The Trajectory of Wealth in Retirement

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Abstract

In this paper, we develop a measure of household resources that converts total financial and nonfinancial assets, plus annuity-like assets (mainly, Social Security and defined benefit pensions) into an expected annual amount of wealth per person in retirement. We use this measure, which we call "annualized comprehensive wealth," to investigate spend-down behavior among a panel of older households in the Health and Retirement Study (HRS) from 1998 to 2006. Our analysis indicates that for most retired households, comprehensive wealth balances decline much more slowly than their remaining life expectancies, so that the predominate trend is for real annualized wealth to rise significantly with age over the course of retirement. Comparing the estimated age profiles for annualized wealth with profiles simulated from several different life cycle models, we find that a model that takes into account uncertain longevity, random medical expenses, and intended bequests lines up best with the broad patterns of rising annualized wealth in the HRS.

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1 Introduction

The ability to finance consumption in old age depends not only on the total amount of resources at the onset of retirement, but also, crucially, on how quickly or slowly those resources are spent after retirement. To provide a new empirical perspective on spend-down patterns, we construct a measure of the total resources available per expected year of life for a panel of retired households in the Health and Retirement Study (HRS) from 1998 to 2006. We call our measure "annualized comprehensive wealth." Our measure is *comprehensive* because in addition to net worth as it is usually defined—the sum of financial and nonfinancial assets net of debt—it also includes the value of Social Security benefits, defined-benefit pensions, and, for eligible recipients, transfer payments such as Food Stamps and Supplemental Security Income. For many retirees, these additional items constitute a sizable fraction of total resources. Our measure is an *annualized* concept in the sense that it measures the amount of wealth that is available for each expected year of remaining life and for each person in a retired household. In examining this measure of retirement wealth, we were motivated by the following reasoning. Annualized comprehensive wealth measures the constant amount that a retired household could afford to spend, in expectation, every year until they die. If the micro-data showed a strong tendency for annualized comprehensive wealth to either fall or rise substantially in retirement, we would probably want to know why.

Our paper adds to a large and growing body of research on the evolution and adequacy of retirement wealth.[1] Most directly, our paper is related to two studies that highlight the importance of precautionary saving for explaining the wealth holdings of older Americans (Palumbo, 1999; De Nardi, French, and Jones, 2006). These studies each find that wealth balances do not decline as quickly as standard life-cycle models would predict but that a slow decumulation pattern can be explained (at least partly) by the precautionary effects of uncertain out-of-pocket medical costs. The key contribution of our study is to look at a similar set of questions through the lens of annualized wealth, which we argue provides a more direct measure of the evolution of household resources. While an annualized concept of wealth is not itself an entirely new idea, as far as we know, we are the first to examine annualized wealth in the context of the life cycle model.[2]

[1] The research on retirement wealth is too extensive to include more than a representative set of citations. A number of previous papers find that a substantial fraction of aging households are poorly positioned to finance retirement (see Bernheim, 1992; Munnell and Soto, 2005; Mitchell and Moore, 1998) and that the situation may be even worse for younger age groups (Munnell, Webb, and Delorme, 2006). See Skinner (2007) for a recent perspective on the literature. However, other studies generally find that observed behavior is in line with the predictions generated by stochastic life cycle models (see Engen, Gale, and Uccello, 1999, 2005; Scholz, Seshadri, and Khitatrakun, 2006). Another set of papers examines changes in consumption at the time of retirement (Hurd and Rohwedder, 2006; Aguiar and Hurst, 2005; Blau, 2008).

[2] Two recent empirical studies examine an annualized concept of wealth in the context of wealth adequacy.

What are the advantages of looking at annualized wealth as opposed to wealth balances alone? First, it helps us identify the direction of change in a household's ability to finance future spending in retirement. Whereas a decline in wealth balances can be consistent with either an increase or a decrease in the amount of resources available per expected remaining year of life, a decline in annualized wealth implies an unambiguous contraction. Second, annualized comprehensive wealth is a measurement concept that could help distinguish between reductions in consumption due to insufficient resources (in which case we would expect both annualized wealth and consumption to be low) and the consequences of other motives, such as precautionary savings or intentional bequests (in which cases we would expect annualized wealth to exceed consumption). Whether annualized wealth rises or falls during retirement therefore can provide important clues that can help in sorting out the underlying causes of spending and saving behavior in retirement. Finally, because we generally lack household-level panel data on wealth and consumption changes over retirement, annualized wealth provides a bridge between wealth balances and what those balances imply for annual consumption possibilities.[3] Developing that bridge is one of the principle motivations and contributions of the current study.

Our analysis of the HRS panel documents strongly rising patterns of annualized wealth in retirement. We find that the median value of annualized comprehensive wealth for the cohort of households aged 70 to 75 years in 1998 rises significantly in retirement, from about $32,800 per person per year in 1998 to about $42,200 per person per year in 2006—a net increase of nearly 30 percent in just eight years. That is, comprehensive wealth balances in the HRS tend to decrease much more slowly than life expectancy shortens in old age. Our regression-based estimates of the age profile through the full span of retirement indicate that the median surviving household tends to see its annualized comprehensive wealth climb from $25,600 per person per expected year of life at age 65 to more than $50,000 by age 90.[4]

Haveman, Holden, Wolfe, and Sherlund (2006) report ratios of retirement wealth in annual terms to poverty using cross-sectional data. Haveman, Holden, Wolfe, and Romanov (2007) use Social Security data to compare wealth for a particular older cohort at two points in time. In a separate paper, we report some statistics on annualized wealth in recent waves of the Health and Retirement Study (Love, Smith, and McNair (2008)). None of these papers consider the evolution of annualized wealth over the course of retirement in the context of the life cycle model.

[3]Note the distinction between consumption *possibilities* and optimal consumption. As we show later, in certain specifications of a life-cycle model, annualized wealth tracks optimal consumption fairly closely, particularly over the first half of retirement. In general, however, the two concepts are not the same, and interpreting annualized comprehensive wealth as a measure of welfare is complicated by the presence of precautionary saving motives and other factors.

[4]Survivorship introduces complications into any study examining the evolution of wealth. As we discuss in more detail below, the panel nature of our data allow us to control, at least partly, for some sources of survivorship bias (e.g., the over-representation of longer-lived, wealthier households that can lead to bias in cross section studies). In addition, we also show how our empirical results change when we control for subjective survival expectations and for non-random attrition. Nevertheless, because survivors may always

As in other studies of household savings, we find considerable heterogeneity in the evolution of household wealth, with annualized wealth falling for some households and rising for others. The distribution, however, is heavily tilted toward increases in annualized wealth. Indeed, we estimate that nearly one-half of older households saw their annualized comprehensive wealth rise by more than 25 percent from 1998 through 2006, while about one in eight experienced a decrease of 25 percent or more over the same time period. Further, this distribution of outcomes is surprisingly similar when we look across retired households by marital status and even by household income. We also find (to varying degrees) patterns of increasing median annualized wealth across race, education, and health groups. Looking at wealth components, we find that both financial and nonfinancial wealth rose in annualized terms over the sample period.[5] Although some of the increase in nonfinancial wealth in the HRS panel seems to have been accounted for by large capital gains accruing to housing between 1998 and 2006, the data indicate that we would have estimated a net increase in annualized wealth in retirement even absent those unusual gains.

Why might households draw down their wealth balances so slowly relative to life expectancy? To consider some possible explanations, we simulate several specifications of life-cycle models of retirement consumption, adding to the simplest models some elements that have been emphasized in previous studies: uncertain longevity (Yaari, 1965; Davies, 1981; Hubbard, 1987; Hurd, 1989), random (and potentially large) out-of-pocket medical expenses (Palumbo, 1999; French and Jones, 2004; Anderson, French, and Lam, 2004), and explicit bequest motives (Kotlikoff and Summers, 1981; Hurd, 1987, 1989; Bernheim, 1991; Laitner and Juster, 1996; Dynan, Skinner, and Zeldes, 2002; De Nardi, 2004; Kopczuk and Lupton, 2007). We benchmark our different model specifications to the HRS data on a household-by-household basis and compare simulated annualized wealth trajectories with the empirical trends. We find that although models incorporating either random medical expenses or altruistic bequests can generate upward-sloping profiles of annualized wealth, the simulated profiles are generally much flatter than those evident in the HRS panel data. Rather, the strength of the overall increase in annualized comprehensive wealth seen in the HRS lines up best with model simulations that incorporate both of these saving motives, in combination with uncertain longevity. In particular, we find that the prospect of large medical expenses induces retirees to build a precautionary buffer early on, while a desire to leave a bequest leads them to maintain "excess savings" toward the end of life, and the size of these effects are not far from the patterns in the HRS.

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differ in important ways from non-survivors, it is not possible to eliminate all potential sources of bias.

[5] Essentially by definition, the annualized values of Social Security and DB pension wealth are virtually constant over the retirement period. We convert expected Social Security and DB pension payments into a present value and then back into an annualized value in order to account for the non-indexation of some benefits as well as the effect of survivors benefits on the expected resource stream of married couples. See Appendix 1 for more details.

We also find that while conventional life cycle specifications may do a good job explaining some general tendencies of annualized wealth changes for the median household, they are less successful at matching the heterogeneity in wealth trajectories across individual households. The key contribution of our modeling approach is to investigate the behavior of annualized wealth (rather than wealth levels) in standard specifications of stochastic life cycle models. Doing so not only allows us to connect the simulation findings to our empirical measures; it also highlights how the evolution of consumption (what we would ideally like to measure) and annualized wealth (what we are actually able to measure) are likely to differ depending on the relative importance of bequests and precautionary saving at the tail end of the life cycle.

2 Data and Descriptive Statistics

We use longitudinal data from the 1998 through 2006 waves of the Health and Retirement Study (HRS). The HRS is a panel of older households that began by surveying respondents aged 51 to 61 in 1992. The HRS has reinterviewed those households every two years and has added several additional cohorts along the way. In 1998, the HRS merged with a similar survey called Aging and Health Dynamics (AHEAD), which covered households aged 70 and over in 1993. The 1998 wave of the HRS also added two additional cohorts: the War Baby cohort (aged 51 to 56 in 1998) and the Children of the Depression cohort (aged 68 to 74 that year). Thus, the 1998 wave is the first to represent the full population of U.S. households aged 51 and over—for this reason, we begin our analysis with the 1998 wave.[6]

We select households aged 65 or more in the 1998 HRS survey, and we collect information on households that survive through the 2006 wave. We focus on surviving households to mitigate the effect of survivorship bias: since we are interested in wealth profiles, non-random attrition from the sample could significantly impact the results. For example, if we included non-surviving 1998 households and lower-wealth households were more likely to drop out, we could find upward-sloping median wealth profiles just from changing sample composition, even if each individual household's profile were perfectly flat. Selecting surviving households mitigates this source of bias by holding the sample constant.

