Differential Mortality and Wealth Accumulation

Orazio P. Attanasio
Hilary Williamson Hoynes

ABSTRACT

In this paper, we examine the role played by differential mortality in estimates of life cycle wealth profiles. Our study makes three contributions. First, we show that the Survey of Income and Program Participation (SIPP) provides reliable data on mortality as compared to the US life table data. Second, we provide estimates of the relationship between mortality and wealth and show strong evidence of differential mortality. Lastly, and most importantly, we show that the differences in mortality by wealth are large enough to substantially affect the estimated wealth-age profiles.

I. Introduction

The issue of asset accumulation and decumulation is central to the life cycle theory of consumer behavior and to many policy questions. One of the main implications of some versions of the life cycle model is that assets are decumulated in the last part of life (Modigliani and Brumberg 1954; Modigliani and Ando 1957). Despite the large amount of research devoted to establishing whether people actually decumulate assets in the last part of the life cycle, no conclusive evidence has yet emerged (see review by Hurd 1990; also see Blinder, Gordon and Wise 1983; Jianakoplos, Menchik, and Irvine 1989; King and Dicks-Mireaux 1982; and Mirer 1979).

Orazio Attanasio is a professor of economics at University College London. Hilary Hoynes is an assistant professor of economics at the University of California at Berkeley. *This research was supported by the Institute for Industrial Relations, the Institute for Business and Economic Research, and the National Institute on Aging. Computing support was provided by the Econometrics Laboratory at UC Berkeley. The authors are thankful to Dan McFadden, Paul Ruud, Frank Wolak, and seminar participants at Berkeley, Dartmouth, Stanford, Wisconsin, National Bureau of Economic Research and IFS for useful comments. Harish Chand and Cindy Gustafson provided excellent research assistance. The data used in this article can be obtained beginning April 2000 through March 2003 from Hilary Hoynes at hilary@econ.berkeley.edu.*
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The ideal data for estimating wealth age profiles would consist of panel data with a broad-based age sample whose wealth data is collected over a long period of time. While there are panel data sets available, they typically either cover narrow age groups, are too short, or do not contain the necessary information on wealth.[1] As a consequence, many studies examining age wealth profiles rely on cross-sectional data sets.

In a classic paper, Shorrocks (1975) points out that there are two important sources of bias which may result from using cross-sectional data with the purpose of estimating life cycle wealth profiles: cohort effects and differential mortality. With cross-sectional data, there is a one-to-one relationship between age and birth cohort. In the presence of strong cohort effects (due to differences in the macroeconomic environment, for example), the cross sectional age-wealth profile does not necessarily correspond to the profile of any individual. If, for example, younger generations are richer in lifetime terms than older ones, then identifying the age profile of wealth with the cross section profile can give the illusion of asset decumulation at the end of the life cycle even when this does not occur. Differential mortality may, on the other hand, introduce an upward bias in the last part of the life cycle profile. If poorer individuals have higher mortality risk, one will overestimate the last part of the wealth age profile when using cross-sectional data because means (or other measures of location) are taken over a population which becomes richer as it ages.[2]

Omitted cohort effects can be handled by pooling a time-series of cross-sectional data sets and constructing synthetic panels, thereby controlling for age and cohort. Attanasio (1993) uses synthetic panels obtained from the Consumer Expenditure Survey to estimate wealth-age profiles and finds mild evidence of decumulation in the last part of the life cycle.[3]

The impact of differential mortality on the wealth-age profile will depend on the relationship between mortality and wealth. There is widespread evidence that economic welfare affects mortality rates, although most of this literature focuses on income, as opposed to wealth, as the measure of resources (for example, see Kitigawa and Hauser 1973). Relatively few studies have explored the role of wealth. Jianakoplos, Menchik, and Irvine (1989), using the National Longitudinal Survey (NLS) of Older Men, show that elderly individuals in the bottom two deciles of the wealth distribution exhibit mortality rates three times as large as those of individuals in the top decile. More recently, Menchik (1993) uses the NLS of Older Men to estimate

1. Two cohort-based data sets produced in the 1970s–1980s collected information on wealth. The Retirement History Survey collected wealth data every two years over a ten-year period for a sample of men age 58–61 in 1979. The National Longitudinal Survey (NLS) of Older Men collected wealth data five times over a 17-year panel for a sample of men aged 45–59 in 1966. Two new cohort-based data sets, the Health and Retirement Survey (HRS) and the Asset and Health Dynamics (AHEAD), follow older Americans. Such data could also be used to estimate the relationship between wealth and mortality simultaneously with the process of wealth accumulation, perhaps while also taking into account cohort effects.

2. These are not the only sources of bias in estimating wealth-age profiles. Just to mention a few, attrition is reportedly stronger for richer households (Jianakoplos, Menchik, and Irvine. 1989) and wealth accumulation can be related to changes in family composition such as divorce and widowhood (Burkhauser, Holden, and Feaster 1988; Hurd and Wise 1989). These issues are not addressed in this paper.

3. Cohort techniques, as proposed by Browning, Deaton, and Irish (1985) and Deaton (1985) and recently discussed by Moffitt (1993), have been extensively used to estimate dynamic structural models from time series of cross sections.

mortality over a 15—year panel and finds an inverse relationship between mortality and wealth which persists in the presence of controls for health, permanent income, and background variables.

No papers use the information on the mortality-wealth relationship to explore the importance of differential mortality in estimating wealth-age profiles using cross-sectional data. Shorrocks, in his original paper, applied some rough corrections for differential mortality and found that the corrected data showed asset decumulation in the last part of life, while the uncorrected did not.[4] Jianakoplos, Menchik, and Irvine (1989) found greater asset decumulation among the survivors of a 15-year panel compared to the full sample (or unbalanced panel).

In our paper, we estimate mortality rates as a function of wealth and use the estimates to "correct" wealth-age profiles for differential mortality. The distortion induced by differential mortality in the wealth-age profiles can be thought of in terms of a sample selection process. Given observed wealth, each observation in the data has a different probability of being included in the sample, depending on the probability of surviving to the observed age. We use our estimated mortality rates to construct these survival probabilities. We then construct a "corrected" average wealth-age profile by simply using weights equal to the reciprocal of survival probability.

