HOW MUCH IS ENOUGH? THE DISTRIBUTION OF LIFETIME HEALTH CARE COSTS

Anthony Webb and Natalia Zhivan*

CRR WP 2010-1
Released: February 2010
Date Submitted: February 2010

Center for Retirement Research at Boston College
Hovey House
140 Commonwealth Avenue
Chestnut Hill, MA 02467
Tel: 617-552-1762 Fax: 617-552-0191

* Anthony Webb is associate director of research at the Center for Retirement Research (CRR) at Boston College. Natalia Zhivan is a consultant to the CRR. The CRR gratefully acknowledges Prudential Financial for its support of this research. The opinions and conclusions expressed are solely those of the authors and do not represent the opinions of Prudential Financial or Boston College.

About the Center for Retirement Research

The *Center for Retirement Research at Boston College*, part of a consortium that includes parallel centers at the University of Michigan and the National Bureau of Economic Research, was established in 1998 through a grant from the Social Security Administration. The Center's mission is to produce first-class research and forge a strong link between the academic community and decision makers in the public and private sectors around an issue of critical importance to the nation's future. To achieve this mission, the Center sponsors a wide variety of research projects, transmits new findings to a broad audience, trains new scholars, and broadens access to valuable data sources.

Center for Retirement Research at Boston College
Hovey House
140 Commonwealth Avenue
Chestnut Hill, MA 02467
phone: 617-552-1762 fax: 617-552-0191
e-mail: crr@bc.edu
crr.bc.edu

Affiliated Institutions:
The Brookings Institution
Massachusetts Institute of Technology
Syracuse University
Urban Institute

Abstract

Estimates of the expected present value of lifetime out-of-pocket medical costs from age 65 onward are of limited value to households managing wealth decumulation in retirement. Their risk characteristics may differ from the average. They will also care about the whole probability distribution of health cost outcomes, and will want to update that probability distribution during the course of retirement. Using *Health and Retirement Study* data, we simulate health, mortality, and health cost histories of retired households. We show that the life expectancy and average health costs of our simulated households closely match published life tables and the findings of previous research. Using our simulated data, assuming a 3-percent real interest rate and including Medicare and private insurance premiums, we estimate that a typical household age 65 has a 5-percent risk of the present value of its lifetime health care costs exceeding $311,000, or $570,000 including the cost of long-term care. We find that relatively little resolution of uncertainty occurs with age, even for those who remain free of chronic disease.

Introduction

Out-of-pocket health costs represent a large uninsured risk for most retired households. Previous research has estimated the expected present value of per-person out-of-pocket health care costs from age 65, exclusive of long-term care but including Medicare and Medigap premiums, at about $100,000.[1] [2] But this statistic is of limited value to households managing wealth decumulation in retirement. Their risk characteristics may differ from the average. They will also care about the whole probability distribution of outcomes, not just the mean. In addition, they need to be able to update this information as they age and as their health status evolves. To address these requirements, this paper provides estimates of the distribution of the present value of lifetime health care costs, conditional on age and socioeconomic and health status.

One way of quantifying health care cost uncertainty would be to use a panel micro data set to calculate the present value of each individual's health care costs from age 65 to age of death, regress remaining lifetime health care costs on information available to the individual at various ages, and analyze the model's predictive power. Unfortunately, such a panel data set does not yet exist.[3] We therefore adopt an alternative approach, similar to that adopted by Michaud, Goldman, Lakdawalla, Zheng, and Gailey (2009), namely to use the *Health and Retirement Study* (HRS) to create simulated lifetime health-care-cost histories, and we base our subsequent analysis on these simulated histories. Our simulated households get sick, incur medical costs, enter nursing homes, and eventually die at rates calibrated to match those observed in the HRS.[4]

---

[1] Munnell, Soto, Webb, Golub-Sass, and Muldoon (2008).
[2] We follow previous research in using a 3-percent real interest rate to calculate all our present values.
[3] The *Health and Retirement Study*, a nationally representative panel of 12,652 individuals age 51 to 61 in 1992 or married to an age-eligible individual, who have been re-interviewed every two years up to and including 2006, will eventually be an ideal data set for such an analysis. However, it currently only covers a maximum of 14 years, so that only a small and unrepresentative number of individuals age 65 or less at baseline have as yet died.
[4] We adjust for oversampling of black households and residents of Florida, and for the exclusion of those institutionalized at baseline.

An important unresolved question is the extent to which health care costs are affected by age and proximity to death. The observed relationship between age and expenditure could arise, in part, because older individuals are more likely to be in the last year of life. Quantifying the relationship between age and health care costs is important because it will affect the distribution of lifetime health care costs.[5]

We find evidence of a relationship between health care costs and proximity to death, which implies that researchers who model health care costs solely as a function of age, socioeconomic status, and past health care costs likely overstate the effect of age. But we find that the relationship is no longer statistically significant once we control for the presence of chronic conditions and residence in a nursing home, obviating the need for our simulation model to incorporate time to death.[6]

While the health care expenditures of most households are constrained by their available resources, the indigent receive free health care through Medicaid. When estimating econometric models of health care expenditure, we exclude Medicaid-eligible households and include an indicator variable for those with less than zero financial assets to avoid underestimating the risk faced by the remainder of the population.

The remainder of the paper is structured as follows. In Section 1, we explain why it is important that households be able to quantify the uncertainty regarding their remaining lifetime health care costs, and outline our methodology. In Section 2, we describe the main health care costs and risks faced by retired households. In Section 3, we summarize previous literature. In Section 4, we present our models of

[5] If health care costs increase with age, individuals who survive to advanced ages can expect to have many years of high health care costs. But if health care costs are mainly incurred in the final year of life, those who live unusually long might have lifetime health care costs that are no higher than those of people who die young.

[6] "Medical condition" is a broad term that includes diseases, disorders (functional abnormalities), and normal conditions that might benefit from medical intervention. Our focus is on diseases and disorders that commonly affect the elderly.

mortality, health status, and health care costs. In Section 5, we lay out our simulation model and summarize the results. Section 6 concludes.

1. Significance of topic and outline of research methodology

Significance of topic

Several studies have calculated the expected present value of the average household's lifetime health care costs at age 65.[7] But this information is of only limited value to households trying to calculate how much wealth to accumulate for retirement and how rapidly to decumulate that wealth during retirement. Expected lifetime health care costs will vary between households due to heterogeneity in health status and socioeconomic characteristics. Furthermore, households determining how much to set aside to cover health costs in retirement need to know not only the average expenditure for households of their type, but also the probability that their lifetime health care costs will be much higher than average. Finally, households require estimates of the probability distribution of remaining lifetime health care costs not only at age 65, but also at each subsequent age, based on health and health cost outcomes, so that they can appropriately update their asset decumulation plans.

This paper addresses the above concerns by providing estimates of the mean and 95th percentile of remaining lifetime health care costs at selected ages for prototypical households. We include medical, dental, home-health care, and nursing home costs, but also provide analyses that exclude nursing home costs.[8] We report amounts both inclusive and exclusive of Medicare, Medigap, and retiree health

---

[7] For example, see Munnell, Soto, Webb, Golub-Sass, and Muldoon (2008) and Fronstin, Salisbury, and VanDerhei (2008).

[8] Long-term care includes both home health care and care provided in nursing homes. Home health care is often a substitute for nursing home care, and long-term care insurance often covers both categories of expenditure. Although it would be preferable to include home health care costs with nursing home costs, our treatment is dictated by our modeling of health transitions. We exclude expenditure on assisted-living facilities. Although the cost of such facilities can be substantial, for many households the risk is hedged by their house, which can be sold and the proceeds used to pay for the cost of care. The house is arguably less effective at hedging the cost of nursing home care because in many cases a community spouse will want to continue to live in the house.

insurance premiums. Households face the risk of living and continuing to pay Medicare and private insurance premiums for longer than expected. They also face the risk that premiums may increase faster than expected. The numbers exclusive of premiums are more relevant to those who can afford to pay those premiums out of income – for example households with substantial defined benefit pensions. The numbers inclusive of premiums are more relevant to households that must pay those premiums by drawing on capital, and face the risk of outliving that capital.

The simulated health-care-cost histories are based on the assumption that households are not subject to substantial constraints regarding the amount of their expenditure.[9] In practice, households are constrained by their financial resources, and they may also restrict their spending – by delaying filling prescriptions, foregoing medical checkups, etc. – even before exhausting their wealth. In addition, a sizeable minority may end up on Medicaid. The objective of the analysis is not to calculate how much households spend on health care in practice, or even how much households should optimally choose to set aside to cover health care costs, but to quantify the magnitude and distribution of the potential lifetime expenditure.[10]

Outline of research methodology

Our research methodology involves simulating a large number of chronic conditions, mortality, and health-care-cost histories from age 65 to age of death for each HRS household turning age 65 between 1992 and 2006. For each household, we calculate the mean and 95th percentile of the distribution of the present value of remaining lifetime health care costs at age 65. The difference between the mean

[9] The authors exclude Medicaid-eligible households from the HRS sample upon which the simulated data are based and include an indicator variable for those with less than zero financial assets to avoid underestimating the risk faced by the remainder of the population. The risk posed by health care costs depends on their correlation with other risks the household faces in retirement, particularly longevity risk, and on how health and non-health consumption enter into the utility function. Turra and Mitchell (2007) and Pang and Warshawsky (2007) are examples of an emerging literature that addresses these issues. Our data will permit a more realistic modeling of health care costs, and the incorporation of health insurance purchase as a household choice.

[10] Hubbard, Skinner, and Zeldes (1995) argue that it may be optimal for low-income households to accumulate very little financial wealth during their lifetime, and to rely on Medicaid in the event of an adverse health shock.

and the 95th percentile can be interpreted as an indicator of health care cost uncertainty.

We then examine whether and to what extent the above households can expect uncertainty regarding lifetime health care costs to be resolved with the passage of time. We recalculate the mean and 95th percentile of each household's remaining lifetime health care costs at age 70, age 75, and so on. We then average these means and 95th percentiles over all the households that survive to each age to determine how, for the average household, expectations of remaining lifetime health care costs evolve with the passage of time. But the evolution of the expectations of any particular household will depend on its health and mortality outcomes.

2. Retiree health care expenses

The major health care expenses faced by households age 65 and over include premiums for Medicare Part B (which covers physician and outpatient hospital services) and Part D (which covers drug-related expenses); co-payments related to Medicare covered services; payments related to health care services that are not covered by Medicare, but which may sometimes be wholly or partially covered by private insurance; and long-term care, Medigap, and retiree health insurance premiums.[11] In 2007, the Centers for Medicare and Medicaid Services estimated that Medicare out-of-pocket expenses, excluding Medicare Part B and Part D premiums, averaged $2,400 per year for a single individual, some of which might be covered by Medigap or private insurance. For a couple, the amount would be $4,800. In addition to Medicare expenses are uninsured expenditures for long-term and home-health care, dental care, eyeglasses, hearing aids, and other items not covered by Medicare.

Total annual health care costs are then projected to grow over time. Over the period 1960-2007, inflation-adjusted per-capita national health expenditure has grown at

[11] Households become eligible for Medicare at age 65. Many retire at younger ages, and face quite different risks up to age 65.

an average 4.2 percent a year.[12] Although historical data provide a guide, the rate at which health expenditure will grow is uncertain, and this uncertainty contributes to the risk that households face. The rate of growth is therefore allowed to vary from simulation to simulation, following an AR(1) process estimated from data for the above period.

The 4.2 percent rate of growth in inflation-adjusted out-of-pocket health care costs is consistent with estimates of Hagist and Kotlikoff (2005). But it is significantly higher than the 3.2 to 3.5 inflation-adjusted rate projected by the Centers for Medicare and Medicaid Services (2007) under the alternative assumptions that the physician payment schedule either stays constant in real terms or increases at 2 percent a year. We test the sensitivity of our results to the alternative assumption that health care costs grow at a rate of 3.2 percent a year.