The downside of this approach, of course, is that it provides no information on the profiles of non-surviving households—which could differ from those of surviving households. To investigate this, we separately estimate the profiles of non-surviving households through their final year of observation. As we show below, we find that, while non-surviving house-

[6]We use the RAND HRS data file, which is RAND's longitudinal file of commonly used HRS variables linked by households across time. We supplement this file with our own calculations of the actuarial present values of expected flows from Social Security, defined-benefit pensions, life annuities, and transfer payments such as veterans' benefits, Food Stamps, and Supplemental Security Income. See Appendix 1 for details.

holds tend to have lower levels of wealth, the slopes of their wealth age profiles are quite similar to the survivor group—in particular, median annualized wealth rises at similar rates regardless of survival status. We conclude that survivorship bias is not driving the tendency for annualized wealth profiles to rise in the HRS.

Table 1 reports some demographic information for our sample of 4,630 households in 2006. The average age is about 80 (for married households, we take the maximum of the spouses' ages). Nearly half are single women (many of them widowed), about 37% are married, and 14% are single men. Average annual income is about $47,000. For just over half the sample, a high school degree is the highest level of education attained. About 10% of the households in our sample are nonwhite and 5% are Hispanic. About two-fifths report being in fair or poor health, and the average household spent about $2,500 on out-of-pocket on medical care during the prior year.[7]

For selected survey years, Table 2 provides a breakdown of the components of comprehensive wealth for the median surviving household aged 70-75 in 1998.[8] Because the median is a nonlinear statistic, median comprehensive wealth will not generally equal the sum of the component medians. To generate a table in which the components add up to the total median comprehensive wealth for a given year, we calculate mean values of a trimmed sample selected so that the mean comprehensive wealth of the trimmed sample is equal to the median of the original sample. Thus, the rows of the table can be thought of as representing the average breakdown of median comprehensive wealth in each year.

As shown in the table, just over half of median comprehensive wealth ($264,000 of $493,000) is made up of the present value of annuity-like benefits in 1998—the largest of which is Social Security ($177,000). However, the share of wealth from this source declines over time as life expectancies fall (from 54% in 1998 to 43% in 2006). Financial wealth, in contrast, maintains a roughly constant share of about one-fifth of comprehensive wealth, while nonfinancial wealth (mostly housing) increases its share significantly, from a quarter in 1998 to over a third in 2006, due in part to sizable capital gains over this time period. The remainder of our analysis will focus on our measure of annualized wealth, rather than on wealth balances.

[7]The survey actually asks about spending over the prior two years. We assume the spending was evenly divided over each of the prior two years. Note that the distribution of annual out-of-pocket medical expenses is quite positively skewed; median annual outlays are reported to be only about half as large as the mean (around $1,200 for the median household).

[8]Choosing a single cohort helps distinguish age effects from cohort effects by holding the cohort constant.

3 A Measure of Annualized Wealth for Retirees

3.1 Definition of annualized wealth

We define annualized wealth to convert our broad measure of total comprehensive wealth into an amount of annual resources available per person over their expected remaining lifetimes. Our measure of annualized wealth can be thought of as the per-person annual payout from an actuarially fair, inflation-indexed, joint fixed life annuity that a retired household could, in theory, purchase with its comprehensive wealth balance (see Brown and Poterba (2000)).[9] However, as we describe below, annualized wealth is also closely related to optimal consumption in some simple life-cycle model specifications.

For each household, we define annualized wealth as

$$AW_t = a_t W_t,$$

where W_t is the household's comprehensive wealth balances at age t, and a_t is the annualizing factor that converts the balance into dollars per person per expected year of remaining life. We define a_t as

$$a_t = \left[\sum_{i=0}^{T} \left\{ \frac{\alpha S^f_{t+i} S^m_{t+i} + S^f_{t+i}(1 - S^m_{t+i}) + S^m_{t+i}(1 - S^f_{t+i})}{(1+r)^i} \right\} \right]^{-1}, \tag{1}$$

where S^f_{t+i} is the probability that a female currently aged t lives to age $t+i$, S^m_{t+i} is the analogous probability for males, T is the maximum attainable age for any person, r is the real discount rate (assumed to be constant)[10], and α is an adjustment for household economies of scale ($\alpha \leq 2$) that may allow couples to spend less per person than single retirees.[11]

[9] For practical purposes, Social Security is such an annuity. In general, however, we view annualized wealth as a hypothetical construct because, in the U.S. at least, prices for actual fixed life annuities are far from actuarially fair. See, for example, Mitchell, Poterba, Warshawsky, and Brown (1999).

[10] We assume a real interest rate of 2.5 percent and an inflation rate of 2 percent, in line with recent values of the inflation-indexed long-term average interest rate. According to the Federal Reserve Statistical Release H15, the average yields on TIPS with maturities longer than 10 years was 2.26 percent for the 2003–2007 period reported in the table. The average value of 10-year nominal Treasuries over the same period is 4.40 percent.

[11] See Citro and Michael (1995) and Fernándes-Villaverde and Krueger (2007) for a detailed discussion of household equivalence scales. In the absence of scale economies, $\alpha = 2$; we adopt an equivalence scale of 1.67 for a two-person household. For comparison, the OECD scale for a two-adult household is 1.7 and the scale recommended in Citro and Michael (1995) for a two-adult household is 1.62 ($= 2^{0.7}$). In our sample, about 15 percent of households contain more than two members (either children living at home or other adults). Adjusting our annualizing factor for these more complicated family structures would require modeling the likelihood that the additional members remain in the family unit, as well as their contribution to total household resources. In the absence of such data, we ignore the effect of additional members on the equivalence scale.

Table 3 illustrates how our annualizing factor varies with age and marital status. For a given age, couples have lower factors because they have to share resources (though with some economies of scale, as noted above). Single men have lower life expectancies, and thus higher annualizing factors (i.e., they can afford to spend more per year) than single women. As households age, life expectancies fall, causing the annualizing factors to rise.

3.2 Annualized wealth and optimal consumption in the life cycle model

Figure 1 shows the shape of the optimal age profile in retirement of annualized wealth in several versions of stylized stochastic life cycle models; the figure also shows how annualized wealth relates to (or compares with) the age profile of optimal consumption in the models.[12] The purpose of this figure is purely illustrative: We set initial wealth levels in retirement to match the median in the HRS, but, for now, we do not attempt to match other sample characteristics (as we do in later in the paper).

Panel (a) of the figure shows that in the simplest life cycle model of consumption during retirement—a stripped-down version in which forward-looking, retired households are uncertain about their longevity, but not about anything else that affects their spending decisions—our measure of annualized wealth is very close to the optimal level of consumption for all ages.[13] As shown in panel (b), adding an explicit bequest motive to the life cycle model drives a wedge between the levels of annualized wealth and optimal consumption as households age—at least among those retirees who have "enough" resources for the bequest motive to operate strongly (the figure shows that, in this calibration, the median retiree's spending and saving decisions are affected by the bequest motive). But even with a relatively strong bequest motive, the growth rate of annualized wealth is relatively slow, on the order of about 1 percent per year from age 65 to 83—the period when the age profile is steepest.

Panel (c) shows age profiles from a simulated life cycle model that ignores any explicit bequest motive, but that includes a precautionary saving motive for retirees. In this version of the model, retirees are assumed to realize random draws for (potentially large) out-of-pocket medical expenses that essentially serve as "resource shocks" with no separate utility value (that is, they derive utility only from spending on nonmedical goods and services). As in the specification with the bequest motive, the precautionary saving motive can be

[12] The life cycle models used to generate this figure are similar to the models used below to more directly compare with the empirical age profiles of annualized comprehensive wealth in the HRS. Appendix 2 describes the model specifications in detail.

[13] The difference between annualized wealth and consumption depends on the degree of relative risk aversion and on the value of assets retirees bring into retirement relative to their Social Security and DB pension benefits. The close correspondence between consumption and annualized wealth holds for moderate degrees of risk aversion; indeed, under log utility, annualized wealth is exactly equal to optimal consumption at each age.

seen to drive a wedge between the levels and the slopes of annualized wealth and optimal consumption during retirement—particularly over the first half of retirement. Panel (c) shows that the age profiles of both optimal consumption and annualized wealth slope up from age 65 through 83—at average annual rates of 1 percent and 11/4 percent per year, respectively. At older ages, both profiles show a fairly steep downward trajectory.

Panel (d) shows that a life cycle model of retirement spending that includes both the precautionary saving and the bequest motive implies the largest wedge between the levels and the slopes of the age profiles for annualized wealth and optimal consumption. The combination of the two motives leads retirees to build up relatively large buffers of resources relative to life expectancy from age 65 to about 83, then to essentially maintain the large buffer in old age even as their rates of survival drop sharply. In these calibrations of the life cycle model, the precautionary and bequest motives combine to generate a modest upward sloping age profile for annualized wealth in the first stage of retirement (say, from age 65 to 83) on the order of 2 percent per year.

To summarize, we have shown that calibrated life cycle models do not generally suggest that retirees should necessarily attempt to maintain a constant level of annualized wealth over the course of retirement (as might be the case, for example, if retirees knew they would live to their life expectancies for certain). However, in the models we have considered, optimal age profiles for annualized wealth only display a modest upward slope over the first half of retirement. Therefore, if a significantly downward-sloping age profile for annualized wealth were prevalent in the HRS panel data, we would be tempted to infer that many retirees seemed to be "running out of money" early in retirement and we would want to think about why this is happening. By contrast, if a substantially upward-sloping age profile were prevalent in the data, we would wonder why so many in the HRS were "saving so much money"—even relative to life cycle models calibrated to include plausible bequest motives and precautionary motives.

4 Age Profiles of Annualized Wealth in the HRS

4.1 Annualized wealth for a cohort of retirees in the HRS

Table 4 reports median levels of comprehensive wealth and annualized wealth for a balanced panel of households aged 70 to 75 in 1998 with complete panel data from 1998 through 2006.[14] For the median household in this cohort, comprehensive balances fall from

[14]As discussed above, the balanced panel has the advantage of mitigating the "classical problem" of survivorship bias that affects similar tabulations computed using cross-section data. As explained in Shorrocks (1975) and Attanasio and Hoynes (2000), the classical problem is that if wealthier individuals are more likely to survive to older ages, then cross-section data will tend to show a positive association between wealth and age, as the less wealthy individuals are "over-represented" in the younger age groups.

$493,000 in 1998 to $434,000 in 2002 and to $393,000 in 2006—an average rate of decrease of 3.7 percent per year. However, because of decreases in household size and life expectancies, annualizing factors rise considerably, and thus annualized comprehensive wealth grows markedly over the 8-year period—from $32,800 per person per expected year of life in 1998 to $35,400 in 2002 and to $42,200 in 2006. This represents an average annual increase in annualized wealth of 4.3 percent per year, or nearly 30 percent, cumulatively, from 1998 through 2006. Thus, we find that while comprehensive wealth declines with age, it declines much more slowly than life expectancies shorten.

