Human Mortality Database

The Human Mortality Database provides harmonized mortality data for 37 countries. For the countries in our sample, we use gender- and age-specific time series for one-year central death rates starting in 1950 (1956 for Germany; 1958 for Poland). To match subjective survival probability estimates and their dispersion with objective counterparts, we estimate the Lee-Carter (1992) mortality model using data from the Human Mortality Database. The Lee-Carter model is a well-established framework for probabilistic mortality forecasting. It has been applied to several European countries, including France, Germany, Italy, the United Kingdom (Tuljapurkar, Li, and Boe, 2000), Denmark, Finland, Norway, Sweden (Koissi, Shapiro, and Högnäs, 2006), Spain (Debón, Montes, and Puig, 2008), and Belgium (Denuit, 2009).

According to the Lee-Carter model, the log of the central death rate $m_{x,t}$ for age x at time t is:

$$\ln(m_{x,t}) = a_x + b_x k_t \,. \tag{1.1}$$

With this model, a series of full mortality tables is defined by the age-specific constants a_x and b_x, and the time-varying mortality index k_t, which is a random variable (for simplicity's sake, country and gender indices are suppressed). Following Lee and Carter (1992), Lee (2000), and Cocco and Gomes (2009), k_t follows a random walk with drift, with k_t given by

$$k_t = k_{t-1} + \theta + \varepsilon_t \,, \quad (1.2)$$

where ε_t is normally distributed with $E[\varepsilon_t] = 0$ and $Std[\varepsilon_t] = \sigma_\varepsilon$. The one-period survival probability for age x at time t, $p_{x,t}$, is approximated by Equation (1.3) (Cairns, Blake, and Dowd, 2008).

$$p_{x,t} = 1 - m_{x,t} / (1 + 0.5m_{x,t}) \quad (1.3)$$

The parameters of the Lee-Carter model are estimated separately for males and females between ages 30 and 100 in each country using the *R* package *Demography* provided by Hyndman et al. (2008). We adapt to the multi-period forward-looking nature of SHARE responses by using the estimates of the Lee-Carter model to calculate forecasts for multi-period survival rates $E(p_{x,t,T-x})$ that take into account both the trends in survival probability change and the specific survey year (2006 or 2007). Likewise, we use the Lee-Carter model to calculate the corresponding standard deviations of the multi-period survival rates $Std(p_{x,t,T-x})$.

2. Calculation of the Dispersion Measures and Descriptive Results

Survival rates vary with sociodemographic factors such as age, gender, and income, and it is thus intuitive to expect dispersion in the subjective survival expectations of respondents who are heterogeneous with respect to these factors. Since we are interested only in the response dispersion caused by uncertainty over the survival rate, we subdivide the sample into groups of individuals who can be expected to have homogenous survival rates. To do so, we use all available information from the Human Mortality Database: age, gender, country, and, in addition, marital status ("couple") from the SHARE data set.[4] Other factors, such as income, which are not available in the Human Mortality Database but in the SHARE data set and known to have an impact on survival rates and, possibly, on the response dispersion are incorporated via control variables in the regression analyses.

For every age-gender-country-couple group, we calculate a measure of the dispersion of the subjective survival expectations by first calculating the standard deviation of the response values within this group. To enable meaningful comparisons, especially between different age groups, we normalize these standard deviations by the corresponding group-specific mean.

That is, following, for example, Doukas, Kim, and Pantzalis's (2006) analysis of financial analyst forecasts, we choose the coefficient of variation as the measure of dispersion. We adopt an analogous approach for the objective survival probability forecasts. The coefficient of variation is calculated based on the predictions for E($p_{x,t,T-x}$) and Std($p_{x,t,T-x}$) from the Lee-Carter mortality model.

Summary statistics for the data on the group level, including the dispersion measures, are provided in Table 4. We restrict our analysis to groups containing at least two individuals, which gives different numbers of groups for different countries.

-- *Table 4 here* --

Figure 2 plots the group-specific coefficients of variation of the objective survival probability forecasts against the group-specific coefficients of variation of the subjective estimates. The scatter plot suggests a positive relationship between the two dispersion measures: greater dispersion in the subjective survival probability estimates tends to coincide with greater dispersion in the objective survival rate data. A separate analysis by marital status and gender shows that this tendency is also found within these subgroups (see Figure 3).

-- *Figure 2 here* --

-- *Figure 3 here* --

Figure 4 shows the age-specific group averages of the two dispersion measures. Age-specific coefficients of variation in objective survival rates are plotted in Panel A; those for the dispersion of subjective responses in Panel B.

-- *Figure 4 here* --

Figure 4 reveals that both dispersion measures are related to age. Elder (2007) argues that age is likely to have a detrimental effect on the cognitive abilities needed to estimate survival rates. In the following, we employ a regression analysis that controls for age and other factors

[4] Grouping according to marital status is crucial because key economic covariates such as income and net worth are reported as household-level aggregates. Thus, individual respondents living in a partnership appear to be wealthier since both partners' entries for these variables refer to the combined wealth amount.

to understand more precisely to what extent the positive relationship shown in Figures 2 and 3 is due to the hypothesized effect of longevity risk on individuals' forecasts.

3. Regression Analyses of Subjective Dispersion

Using the grouped data described above, we regress the dispersion of individuals' subjective estimates of their future survival rates on the actual uncertainty of these rates. In this analysis, we control for key demographic characteristics and other factors potentially affecting the dispersion in subjective survival estimates. We estimate the following OLS regression model:

$$SUB\_DISP_j = \alpha + \beta OBJ\_DISP_j + \boldsymbol{\delta}^{\mathrm{T}}\mathbf{z}_j + \varepsilon_j \,, \qquad (3.1)$$

where SUB_DISP_j is the measure of dispersion of subjective survival probabilities in the age-gender-country-couple-specific group j, OBJ_DISP_j is the objective uncertainty about the future survival rate for group j (estimated from the Lee-Carter model), and $\mathbf{z}_j$ is a vector of group-specific control variables. In addition to the variables used for grouping, we include sociodemographic control variables that have been shown to explain mortality differentials, as well as controls related to respondents' abilities to perform estimation tasks. With respect to mortality-related controls, we include net worth, income, education, self-perceived health, grip strength, and smoking behavior (e.g., Hamermesh, 1985; Smith, Taylor, and Sloan, 2001; Hurd and McGarry, 2002; Brown, 2003; Elder, 2007; Andersen-Ranberg et al., 2009; Sullivan and von Wachter, 2009).[5] Controls related to respondents' estimation ability include variables measuring cognitive abilities (education, numeracy score, ability to recall words) (e.g., Hill, Perry, and Willis, 2004), as well as possible tendencies toward making biased predictions (optimism and risk aversion) (e.g., Bassett and Lumsdaine, 1999; Kézdi and Willis, 2003; Hill, Perry, and Willis, 2004). For each of these variables, we calculate a group-specific measure of dispersion and include this measure in Equation (3.1) as a control variable.[6] In this way, we control for the possibility that heterogeneity in these factors causes additional dispersion of subjective survival probability estimates within a group. Furthermore, we include the forecast horizon and squared forecast horizon in the set of control variables. This controls for possible nonlinearities not yet captured by the normalization of the survival

[5] A body mass index measure (see, e.g., Harris et al., 1988; Calle et al., 1999) is not included, since there are too many missing values in SHARE (56% of the selected sample).

[6] Depending on whether it is relative differences (scale variables such as income net worth) or absolute differences (most ordinal variables such as numeracy score and some scale variables such as risk aversion) that are more informative, either the coefficient of variation or the standard deviation is used as the dispersion measure.

probability dispersions that is implemented through the coefficient of variation. Since variables in Equation (3.1) are not directly observed but generated, we use bootstrap standard errors (Efron and Tibshirani, 1993).

Results for three model variants of Equation (3.1) are given in Table 5. Model (1) includes all control variables that exhibit no within-group variation (because they define the groups). Model (2) introduces the variables that control for within-group variation and that are available for the majority of respondents. Model (3) includes the full set of control variables, leading to a reduced sample size due to a considerable number of missing observations for the "grip strength," "smoke now," and "risk aversion" control variables.

-- *Table 5 here* --

Results for all three models reveal that the dispersion in subjective survival estimates of SHARE respondents is positively and strongly significantly related to the dispersion in objective survival probabilities. The dispersion in subjective survival estimates increases significantly with age (age, age^2), possibly reflecting a decrease in cognitive abilities, as pointed out by Elder (2007) in his analysis of survival expectation levels. The estimation results of Model (1) indicate that married respondents and males have a lower dispersion in subjective survival estimates. Neither effect is present in Models (2) and (3) and thus should be interpreted with caution. Differences in group size have no impact on the dispersion. Adding socioeconomic, cognitive, and other control variables that account for survival rate dispersion unrelated to longevity risk in Models (2) and (3) improves model fit as measured by the R^2, while the coefficient for the dispersion in objective survival probabilities remains positive and strongly significant.

In conclusion, results of the regression analysis that controls for key variables related to the dispersion in the objective survival probabilities (e.g., age, gender, wealth, income, health), cognitive abilities (e.g., age, numeracy, recall), and possible estimation biases (optimism, risk aversion) confirm the findings of the univariate analysis: the data exhibit a significant and positive relationship between the dispersion in objective survival probabilities and the dispersion in subjective estimates. This finding supports *Hypothesis 1* as it is an indication that the SHARE respondents are aware of longevity risk.

4. Analysis of Estimation Error Level

In this section, we analyze the level of the estimation error, which is the difference between subjective and objective survival probability estimates for each respondent. This analysis is a prerequisite for our later analysis of saving behavior. Since savings decisions are based on a prognosis of the level of survival rates, that is, on a prognosis as to expected lifespan, level errors play a role in this context. Previous literature establishes a relationship between the survival probability estimation error and various individual characteristics, one of the most important of which is age: younger people tend to underestimate actual survival rates; older people tend to overestimate them (e.g., Hamermesh, 1985; Elder, 2007; Hurd, Rohwedder, and Winter, 2009). Related to this observation are findings from the financial analyst forecast dispersion literature showing that greater objective uncertainty is associated with larger levels of estimation errors (see, e.g., Zhang, 2006a). We thus investigate whether the dispersion of objective rates plays a role with respect to the level of the survival probability estimation error.

We use two alternative measures of the respondent's estimation error (see Table 3). Both measures are defined in relative terms; again, this is done to enable comparison of each group's estimates on a similar scale. The first measure defines the estimation error as the difference between the subjective and the objective estimate of the survival probability, divided by the objective probability. This measure distinguishes between positive and negative deviations of subjective estimates from the objective probabilities. On average, positive and negative values can cancel out within one group, and thus the second measure defines the estimation error as the absolute (positive) value of the difference between the subjective and objective estimates of the survival probability, divided by the objective probability. As expected, the second measure tends to be larger on average (see Table 4).

Estimation errors calculated using the first measure confirm the findings of previous demographic studies regarding the effect of age: higher age leads to more optimism about one's survival prospects (see Figure 5).

-- *Figure 5 here* --

Figure 6 shows that the level of estimation error (especially in absolute terms, i.e., using the second measure) increases when the dispersion of objective survival rates increases.

-- *Figure 6 here* --

To disentangle the effects that dispersion in objective survival rates, age, and other control variables have on the level of the estimation error, we estimate the following regression model:

$$EST\_ERR\_LEVEL_j = \alpha + \beta OBJ\_DISP_j + \boldsymbol{\delta}^{T}\mathbf{z}_j + \varepsilon_j. \quad (4.1)$$

Model (4.1) uses the same set of control variables as Model (3.1). However, we now include the control variables in their levels, instead of in their dispersion, because we are measuring an effect on a (error) level variable.

