

Longevity 19

Mortality Risks, Survival Pessimism, and Subjective Well-Being: Evidence from the Health and Retirement Study

Lisa Posey, *Penn State University*

Sharon Tennyson, *Cornell University*

Nan Zhu, *Penn State University*

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- 2 Research Data
- 3 First Stage: Survival Regression w/ SWB
- 4 Second Stage: Biases in Self-Estimated Surv. Prob
- 5 Conclusion

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#1: SWB and Mortality Risks—Literature

Relationship between positive affect or “happiness”—subjective well-being (SWB)—on health and longevity:

- SWB: feeling positive emotional states, being satisfied with life, and having a sense of purpose in life (Martín-María et al., 2017)
- Findings overall mixed: Veenhoven, 2008; Martín-María et al., 2017
- More recent studies find significant positive associations between SWB and longevity:
 - ▶ Lawrence et al. (2015), Gana et al. (2016), Jacobs et al. (2021)
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#2: Objective vs. Subjective Mortality Risks—Literature

- Objective (actual) mortality matters for life insurance premium setting
- Subjective beliefs—Individuals' own **perception** of future mortality—(arguably) more relevant in their decision-making
 - ▶ Yaari (1965); Post and Hanewald (2013); O'Dea and Sturrock (2023)
- Comparison between objective and subjective (self-estimated; self-rated) mortality risks:
 - ▶ Elder (2013): survival predictions based on subjective forecasts are far less accurate than standard population life tables
 - ★ Contradictory to earlier works in Hurd and McGarry (2002) and Perozek (2008)
 - ▶ Griffin et al. (2013): determinants of subjective life expectancies
 - ▶ Identifying factors that result in differentiating subjective life expectancies:
 - ★ Ludwig and Zimper (2013), Post and Hanewald (2013), Bissonnette et al. (2017), Solinge and Henkens (2018), Comerford (2021)

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In This Paper...

- Study how individuals' SWB affects both objective and subjective mortality risks
 - ▶ Data on respondents' expressions of SWB from the Health and Retirement Study (HRS)
- **Two-stage** approach based on individual-level (HRS) data to focus on the bias in subjective life estimation:
 - ▶ First stage: (Series of) Cox proportional hazards models (Cox, 1975)
 - ★ Goal: quantify how demographic, socioeconomic, health and behavioral factors affect the actual mortality
 - ▶ Second stage: Regressions on the bias in survival estimation (difference between the self-assessed and actual survival probabilities)
 - ★ Goal: quantify how the same factors affect the forming of the subjective bias
 - ▶ The same underlying channels impact the actual mortality and the subjective belief *potentially differentially*

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Individual Mortality Estimation & Longitudinal Aging Studies

Rich set of literature on modeling/forecasting *population* mortality risk (Lee and Carter, 1992, etc.)

- Aggregated mortality data exclude more nuanced heterogeneities that might also predict mortality
- Socioeconomic/behavioral factors typically difficult to collect on a large scale
- Until....

Longitudinal aging studies in the past few decades across the globe:

- U.S.: Health and Retirement Study (HRS)
- U.K.: English Longitudinal Study of Ageing (ELSA); Australia: 45 And Up, ...

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Mortality in HRS

- Created in 1992, surveys seniors (50 and older) in the U.S. on a biannual basis
 - ▶ Comprehensive set of questions broadly related with the “challenges and opportunities of aging”
- Tracks respondents' time of death (exit interviews; external validation)
 - ⇒ Quantitative analyses of how socioeconomic/behavioral/health factors potentially affect mortality:
 - ★ Gerdtham and Johannesson (2004), Balia and Jones (2008), Palme and Sandgren (2008), Hudomiet et al. (2021), etc.
- Survey questions about respondents' self-estimated survival probabilities to certain given target ages:
 - ▶ *RwLIV10: “What is the percent chance that you will live to be (80, 85, 90, 95, or 100) or more?”*

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SWB in HRS

- Self-reported SWB score:
 - ▶ Combined measure of life satisfaction and positive affect (Okbay et al., 2016) using the HRS Psychosocial and Lifestyle Questionnaire:
 - ★ Life satisfaction: 5-item questionnaire developed by Diener (Diener et al., 1985; Pavot and Diener, 1993); 7-point scale
 - ★ Positive affect based on thirteen items from the Positive and Negative Affect Schedule - Expanded Form (PANAS-X: Watson and Clark, 1994); 5-point scale
 - ▶ Use the SWB score from the first survey (reduce reverse causality of SWB on mortality/health)
 - ▶ Standardized for following analyses