With today's amounts and assumed growth rates, it is possible to project annual out-of-pocket medical expenditures for retirees into the distant future. These annual figures can then be cumulated for each cohort and expressed in present-value terms. This calculation shows the amount of after-tax money that households of differing ages will need to have on hand at the beginning of their retirements to cover the expected expenditures over their remaining lifetimes.

An important financial risk for many retired households is the cost of nursing home care, which will generally not be covered by Medicare. The Congressional Budget Office (2004) reports that an individual age 65 in 2010 has a 33 percent lifetime risk of requiring nursing home care, based on data from Spillman and Lubitz (2002). Paid long-term care is very expensive. Prudential (2008) reports that in 2008, the annual cost of a nursing home was about $71,000 for a semi-private room and $79,000 for a private room. Alternatively, employing a home health aide for four hours a day, five days a week would cost nearly $22,000 per year.

[12] Data is from the Centers for Medicare and Medicaid Services (CMMS), Office of the Actuary.

3. Previous research

Using data from the HRS, French and Jones (2004) estimate a time series model of health care costs in which costs are a function of age and age squared, not of proximity to death. They carefully model the time series properties of health care costs, reflecting patterns in the data showing that some people have persistently high or low costs, relative to others with similar income and health insurance status. The persistence of health care costs reflects persistence in health status, as well as individual fixed effects.[13]

But a considerable body of research, summarized in Seshamani and Gray (2003), indicates that proximity to death may be a more significant determinant of health costs than age.[14] As mentioned in the introduction, part of the correlation between age and health care costs may simply reflect the fact that the probability of death, conditional on survival to date, increases with age.[15]

Increases in health costs reflect not only increases in the price of inputs to health care, but also medical innovation and changes in the underlying health of the population. Soldo, Mitchell, Tfaily, and McCabe (2006) show that more recent birth cohorts report a greater self-reported incidence of chronic conditions at the verge of retirement. Our analyses confirm their findings and also show that these differences persist into retirement. In Section 4, we consider the implications of this finding for health care costs.

---

[13] In addition to individual-level differences in incomes and preferences, there is also evidence of geographic variation in the intensity of health care. See The Dartmouth Atlas of Health care, www.dartmouthatlas.org

[14] Zweifel, Felder, and Meiers (1999) reached similar conclusions, using Swiss data.

[15] It is even more difficult to determine whether reductions in age-specific mortality rates will result in reductions in age-specific health care costs. In other words, if 70-year-olds come to experience the mortality rates of current 65-year-olds, would they also come to experience the health care costs of current 65-year-olds? Aaron (2009) contains a discussion of the issues.

Our model has similarities to that of Michaud, Goldman, Lakdawalla, Zheng, and Gailey (2009), who construct a microsimulation model of health care costs. Their focus is on the impact of long-run trends in mortality and morbidity on the cost of entitlement programs. They therefore assume that all individuals with the same chronic conditions and socioeconomic characteristics incur the same health care costs. This is a useful simplification when modeling aggregate costs, but not for modeling the risks faced by individuals, who differ in the severity of their conditions and their responsiveness to treatment. The authors raise important methodological questions that we also consider in our model – for example, whether feedbacks between conditions should be determined solely by the data, or whether they should be constrained by the findings of clinical research.

4. Modeling the evolution of lifetime health care costs

We use data from the *Health and Retirement Study* (HRS). At each interview, individuals were asked detailed questions about health care utilization and services. The HRS has three important strengths. First, "exit interviews" were conducted with the relatives of deceased participants, capturing expenditure and the onset of chronic conditions in the last year of life. Second, the survey makes use of "unfolding brackets," reducing item non-response and improving the accuracy and completeness of the data. Individuals who are unable to specify a precise dollar amount for an item of expenditure are led through a series of unfolding brackets and invited to specify the range within which the amount lies. Third, the data set contains a large amount of information on socioeconomic characteristics of the household.

The HRS does suffer from several disadvantages. Expenditure on nursing homes is only separately identified in the 2002 wave onward, the recording of chronic conditions is less comprehensive in the exit interviews than in those with living participants, and the survey excludes individuals who were institutionalized at baseline. We address the above issues in our analysis. In addition, there are limitations in the recording of medical expenditures in the 1992, 1993, and 1994 waves, so we exclude these years from our analyses of medical costs. [16]

In summary, our research strategy is as follows. First, we use the HRS data to estimate mortality rates as a function of age, gender, socioeconomic status, health behaviors, and whether the individual reports that he is suffering from various conditions. Second, we estimate the probability of onset of particular conditions, and admission to and exit from nursing homes, as a function of age, gender, socioeconomic status, health behaviors, and whether the individual reports other pre-existing conditions. Third, we simulate a large number of condition and mortality histories for prototypical individuals. Fourth, we estimate out-of-pocket medical costs incurred since the previous interview as a function of age, gender, socioeconomic status, health behaviors, whether the individual reports that he has been newly or previously diagnosed with each of the above conditions, whether he is currently institutionalized, and in some specifications, proximity to death. Fifth, we use our estimates of medical costs to create lifetime health-care-cost histories for our simulated households. Finally, we use our simulated lifetime health-care-cost histories to determine how uncertainty regarding remaining lifetime health care costs is gradually resolved as the individual ages and with the onset of chronic conditions, given the information contained in our models.

We recognize that our calculations may overstate the degree of uncertainty the individual faces because mortality, the onset of chronic conditions, and health care costs may each be influenced by factors known to the individual or under his control but which are not incorporated in our model. We attempt to minimize this bias by including a rich set of socioeconomic characteristics and health behaviors.

[16] Individuals were not asked about medical costs in wave one of the HRS. Individuals in wave two were only asked for a global estimate, potentially resulting in under-reporting. In 1993, the financial respondent in AHEAD households (those born before 1924) was asked to estimate household expenditure for the previous 12 months in a format that differs from subsequent years' questionnaires.

Conversely, if households fail to make appropriate use of the information contained in our models, our calculations will understate the degree of uncertainty.

In the following subsections, we discuss each of the above steps in more detail.

Estimating mortality rates as a function of age and health status

It is well known that female life expectancy exceeds that for men. Many studies (for example, Deaton and Paxson, 2001, and Cutler and Lleras-Muney, 2006) have also shown a negative correlation between education and mortality. And several studies, including Cutler, Lleras-Muney, and Vogl (2008), have shown that financial resources and ethnicity have independent effects.

We estimate a hazard model of the following form:

$$h(i,t) = \exp(x_{i,t}B)\exp(\gamma t) \qquad (1)$$

When γ is positive, the hazard function increases exponentially with age.[17] The hazard function also shifts proportionately, depending on the characteristics of individual *i* at time *t*.[18] We estimate separate models for men and women. We include education, ethnicity, and financial assets.[19] We also control for whether at the first interview after turning 65 the individual reported that he currently smoked.[20] Mortality is also allowed to vary with whether the individual reports that he has ever suffered from lung disease, diabetes, cancer, heart disease, or stroke,

[17] Previous research has shown that exponential models fit mortality data well up to very advanced ages.
[18] So acquiring a disease has the same proportionate impact on the mortality rate regardless of age.
[19] Not all our sample is observed at age 65. According to the life-cycle model of savings behavior, wealth should decline with age. Our model will therefore overestimate the wealth of those first observed at older ages, relative to those observed at 65. We consider this is preferable to the alternatives of either ignoring financial wealth or backcasting or forecasting financial wealth to a common age.
[20] We make the assumption that this behavior is fixed. We found that obesity and various measures of drinking behavior had no statistically significant effect on mortality.

and whether he is currently institutionalized, a highly significant predictor of mortality.[21] We also control for the ages at which the individual's parents died.[22] Table 1 reports hazard ratios, the impacts of the various characteristics on mortality, relative to the base case of a male or female with a high school education and no pre-existing conditions.[23] So the female less-than-high-school hazard ratio of 1.151 indicates that a female with less than a high school education has a mortality rate at all ages that is 15.1 percent higher than that of the base case of a woman who has completed high school. The p value of 0.006 indicates that this percentage differs from zero, and the hazard ratio differs from one, at the 1 percent significance level. The "some college" hazard ratio of 0.921 indicates that a woman who has attended college has a mortality rate 7.9 percent lower than one who has completed high school.

Those who self-report suffering from chronic conditions have much higher mortality, as do those living in a nursing home. As mentioned previously, the HRS panel excludes households containing individuals who were institutionalized at baseline, and failure to control for this exclusion in our simulations would result in understating both mortality risk and nursing home costs. The age at which a woman's mother died is statistically significant. The coefficients on many other

---

[21] Individuals are asked the year in which they were first diagnosed with lung disease, cancer, heart disease, or stroke. We assume that they contracted these diseases on July 1 of that year. Individuals were not asked when they were first diagnosed with diabetes, high blood pressure, or arthritis, and we treat them as being diagnosed halfway between the dates of the current and previous interviews. The relatives of deceased participants are asked whether the participant was diagnosed with lung disease, cancer, heart disease, or a stroke. We treat individuals as first suffering from these diseases on their last birthday. There is no exit data on diabetes, high blood pressure, or arthritis. We assume that none of the individuals addressed in the exit interviews contracted these diseases between their last non-exit interview and the date of death. Individuals are classified as living in a nursing home at a given age if they or their relative report that they were living in a nursing home at the date of the interview, and that they had moved there prior to their birthday. Alzheimer's disease is a substantial risk factor for long-term care. Unfortunately, it is difficult to identify participants suffering from or diagnosed with this disease. Some, but not all, HRS participants are asked whether they have ever been told that they suffer from a memory-related disease. Although participants are administered word recall tests, we find only a very weak correlation between test scores and self-reports of suffering from a memory-related disease.

[22] In a few cases, one or both parents was alive in 2006, but had not yet attained their life expectancy.

[23] Using HRS respondent-level weights.

variables have the signs we would expect, although falling somewhat short of statistical significance.

Our model is estimated using mortality data for HRS participants who are at least 65 at some time during the period 1992 to 2006. The U.S. Social Security Administration Trustees Report (2009) projects continuing improvements in mortality, so our model may understate the longevity of individuals alive today. We follow previous research (for example, Mitchell, Poterba, Warshawsky, and Brown, 1999) by adjusting our forecast mortality rates by the ratio of cohort to period mortality for the appropriate age and year.[24]

Estimating probabilities of acquiring diseases and of entering/exiting a nursing home

We then model the probabilities of participants reporting the first onset of the above conditions and of entering or exiting long-term care.[25] Although we control for pre-existing conditions, our models do not imply causality – for example, that heart disease causes lung disease – only that the presence of lung disease is a good predictor of the risk of contracting heart disease.[26] We acknowledge that self-reports may understate the true prevalence of disease, and that socioeconomic differences in rates of undiagnosed conditions probably explain our finding that those with less education actually have a lower incidence of some conditions. But as our focus is on medical costs, it makes sense to use self-reported data, as an individual will not spend money on treating a condition of which he is unaware.

We again estimate models for men and women separately.[27] We condition on education, socioeconomic status, race/ethnicity, and being diagnosed with other

[24] A cohort mortality table shows mortality rates of individuals born in a particular year. A period mortality table shows mortality rates of people of all ages observed in a particular year.
[25] Individuals are asked, "Has a doctor ever told you that you have…"
[26] In some cases, for example, the relationship between lung disease and being underweight, the causality clearly runs from dependent variable to regressor.
[27] Our models will somewhat underestimate the probability of being diagnosed with diabetes because the relatives of deceased participants are not asked whether they were diagnosed with this disease between the final interview and the date of death.

conditions.[28] We also condition on whether the individual reported that he smoked or was overweight or obese at the first interview after turning age 65. Health behaviors have a cumulative effect on the probability of succumbing to a condition, and a fully specified model would control for both current and past behavior. Our analyses of the HRS data indicate that while body mass index and smoking vary over time, these health behaviors are relatively stable at older ages, absent a precipitating shock. We therefore condition on behaviors at the later of age 65 or the date of the first interview. As with our mortality model, a potential concern is that our model may omit information known to the individual about his risk of contracting the above diseases.

