Maastricht University

Netspar

Longevity Risk, Subjective Survival Expectations, and Individual Saving Behavior

Thomas Post [a] **and Katja Hanewald** [b]

[a] **Maastricht University, Netspar**

[b] **University of New South Wales**

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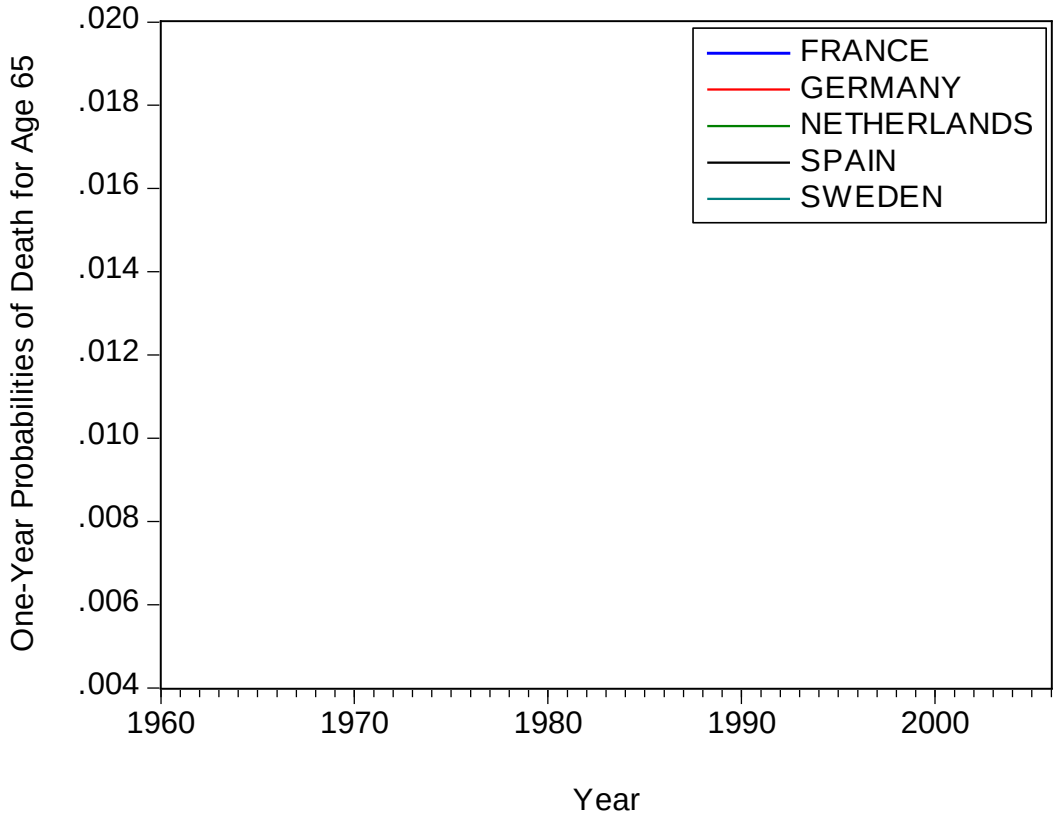
School of Business and Economics

Introduction

- Mortality decline exhibits considerable variation: “Longevity Risk” (stochastic mortality)



Introduction

- Theory indicates that longevity risk is key determinant of
  - individual consumption and saving decisions
  - asset allocation decisions: annuities, longevity bonds
  - retirement timing decisions
- Research objectives

  1. Are individuals *aware* of longevity risk?

  2. Is individual saving *behavior* affected by the perception of longevity risk?

1. Research Objective: Awareness

Individual Perception of Survival Fluctuations

Survey of Health, Ageing and Retirement in Europe (SHARE):

Subjective survival expectations

"Subjective survival data"

Match ?

Actual Survival Fluctuations

Human Mortality Database (HMD):

Time series for actual survival rates

"Objective survival data"

Subjective Survival Expectations - SHARE

- Wave 2 (2006/2007)
  - Austria, Belgium, Czechia, Denmark, France, Germany, Italy, the Netherlands, Poland, Spain, Sweden, and Switzerland
  - selected sample: 26,497 individuals

- "What are the chances that you will live to be age *T* or more?"