The middle section of Table 4 compares changes in the annualizing factors and annualized wealth of retirees in the cohort who were single in 1998 with those who were married in that year. While both single and married retirees in the HRS experienced significant increases in annualized comprehensive wealth between 1998 and 2006, the increases were somewhat larger for couples (4.7 percent per year, on average) than for single retirees (3.7 percent). One reason for this difference is that some spouses die during the period, leading to a jump in their households' annualizing factor (owing to the steep drop in the "overall" life expectancy) and therefore in the amount of annualized wealth that can be afforded with a given comprehensive wealth balance.

The bottom section of the table compares the trajectory of annualized wealth from 1998 to 2006 for households in the bottom 20 percent of the income distribution with those in the top 20 percent. The conclusions are similar to those above. The median retired household in both income groups experienced a significant increase in annualized comprehensive wealth over the 8-year period covered by our HRS data, but the rate of increase was larger for retirees in the high-income group than in the low-income group. The quantitative difference in the slope of the age profile for annualized wealth reflected two factors: First, high-income retirees spent down their comprehensive wealth balances more slowly than did low-income retirees (0.6 percent per year, on average, vs. 5.6 percent); and second, high-income retirees experienced a slower average rate of increase in their annualizing factors between 1998 and 2006, in part because they were more likely to stay married.

Table 5 shows that, for several subgroups of income and marital status, about 45 percent of households experienced an increase in annualized wealth between 1998 and 2006 that was 25 percent or larger, while about 10 to 15 percent of households experienced a decrease in annualized wealth of at least 25 percent.

As noted above, confining the analysis to individuals who survived until 2006 reveals nothing about the possibly different trajectories for non-survivors. When we calculate changes in wealth among households who drop out before 2006, we find that they do indeed have lower levels of annualized wealth—about $24,000 per person per year at the median in 1998, compared to $33,000 among survivors—but the *trajectory* of annualized wealth is quite similar—growth of about 3.4 percent per year for non-survivors, vs. 4.3 percent per year among survivors. Moreover, the distribution of annualized wealth changes is essentially identical between the two groups.

4.2 Age profiles of annualized wealth in the HRS over the span of retirement

As a preliminary empirical look at the evolution of resources over the course of retirement, we construct nonparametric profiles of median wealth in the HRS between the ages of 65 and 90 years.[15] Although nonparametric age profiles have a number of drawbacks (in particular, they do not control for cohort effects, survivorship bias, or household characteristics) they provide a sense of the raw data patterns without imposing any structural assumptions.[16]

Figure 2 shows that median annualized financial wealth is rising in real terms for most cohorts over the panel period (despite volatility in the stock market), but the combined profile in financial wealth across cohorts is relatively flat across the entire age distribution. This suggests that households do not appear to run down their financial wealth any more or less quickly than their life expectancies are shortening. We also see within-cohort increases in annualized *nonfinancial* wealth, reflecting the strong housing market over this period. But in contrast to financial wealth, we also see an increasing age profile of nonfinancial *across* cohorts, suggesting that households may be reluctant to fully consume their housing wealth as they age. The real annualized value of annuity-like wealth (mainly, Social Security and DB pensions, recall) is, not surprisingly, roughly flat over the retirement period, with perhaps a slight decline because some benefits are not fully indexed to inflation. All told, the median value of annualized comprehensive wealth shows an upward slope across older ages, from about $30,000 per person per year at age 65 to about $45,000 per person per year by age 90.

The raw profiles provide a broad-brushed view of the trajectory of annualized wealth within and across cohorts. To see whether these patterns hold up when we control for cohort effects, year effects (which help to control for movements in asset prices), and survivorship bias, we turn to estimating regression-based age profiles of wealth. Our basic strategy is to pool growth rates in annualized wealth across all observations in all survey waves of the HRS and to regress the growth rates on age indicator variables. The estimated

[15] To produce these profiles, we divide the surviving 1998 sample into age bins and calculate the median value of wealth for each bin over the following eight years. We use the HRS sampling weights to compute the medians in each age group. We plot six points for each age group, corresponding to the 1998, 2000, 2002, 2004 and 2006 waves of the HRS. Arrayed by age on the horizontal axis, the series of segments trace out an empirical age profile of wealth.

[16] To conserve on space, we omit the raw profiles for the components of wealth balances (as opposed to annualized wealth). At the median, the raw profiles for median comprehensive wealth and all of its components decline markedly with age, suggesting that some degree of spend-down is occurring.

coefficients can then be used to construct age profiles over the full range of ages from 65 to 90. The focus on wave-to-wave growth rates helps mitigate survivorship bias in two ways. First, because the wave-to-wave growth rates are calculated only for households who survive from one wave to the next, the slope estimates of annualized wealth will be unaffected by the "classical problem" of nonrandom attrition. At the same time, selecting wave-to-wave survivors rather than full-panel survivors mitigates the sample selection problem that arises because survivors may differ in their saving behavior (and in other ways) from non-survivors.[17] Second, we mitigate the bias further by focusing on growth rates rather than levels. As noted above, there is much less difference between survivors and nonsurvivors in growth rates than in levels. While our methods help to reduce the effects of survival bias, we cannot claim to have eliminated it entirely—the fact remains that, for each age, we can only calculate a wealth change among households who survive for at least two waves.

To produce the regression-based profiles, we use a four-step procedure. First, we calculate a household-level wealth-growth factor from each wave to the next (resulting in four growth factors per household). Second, we pool all of the growth factors in the unbalanced panel data and estimate a median regression of the growth factors on indicators for two-year age brackets (e.g., 60-61, 62-63, etc.) and survey-year dummies.[18] Third, we use the estimated age coefficients to calculate predicted median growth factors for each age bin, and then multiply these together to construct a predicted "cumulative growth factor" across the full range of ages.[19] Finally, we connect the dots between each age's predicted cumulative growth factors to form an age profile. The resulting profile will be purely relative (e.g., an index taking the value of 1 at age 65); to convert it to level terms, we benchmark the middle of each age profile so that it passes through the median level of wealth held by 78-year-olds in our full sample.

4.3 Age profiles by household type

Figure 3 shows the resulting profiles of annualized comprehensive wealth, for various groups of households. Panel (a) shows that the median profile of annualized wealth for all households increases fairly steeply from about $26,000 per person per year at age 65 to about $52,000 at age 90. Panel (b) indicates an even steeper profile among married households,

[17] Survivors are always different than nonsurvivors—for example, they tend to have more wealth—but the differential is smaller when survival is defined only to the next wave, rather than to the end of the panel.

[18] We use two-year age bins, rather than single-year age indicators, simply to smooth the age profiles a bit. The results are qualitatively the same when we use single-year age dummies. We use the survey-year dummies to remove year effects (e.g. market conditions) when creating the profiles. Rather than including household characteristics in the regression, we estimate separate profiles for different household groups, as discussed below.

[19] For example, if the predicted median growth factor for age 60-61 were 1.10 and the predicted median growth factor for age 62-63 were 1.05, then the predicted *cumulative* growth factor for age 62-63 would be $1.10 \times 1.05 = 1.155$.

with single men and women experiencing much more gradual increases.[20] One should keep in mind, however, that any remaining survival bias due to differential mortality by wealth is exacerbated when selecting married couples.[21] Panel (c) shows median age profiles by income, where the income groups are defined conditional on marital status and age. We find that median annualized comprehensive wealth shows a gradual net increase for lower- and middle-income households, and a pronounced rise for upper-income households. That is, we find a rising pattern of median annualized wealth across all of the income distribution.

Panel (d) breaks households down by race and demonstrates a significantly steeper rise in annualized wealth among white households than nonwhite or Hispanic households. Panel (e) illustrates the effect of health status in 1998: healthy households show much more rapid accumulation of annualized wealth than less healthy households. However, like marital status, health status is variable over time, and thus the "healthy" profile is essentially representing households who are healthy as of the base year, rather than healthy at age 65.

Finally, panel (f) groups households by their base-year level of out-of-pocket medical expenses (where the groups are equal thirds of the expense distribution). We find that the slopes are quite similar across the groups until very old ages, when households with the highest levels of medical expenses show decreasing annualized wealth. This could indicate spend-down of resources in order to finance their medical care, or perhaps indicate increasing pessimism about life expectancy or quality of life, which could accelerate non-medical spending as well. To get a better sense of how empirically estimated age profiles might vary with such expectations of the future, we group households by expectation using some of the forward-looking questions in the HRS.

4.4 Age profiles by household expectation

Figure 4 breaks down estimated age profiles of annualized wealth by self-reported expectations over longevity, bequests, and nursing home stays. It also reports an estimated age profile for an alternative concept of annualized wealth that excludes resources that retirees might consider "already spoken for" in the sense that they are needed to cover expected (average) out-of-pocket medical expenses over the household's remaining lifetime.

Panel (a) shows that retirees in the HRS who are optimistic about their life expectancies relative to the actuarial values in the Social Security life tables (given their age and sex)

[20] Since we do not observe marital status as of age 65 for all households, we identify married households based on their status in the base year of 1998. Thus the profile is best interpreted as the median among "base-year-married" households, rather than among all households married at age 65.

[21] As a simple illustration, suppose that wealthy individuals of either gender survive to the next period with probability 0.9 and that poor individuals survive with probability 0.8. Compare these differential probabilities with those of a married couple. If marriages end only in death, a wealthy married couple will survive to the next period with probability 0.81, while a poor married couple will survive only with probability 0.64.

have significantly steeper increases in annualized wealth, primarily at the older ages. Thus, one motive for some retirees to build up wealth relative to actuarial life expectancies could be to provide resources that can last for a longer life than the standard tables predict. Heterogeneity in life expectancies seems to account for a little of the cross-section variation age profiles of annualized wealth, although even "pessimistic" retirees do not exhibit the downward-sloping trajectories one might expect.[22]

As shown in panel (b), the slope of the age profile also correlates with self-reported expectations about the likelihood that HRS respondents will leave a bequest, especially among the oldest retirees.[23] Households reporting a low probability of leaving a bequest display quite flat profiles at all ages in retirement, while those with medium and high probabilities show much steeper patterns, particularly around age 80. Of course, it is difficult to know whether this means that bequest expectations *explain* age profiles of wealth because of the likelihood of reverse causality—retirees who find themselves growing wealthier over the sample period would seem bound to be more likely to expect leaving a bequest, even if that had not been their primary motivation.[24]

Panel (c) distinguishes between households who report being more or less likely to be admitted to a nursing home in the next 5 years, capturing some of their expectations about the likelihood of significant future medical expenses. We find rising age profiles of annualized wealth across all categories of nursing-home expectations, though the rates of increase are significantly higher for retirees reporting medium and high probabilities of future nursing home stays than for those reporting low odds. Thus, the HRS survey data suggest that precautionary saving motives arising from the possibility of large future medical expenses could explain some of the broad tendency for annualized wealth to rise in the HRS panel and some of the variation among households, as well.