The regression results for both estimation error measures yield significant and positive coefficients for the dispersion of objective survival rates. However, the estimation results are highly sensitive to outliers (compare Figure 6, Panels A and B). Standard diagnostic tests clearly reject the normality assumption for the regression residuals. Taking the logarithm of the estimation error, which is possible only for the second, always positive measure, however, yields a stable model and gives a more linear relationship (compare Figure 6, Panel C). The regression results for the logarithm of the estimation error level are provided in Table 6.

-- *Table 6 here* --

With respect to age (and age^2), we find a U-shaped impact on the absolute estimation error level from age 57 (Model (1)) or age 52 (Model (2)) onward that partly confirms the positive age effect established in the demographic literature. Note, however, that in this setup, in which we look at absolute error levels, the effects of the sociodemographic control variables should not be compared with demographic studies on mortality differentials, as these include negative and positive error values in their analysis, but with studies that look at *absolute* forecast precision as, for example, in the financial analyst forecast literature. With respect to the main objective of the regression model’s specification, we find a significant positive effect of the objective dispersion on the level of the estimation error. This accords well with the effects documented in the financial analyst literature (Zhang, 2006a). Furthermore, smaller estimation errors are associated with being female, being wealthier in terms of income and net worth, having more grip strength, and being a nonsmoker.

5. Longevity Risk, Forecaster Uncertainty and Disagreement, and Individual Saving Behavior

The results of Section 3 evidence a positive relationship between the dispersion in objective survival data and the dispersion in individuals' subjective survival expectations. Building on findings from the literature on forecast dispersion, we argue that this is evidence that individuals are aware of longevity risk.

Methodologically, dispersion in point forecasts may reflect both forecasters' perceived uncertainty underlying the forecast variable[7] as well as disagreement among forecasters (who individually may feel certain about their estimate) (e.g., Zarnowitz and Lambros, 1987; Barron et al., 1998; Giordani and Söderlind, 2003; Engelberg, Manski, and Williams, 2009; Barron, Stanford, and Yu, 2009; Lahiri and Sheng, 2010).

To better understand the drivers of survival probability dispersion, we use data on SHARE respondents' saving behavior and follow a systematic testing procedure. This analysis also involves the question of whether respondents are not only aware of but also act on the existence of longevity risk, that is, whether they adjust their saving behavior in response to their awareness of longevity risk.

Previous theoretical findings show that both a longer expected lifespan (Bloom et al., 2007, Cocco and Gomes, 2009; Salm, 2010) and a higher perceived uncertainty regarding the distribution of this lifespan (Cocco and Gomes, 2009)[8] increase savings. We utilize these findings to discriminate between forecaster uncertainty and disagreement as follows.

We expect that individuals who perceive more uncertainty than others about their survival rate will have higher self-insurance savings in comparison to less uncertain individuals. Thus, if forecast dispersion reflects uncertainty, similar amounts of forecast dispersion should translate into similar saving levels, that is, we expect no dispersion in savings levels. For different amounts of forecast dispersion, however, we expect to observe different savings levels.

[7] In the sense of Kahneman and Tversky (1982), there is positive link between external and internal uncertainty with respect to survival probabilities.

[8] The positive savings reaction with respect to an increase such partially insurable (background) risk is shown for the general case, for example, in Carroll (1997); Courbage and Rey (2007); Menegatti (2009).

If, however, forecast dispersion does not reflect individuals' uncertainty about their subjective survival rates, but disagreement in opinion, we expect quite opposite effects. Disagreement about survival prospects among individuals will lead to differences in their individual savings levels. That is, the higher the disagreement as measured by the dispersion in point forecasts, the higher should be the dispersion of savings among individuals, but there should be no effect on the average level of savings.[9]

Based on these arguments, we formulate three mutually exclusive research hypotheses:

> *Hypothesis 2*: If uncertainty in objective survival probability causes uncertainty in individuals regarding their individual survival rate expectation, but no disagreement between individuals, then higher forecast dispersion will be related to higher savings levels, but not to higher savings dispersion.
>
> *Hypothesis 3*: If uncertainty in objective survival probability causes disagreement between individuals, but individuals are certain about their survival rate expectation, then higher forecast dispersion will related to higher savings dispersion, but not to higher savings levels.
>
> *Hypothesis 4*: If uncertainty in objective survival probability causes both forecast uncertainty and disagreement between individuals with respect to subjective survival expectations, then higher forecast dispersion will be related to both higher savings levels and higher savings dispersion.

Figure 7 summarizes the conceptual framework underlying *Hypotheses 2–4*.

-- *Figure 7 here* --

To test *Hypotheses 2–4*, we estimate two simultaneous equation models, the first for the savings level, the second for the savings dispersion. The simultaneous equation model for the savings level contains the following three equations:

[9] Only if there is a general bias in the level of survival prospect estimation related to objective uncertainty, would there be an effect on the average savings level. Building on the results of Section 4, we control for this effect.

$$SUB\_DISP_j = \alpha_1 + \beta_1 OBJ\_DISP_j + \boldsymbol{\delta}_1^{\mathrm{T}}\mathbf{z}_{1j} + \varepsilon_{1j}\,, \tag{5.1}$$

$$EST\_ERR\_LEVEL_j = \alpha_2 + \beta_2 OBJ\_DISP_j + \boldsymbol{\delta}_2^{\mathrm{T}}\mathbf{z}_{2j} + \varepsilon_{2j}\,, \tag{5.2}$$

$$SAVE\_LEVEL_j = \alpha_3 + \gamma_1 SUB\_DISP_j + \gamma_2 EST\_ERR\_LEVEL_j + \boldsymbol{\delta}_3^{\mathrm{T}}\mathbf{z}_{3j} + \varepsilon_{3j}\,, \tag{5.3}$$

Equation (5.1) reestablishes the link analyzed in Section 3, Equation (3.1), between objective and subjective survival expectation dispersion. Similarly, Equation (5.2) incorporates the findings of Section 4, where, in Equation (4.1), we identified a positive link between objective dispersion and the survival probability estimation error level. As indicated previously, this equation for the level of estimation error is necessary because in Equation (5.3) we want to control for the possibility that even under pure disagreement (*Hypothesis 3*), objective dispersion may lead to some estimation bias with respect to the survival probability level. These estimation errors could very well have an impact on saving levels, as well, if individuals are biased with respect to their expected lifetime when planning their savings. Thus, without this control it would be difficult to discriminate between *Hypotheses 2* and *3*. Finally, in Equation (5.3), the overall impact of subjective dispersion and estimation error levels on the savings level is modeled. Again, the vector **z** contains group-specific control variables. For the savings level in Equation (5.3), we introduce additional control variables that are likely to have an impact on saving behavior. Specifically, we add an indicator for the strength of the bequest motive ("leave inheritance"; positive expected coefficient), an indicator on respondents' subjective expectations regarding future government pensions ("reduction in pension amount"; negative expected coefficient),[10] and the subjective estimate of the survival probability itself (positive expected coefficient).

We use two alternative indicators to measure savings: the total net worth of a respondent and the respondent's financial assets (see Table 3 for definitions of both). Net worth is a very broad measure of wealth accumulation and includes items, such as real estate or cars, which are, in part, also consumption goods. Financial assets are less comprehensive but avoid the latter issue.

The simultaneous equation model for the savings level is estimated via three-stage least squares (3SLS); the estimation results can be found in Table 7. Results for the model's key equation (Equation (5.3)) show no significant link between the dispersion in survival probability estimates and the amount of financial assets or net worth.

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[10] Note that including these two control variables reduces the sample size further, due to missing values.

-- *Table 7 here* --

In a next step, we specify a simultaneous equation model for savings dispersion:

$$SUB\_DISP_j = \alpha_1 + \beta_1 OBJ\_DISP_j + \boldsymbol{\delta}_1^{\mathrm{T}}\mathbf{z}_{1j} + \varepsilon_{1j}\,, \tag{5.4}$$

$$SAVE\_DISP_j = \alpha_2 + \gamma SUB\_DISP_j + \boldsymbol{\delta}_2^{\mathrm{T}}\mathbf{z}_{2j} + \varepsilon_{2j}\,, \tag{5.5}$$

Again, we incorporate the relation between objective dispersion and subjective dispersion first described in Equation (3.1), now labeled Equation (5.4). The overall impact of the dispersion of subjective estimates on savings dispersion is modeled in Equation (5.5) using the coefficient of variation for net worth or financial assets as the dependent variable. In contrast to the simultaneous equation model for the savings level, there is no need to include an equation for the estimation error. Here, such an equation would refer to the estimation error dispersion, thus in principle resembling Equation (5.4).[11]

The results of the 3SLS estimation for the simultaneous equation model for savings dispersion vary between the savings indicators (see Table 8): there is a positive and significant link between the dispersion of subjective survival estimates and the dispersion of financial assets, but no significant link between the dispersion of subjective survival estimates and the dispersion of net worth.

-- *Table 8 here* --

These results lead to two possible conclusions regarding *Hypotheses 2–4*. First, if net worth is the appropriate indicator for savings, all three hypotheses are rejected. This finding would imply that while the subjective survival probability estimation of SHARE respondents is indeed impacted by objective survival rate dispersion, respondents do not act on this at all. If, on the other hand, financial assets are the appropriate indicator for savings, *Hypotheses 2* and *4* are rejected and we can conclude that the impact of longevity risk on respondents' expectations is that it does not lead to uncertainty but to disagreement. Given that net worth encompasses consumption goods, and that the goodness of fit of the simultaneous equation model for savings dispersion that uses net worth as a savings indicator yields a worse fit as indicated by the AIC and BIC (see Table 8), we favor the second interpretation of the

[11] The level of the estimation error is a deterministic additive transformation of the subjective survival probability estimate. This transformation does not contribute additional dispersion.

regression results: SHARE respondents are aware of longevity risk, respondents adjust their savings, but the adjustment is driven by forecaster disagreement (*Hypothesis 3*). Thus, awareness of longevity risk affects savings dispersion, but not average saving levels.[12]

6. Robustness Checks

6.1. The Stochastic Process and the Estimation Window for Objective Mortality Data

The Lee-Carter model used for predicting objective future survival rates and their dispersion imposes some structural restrictions on the possible development of future mortality rates. For example, shocks to survival rates in a given year are perfectly correlated across age groups due to their common dependence on the realization of the mortality index k_t (compare Equations (1.1) and (1.2)). Furthermore, the parameters of the time series model for k_t are assumed to be constant over time. In this subsection, we test the robustness of our results by relaxing these restrictions. Specifically, we first reestimate the Lee-Carter model using the country-, gender-, and age-specific time series for one-year central death rates from 1975 (instead of 1950). This shorter period is chosen to test the model's sensitivity with respect to the empirical findings that around the mid 1970s major causes of death changed in most industrialized countries, leading to different annual rates of change in survival rates and different volatilities (see, e.g., Levi et al., 2002; Page, 2001; Hanewald, 2010).

Second, using the original time series starting in 1950, we estimate an alternative mortality model that imposes much less structure on the data. To this end, we use the following simple stochastic process for the evolution of multi-period mortality rates over time: $q_{x,t,T\text{-}x} = q_{x,t\text{-}1,T\text{-}x} \cdot r_{x,t,T\text{-}x}$, where $r_{x,t,T\text{-}x}$ follows a lognormal distribution with mean $\mu_{x,T\text{-}x}$ and standard deviation $\sigma_{x,T\text{-}x}$ (again, country and gender indices are suppressed). This model makes no assumptions about the dependency of annual changes in mortality rates on time, age, or cohort. It can be understood as one extreme case of the spectrum of different probabilistic mortality models, whereas the Lee-Carter model is at the other end of the spectrum, and between the two are the various age-period-cohort mortality models discussed in the literature (see, e.g., Cairns, Blake, and Dowd, 2008). For this simpler model, we adapt to the forward-looking nature of SHARE responses by calculating forecasts for $q_{x,t,T\text{-}x}$ (and for

[12] Next to savings, voluntary annuitization is a natural candidate for investigating an impact of longevity risk on behavior. However, voluntary annuitization is rare among SHARE respondents. Only 19% of the age-gender-country-couple groups have positive annuitization levels which results in group-level sample sizes that are too small for meaningful econometric analyses.

multi-period rates of survival $p_{x,t,T\text{-}x}$), the corresponding standard deviations, and the resulting coefficients of variation conditional on the survey year. We estimate the model's parameters $\mu_{x,T\text{-}x}$ and $\sigma_{x,T\text{-}x}$ from the Human Mortality Database by constructing for all time-horizon-age-gender-country-specific groups of respondents in the SHARE data corresponding time series of multi-period mortality rates.