Current age of respondent x	Target age T
≤ 65	75
66-70	80
71-75	85
76-80	90
…	…

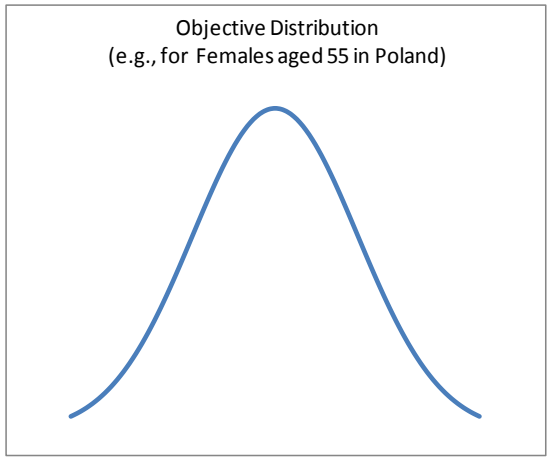
Subjective survival estimates are informative, they

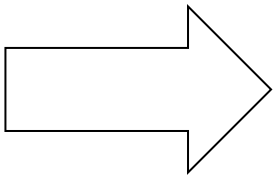
- exhibit meaningful differentials according to age, gender, health and socioeconomic status
  (e.g., Hamermesh, 1985; Hurd and McGarry, 1995; Popham and Mitchell, 2007; Delavande and Rohwedder, 2008)
- match in tendency the shape survival functions of actual life tables
  (Hamermesh, 1985; Elder, 2007; Hurd et al., 2009)
- predict development of aggregate mortality rates
  (Hamermesh, 1985; Perozek, 2008)
- predict individuals' actual survival
  (Hurd et al. 1998; Hurd and McGarry, 2002; Siegel et al. 2003; Winter, 2008)
- predict economic decisions like consumption, savings, bequests, and retirement benefit claiming
  (e.g., Gan et al., 2004; Hurd et al., 2004; Bloom et al., 2007; Delavande and Willis, 2008)

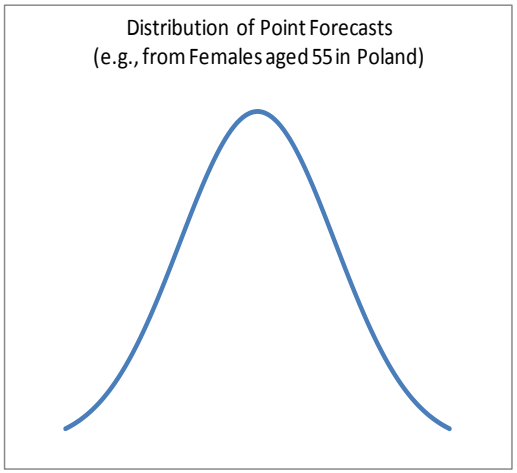
But

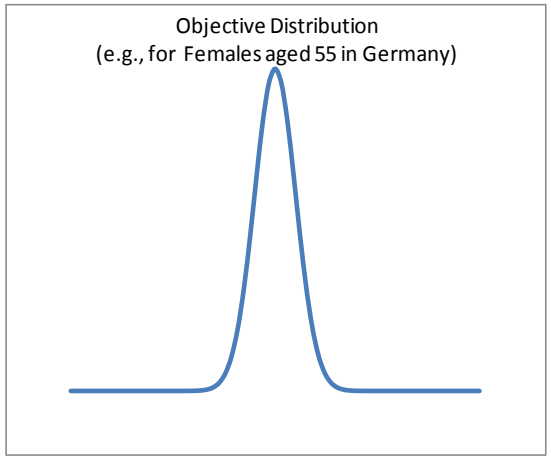
- The probabilities elicited in SHARE are *point forecasts*
- Can a sample of point forecasts be used to get information on the perceived *variation* of the forecast variable?
- Yes, numerous empirical studies successfully demonstrated the reliability of measures of *dispersion* of point forecasts as proxy for variability of the forecast variable
  - inflation, unemployment, firm earnings, stock returns, bond spreads, consumer goods demand

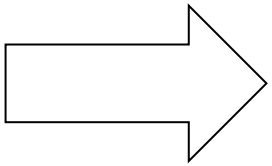
Higher dispersion of a forecast variable results in higher dispersion of point forecasts for this variable

