Stochastic Mortality and the Dispersion of Subjective Estimates of Survival Probabilities—Evidence from Europe

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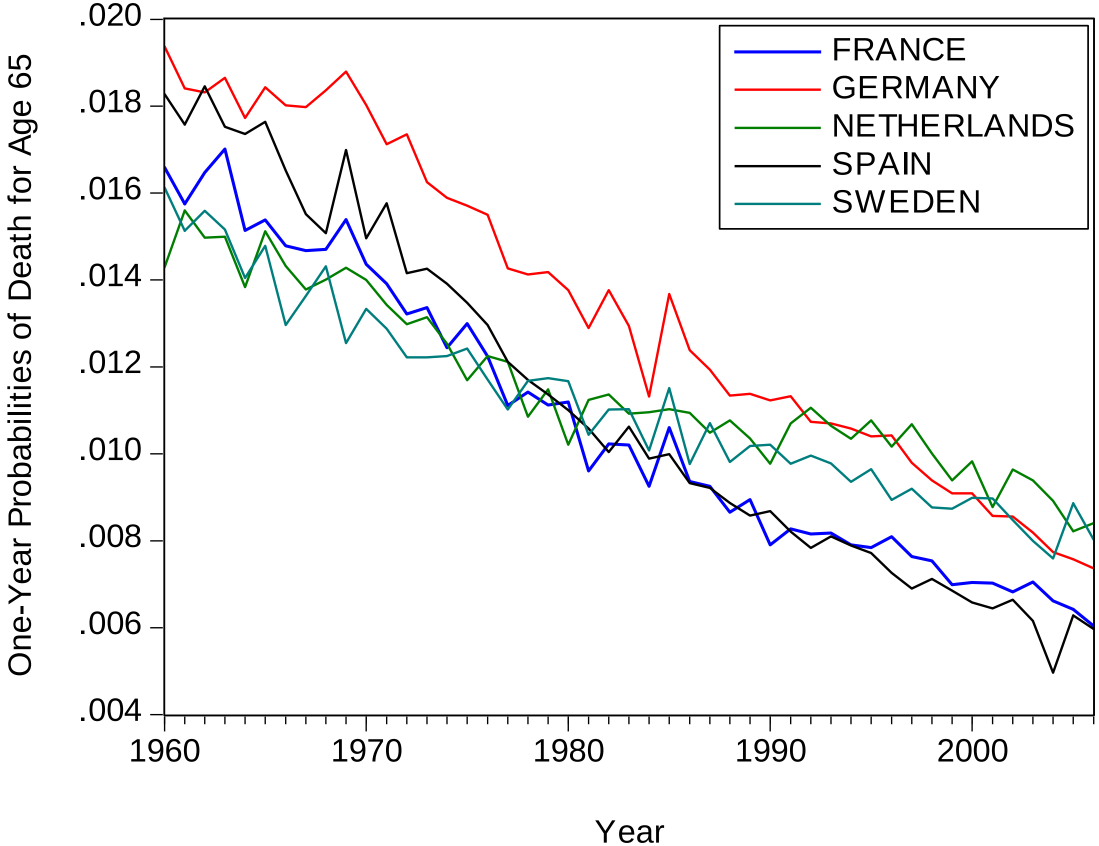
Introduction

- Mortality decline exhibits considerable variation: “stochastic mortality”