Tables 2A and 2B report hazard ratios for chronic condition models for men and women, respectively. The hazard ratios have the same interpretation as in the mortality models. Table 2C shows hazard ratios for models of admission to nursing homes and marginal effects derived from probit models of exit from nursing homes. [29] In contrast to the hazard ratios, a value greater than zero implies a positive relationship between the characteristic and the probability of exit from a nursing home. For example, the male some-college coefficient of 2.317 implies that having some college-level education is associated with a 2.317 percentage point increase in the probability of returning from a nursing home to live in the community in the course of a year.

In initial analyses, not reported in this paper, we found that minorities and those with less education were significantly and substantially more likely to report having a variety of chronic conditions, even though inequalities in health care utilization likely result in a greater under-reporting of the incidence of conditions among disadvantaged groups. Individual correlates lose significance in models in which

[28] We use data on the year in which participants contracted a disease to determine the age at which it was contracted.
[29] There were insufficient nursing home residents to permit estimation of a hazard model.

first onset is the dependent variable. Nonetheless, several patterns emerge. Considering the conditions in turn:

Diabetes

The overweight and obese, those with fewer years of schooling, and younger birth cohorts are more likely to report diagnosis of diabetes, although the trend toward a higher incidence of diabetes among younger birth cohorts is only statistically significant for males.

Cancer

The incidence of first diagnosis of cancer is higher among younger birth cohorts, among smokers, and also among those with lung disease. Although the differences are generally not statistically significant, the self-reported incidence of cancer is actually lower among minorities and higher among women with a college education, results that are consistent with previous research that attributed the higher incidence of cancer among those in higher socioeconomic groups to disparities in access to health screening (Cutler and Lleras-Muney, 2006).

Lung disease

The incidence of first diagnosis of lung disease is higher among smokers, among those previously reporting cancer, and among men previously reporting heart disease. It is also higher among younger birth cohorts, but lower among blacks.

Heart disease

The incidence of first diagnosis of heart disease is higher for those previously reporting diabetes or lung disease. It is lower among Hispanics and among black men.

Stroke

The incidence of reporting that one has suffered a stroke is substantially higher for smokers and those suffering from diabetes, lung, or heart disease.

Admission to a nursing home

The risk of admission to a nursing home is substantially and significantly higher for those reporting that they suffer from diabetes or have suffered a stroke. It is substantially and significantly lower for both married men and married women, and for black and Hispanic women. Consistent with the findings of previous research, it is also significantly lower for both men and women with daughters, especially when the daughter is the oldest child.

Exit from a nursing home to the community

We have a relatively small sample of individuals who returned from nursing homes to live in the community during the sample period. We were unable to identify any statistically significant correlates for men, and we found it difficult to explain the few that we identified for women.

For all the above diseases, our models have relatively low predictive power. Including lagged self-reported health improves their predictive power somewhat. We conclude that current good health provides only a very limited guarantee of future good health.

An obvious concern is the extent to which we can use the age-specific incidence of the above diseases to project incidence among succeeding birth cohorts. Rates of obesity are increasing, but the prevalence of smoking has substantially declined. Figure 1 compares the simulated prevalence of cancer, diabetes, and heart disease for the 1930-34 birth cohort, based on our disease and mortality models, with the self-reported prevalence in the 1910-14, 1915-19, through to the 1925-29 birth cohorts. Succeeding birth cohorts have a substantially higher age-specific self-reported prevalence of cancer and diabetes, and a somewhat higher prevalence of heart disease. Consistent with the above patterns, our simulated prevalence closely tracks the observed prevalence at ages for which we have data, and then projects a higher prevalence than that observed among previous birth cohorts.

The implications for both mortality and health care costs are unclear. If the true prevalence of these diseases is increasing, then we can expect health care costs to rise and for mortality rates to be higher than would otherwise have been the case. But if the increase in self-reported incidence of these diseases reflects improvements in both access to health care and diagnosis, we may expect the relationships between these diseases and both mortality rates and health care costs to change over time.[30]

Based on our simulations, we project that the probabilities of entering a nursing home for a year or more are 20 percent for both men and women. Using data from Spillman and Lubitz (2002), the Congressional Budget Office (2004) estimates that people turning 65 in 2010 face a 33 percent probability of spending three months or more, 24 percent a year or more, and 9 percent five years or more. In part, our somewhat lower probability reflects the exclusion of individuals who were institutionalized at baseline, an effect that we find has persistent effects on institutionalization rates. But it also reflects our finding of lower age-specific institutionalization rates among younger birth cohorts, a finding that is confirmed by other research. Institutionalization rates at younger ages are very low, and we are therefore cautious about extrapolating reductions in nursing home utilization at older ages from cross-cohort differences at these younger ages.[31]

Figure 2 compares the survival rates for the 1930-34 birth cohort, based on our mortality and health transition models, and before our adjustment for nursing home utilization, with those predicted by the Social Security Administration for the same birth cohort. Our survival probabilities are close to, but slightly lower than, those predicted by cohort mortality tables, reflecting our projections of a higher age-specific prevalence of chronic disease.

[30] We tested whether the relationship between disease and mortality is changing over time by interacting the presence of the above diseases with birth cohort, with inconclusive results.
[31] French and Jones (2004) did not correct for the exclusion of individuals institutionalized at baseline.

As we will show later, medical costs rise substantially with the onset of chronic disease. Although the better educated have a lower incidence of chronic disease at any given age, they also have greater life expectancy. We therefore investigate the relationship between educational attainment and the number of years that an individual can expect to suffer from a chronic disease. Table 3 reports the mean and standard deviation of the numbers of years that those with less than a high school education, a high school education, or some college can expect to suffer from one, two, or three or more chronic diseases. Education does not appear to be closely related to the average period that individuals suffer from chronic disease. In all three groups, a significant proportion of individuals live for considerable periods subsequent to the onset of chronic disease.

Estimating annual out-of-pocket medical expenses

We estimate OLS models in which our dependent variable is log health care costs reported at wave *t*.[32] As mentioned previously, we exclude Medicare Part B and Part D, Medigap, and retiree health insurance premiums.[33] Explanatory variables include indicators for whether the individual suffers from each of the chronic diseases, and for first onset of each disease, plus socioeconomic controls and wave dummies.[34] We use pooled cross-section data for waves three to eight of the HRS. From an original sample of 70,067 person-wave observations for individuals aged 65 or older, we drop 11,067 observations for individuals who were covered by Medicaid, 7,749 for individuals holding long-term care insurance or whose nursing home costs were covered by insurance, 1,738 for individuals who had short stays in

[32] We exclude observations for individuals who have not yet attained age 65. We also exclude those who report incurring zero medical expenses, about 6 percent of the sample. They are much poorer than average and are likely foregoing needed health care. We recognize that budget constraints may be restricting the health care expenditure of some of the remainder of the sample.

[33] In the exit interviews, relatives of deceased participants were asked to report expenditure from the last interview until the date of death. This period was invariably less than two years, and we added part of the expenditure for the previous period to make the data comparable.

[34] It is not possible to separately identify wave, age, and cohort effects. We assume that, after controlling for socio-economic factors, cohort-related differences in health costs depend solely on differences in the prevalence of chronic disease.

nursing homes, 2,512 for individuals who had zero medical expenses, and 12,087 where data was otherwise missing or unusable, leaving a sample of 14,687 male and 20,227 female person-wave observations.[35] We investigate the impact on medical costs of proximity to death in two ways. First, we take the subsample of individuals who can be identified from the data as having died prior to 2006, and estimate models that include years to death, but a) include, and b) exclude health-related variables. In each case, we test whether the years to death coefficient is significantly different from zero. Second, we follow Shang and Goldman (2008) and add predicted one-year probability of dying to models that include or exclude health-related variables and in each case test whether the coefficient on one-year mortality probability is significantly different from zero.

Another potential concern is reporting error. Hurd and Rohwedder (2009) show that some HRS households report health care spending that was implausibly large in relation to their income and assets. We exclude approximately 2 percent of the sample whose reported health care costs appear implausibly large in relation to their income and assets. We find that our estimates of the distribution of lifetime health care costs are relatively insensitive to this exclusion.

Tables 4A and 4B report results for men and women, respectively. Controlling for health status, those with more education spent significantly and substantially more on health care. All of the diseases were associated with increased health care spending, but first onset was not associated with further increases. The institutionalized also spent more on health care, inclusive of the cost of nursing home care.

Years-to-death is significant, or borderline significant in models that exclude chronic conditions, but loses significance once conditions are added. Consistent with Shang and Goldman (2008), predicted one-year mortality probability, based on a mortality

[35] We intend to include a detailed analysis of people with short nursing home stays in a later version of this paper. Individuals who reported zero medical costs had very low income and assets.

model that includes parents' ages of death, is statistically significant in models that exclude chronic conditions, but loses significance once conditions are added. We interpret these results as meaning that years-to-death primarily affects health care costs via the increased prevalence of chronic conditions among those close to death.

The annual cost of nursing home care predicted by our model, evaluated at the means of the independent variables for those who are institutionalized, is $19,995, well below the average cost referred to above.[36] Our analysis of the HRS data for waves six and seven shows expenditure on nursing home care by non-Medicaid eligible institutionalized individuals averages only $51,014 for two years. We attribute these low numbers to reporting error and assume nursing home costs of $70,000 a year in 2004-2006 dollars.[37] To separately identify the effect of nursing home costs, we report simulation results both including and excluding these costs.

Previous research has documented substantial regional variation in health care costs. The HRS data contains geographic identifiers, available to qualified researchers on a restricted basis that permit identification of the respondent's Hospital Referral Region (HRR). We test whether there are systematic regional variations in out-of-pocket heath care costs by including average HRR health care costs as an explanatory variation, but find no evidence.

5. Simulating lifetime health care costs

The HRS data is for the period 1994 to 2006, the latest interviews being conducted in the fall of 2006. Medicare Part D prescription drug coverage was introduced on January 1, 2006. Although the program will decrease medical cost risk, it is unclear

---

[36] An undesirable feature of the log-linear model is that disease status affects the predicted dollar cost of nursing home care.

[37] A potential concern is that if nursing home costs are under-reported, end-of-life medical expenses may be similarly under-reported, as might occur if the proxy interviewee is unfamiliar with the deceased's finances. Although we cannot be certain, we suspect that the low reported nursing home costs are the result of mis-reporting of Medicaid eligibility status. Such mis-reporting is likely to have a much smaller effect on estimates of medical expenditure because residents of nursing homes are disproportionately likely to be Medicaid eligible.

by how much. Many households already had some form of prescription drug coverage prior to the introduction of Part D, there will likely be behavioral effects, and the effect on risk depends on where prescription drug expenditure falls in relation to the "donut hole." Given the uncertainty, we do not attempt to incorporate the impact of Medicare Part D into our model.

Labor represents a substantial proportion of nursing home costs. We assume that the cost of nursing home care increases at 1.1 percent faster than the rate of inflation, the 1.1 percent equaling the Social Security Trustees' projection of the long-run rate of wage growth. Our analyses of the Consumer Price Index (CPI) shows that over the period 1997-2009 the cost of "nursing homes and adult day services" has increased at an average of 2.0 percent in excess of overall inflation. Our forecasts will understate health care costs if the cost of nursing home care continues to increase at this higher rate.