The group-level summary statistics for the alternative mortality model calibration are given in Table 9: Column 1 gives the original specification ("Baseline Specification"), Column 2 refers to the Lee-Carter variant based on 1975+ mortality data ("Lee-Carter 1975"), and Column 3 refers to the alternative mortality model ("Alternative Mortality Model").

-- *Table 9 here* --

The estimates summarized in Table 9 show that both the estimation window for the Lee-Carter model and the choice of the mortality model have an effect on the dispersion in the objective survival rates (decrease) as well on the level of the estimation error (small increase for the shorter estimation window, decrease under the alternative mortality model). To assess the impact on the dispersion of subjective survival estimates, the regression model introduced in Section 3 is re-estimated for the two alternative model specifications; the results are given in Columns 2 and 3 of Table 10.

-- *Table 10 here* --

The regression results show that the positive and strongly significant relation between the dispersion of subjective survival estimates and the dispersion in the objective rate established in Section 3 is robust both to the estimation window for the Lee-Carter model and to the choice of the mortality model. Furthermore, all control variables found to be significant in the original model continue to be significant and have the same sign under both alternative specifications. The same holds true for the regression analysis of the level of the relative absolute estimation error under the alternative mortality model (Column 3 of Table 11), but not for the shorter estimation window used to estimate the Lee-Carter mortality model. For the more recent mortality data from 1975 onward, the coefficient for the dispersion in objective survival rates is insignificant, which means that there is no effect on the level of absolute estimation error (Column 2 of Table 11).

-- *Table 11 here* --

Finally, the results of the simultaneous equation models for financial assets as the savings measure under the alternative specifications are given in Columns 2 and 3 of Tables 12 (savings level) and 13 (savings dispersion).

-- *Table 12 here* --

-- *Table 13 here* --

The regression results for the alternative specifications confirm the finding of Section 5 that the dispersion of subjective survival expectations is due to disagreement among SHARE respondents.

6.2. The Dispersion Measure

In Section 2, we introduced the coefficient of variation as the measure of dispersion in point forecasts, arguing that the normalization achieved using this measure allows us to better compare different age groups. There are alternative dispersion measures that achieve normalization as well, but vary in their sensitivity to dispersion of the variable of interest in different parts of the distribution. For example, there are the so-called measures of inequality, which were developed to measure the inequality within an income distribution (Cowell, 1977; Shorrocks, 1980; Atkinson, 1983). To check the robustness of our results, we employ two commonly used inequality measures that allow for zero values in the distribution of interest: the "half of squared coefficient of variation" and the Gini coefficient. The regression results for the dispersion in point forecasts, the level of the estimation error, and the saving behavior using these two alternative measures yield results similar to those of the original specification with respect to both the number of significant control variables and the sign of coefficients.[13]

6.3. Focal Responses

Focal-point responses are widely observed in studies that elicit subjective expectations about probabilities: survey responses are often clustered at the 0%, 50%, or 100% level. With respect to survival expectations, this effect is observed in studies based on the U.S. Health and Retirement Survey (e.g., Hurd and McGarry, 1995; Hurd, McFadden and Gan, 1998) and on

SHARE (e.g., Hurd, Rohwedder, and Winter, 2009). This phenomenon also occurs in our sample. Table 1 shows that the percentage of respondents with a 50% estimate ranges between 18.7% (Italy) and 31.3% (Poland) over all countries in our sample. For responses that are clustered at either the 0%, 50%, or 100% level, this range is between 37.4% (The Netherlands) and 50.9% (Sweden).

Previous studies take different approaches to the focal response issue. Some studies replace focal responses with imputed values (Bloom et al., 2007; Delavande and Rohwedder, 2008); others consider focal responses as an "index of precision" that measures the respondents' degree of uncertainty (Lillard and Willis, 2001; Kézdi and Willis, 2003; Hill, Perry, and Willis, 2004) or as an indicator of the individual's lack of knowledge regarding the forecast variable (e.g., Bruine de Bruin et al., 2000; Delavande and Rohwedder, 2008; Manski and Molinari, 2010). Following the literature, we check the robustness of our results by running regressions that either exclude focal responses, use imputed values for focal responses,[14] or use the percentage of focal responses as an alternative dependent variable potentially measuring respondents' uncertainty or disagreement.

Table 9 contains group-level summary statistics for the original data set in Column 1 and for modified versions of the data in which the 0%, 50%, and 100% level focal responses were imputed or excluded in Columns 4 and 5, respectively.[15]

The regression results for the dispersion of subjective survival estimates based on the samples with either imputed or excluded focal responses are shown in Columns 4 and 5 of Table 10. These regression results confirm our previous findings: the coefficient on the dispersion in objective survival rates is positive and significant in both models. The third model, which uses the percentage of focal responses as an alternative dependent variable, shows a significant and positive coefficient for the dispersion in objective survival rates, but has very low explanatory power (R^2 = 1.6%; see Table 14).[16]

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[13] Regression results are available from the authors on request.

[14] The imputation of the focal responses follows Delavande and Rohwedder (2008) and is based on the set of socioeconomic and cognitive skill covariates introduced in Section 3.

[15] All results relating to focal responses presented in this section are based on the responses that are either at the 0%, 50%, or 100% level. Robustness checks that focus only on the 50% level responses yielded very similar results (available from the authors on request).

[16] In this regression model, the control variables are included in their levels because the dependent variable is a level variable as well.

-- *Table 14 here* --

Results for the estimation error level (relevant only for the models with imputed or excluded focal responses) do not confirm the findings obtained in Section 4: the effect of the positive link between the dispersion in objective survival rates on the level of the estimation error is not significant (compare Table 11, Columns 4 and 5).

Unlike in all previous regression analyses, the models for the level of savings for the samples with either imputed or excluded focal responses yield a significant and positive coefficient for the dispersion in subjective survival estimates (Table 12, Columns 4 and 5). This result differs from the results of all previous regression analyses and indicates uncertainty effects for SHARE respondents. In both model variants, the link between the dispersion of savings and the dispersion of subjective estimates is present (Table 13, Columns 4 and 5), that is, disagreement effects are found as well.

Finally, we replace the coefficient of variation of the subjective estimates with the percentage of focal responses in the two simultaneous equation models for the level and the dispersion of financial assets (Equations (5.1), (5.3), (5.4), and (5.5)) The results for both the savings level (Table 15) and dispersion (Table 16) show no significant relationship between the percentage of focal responses and respondents' saving behavior.

-- *Table 15 here* --

-- *Table 16 here* --

The percentage of focal responses is significantly and positively linked to the dispersion in objective survival rates. Therefore, this variable could be viewed as an alternative measure of respondents' uncertainty/disagreement, as suggested by Lillard and Willis (2001). However, the corresponding regression model has very low explanatory power and the percentage of focal responses is not a significant covariate in the regression models for saving behavior. Instead, the other two model variants that excluded or imputed focal responses gave a better fit of the regression models for the savings level. We thus conclude that the percentage of focal responses is not a good indicator of respondents' uncertainty/disagreement regarding survival rates but, instead, an indicator of a “don’t know” answer, as suggested, for example, by Bruine de Bruin et al. (2000).

7. Summary and Conclusions

Annual rates of decline in mortality exhibit considerable variation: the so-called longevity risk. A large number of theoretical studies suggests that longevity risk is an important determinant of individuals’ decisions about consumption, saving, asset allocation, and retirement timing, as well as for equilibrium annuity prices. Our analysis of subjective survival expectations elicited in the Survey of Health, Ageing and Retirement in Europe (SHARE) from 12 European countries and objective mortality data from the Human Mortality Database reveals that SHARE respondents are aware of longevity risk. This awareness is reflected in the dispersion of respondents’ subjective survival probability estimates, which co-varies with the dispersion in actual population survival rates. We furthermore find that the observed awareness of longevity risk translates into an increased dispersion of saving outcomes, indicating that disagreement effects impact the underlying decision-making process.

We performed a number of tests to check the robustness of our results with respect to the estimation window for the dispersion in the objective survival rate data, the mortality model, the dispersion measure used, and the treatment of focal responses. The results of these robustness checks confirm that the link between the dispersion in respondents’ subjective survival estimates and the dispersion of objective survival rates observed in historical life table data is very robust to alternative specifications, which indicates that SHARE respondents are indeed aware of longevity risk. Furthermore, there is a significant and positive link between the dispersion in point forecasts and savings dispersion in all model specifications, indicating disagreement effects among respondents. The evidence for respondents being uncertain about survival rates is weaker: only two model variants used in the robustness checks yield a significant and positive link between the dispersion in point forecasts and savings levels.

This study’s findings have particular relevance for the design of pension systems that emphasize individually managed retirement savings. In such systems, it is essential that individuals make informed decisions based on sound expectations about asset returns, returns to human capital, and mortality risks. Our finding that mostly disagreement effects impact how individuals adjust their savings in response to longevity risk indicates that individual savings adjustments might not be effective in protecting individuals against the economic risks arising from uncertainty in survival rate development. These results, in combination with the findings of Cocco and Gomes (2009), who show in a theoretical framework that responding to longevity risk with suboptimal investment and insurance choices can imply considerable individual welfare costs, make clear that the question of optimal savings and asset allocation strategies is still an important area for further research. A policy implication of our results is that communication and education regarding longevity risk should be improved.