We estimate the determinants of mortality rates using a sample of married couples drawn from the 1984 and 1987 panels of the Survey of Income and Program Participation (SIPP). This data set contains information on wealth at a point in time and on death over a two-and-one-half-year period. The SIPP is the best data set for this purpose because it is representative of the entire U.S. population (as opposed to being a cohort-based survey) and it has large sample sizes which are necessary for getting precise estimates of the mortality equation. Having estimated the mortality model it is possible to use our estimates to correct life cycle profiles derived from any data set whose reference population is the same as that of SIPP and that contains a measure of wealth comparable to that used for the estimation of our model. We use our estimates to correct life cycle profiles of wealth using a sample of married couples from the Consumer Expenditure Survey (CEX). We present corrections using the CEX because it is available over a long time period (1980–1995) and can therefore be used to construct synthetic panels which, as discussed above, also control for the presence of cohort effects.

Our analysis makes three contributions. First, we show that the SIPP provides reliable data on mortality as compared to the U.S. life table data. This is potentially very valuable, as we know of no other study that uses the mortality data in the SIPP. Second, we provide estimates of the relationship between mortality and wealth and show strong evidence of differential mortality. Last, and most important, we show that the differences in mortality by wealth are large enough to substantially affect the estimated wealth-age profiles.

The paper is organized as follows. In Section II we describe the SIPP data and present descriptive evidence of the relationship between mortality and wealth. In Section III we specify our model of mortality rates and discuss how to use them to correct wealth-age profiles. In Section IV we present mortality estimates, while in

4. Shorrocks used a sample of estate records along with external actuarial mortality rates by wealth to correct the observed wealth profiles.

Section V we apply these estimates to correct estimated wealth profiles. Section VI concludes. In appendices to the paper we present additional data description and sensitivity tests.

II. Mortality and Wealth in the SIPP

A. *The SIPP Data*

In order to estimate mortality rates and model them as a function of wealth, we need a large representative sample containing data on wealth as well as information on mortality over some period of time. The SIPP provides the best data to use for these purposes. The only alternative is the Panel Study of Income Dynamics (PSID). The PSID is also a nationally representative sample in which one can observe death of survey members. Despite the length of the PSID (now in its thirtieth year), the sample sizes are relatively small and wealth is only observed at five year intervals starting in 1985.

The first SIPP panel began in 1984 and in each year since, a new SIPP panel has been sampled. Each of the SIPP panels consist of nationally representative stratified random samples. Our study pools data from the 1984 panel (containing 21,000 families) and the 1987 panel (containing 12,000 families). In each panel, a household is interviewed three times a year and provides information on employment, earnings, income, household composition, and demographics for each member of the household for each of the previous four months. There are a total of seven interviews (waves) over the 28 month period which comprises the panel. The death of any sample member is identified at these four month intervals. In each of the interviews, data is provided identifying the reason that a person left the household, if applicable, and death is one of these routes.

A full inventory of household wealth is collected at two points during the SIPP panel, one at the fourth interview and one at the seventh interview. For all of our empirical work, we construct measures of household wealth using the values reported in Wave 4.[5] Data is collected for financial wealth (interest earning assets, stocks and mutual funds), Individual Retirement (IRA) and Keogh accounts, home equity, vehicle equity, business equity, and other real estate. Curtin, Juster, and Morgan (1989) show that the SIPP data compares favorably to other household survey measures of wealth, which all suffer to some degree from underreporting of asset types such as stocks. As with most survey data sets, the SIPP does not provide information on public or private pension wealth. When pooling the 1984 and 1987 data, a deflator is used to convert the dollar amounts in the two surveys.[6]

5. The second wealth assessment does not turn out to be very helpful for our analysis. Two observations on wealth one year apart are not sufficient to capture the dynamics of the evolution of wealth. Further, we only observe this later wealth data for those who survive to the end of the panel.

6. We use the Consumer Price Index (CPI) for all goods to deflate the asset data. The results are not sensitive to the choice of this deflator. In particular, estimating the models separately for the 1984 and 1987 panels result in qualitatively similar results.

B. Descriptive Evidence on Mortality and Wealth

Table 1 presents estimates of the mortality rates in the SIPP for persons age 50 and over by age and sex and compares them with the annual mortality rates published in the U.S. life tables (Social Security Administration 1992). The life table data, which is based on vital statistic data, is presented for 1980 and 1990 to bound the time period used in the SIPP. We have used the quarterly death information in the SIPP to construct annual mortality rates comparable to those in the life tables. A one-year death rate is formed by taking the ratio of the number of people who die at a given age compared to the number of people observed to be ''at risk of dying'' at that age. The number of observations in the pooled 1984–87 data for those age 50 or older is 19,637.

The SIPP mortality rates compare quite favorably with the life table data. Annual mortality rates for men vary from 0.9 percent for those age 50–54 to 5.9 percent among those age 75–79. Rates for women vary from 0.5 percent for ages 50–54 to 4.0 percent for ages 75–79. With a few exceptions, these rates fall between the 1980 and 1990 life table estimates.[7]

The SIPP mortality rates also show the expected patterns with respect to important demographic factors. Table 2 presents one-year mortality rates by race and education within ten-year age and sex groups. Within the age-sex groups, mortality rates are consistently higher for blacks and those with lower education levels. For example, black mortality rates for men ages 60–69 are 4.8 percent, compared to 2.4 for whites. In the same group, those with less than a high school education have a mortality risk of 3.2 percent, compared to a risk of 2.1 percent for those with a high school degree or higher. These differences are almost always statistically significant (standard errors are in parentheses). In additional tabulations not reported here, we also find (within the age-sex groups) higher mortality rates for those reporting a disability, those with lower family incomes, and those living in the Northeast or South. These patterns are well established in the existing empirical literature (for example see the pioneering work by Kitigawa and Hauser 1973; and a review by Feinstein 1993).

Before presenting the descriptive evidence relating mortality to wealth, we refine our sample somewhat. For the remainder of tables, and for the regression estimates presented later, the sample is limited to married couples where the head of household is aged 50 or greater. We limit the sample to those aged 50 and over because mortality risk becomes more difficult to identify as the underlying risk falls. We limit the sample to married couples to create greater homogeneity in life-cycle wealth profiles. This will become more clear, and will be discussed further, after the presentation of the model of mortality and wealth presented in the next section. This sample consists of 7,025 couples.[8]

Table 3 presents descriptive data on components of household wealth for this sample of married couples. Home equity and interest earning assets represent the

7. Life table estimates vary by calendar year because of cohort or time effects. During this period, there were some reductions in mortality rates uniformly across age and sex classes.

8. In addition to the sample selection criteria cited in the text, we also drop couples with missing wealth data, those with negative wealth, and those who separate or divorce during the panel. Finally, one member of the couple must be head of the household. In this analysis, we arbitrarily refer to the husband as the ''head'' and the wife as the ''spouse''.