Figures 3A and 3B show the mean, median, and 95th percentile of remaining lifetime health care costs, including the cost of nursing home care, for an intact high-school educated couple at selected ages, 3A including and 3B excluding Medicare, Medigap, and retiree health insurance premiums. The couple is assumed to be initially free of chronic disease, and we average over households with and without supplemental insurance coverage.[38] As mentioned previously, we exclude the cost of assisted living facilities. The numbers are in 2009 dollars, and are for the birth cohort turning 65 in 2009.[39] Subsequent birth cohorts would face higher costs.[40] At age 65, the mean and 95th percentile of remaining lifetime health care costs, including premiums, are $260,000 and $570,000, respectively. The 95th percentile is more

[38] There is relatively little difference between the out-of-pocket expenses of those with and without Medigap coverage (Monk and Munnell, 2009), likely reflecting both selection and behavioral effects. But purchase of Medigap coverage will still reduce the risk of those who do not adjust their consumption of health services in response.
[39] We adjust health care costs to reflect increases in expenditure between 2004-2006, the most recent HRS data used in our model, and 2009.
[40] The rate of increase may be even more rapid if there is a more rapid increase in the incidence of chronic disease among subsequent birth cohorts than that projected by our model.

than twice the mean.[41] Comparable figures excluding premiums are $176,000 and $485,000, respectively. On average, households can expect both the mean and the 95th percentile of remaining lifetime health care costs to decline only slowly with age. Although life expectancy declines with age, the effect is offset by an increase in the probability of surviving to very advanced ages, and an increase in the expected present value of the expenditures at those ages. By age 85, the expected present value of remaining lifetime health care costs has decreased by about 22 percent. The average 85-year-old household will estimate the mean and 95th percentile of its remaining lifetime health care costs at $203,000 and $477,000, respectively, inclusive of long-term care and insurance premiums.

Figure 4A and 4B show the results of the same simulation, but excluding the cost of nursing home care, 4A including and 4B excluding insurance premiums. Including premiums, the age 65 mean and 95th percentile amount to $197,000 and $311,000, respectively, and at age 85, $140,000 and $266,000, respectively. Excluding both premiums and the cost of nursing home care, the age 65 mean and 95th percentile are $113,000 and $226,000. Nursing homes contribute substantially to overall risk. Once nursing home costs are included, there is a substantial increase from $113,000 to $309,000 in the difference between the mean and the 95th percentile of the distribution of lifetime health care costs, reflecting the assumption of the model that households are not covered by long-term care insurance.

The above numbers assume a continuation of historic rates of growth of spending on medical services.[42] At the lower 3.2 percent rate projected by the Centers for Medicare and Medicaid Services (2007) under the assumption that the physician payment schedule remains constant in real terms, the 95th percentile of all health care costs reduces the present value of medical costs from age 65 by approximately 11 percent. In analyses available on request, we find that uncertainty about the

[41] Data for other percentiles is available from the authors on request.
[42] The growth in spending results not only from increases in the cost of medical inputs in excess of the rate of inflation, but also from the introduction of new and expensive medical technologies.

rate of growth of spending on medical services is not a significant additional risk factor.

Figure 4C shows results inclusive of all health-care costs, excluding premiums, for households in which both spouses are currently free of chronic disease. Remaining lifetime health care costs for these households are very close to the average for all households.[43] Although households free of any chronic disease have lower current health care costs, they also live longer than average. At 80, men and women in our simulations who are free of any chronic disease have remaining life expectancies that are 23 and 24 percent longer than the average for all 80 year olds, so that health care costs accrue over a longer period. The risk of the currently healthy requiring nursing home care is comparable to that faced by the population as a whole reflecting the fact that entry to a nursing home is precipitated not only by the onset of chronic disease, but also by frailty. And people who are free of any chronic disease at age 80 can still expect to spend almost four years suffering from one or more chronic disease prior to death.

Figures 5 and 6 show mean individual-level health care costs, excluding long-term care and Medicare and Medigap premiums, by age and by proximity to death.[44] To illustrate the effects more clearly, we remove the effect on expenditure of increases in health care costs over time. Health care costs increase with both age and proximity to death. But the increases are not dramatic. The age coefficients in the health care cost models are small and not statistically significant. As previously discussed, we find that proximity to death has little effect on health care costs once we control for disease status. Most of the relationship between health care costs and age and proximity to death in the above figures flows from the greater prevalence of chronic disease at older ages and when close to death.

[43] This doesn't imply that underwriting has no value as a risk management tool. Households that are in poor health die younger and pay fewer years' premiums, and in the absence of medical underwriting, many households would delay purchasing insurance until their health declined.
[44] W switch from couples to individuals because it is not meaningful to talk of proximity to death for a couple.

6. Conclusions

Our simulations show that households are at significant risk of incurring health care costs that are more than twice the average. A typical couple age 65 can expect to incur health care costs of $260,000 in present-value terms over their lifetimes, including the cost of long-term care and Medicare, Medigap, and retiree health insurance premiums, assuming their financial resources permit. But this couple faces a 5-percent chance that it will spend more than $570,000. At age 65, remaining life expectancy for men and women born in 1944 is 17 and 21 years, respectively. By age 85, it has more than halved, to six and seven years, respectively. But health care cost risk decreases much less than proportionately, and a typical couple age 85 still faces a 5 percent chance that the present value of its remaining lifetime health care costs will exceed $477,000.

An emerging literature investigates the impact of medical expenditure risk on not only the rate at which households decumulate wealth (DeNardi, French, and Jones, 2006), but also on annuitization and other insurance purchase decisions. Our analysis provides further evidence that many households face very substantial risk.

Our calculations assume that expenditures are not constrained by available resources. In many instances, the household's financial resources will not permit expenditure at the average cost level, much less anything greater. In that case, the household will have to either forego needed health care or rely on Medicaid. The risk is not of destitution, but of health care costs impoverishing a couple or a surviving spouse, or of the household not having the retirement it planned for.

References

Centers for Medicare and Medicaid Services. 2007. "Projected Medicare Part B Expenditures under Two Illustrative Scenarios with Alternative Physician Payment Updates." Memorandum from M. Kent Clemens. Washington, DC: U.S. Department of Health and Human Services.

Congressional Budget Office. 2004. "Financing Long-Term Care for the Elderly." Washington, DC: Government Printing Office.

Cutler, David M. and Adriana Lleras-Muney. 2006. "Education and Health: Evaluating Theories and Evidence." Working Paper 12,352. Cambridge, MA: National Bureau of Economic Research.

Cutler, David M., Adriana Lleras-Muney, and Tom Vogl. 2008. "Socioeconomic Status and Health: Dimensions and Mechanisms." Working Paper 14,333. Cambridge, MA: National Bureau of Economic Research.

Deaton Angus and Christina Paxson. 2001. "Mortality, Education, Income, and Inequality Among American Cohorts." *Themes in the Economics of Aging*, edited by David A. Wise, 129-65. Chicago, IL: University of Chicago Press.

DeNardi, MariaCristina, Eric French, and John Bailey Jones. 2006. "Differential Mortality, Uncertain Medical Expenses, and the Savings of Elderly Singles." Working Paper 12,554. Cambridge, MA: National Bureau of Economic Research.

French, Eric and John Bailey Jones. 2004. "On the Distribution and Dynamics of Heath Care Costs." *Journal of Applied Econometrics* (19): 705-721.

Fronstin, Paul, Dallas Salisbury, and Jack VanDerhei. 2008. "Savings Needed to Fund Health Insurance and Health Care Expenses in Retirement: Findings from a Simulation Model." Issue Brief No. 317 (May). Washington, DC: Employee Benefit Research Institute.

Hagist, Christian, and Laurence Kotlikoff. 2005. "Who's Going Broke? Comparing Growth in Healthcare Costs in Ten OECD Countries." Working Paper 11,833. Cambridge, MA: National Bureau of Economic Research.

Hubbard, Glenn R., Jonathan Skinner, and Stephen P. Zeldes. 1995. "Precautionary Saving and Social Insurance." *Journal of Political Economy* 103(2): 360-99.

Hurd, Michael D. and Susann Rohwedder. 2009. "The Level and Risk of Out-of-Pocket Health Care Spending." Paper presented at 11th Annual Joint Conference of the Retirement Research Consortium in Washington, DC (August 10-11).

Michaud, Pierre-Carl, Dana Goldman, Darius Lakdawalla, Yuhui Zheng, and Adam Gailey. 2009. "Understanding the Economic Consequences of Shifting Trends in Population Health." Working Paper 15,231. Cambridge, MA: National Bureau of Economic Research.

Mitchell, Olivia, James Poterba, Mark J. Warshawsky and Jeffrey R. Brown. 1999. "New Evidence on the Money's Worth of Individual Annuities." *American Economic Review* 89(5): 1,299-1,318.

Munnell, Alicia H., Mauricio Soto, Anthony Webb, Francesca Golub-Sass, and Dan Muldoon. 2008. "Heath Care Costs Drive Up the National Retirement Risk Index." *Issue in Brief* 8-3. Chestnut Hill, MA: Center for Retirement Research at Boston College.

Monk, Courtney and Alicia H. Munnell. 2009. "The Implications of Declining Retiree Health Insurance." Working Paper 2009-15. Chestnut Hill, MA: Center for Retirement Research at Boston College.

Pang, Gaobo and Mark Warshawsky. 2007. "Optimizing the Equity-Bond-Annuity Portfolio in Retirement: The Impact of Uncertain Health Expenses." Watson Wyatt Technical Paper.

Prudential. 2008. "Long-Term Care Cost Study." Research report: http://web.prudential.com/media/managed/LTCCostStudy.pdf

Seshamani, Meena and Alistair M. Gray. 2004. "A Longitudinal Study of the Effects of Age and Time to Death on Hospital Costs." *Journal of Health Economics* 23(2): 217-235.

Shang, Baoping and Dana Goldman. 2008. "Does Age or Life Expectancy Better Predict Health Care Expenditures." *Health Economics* 17: 487-501.

Spillman, Brenda C. and James Lubitz. 2002. "New Estimates of Lifetime Nursing Home Use: Have Patterns of Use Changed?" *Medical Care* 40(10): 965-975.

U.S. Social Security Administration. 2009. "The 2009 Annual Report of the Board of Trustees of the Federal Old Age, Survivors and Disability Insurance Trust Funds." Washington, DC: U.S. Government Printing Office.

Soldo, Beth J., Olivia S. Mitchell, Raina Tfaily, and John F. McCabe. 2006. "Cross-Cohort Differences in Health on the Verge of Retirement." *Redefining Retirement: How Will Boomers Fare?* edited by Brigitte Madrian, Olivia S. Mitchell, and Beth J. Soldo. Oxford: Oxford University Press. 138-158.

Turra Cassio M. and Olivia S. Mitchell. 2007. "The Impact of Health Status and Out-of-Pocket Medical Expenditures on Annuity Valuation." Working Paper 2007-30. Pension Research Council.

Zweifel, Peter, Stefan Felder, and Markus Meiers. 1999. "Ageing of Population and Health Care Expenditure: A Red Herring?" *Health Economics* (8): 485-496.

Table 1: Gompertz Mortality Hazard Model

	Males		Females	
	Hazard ratio	P value	Hazard ratio	P value
Less than high school	1.077	0.212	1.151	0.006
College	0.921	0.250	0.924	0.312
Married at age 65	1.010	0.863	0.960	0.420
Non white	1.155	0.097	1.129	0.116
Hispanic	1.075	0.554	0.729	0.006
Self reported:				
Diabetes	1.308	0.000	1.465	0.000
Cancer	1.658	0.000	2.023	0.000
Lung disease	1.706	0.000	1.805	0.000
Heart disease	1.536	0.000	1.569	0.000
Stroke	1.335	0.000	1.511	0.000
Smoked at age 65/first interview	1.640	0.000	1.511	0.000
Resident in nursing home	2.606	0.000	2.286	0.000
Number of children	0.988	0.324	0.965	0.002
Number of years labor force participatio	0.983	0.000	0.994	0.000
Log financial assets	1.009	0.264	0.985	0.009
Has zero or negative financial assets	1.009	0.272	0.868	0.168
Age mother died	0.997	0.060	0.997	0.006
Age father died	0.999	0.573	0.997	0.062
Born 1920-1924	0.997	0.965	1.067	0.351
Born 1925-1929	0.951	0.065	1.179	0.103
Born 1930-1934	1.160	0.205	1.181	0.139
Gamma	0.849	0.573	0.090	0.000

Notes: 8,362 men and 6,417 women in the Health and Retirement Study, born before 1934. HRS sample weights. Coefficients with p values of less than 0.05 are shown in grey.