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Table 1 Assignment of the individual target age *T* for the estimation of the subjective survival probability in SHARE

Current age of respondent, *x*	Target age, *T*
≤65	75
66–69	80
70–74	85
75–79	90
80–84	95
85–94	100
95–99	105
100–104	110
105+	120

Table 2 Summary statistics for the SHARE sample selected

	Country																							
	Austria		Belgium		Czechia		Denmark		France		Germany		Italy		Netherlands		Poland		Spain		Sweden		Switzerland	
	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std
	N = 1,290		N = 2,923		N = 2,211		N = 2,437		N = 2,321		N = 2,400		N = 2,723		N = 2,415		N = 2,224		N = 1,757		N = 2,414		N = 1,379	
Demographics																								
Age, *x*	66.04	9.60	63.85	10.48	62.86	9.87	63.06	10.50	63.50	10.64	64.09	9.43	64.72	9.55	63.06	9.78	63.11	9.99	65.21	10.58	65.07	10.02	63.98	10.55
Gender	0.59	0.49	0.54	0.50	0.58	0.49	0.55	0.50	0.57	0.50	0.54	0.50	0.54	0.50	0.55	0.50	0.56	0.50	0.54	0.50	0.53	0.50	0.55	0.50
Couple	0.63	0.48	0.75	0.44	0.71	0.46	0.76	0.43	0.72	0.45	0.81	0.39	0.83	0.38	0.80	0.40	0.77	0.42	0.80	0.40	0.77	0.42	0.72	0.45
Education	2.92	1.32	2.80	1.50	2.50	1.11	3.40	1.41	2.58	1.73	3.41	1.06	1.92	1.23	2.83	1.38	2.28	1.29	1.64	1.36	2.78	1.55	2.93	1.17
Health, Cognition, Preferences																								
Self-Perceived Health	3.02	1.03	2.95	1.01	3.33	0.99	2.54	1.15	3.12	1.01	3.18	1.00	3.26	1.08	2.93	1.04	3.85	0.99	3.40	0.96	2.75	1.18	2.56	1.01
Grip Strength	35.20	11.81	35.68	12.25	36.21	11.52	34.91	12.53	34.25	11.93	37.19	11.67	33.15	11.63	36.20	11.52	33.56	11.91	30.61	11.50	36.79	12.21	35.74	11.39
Smoke Now	0.16	0.37	0.19	0.39	0.53	0.50	0.34	0.47	0.17	0.38	0.22	0.42	0.22	0.42	0.26	0.44	0.49	0.50	0.22	0.41	0.18	0.38	0.27	0.44
Numeracy	3.73	1.02	3.41	1.06	3.56	1.04	3.66	1.11	3.32	1.11	3.75	1.07	2.99	1.06	3.75	1.09	2.98	1.09	2.62	1.04	3.71	1.02	3.87	0.96
Recall	5.47	1.98	5.17	1.77	5.09	1.61	5.69	1.71	4.94	1.71	5.60	1.66	4.53	1.81	5.51	1.69	4.36	1.75	3.83	1.71	5.47	1.68	5.43	1.66
Optimism	9.99	2.13	9.61	2.24	9.96	2.18	10.20	1.84	9.32	2.30	10.12	1.91	9.27	2.54	10.11	1.95	8.27	2.55	9.22	2.62	10.14	1.83	10.27	1.79
Risk Aversion	3.80	0.46	3.67	0.58	3.63	0.57	3.40	0.78	3.73	0.56	3.69	0.55	3.82	0.47	3.68	0.61	3.88	0.42	3.90	0.35	3.30	0.95	3.62	0.62
Leave Inheritance	0.07	0.20	0.22	0.34	0.07	0.19	0.22	0.37	0.18	0.32	0.13	0.28	0.10	0.24	0.18	0.33	0.04	0.16	0.11	0.25	0.23	0.37	0.19	0.33
Economic Indicators PPP adjusted €																								
Income	38,143	238,135	42,744	220,896	20,385	200,827	32,647	24,681	60,880	337,747	33,365	38,332	37,127	247,196	41,293	49,527	37,758	486,459	79,345	563,669	32,818	24,335	40,149	39,470
Financial Wealth	34,288	104,395	99,183	227,134	12,256	20,459	120,028	243,569	66,967	163,512	54,269	89,181	23,069	53,484	83,430	217,245	14,708	321,948	35,619	88,437	90,796	187,542	145,616	281,103
Net Worth	195,232	288,325	344,129	412,656	196,963	636,921	505,219	1,167,903	392,823	705,758	233,296	411,079	296,063	396,507	417,854	1,093,928	76,585	526,173	337,753	651,830	744,723	3,303,543	475,794	1,207,388
Expectations																								
Forecast Horizon (Survival)	14.79	4.04	16.22	4.81	16.38	4.88	16.50	5.04	16.41	5.03	15.58	4.48	15.42	4.45	16.16	4.63	16.40	4.69	15.69	4.64	15.26	4.29	16.11	4.96
Subj. Survival Probabiliy	0.59	0.30	0.58	0.27	0.43	0.28	0.69	0.30	0.62	0.29	0.60	0.31	0.67	0.30	0.66	0.27	0.48	0.30	0.61	0.31	0.62	0.31	0.66	0.28
Focal Response I	0.21	0.41	0.24	0.43	0.31	0.46	0.19	0.39	0.26	0.44	0.23	0.42	0.19	0.39	0.20	0.40	0.31	0.46	0.19	0.39	0.22	0.42	0.23	0.42
Focal Response II	0.43	0.50	0.38	0.49	0.47	0.50	0.49	0.50	0.45	0.50	0.46	0.50	0.45	0.50	0.37	0.48	0.51	0.50	0.42	0.49	0.47	0.50	0.45	0.50
Reduction Pension Amount	0.50	0.33	0.35	0.32	0.42	0.34	0.34	0.35	0.53	0.35	0.47	0.42	0.46	0.35	0.42	0.33	0.36	0.32	0.31	0.31	0.51	0.31	0.44	0.37

Notes: Summary statistics are based on the unweighted data. Std = standard deviation. Variables are defined in Table 3.

Table 3 Definition of variables

Variable	Definition
Age	Age of respondent
Gender	Gender: 0 = male, 1 = female
Couple	Marital status: 0 = married or partnership, 1 = otherwise
Education	International Standard Classification of Education (ISCED 97) (0 = no education … 6 = Ph.D.)
Self-Perceived Health	Self-perceived health ("US version") (1 = excellent … 5 = poor)
Grip Strength	Maximum grip strength measurement of hands
Smoke Now	Smoke at the present time: 0 = no, 1 = yes
Numeracy	Numeracy score (mathematical performance) (1 = bad … 5 = good)
Recall	10-word listening and recall task: number of words recalled by respondent
Optimism	Optimism index ranging from 0 (not optimistic at all) to 12 (very optimistic); index is given by 12 minus the SHARE depression index; the index covers 12 dimensions, including depression, pessimism, suicidality, guilt, sleep deprivation, disinterest in activities, irritability, loss of appetite, fatigue, lack of concentration, enjoyment of activities, tearfulness, and hopes for the future
Risk Aversion	Attitude toward taking financial risks: 1 = "Take substantial financial risks expecting to earn substantial returns," 2 = "Take above average financial risks expecting to earn above average returns," 3 = "Take average financial risks expecting to earn average returns," 4 = "Not willing to take any financial risks"
Leave Inheritance	Self-rated chance of leaving an inheritance (0–100%)
Income	Total, purchasing power adjusted, Euro, net income of household, including income from employment, self-employment, pensions, invalidity or unemployment benefits, alimony or other private regular payments, long-term care insurance, housing allowances, child benefits, poverty relief, real estate (incl. imputed rents), land or forestry, and capital income
Financial Wealth	Total, purchasing power adjusted, Euro, financial wealth of household including bank accounts, government and corporate bonds, stocks, mutual funds, individual retirement accounts, contractual savings for housing, and life insurance policies
Net Worth	Total, purchasing power adjusted, Euro, net worth of household, including real assets (real estate, share owned of businesses, cars), financial assets (bank accounts, government and corporate bonds, stocks, mutual funds, individual retirement accounts, contractual savings for housing, and life insurance policies) minus the value of mortgages and financial liabilities
Forecast Horizon	Forecast horizon for estimate of subjective survival probability = T (as defined in Table 1) minus age
Subjective Survival Probability	Response to the question: "What are the chances that you will live to be age T or more?" divided by 100 (0–100%)
Focal Response I	Indicator variable for focal responses to subjective survival probability question: 0 = no focal response, 1 = response equal to 50%
Focal Response II	Indicator variable for focal responses to subjective survival probability question: 0 = no focal response, 1 = response equal to 0%, 50%, or 100%
Reduction Pension Amount	Self-rated chance that government will reduce pension income (0–100%)
Relative Estimation Error	(Subjective survival probability – objective estimate of the survival probability) / objective probability
Relative Absolute Estimation Error	ABS[(subjective survival probability – objective estimate of the survival probability) / objective probability]
Group Size	Number of respondents in an age-gender-country-couple group

Table 4 Summary statistics for the grouped SHARE/Human Mortality Database data

	Country																							
	Austria		Belgium		Czechia		Denmark		France		Germany		Italy		Netherlands		Poland		Spain		Sweden		Switzerland	
	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std
	N = 141		N = 167		N = 158		N = 167		N = 164		N = 142		N = 159		N = 160		N = 150		N = 151		N = 166		N = 146	
Group Size	9.00	6.14	17.37	14.59	13.87	11.27	14.48	13.26	13.99	11.27	16.70	14.54	16.99	15.89	14.96	15.02	14.66	12.53	11.45	9.05	14.37	13.44	9.21	6.48
Age, *x*	67.84	11.60	67.41	12.89	66.15	12.27	66.95	12.87	67.56	13.17	66.65	11.52	66.69	12.39	67.29	12.36	67.32	11.64	67.88	12.22	68.17	12.62	66.92	12.09
Gender	0.52	0.50	0.52	0.50	0.53	0.50	0.53	0.50	0.53	0.50	0.54	0.50	0.53	0.50	0.54	0.50	0.52	0.50	0.54	0.50	0.51	0.50	0.56	0.50
Couple	0.55	0.50	0.53	0.50	0.54	0.50	0.53	0.50	0.55	0.50	0.56	0.50	0.53	0.50	0.54	0.50	0.53	0.50	0.56	0.50	0.54	0.50	0.57	0.50
Forecast Horizon	15.14	4.82	15.86	5.63	16.16	5.82	15.99	5.66	15.70	5.72	15.57	4.94	15.92	5.51	15.71	5.19	15.35	4.73	15.43	4.83	15.44	5.25	15.79	5.17
Subj. Survival Probabiliy	0.55	0.20	0.53	0.17	0.39	0.15	0.60	0.20	0.55	0.17	0.55	0.19	0.62	0.18	0.59	0.18	0.45	0.14	0.57	0.18	0.53	0.22	0.62	0.19
CV Subj. Estimate	0.56	0.35	0.57	0.35	0.74	0.37	0.54	0.34	0.56	0.33	0.59	0.34	0.49	0.29	0.49	0.27	0.69	0.31	0.58	0.33	0.65	0.43	0.46	0.31
CV Obj. Probability	0.03	0.02	0.04	0.02	0.06	0.04	0.04	0.03	0.04	0.03	0.03	0.02	0.04	0.03	0.03	0.02	0.05	0.03	0.05	0.03	0.03	0.02	0.03	0.02
Relative Estimation Error	0.69	2.95	0.96	3.38	0.50	2.41	1.14	3.72	0.37	1.58	0.28	1.38	0.65	2.65	0.92	2.75	1.23	4.39	0.73	2.45	0.49	1.97	0.56	2.14
Relative Abs. Est. Error	1.16	2.88	1.44	3.35	1.25	2.40	1.52	3.73	0.88	1.57	0.81	1.35	1.06	2.59	1.28	2.67	1.82	4.29	1.24	2.43	1.04	2.04	0.95	2.07

Notes: N denotes the number of groups. For calculation of group-based measures, the SHARE weights are not applied. Groups are based on age, gender, country, and couple. Std = standard deviation, CV = coefficient of variation.

Table 5 OLS regression results; dependent variable: coefficient of variation of group-specific subjective survival probability

	(1)		(2)		(3)	
	Coef.	Bootstr. std. err.	Coef.	Bootstr. std. err.	Coef.	Bootstr. std. err.
Group Size	-0.0005	0.0006	-0.0008	0.0006	-0.0007	0.0006
Age	0.0130	0.0167	0.0162	0.0174	-0.0135	0.0211
Age^2	0.0000	0.0001	0.0000	0.0001	0.0002	0.0001
Gender	0.0258	0.0140 *	0.0119	0.0143	0.0000	0.0143
Couple	-0.0326	0.0178 *	-0.0244	0.0182	-0.0273	0.0169
Forecast Horizon	0.0275	0.0087 ***	0.0249	0.0087 ***	0.0202	0.0108 *
Forecast $Horizon^2$	-0.0002	0.0002	-0.0002	0.0003	-0.0002	0.0003
CV Obj. Prob.	2.5069	0.5348 ***	2.3448	0.5362 ***	2.1515	0.5613 ***
Std Education			-0.0240	0.0168	-0.0351	0.0178 **
Std Self-Perc. Health			-0.0079	0.0251	-0.0230	0.0275
CV Grip Strength					-0.0418	0.1065
Std Smoke Now					-0.0444	0.0376
Std Numeracy			0.0367	0.0250	0.0279	0.0263
Std Recall			0.0147	0.0152	0.0157	0.0147
Std Optimism			0.0334	0.0105 ***	0.0428	0.0103 ***
Std Risk Aversion					0.0007	0.0228
CV Income			0.0001	0.0069	-0.0049	0.0065
CV Net Worth			0.0006	0.0045	0.0017	0.0037
Constant	-0.9536	0.6236	-1.1118	0.6485 *	0.0814	0.7674
N	1,871		1,859		1,602	
Adjusted R^2	0.4471		0.4503		0.4874	

* significant at 10%, ** significant at 5%, *** significant at 1% level

Notes: Standard errors are bootstrapped with 10,000 replications. Std = standard deviation, CV = coefficient of variation. Age coefficients are jointly significant at the 1% level in all models.

