The Future of Mortality: Demographic Implications to the Social Security Trust Fund*

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Abstract

We assess how demographic factors, specifically mortality, directly affect the fiscal viability of the Social Security public pension program. Future mortality, in turn, is affected by historical and current lifestyle, behavior, and biomedical advances. Yet, official forecasts are based on historical mortality trends and unspecified subjective judgment. In contrast, we use a general Bayesian hierarchical modeling approach to develop mortality forecasts that considers rising obesity and decreasing smoking prevalence over the last 50 years in the US. We calculate future gains in life expectancy and project the the solvency of the Social Security Trust Fund. As a methodological advance in demographic forecasting, we also apply the Bayesian Modeling Averaging technique to the account for model based uncertainty in mortality forecasts.

Key Words: Forecasting, Mortality, Social Security.

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1 Introduction

Long-term demographic and economic forecasts are especially important to societies with old-age transfer systems. Previously, demographers focused on the dominant role of fertility levels and resulting changes in the population aging process (Lee and Tuljapurkar, 1997). Today, mortality has replaced fertility as the central demographic factor in populations with low fertility and high life expectancy such as the United States. Long-term mortality forecasts affect public policy decisions in the age of eligibility, taxation rates, and benefit levels of the Old-Age Survivors Insurance and Disability Insurance (referred to here as Social Security), which provides the majority of income to older Americans (Schneider, 1999). While future mortality is affected by historical and current lifestyle, behavior, and biomedical advances, official Social Security forecasts are based solely on historical mortality and unspecified subjective judgment.

Forecasting mortality is based on three important factors: reference period, methodology, and incorporation of expert judgment. Mortality forecasting has been the subject of intense study since at least Graunt's Bills of Mortality in the year 1662, which was based on mathematical formulation. Stochastic forecasts incorporate unavoidable uncertainty in projections of the future (Tuljapurkar and Boe, 1999). Lee and Carter (1992) developed an extrapolative stochastic time series forecasting method of age-specific mortality rates based on long-term historical patterns and trends. A need still remains for a stochastic time series forecasting method that incorporates additional information and knowledge about medical and behavioral influences on mortality (Lee and Carter, 1992).

Using a general Bayesian hierarchical modeling approach to information pooling developed by Girosi and King (2007), I forecast age, sex, and cause specific mortality. The stochastic methodology allows pooling separate cross-sections of age-specific mortality based on similarities across their expected values (Girosi and King, 2007). The method also allows smoothing over age and time. I improve mortality forecasts by considering information from the covariates obesity and smoking prevalence. Current SSA mortality forecasts will be directly comparable to the informed forecasts. Specifically, I consider age, sex, and cause-specific death data from US Vital Statistics from 1980 to 2003 and intercensal estimates from the US Census Bureau. Current covariates include obesity (based on body mass index) and smoking prevalence.

The paper will be organized as follows. First, we will provide an overview of morality forecasting and argue the need for stochastic methods that incorporate additional information and allow for smoothing across age and time. Second, we will discuss SSA forecasting methods. Third, we will provide an overview of the methodology developed by (Girosi and King, 2007) and provide a detailed discussion of my methodological contribution to optimal smoothing parameter choice. Fourth, we will present informed mortality forecasts that incorporate additional information on medical and behavioral factors. Finally, we will discuss implications to SSA mortality and trust fund projections.

1.1 Social Security Mortality Forecasting

Since 1950, the Social Security Administration, Office of the Chief Actuary (OACT), has been responsible for annual forecasts of mortality rates 75 years into the future (Waldron, 2005). Combined with other demographic and economic forecasts, the Trustees forecast the solvency of the social security system and status of the trust fund.

OACT first calculates age and sex specific death counts from mortality data collected from the US National Center for Health Statistics, based on information provided by States in the Death Registration Area. Then, population estimates are taken from US Census intercensal data for all ages from 1900 to 1967 and ages less than 65 for the years 1968 to 2001. For ages 65 and greater for these years, population estimates were derived from Medicare data because of better data quality (Bell and Miller, 2005). The ratio of the death counts and population estimates forms the central death rate for age groups $0-4, 5-9, \ldots, 90-94, 95+$.

OACT uses three methods to calculate central death rate based on age. For ages 0 to 4, central deaths rates for the years 1900-1939 were based on separate ordinary least squares regression for each age $(1 \dots 4)$ and sex from the years 1940 to 2001, when direct information was available. For ages $5 - 94$, the central death rate for each age group is a weighted average of the central death rates for each age, weighted by the population for each age. Finally, for the ages 95+, the central death rate is a function of the central death rates for the previous age, age 93, and age 94.