Panel (d) examines the effect of expected medical costs more generally on estimated age profiles for annualized wealth. To the extent that medical costs represent an exogenous shock to household resources, it may be of interest to track the evolution of annualized wealth net of expected annualized medical costs. We calculate each household's expected future medical costs by regressing log out-of-pocket expenses on age, education, race, financial

[22]Somewhat arbitrarily, we categorize households as "optimistic" if the ratio of their self-reported probability of surviving to a given age (coded by Rand) to the actuarial probability (in the life tables) is greater than 120%. Similiarly, we categorize households as "pessimistic" if the ratio of self-reported to actuarial survival rates is less than 80%.

[23]The question asks households for their subjective probability that they will leave a bequest of at least $100,000. We arbitrarily categorize households as "high" if they report a probability of at least 80%, and "low" if the reported probability is less than 20%.

[24]Note that the question is phrased as a bequest *expectation* rather than a bequest *motive*. There is a conceptual difference due to accidental bequests: a household that is self-insuring against outliving its resources may acknowledge the possibility of leaving an unplanned bequest (i.e., dying early) even if it places little value on doing so.

wealth, and year dummies. We estimate separate regressions for married couples, single males, and single females, and then use the coefficients to compute predicted present value medical costs for each household. As shown in the figure, subtracting the annualized value of expected medical costs has quite a small effect on the trajectory of annualized wealth. This is because typical annual per capita medical expenditures in the HRS data are small—only about $700 at the median. In addition, we have not found any strong association between changes in annualized wealth and reported medical expenses in the HRS. This suggests that although uncertainty about future medical expenses might be leading to precautionary motives for retirees to build wealth in annualized terms, it does not look as though high average (or expected) future expenses account for much of the upward-sloping profile early in retirement.

4.5 Sensitivity of the estimated age profiles to capital gains over the sample period

How should we interpret the build-up in wealth relative to life expectancy at the end of the life cycle? One question is whether the upward-sloping age profiles are simply the consequence of unexpected capital gains on housing or corporate equity over the 1998-2006 sample period.[25] To test the sensitivity of our results to these changes in capital gains, we re-estimate the regression-based age profiles using a counterfactual HRS dataset that holds each household's level of corporate equity and net housing wealth fixed over the sample years, letting the other components of comprehensive wealth follow their reported trajectories in the HRS. To remove capital gains from equities, we replace each household's reported holdings of corporate equity in each wave with its (household-specific) average value over the eight-year period. To remove the effects of the dramatic run-up in house prices, we replace each *non-moving* household's reported housing wealth in the five waves with the level it reported in 1998 (thereby assuming no change in housing wealth over our sample period).[26]

Perhaps surprisingly, we find that these adjustments to the reported measures of comprehensive wealth in the HRS do not materially change our result that median annualized wealth rises with age across all three income groups. The profiles continue to slope up for two reasons: first, other forms of financial and nonfinancial wealth (such as deposits, money

[25] Equity prices gyrated markedly over the sample period. The change in the Wilshire 5000 stock price index between 1998 and 2000 was 7.6 percent, between 2000 and 2002 was -31.5 percent, between 2002 and 2004 was 43.5 percent, and between 2004 and 2006 was 19.1 percent. Housing prices, in contrast, climbed steadily and substantially. On a seasonally adjusted basis, the cumulative change in the national purchase-only house price index produced by the Office of Federal Housing Enterprise Oversight (OFHEO) between 1998 and 2006 was 72.9 percent.

[26] We do not change the housing wealth of movers, because these wealth changes may not be due to capital gains—that is, these households may have either downsized or upsized their housing consumption.

market funds, mutual funds, vehicles, and business equity) increased notably in annualized terms across waves of the HRS. But more importantly, we find a rising slope of wealth across cohorts, reflecting different starting levels of wealth by age as of the base year of 1998. Thus, we conclude that the upward sloping age profile for annualized comprehensive wealth over retirement is not being driven by the effects of unanticipated capital gains on corporate equity or housing over our sample period.

5 Age Profiles of Annualized Wealth in Selected Life Cycle Models of Consumption

To shed more light on how the upward-sloping age profiles of annualized wealth might be interpreted, we compare our empirical profiles to those generated by a few fairly standard specifications of the life cycle model of consumption in retirement. The models are similar to those used in several other studies.[27] Our intention is not to try to develop a new framework capable of reproducing all key patterns in the data, but simply to ask whether a few factors that have been considered in the literature—uncertain longevity, an explicit bequest motive, and a precautionary motive—seem important in light of our new analysis of the age profiles of annualized wealth. As in section 3 above, we simulate four variations of the life cycle model, beginning with a baseline specification that introduces uncertainty only about how long retirees will actually live, then adding an explicit bequest motive (utility from wealth held at the time of death), a precautionary saving motive arising from uncertainty about future (random, exogenous) medical expenses, and all three of these features at the same time. The model specifications, described in detail in Appendix 2, adapt the cash-on-hand framework of Carroll (1997) and others to allow for household composition changes (see, e.g., Cubeddo and Ríos-Rull (2005)), an explicit bequest motive, and uncertainty about future resources (because of medical expenses).

We present results from two distinct simulation exercises. The first is designed to compare the broad empirical patterns of changes in annualized wealth over the span of retirement in the HRS data with simulated samples from the four life cycle models. These first set of simulations (reported in table 6) begin with an initial distribution of retirees aged 65 that have the same distribution of characteristics (marital status, net retirement income, and level of comprehensive wealth) as households aged 65 to 70 in our HRS sample.[28] The

[27] See, for example, Cagetti (2003); Carroll (1992, 1997) and Carroll and Samwick (1998) for models of precautionary saving in response to uncertain income, Palumbo (1999); Rust and Phelan (1997); French and Jones (2004); Anderson, French, and Lam (2004) and Davis (2006) for studies of the effect of uncertain medical expenses, and Kotlikoff and Summers (1981); Hurd (1987, 1989); Bernheim (1991); Laitner and Juster (1996); Dynan, Skinner, and Zeldes (2002); De Nardi (2004) and Kopczuk and Lupton (2007) for models incorporating explicit bequest motives.

[28] To run the simulation, we randomly draw (with replacement) 20,000 observations from our HRS sample

simulation involves drawing random realizations for survival and, where applicable, out-of-pocket medical expenses and assigning household consumption using the optimal policy function from the life cycle model (using a common set of preference parameters for all households in the simulation). The second set of simulations (reported in table 7) is more ambitious in that it uses more detailed information in the HRS data and the optimal policy functions from the life cycle model specifications to simulate annualized comprehensive wealth for each household in the HRS sample. These simulations provide another perspective on how well the stylized models fit the broad age-patterns of annualized wealth in the HRS and they "test" for how well the models might account for heterogeneity in changes in annualized wealth across households.

Table 6 compares median growth rates of annualized wealth in the HRS data (column (A)) with the first set of simulated values from the four life cycle model specifications (columns (B) to (E)). Column (B) shows that the baseline life cycle model produces consistently negative growth rates for annualized wealth, reflecting the discounting effect of declining survival probabilities in old age—this simulated pattern is in stark contrast with the HRS data (column (A)). Column (C) reveals that the life cycle model with an explicit bequest motive can generate an upward-sloping trajectory of annualized wealth in retirement, but simulated trajectory is much flatter than that seen in the HRS data, particularly for married couples. Column (D) shows that, over the first half of retirement (that is, up until age 80), the life cycle model with a precautionary motive due to random medical expenses generates a steeper upward-sloping trajectory of annualized wealth that is fairly close to the shape of the typical age profile in the HRS. However, beyond age 80, the optimal consumption rule in the precautionary saving model would drive down annualized wealth—a pattern that is contradicted by the HRS panel data on the oldest retirees. Thus, on their own, the "saving tendencies" in the calibrated life cycle models that include either a bequest motive or a precautionary motive do not seem to be strong enough to replicate the broad tendencies in the HRS.

However, column (E) indicates that simulated retirement periods from a life cycle model that includes all three elements—uncertain longevity and bequest and precautionary motives—come closer to matching the broad patterns in the HRS. Over the span of retirement (that is, looking across all ages), the model's simulated average increase in annualized wealth is 0.9% for married couples, 2.8% for single retirees, and 2.2% overall; corresponding estimates from the HRS panel are 1.5%, 2.6%, and 2.1%. However, the timing of the increases in wealth do not match very well: The model simulation shows faster increases in annualized wealth for households younger than age 80 than for the older retirees, while the oldest retirees in the HRS are found to have the fastest rates of increase.

aged 65 to 70.

Table 7 summarizes results from the second set of simulations, which use each household's actual income net of medical costs, marital status, ages, education, and cash on hand in each year of the HRS to predict a household-specific growth rate of annualized wealth, taking as given a household-specific bequest parameter.[29] Our procedure for selecting household-specific bequest parameters takes at face value each survey respondent's reported probability of leaving a bequest of at least $100,000.[30] For each household in our sample, we search over a range of values for the bequest parameter to find the value that generates the closest match between the simulated and reported probability of leaving a bequest over $100,000. The HRS bequest question does not distinguish between what underlying motives might generate a bequest—say, altruism toward children or grandchildren or accidental bequests from early death or favorable medical expense realizations. But our calibration procedure easily matches the strong tendency in the HRS data for wealthier respondents to be much more confident of leaving a large bequest than others. Indeed, all else equal, our calibration procedure will choose a *smaller* altruistic bequest parameter for a very wealthy HRS respondent who reports a 50% probability of leaving a $100,000 bequest than it will for a much more poor household who reports the same probability.

Table 7 shows that, as was the case in the first simulation, the baseline model generates negative growth rates of annualized wealth.[31] Columns (C) through (E) show, again, that models that includes both a bequest motive and uncertain medical expenses produce results that are more in line with the HRS than those produced by models with a bequest motive or medical costs in isolation. Further, when the bequest parameter is calibrated according to each household's stated probability of leaving a bequest, we see a smaller effect of bequests on the median growth rate of annualized wealth among older households. Intuitively, households with substantial resources in retirement reporting only a medium-sized probability of leaving a bequest will need only a small bequest parameter to rationalize their stated expectations. On the whole, the household-by-household simulations show somewhat wider gaps between the typical slopes of the empirical and simulated age profiles of annualized

[29] We pool the entire sample and estimate the growth of annualized wealth for all of our households in multiple years. As an alternative estimation procedure, we also experimented with using each household's actual income and medical expense fluctuations (in addition to information about changes in marital status) over the 1998-2006 sample period to compute an average simulated growth rate of annualized wealth. Using the expected path of income for each household type, we calculated the permanent shocks as the average annual percentage deviations of the actual income path from the predicted path and the transitory shocks as the difference between each year's deviation from predicted growth and the permanent shock. The fit was not improved by such an exercise—the volatility in reported household income net of medical costs generated noisy estimates of annualized growth—so we report the results from the more straightforward procedure that uses pooled household information for each year.

[30] The HRS asks respondents: "[W]hat are the chances that you [and your] [you/husband/wife/partner] will leave an inheritance totaling $100,000 or more?"