Table 2A: Disease Models - Males

	Diabetes		Cancer		Lung disease		Heart disease		Stroke	
	Hazard ratio	P value	Hazard ratio	P value	Hazard ratio	P value	Hazard ratio	P value	Hazard ratio	P value
Less than high school	0.927	0.535	0.996	0.966	1.002	0.988	1.138	0.117	0.991	0.931
College	0.732	0.064	0.971	0.794	0.793	0.179	1.055	0.579	0.761	0.048
Married at age 65	0.810	0.121	1.029	0.776	1.198	0.195	1.161	0.099	0.783	0.025
Non white	1.122	0.468	0.994	0.962	0.632	0.012	0.591	0.000	1.013	0.928
Hispanic	1.788	0.003	0.612	0.009	0.705	0.150	0.557	0.001	0.935	0.760
Self reported:										
Diabetes			1.029	0.783	0.730	0.059	1.336	0.001	1.558	0.000
Cancer	1.371	0.012			1.363	0.017	1.048	0.590	0.982	0.663
Lung disease	0.798	0.216	1.364	0.006			1.517	0.000	1.262	0.092
Heart disease	1.170	0.149	1.021	0.802	1.162	0.178			1.436	0.000
Stroke	1.248	0.144	1.223	0.067	0.983	0.913	1.167	0.133		
If at age 65/first interview										
Overweight	1.765	0.000	0.980	0.819	0.853	0.211	1.001	0.990	0.910	0.357
Obese	3.072	0.000	1.234	0.079	0.993	0.966	1.191	0.102	0.793	0.130
Underweight	0.310	0.128	0.943	0.804	1.914	0.020	0.679	0.165	0.702	0.275
Smoked	0.310	0.128	1.045	0.709	3.136	0.000	1.147	0.155	1.300	0.049
Home owner	1.173	0.360	0.951	0.648	0.823	0.234	1.193	0.098	1.228	0.119
Log financial assets	1.008	0.600	0.998	0.859	0.977	0.120	0.973	0.008	1.000	0.973
Has zero or negative financial assets	1.409	0.100	0.994	0.972	1.426	0.093	1.063	0.675	1.050	0.805
Have defined benefit pension income	0.963	0.107	1.014	0.865	1.113	0.362	1.051	0.490	1.064	0.515
Number of years labor force participation	0.996	0.270	0.995	0.041	0.988	0.001	1.001	0.745	0.992	0.007
Born 1920-1924	1.596	0.013	1.211	0.119	1.367	0.084	1.103	0.369	1.118	0.431
Born 1925-1929	1.869	0.005	1.346	0.057	2.515	0.000	1.103	0.488	0.919	0.663
Born 1930-1934	1.750	0.042	1.594	0.011	2.043	0.007	1.172	0.335	1.240	0.309
Gamma	0.008	0.128	0.044	0.000	0.066	0.000	0.051	0.000	0.058	0.275

Notes: 1) Models for the health conditions have the following unweighted sample of individuals and number of failures: diabetes – 3970 and 415; cancer – 4063 and 763; lung disease – 4243 and 409; heart disease – 3335 and 939; stroke – 4227 and 555. 2) HRS sample weights. 3) Coefficients with p values of less than 0.05 are shown in light grey, and those with p values of less than 0.01, in dark grey.

Table 2B: Disease Models - Females

	Diabetes		Cancer		Lung disease		Heart disease		Stroke	
	Hazard ratio	P value	Hazard ratio	P value	Hazard ratio	P value	Hazard ratio	P value	Hazard ratio	P value
Less than high school	1.138	0.256	1.134	0.178	0.915	0.451	1.050	0.499	0.957	0.603
College	1.016	0.926	1.212	0.114	0.824	0.260	0.846	0.122	1.007	0.952
Married at age 65	0.813	0.059	0.790	0.051	0.890	0.332	0.951	0.469	0.856	0.057
Non white	1.257	0.072	0.701	0.070	0.660	0.009	0.805	0.018	1.092	0.403
Hispanic	1.488	0.014	0.701	0.070	0.778	0.267	0.634	0.002	0.729	0.058
Self reported:										
Diabetes			1.258	0.032	1.026	0.853	1.513	0.000	1.531	0.000
Cancer	0.908	0.506			1.290	0.041	0.991	0.919	1.013	0.898
Lung disease	1.072	0.679	1.352	0.014			1.619	0.000	1.198	0.137
Heart disease	1.364	0.004	1.158	0.086	1.572	0.000			1.482	0.000
Stroke	1.061	0.682	0.976	0.837	0.826	0.216	1.340	0.000		
If at age 65/first interview										
Overweight	2.212	0.000	1.309	0.004	1.020	0.862	1.142	0.062	0.984	0.845
Obese	3.228	0.000	1.288	0.028	1.234	0.176	1.371	0.000	1.126	0.251
Underweight	0.382	0.006	1.221	0.177	1.299	0.131	1.044	0.713	0.798	0.122
Smoked	1.043	0.790	1.580	0.000	3.804	0.000	1.256	0.022	1.330	0.021
Home owner	1.202	0.123	1.051	0.622	0.870	0.216	0.902	0.163	0.965	0.675
Log financial assets	0.963	0.005	1.025	0.031	0.987	0.311	0.978	0.006	0.997	0.767
Has zero or negative financial assets	0.849	0.324	1.163	0.369	1.306	0.129	0.907	0.445	1.101	0.492
Have defined benefit pension income	1.079	0.455	1.081	0.347	0.789	0.020	1.046	0.482	0.896	0.148
Number of years labor force participation	0.993	0.015	1.002	0.324	1.003	0.197	1.001	0.496	1.002	0.379
Born 1920-1924	1.276	0.159	1.215	0.118	1.227	0.176	1.129	0.192	0.983	0.876
Born 1925-1929	1.352	0.149	1.510	0.009	1.842	0.001	1.154	0.248	0.689	0.022
Born 1930-1934	1.500	0.090	1.256	0.206	1.574	0.043	1.149	0.324	0.865	0.397
Gamma	-0.007	0.551	0.034	0.000	0.046	0.131	0.061	0.713	0.062	0.000

Notes: 1) Models for the health conditions have the following unweighted sample of individuals and number of failures: diabetes – 5879 and 516; cancer – 5982 and 737; lung disease – 6263 and 493; heart disease – 5232 and 1269; stroke – 6222 and 926. 2) HRS sample weights. 3) Coefficients with p values of less than 0.05 are shown in light grey, and those with p values of less than 0.01, in dark grey.

Table 2C: Entry To and Exit From Nursing Homes

	Entry to nursing home				Exit from nursing home			
	Men		Women		Men		Women	
	Hazard ratio	P value	Hazard ratio	P value	Marginal effect	P value	Marginal effect	P value
Less than high school	0.970	0.813	1.105	0.230	-1.505	0.479	-2.536	0.005
College	0.701	0.048	1.017	0.896	2.317	0.424	-0.985	0.460
Married at age 65	0.701	0.004	0.776	0.003	2.929	0.166	0.610	0.548
Non white	0.961	0.805	0.764	0.029	-1.231	0.649	2.905	0.068
Hispanic	0.738	0.331	0.607	0.011	-0.353	0.934	7.692	0.022
Self reported:								
Diabetes	1.499	0.002	1.576	0.000	2.916	0.232	0.800	0.500
Cancer	0.819	0.133	1.038	0.710	0.934	0.717	-0.403	0.718
Lung disease	1.151	0.374	1.076	0.570	-0.400	0.898	0.521	0.663
Heart disease	1.108	0.366	1.199	0.013	1.108	0.572	2.249	0.010
Stroke	2.654	0.000	1.961	0.000	0.244	0.898	-0.529	0.544
If at age 65/first interview								
Overweight	0.880	0.303	0.891	0.163	1.869	0.404	1.220	0.218
Obese	1.074	0.676	1.007	0.951	-3.676	0.142	-0.137	0.911
Underweight	1.211	0.484	0.957	0.741	9.173	0.185	-2.080	0.127
Smoked	0.920	0.620	1.653	0.000	4.880	0.122	1.582	0.277
Home owner	0.765	0.050	0.705	0.000	1.890	0.397	-0.506	0.564
Log financial assets	0.957	0.002	0.992	0.403	-0.262	0.327	0.484	0.000
Has zero or negative financial assets	0.872	0.530	1.014	0.934	1.702	0.677	10.968	0.000
Have defined benefit pension income	0.767	0.017	1.040	0.599	2.615	0.217	1.661	0.052
Number of years labor force participation	0.995	0.137	0.997	0.146	0.045	0.429	0.037	0.100
Daughter	0.833	0.160	0.824	0.022	-3.253	0.149	4.606	0.629
Oldest child is daughter	0.709	0.033	0.740	0.005	1.044	0.749	1.004	0.416
Number of children	0.975	0.321	0.959	0.032	-0.122	0.780	-0.069	0.773
Born 1920-1924	1.133	0.464	0.891	0.317	7.776	0.051	0.786	0.667
Born 1925-1929	1.202	0.481	0.824	0.297	23.486	0.009	7.074	0.049
Born 1930-1934	2.103	0.005	0.700	0.110	22.970	0.043	9.351	0.133
Age	-	-	-	-	3.547	0.913	-3.943	0.791
Age squared	-	-	-	-	0.000	0.992	0.003	0.712
Gamma	0.143	0.000	0.121	0.000	-	-	-	-

1) HRS sample weights. 2) Coefficients with p values of less than 0.05 are shown in light grey, and those with p values of less than 0.01, in dark grey.