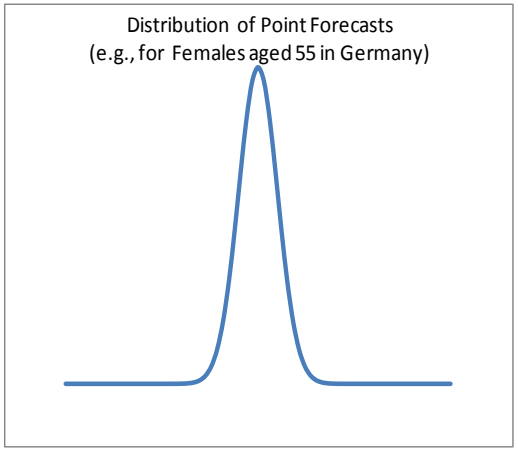












Research Hypothesis

- 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
- Test of hypothesis
  - Examine, whether gender-, age-, and country-specific heterogeneity in mortality uncertainty found in HMD mortality data corresponds to forecast dispersion elicited in SHARE

Calculation of Dispersion Measures - HMD

- Objective mortality (and survival) rates
  - Available by country, gender, and age
  - For each country and gender we calibrate a standard model for stochastic mortality: Lee-Carter
  - Then, we forecast for each SHARE respondent (and the matching forecast horizon) the expected future multi-period survival probability $E(p_{x,t,T-x})$ and the standard deviation of $p_{x,t,T-x}$
  - Finally, by each country-gender-age group in SHARE we calculate a normalized dispersion measure

    Coefficient of variation = $\text{Std}(p_{x,t,T-x}) \,/\, E(p_{x,t,T-x})$

Calculation of Dispersion Measures - SHARE

- Based on HMD data structure for survival rates
  - We calculate

    group-specific (country-gender-age)

    coefficients of variation for subjective survival probability estimates

- Implicit assumption *at this* point:
  - Within each country-gender-age group
    expected objective mortality is equal for all respondents
    (like in the HMD data)

    → dispersion in point forecasts within groups not caused by heterogeneity in mortality but by perception of longevity risk