Table 1

Mortality Rates by Age and Sex, Comparison of 1984 and 1987 SIPP to U.S. Life Tables[a]

	1984–87 SIPP[b]			
	Number of Observations	Mortality Rate	1980 Life Table[c]	1990 Life Table[c]
Men				
50–54	1,700	0.0092 (0.0018)	0.0094	0.0077
55–59	1,708	0.0129 (0.0020)	0.0145	0.0121
60–64	1,645	0.0208 (0.0026)	0.0220	0.0188
65–69	1,364	0.0313 (0.0035)	0.0342	0.0296
70–74	992	0.0476 (0.0049)	0.0502	0.0444
75–79	677	0.0594 (0.0067)	0.0734	0.0678
Women				
50–54	1,851	0.0051 (0.0013)	0.0050	0.0043
55–59	1,984	0.0069 (0.0014)	0.0075	0.0068
60–64	1,925	0.0122 (0.0018)	0.0113	0.0108
65–69	1,775	0.0225 (0.0026)	0.0172	0.0167
70–74	1,387	0.0269 (0.0032)	0.0262	0.0252
75–79	1,016	0.0397 (0.0044)	0.0418	0.0393

a. Mortality rates represent the probability of death over a 12-month period.
b. Authors' tabulation of the SIPP. The SIPP data includes the survival status of each survey member at four-month intervals. A one-year death probability is formed by taking the ratio of the number of people who die at a given age to the number of people "at risk of dying" at that age. Standard errors in parentheses.
c. Source: Social Security Administration (1992).

Table 2
Mortality Rates by Education and Race within Age-Sex Groups, 1984/1987 SIPP

	Number of Observations	50–59	60–69	70–79	80+
	Annual mortality rates for men				
Education					
Less than high school	3617	0.016	0.032	0.053	0.106
		(0.003)	(0.004)	(0.005)	(0.011)
High school or more	5022	0.009	0.021	0.051	0.114
		(0.002)	(0.003)	(0.006)	(0.017)
Race[a]					
White	7753	0.011	0.024	0.050	0.107
		(0.001)	(0.002)	(0.004)	(0.010)
Black	712	0.019	0.048	0.082	0.113
		(0.006)	(0.003)	(0.018)	(0.031)
	Annual mortality rates for women				
Education					
Less than high school	4637	0.009	0.020	0.038	0.072
		(0.002)	(0.003)	(0.004)	(0.007)
High school or more	6361	0.005	0.015	0.027	0.068
		(0.001)	(0.002)	(0.003)	(0.009)
Race[a]					
White	9800	0.006	0.016	0.031	0.069
		(0.001)	(0.002)	(0.003)	(0.006)
Black	1018	0.005	0.030	0.047	0.090
		(0.003)	(0.007)	(0.010)	(0.022)

Source: Authors' tabulation of the SIPP. Mortality rates represent the probability of death over a 12-month period. Standard errors in parentheses.
a. ''Other'' racial category suppressed due to small sample sizes.

most important components of household wealth. About 83 percent of all married couples over age 50 have home equity and 80 percent have interest earning assets totaling, on average, $78,000. Four measures of wealth are summarized in Table 3. The most comprehensive definition of wealth, total net worth, includes all wealth components less household debt. Only about 7 percent of households report zero wealth for this broad definition.

Table 4 explores the correlation between household wealth and death rates using this sample of married couples. As a simple summary of the data, we present the probability of death of either the head or spouse by age of the head of household and wealth quartile. The wealth quartiles are assigned within the cohort defined by five-year age classes for the head of household. The number of observations for the five-year age classes average 1,000 and range from 336 to 1,458. There are several patterns which emerge from this table. First, not surprisingly, ''couple'' mortality

Table 3
Components of Household Wealth, 1984 and 1987 SIPP, Married Couple Families with Head, Aged 50 or Older

			Households with Nonzero Amounts				
	Mean	Percent Nonzero	25 Percentile	Median	75 Percentile	Mean	Max
Components of wealth							
Interest earning assets	23,798	79.4	2,958	12,000	40,000	29,988	367,914
Stocks and mutual funds	14,550	25.0	2,500	9,000	32,744	58,275	6,675,000
Home equity	54,298	82.9	34,563	54,573	81,860	65,461	250,127
Vehicle equity	6,263	89.6	2,550	5,525	9,550	6,987	593,342
Business equity	8,547	11.7	5,000	25,240	95,000	73,043	650,000
Other real estate	18,150	26.9	11,824	35,000	77,312	67,497	787,000
Other assets	9,635	63.2	311	1,000	3,500	15,238	6,430,400
IRA/Keogh	4,149	32.9	4,400	8,400	15,000	12,622	139,161
Measures of wealth							
(1) Total financial wealth	47,977	87.5	3,297	15,462	52,753	54,848	6,938,000
(2) Financial assets + home equity	102,281	91.9	39,999	74,000	129,198	111,331	7,138,000
(3) Total nonretirement wealth	135,241	93.3	48,479	91,549	167,175	144,938	7,757,700
(4) Total net worth	137,466	93.3	48,248	93,000	171,135	147,322	7,757,700

Source: Authors' tabulations of 1984 and 1987 Survey of Income and Program Participation. Sample consists of all married couples with head of household aged 50 or older. See text for details of sample selection. All dollar amounts are in 1984 dollars. Wealth definition (1) includes interest earning assets (savings accounts, CDs, money market accounts, and bonds), equity in stocks and mutual funds, and other assets (checking accounts, savings bonds). Definition (2) adds home equity to the measure in (1). Definition (3) includes the components in (2) plus vehicle equity, business equity and other real estate equity. Definition (4) adds deposits in IRA/Keogh accounts and subtracts unsecured debt.

Table 4
Probability of Death of Either Head or Spouse By Age of Head and Wealth Quartile

	Number of Observations	All Couples	Wealth Quartile Quartile 1	Quartile 2	Quartile 3	Quartile 4
Age of head						
All	7,025	0.035	0.065	0.030	0.029	0.023
		(0.016)	(0.005)	(0.003)	(0.003)	(0.002)
50–54	1,432	0.009	0.024	0.009	0.005	0.002
		(0.002)	(0.005)	(0.004)	(0.003)	(0.003)
55–59	1,458	0.012	0.038	0.001	0.004	0.012
		(0.002)	(0.007)	(0.003)	(0.004)	(0.002)
60–64	1,396	0.026	0.042	0.020	0.025	0.021
		(0.003)	(0.009)	(0.005)	(0.006)	(0.006)
65–69	1,135	0.039	0.063	0.045	0.035	0.018
		(0.004)	(0.013)	(0.008)	(0.006)	(0.006)
70–74	764	0.063	0.129	0.036	0.045	0.052
		(0.006)	(0.017)	(0.013)	(0.011)	(0.008)
75–79	504	0.076	0.111	0.076	0.082	0.041
		(0.009)	(0.021)	(0.018)	(0.017)	(0.14)
80+	336	0.121	0.195	0.137	0.104	0.067
		(0.013)	(0.037)	(0.028)	(0.024)	(0.017)

Source: Author's tabulations of 1984 and 1987 SIPP. Sample consists of all married couples present at the first interview with head of household aged 50 or older who have data on household wealth. For information on identifying death in the SIPP and a description of calculating 12-month mortality rates see the notes following Table 1. Wealth quartiles are age-specific. Standard errors are in parentheses.

risk increases with the age of the head of household. Second, within each age group, death rates are inversely related to wealth quartile. Mortality in the lowest wealth quartile is, on average, about three times as high as mortality in the highest wealth quartile. Third, most of the effect of wealth is shown in the high death rates among the lowest wealth quartile—the relationship between wealth and mortality risk is much less strong among the upper three wealth quartiles. Overall, these data suggest a substantial amount of variation in mortality risk across wealth class.