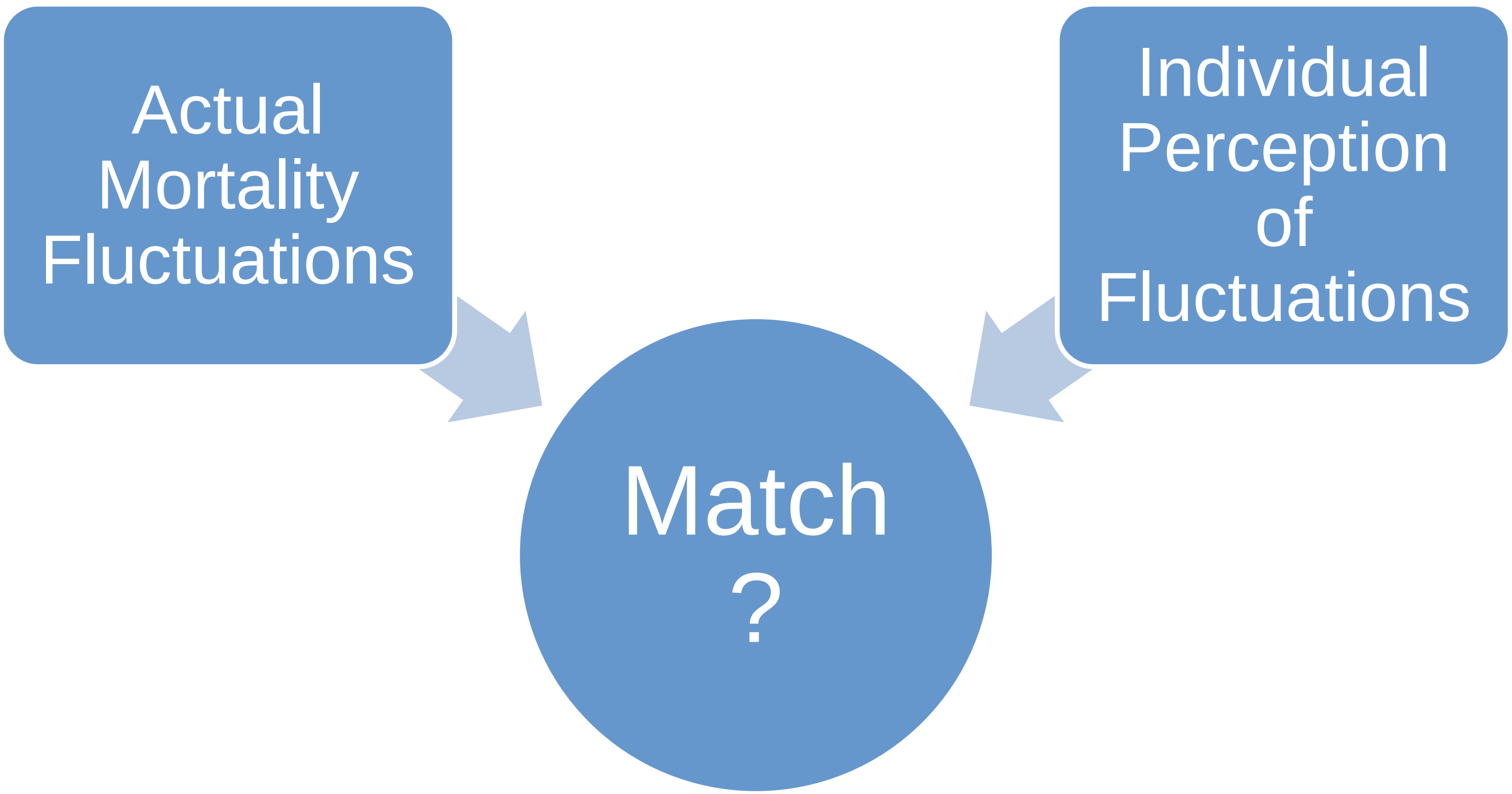
Introduction

- *Theory* indicates that stochastic mortality is a key determinant of
  - individual consumption and saving decisions
    (e.g., Cocco and Gomes, 2009; De Nardi, French and Jones, 2009)
  - asset allocation decisions regarding annuities and longevity bonds
    (e.g., Menoncin, 2008; Post, 2009; Stevens, 2009; Schulze and Post, 2010)
  - retirement timing descision
    (Cocco and Gomes, 2009)
  - equilibrium annuity prices
    (Van de Ven and Weale, 2008)

- Research question:

  Are individuals *aware* of stochastic mortality?

