Forecasting Survival by Socioeconomic Status and Implications for Social Security Benefits

Péter Hudomiet (RAND), **Michael D. Hurd** (RAND), **Susann Rohwedder** (RAND)

21st Annual SSA Research Consortium Meeting

August 1 & 2, 2019

National Press Club

529 14th Street NW

Washington, D.C.

This research was supported by a grant from the U.S. Social Security Administration (SSA) as part of the Retirement and Disability Research Consortium (RDRC). The findings and conclusions are solely those of the authors and do not represent the views of SSA, any agency of the federal government, or the Michigan Retirement and Disability Research Center.

Introduction

Income and wealth inequality have increased in recent decades, and there is evidence that inequalities in mortality for middle aged and older individuals have also increased (Auerbach et al., 2017; Bosworth et al., 2016; Case and Deaton 2015; Chetty et al 2016; Goda et al., 2011; Sanzenbacher et al., 2017). Mortality is (negatively) correlated both with income and wealth so that increases in mortality inequality will result in increases in aggregate Social Security payouts: individuals with greater annual benefits tend to live longer. An important question is whether this trend in mortality inequality will continue; that is, will high SES persons continue to have greater gains in life expectancy than lower SES persons.

We use a novel method to forecast life expectancy as a function of socioeconomic status and to investigate its implications for expected Social Security payments. Specifically, we forecast trends in survival by making use of trends in the subjective probabilities of survival of currently middle-aged individuals observed in the Health and Retirement Study (HRS), as well as trends in their health status, health behavior and other variables. Because subjective probabilities of survival are forward-looking measures, the method goes beyond extrapolating survival from its past trends, and so it may be a significant improvement over previously used methods in the literature: it has the capability of predicting changes in trends because it uses information known to the individual but not observed in objective indicators.

In the first part of the paper we document trends in subjective survival probabilities and other health variables from the 1934 to the 1957 birth cohorts. Then we use a survival model to forecast mortality of those cohorts as a function of socio-economic indicators.

Methods

We use data from the Health and Retirement Study from 1992 to 2016. Our main object of interest is observed mortality as tracked at the individual level from age 57 to the end of the observation period.

Our basic strategy is to fit a Gompertz mortality model to individual data from the cohorts born in 1934 to 1957. The explanatory variables are observed at age 57 so that we can predict future mortality such as the mortality of the 1957 cohort as it ages past age 59 (observed in 2016). Because of parametric assumptions we are able to compare predicted out-of-sample mortality of earlier cohorts with predicted out-of-sample mortality of later cohorts which will quantify any widening of the SES mortality differential.

The explanatory variables in the mortality models include health, mortality risk factors, subjective expectations, demographics, and SES. Subjective survival expectations have been included in the HRS since 1992, and the literature has demonstrated their validity (e.g. Hurd and McGarry, 2002). To measure health status, we use subjective health, activities of daily living and various "ever had" conditions which is measured by the response to the question "has a doctor ever told you that you had…" As health risk factors we include smoking, the frequency and the quantity of alcohol consumption, and BMI.

From the point of view of the Social Security system the most direct measure of SES is the relationship between Social Security benefits and mortality. We use as a summary measure, the quintile of Social Security wealth. In the case of couples we use the maximum of the Social Security wealth of the spouses.

The Gompertz mortality model is widely used in studies of human mortality. It specifies that mortality hazard is given by $h_i(t \mid a) = \lambda_{0i} \exp(\lambda_1 t)$ for individual *i* at time *t* conditional on reaching age *a*. Individual variation in the hazard is modelled via a dependence of the shape parameter (λ_{0i}) of the survival function on

- Health measures (self-reported health, subjective probability of surviving past age 75 (P75), ever had conditions, ADLs, obesity, smoking, drinking)
- SES (gender, marital status, race, education, SS wealth, occupations)
- Linear time trend in birth years
- Interactions with birth years (gender, education, SS wealth)
- Interactions with gender (marital status, diabetes)

Some data are missing at baseline (wave in which the individual is age 57) because of item nonresponse or unit nonresponse in that wave. We impute values based on other waves (ages 54-60) and on regression-based models.