III. Model of Wealth and Mortality

A. Motivation

With a relatively large data set in which individual households are observed over a period of time and containing information on several economic variables, relating mortality and wealth is relatively straightforward. One can estimate a simple statistical model in which mortality is explained both by age and by economic status, appropriately defined. However, one of the reasons to be interested in measuring the effect of wealth on mortality is to assess the bias that such an effect induces on the estimated life cycle profile of wealth. In this case, interpreting and using the estimates of a simple relationship between wealth and mortality is not as straightforward as it might seem.

One can think of the bias introduced by the presence of differential mortality in a standard sample selection context. If wealth and mortality are inversely related, then as one samples in subsequent years from a given cohort of individuals, one is drawing from a population that is becoming progressively richer as the poorest individuals die younger. To correct for this bias, therefore, one can compute weights that are inversely proportional to the probability that each individual in the sample has survived to the observed age. The weights can then be applied to the selected sample to obtain wealth-age profiles corrected for differential mortality.

To be specific, suppose that we are interested in estimating the evolution of wealth with age for an average individual. We observe wealth for a set of individuals of age a at time t and wealth for a set of individuals of age $a + 1$ at time $t + 1$.[9] Suppose that the probability of surviving from age a to $a + 1$ is a function of age and wealth as given by $P(a, W(a))$. Then we can relate expected wealth at age $a + 1$ to wealth at age a:

$$(1) \quad \sum_i E(W(a + 1)) = \sum_i P(a, W(a))b_a W(a).$$

We are interested in the age-specific parameters b_a which tell us about the degree of accumulation or decumulation over the life cycle. However, observed wealth at time $t + 1$ is affected both by the evolution of wealth and by the survival probabilities. It is straightforward though, to deal with the sample selection by constructing weights equal to the inverse of the probability of survival for each individual in the data. The weights can be easily constructed from estimates of an equation linking mortality to wealth.

More generally, however, we are interested in computing the entire average wealth-age profile for a given cohort. Therefore, we have to take account not only of survival between a and $a + 1$ but also survival *until age a.* That is, the sample generating $W(a)$ is also a select sample. One can substitute recursively for survival probabilities from year to year in the above formula, resulting in a cumulative probability of surviving to age a. The weight in this case is the inverse of the probability of surviving until age a. Therefore it is necessary to evaluate the probabilities of survival for all ages preceding age a and how these are affected by wealth.

This discussion makes clear that the information contained in a single cross section is not sufficient to compute the relevant weights to correct for the selectivity bias. For each individual aged a one knows wealth *at that age*, but, without a long panel, not necessarily his or her wealth at previous ages. In the remainder of this section, we discuss a set of assumptions that allow us to construct information on prior wealth that is necessary to estimate the probability of survival to the current age. We also

9. In our application, we use a time series of repeated cross-sections to estimate the wealth-age profiles. If one is using a single cross section, the wealth data at ages a and $a + 1$ are both measured at time t and refer to different cohorts. This difference is not important for this discussion.

discuss the robustness of our results to deviations from the assumptions we make to correct the estimated wealth-age profiles.

Before discussing these issues in detail, however, we discuss the specification of the statistical model for the mortality rates.

B. The Statistical Model

There are several ways in which wealth can affect mortality. In particular, one could imagine that the absolute level of wealth might have an effect on the probability of surviving. Such a link could arise, for instance, if greater wealth gives access to a greater amount of resources. Alternatively, it might be the case that it is not the level of wealth that matters for mortality, but rather the relative position in the wealth distribution. Furthermore, it might be the case that the variable relevant for mortality is not wealth but rather some measure of permanent income. If that is the case, the observed correlation between mortality and wealth could be explained by the fact that wealth and permanent income are obviously related.

We model mortality as a flexible function of age and of the percentile occupied by an individual household within the wealth distribution of households of the same age. The choice of relative wealth, as opposed to the level of wealth, is important for many reasons. In particular, we think that the most plausible relationship is between mortality and some measure of lifetime resources. This relationship might be better captured by relative wealth within a cohort. Furthermore, as will be clear from the discussion below, if mortality depends on relative rather than absolute wealth, it is easier to recover the information on prior wealth that is necessary for constructing the weights or correction factors. A model in which mortality depends on the level of wealth would require the use of much stronger and more unpalatable assumptions for the estimation of life cycle profiles. In addition, age-specific wealth percentiles may be preferred to wealth levels because the distribution of wealth is highly skewed and is typically top coded in survey data. The use of relative wealth within an age group is also a natural way to capture the fact that having a given level of wealth as a 30-year-old is very different from having the same level of wealth at age 70. There are, however, limitations to this specification. For example, if the population gets richer over time (uniformly), then mortality rates do not change. While there is evidence of falling mortality rates over time, the SIPP data does not cover a sufficiently long period of time to separate trend effects from age effects.[10]

C. Correcting Average Wealth-Age Profile for Mortality Differentials

Let us assume that there exists a benchmark age a^b from which differential mortality starts being important.[11] That is, before age a^b there are no effects of wealth on mortality. The weight to be given to an individual of age a in the computation of mean (or median) age-wealth profiles depends on the cumulative probability of sur-

10. This specification seems to capture the basic relationship between mortality and wealth as we estimated models relating mortality to wealth levels obtaining qualitatively similar results.