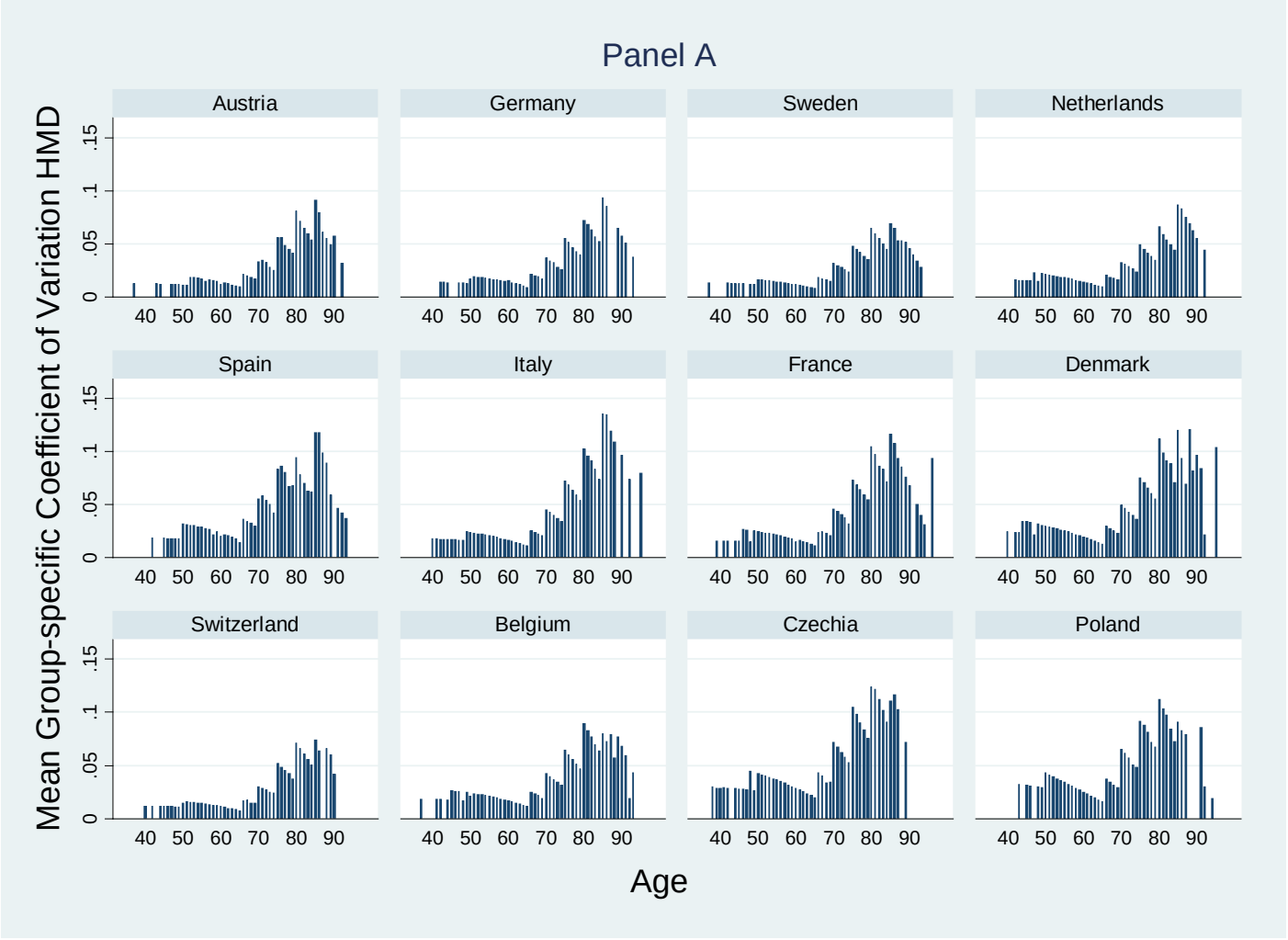
Empirical Findings

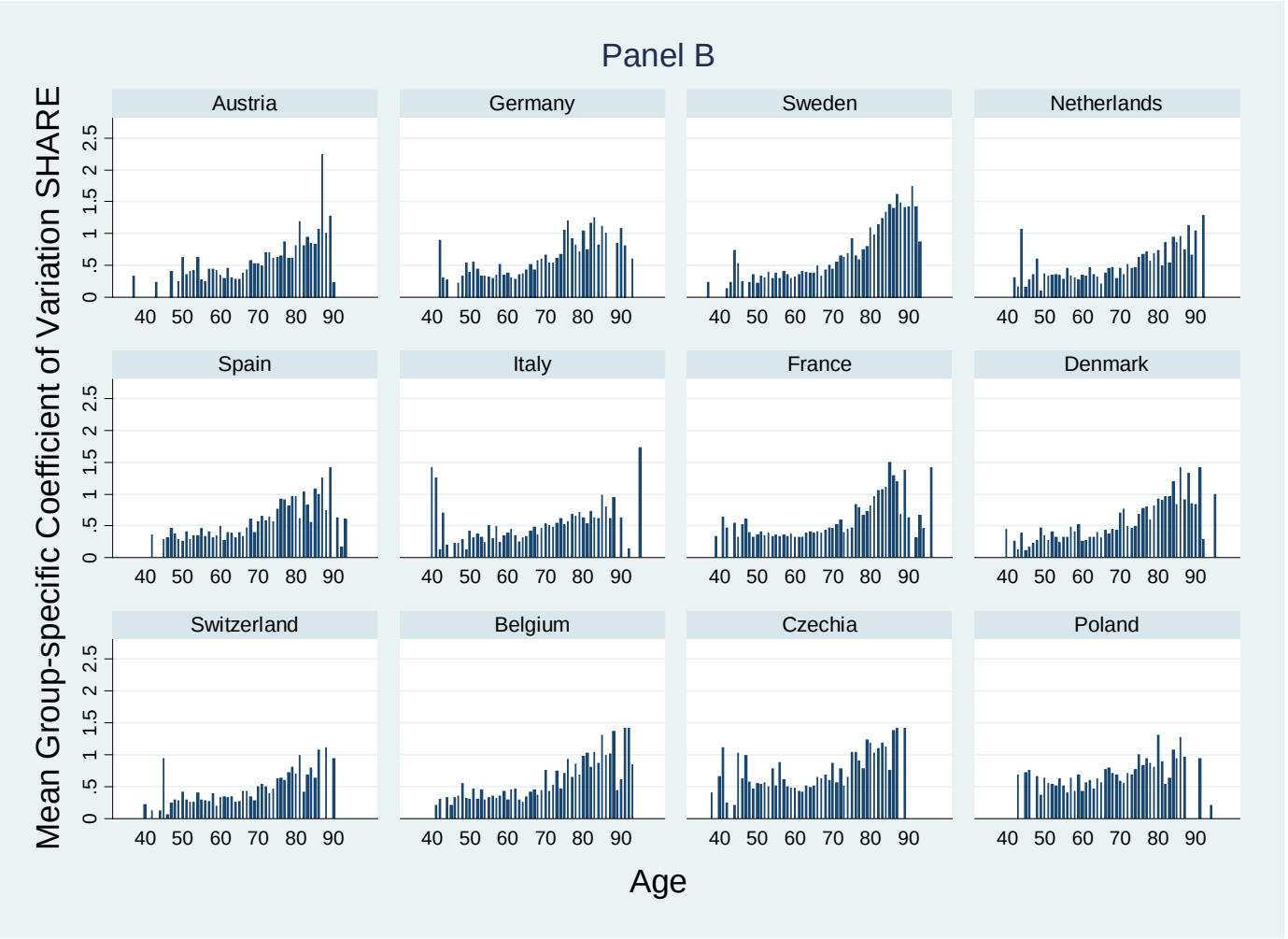
- Group-specific coefficients of variation
- Data grouped according to country, age, gender