OACT forecasts mortality by age group, sex, and causes of death through a combination of linear extrapolation and subjective judgment and linear extrapolation of 1979 to 2000 data. Cause of death information is available from 1979 to 2001 from US Vital Statistics and based on the Tenth Revision of the International List of Diseases and Causes of Death: Heart Disease, Cancer, Vascular Disease, Violence, Respiratory Diseases, Diabetes Mellitus, and All Other Causes. Specifically, the average annual percent reduction in cause-specific mortality is defined as the complement of the exponential of the slope of the ordinary least squares line of the logarithm of central death rates versus year. For example, the age-adjusted male central death rate for heart disease decreased from 517.4 per $100,000$ in 1981 to 321.4 per $100,000$ in 2001. this corresponds to an average annual reduction of 2.34%.

For the years 2001 and 2002, the average annual reduction in mortality for a given age group, sex and cause of death was assumed to equal the average annual reductions between the years 1981 and 2000. For the years 2003 to 2029, the log mortality rate decreases linearly from 100% of the average annual reduction from 1981 to 2000 to the ultimate reduction in 2029. If the average annual reduction from 1981 to 2000 was positive, the log mortality rate decrease linearly from 75% of this initial average anual reduction to the ultimate reduction level in 2029. After 2029, the average annual reduction remains constant at the ultimate reduction level.

Table 1 shows the observed and forecasted all-age rate of decline for seven leading causes of

	total	heart	cancer	vascular	violence	respiratory	diabetes	other
1981-2001	0.010	0.024	0.004	0.020	0.012	−0.004	−0.030	−0.007
2002-2003	0.008	0.022	0.003	0.019	0.011	−0.005	−0.023	−0.006
2004-2029	0.008	0.017	0.004	0.021	0.009	0.001	−0.001	0.002
2030-2100	0.007	0.015	0.005	0.021	0.009	0.002	0.005	0.004

Table 1: Observed and Forecasted Rates of Decline For Leading Causes of Death, All-Age, Male. A negative rate of decline corresponds to an increase in mortality rates. Source: Social Security Administration.

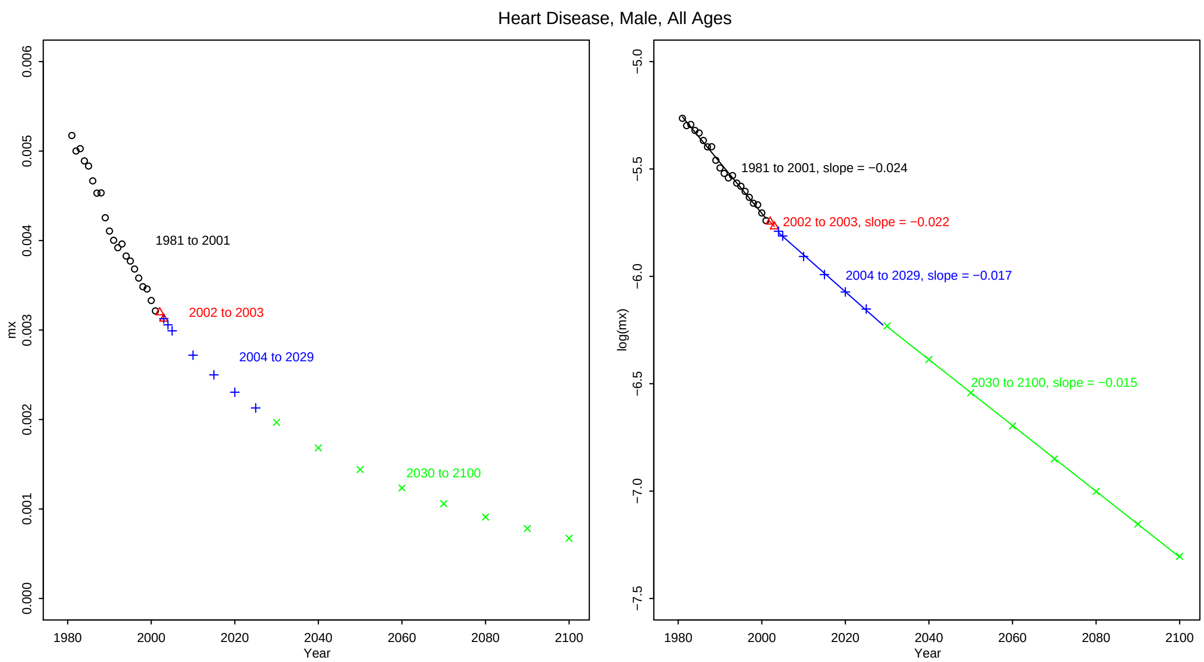

Figure 1: Mortality Rate, Male Heart Disease, All Ages. Source: Social Security Administration Forecasts.