General Approach



Data

- Past fluctuations of mortality rates
  - Human Mortality Database (HMD)
  - Country-, gender- and age-specific time series for one-year probabilities of deaths $q_{x,t}$
  - “Objective mortality data”

- Actual mortality perception of individuals
  - Survey of Health, Ageing and Retirement in Europe (SHARE)
  - “Subjective mortality data”

Subjective Survival Expectations - SHARE

- Wave 1 (2004/2005)
  - Austria, Belgium, Denmark, France, Germany, Italy, Netherlands, Spain, Sweden, and Switzerland
  - selected sample: 23,169 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, e.g., 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 individuals' actual survival
  (Hurd et al. 1998; Hurd and McGarry, 2002; Siegel et al. 2003; Winter, 2008)
- predict development of aggregate mortality rates
  (Hamermesh, 1985; Perozek, 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)

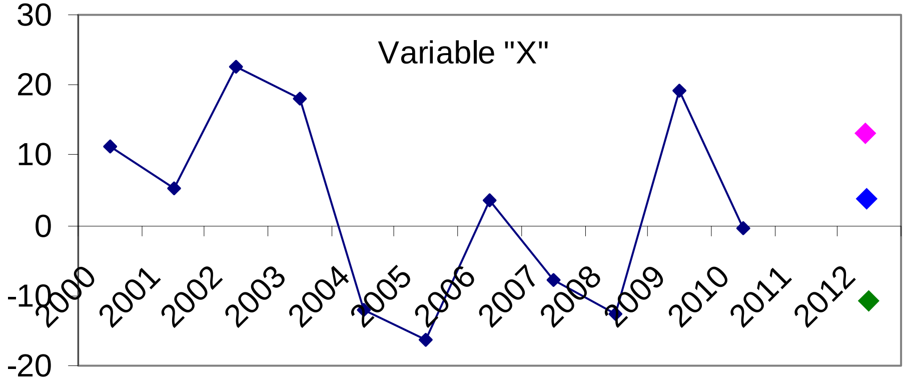
But

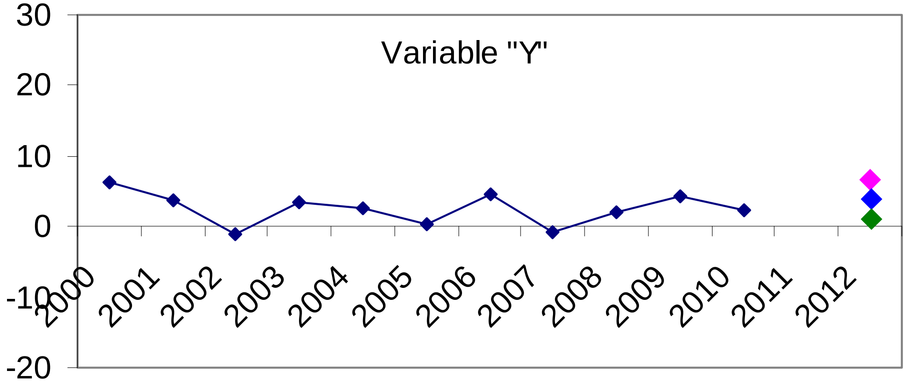
- The probabilities elicited in SHARE are *point forecasts*
- Can a sample of point forecasts help in making inference about the *variation* of the forecast variable?
  - Yes, for example, Du and Budescu (2007) find in an experimental study on investors' price forecasts that

    "low past volatility [of the time series] … improves forecast accuracy"
  - Numerous empirical studies use dispersion of point forecasts as proxy for variability of economic variables like
    - inflation, unemployment, firm earnings, stock returns, consumer goods demand

Illustrating the idea behind it

- Please make a guess for 2012:





→ Dispersion in point forecasts reflects the perceived uncertainty regarding the forecast variable

Research Hypothesis

- If individuals are aware of stochastic mortality, then the dispersion of subjective forecasts should be higher whenever the variability of the underlying objective mortality rates is higher

- Test this hypothesis:
  - Check 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
  - Consider groups which are homogenous with respect to key demographic factors
  - Construct time series of multi-period mortality rates, $q_{x,t,T-x}$
  - Model: $q_{x,t,T-x} = q_{x,t-1,T-x} \cdot r_{x,t,T-x}$, where $r_{x,t,T-x} \sim \ln N(\mu_{x,T-x}, \sigma_{x,T-x})$
  - Forward-looking nature of SHARE responses: Calculate forecast $E(q_{x,t,T-x})$, $E(p_{x,t,T-x})$, and $Std(p_{x,t,T-x})$ conditional on the survey year
  - Account for base-level differences between groups: Coefficient of variation $CV = Std(p_{x,t,T-x}) / E(p_{x,t,T-x})$

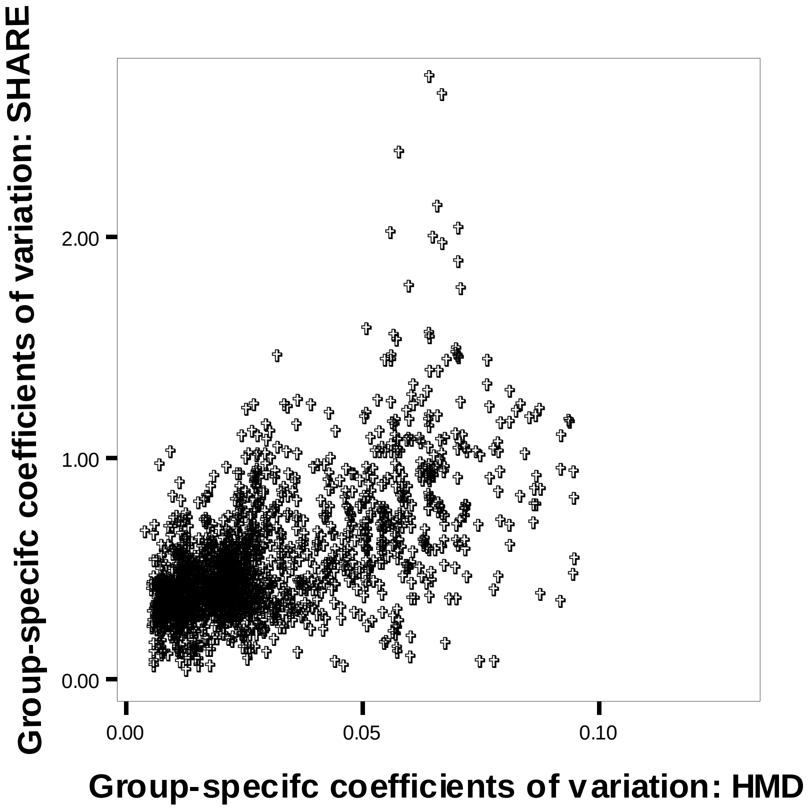
Calculation of Dispersion Measures - SHARE

- Same structure as (objective) HMD data
  - Calculate group-specific (age-gender-country) coefficients of variation (CV) for subjective survival probability estimates

- Control for additional mortality related factors
  - Our interest: response dispersion caused by uncertainty as to the mortality rate
  - Ideally: mortality-homogenous groups (age, gender, country, couple, wealth, income, education level, and health status, …)
  - Actual: further grouping by wealth and income tercentiles