Table 3: Average Number of Years from Age 65 Spent with Chronic Disease

	One or more		Two or more		Three or more	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Male						
Less than high school	12.5	7.6	8.8	6.5	5.6	4.7
High school	12.9	7.1	8.7	5.9	5.8	4.6
Some college	13.4	7.0	9.1	5.9	6.1	4.5
College	14.0	7.5	9.2	6.5	5.4	4.4
Female						
Less than high school	13.9	8.6	9.4	6.5	7.4	5.6
High school	14.7	8.2	10.0	7.0	6.9	5.9
Some college	14.1	8.1	8.8	6.6	5.9	5.5
College	14.1	8.4	9.1	6.6	5.4	4.9

Note: Calculations Based on Simulated Health Cost Histories

Table 4A: Health Care Costs - Men

	Basic model		Omitting health conditions - known deceased		With health conditions - known deceased		Omitting health conditions but with predicted mortality probability		With health conditions and predicted mortality probability	
	Coefficient	Std error	Coefficient	Std error	Coefficient	Std error	Coefficient	Std error	Coefficient	Std error
Education:										
Less than high school	-0.013	0.064	0.077	0.110	0.019	0.102	-0.006	0.067	-0.010	0.064
Some college	0.120	0.066	0.060	0.130	0.010	0.121	0.156	0.068	0.119	0.066
College	0.316	0.062	0.373	0.139	0.423	0.135	0.308	0.065	0.314	0.062
Black	-0.008	0.087	-0.176	0.189	-0.040	0.187	-0.076	0.088	-0.006	0.087
Hispanic	-0.123	0.128	-0.077	0.284	0.045	0.296	-0.209	0.131	-0.121	0.128
Married	0.079	0.060	0.237	0.110	0.226	0.105	0.119	0.062	0.077	0.060
Self-reported:										
Diabetes	0.552	0.054			0.478	0.097			0.557	0.054
Cancer	0.203	0.059			0.130	0.105			0.218	0.062
Lung disease	0.165	0.079			0.202	0.119			0.184	0.082
Heart disease	0.670	0.047			0.707	0.090			0.680	0.048
Stroke	0.323	0.072			0.353	0.102			0.335	0.073
First wave reports:										
Diabetes	-0.053	0.091			0.101	0.180			-0.053	0.091
Cancer	0.025	0.089			-0.110	0.141			0.022	0.089
Lung disease	-0.006	0.123			-0.054	0.180			-0.003	0.123
Heart disease	-0.009	0.078			0.054	0.117			-0.010	0.078
Stroke	0.194	0.100			0.234	0.152			0.193	0.100
In nursing home	3.233	0.221			3.276	0.256			3.313	0.229
Newly admitted to nursing home	-0.550	0.244			-0.584	0.273			-0.571	0.242
Exit interview	0.484	0.071	0.451	0.098	0.346	0.095	0.682	0.074	0.489	0.072
Age	-0.030	0.062	0.064	0.129	0.117	0.126	0.182	0.068	-0.049	0.066
Age squared	0.000	0.000	0.000	0.001	-0.001	0.001	-0.001	0.000	0.000	0.000
Age to death			-0.061	0.051	-0.006	0.050				
Age to death squared			0.003	0.005	0.001	0.005				
Predicted probability of dying							5.023	0.504	-0.454	0.446
Insurance:										
Medigap	0.074	0.052	-0.128	0.116	-0.206	0.113	0.105	0.054	0.073	0.053
Retiree healthinsurance	-0.194	0.048	-0.243	0.098	-0.250	0.093	-0.158	0.050	-0.194	0.048
Financial wealth at age 65:										
Negative financial wealth	0.079	0.103	0.029	0.199	-0.038	0.190	0.144	0.108	0.079	0.103
1st quartile	-0.035	0.093	-0.226	0.168	-0.229	0.160	0.033	0.096	-0.036	0.093
2nd quartile	-0.060	0.082	-0.219	0.150	-0.129	0.143	-0.043	0.086	-0.062	0.082
4th quartile	0.048	0.070	-0.066	0.127	-0.005	0.120	0.067	0.073	0.046	0.070
5th quartile	0.283	0.070	0.099	0.139	0.114	0.131	0.288	0.073	0.282	0.070
Wave 3	-0.519	0.063	-1.094	0.225	-0.991	0.221	-0.654	0.063	-0.516	0.063
Wave 4	-0.498	0.054	-1.006	0.215	-0.956	0.210	-0.595	0.055	-0.496	0.054
Wave 5	-0.272	0.047	-0.842	0.204	-0.834	0.200	-0.333	0.048	-0.271	0.047
Wave 6	-0.306	0.052	-0.772	0.207	-0.830	0.205	-0.339	0.053	-0.306	0.052
Wave 7	0.097	0.044	-0.162	0.185	-0.325	0.184	0.094	0.045	0.097	0.044
Constant	6.828	2.354	3.744	5.084	1.289	4.940	-0.587	2.581	7.481	2.488

Table 4B- Health Care Costs - Women

	Basic model		Omitting health conditions - known deceased		With health conditions - known deceased		Omitting health conditions but with predicted mortality probability		With health conditions and predicted mortality probability	
	Coefficient	Std error	Coefficient	Std error	Coefficient	Std error	Coefficient	Std error	Coefficient	Std error
Education:										
Less than high school	-0.100	0.051	-0.162	0.104	-0.117	0.093	-0.109	0.054	-0.096	0.051
Some college	0.191	0.049	0.057	0.109	0.134	0.101	0.171	0.051	0.191	0.049
College	0.277	0.055	0.107	0.132	0.127	0.114	0.274	0.058	0.273	0.055
Black	-0.128	0.069	-0.159	0.156	0.017	0.153	-0.175	0.072	-0.124	0.068
Hispanic	-0.111	0.104	-0.354	0.319	-0.127	0.276	-0.123	0.110	-0.118	0.104
Married	0.185	0.039	0.227	0.081	0.269	0.073	0.177	0.041	0.183	0.039
Self-reported:										
Diabetes	0.588	0.048			0.441	0.096			0.604	0.049
Cancer	0.088	0.052			0.071	0.089			0.123	0.054
Lung disease	0.427	0.061			0.581	0.092			0.460	0.063
Heart disease	0.552	0.040			0.578	0.076			0.571	0.042
Stroke	0.341	0.059			0.327	0.098			0.368	0.060
First wave reports:										
Diabetes	-0.077	0.073			0.093	0.148			-0.081	0.073
Cancer	0.221	0.089			0.224	0.123			0.213	0.088
Lung disease	-0.147	0.105			-0.463	0.192			-0.145	0.105
Heart disease	0.067	0.061			0.022	0.107			0.065	0.061
Stroke	0.047	0.082			0.070	0.127			0.043	0.081
In nursing home	3.398	0.115			3.383	0.146			3.506	0.133
Newly admitted to nursing home	-0.589	0.127			-0.659	0.146			-0.587	0.128
Exit interview	0.595	0.063	0.658	0.097	0.454	0.091	0.880	0.069	0.603	0.064
Age	-0.001	0.045	-0.227	0.109	-0.136	0.100	0.118	0.051	-0.031	0.047
Age squared	0.000	0.000	0.001	0.001	0.001	0.001	-0.001	0.000	0.000	0.000
Age to death			-0.088	0.041	-0.010	0.038				
Age to death squared			0.007	0.004	0.003	0.004				
Predicted probability of dying							6.641	0.666	-0.965	0.558
Insurance:										
Medigap	0.131	0.043	0.079	0.109	0.061	0.098	0.132	0.046	0.132	0.043
Retiree healthinsurance	-0.224	0.040	-0.327	0.089	-0.297	0.082	-0.233	0.042	-0.222	0.040
Financial wealth at age 65:										
Negative financial wealth	-0.078	0.085	-0.176	0.218	-0.368	0.202	-0.024	0.090	-0.077	0.085
1st quartile	-0.161	0.074	-0.214	0.143	-0.241	0.130	-0.153	0.078	-0.156	0.074
2nd quartile	0.043	0.059	0.003	0.127	-0.078	0.115	0.067	0.061	0.045	0.059
4th quartile	0.099	0.056	0.009	0.120	-0.014	0.109	0.078	0.059	0.100	0.056
5th quartile	0.209	0.059	0.313	0.135	0.245	0.118	0.184	0.061	0.211	0.058
Wave 3	-0.488	0.050	-0.665	0.199	-0.724	0.180	-0.570	0.052	-0.487	0.050
Wave 4	-0.458	0.044	-0.525	0.182	-0.670	0.163	-0.499	0.045	-0.457	0.044
Wave 5	-0.268	0.040	-0.286	0.172	-0.515	0.152	-0.296	0.041	-0.267	0.040
Wave 6	-0.153	0.040	-0.033	0.160	-0.251	0.145	-0.171	0.041	-0.153	0.040
Wave 7	0.151	0.035	0.388	0.145	0.074	0.134	0.152	0.036	0.151	0.035
Constant	6.096	1.723	15.989	4.345	12.257	3.980	2.119	1.937	7.166	1.788

Notes: 1) See text of paper for sample attrition. Of our final sample of 14,687 male and 20,227 female person-wave observations, 5747 and 6,087 were for deceased men and women for who we could calculate years to death. 2) Coefficients with p values of less than 0.05 are shown grey.