[31] The HRS data column shows different values than those in the previous table because this is a different, randomly-selected sample of 5,000 observations. Not surprisingly, the samples disagree most for the oldest (and therefore most sparsely represented) households in the data.

wealth.

In addition, we should note that all of the life cycle model specifications we consider are much too stylized to accurately predict the degree of heterogeneity in the cross-section trajectories of annualized wealth (conditional on age and marital status) that we observe in the HRS. We estimate that the root mean-squared error for rates of change in annualized wealth between the actual and the simulated household data is on the order of 5 or 6 percentage points per year. That is, the HRS panel data exhibit much greater cross-section variation in the trajectories of annualized wealth than stylized life cycle models with bequest and precautionary motives can generate.

6 Conclusion

By examining the trajectory of annualized comprehensive wealth—a measure of total resources per person per expected remaining year of retirement—our analysis brings some saving patterns into relief that would otherwise be difficult to discern. Our primary empirical finding from the HRS is that annualized comprehensive wealth tends to *rise* with age in retirement, reflecting the tendency for wealth balances to decrease more slowly than remaining life expectancies shorten. And the magnitudes of the typical increases in annualized wealth are significant. We find this pattern of increasing annualized wealth over retirement for most types of households and for the major components of comprehensive wealth. In addition, we estimate that a much larger share of retirees experience a considerable increase in annualized comprehensive wealth over the eight years covered by our HRS sample (1998 to 2006) than experience a significant decline (45% to 15%).

It is reasonably well known that retirees in the lower range of the income distribution (conditional on their age and marital status) rely almost exclusively on DB pension benefits, Social Security benefits, and other government transfers to finance spending. Although these sources do not constitute a high level of comprehensive wealth, their annuity-like payout scheme means that they can finance a more or less constant path of outlays through retirement. While annuity-like benefits are also an important source of wealth for retirees in the middle- and upper-income groups, these retirees also tend to have significant financial and nonfinancial wealth. A new finding from our analysis is that, for the median retiree in the middle- and upper-income groups, annualized comprehensive wealth tends to rise over retirement. One might have expected wealth balances to fall more or less in line with their decreasing life expectancy at older ages—after all, this is the trajectory that would be predicted by the simplest life cycle model of consumption in retirement.

To begin to gauge what factors could lie behind the tendency for annualized comprehensive wealth to rise in retirement, we compare the empirical age profiles of annualized wealth from the HRS data with simulated profiles from life cycle models that are extended to include uncertainty about longevity, precautionary saving in light of uncertain medical expenses, and an explicit motive for retirees with greater resources to leave bequests. Within the class of models we consider, specifications that include all three of these factors seem to line up best with the rate of increase of annualized comprehensive wealth in the HRS data. In this case, saving in retirement (relative to the simplest life cycle benchmark) provides insurance against the possibility of financing consumption into advanced ages, is available to help finance possibly very large medical expenditures, and it increases the size of intended (as well as unanticipated) bequests. Quantitatively, the simulated age profiles for annualized wealth match up fairly well with the estimated profiles, although the stylized models cannot capture much of the significant heterogeneity of annualized wealth patterns across retirees in the HRS. Overall, we think more work is needed to better understand what combination of experiences and motivations might be most important for accounting for the rising trajectory of annualized wealth in old age.

References

Aguiar, M., and E. Hurst (2005): "Consumption versus Expenditure," Journal of Political Economy, 113(5), 919–48.

Anderson, K., E. French, and T. Lam (2004): "You can't take it with you: Asset run-down at the end of the life cycle," Economic Perspectives, Federal Reserve Bank of Chicago, Q3, 40–54.

Attanasio, O. P., and H. W. Hoynes (2000): "Differential Mortality and Wealth Accumulation," Journal of Human Resources, 35(1), 1–29.

Bernheim, B. D. (1987): "The Economic Effects of Social Security: Toward a Reconciliation of Theory and Measurement," Journal of Public Economics, 33, 273–304.

——— (1991): "How Strong are Bequest Motives? Evidence Based on Estimates of the Demand for Life Insurance and Annuities," Journal of Political Economy, 99(5), 899–927.

——— (1992): "Is the Baby Boom Generation Preparing Adequately for Retirement?," Discussion paper, Merrill Lynch.

Blau, D. M. (2008): "Retirement and Consumption in a Life Cycle Model," Journal of Labor Economics, 26(1), 35–71.

Brown, J. R., and J. M. Poterba (2000): "Joint Life Annuities and Annuity Demand by Married Couples," The Journal of Risk and Insurance, 67(4), 527–553.

Cagetti, M. (2003): "Wealth Accumulation Over the Life Cycle and Precautionary Savings," Journal of Business and Economic Statistics, 21(3), 339–353.

Carroll, C. D. (1992): "The Buffer-Stock Theory of Saving: Some Macroeconomic Evidence," Brookings Papers on Economic Activity, 1992(2), 61–156.

——— (1997): "Buffer-Stock Saving and the Life Cycle/Permanent Income Hypothesis," The Quarterly Journal of Economics, 112(1), 1–55.

——— (2006): "The Method of Endogenous Gridpoints for Solving Dynamic Stochastic Optimization Problems," Working Paper.

——— (2007): "Lecture Notes on Solution Methods for Microeconomic Dynamic Stochastic Optimization Problems," Lecture Notes.

Carroll, C. D., and A. A. Samwick (1997): "The Nature of Precautionary Wealth," The Journal of Monetary Economics, 40(41-71).

——— (1998): "How Important is Precautionary Saving?," Review of Economics and Statistics, 80(3), 410–419.

Citro, C. F., and R. T. Michael (eds.) (1995): Measuring Poverty: A New Approach. Washington, D.C.: Nat. Acad. Press.

Cubeddo, L., and J.-V. Ríos-Rull (2005): "Families as Shocks," Journal of the European Economic Association, April-May(1), 671–682.

Davies, J. B. (1981): "Uncertain Lifetime, Consumption, and Dissaving in Retirement," The Journal of Political Economy, 89(3), 561–577.

Davis, M. (2006): "The Insurance, Health, and Savings Decisions of Elderly Women Living Alone," Manuscript.

De Nardi, M. (2004): "Wealth Inequality and Intergenerational Links," Review of Economic Studies, 71, 743–768.

De Nardi, M., E. French, and J. B. Jones (2006): "Differential Mortality, Uncertain Medical Expenses, and the Saving of Elderly Singles," Manuscript.

Dynan, K. E., J. Skinner, and S. P. Zeldes (2002): "The Importance of Bequests and Life-Cycle Saving in Capital Accumulation: A New Answer," The American Economic Review, 92(2), 274–278.

Engen, E. M., W. G. Gale, and C. E. Uccello (1999): "The Adequacy of Household Saving," Brookings Papers on Economic Activity, 1999(2), 65–187.

——— (2005): "Effects Of Stock Market Fluctuations On the Adequacy of Retirement Wealth Accumulation," Review of Income and Wealth, 51(3).

Fernándes-Villaverde, J., and D. Krueger (2007): "Consumption Over the Life Cycle: Facts from Consumer Expenditure Survey Data," Review of Economics and Statistics, 89(3), 552–565.

French, E., and J. B. Jones (2004): "The Effects of Health Insurance and Self-Insurance on Retirement Behavior," Manuscript.

Haveman, R., K. Holden, B. Wolfe, and A. Romanov (2007): "Assessing the Maintenance of Savings Sufficiency over the First Decade of Retirement," International Tax and Public Finance, 14, 481–502.

Haveman, R., K. Holden, B. Wolfe, and S. Sherlund (2006): "Do Newly Retired Workers in the United States Have Sufficient resources to Maintain Well-Being?," Economic Inquiry, 44, 249–264.

Hubbard, R. G. (1987): "Uncertain Lifetimes, Pensions and Individual Saving," in Issues in Pension Economics, ed. by Z. Bodie, J. Shoven, and D. Wise. Chicago: NBER and the University of Chicago Press.

Hubbard, R. G., J. Skinner, and S. P. Zeldes (1995): "Precautionary Saving and Social Insurance," Journal of Political Economy, 103(2), 360–399.

Hurd, M. D. (1987): "Savings of the Elderly and Desired Bequests," The American Economic Review, 77(3), 298–312.

——— (1989): "Mortality Risk and Bequests," Econometrica, 57(4), 779–813.

Hurd, M. D., and S. Rohwedder (2006): "Some Answers to the Retirement-Consumption Puzzle," NBER Working Paper No. 12057, February.

Kopczuk, W., and J. P. Lupton (2007): "To Leave or Not to Leave: The Distribution of Bequest Motives," Review of Economic Studies, 74(1), 207–235.

Kotlikoff, L., and L. Summers (1981): "The Role of Intergenerational Transfers in Aggregate Capital Accumulation," Journal of Political Economy, 89(4), 706–732.

Laitner, J., and F. T. Juster (1996): "New Evidence on Altruism: A Study of TIAA-CREF Retirees," The American Economic Review, 86(4), 893–908.

Love, D. A., P. A. Smith, and L. C. McNair (2008): "A New Look at the Wealth Adequacy of Older U.S. Households," Federal Reserve Board Finance and Economics Discussion Series #2008-20.

Mitchell, O. S., and J. F. Moore (1998): "Can Americans Afford to Retire? New Evidence on Retirement Saving Adequacy," Journal of Risk and Insurance, 65(3), 371–400.

Mitchell, O. S., J. M. Poterba, M. J. Warshawsky, and J. R. Brown (1999): "New Evidence on the Money's Worth of Individual Annuities," American Economic Review, 89, 1299–1318.

Munnell, A. H., and M. Soto (2005): "What Replacement Rate Do Households Actually Experience in Retirement?," Working Paper.

Munnell, A. H., A. Webb, and L. Delorme (2006): "Retirements at Risk: A New National Retirement Index," Boston College Center for Retirement Research, June.

Palumbo, M. G. (1999): "Uncertain Medical Expenses and Precautionary Saving Near the End of the Life Cycle," Review of Economic Studies, 66(2), 395–421.

Rust, J., and C. Phelan (1997): "How Social Security and Medicare Affect Retirement Behavior in a World of Incomplete Markets," Econometrica, 65(4), 781–831.

Scholz, J. K., A. Seshadri, and S. Khitatrakun (2006): "Are Americans Saving "Optimally" For Retirement?," Journal of Political Economy, 114, 607–643.

Shorrocks, A. F. (1975): "The age-wealth relationship: a cross-section and The Age-Wealth Relationship: A Cross-Section and Cohort Analysis," The Review of Economics and Statistics, 55(3), 155–163.

Skinner, J. (2007): "Are You Sure You're Saving Enough for Retirement?," Journal of Economic Perspectives, 21(3), 59–80.

SSA (2006): Period Life Table, 2002. Social Security Administration.

Yaari, M. E. (1965): "Uncertain Lifetime, Life Insurance, and the Theory of the Consumer," The Review of Economic Studies, 32(2), 137–150.