Subjective

Objective

However, this positive relationship could be an age-effect




Panel B
Austria
Germany
Sweden
Netherlands
Spain
Italy
France
Denmark
Switzerland
Belgium
Czechia
Poland
Mean Group-specific Coefficient of Variation SHARE
0 .5 1 1.5 2 2.5
40 50 60 70 80 90
Age

- Or, dispersion of responses within groups could be driven by heterogeneity in factors related to mortality
  - Income, wealth, health…
- Thus, dispersion of responses would not pick up awareness of longevity risk
- → Multivariate regression
  - Model: $SUB\_DISP_j = \alpha + \beta\, OBJ\_DISP_j + \delta^{T} z_j + \varepsilon_j$

Regression Results (OLS grouped data)

Dependent Variable	CV of Group-Specific Subj. Survival Prob. (1)	
	Coef.	Bootstr. std. err.
Group Size	-0.001	0.001
Age	0.013	0.017
Age^2	0.000	0.000
Gender	0.026	0.014 *
Couple	-0.033	0.018 *
Forecast Horizon	0.027	0.009 ***
$Forecast\ Horizon^2$	0.000	0.000
CV Obj. Prob.	2.507	0.535 ***
Constant	-0.954	0.624
N	1,871	
Adjusted R^2	0.447	

Regression Results (OLS grouped data)

Dependent Variable	CV of Group-Specific Subj. Survival Prob. (1)		CV of Group-Specific Subj. Survival Prob. (2)		CV of Group-Specific Subj. Survival Prob. (3)	
	Coef.	Bootstr. std. err.	Coef.	Bootstr. std. err.	Coef.	Bootstr. std. er
Group Size	-0.001	0.001	-0.001	0.001	-0.001	0.001
Age	0.013	0.017	0.016	0.017	-0.013	0.021
Age^2	0.000	0.000	0.000	0.000	0.000	0.000
Gender	0.026	0.014 *	0.012	0.014	0.000	0.014
Couple	-0.033	0.018 *	-0.024	0.018	-0.027	0.017
Forecast Horizon	0.027	0.009 ***	0.025	0.009 ***	0.020	0.011 *
$Forecast\ Horizon^2$	0.000	0.000	0.000	0.000	0.000	0.000
CV Obj. Prob.	2.507	0.535 ***	2.345	0.536 ***	2.151	0.561 ***
Std Education			-0.024	0.017	-0.035	0.018 **
Std Self-Perc. Health			-0.008	0.025	-0.023	0.028
CV Grip Strength					-0.042	0.107
Std Smoke Now					-0.044	0.038
Std Numeracy			0.037	0.025	0.028	0.026
Std Recall			0.015	0.015	0.016	0.015
Std Optimism			0.033	0.010 ***	0.043	0.010 ***
Std Risk Aversion					0.001	0.023
CV Income			0.000	0.007	-0.005	0.007
CV Net Worth			0.001	0.005	0.002	0.004
Constant	-0.954	0.624	-1.112	0.648 *	0.081	0.767
N	1,871		1,859		1,602	
Adjusted R^2	0.447		0.450		0.487	