Figure 1A: Incidence of Cancer by Age and Birth Cohort

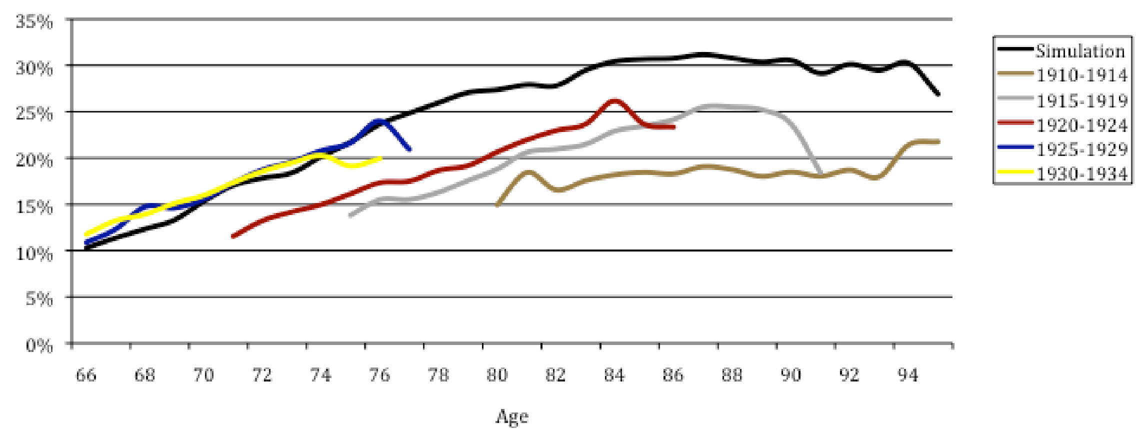


Figure 1B: Incidence of Diabetes by Age and Birth Cohort

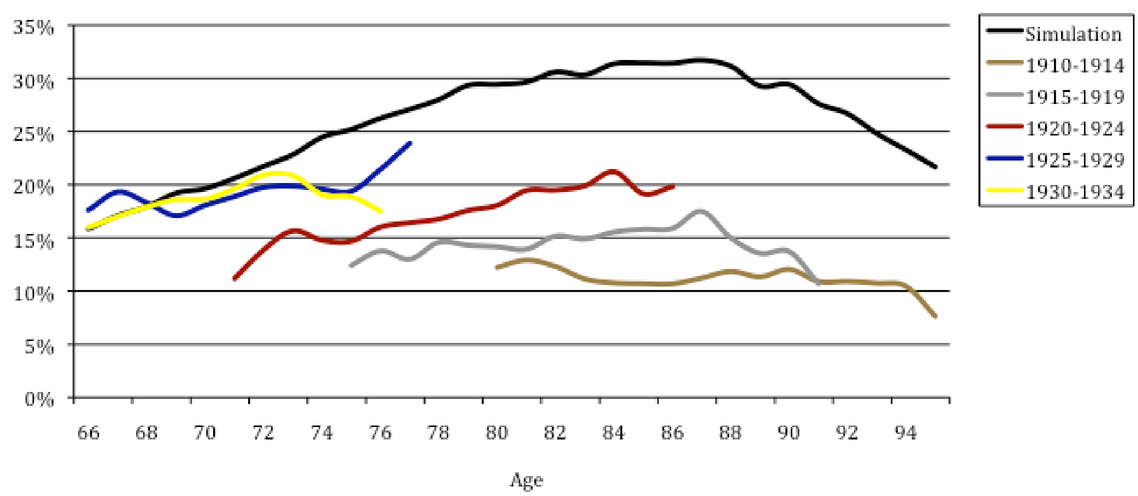


Figure 1C: Incidence of Heart Disease by Age and Birth Cohort

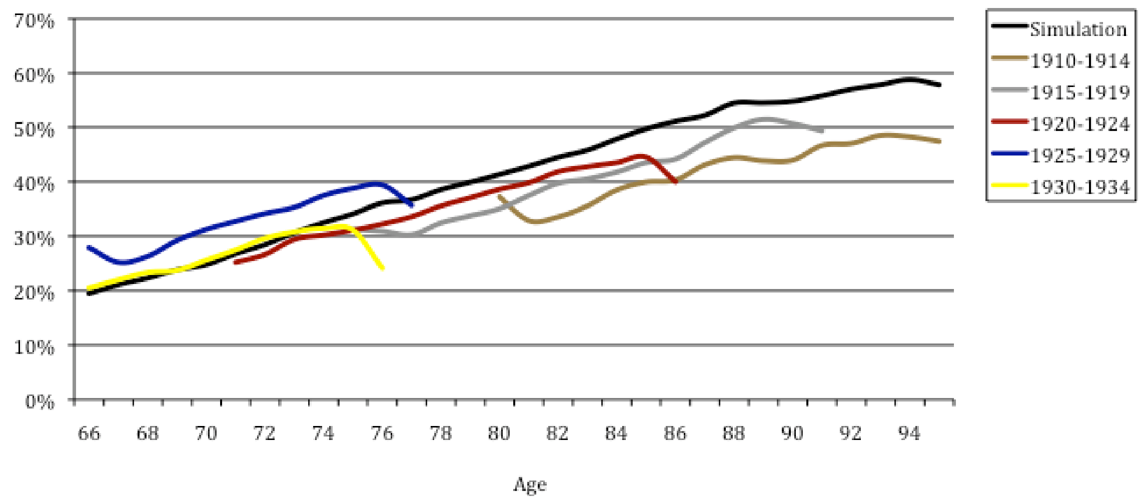


Figure 2: Comparison of Simulated with Period and Cohort Survival Rates

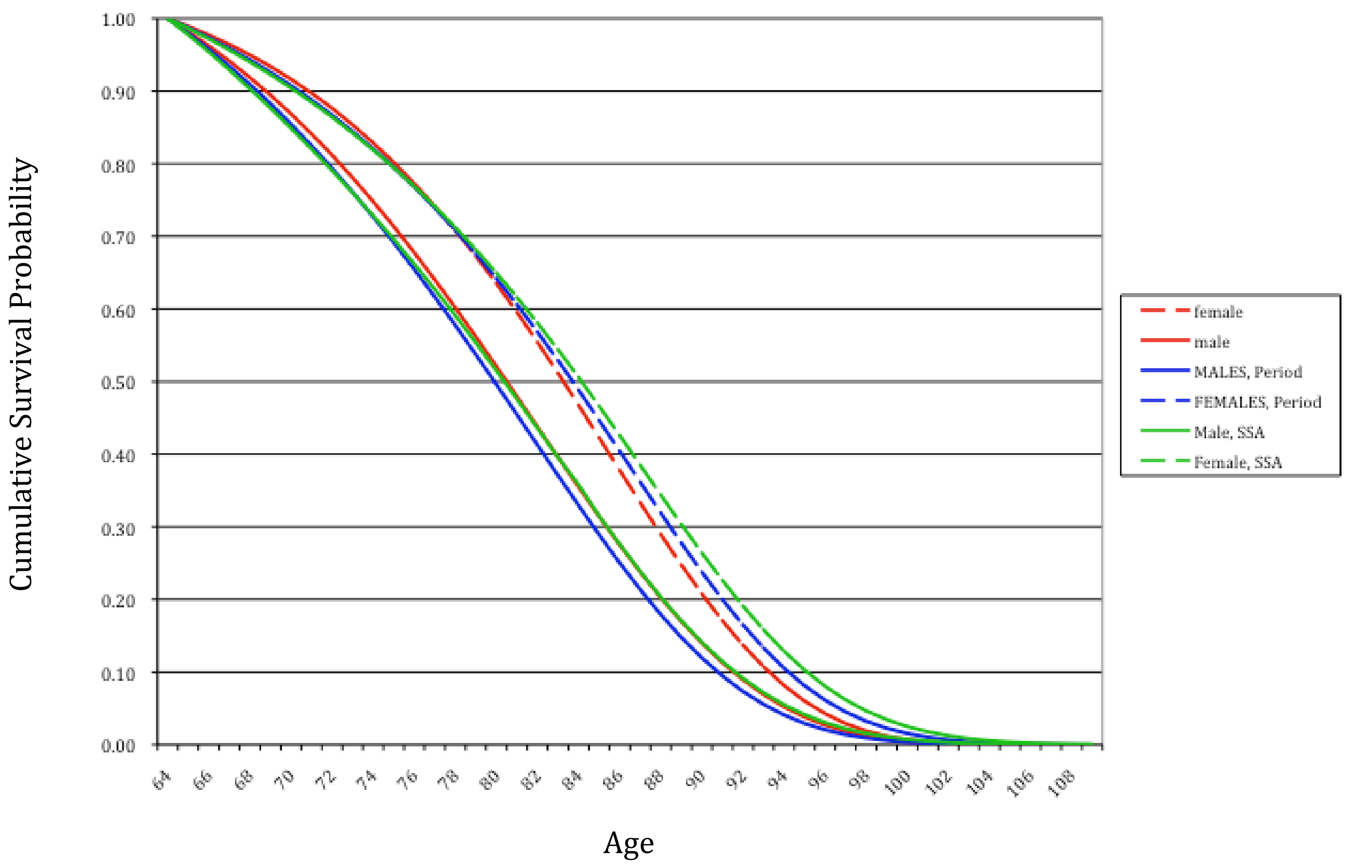
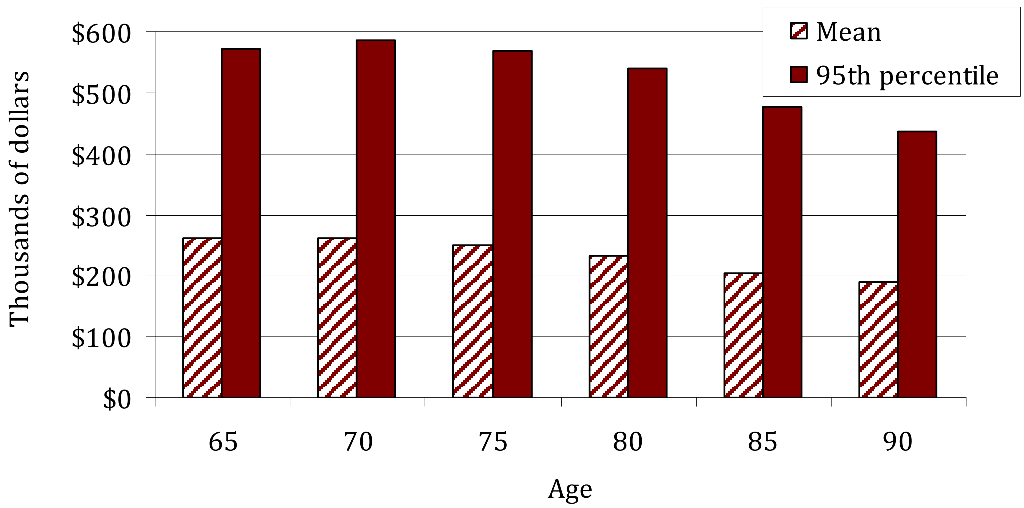
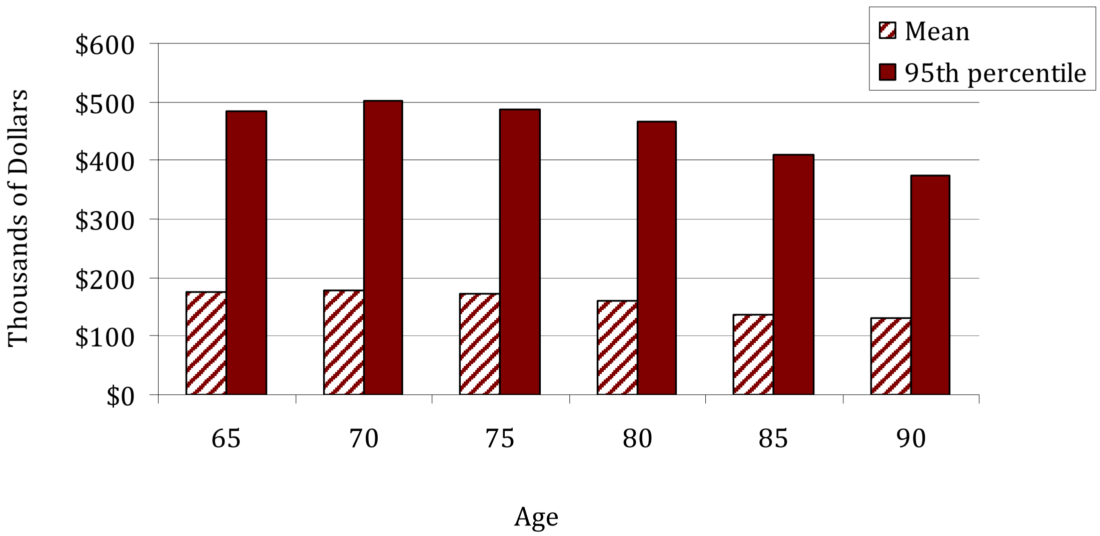


Figure 3A: Mean and 95th Percentile of Health Care Costs Including Nursing Home Costs and Insurance Premiums - Married Couples at Selected Ages



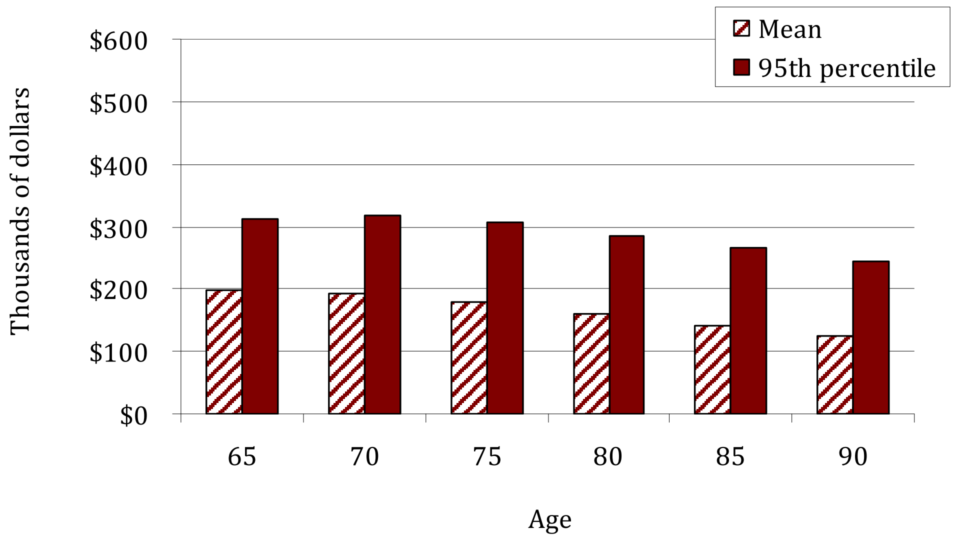
Notes: Amounts are in 2009 dollars for in-tact married couples. Households are assumed to have a high-school education, and to be free of chronic disease at age 65.

Figure 3B: Mean and 95th Percentile of Health Care Costs Including Nursing Home Costs But Excluding Insurance Premiums - Married Couples at Selected Ages



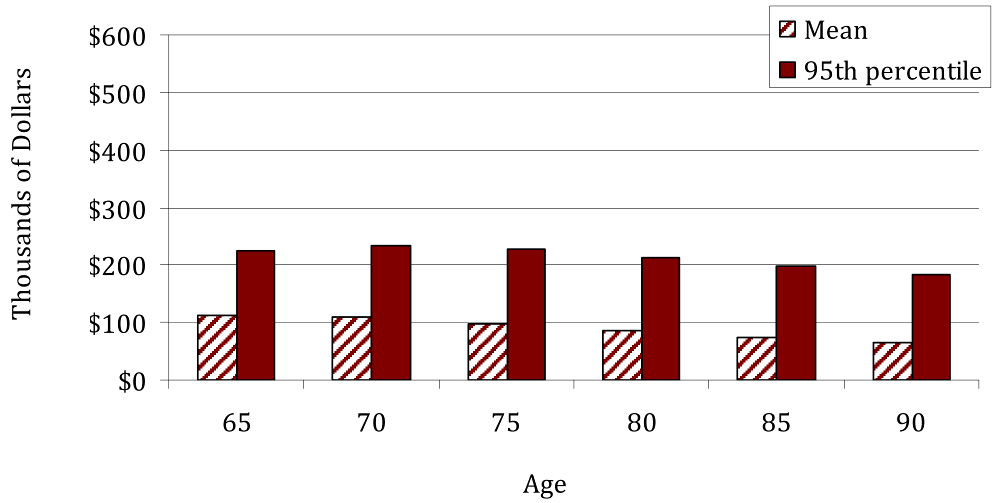
Notes: See Figure 3A.