11. In this section, for simplicity, we refer to single individuals, while in the empirical application we consider married couples as the unit of observation. In a later section, we discuss how to amend the approach outlined below to consider couples rather than individuals.

viving between the benchmark age a^b and a. Therefore, if our hypothesis about the importance of relative rather than absolute position holds true, this survival probability depends on the wealth position at each age between a^b and a. In a cross section, while one observes the wealth position of an individual at the current age a, one does not observe the wealth position at ages a^b through $a - 1$. To make our model operational we need an assumption that allows us to infer these positions from the position at age a and from the model of mortality we estimate. The simplest alternative is what we call the noncrossing assumption. That is, we assume that the ranking of individuals in terms of wealth does not change with age after the benchmark age: within an age or birth cohort, if A is richer than B at one age, they will always be richer than B.

The noncrossing assumption is a very strong restriction. Notice, however, that, if wealth accumulation behavior differs because of differential mortality, it is likely to differ in a way which is consistent with the assumption. Within a life cycle model, individuals who expect to live a shorter life should, all else equal, decumulate their wealth after retirement at a faster pace (Davies 1981).[12] If poorer individuals decumulate assets more quickly after retirement because of shorter life expectancy, they will not ''overtake,'' in terms of wealth, richer individuals. Furthermore, we conducted a direct examination of the no-crossing assumption using a sample of married couples from the National Longitudinal Survey of Older Men, a panel data set from 1966–81. We used the five observations on wealth spanning a 15-year period and found that the majority of individuals experienced changes in their relative cohort-wealth of less than five percentage points. This evidence, which we find to be encouraging, is described in more detail in Appendix 1 and seems to indicate that there are no strong and systematic deviations from the noncrossing assumption. In the Appendix, we also summarize the results of a Monte Carlo analysis which examines the sensitivity of our corrections to a particular violation of the no-crossing assumption, one where there is crossing of a nonsystematic (iid) nature. The wealth corrections were substantially unchanged by this exercise.[13]

The noncrossing assumption, together with the assumption that mortality depends on relative wealth, allows us to use the observed data on current wealth, along with our empirical model of mortality rates, to estimate a person's (within cohort) wealth percentile for periods not observed in the data. To see this, recall that we ultimately need to construct weights for each observation equal to the inverse of the cumulative probability of surviving from the benchmark age to the observed age. For an observation of age $a^b + k$, this weight is:

$$(2) \quad \frac{1}{\prod_{i=0}^{k-1} PS(a^b + i, wp(a^b + i))},$$

12. Hurd and McGarry (1995) show that people seem to be aware of differential mortality, that is, they assess their own chances quite well.

13. While the noncrossing assumption seems very strong, it is implicit in many models of wealth accumulation. For example, Equation 1 relates expected wealth in period $t + 1$ to expected wealth in period t. In that equation, b_a is the parameter of interest and captures the rate of change in wealth from one year to the next. If that parameter is the same for all individuals in a cohort, then this implies the non-crossing assumption.

where $PS(a, wp(a))$ is the probability of surviving from age a to $a + 1$ for someone at percentile $wp(a)$ in the distribution of wealth for their cohort. Once we adopt a specification for PS, the survival probability is easily estimated using data on death, age, and wealth.

The main issue we have to resolve is the following. To compute the appropriate weight for an individual age $a^b + k$, we have to establish her wealth percentile at all ages from a^b to $a^b + k - 1$. Yet we only observe wealth at the current age. Therefore, we have to use the distribution of current wealth and the estimates for the survival rates to infer the wealth percentile for the previous ages. Given the noncrossing assumption the only reason the individual percentile can change with age is because of differential mortality. However, given the estimated model for PS and the observed data on wealth percentile at age $a^b + k$ we can infer the wealth percentile at the previous age.

To be more specific, consider someone at wealth percentile y at age $a - 1$. Let $WP(a, a - 1, y)$ be the wealth percentile for that person a year later at age a, given mortality that takes place between ages $a - 1$ and a. Such a quantity is linked to the survival probabilities between ages $a - 1$ and a by the following relationship:

$$(3) \quad WP(a, a - 1, y) = \frac{\int_0^y PS(a - 1, x)dx}{\int_0^1 PS(a - 1, x)dx}$$

The denominator of this expression measures the total fraction of the cohort that survives between ages $a - 1$ and a. The numerator is the fraction of the cohort, up to wealth percentile y, that survives to the next period. The ratio of the two gives the wealth percentile at age a of the individuals at wealth percentile y at age $a - 1$. We use Equation 3 to solve for y: We observe wealth percentile at age a and want to derive y, the wealth percentile at age $a - 1$. Having solved for the wealth percentile at age $a - 1$, this expression can then be used recursively to compute the wealth percentiles at all ages from the benchmark age until a.

To summarize, we have three key assumptions about mortality rates that are necessary for the empirical exercise. First, we assume that mortality depends on relative wealth. Second, we assume that wealth starts having an effect on mortality rates only from an arbitrary fixed benchmark age. The main justification for this assumption is empirical tractability, in that it avoids estimating mortality rates at ages in which these are very low and therefore difficult to estimate on a sample of limited size. We do, however, examine the sensitivity to the choice of benchmark age in the empirical work and find very little change in the results. Third, we assume that there are no cohort effects on mortality (besides those captured indirectly by wealth and other controls). This assumption is also made for simplicity and because we are using data from a relatively short period in which cohort effects are difficult to identify. These, in combination with the noncrossing assumption, allow us to obtain the necessary information to calculate the weights, or correction factors, given in Equation 2.

These assumptions may be strong, but are critical for the use of our simple model to correct the average wealth-age profile for the effect of differential mortality. As we have discussed above, we check the robustness of our results to violations of these assumptions and conclude that they are quite robust.

An alternative to the model we present and estimate below, is a model in which mortality depends not on current wealth but on the wealth percentile occupied at an earlier fixed age. One could argue that this specification is appealing if mortality is related to lifetime resources that are better proxied by wealth at a fixed point in the life cycle. However, such a mortality model is much harder to estimate than the model here. Moreover, it can be shown that these two models are equivalent (except for functional form) and they yield very similar results for correcting wealth profiles.[14]

IV. Estimates of Mortality Rates

A. Construction of SIPP Estimation Sample

In this section we present estimates of an empirical model that relates age and the position in the wealth distribution to mortality outcomes. As described in Section II, the estimation sample includes 7,025 married couples where the head of household is aged 50 or older. As stated earlier, we adopt the age restriction because of a lower mortality incidence at younger ages. We then use age 50 as our ''benchmark age'' and assume that there is no differential mortality prior to age 50. We limit the analysis to married couples for several reasons. First, wealth is a family not an individual concept. Second, the noncrossing assumption may be less valid if we allow for multiple family types. For example, changes in family composition due to divorce or widowhood are likely to lead to dramatic changes in wealth and income (Burkhauser, Holden, and Feaster 1988; Hurd and Wise 1989). Further, never-married men or women may have a different shape to their wealth profiles compared to married couples because of the absence of costs due to college education, for example. Third, the mortality model would be complicated by the existence of multiple family types—single men, single women, and married couples.