Additional Covariates/Treatment

- Two additional control covariates:
 1. Self-rated health:
 - ★ categorical variable (1 to 5)
 - ★ Control for health information that is correlated with both SWB and actual mortality
 2. Survival residual value:
 - ★ Regressing individuals' self-assessed survival probabilities on all other covariates
 - ★ Proxy variable for unobserved factors affecting subjective mortality that also affect objective mortality
- Other demographic/socioeconomic/(objective) health covariates
- Only consider respondents with SWB information, *and* between ages 50-90 (18,541 qualifying respondents in total)

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Summary Statistics

Variable	Type	%, Mean (SD)
Age at entry	Continuous	65.51 (9.92)
Gender (0 if male, 1 if female)	Binary	57.81%
Year of birth	Categorical	1945.33 (11.40)
Smoking status (0 if no, 1 if yes)	Binary	15.26%
Years of education	Categorical (0 – 17)	12.95 (2.99)
High blood pressure	Categorical (0 – 4)	0.63 (0.61)
Diabetes	Categorical (0 – 4)	0.25 (0.51)
Cancer	Categorical (0 – 4)	0.15 (0.40)
Lung disease	Categorical (0 – 4)	0.12 (0.40)
Heart problem	Categorical (0 – 4)	0.25 (0.52)
Stroke	Categorical (0 – 4)	0.07 (0.30)
Psychiatric problem	Categorical (0 – 4)	0.21 (0.51)
Arthritis/rheumatism	Categorical (0 – 4)	0.61 (0.61)
Self-rated health	Categorical (1 – 5)	2.82 (1.08)
Self-reported SWB score (normalized)	Continuous	0.00 (1.00)
Survival residual value	Continuous	0.00 (0.29)

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Standard Cox PH model

Cox proportional hazards model:

$$\mu_t^{(i)} = \beta_0(t) \times \exp \{ \beta' \cdot Z_i \}$$

- $\mu_t^{(i)}$: hazard rate/force of mortality for individual i
- $\beta_0(t)$: non-parametric term
- β : vector of regression coefficients; Z_i : covariates for individual i
- The estimation of β is standard and is based on the partial log-likelihood:

$$l(\beta) = \sum_{i=1}^n \Delta_i \left\{ \beta' \cdot Z_i - \ln \left(\sum_{j=1}^n Y_j(T_i) \exp \{ \beta' \cdot Z_j \} \right) \right\}$$

- ▶ Observation time $X_i = \min\{T_i, C_i\}$, $i \in \{1, \dots, n\}$, where T_i is the failure time and C_i is the censoring time
- ▶ Indicator for observed death of subject i : $\Delta_i = \mathbf{1}_{\{T_i < C_i\}}$
- ▶ At-risk counting processes: $Y_i(t) = \mathbf{1}_{\{X_i \geq t\}}$
- ▶ Observed-death counting processes: $N_i(t) = \mathbf{1}_{\{T_i \leq t, \Delta_i = 1\}}$

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Our Specific Setup

$$\mu_t^{(i)} = \beta_0(t) \times \exp\left\{\beta_1 \text{AE}_i + \beta_2 \text{GD}_i + \beta_3 \text{YoE}_i + \beta_4 \text{SM}_i + \beta_5 \text{HiBP}_i + \beta_6 \text{DIAB}_i\right. \\ \left. + \beta_7 \text{CANCER}_i + \beta_8 \text{LUNG}_i + \beta_9 \text{HEART}_i + \beta_{10} \text{STROK}_i\right. \\ \left. + \beta_{11} \text{PSYCH}_i + \beta_{12} \text{ARTHR}_i + \beta_{13} \text{YoB}_i\right. \\ \left. + \beta_{14} \text{SWB}_i\right\}, i = 1, \dots, n. \quad (1)$$

$$+ \beta_{14} \text{SH}_i + \beta_{15} \text{SURV_resid}_i + \beta_{16} \text{SWB}_i\left\}, i = 1, \dots, n. \quad (2)$$