Robustness Checks

Dependent Variable	Baseline Specification CV of Group-Specific Subj. Survival Prob. (1)		Lee-Carter 1975 CV of Group-Specific Subj. Survival Prob. (2)		Alternative Mortality Model CV of Group-Specific Subj. Survival Prob. (3)		Focal Responses Imputed CV of Group-Specific Subj. Survival Prob. (4)		Focal Responses Excluded CV of Group-Specific Subj. Survival Prob. (5)	
	Coef.	Bootstr. std. err.	Coef.	Bootstr. std. err.	Coef.	Bootstr. std. err.	Coef.	Bootstr. std. err.	Coef.	Bootstr. std. err.
Group Size	-0.001	0.001	-0.001	0.001	-0.001	0.001 **	0.000	0.000	-0.001	0.001
Age	-0.013	0.021	-0.022	0.022	-0.019	0.021	0.020	0.016	0.052	0.019 ***
Age^2	0.000	0.000	0.000	0.000 *	0.000	0.000 *	0.000	0.000	0.000	0.000 *
Gender	0.000	0.014	-0.014	0.013	-0.021	0.012 *	-0.004	0.011	-0.006	0.014
Couple	-0.027	0.017	-0.025	0.017	-0.021	0.017	-0.034	0.013 ***	-0.010	0.016
Forecast Horizon	0.020	0.011 *	0.028	0.010 ***	0.026	0.010 ***	-0.017	0.009 *	-0.017	0.013
$Forecast\ Horizon^2$	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000 **	0.001	0.000 ***
CV Obj. Prob.	2.151	0.561 ***	2.161	0.481 ***	3.229	0.462 ***	1.582	0.384 ***	1.560	0.589 ***
Std Education	-0.035	0.018 **	-0.034	0.018 *	-0.032	0.018 *	-0.005	0.013	0.007	0.015
Std Self-Perc. Health	-0.023	0.028	-0.027	0.028	-0.021	0.027	-0.004	0.022	0.009	0.024
CV Grip Strength	-0.042	0.107	-0.040	0.106	-0.044	0.105	0.037	0.074	-0.062	0.086
Std Smoke Now	-0.044	0.038	-0.051	0.038	-0.067	0.037 *	0.018	0.028	-0.001	0.031
Std Numeracy	0.028	0.026	0.028	0.026	0.033	0.026	-0.016	0.022	0.032	0.023
Std Recall	0.016	0.015	0.014	0.015	0.011	0.015	0.006	0.012	-0.001	0.014
Std Optimism	0.043	0.010 ***	0.041	0.010 ***	0.042	0.010 ***	0.041	0.008 ***	0.047	0.008 ***
Std Risk Aversion	0.001	0.023	0.000	0.022	0.007	0.022	-0.010	0.017	-0.017	0.020
CV Income	-0.005	0.007	0.000	0.006	0.004	0.006	-0.002	0.005	-0.011	0.011
CV Net Worth	0.002	0.004	0.001	0.004	0.001	0.003	0.001	0.002	0.001	0.003
Constant	0.081	0.767	0.257	0.788	0.299	0.771	-0.511	0.593	-1.940	0.667 ***
N	1,602		1,602		1,602		1,602		1,316	
Adjusted R^2	0.487		0.492		0.503		0.392		0.373	