Table 6 OLS regression results; dependent variable: log of group-specific relative absolute estimation error

	(1)			(2)		
	Coef.	Bootstr. std. err.		Coef.	Bootstr. std. err.	
Group Size	0.0007	0.0011		0.0006	0.0011	
Age	-0.2195	0.0327	***	-0.2256	0.0351	***
Age^2	0.0022	0.0002	***	0.0022	0.0002	***
Gender	-0.2375	0.0364	***	-0.4718	0.0755	***
Couple	0.1357	0.0364	***	0.1492	0.0365	***
Forecast Horizon	0.2066	0.0192	***	0.2138	0.0212	***
Forecast $Horizon^2$	-0.0043	0.0005	***	-0.0046	0.0006	***
CV Obj. Prob.	2.9663	1.2072	**	2.7017	1.2609	**
Education	0.0012	0.0224		-0.0043	0.0239	
Self-Perc. Health	0.0395	0.0333		0.0287	0.0331	
Grip Strength				-0.0157	0.0042	***
Smoke Now				0.2079	0.0581	***
Numeracy	0.0336	0.0338		0.0494	0.0367	
Recall	-0.0071	0.0234		0.0101	0.0250	
Optimism	-0.0032	0.0180		-0.0020	0.0179	
Risk Aversion				0.0262	0.0466	
ln(Income)	-0.1078	0.0223	***	-0.0882	0.0215	***
ln(Net Worth)	-0.0661	0.0183	***	-0.0615	0.0183	***
Constant	3.6240	1.2380	***	4.0897	1.3564	***
N	1,854			1,766		
Adjusted R^2	0.7877			0.7922		

* significant at 10%, ** significant at 5%, *** significant at 1% level

Notes: Standard errors are bootstrapped with 10,000 replications. CV = coefficient of variation.

Table 7 Simultaneous equation model for the savings level; three-stage least squares estimation results (third equation)

Dependent Variable	Net Worth Level			Financial Assets Level		
	Equ. (5.3): SAVE_LEVEL =					
	ln(Net Worth)			*ln(Financial Assets)*		
	Coef.	Bootstr. std. err.		Coef.	Bootstr. std. err.	
Age	0.0709	0.3006		-0.0788	0.4691	
Age^2	-0.0002	0.0023		0.0012	0.0036	
Gender	-0.3528	0.2358		-0.2454	0.4342	
Couple	0.5884	0.0929	***	0.1470	0.1254	
Forecast Horizon	0.1174	0.0759		0.0866	0.1118	
$\text{Forecast Horizon}^2$	-0.0021	0.0028		-0.0012	0.0040	
Education	-0.0211	0.0561		0.1375	0.0689	**
Self-Perc. Health	-0.3610	0.0869	***	-0.4224	0.0996	***
Grip	-0.0188	0.0119		-0.0127	0.0212	
Smoke Now	-0.0659	0.1708		-0.2815	0.2101	
Numeracy	0.0066	0.0926		0.1290	0.1140	
Recall	-0.0641	0.0476		0.1118	0.0707	
Optimism	0.0102	0.0399		0.0948	0.0558	*
Risk Aversion	-0.4839	0.1150	***	-0.4057	0.1588	**
ln(Income)	0.2194	0.0623	***	0.4572	0.0680	***
Leave Inheritance	0.1828	0.2322		1.1104	0.5053	**
Reduction Pension Amount	0.0379	0.0815		0.0838	0.1303	
Sub. Surv. Prob.	-0.7583	1.0127		-0.1555	1.8368	
CV Sub. Surv. Prob.	-0.6160	1.6160		-1.3301	2.5903	
ln(Rel. Abs. Est. Error)	-0.9933	0.5852	*	-0.6242	0.9914	
Constant	8.4929	10.6988		5.7078	16.5264	
N	913			924		
AIC	-144			980		
BIC	140			1,265		

* significant at 10%, ** significant at 5%, *** significant at 1% level

Notes: Standard errors are bootstrapped with 10,000 replications. CV = coefficient of variation.

Table 8 Simultaneous equation model for the dispersion in savings; three-stage least squares estimation results (second equation)

Dependent Variable	Net Worth Dispersion		Financial Assets Dispersion	
	Equ. (5.5): SAVE_DISP =			
	CV Net Worth		*CV Financial Assets*	
	Coef.	Bootstr. std. err.	Coef.	Bootstr. std. err.
Age	0.0846	0.4665	0.1932	0.2934
Age^2	-0.0007	0.0035	-0.0015	0.0022
Gender	0.2869	0.2064	0.0229	0.0484
Couple	0.3315	0.1480 **	0.1481	0.0450 ***
Forecast Horizon	0.0803	0.0887	-0.0166	0.0470
Forecast $Horizon^2$	-0.0024	0.0040	0.0008	0.0024
Std Education	0.0253	0.2015	0.0818	0.0592
Std Self-Perc. Health	0.2522	0.3580	-0.1704	0.0879 *
CV Grip Strength	-0.2836	1.1087	0.8654	0.3366 **
Std Smoke Now	0.8432	0.5014 *	0.2798	0.1309 **
Std Numeracy	0.5576	0.2947 *	-0.0626	0.0712
Std Recall	-0.0611	0.1343	-0.0003	0.0469
Std Optimism	-0.0199	0.1092	0.0481	0.0436
Std Risk Aversion	0.6935	0.3748 *	-0.0992	0.0758
CV Income	0.2190	0.4539	0.0948	0.0293 ***
Std Leave Inheritance	0.2177	1.1579	-0.0273	0.2518
Std Reduction Pension Amount	-0.0071	0.5598	0.0094	0.1113
CV Sub. Surv. Prob.	1.6610	1.9590	1.1338	0.5610 **
Constant	-4.3236	15.4113	-5.5622	9.6087
N	768		768	
AIC	2,398		-3,495	
BIC	2,575		-3,319	

* significant at 10%, ** significant at 5%, *** significant at 1% level

Notes: Standard errors are bootstrapped with 10,000 replications. Std = standard deviation, CV = coefficient of variation.

Table 9 Summary statistics for the grouped data for alternative specifications

	(1) *Baseline Specification*		(2) *Lee-Carter 1975*		(3) *Alternative Mortality Model*		(4) *Focal Responses Imputed*		(5) *Focal Responses Excluded*	
	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std
	N = 1,871		N = 1,871		N = 1,871		N = 1,871		N = 1,615	
Group Size	14.00	12.67	14.00	12.67	14.00	12.67	14.00	12.67	8.86	7.41
Age, *x*	67.24	12.32	67.24	12.32	67.24	12.32	67.24	12.32	66.47	11.53
Gender	0.53	0.50	0.53	0.50	0.53	0.50	0.53	0.50	0.56	0.50
Couple	0.54	0.50	0.54	0.50	0.54	0.50	0.54	0.50	0.56	0.50
Forecast Horizon	15.68	5.29	15.68	5.29	15.68	5.29	15.68	5.29	15.70	4.99
Subj. Survival Probabiliy	0.55	0.19	0.55	0.19	0.55	0.19	0.54	0.17	0.55	0.19
CV Subj. Estimate	0.58	0.35	0.58	0.35	0.58	0.35	0.49	0.24	0.48	0.29
Focal Response II	0.45	0.20	0.45	0.20	0.45	0.20	0.00	0.00	0.00	0.00
CV Obj. Probability	0.04	0.03	0.03	0.02	0.04	0.03	0.04	0.03	0.04	0.03
Relative Estimation Error	0.71	2.79	0.74	2.96	0.45	2.05	0.87	3.38	0.49	2.30
Relative Abs. Est. Error	1.21	2.75	1.24	2.92	0.99	2.01	1.28	3.28	0.91	2.20

Notes: N denotes the number of groups. For calculation of group-based measures, the SHARE weights are not applied. Groups are based on age, gender, country, and couple. Std = standard deviation, CV = coefficient of variation. Baseline Specification = original model specification introduced in Section 1; Lee-Carter 1975 = mortality data estimation window starts 1975; Alternative Mortality Model = mortality model introduced in Section 6; Focal Responses Imputed = all responses indicating a 0%, 50%, or 100% chance of survival imputed; Focal Responses Excluded = all responses indicating a 0%, 50%, or 100% chance of survival removed from the sample.

Table 10 OLS regression results for alternative specifications; dependent variable: coefficient of variation of group-specific subjective survival probability

	(1) *Baseline Specification*		(2) *Lee-Carter 1975*		(3) *Alternative Mortality Model*		(4) *Focal Responses Imputed*		(5) *Focal Responses Excluded*	
	Coef.	Bootstr. std. err.	Coef.	Bootstr. std. err.	Coef.	Bootstr. std. err.	Coef.	Bootstr. std. err.	Coef.	Bootstr. std. err.
Group Size	-0.0007	0.0006	-0.0008	0.0006	-0.0011	0.0006 **	-0.0004	0.0004	-0.0014	0.0009
Age	-0.0135	0.0211	-0.0216	0.0217	-0.0193	0.0213	0.0197	0.0161	0.0518	0.0189 ***
Age^2	0.0002	0.0001	0.0003	0.0002 *	0.0003	0.0001 *	-0.0001	0.0001	-0.0003	0.0001 *
Gender	0.0000	0.0143	-0.0141	0.0128	-0.0205	0.0119 *	-0.0043	0.0111	-0.0062	0.0142
Couple	-0.0273	0.0169	-0.0253	0.0168	-0.0213	0.0167	-0.0337	0.0126 ***	-0.0098	0.0160
Forecast Horizon	0.0202	0.0108 *	0.0283	0.0103 ***	0.0259	0.0100 ***	-0.0170	0.0093 *	-0.0173	0.0128
Forecast $Horizon^2$	-0.0002	0.0003	-0.0004	0.0003	-0.0005	0.0003	0.0006	0.0003 **	0.0011	0.0004 ***
CV Obj. Prob.	2.1515	0.5613 ***	2.1608	0.4813 ***	3.2289	0.4623 ***	1.5816	0.3845 ***	1.5601	0.5888 ***
Std Education	-0.0351	0.0178 **	-0.0339	0.0177 *	-0.0318	0.0179 *	-0.0050	0.0128	0.0065	0.0151
Std Self-Perc. Health	-0.0230	0.0275	-0.0266	0.0279	-0.0211	0.0271	-0.0035	0.0224	0.0090	0.0241
CV Grip Strength	-0.0418	0.1065	-0.0395	0.1056	-0.0443	0.1045	0.0371	0.0741	-0.0620	0.0860
Std Smoke Now	-0.0444	0.0376	-0.0515	0.0376	-0.0671	0.0371 *	0.0185	0.0279	-0.0012	0.0308
Std Numeracy	0.0279	0.0263	0.0285	0.0264	0.0328	0.0263	-0.0162	0.0225	0.0322	0.0234
Std Recall	0.0157	0.0147	0.0138	0.0147	0.0111	0.0149	0.0060	0.0120	-0.0014	0.0139
Std Optimism	0.0428	0.0103 ***	0.0410	0.0102 ***	0.0420	0.0103 ***	0.0413	0.0079 ***	0.0471	0.0085 ***
Std Risk Aversion	0.0007	0.0228	0.0001	0.0225	0.0066	0.0221	-0.0104	0.0166	-0.0174	0.0201
CV Income	-0.0049	0.0065	-0.0004	0.0064	0.0042	0.0061	-0.0015	0.0052	-0.0114	0.0108
CV Net Worth	0.0017	0.0037	0.0011	0.0039	0.0007	0.0032	0.0009	0.0023	0.0008	0.0030
Constant	0.0814	0.7674	0.2571	0.7877	0.2986	0.7713	-0.5112	0.5935	-1.9398	0.6674 ***
N	1,602		1,602		1,602		1,602		1,316	
Adjusted R^2	0.4874		0.4919		0.5030		0.3920		0.3733	

Notes: Standard errors are bootstrapped with 10,000 replications. Std = standard deviation, CV = coefficient of variation. Baseline Specification = original model specification introduced in Section 1; Lee-Carter 1975 = mortality data estimation window starts 1975; Alternative Mortality Model = mortality model introduced in Section 6; Focal Responses Imputed = all responses indicating a 0%, 50%, or 100% chance of survival imputed; Focal Responses Excluded = all responses indicating a 0%, 50%, or 100% chance of survival removed from the sample; Age coefficients are jointly significant at the 1% level in all models.