death. Overall, there is a gradual reduction in the rate of mortality decline due to heart disease, cancer, vascular disease, and violence. for example, male mortality due to heart disease is shown for all ages in Figure 1. The left panel shows the observed and forecasted all=age mortality rates. The rates of decline are best seen by examining the log mortality rate in the right panel. From 1981 to 2001, the average annual reduction was approximately 0.024. The same rate of decline is assumed for the 2002 and 2003 forecasts. The log mortality rate is assumed to decline linearly between 2004 and 2029, the year at which the ultimate reduction level starts.

2 Data and Methodology

Mortality data from 1980 to 2003 comes directly from US Vital Statistics. Obesity and smoking prevalence is estimated from cross-sectional National Health Interview Surveys.

3 Mortality Forecasts

Figure 2 shows mortality data and forecasts for male mortality due to heart disease. Four mortality forecasts are presented for each age shown. The forecasts are based on time alone, time plus obesity prevalence, time plus smoking prevalence, and time plus obesity and smoking prevalence. Decreases in smoking appear to lower forecasted mortality rates even more than is predicted by time alone. Yet, sharply rising obesity may contribute to slightly higher mortality rates.

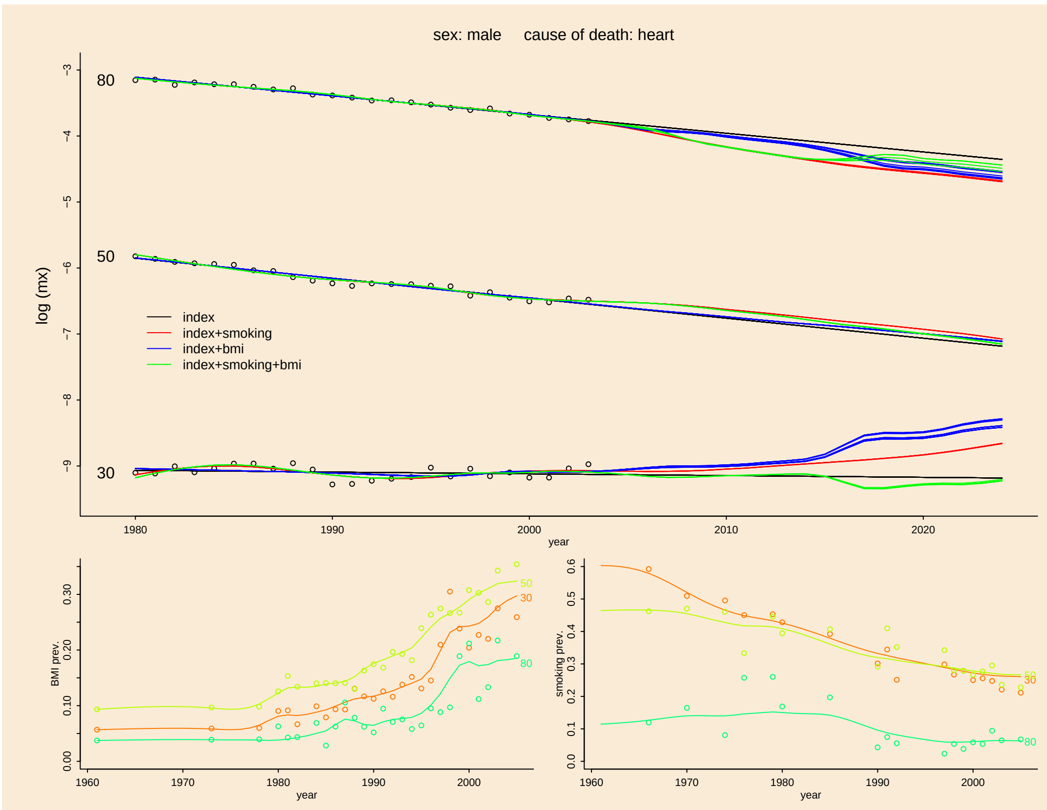

Figure 2: Male Mortality Due to Heart Disease with Lagged Smoking and Obesity Prevalence for Select Ages. The upper panel shows observed log male mortality rates from 1980 to 2003 for ages 30, 50, and 80. Four forecasts are presented for each age: time alone; time and smoking prevalence; time and obesity prevalence; and time and smoking and obesity prevalence. The lower right (left) panel shows lagged obesity (smoking) prevalence for the selected ages.

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