Appendix 1: Present Value Calculations for Comprehensive Wealth

In this appendix, we discuss our method for computing present values of annuitized streams of payments in the HRS. See Love, Smith, and McNair (2008) for additional details.

Defined-benefit pensions

The HRS includes questions about current pension benefits (for retirees) and expected future pension benefits (for workers). Since our sample selects households whose older member is at least 65, we are primarily (but not exclusively) using data on retirees. Households are asked about the current (or expected) pension amount (and start date, if they have not yet begun), cost-of-living adjustments (COLAs), and survivors' benefits.[32] In the case of working households, we use the expected pension at retirement; this serves to include the value of benefits not yet accrued. For DB plans with COLAs (about 40 percent of the reported plans), we discount using a real interest rate. For plans without COLAs, we discount using a nominal rate.

We define the actuarial present value of pension wealth as the annual pension benefit multiplied by the sum of discounted annual survival probabilities, with an extra term accounting for any payments made to the spouse after the death of the respondent.[33] We compute present values for each plan held by the respondent and spouse and sum them to arrive at our calculation of household-level pension wealth. Some current workers report that they expect to receive lump-sum payouts from their DB plans upon retirement; in this case, we discount the lump sum back to the current age, again using life-table survival probabilities.

The survival probabilities are based on the one-year age- and sex-specific conditional death probabilities in the Social Security Administration's 2002 Period Life Table (SSA, 2006). Period life tables provide a snapshot of the mortality conditions prevailing in a single year, rather than the expected mortality experience of a given cohort over time. For young cohorts (e.g., children born in 2002), one might expect actual longevity to be significantly greater than shown in the 2002 period life table, since longevity generally improves over time. However, since our sample is of older households in 2006, we conclude that the 2002 period table is a reasonable estimate of our sample's expected mortality experience.[34]

[32] We use self-reported pension data to calculate pension wealth. Because most of the sample is currently receiving benefits, we are less concerned about households' misunderstanding or ignorance of pension formulas.

[33] Bernheim (1987) argues that actuarial discounting is inappropriate for risk-averse individuals facing imperfect annuity markets, because such individuals would attach additional value to the otherwise unavailable insurance product. He suggests straight discounting (ignoring the probability of death) instead. However, he points out that his analysis rests on the premise that individuals place no value on the death-contingent value of assets (i.e., that there are no bequest motives). We treat the household as a unit, and explicitly value the death-contingent component of each individual's assets (e.g., survivors' benefits and life insurance). Thus we use the actuarial present value of DB and Social Security benefits. Note that we are only computing the amount of wealth, and not the utility value of that wealth. Similarly, we make no adjustment in the PV calculation for the utility value of risk (e.g., longevity risk or the risk of a large medical-expense shock.)

[34] Note that these are average survival for the population. Thus, to the extent that, for example, lower-wealth respondents face lower survival probabilities than higher-wealth respondents, our calculations will

Social Security benefits

The present value of Social Security benefits is computed in a similar manner, with the main differences being that Social Security benefits are always indexed for inflation and that survivors' benefits entitle retirement-age widows or widowers to 100% of the spouse's benefits if these exceed their own benefit amount.[35]

Annuities and welfare benefits

The present value of annuity wealth is calculated in the same way as pensions, where we make similar adjustments for COLAs and survivor benefits. Our measure of expected welfare payments includes veteran's benefits, food stamps, Supplemental Security Income (SSI), and other welfare. In this calculation, we assume that individuals who are currently receiving these payments will continue to receive the same inflation-indexed welfare payments as long as they live. Moreover, we apply SSI as a floor to our calculation of annualized wealth—that is, we assume that current nonrecipients will begin to receive SSI if their resources fall sufficiently low in the future.[36] Since welfare benefits are typically indexed to inflation, we discount this stream of expected welfare payments using the real interest rate and the relevant conditional survival probabilities.

Annualized values of annuity-type wealth

Note that the annual benefits from annuity-type sources such as pensions, annuities, and Social Security are not, in general, equivalent to the annualized present values of these sources of wealth. For example, because DB benefits are not typically adjusted for inflation, the real value of benefits will decline over time relative to their annualized present value. (The annualized present value in period t of a declining real stream of payments will always be less than or equal to the real value of a single payment from that stream in period t, with equality only in the final period.) Moreover, the annualized present value takes account of any benefit changes expected to occur as a result of spousal deaths. For annuity payments, like Social Security, that pay out in real terms, annualized wealth will be identical to the benefit stream for a single-member household. We convert annuity-type benefit streams into a present value and then back into an annuity in order to account for the effects of non-indexation of benefits and survivors benefits on the resource stream of married couples.

tend to overstate the pension wealth of the lower-wealth groups and to understate the pension wealth of the higher-wealth groups. However, we do not expect this to be a large effect because differential mortality seems to be evident primarily at very old ages (see Anderson, French, and Lam (2004) and Attanasio and Hoynes (2000)), where heavy discounting is already being applied for most retirees.

[35]Again, since the vast majority of the sample is already receiving benefits, we are less concerned about households' ignorance of Social Security formulas. Moreover, annual notifications of accrued benefits from the Social Security Administration help alleviate such concerns even among individuals who are still working.

[36]In practice, the SSI floor binds in very few cases in our sample.

Appendix 2: Description of the Life Cycle Model Used in the Simulations

6.1 The model

The life-cycle model augments the cash-on-hand framework of Carroll (1997) to allow for household composition (see, e.g., Cubeddo and Ríos-Rull (2005)) and bequests. We will describe only the final specification since the others involve "turning off" select features. In each period t, households choose an amount of consumption C_t that maximizes their expected discounted utility from their current ages to a maximum age of 120, subject to a budget constraint that represents a transition equation for cash on hand X_t—the sum of wealth and current income—and a non-negativity constraint for wealth at each age.[37] Since we are interested in matching the behavior of retired households in the HRS, we confine our solution to ages of 65 and older.[38]

Households differ by age, sex, marital status, and education. Spouses may be of different ages but they are assumed to share the same education level. In defining the value functions, it will be helpful to index a married couple with m, a single male with g, and a single female with g^*. In each period t, a household of a particular type is constrained to consume no more than the sum of saving from the previous period, $R(X_{t-1} - C_{t-1})$, and income net of medical costs, Y_t.[39] The value function for a single (male) is given by:

$$V_{t,g}(X_t) = \max_{C_t} \left\{ u_g(C_t) + \beta p_{g,t} \mathbf{E}_t V_g(X_{t+1}) + \beta(1 - p_{g,t}) \mathbf{E}_t B(X_{t+1}) \right\}, \tag{A-1}$$

where

$$X_{t+1} = R(X_t - C_t) + Y_{t+1} \tag{A-2}$$

$$X_t \geq C_t, \tag{A-3}$$

where $u_g(.)$ is the period utility function, β is the discount factor, $p_{g,t}$ is the conditional survival probability, and $B(.)$ is a bequest function. Period utility for a household of type $i \in \{m, g, g^*\}$ is iso-elastic and depends on household economies of scale:

$$u_i(C_t) = \frac{1}{1-\rho} \left(\frac{C_t}{n_i} \right)^{1-\rho}, \tag{A-4}$$

[37] A complete treatment of the life cycle from the beginning of working life would introduce potentially interesting sources of heterogeneity in wealth and retirement income, but this type of heterogeneity is not the focus of our analysis. For our purposes, little is lost by starting our model at retirement, and we gain transparency and simplicity since we can show how different factors affect consumption patterns *independent of initial retirement wealth.*

[38] Our modeling exercise differs from Scholz, Seshadri, and Khitatrakun (2006), which compares observed wealth levels in the HRS with predicted levels using household-specific lifetime earnings.

[39] The formulation of income net of medical costs is a simplification of the process used in other work on medical expenses, such as Hubbard, Skinner, and Zeldes (1995); Palumbo (1999); French and Jones (2004). In contrast to these studies, we do not model social insurance, and we do not allow income net of medical costs to become negative (as would be the case if households paid medical expenses in excess of their retirement income). The simplification avoids nonconvexities in the value function, which allows for considerably faster computations.

where n_i is a scale adjustment, ρ is the coefficient of relative risk aversion and $1/\rho$ is the elasticity of intertemporal substitution. When operative, the bequest motive is captured by the iso-elastic function:

$$B(X_t) = \frac{b}{1-\rho}\left(\frac{X_t}{b}\right)^{1-\rho}, \tag{A-5}$$

where b determines the intensity of the bequest motive.

Married couples face a slightly different problem. Spouses typically face different survival probabilities, and the longer-lived spouse has more incentive to save than the shorter-lived one. We follow Cubeddo and Ríos-Rull (2005) and assume that the household solves a joint maximization problem with (in our case) equal decision weights on the husband's and wife's utilities and with current household consumption constrained to be split equally between the spouses.[40] The married couple's value function is given by:

$$\begin{aligned} V_{t,m}(X_t) = \max_{C_t}\{ & u_m(C_t) + \beta p_{g,t} p_{g^*,t} \mathbf{E}_t V_{t+1,m}(X_{t+1}) + \beta(1-p_{g,t})(1-p_{g^*,t})\mathbf{E}_t B(X_{t+1}) \\ & + \frac{1}{2}\beta p_{g,t}(1-p_{g^*,t})\mathbf{E}_t V_{t+1,g}(X_{t+1}) + \frac{1}{2}\beta p_{g^*,t}(1-p_{g,t})\mathbf{E}_t V_{t+1,g^*}(X_{t+1})\}, \end{aligned} \tag{A-6}$$

subject to equations (A-2)-(A-3). The three terms in the first line of the value function represent (1) the sum of each spouse's weighted utility from consuming C_t as a couple, (2) the expected value of remaining married in the next period, and (3) the expected value of bequeathing remaining cash on hand in the event that both members die in the next period. The two expressions in the second line correspond to the weighted utilities of the husband and wife, respectively.

We solve the model by first normalizing the variables by permanent income P_t and then using the normalized value functions to obtain consumption decision rules for each point in the state space.[41] In practice, we approximate the value functions by considering 200 endogenously chosen cash-on-hand values and by numerically computing the expectation integrals with 10-point Gauss-Hermite quadrature for each of the transitory and permanent shock distributions. By interpolating the resulting consumption decision rules, we can simulate household consumption decisions for different ages, education levels, marital status, income, and cash on hand.

6.2 Income process

The process for income net of medical costs follows Carroll (1997). Income Y_t is the product of a transitory shock Θ_t, a permanent shock N_t, and a growth factor G_t that captures

[40] The standard consumption Euler condition applies at the household level but not necessarily at the individual level.

[41] See Carroll (2007) for an excellent introduction to solving models of this type. We apply Carroll's (2006) method of endogenous gridpoints, which dramatically reduces computational time by working with end-of-period saving rather than beginning-of-period cash on hand.

changes in trend income over time and in response to changes in marital status:

$$
\begin{aligned}
Y_t &= P_t \Theta_t & \text{(A-7)} \\
P_t &= G_t P_t N_t, & \text{(A-8)}
\end{aligned}
$$

where $\log(N_t) \sim \mathcal{N}(-\frac{\sigma_n^2}{2}, \sigma_n^2)$ and $\log(\Theta_t) \sim \mathcal{N}(-\frac{\sigma_\theta^2}{2}, \sigma_\theta^2)$.