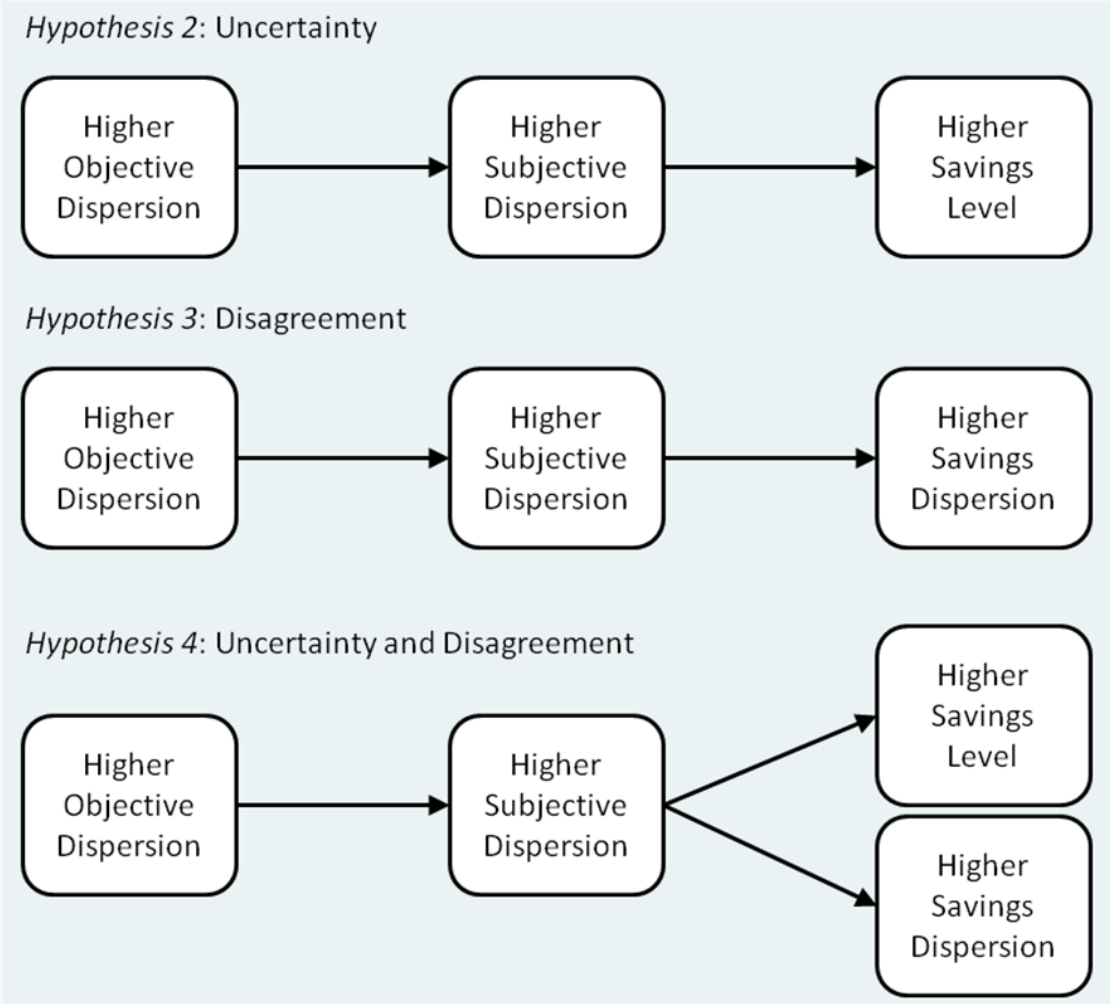
Longevity Risk Awareness Results Summary

- For various models
  - Dispersion in subjective survival estimates positively related to the uncertainty in objective survival data
- Support for research hypothesis
  - Evidence for awareness of longevity risk among SHARE respondents

2. Research Objective: Longevity Risk and Individual Saving Behavior

- Open questions
  - Do respondents also act on the awareness of longevity risk?
    - Is savings behavior (level) adapted?
  - Dispersion in survival forecasts: uncertainty or disagreement?