► covariates

Cox PH Model Results

	[A]	[B]
Age at entry, AE _i	0.1436*** (0.0121)	0.1447*** (0.0119)
Gender, GD _i	-0.3496*** (0.0351)	-0.3603*** (0.0352)
Years of education, YoE _i	-0.0287*** (0.0057)	-0.0079 (0.0057)
Smoking status, SM _i	0.8234*** (0.0477)	0.7698*** (0.0478)
High blood pressure, HiBP _i	0.0892** (0.0274)	0.0420 (0.0287)
Diabetes, DIAB _i	0.2201*** (0.0263)	0.1715*** (0.0281)
Cancer, CANCR _i	0.2150*** (0.0292)	0.1804*** (0.0301)
Lung disease, LUNG _i	0.2965*** (0.0277)	0.2498*** (0.0292)
Heart problem, HEART _i	0.2090*** (0.0236)	0.1386*** (0.0252)
Stroke, STROK _i	0.3069*** (0.0351)	0.2522*** (0.0359)
Psychiatric problem, PSYCH _i	0.0070 (0.0299)	-0.0255 (0.0311)
Arthritis/rheumatism, ARTHR _i	-0.0120 (0.0294)	-0.0639* (0.0310)
Normalized birth year, YoB _i	2.4789*** (0.5800)	2.4747*** (0.5762)
Self-rated health, SH _i	.	-0.3554*** (0.0193)
Survival residual value, SURV_resid _i	.	-0.2008*** (0.0595)
Subjective well-being, SWB _i	-0.2252*** (0.0183)	-0.1020*** (0.0196)

Discussions

- Column [A]: baseline results
 - ▶ Most demographic/socioeconomic factors are statistically significant with consistent coefficient
 - ▶ SWB: statistically significant with negative coefficients
 - ★ Higher SWB is associated with lower mortality (greater longevity)
- Column [B]: w/ two covariates on privately observed health/mortality info
 - ▶ Better model fit (partial likelihood ratio test: 3534 to 3888)
 - ▶ Coefficients of self-rated health and survival residual value both negative and significant
 - ★ Individuals possess and utilize (hidden) information on survival
 - ▶ SWB: still significant, but effect reduced by half
 - ★ Connection between SWB and the two extra covariates

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Implications for Life Expectancy (LE)

- Quantifying average difference of LE estimates (70-year old male):

	Percentile of SWB Score					
	Baseline (1)			Extension (2)		
	5%	50%	95%	5%	50%	95%
LE estimates in years	11.31	14.15	15.93	12.73	14.03	14.84
Difference in LE (%)	-20.04%	-	12.62%	-9.23%	-	5.82%

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Subjective Estimation Biases

- Denote:

$$P^S = P^O + P^{bias}$$

- ▶ P^O : objective target survival probability
 - ▶ P^S : subjective target survival probability
 - ▶ P^{bias} : estimation bias
- P_i^S : Raw answers to the HRS question "*RwLIV10*"
 - P_i^O : Calculated based on our first-stage results:

$$P_i^O(t) = \exp(-H_0(t))^{\exp\{\beta' \cdot Z_i\}}$$

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Regression on the Estimation Bias

$$\begin{aligned}
 P_i^{bias}(t) = & \gamma_0 + \gamma_1 \log(AE_i) + \gamma_2 GD_i + \gamma_3 YoE_i + \gamma_4 SM_i + \gamma_5 HiBP_i + \gamma_6 DIAB_i \\
 & + \gamma_7 CANCR_i + \gamma_8 LUNG_i + \gamma_9 HEART_i + \gamma_{10} STROK_i + \gamma_{11} PSYCH_i \\
 & + \gamma_{12} ARTHR_i + \gamma_{13} YoB_i + \gamma_{14} Duration \\
 & + \gamma_{15} SWB_i, i = 1, \dots, n. \tag{3} \\
 & + \gamma_{15} SH_i + \gamma_{16} SWB_i, i = 1, \dots, n. \tag{4}
 \end{aligned}$$

- Respondents younger than 65 (needing a minimum of 20-year forecasting window) removed from the second stage due to observation period limit (# observation: 8,830)

▶ plots

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Regression Results

	[A]	[B]
log Age at entry, $\log(AE_j)$	1.4260*** (0.1223)	1.4571*** (0.1196)
Gender, GD_j	0.0284*** (0.0065)	0.0281*** (0.0063)
Years of education, YoE_j	0.0083*** (0.0011)	0.0042*** (0.0010)
Smoking status, SM_j	-0.0385** (0.0109)	-0.0304** (0.0106)
High blood pressure, $HiBP_j$	-0.0175** (0.0055)	-0.0052 (0.0053)
Diabetes, $DIAB_j$	-0.0267*** (0.0060)	-0.0124* (0.0058)
Cancer, $CANCR_j$	-0.0350*** (0.0068)	-0.0244*** (0.0067)
Lung disease, $LUNG_j$	-0.0442*** (0.0071)	-0.0266*** (0.0070)
Heart problem, $HEART_j$	-0.0410*** (0.0056)	-0.0234*** (0.0055)
Stroke, $STROK_j$	-0.0140 (0.0091)	-0.0023 (0.0088)
Psychiatric problem, $PSYCH_j$	-0.0002 (0.0059)	0.0055 (0.0057)
Arthritis/rheumatism, $ARTHJ_j$	0.0036 (0.0054)	0.0050 (0.0052)
Normalized birth year, YoB_j	-0.2297** (0.0758)	-0.2164** (0.0741)
Time to target age, $Duration_j$	0.0387*** (0.0022)	0.0396*** (0.0021)
Self-rated health, SH_j	.	0.0699*** (0.0034)
Subjective well-being, SWB_j	0.0605*** (0.0035)	0.0362*** (0.0036)