We estimate separate income age profiles and covariance structures using the 1998-2006 waves of the HRS. We define non-asset income in retirement as the sum of Social Security benefits, pension benefits, private annuities, and any welfare payments, averaged over the 8-year period and measured in 2006 dollars. (We average income over the sample period because our focus is on medical cost risk and large fluctuations in annuitized retirement income are likely to reflect measurement error rather than true volatility.) From this measure of income, we then subtract annual out-of-pocket medical costs to arrive at our measure of income net of medical costs. Because we estimate the income profiles using the natural logarithm of net income, we restrict our sample to households with non-negative values of net income. The restriction eliminates between 2 and 3 percent of the sample—presumably those experiencing catastrophically large medical costs.[42]

We follow a two-step process in estimating the net-income process in the model. First, for each education group, we regress the natural logarithm of net retirement income on age, marital status dummies for single male and single female, and a set of 5-year birth-year controls. The coefficient estimates from this first step allow us to construct average growth rates for permanent income by education and marital status. In the second step of the process, we estimate the covariance process of net retirement income by following the variance decomposition procedure in Carroll and Samwick (1997).[43] The coefficient estimates (not shown) imply a slightly declining age profile of net retirement income for high school and college graduates, and a slightly upward sloping pattern for dropouts. The age pattern is consistent with the means testing for Medicaid—lower-income households (dropouts) are less likely to pay for large out-of-pocket expenses than high-income households. The estimated variances show considerable volatility in both transitory and permanent components. The estimates reflect the large size of out-of-pocket expenses relative to income in retirement. We estimate permanent variances (standard errors in parentheses) of 0.0368 (0.0015), 0.0263 (0.0006), and 0.0335 (0.0007) for household heads with less than high school, high school, and college educations, respectively. The estimated transitory variances for the three education categories are: 0.0729 (0.0048), 0.0583 (0.0018), and 0.0815 (0.0022).

[42] Allowing for negative net income, however, would rule out efficient numerical optimization techniques by introducing nonconvexities in the value function. While these nonconvexities can generate interesting economic behavior, they are not the focus of this section of the paper, which is to see whether the most standard life-cycle models are capable of producing the upward-sloping annualized wealth profiles observed in the data.

[43] Let r_t^d denote the difference between the unexplained part of net-income in period $t+d$ and that in period t. Using the fact that $Var(r_t^d) = d\sigma_N^2 + 2\sigma_\Theta^2$, we can obtain parameter estimates by regressing $Var(r_t^d)$ on a set of d's and a vector of 2's, adjusting for the two-year spacing of the HRS waves.

Tables and Figures

Table 1: Household Characteristics in 2006

Variable	Mean
Age (years)	80.5
Married (%)	36.8
Single Male (%)	13.6
Single Female (%)	49.6
Income (thous. $2006)	46.6
HS is Highest Degree (%)	54.2
College Degree (%)	18.0
Nonwhite (%)	10.5
Hispanic (%)	5.0
Fair or Poor Health (%)	41.4
Out-of-pocket Medical Expense (thous. $2006)	2.5

Sample size is 4,630 households. Means calculated using HRS sample weights.

Table 2: Components of Comprehensive Wealth: Surviving Households Aged 70-75 in 1998*

	Wealth (th. 2006 $)			*Share of CW (%)*		
	1998	2002	2006	1998	2002	2006
Financial	98	92	82	20	21	21
Stocks[1]	43	40	30	9	9	8
Other[2]	55	52	52	11	12	13
Nonfinancial	130	134	142	26	31	36
Housing	97	106	117	20	24	30
Other[3]	34	28	25	7	7	6
Annuity-like benefits	264	207	169	54	48	43
Social Security	177	139	115	36	32	29
DB Pensions	72	55	41	15	13	10
Other[4]	15	13	13	3	3	3
Comprehensive Wealth	493	434	393	100	100	100

*For each year, the rows report means from a trimmed sample selected so that the trimmed mean comprehensive wealth (CW) is equal to the untrimmed median; thus, the components sum to median CW. Calculations use HRS sample weights. Sample size is 1,360 in 2006.

[1]Shares held directly and through mutual funds, trusts, and retirement accounts.

[2]Liquid assets, bonds, and non-stock assets held in trusts and retirement accounts.

[3]Vehicles and businesses.

[4]Life annuities and government transfers.

Table 3: Sample Annualized Factors for Singles and Couples

	Annualizing factor			Annualized value of $500,000		
Age of head	Couple	Single female	Single male	Couple	Single female	Single male
67	.043	.076	.089	$21,400	$38,000	$44,500
77	.063	.117	.141	$31,500	$58,500	$70,500
87	.096	.221	.272	$48,000	$110,500	$136,000

Table 4: Evolution of Median Wealth: Surviving Households Aged 70-75 in 1998*

	1998	2002	2006	Annual % Change, 1998–2006
Comp. Wealth (th. 2006 $)	493	434	393	-3.7
Annualizing Factor (%)	6.0	8.0	12.3	12.9
Ann. Wealth (th. 2006 $)	32.8	35.4	42.2	4.3
By Marital Status in 1998				
Comp. Wealth (th. 2006 $)				
Single	292	266	245	-2.9
Married	660	580	530	-3.6
Annualizing Factor (%)				
Single	9.6	11.7	14.7	7.3
Married	5.3	6.5	8.2	7.6
Ann. Wealth (th. 2006 $)				
Single in 1998	28.3	29.9	35.1	3.7
Married in 1998	35.5	39.4	46.8	4.7
By Income in 1998				
Comp. Wealth (th. 2006 $)				
Bottom 20%	234	197	166	-5.6
Top 20%	1077	1047	1039	-0.6
Annualizing Factor (%)				
Bottom 20%	5.8	9.6	12.3	13.4
Top 20%	5.8	7.2	10.4	10.2
Ann. Wealth (th. 2006 $)				
Bottom 20%	14.3	15.6	16.6	2.5
Top 20%	76.1	80.8	99.9	4.6

*Sample size is 1,360 in 2006. Income categories are defined conditional on age and marital status in 1998.

Table 5: Distribution of Changes in Annualized Wealth from 1998 to 2006: Surviving Households Aged 70-75 in 1998

	Percent of Households with a Change in Annualized Wealth that is:				
Classification	<-25%	-25% to -10%	-10% to 10%	10% to 25%	>25%
Full Sample	12	10	19	14	45
Single in 1998	15	11	20	12	43
Married in 1998	11	9	19	15	46
Bottom 20% of Income in 1998	13	9	22	15	41
Top 20% of Income in 1998	15	9	14	15	46

*Sample size is 1,360 in 2006. Income categories are defined conditional on age and marital status in 1998.

Table 6: Empirical and Simulated Growth Rates of Annualized Comprehensive Wealth*

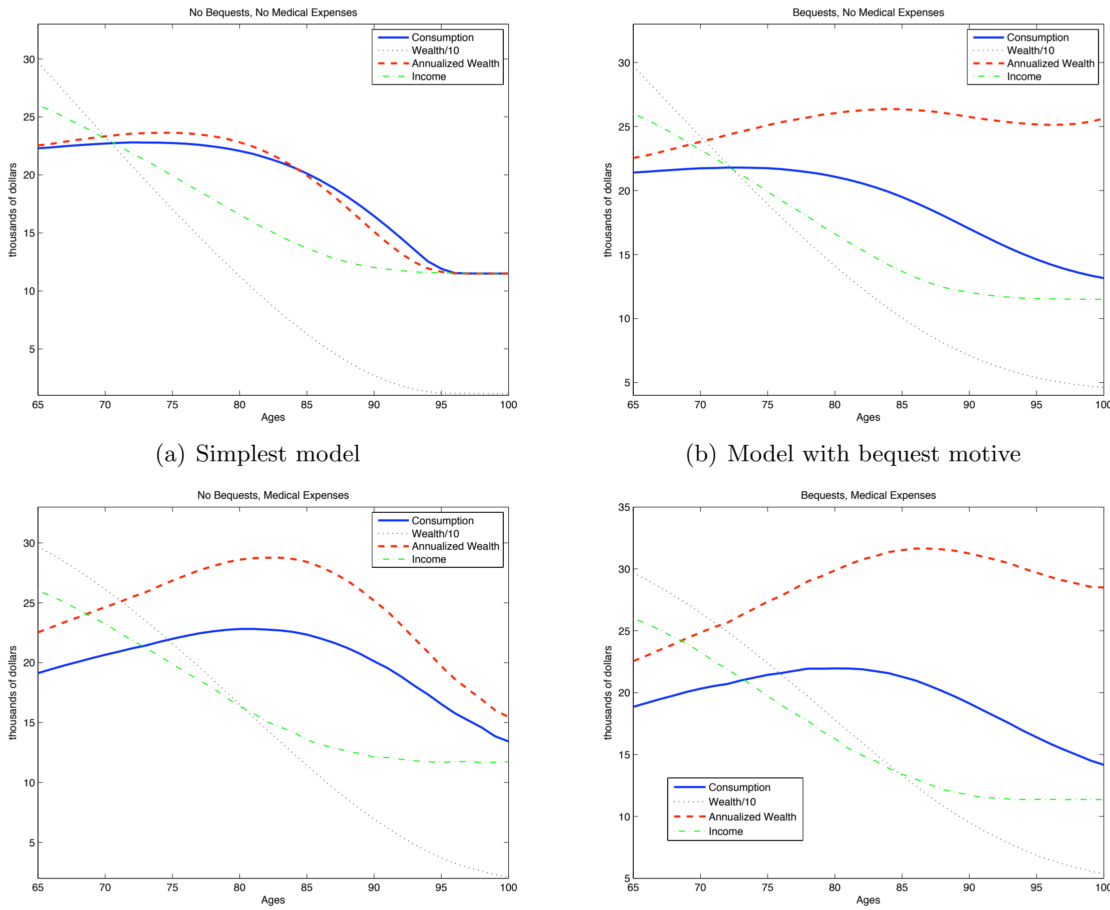
Age category	(A) HRS Data	(B) Baseline	(C) Baseline + bequests	(D) Baseline + Med Costs	(E) Med Costs + Bequests
Entire sample					
< 70	1.00	0.03	0.95	1.98	2.23
71-80	2.37	-0.42	1.31	1.74	2.25
81+	2.75	-1.65	1.98	-0.49	1.69
All	2.05	-0.69	1.48	1.44	2.21
Married couples					
< 70	0.64	-0.55	0.05	1.26	1.42
71-80	1.97	-1.04	0.03	0.65	1.00
81+	2.11	-1.64	0.31	-1.23	0.04
All	1.54	-1.25	0.06	0.37	0.85
Singles					
< 70	1.48	0.71	2.10	2.92	3.28
71-80	2.84	-0.07	2.03	2.34	3.03
81+	3.16	-1.64	2.15	-0.41	1.87
All	2.58	-0.46	2.10	1.86	2.81

*The table shows the median percentage growth rates of annualized wealth for the HRS data and each of four different model specifications. Each specification is solved for a CRRA parameter $\rho = 3$, a discount factor $\beta = 0.98$, survival probabilities according to the SSA life tables, and an initial simulated distribution of cash-on-hand, income, demographics, and education that is sampled 20,000 times from the HRS distribution of respondents aged 65-70. The second column, the "baseline" specification, includes no bequest motive and no medical costs. The third column adds to the baseline a bequest motive with parameter $b = 3$. The fourth column adds to the baseline the uncertain medical costs described in the text. The last column includes both the bequest motive and the uncertain medical costs.