Table 11 OLS regression results for alternative specifications; dependent variable: log of group-specific relative absolute estimation error

	(1)		(2)		(3)		(4)		(5)	
	Baseline Specification		*Lee-Carter 1975*		*Alternative Mortality Model*		*Focal Responses Imputed*		*Focal Responses Excluded*	
	Coef.	Bootstr. std. err.	Coef.	Bootstr. std. err.	Coef.	Bootstr. std. err.	Coef.	Bootstr. std. err.	Coef.	Bootstr. std. err.
Group Size	0.0006	0.0011	0.0008	0.0012	-0.0005	0.0011	0.0004	0.0013	0.0072	0.0024 ***
Age	-0.2256	0.0351 ***	-0.2325	0.0382 ***	-0.3409	0.0371 ***	-0.2319	0.0392 ***	-0.0674	0.0521
Age^2	0.0022	0.0002 ***	0.0023	0.0003 ***	0.0029	0.0003 ***	0.0023	0.0003 ***	0.0012	0.0004 ***
Gender	-0.4718	0.0755 ***	-0.5286	0.0741 ***	-0.0325	0.0707	-0.3938	0.0835 ***	-0.3144	0.0879 ***
Couple	0.1492	0.0365 ***	0.1577	0.0369 ***	0.0796	0.0329 **	0.1417	0.0414 ***	0.1741	0.0456 ***
Forecast Horizon	0.2138	0.0212 ***	0.2443	0.0197 ***	0.2217	0.0177 ***	0.2686	0.0238 ***	0.2084	0.0304 ***
Forecast $Horizon^2$	-0.0046	0.0006 ***	-0.0052	0.0005 ***	-0.0058	0.0005 ***	-0.0061	0.0006 ***	-0.0034	0.0009 ***
CV Obj. Prob.	2.7017	1.2609 **	-0.9738	0.9333	3.8949	0.9775 ***	0.4296	1.3449	0.7160	1.6330
Education	-0.0043	0.0239	-0.0027	0.0249	-0.0510	0.0258 **	-0.0275	0.0285	-0.0188	0.0278
Self-Perc. Health	0.0287	0.0331	0.0297	0.0342	0.0658	0.0339 *	0.0574	0.0344 *	0.1217	0.0353 ***
Grip Strength	-0.0157	0.0042 ***	-0.0189	0.0043 ***	-0.0006	0.0041	-0.0102	0.0047 **	-0.0073	0.0049
Smoke Now	0.2079	0.0581 ***	0.2556	0.0588 ***	0.1914	0.0543 ***	0.2689	0.0648 ***	0.2320	0.0723 ***
Numeracy	0.0494	0.0367	0.0475	0.0369	-0.0068	0.0357	0.0430	0.0421	0.0804	0.0457 *
Recall	0.0101	0.0250	0.0159	0.0254	0.0117	0.0243	0.0204	0.0279	-0.0151	0.0268
Optimism	-0.0020	0.0179	0.0053	0.0181	0.0044	0.0169	-0.0140	0.0178	-0.0410	0.0187 **
Risk Aversion	0.0262	0.0466	0.0193	0.0492	-0.0129	0.0463	0.0001	0.0579	0.0554	0.0485
ln(Income)	-0.0882	0.0215 ***	-0.0973	0.0220 ***	-0.0458	0.0213 **	-0.0731	0.0231 ***	-0.1181	0.0306 ***
ln(Net Worth)	-0.0615	0.0183 ***	-0.0642	0.0207 ***	-0.0310	0.0184 *	-0.0723	0.0199 ***	-0.0857	0.0220 ***
Constant	4.0897	1.3564 ***	3.9516	1.4590 ***	7.2500	1.4385 ***	3.3419	1.5073 **	-2.0553	1.9312
N	1,766		1,766		1,766		1,766		1,497	
Adjusted R^2	0.7922		0.7838		0.7635		0.7743		0.7047	

* significant at 10%, ** significant at 5%, *** significant at 1% level

Notes: Standard errors are bootstrapped with 10,000 replications. CV = coefficient of variation. Baseline Specification = original model specification introduced in Section 1; Lee-Carter 1975 = mortality data estimation window starts 1975; Alternative Mortality Model = mortality model introduced in Section 6; Focal Responses Imputed = all responses indicating a 0%, 50%, or 100% chance of survival imputed; Focal Responses Excluded = all responses indicating a 0%, 50%, or 100% chance of survival removed from the sample.

Table 12 Simultaneous equation model for the savings level; three-stage least squares estimation results (third equation) for alternative specifications; dependent variable: log of financial assets

	(1) *Baseline Specification*		(2) *Lee-Carter 1975*		(3) *Alternative Mortality Model*		(4) *Focal Responses Imputed*		(5) *Focal Responses Excluded*	
	Coef.	Bootstr. std. err.	Coef.	Bootstr. std. err.	Coef.	Bootstr. std. err.	Coef.	Bootstr. std. err.	Coef.	Bootstr. std. err.
Age	-0.0788	0.4691	-0.1400	0.4446	-0.4813	0.5942	-0.3155	0.5430	-0.3199	0.6138
Age^2	0.0012	0.0036	0.0018	0.0034	0.0041	0.0045	0.0025	0.0041	0.0025	0.0048
Gender	-0.2454	0.4342	-0.2462	0.3771	0.0141	0.3782	0.0812	0.3797	0.4357	0.3860
Couple	0.1470	0.1254	0.1294	0.1164	-0.0191	0.1069	0.3293	0.1861 *	0.3601	0.2248
Forecast Horizon	0.0866	0.1118	0.1122	0.0996	0.0819	0.1223	0.1568	0.1676	0.0552	0.1743
Forecast $Horizon^2$	-0.0012	0.0040	-0.0017	0.0038	-0.0035	0.0051	-0.0056	0.0061	-0.0039	0.0061
Education	0.1375	0.0689 **	0.1482	0.0692 **	0.1426	0.0847 *	0.1860	0.0866 **	0.0925	0.0779
Self-Perc. Health	-0.4224	0.0996 ***	-0.4065	0.0992 ***	-0.4643	0.1837 **	-0.0929	0.1586	-0.2736	0.1201 **
Grip	-0.0127	0.0212	-0.0122	0.0197	0.0011	0.0205	-0.0053	0.0206	0.0171	0.0195
Smoke Now	-0.2815	0.2101	-0.2218	0.2045	-0.4990	0.2594 *	-0.4623	0.2182 **	-0.4756	0.2471 *
Numeracy	0.1290	0.1140	0.1107	0.1077	0.3048	0.1657 *	0.1598	0.1197	0.1921	0.1190
Recall	0.1118	0.0707	0.1167	0.0699 *	0.0342	0.0862	0.1557	0.0725 **	0.1028	0.0741
Optimism	0.0948	0.0558 *	0.0821	0.0551	0.0875	0.0567	0.1983	0.0737 ***	0.1223	0.0875
Risk Aversion	-0.4057	0.1588 **	-0.3975	0.1730 **	-0.0405	0.2340	-0.3447	0.1488 **	-0.6174	0.1511 ***
ln(Income)	0.4572	0.0680 ***	0.4483	0.0650 ***	0.4119	0.0748 ***	0.5674	0.0770 ***	0.6111	0.1259 ***
Leave Inheritance	1.1104	0.5053 **	1.0494	0.4661 **	1.7721	0.5606 ***	1.3731	0.4770 ***	1.1806	0.4806 **
Reduction Pension Amount	0.0838	0.1303	0.0889	0.1199	0.2143	0.1832	-0.0094	0.1766	0.2419	0.1965
Sub. Surv. Prob.	-0.1555	1.8368	0.0121	1.2882	4.3597	3.4255	19.2523	7.0293 ***	7.6717	4.4835 *
CV Sub. Surv. Prob.	-1.3301	2.5903	-1.6933	2.2166	-4.3772	2.8826	18.4526	7.8174 **	9.9110	4.2933 **
ln(Rel. Abs. Est. Error)	-0.6242	0.9914	-0.7609	0.9362	2.8677	1.8388	-0.8474	1.2196	-1.0577	1.2059
Constant	5.7078	16.5264	6.9290	15.3585	21.2767	20.7734	-9.3052	15.1640	3.7060	19.0941
N	924		924		924		924		744	
AIC	980		872		1,541		1,649		1,759	
BIC	1,265		1,157		1,826		1,934		2,031	

* significant at 10%, ** significant at 5%, *** significant at 1% level

Notes: Standard errors are bootstrapped with 10,000 replications. CV = coefficient of variation. Baseline Specification = original model specification introduced in Section 1; Lee-Carter 1975 = mortality data estimation window starts 1975; Alternative Mortality Model = mortality model introduced in Section 6; Focal Responses Imputed = all responses indicating a 0%, 50%, or 100% chance of survival imputed; Focal Responses Excluded = all responses indicating a 0%, 50%, or 100% chance of survival removed from the sample.