The consideration of households (married couples) rather than individuals poses some conceptual and practical problems. We redefine the event of ''death'' to be the death of either the head or spouse. That is, we are estimating wealth profiles for married couples correcting for the sample selection imposed by household differential mortality.[15]

We assume mortality depends on a cohort-defined wealth percentile. Accordingly, each couple's wealth percentile is assigned within five-year age cohorts (50–54, 55–59, and so on) based on the age of the head of household. Because of bunching in

14. The more complex model was estimated in a previous draft of this paper. Results are available upon request.

15. Married couples can also leave the sample by divorce or separation. One can, in principle, address this problem in a way similar to mortality. In practice, very few couples divorce after age 50. In our sample, less than one percent of couples divorce during the two and one half year panel making it difficult to identify the determinants of divorce. Households can also leave the sample over the panel. We do not model the determinants of this attrition, but treat them as right-censored spells.

the data, we assign all families which "tie" to the highest wealth percentile within the group.[16] Our main estimates assign wealth percentile using total net worth. This measure is the most comprehensive available in the SIPP and includes financial equity, home equity, business equity, and IRA/Keogh accounts less any unsecured debt. We concentrate on this measure because it is closest to the desired concept of lifetime resources that influence mortality rates.[17] Further, the noncrossing assumption is more likely to hold with a more inclusive measure. We also estimate models using financial wealth because that most closely matches the wealth data that is available in the CEX.

Table 5 gives summary statistics for the estimation sample. About 6 percent of the sample (or about 400 observations) has a death of the husband or wife over the course of the panel. The average age of husbands is 63, compared to 59 among the spouses. Household net worth averages 137,466 and the median is 93,000.

B. Empirical Model

The mortality rates are estimated using a discrete time survival model (see Kalbfleisch and Prentice 1980). The SIPP data provides information on death of the head or spouse over four-month periods. We use this information to estimate four-month survival rates as a function of wealth percentile and age of head of household. We choose to estimate four-month mortality rates for several reasons. First, our correction model requires one-year mortality (or survival) rates, and four-month probabilities are easy to aggregate up to the desired 12-month rates. Second, households may leave the sample at some point and the survival model approach allows us to use all of the available information up until that point.

Define $PS^4(a, wp)$ to be the probability of both the head and wife surviving a four month period given age of the head in wave j (a_j) and wealth position within the cohort distribution wp. Let T be the total number of periods (four-month waves) that the married couple is in the sample with both spouses alive in the SIPP panel and let δ_c equal one if either spouse dies. The contribution of this couple to the likelihood function is the product of all of the observed wave to wave transitions:

$$(4) \quad L = \left[\prod_{j=1}^{T-1} PS^4(a_j, wp)\right][1 - PS^4(a_{T-1}, wp)]^{\delta_c},$$

If a couple survives the entire 28-month panel (seven waves), there will be six survival rates in this expression. If one spouse dies between the fourth and fifth inter-

16. The only sizable bunching in the data is among families reporting zero wealth. About 8 percent of married couples in our sample report zero wealth. In that case, each couple with zero wealth is assigned to wealth percentile 8. We have explored alternative methods of dealing with bunching, and the results did not differ substantively.

17. The SIPP data do not measure pension wealth other than IRA/Keogh plans. These sources of wealth are very important: about half of all workers have employer-provided pensions and almost all have social security. Gale (1995) analyzes the 1983 Survey of Consumer Finances, which provides data on pension wealth, and finds that pension wealth accounts for more than one third of total wealth. The available evidence suggests that the omission of pension wealth is not likely to cause a significant bias in the assignment of wealth percentiles. Social security wealth is relatively uniformly distributed (Poterba, Venti, and Wise 1994) and those with private pensions tend to be already at higher wealth levels (Gale 1995).

Table 5
Means of SIPP Data for Mortality Rate Estimation

	Mean	Standard Deviation	Minimum	Maximum
Head				
Age	62.80	8.72	50	85
Less than high school	0.39			
High school	0.29			
Greater than high school	0.32			
Black	0.06			
Disabled[a]	0.17			
Wife				
Age	59.07	9.69	20	85
Less than high school	0.33			
High school	0.41			
Greater than high school	0.26			
Disabled[a]	0.17			
Head or wife dies	0.056			
Head dies	0.040			
Wife dies	0.017			
Household financial assets	47,977	230,961	0	6,938,000
Household net worth	137,466	279,375	0	7,757,700
Number of observations	7,025			

Source: Authors' tabulations of 1984 and 1987 Survey of Income and Program Participation. Sample consists of all married couples where the head of household is aged 50 or older at the first interview and who have data for household wealth. All dollar amounts are in 1984 dollars.
a. Disability status is only available for persons under the age of 65.

view, for example, they will have three survival probabilities and one mortality probability. If a couple leaves the sample (attrits) between the fourth and fifth interviews, they will have three survival probabilities. Thus attrition is treated as a right-censored spell. One-year survival rates are constructed as the product of three sequential four-month survival rates.[18]

In all cases, we model the survival probabilities using a logistic specification,

$$(5) \quad PS^4(a, wp) = \frac{1}{1 + \exp(f(a, wp))},$$

where $f(a, wp)$ is a polynomial in age and wealth percentile. Age of the head of household (typically the husband) is used for age. The substantive results do not change if alternative functional forms are used.

18. We have also estimated a competing risks model allowing for different determinants of death for the husband and wife. The results were similar to what is presented here.

Table 6
Estimates of Mortality Rate Regressions for Married Couples

	Wealth Definition Total Net Worth		Wealth Definition Financial Wealth	
	(1)	(2)	(3)	(4)
WP	−19.773		−28.234	
	(6.334)		(7.797)	
WP squared	31.197		38.581	
	(8.040)		(9.757)	
WP cubed	−14.575		−14.103	
	(3.447)		(4.148)	
Age of head * WP	0.095	0.061	0.205	0.172
	(0.086)	(0.082)	(0.103)	(0.100)
Age of head * WP squared	−0.098	−0.067	−0.197	−0.173
	(0.090)	(0.086)	(0.102)	(0.098)
Age of head	0.074	0.082	0.054	0.061
	(0.016)	(0.016)	(0.020)	(0.020)
Constant	−7.517		−5.752	
	(1.111)		(1.446)	
WP ≤ 25		−6.571		−5.793
		(1.153)		(2.217)
WP ≤ 25 * WP		−36.985		−27.241
		(9.842)		(21.062)
WP ≤ 25 * WP squared		77.877		23.984
		(26.685)		(53.189)
WP > 25 * WP		−1.302		−5.004
		(3.166)		(3.931)
WP > 25 * WP squared		2.354		9.560
		(6.234)		(7.099)
Number of observations	7,025	7,025	7,025	7,025
Log likelihood	−2,032.8	−2,023.8	−2,084.5	−2,079.5

Source: Authors' tabulations of 1984–87 SIPP. These estimates are based on a discrete duration model where four-month death probabilities are modeled using a logit specification. Standard errors are in parentheses.