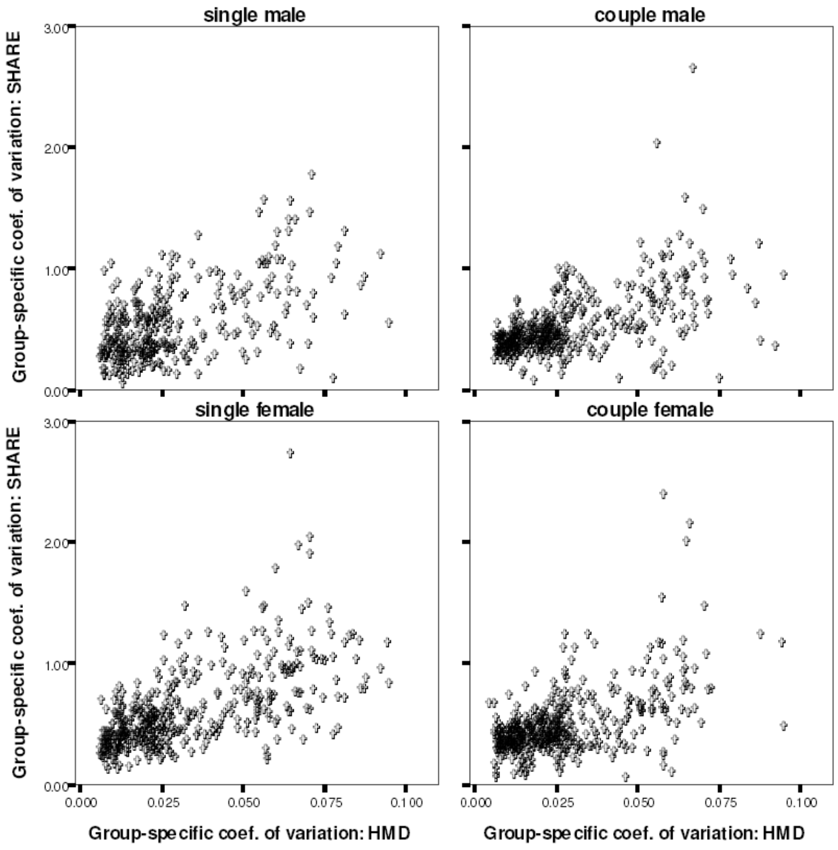
Empirical Results

- Group-specific coefficients of variation of HMD and SHARE
- Data grouped according to country, age, gender, and couple



Empirical Results

- Separate analysis by couple and gender: same tendency



Regression Analysis

- Want to measure the impact of the actual uncertainty regarding future survival rates on the dispersion in subjective estimates
  - Dependent variable: CV in subjective survival estimates (SHARE)
- Want to control for age and other factors potentially affecting the dispersion in subjective survival estimates
  - Use again the grouped data → clustered OLS regressions
  - Consider different grouping variants

Regression Results

- Results for all three models:
  - Dispersion in objective survival probabilities is positively and strongly significantly related to the dispersion in subjective survival estimates of SHARE respondents
  - Age increases forecast dispersion
  - Length of the forecast horizon increases forecast dispersion
  - Gender is not significant
  - High explanatory power

- Grouping according to wealth or income:
  - Very similar results

Regression Results

- Dependent variable: CV of subjective survival estimates

SHARE Wave 1 2004/2005 & HMD Grouped Data									
Data grouped by:	Country, Age, Gender, Couple			Country, Age, Gender, Couple, Wealth			Country, Age, Gender, Couple, Income		
	Coef.	Std. err.		Coef.	Std. err.		Coef.	Std. err.	
Age	0.0195	0.0014	***	0.0169	0.0011	***	0.0175	0.0011	***
Gender	0.0068	0.0113		-0.0104	0.0082		-0.0006	0.0083	
Couple	-0.0231	0.0114	**	-0.0117	0.0084		-0.0048	0.0085	
Time horizon	0.0194	0.0023	***	0.0166	0.0018	***	0.0180	0.0018	***
Coeff. var. obj. prob.	2.0918	0.5087	***	1.9212	0.3944	***	1.7225	0.3937	***
Wealth < 1/3				0.0491	0.0098				
Wealth > 2/3				-0.0081	0.0098				
Income < 1/3							0.0333	0.0099	***
Income > 2/3							0.0023	0.0098	
Constant	-1.1491	0.1135	***	-0.9724	0.0902	***	-1.0386	0.0894	***
Adjusted R^2	0.4500			0.3083			0.3048		