Table: Column [A]: baseline (3); Column [B]: with self-rated health (4)

Discussions

- Positive coefficients (more optimistic subjective estimation): Age, gender, education, duration
- Negative coefficients (more pessimistic assessment): birth year, smokers, health impaired
- Both coefficients of PGL_SWB_i and SWB_resid_i are significant and positive
 - ▶ SWB: impacts biases in respondents' subjective survival probability estimations
 - ▶ Higher SWB leads to a more optimistic (less-pessimist) estimation in the subjective survival probabilities
- Consistent results after controlling for hidden health information

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Implications of SWB for Bias in Survival Estimates

Quantifying average difference of bias in survival estimates (P^{bias}) for representative ages:

	Percentile of SWB Score					
	Baseline (3)			Extension (4)		
	5%	50%	95%	5%	50%	95%
P_{65}^{bias}	-39.41%	-28.16%	-20.86%	-35.80%	-29.06%	-24.68%
P_{75}^{bias}	-18.99%	-7.75%	-0.45%	-14.94%	-8.20%	-3.83%
P_{85}^{bias}	-1.15%	10.09%	17.39%	3.29%	10.04%	14.41%

- Dominating age effect on the estimation bias (see e.g. Elder (2013))
- Potential pronounced impact of SWB on survival estimations

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- 1 Introduction
- 2 Research Data
- 3 First Stage: Survival Regression w/ SWB
- 4 Second Stage: Biases in Self-Estimated Surv. Prob
- 5 Conclusion**

In this paper, we study the effect of SWB on:

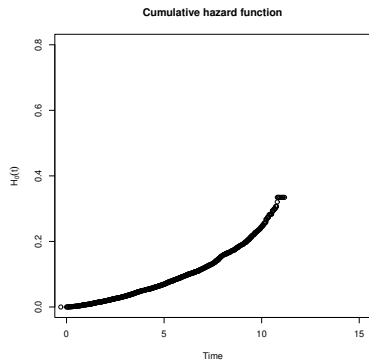
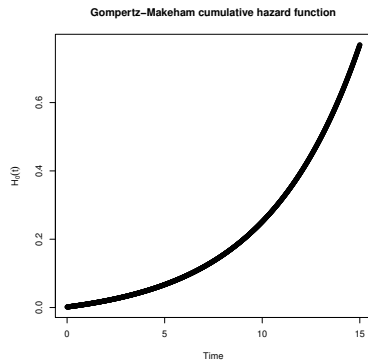
- Objective mortality:
 - ▶ Statistically significant and quantitatively meaningful
 - ▶ Even after controlling for relevant health covariates
 - ▶ Considerable value in longevity enhancement from attention to environmental and experiential factors that contribute to SWB
- subjective survival estimates:
 - ▶ Higher values SWB increase subjective estimates of longevity
 - ▶ Future work on how individuals' decision making varies with SWB in an optimization problem where payoffs depend on expectations regarding longevity
 - ▶ Such an implication varies a lot for different age groups

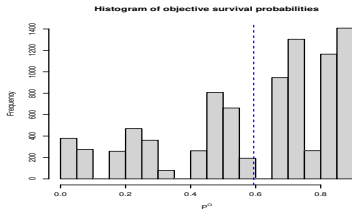


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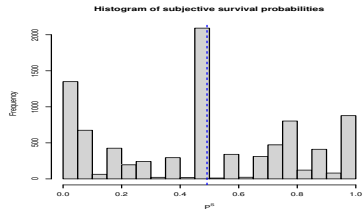
Nan Zhu
nanzhu@psu.edu

Thank you!

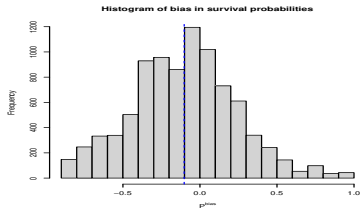
(a) Empirical curve of $H_0(t)$ (b) $\hat{H}_0(t)$ w/ Gompertz-Makeham form[◀ return](#)



(c)



(d)



(e)