C. Results

Table 6 contains the main estimates for the mortality rate equation. The dependent variable is equal to one if the couple survives. Therefore, a positive coefficient implies that an increase in the covariate leads to an increase in the probability of survival. The models are estimated using maximum likelihood. The first two columns use total net worth to assign wealth percentiles while the second two columns use financial wealth.

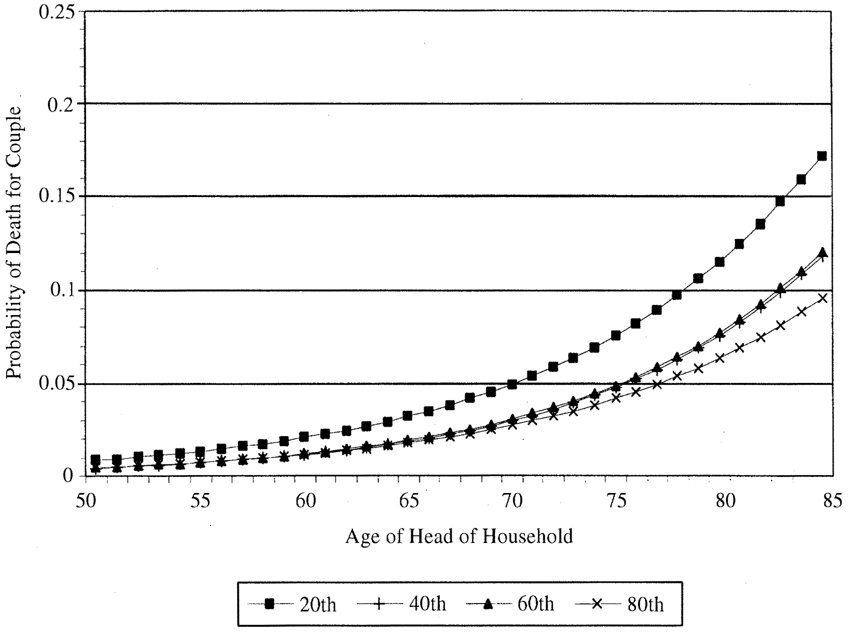

Figure 1a
Probability of Death for Head or Spouse Conditioning on Current Wealth—Basic Model by Age of Head and Selected Wealth Percentiles (20th, 40th, 60th, 80th)

After some specification testing, we chose a basic model that includes a cubic polynomial in wealth percentile, a linear age term and a quadratic polynomial for the interaction between age and wealth percentile.[19] The interaction terms allow for differential effects of wealth among different age groups. To capture the nonlinear effects of low wealth on the mortality rates that we saw in Table 4, the second specification includes a spline in wealth percentile, with a quadratic above and below the 25th percentile.

Most parameters are individually significant at the 5 percent level, and each of the polynomials is jointly significant. The results with the spline in wealth percentile (Columns 2 and 4), show that the polynomial for low wealth levels is strongly significant, but the polynomial at higher wealth levels is insignificant.

The coefficients from the logit model, and especially their relative magnitude, are not easy to interpret. For this reason, we plot the predicted mortality rates implied by the model for various age and wealth percentiles. In Figure 1a we show the profiles for mortality rates of the couple by age of head of household for the 20th, 40th, 60th, and 80th percentiles of the wealth distribution. This figure shows that mortality rates increase with age and decrease with wealth percentile. At age 65,

19. We cannot reject the hypothesis that the coefficients on higher-degree polynomials in wealth, age, and the interaction terms are zero.

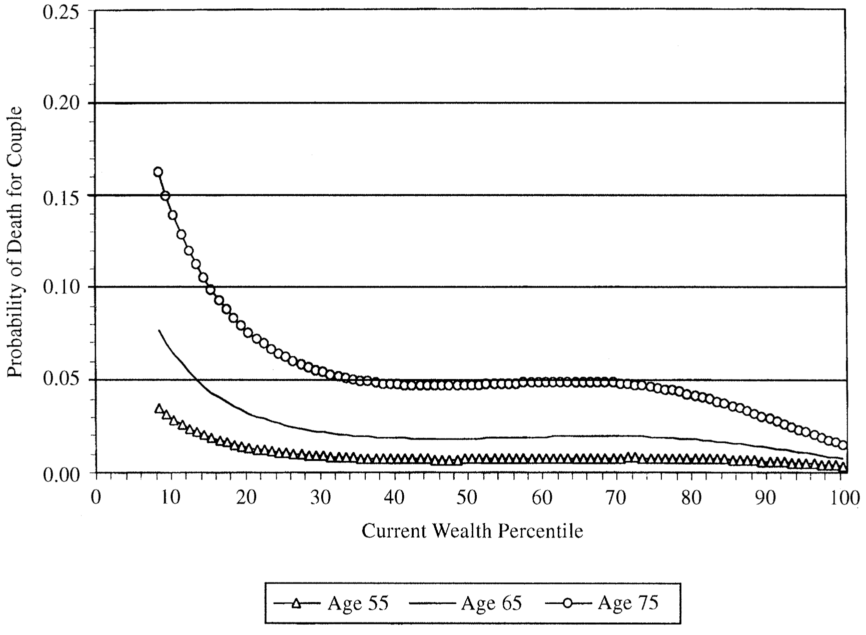

Figure 1b
Probability of Death for Head or Spouse Conditioning on Current Wealth—Basic Model by Wealth Percentile and Selected Ages (55, 65, 75)

the one-year death rate is about 4 percent for the 20th percentile compared to 1.5 percent for the 80th percentile. At age 75, the differential is 8 percent versus 4 percent. This can also be seen in Figure 1b, which shows mortality rates of the couple by wealth percentile for those age 55, 65, and 75.[20] This figure shows that most of the variation in mortality rates is concentrated in the lowest wealth percentiles. This finding is consistent with earlier studies (Menchik 1993; Jianakoplos, Menchik, and Irvine 1989).

Including a spline in wealth percentile, as presented in Column 2 of Table 6 and plotted in Figures 2a and 2b, shows that most of the effects of differential mortality are explained by very high death rates among the lowest wealth groups. The profiles are quite flat after the 20th percentile. This may reflect the fact that persons in the low wealth groups have limited access to health services or higher risk factors. Alternatively, previous poor health may have reduced wealth, which explains higher mortality risk.