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

Analysis of the Estimation Error

- Estimation error = difference between the subjective and the objective estimate of survival probability for every respondent
- Previous literature: impact of individual characteristics on the level of the estimation error (e.g., age)
- We consider two alternative measures for the estimation error, both account for base-level effects
- Our regression results show:
  - Both higher age and a larger dispersion in objective survival rates leads to larger estimation errors
  - The level of the estimation error increases when the dispersion of objective mortality rates increases

Summary and Conclusions

- Theoretical studies indicate that stochastic mortality is an important determinant of economic decisions
- We match subjective survival expectations elicited in the SHARE survey and objective mortality data from the Human Mortality Database, and find:
  - Dispersion of respondent’s subjective estimates co-varies systematically with the dispersion in actual population mortality rate
  - This indicates awareness of stochastic mortality among respondents from ten major European economies

Summary and Conclusions

- Our results: high relevance for the design of pension systems that emphasize individually managed retirement savings and asset allocations
  - Essential that individuals make informed decisions based on sound expectations
  - We can conclude that individuals are aware of stochastic mortality, precondition for informed decisions-making is met

- Open questions:
  - Actual impact on individuals' decisions?
  - Direction of the impact?

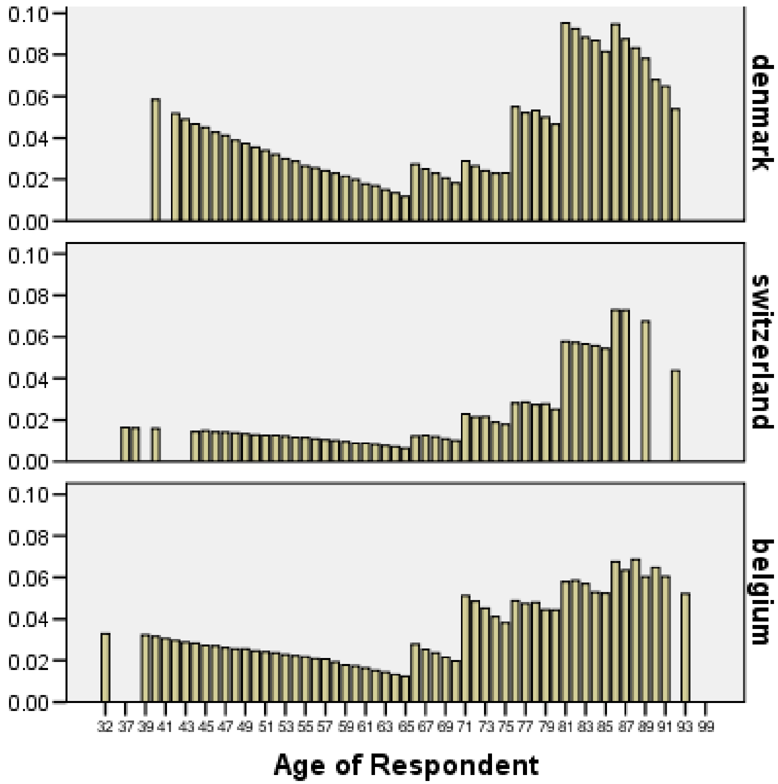
Summary and Conclusions

- Furthermore:
  - Estimation error of subjective survival expectations is positively related to stochastic mortality, as well
  - Greater mortality uncertainty increases the estimation error

→ Important contribution to the existing literature on subjective survival estimates

Need to control for age-related effects

CV HMD



CV SHARE