Table 7: Empirical and Simulated Growth Rates of Annualized Comprehensive Wealth, Matched at the Household Level*

Age category	(A) HRS Data	(B) Baseline	(C) Baseline + bequests	(D) Baseline + Med Costs	(E) Med Costs + Bequests
Entire sample					
<70	1.54	0.02	1.56	0.62	1.78
71-80	2.41	-0.48	1.11	0.57	1.67
81+	3.46	-1.57	-0.01	0.58	1.62
All	2.41	-0.66	0.90	0.58	1.68
Married couples					
<70	1.46	-0.31	1.25	0.30	1.46
71-80	2.07	-0.86	0.69	0.16	1.19
81+	2.93	-3.09	-1.57	-0.86	0.04
All	1.92	-1.02	0.53	0.03	1.09
Singles					
<70	1.61	0.54	2.05	1.10	2.29
71-80	2.74	-0.01	1.62	1.09	2.26
81+	3.68	-0.82	0.77	1.30	2.40
All	2.91	-0.29	1.29	1.16	2.31

*The table shows the median percentage growth rates of annualized wealth for the HRS data and each of four different model specifications. Each specification is solved for a CRRA parameter $\rho = 3$, a discount factor $\beta = 0.98$, survival probabilities according to the SSA 2004 period life tables, and an initial distribution of cash-on-hand, income, demographics, and education for 5,000 randomly-selected households in the 1998-2006 waves of the HRS. The second column, the "baseline" specification, includes no bequest motive and no medical costs. The third column adds to the baseline a bequest motive with bequest parameters matched at the household level, in accordance with the households' stated probability of leaving an inheritance larger than $100,000 (see text for details). The fourth column adds to the baseline the uncertain medical costs described in the text. The last column includes both the bequest motive and the uncertain medical costs.



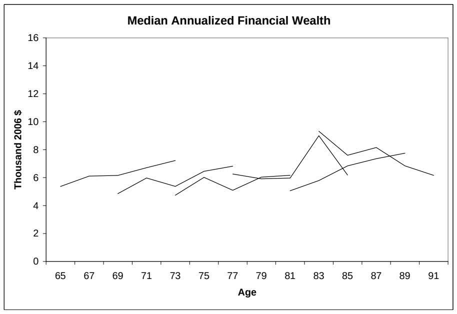
(a) Simplest model

(b) Model with bequest motive

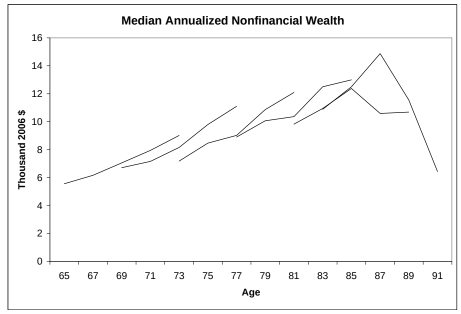
(c) Model with precautionary motive

(d) Model with bequest and precautionary motives

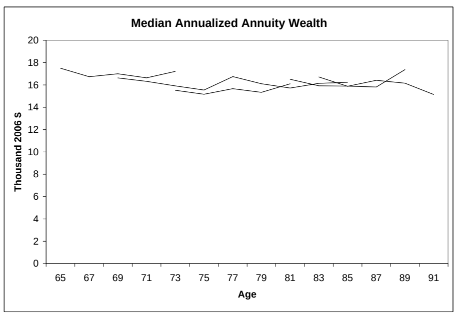
Figure 1: Age Profiles of Annualized Wealth and Optimal of the Life Cycle Model of Spending in Retirement



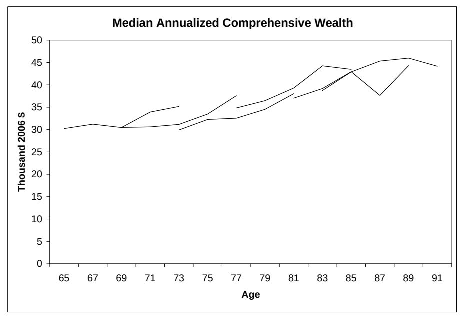
(a) Median Annualized Financial Wealth



(b) Median Annualized Nonfinancial Wealth

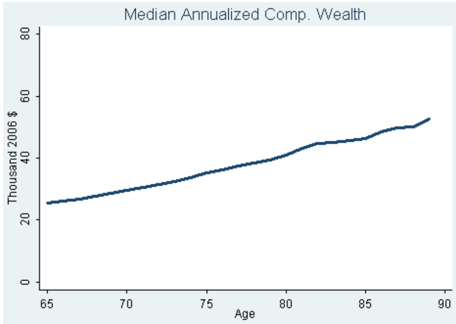


(c) Median Annualized Annuity Wealth

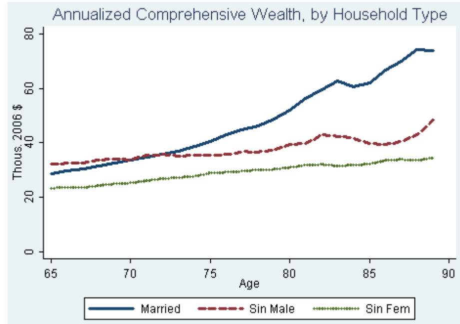


(d) Median Annualized Comprehensive Wealth

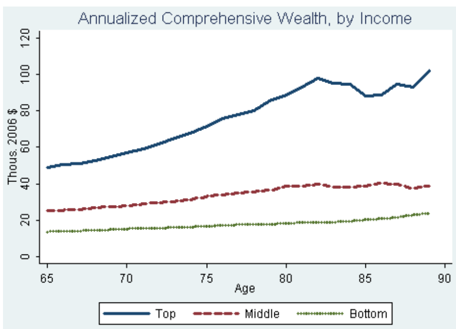
Figure 2: Nonparametric Age Profiles of Median Annualized Wealth



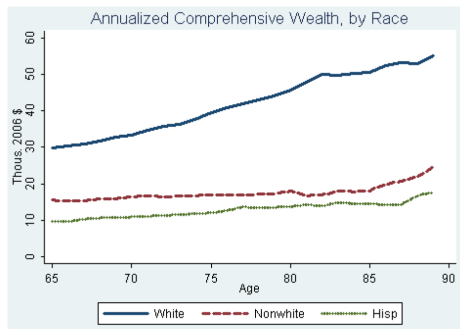
(a) Median ACW, All Households



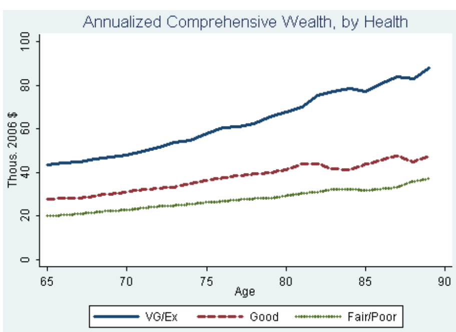
(b) Median ACW, by Marital Status in 1998



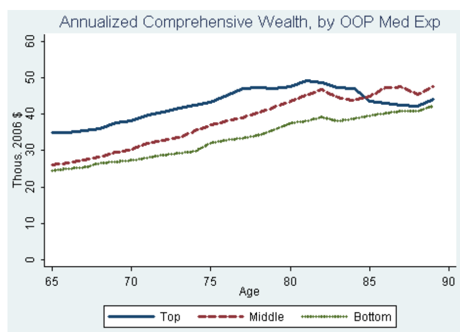
(c) Median ACW, by Income in 1998



(d) Median ACW, by Race

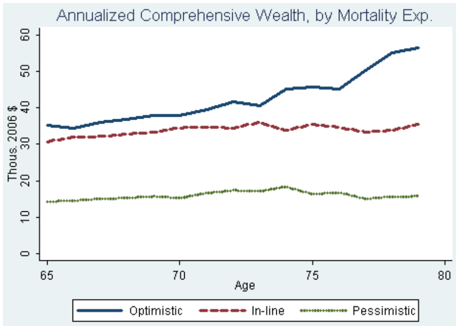


(e) Median ACW, by Health in 1998

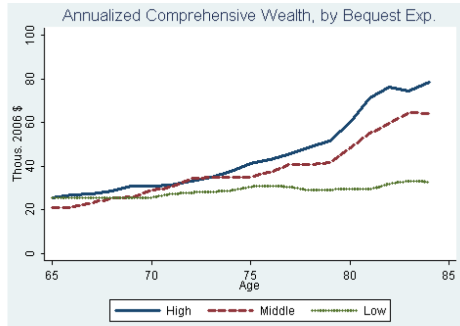


(f) Median ACW, by Out-of-pocket Medical Expenses in 1998

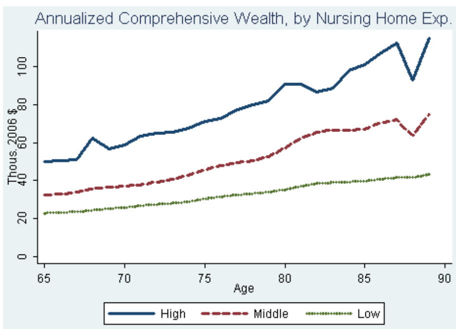
Figure 3: Regression-based Age Profiles of Median Annualized Comprehensive Wealth



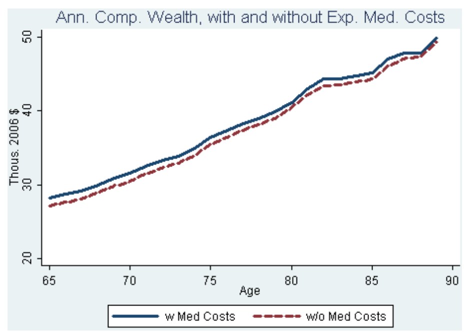
(a) Median ACW, by Mortality Expectation in 1998



(b) Median ACW, by Bequest Expectation in 1998



(c) Median ACW, by Nursing Home Expectation in 1998



(d) Median ACW, with and without Expected Medical Costs

Figure 4: Regression-based Age Profiles of Median Annualized Comprehensive Wealth, by Expectation Group