Table 13 Simultaneous equation model for the dispersion in savings; three-stage least squares estimation results (second equation) for alternative specifications; dependent variable: coefficient of variation of financial assets

	(1)		(2)		(3)		(4)		(5)	
	Baseline Specification		*Lee-Carter 1975*		*Alternative Mortality Model*		*Focal Responses Imputed*		*Focal Responses Excluded*	
	Coef.	Bootstr. std. err.	Coef.	Bootstr. std. err.	Coef.	Bootstr. std. err.	Coef.	Bootstr. std. err.	Coef.	Bootstr. std. err.
Age	0.1932	0.2934	0.1745	0.2986	0.2217	0.2759	0.1452	0.2962	0.0197	0.4141
Age^2	-0.0015	0.0022	-0.0014	0.0022	-0.0016	0.0021	-0.0011	0.0022	-0.0003	0.0031
Gender	0.0229	0.0484	0.0358	0.0456	0.0007	0.0426	0.0145	0.0434	0.0604	0.0430
Couple	0.1481	0.0450 ***	0.1597	0.0452 ***	0.1288	0.0400 ***	0.1550	0.0445 ***	0.1452	0.0449 ***
Forecast Horizon	-0.0166	0.0470	-0.0182	0.0494	-0.0130	0.0431	0.0015	0.0475	-0.0090	0.0632
Forecast $Horizon^2$	0.0008	0.0024	0.0007	0.0024	0.0010	0.0022	0.0003	0.0024	-0.0004	0.0032
Std Education	0.0818	0.0592	0.0988	0.0593 *	0.0524	0.0532	0.0804	0.0593	0.0405	0.0511
Std Self-Perc. Health	-0.1704	0.0879 *	-0.1772	0.0919 *	-0.1585	0.0776 **	-0.1831	0.0912 **	-0.0874	0.0764
CV Grip Strength	0.8654	0.3366 **	0.8494	0.3428 **	0.8917	0.3071 ***	0.9927	0.3260 ***	0.4859	0.3135
Std Smoke Now	0.2798	0.1309 **	0.2963	0.1373 **	0.2518	0.1158 **	0.2202	0.1180 *	0.0373	0.1024
Std Numeracy	-0.0626	0.0712	-0.0674	0.0744	-0.0545	0.0656	-0.0605	0.0693	-0.0641	0.0738
Std Recall	-0.0003	0.0469	0.0007	0.0488	-0.0017	0.0446	0.0127	0.0470	-0.0041	0.0479
Std Optimism	0.0481	0.0436	0.0331	0.0399	0.0739	0.0338 **	0.0279	0.0466	-0.0120	0.0374
Std Risk Aversion	-0.0992	0.0758	-0.0886	0.0775	-0.1165	0.0660 *	-0.1193	0.0653 *	-0.0162	0.0605
CV Income	0.0948	0.0293 ***	0.0937	0.0289 ***	0.0967	0.0287 ***	0.0957	0.0288 ***	0.1695	0.0523 ***
Std Leave Inheritance	-0.0273	0.2518	0.0768	0.2445	-0.2149	0.2001	-0.1335	0.2446	0.0969	0.2560
Std Reduction Pension Amount	0.0094	0.1113	-0.0334	0.1077	0.0693	0.1002	0.0037	0.0871	-0.0152	0.0638
CV Sub. Surv. Prob.	1.1338	0.5610 **	1.4171	0.4610 ***	0.6431	0.3865 *	1.2364	0.5481 **	1.1134	0.4354 **
Constant	-5.5622	9.6087	-4.8953	9.7659	-6.5787	9.0551	-4.0701	9.7040	0.8184	13.5370
N	768		768		768		768		595	
AIC	-3,495		-2,117		-651		-1,717		-1,314	
BIC	-3,319		-1,941		-474		-1,540		-1,147	

* significant at 10%, ** significant at 5%, *** significant at 1% level

Notes: Standard errors are bootstrapped with 10,000 replications. Std = standard deviation, CV = coefficient of variation. Baseline Specification = original model specification introduced in Section 1; Lee-Carter 1975 = mortality data estimation window starts 1975; Alternative Mortality Model = mortality model introduced in Section 6; Focal Responses Imputed = all responses indicating a 0%, 50%, or 100% chance of survival imputed; Focal Responses Excluded = all responses indicating a 0%, 50%, or 100% chance of survival removed from the sample.

Table 14 OLS regression results for alternative specification; dependent variable: percentage of group-specific focal responses

	Coef.	Bootstr. std. err.
Group Size	0.0002	0.0005
Age	-0.0137	0.0130
Age^2	0.0001	0.0001
Gender	0.0662	0.0299 **
Couple	0.0017	0.0142
Forecast Horizon	-0.0091	0.0078
Forecast $Horizon^2$	0.0000	0.0002
CV Obj. Prob.	1.5287	0.3986 ***
Education	0.0034	0.0104
Self-Perc. Health	-0.0265	0.0139 *
Grip Strength	0.0017	0.0018
Smoke Now	0.0181	0.0276
Numeracy	0.0088	0.0151
Recall	-0.0085	0.0101
Optimism	0.0001	0.0066
Risk Aversion	-0.0336	0.0198 *
ln(Income)	-0.0118	0.0102
ln(Net Worth)	-0.0115	0.0077
Constant	1.4510	0.5198 ***
N	1,766	
Adjusted R^2	0.0159	

* significant at 10%, ** significant at 5%, *** significant at 1% level

Notes: Standard errors are bootstrapped with 10,000 replications. CV = coefficient of variation. Focal responses encompass all responses indicating a 0%, 50%, or 100% chance of survival. Age coefficients are not jointly significant.

Table 15 Simultaneous equation model for the savings level; three-stage least squares estimation results (third equation) for alternative specification; savings measure is log of financial assets (percent focal responses as uncertainty/disagreement measure)

	Coef.	Bootstr. std. err.
Age	-0.0234	0.2318
Age^2	0.0005	0.0017
Gender	0.0228	0.2408
Couple	0.1439	0.0710 **
Forecast Horizon	0.0605	0.0501
Forecast $Horizon^2$	-0.0019	0.0020
Education	0.0481	0.0642
Self-Perc. Health	-0.5450	0.0913 ***
Grip	-0.0015	0.0132
Smoke Now	-0.2296	0.1550
Numeracy	0.1998	0.0959 **
Recall	0.0848	0.0578
Optimism	0.0823	0.0419 **
Risk Aversion	-0.3408	0.1150 ***
ln(Income)	0.4971	0.0602 ***
Leave Inheritance	1.5883	0.3111 ***
Reduction Pension Amount	0.1156	0.1619
Sub. Surv. Prob.	1.3877	0.3919 ***
% of Focal Responses	-0.1009	0.2016
ln(Rel. Abs. Est. Error)	0.1173	0.1402
Constant	4.4762	7.8053
N	923	
AIC	2,405	
BIC	2,693	

* significant at 10%, ** significant at 5%, *** significant at 1% level

Notes: Standard errors are bootstrapped with 10,000 replications.

Table 16 Simultaneous equation model for the dispersion in savings; three-stage least squares estimation results (second equation) for alternative specification (percent focal responses as uncertainty/disagreement measure); savings measure is financial assets

	Coef.	Bootstr. std. err.
Age	0.3459	0.2745
Age^2	-0.0025	0.0021
Gender	-0.0325	0.0397
Couple	0.1169	0.0429 ***
Forecast Horizon	-0.0163	0.0432
Forecast $Horizon^2$	0.0020	0.0022
Std Education	0.0197	0.0485
Std Self-Perc. Health	-0.1355	0.0737 *
CV Grip Strength	0.9384	0.2974 ***
Std Smoke Now	0.2080	0.1113 *
Std Numeracy	-0.0285	0.0684
Std Recall	-0.0044	0.0440
Std Optimism	0.1062	0.0281 ***
Std Risk Aversion	-0.1586	0.0649 **
CV Income	0.1076	0.0292 ***
Std Leave Inheritance	-0.3580	0.1661 **
Std Reduction Pension Amount	0.2078	0.1564
% of Focal Responses	0.8937	0.8503
Constant	-11.4313	9.1587
N	768	
AIC	375	
BIC	551	

* significant at 10%, ** significant at 5%, *** significant at 1% level

Notes: Standard errors are bootstrapped with 10,000 replications. Std = standard deviation, CV = coefficient of variation.

Figure 1 One-year realized probabilities of death; mortality data from the Human Mortality Database

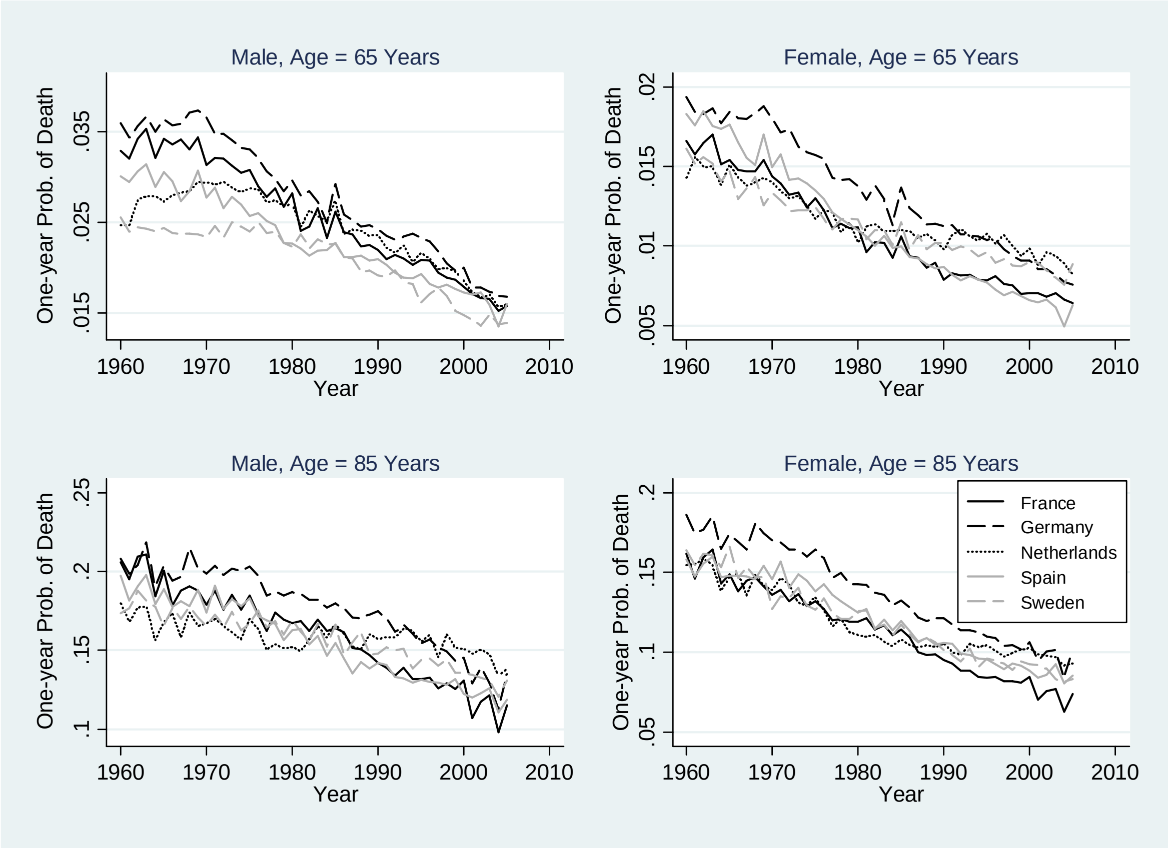
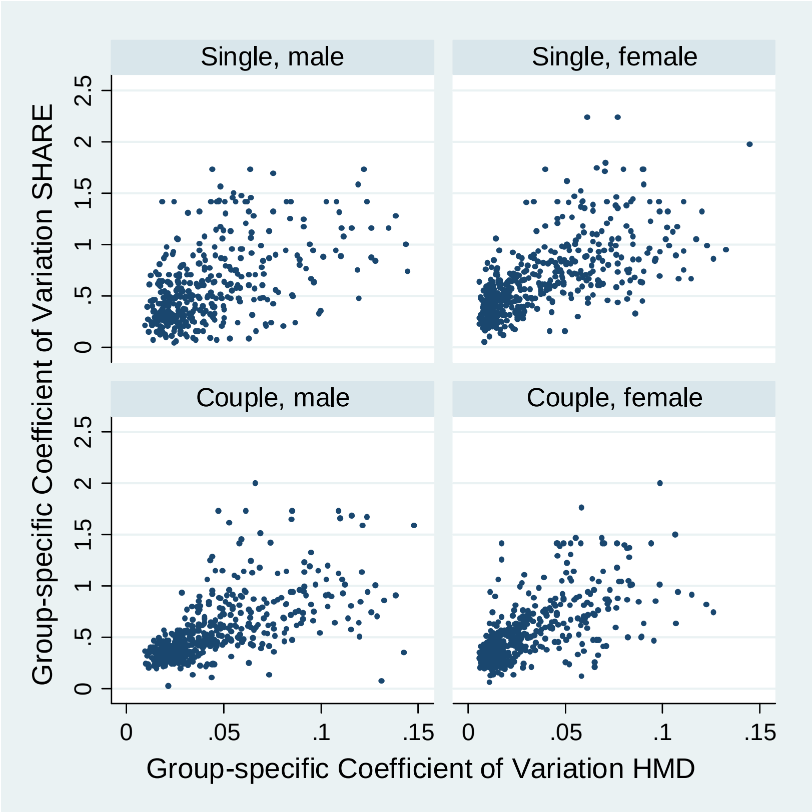


Figure 2 Scatter plot of group-specific coefficients of variation for Human Mortality Database (HMD) data versus group-specific coefficients of variation for SHARE data

Notes: Each point represents one group of individuals with a certain characteristic in the dimensions of age, gender, country, and couple.