Results

We first summarize our findings on trends in the mortality risk factors as a function of SES measures. Diabetes and Class II obesity (BMI > 35) as measured at age 57 increased over time (across cohorts) for both men and women. For example, about 17% of women in the birth cohorts 1954-1957 were Class II obese at age 57 whereas just 8% were in the earlier birth cohorts of 1934-1937. Smoking at age 57 decreased across cohorts. Self-rated fair or poor health, ADL limitations and P75 worsened until the cohorts of 1950-1957 and have improved in the most recent cohorts of 1954-1957. We found no differential trend in obesity as a function of education levels. However, we found a relative increase in obesity among black, non-Hispanic women. By several measures, health disparities worsened: the less educated in the later cohorts had relatively higher rates of ADL limitations, and lower levels of P75.

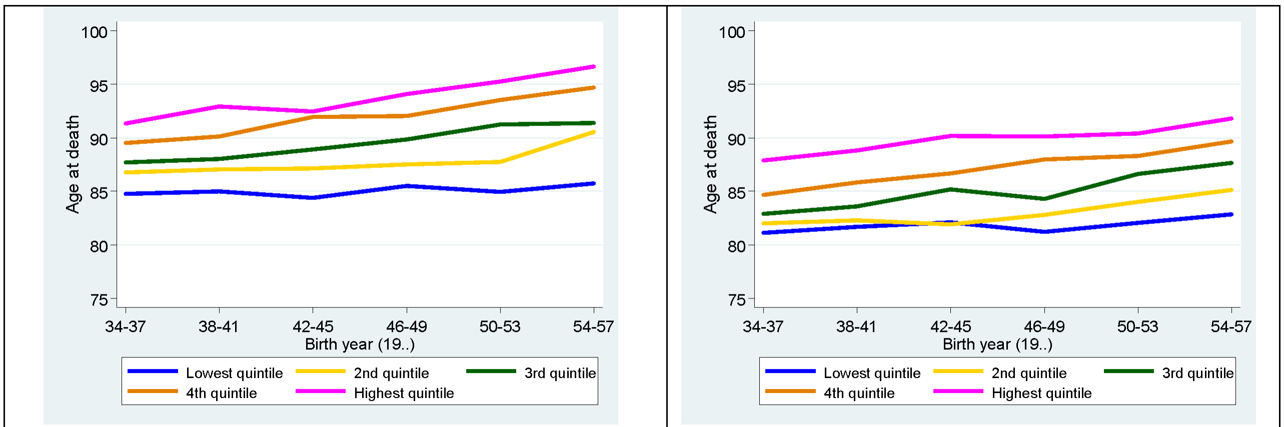
Second, we fit Gompertz models to actual morality as observed over many waves of the HRS. The baseline (age 57) values of the health and other explanatory variables were very strong predictors of observed mortality. The strongest predictor variables, based on the z-values of the coefficients in the Gompertz model were

- Being an active smoker (z=14)
- Ever having cancer (z=12)
- Poor self-reported health (z=11)
- Ever having diabetes (z=8)
- Male (z=7)
- Ever having a stroke (z=6)
- Being a former smoker (z=6)
- Ever having heart problems (z=6)
- Subjective survival probabilities (z=5)

We had observed across cohorts widening differentials as a function of SES in some of these health measures, so we expected that we would observe widening differentials in mortality inequality. To quantify the differentials, we predicted by cohort the median age at death stratified by SES indicators. For example, Figure 1 shows the median age at death conditional on survival to age 67 by gender stratified by Social

Security PIA quintiles. In the birth cohorts 1934-1937, the median age at death among females was predicted to be 84.7 among those in the lowest quintile; in the younger 1954-1957 cohort it was predicted to be 85.7 for a gain of one year or 1.2% over 20 years. Among females in the highest quintile the median ages for the two cohorts were 91.3 and 96.6 for a gain of 5.3 years or 5.8%. Among men the trends were similar but differentials did not increase by as much. We found qualitatively similar differential gains as a function of other SES measures, such as education.

Figure 1. Trends in the median age at death conditional on survival to age 67



Females	Males

Conclusions

Although there were improvements in some risk factors for mortality, in several others the trend was toward worsening risk. Further, in some of the risk factors, such as in subjective health, survival expectations and smoking, we observed widening inequalities. When quantified by estimated Gompertz models of actual mortality, we predicted an overall improvement in survival rates over time, but we found a quantitatively important increase in mortality inequality, which was particularly strong among women.

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