Three Mutually Exclusive Hypotheses



Econometric Approach

- Two simultaneous equation models for
  - Savings level:

$$
\begin{aligned}
SUB\_DISP_j &= \alpha_1 + \beta_1 OBJ\_DISP_j + \delta_1^{\mathsf{T}} \mathbf{z}_{1j} + \varepsilon_{1j} \\
EST\_ERR_j &= \alpha_2 + \beta_2 OBJ\_DISP_j + \delta_2^{\mathsf{T}} \mathbf{z}_{2j} + \varepsilon_{2j} \\
SAVE\_LEVEL_j &= \alpha_3 + \gamma_1 SUB\_DISP_j + \gamma_2 EST\_ERR_j + \delta_3^{\mathsf{T}} \mathbf{z}_{3j} + \varepsilon_{3j}
\end{aligned}
$$

  - Savings dispersion:

$$
\begin{aligned}
SUB\_DISP_j &= \alpha_1 + \beta_1 OBJ\_DISP_j + \delta_1^{\mathsf{T}} \mathbf{z}_{1j} + \varepsilon_{1j} \\
SAVE\_DISP_j &= \alpha_2 + \gamma SUB\_DISP_j + \delta_2^{\mathsf{T}} \mathbf{z}_{2j} + \varepsilon_{2j}
\end{aligned}
$$

- Savings = financial assets

Regression Results (3SLS grouped data)

Savings Level

Dependent Variable	ln(Financial Assets)	
	Coef.	Bootstr. std. err.
Age	-0.268	0.527
Age^2	0.003	0.004
Gender	-0.202	0.443
Couple	0.259	0.127 **
Forecast Horizon	0.123	0.108
$Forecast\ Horizon^2$	-0.003	0.004
Education	0.126	0.073 *
Self-Perc. Health	-0.453	0.106 ***
Grip	-0.008	0.022
Smoke Now	-0.438	0.250 *
Numeracy	0.057	0.119
Recall	0.096	0.072
Optimism	0.023	0.057
Risk Aversion	-0.496	0.146 ***
ln(Income)	0.487	0.073 ***
Children	-0.220	0.088 **
Trust	0.111	0.043 ***
Chance Living Better	-0.509	0.315
Reduction Pension Amount	0.214	0.156
Sub. Surv. Prob.	-0.513	1.943
CV Sub. Surv. Prob.	-2.631	3.049
ln(Rel. Abs. Est. Error)	-0.358	1.123
Constant	13.958	18.718
N	924	

Savings Dispersion

Dependent Variable	CV Financial Assets	
	Coef.	Bootstr. std. err.
Age	-0.069	0.334
Age^2	0.001	0.003
Gender	0.040	0.047
Couple	0.127	0.045 ***
Forecast Horizon	0.042	0.052
$Forecast\ Horizon^2$	-0.002	0.003
Std Education	0.085	0.058
Std Self-Perc. Health	-0.221	0.092 **
CV Grip Strength	0.628	0.333 *
Std Smoke Now	0.203	0.127
Std Numeracy	-0.046	0.079
Std Recall	-0.011	0.049
Std Optimism	0.008	0.042
Std Risk Aversion	-0.125	0.074 *
CV Income	0.089	0.030 ***
Std Children	0.065	0.046
Std Trust	0.081	0.029 ***
CV Chance Living Better	-0.071	0.054
CV Reduction Pension Amount	0.030	0.042
CV Sub. Surv. Prob.	1.073	0.429 **
Constant	2.576	11.010
N	924	

Saving Behavior Results Summary

- No link between dispersion in survival probability estimates and the level of savings

- Positive link between dispersion of subjective survival estimates and the dispersion of savings

  → No uncertainty effects but *disagreement*

Robustness Checks for Savings Models Show

- That the (no) effect of dispersion in subjective estimates on the savings level is not robust
  - For some specifications (focal responses excluded or imputed)

    we find a positive and significant relationship
- The positive and significant link between savings dispersion and dispersion in subjective estimates is robust
- → strong evidence for disagreement effects
  - But, maybe, in addition, also uncertainty effects

Conclusion

- Dispersion of the subjective estimates of survival probabilities is positively linked to the dispersion of objective survival rates
  - Indicates awareness of longevity risk

- Observed effect on savings supports this result
  - Respondents act on awareness of longevity risk
  - But, effects are due to disagreement → optimal response?

- Relevance
  - Awareness: we provide empirical evidence for theoretical studies on individuals' decision making under longevity risk
  - Possibly suboptimal saving reaction: pension systems that rely on individually managed retirement savings, too low savings with respect to longevity risk?