Figure 3 Scatter plot of group-specific coefficients of variation for Human Mortality Database (HMD) data versus group-specific coefficients of variation for SHARE data



Notes: Each point represents one group of individuals with a certain characteristic in the dimensions age, gender, country, and couple.

Figure 4 Mean values of group-specific coefficients of variation for Human Mortality Database (Panel A) and SHARE data (Panel B); data grouped according to age, gender, country, and couple; mean calculated over gender and couple

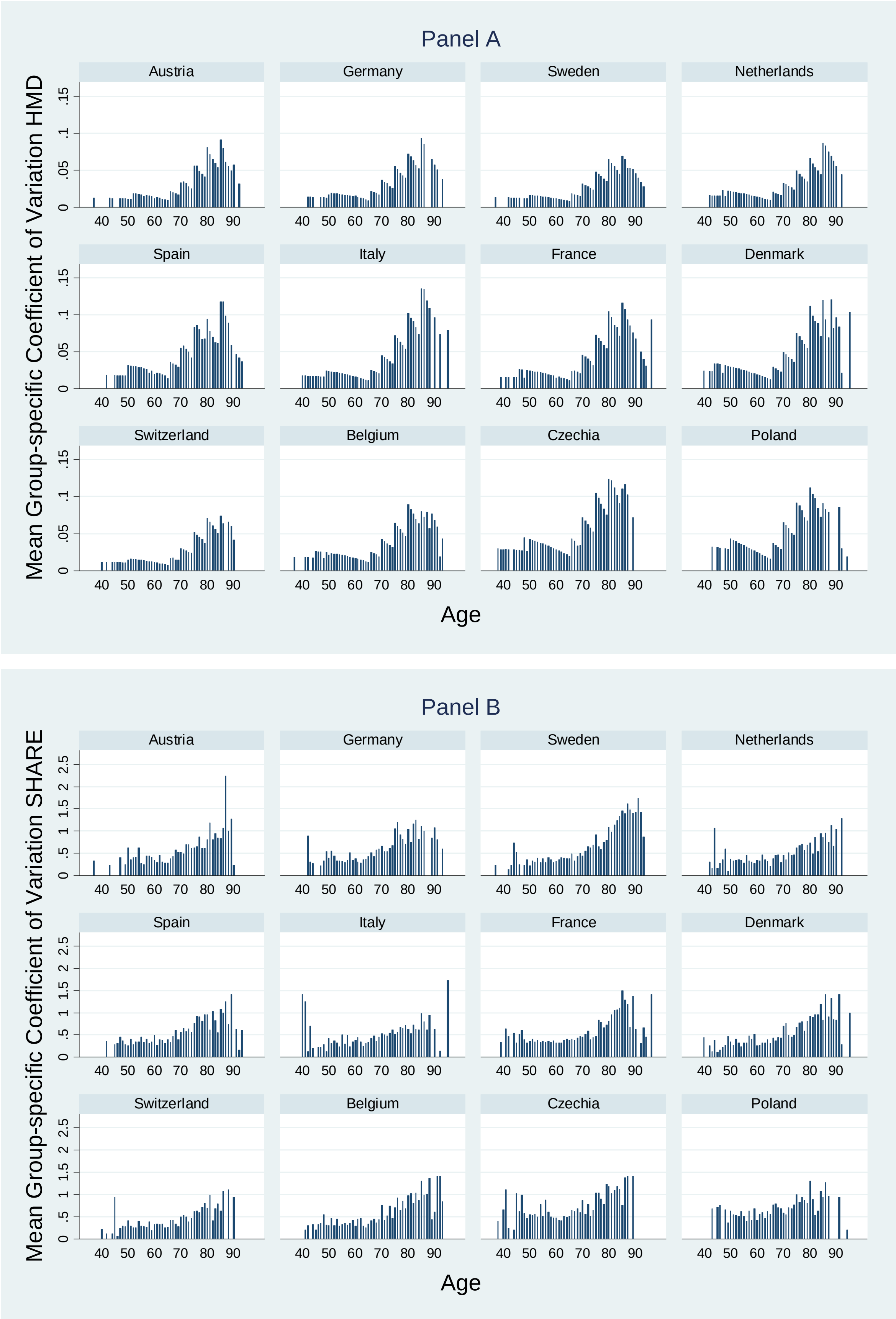


Figure 5 Mean values of the group-specific relative estimation error; data grouped according to age, gender, country, and couple; mean calculated over gender and couple

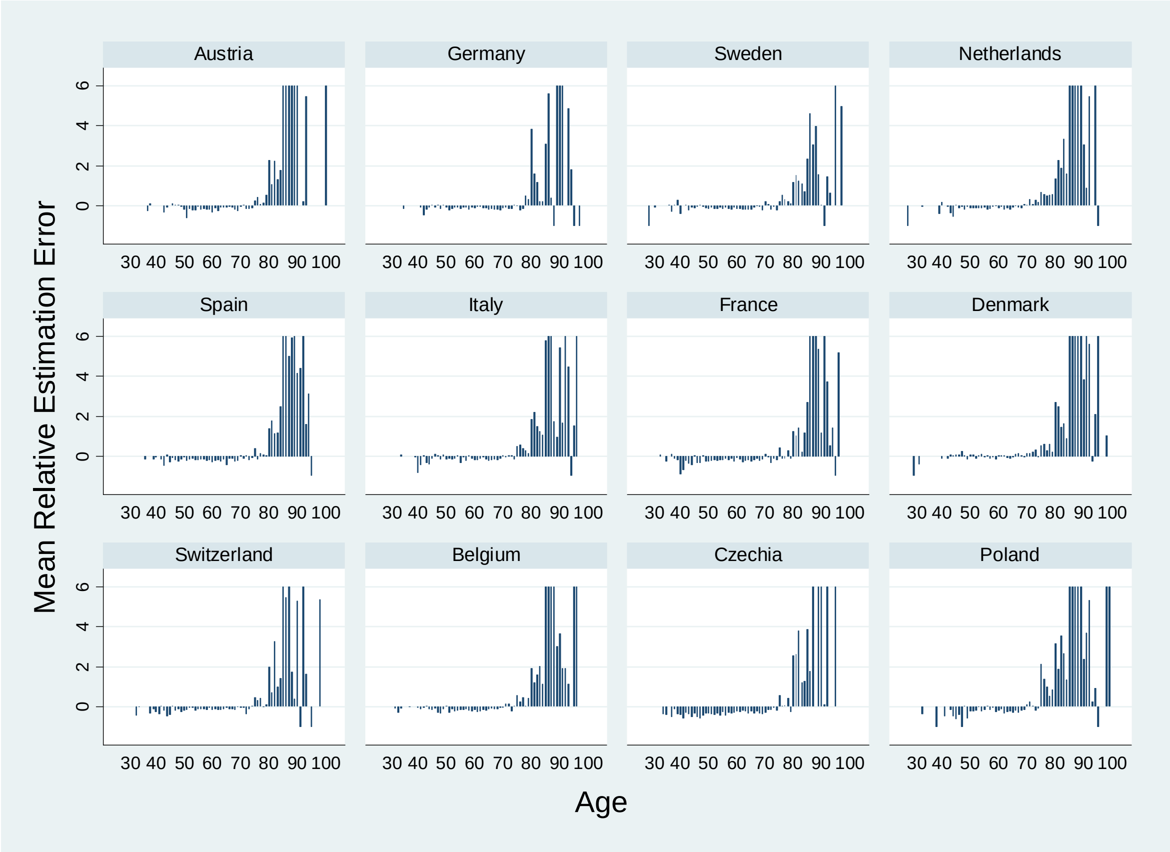
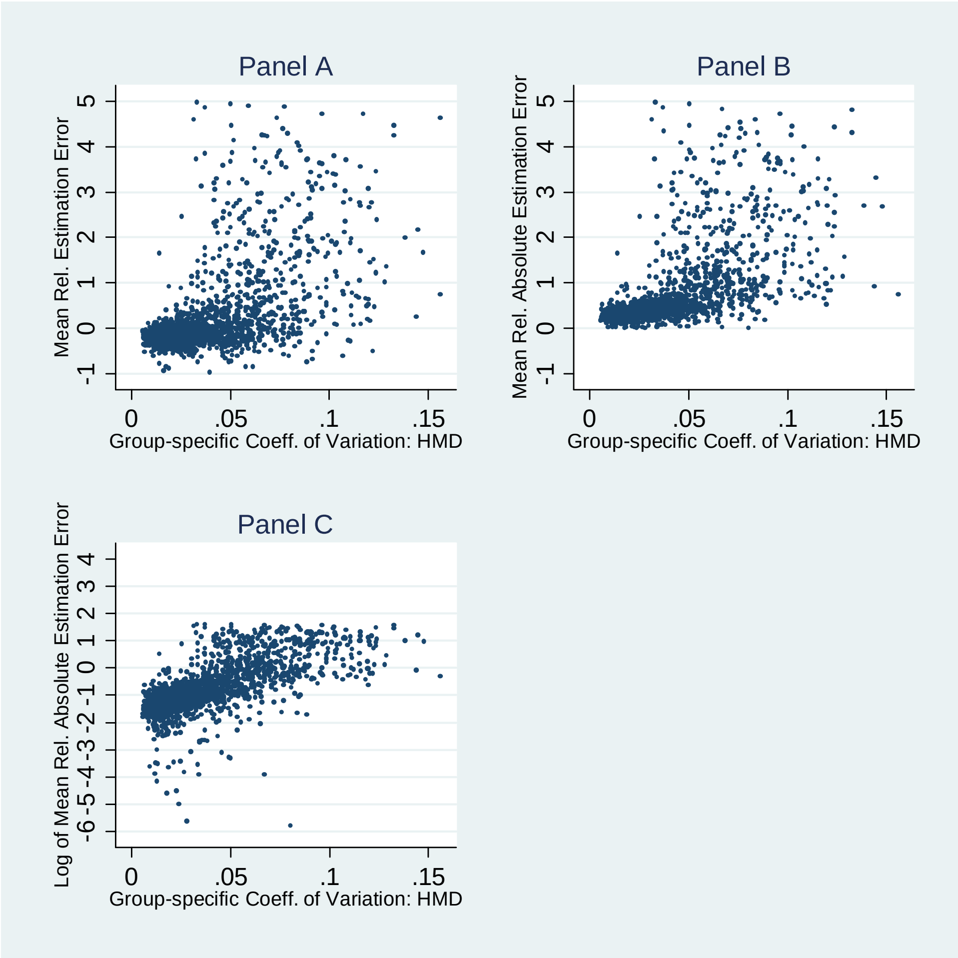


Figure 6 Scatter plots of group-specific coefficients of variation for Human Mortality Database (HMD) data versus the estimation errors in SHARE data; relative estimation error (Panel A), relative absolute estimation error (Panel B), and logarithm of relative absolute estimation error (Panel C)



Notes: Each point represents one group of individuals with a certain characteristic in the dimensions age, gender, country, and couple.

Figure 7 Conceptual links underlying the saving-behavior-related research hypotheses