Figure 4A: Mean and 95th Percentile of Health Care Costs Excluding Nursing Home Costs But Including Insurance Premiums - Married Couples at Selected Ages



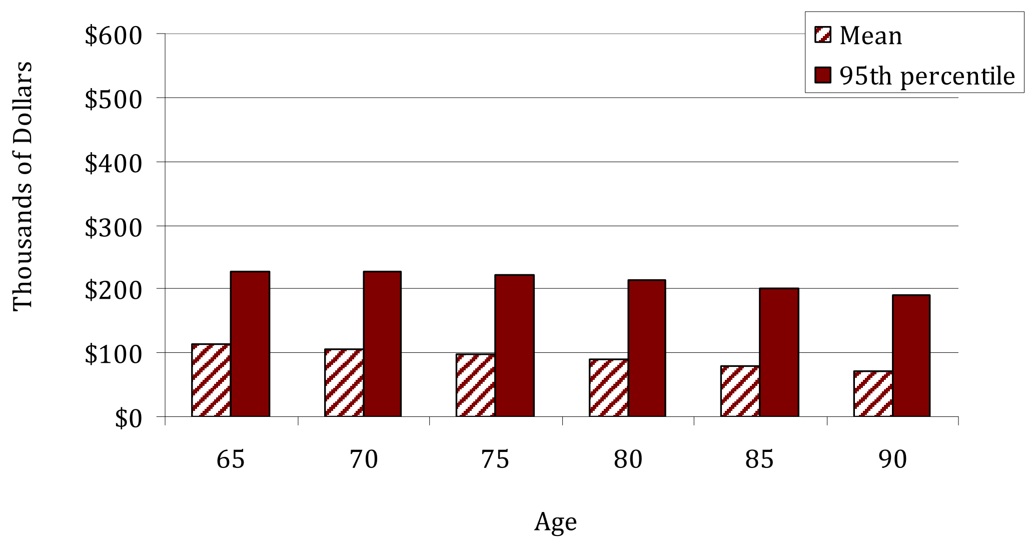
Notes: See Figure 3A.

Figure 4B: Mean and 95th Percentile of Health Care Costs Excluding Nursing Home Costs and Insurance Premiums - Married Couples at Selected Ages



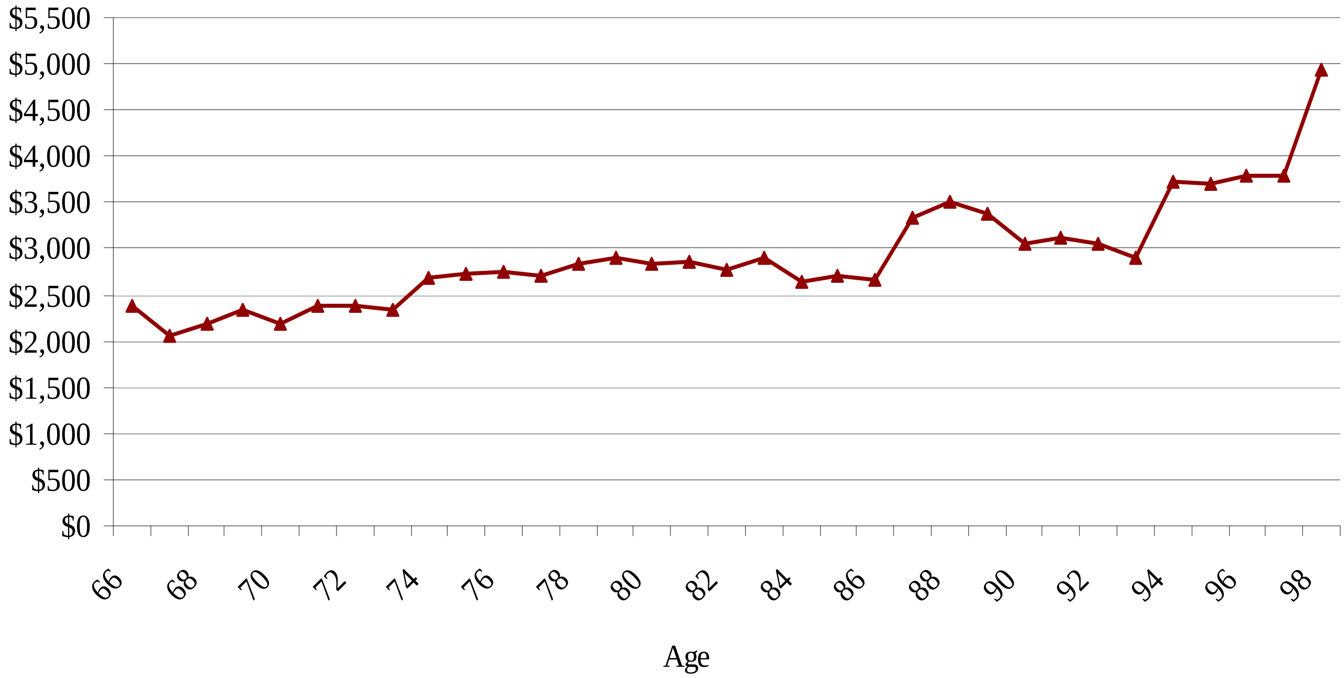
Notes: See Figure 3A.

Figure 4C: Mean and 95th Percentile of Health Care Costs Excluding Nursing Home Costs and Insurance Premiums - Married Couples at Selected Ages Who Remain in Good Health



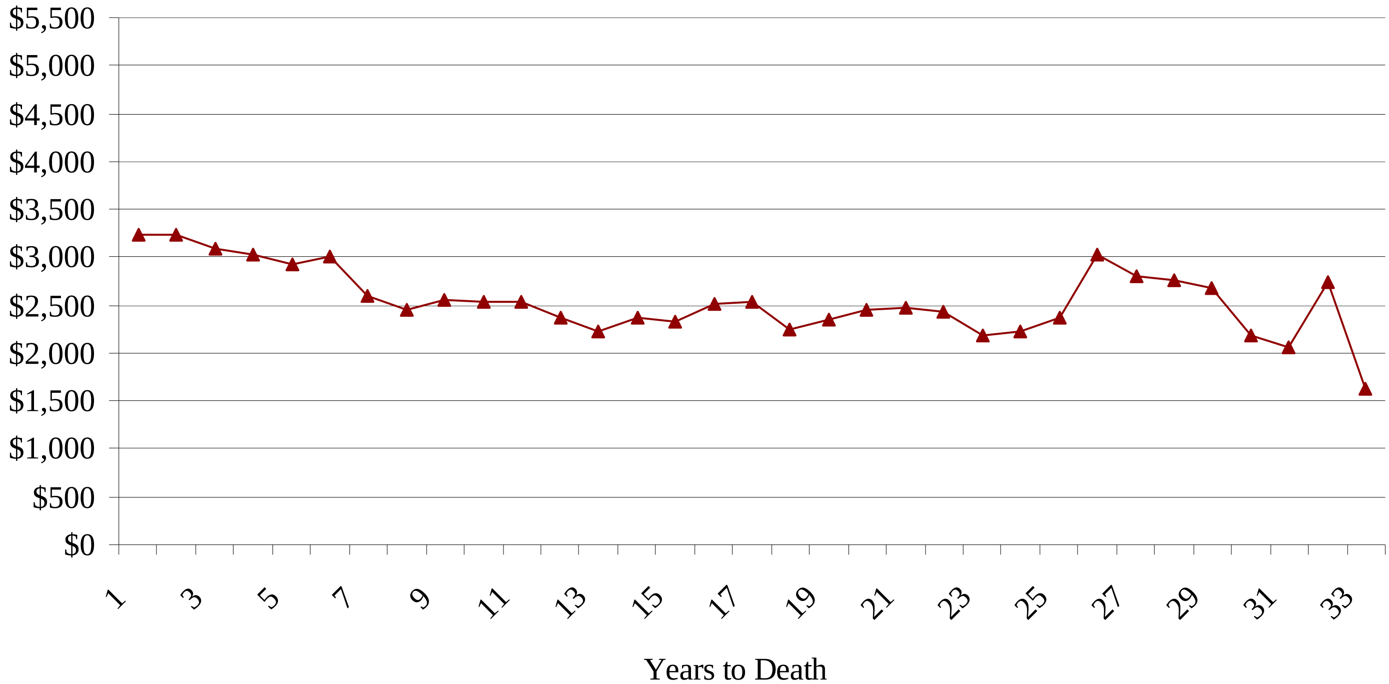
Notes: Amounts are in 2009 dollars for in-tact married couples. Households are assumed to have a high-school education, and to be free of chronic disease at above ages, although tye may subsequently acquire a disease.

Figure 5: Mean Annual Individual-Level Health Care Costs Excluding Premiums and Nursing Home Care , By Age



Notes: The extent to which the health care costs of a particular birth cohort increase with age will depend on the relationship between health costs and age, and the extent to which health costs increase over time. The figure excludes the latter effect and assumes that individuals continue to consume the quantity of health serices consumed during the period 2004-2006, expressed in 2009 dollars.

Figure 6: Mean Annual Individual-Level Health Care Costs Excluding Premiums and Nursing Home Care, By Years to Death



Notes : See Figure 5.

Recent Working Papers from the Center for Retirement Research at Boston College

Impact of Immigration on the Distribution of American Well-Being
Gary Burtless, December 2009

Actual and Anticipated Inheritance Receipts
Norma B. Coe and Anthony Webb, December 2009

Will Automatic Enrollment Reduce Employer Contributions to 401(k) Plans
Mauricio Soto and Barbara A. Butrica, December 2009

How Seniors Change Their Asset Holdings During Retirement
Karen Smith, Mauricio Soto, and Rudolph G. Penner, December 2009

Retirement Security and the Stock Market Crash: What Are the Possible Outcomes?
Barbara A. Butrica, Karen E. Smith, and Eric J. Toder, November 2009

Fees and Trading Costs of Equity Mutual Funds in 401(k) Plans and Potential Savings from ETFs and Commingled Trusts
Richard W. Kopcke, Francis Vitagliano, and Zhenya S. Karamcheva, November 2009

Work Ability and the Social Insurance Safety Net in the Years Prior to Retirement
Richard W. Johnson, Melissa M. Favreault, and Corina Mommaerts, November 2009

Dutch Pension Funds in Underfunding: Solving Generational Dilemmas
Niels Kortleve and Eduard Ponds, November 2009

The Wealth of Older Americans and the Sub-Prime Debacle
Barry Bosworth and Rosanna Smart, November 2009

Insult to Injury: Disability, Earnings, and Divorce
Perry Singleton, November 2009

An Update on 401(k) Plans: Insights from the 2007 Survey of Consumer Finance
Alicia H. Munnell, Richard W. Kopcke, Francesca Golub-Sass, and Dan Muldoon, November 2009

All working papers are available on the Center for Retirement Research website (http://www.bc.edu/crr) and can be requested by e-mail (crr@bc.edu) or phone (617-552-1762).