The predicted mortality rates for the models using financial wealth show very similar patterns to those presented here using total net worth. Using total net worth

20. The percentile profile begins at the 8th percentile because of out-of-sample prediction problems. Recall that because of bunching at zero wealth, as much as 10 percent of the distribution in wealth percentile is concentrated at the 10th percentile.

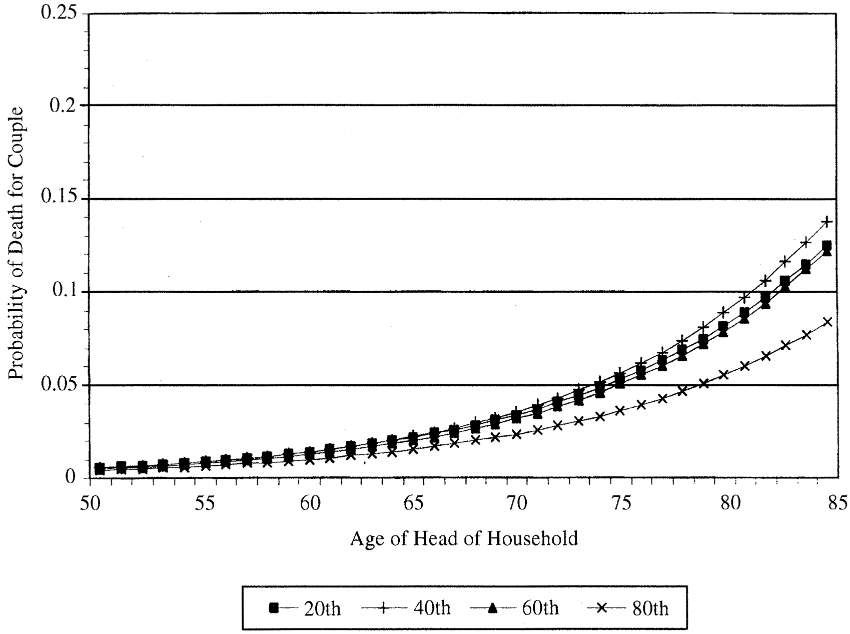

Figure 2a
Probability of Death for Head or Spouse Conditioning on Current Wealth—Low Wealth Spline by Age of Head and Selected Wealth Percentiles (20th, 40th, 60th, 80th)

shows somewhat greater amounts of differential mortality than using financial wealth.

V. Correcting Age Wealth Profiles

As we mentioned in Section I, the two problems that affect the estimate of wealth age profiles from cross-sectional data are the presence of cohort effects and the selectivity bias induced by differential mortality. We control for cohort effect by using a relatively long time series of cross sections to construct synthetic panels. We then use the estimates presented in the previous section to correct these profiles for the effect of differential mortality.

The Consumer Expenditure Survey (CEX) has been collected on a continuous basis since 1980. In what follows we use the data from 1982 to 1995 to construct synthetic panels and to estimate wealth-age profiles.[21] The CEX is mainly designed to collect information on expenditure patterns but, in addition to expenditure data,

21. Further details on the CEX are provided in Appendix 2. We drop the data from 1980 and 1981 because of data problems.

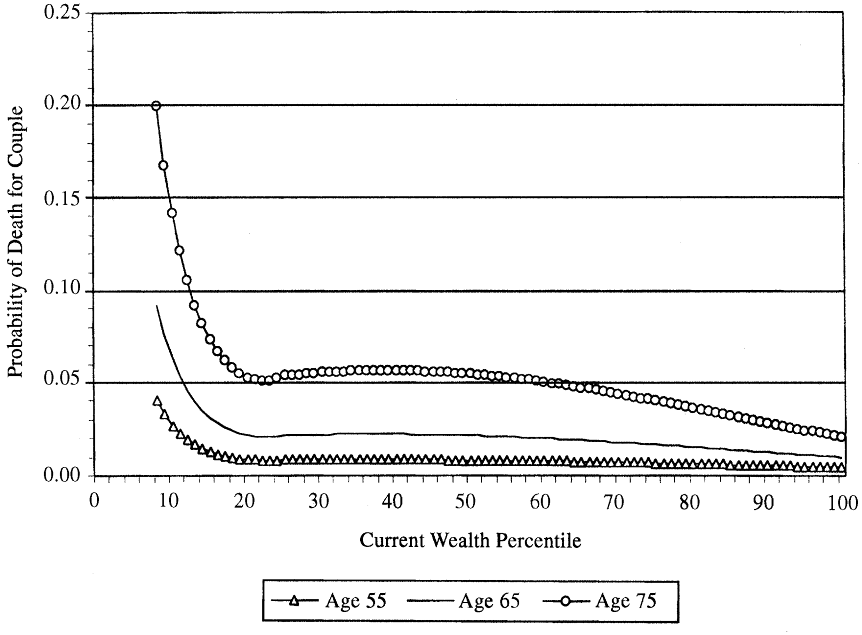

Figure 2b
Probability of Death for Head or Spouse Conditioning on Current Wealth—Low Wealth Spline by Wealth Percentile and Selected Ages (55, 65, 75)

it also contains information on household income and financial assets. Specifically, four components of financial wealth are collected in the last of the five quarterly interviews completed by each household. These components of financial wealth are: checking accounts, saving accounts, U.S. saving bonds, and other bonds and equities.

Before presenting the estimated profiles and their correction, we discuss briefly some of the features of the financial data and compare them to those in SIPP.[22] Given that the CEX is not a survey designed explicitly to measure wealth, it is likely that the CEX data represent an underestimate of actual financial wealth. There are two problems that plague the CEX measures. First, several households have missing values because the reference person refused to answer at least one of the wealth questions. To avoid losing too many observations we redefine as zero the missing values of those observations for which we have valid data for at least two of the four components.[23] Second, each financial wealth component is top coded at $100,000, so that the top tail of the distribution is substantially underestimated. Overall, about 4 percent of the households in the CEX are top coded. Of those with household heads

22. In a previous draft, we presented corrections for SIPP data, as well as CEX data. As discussed above, SIPP does not let us control for cohort effects. The magnitude of the corrections for CEX and SIPP are comparable.
23. We have also tried dropping all the households with missing values. The results did not change considerably.

Table 7
Comparison of CEX and SIPP Measures of Financial Wealth, Married Couples with Head Age 50–80

			Households With Nonzero Amounts			
	Mean	Percent Nonzero	25 Percent	Median	75 Percent	Mean
CEX	30,062	90.9	2,180	10,900	45,014	33,049
SIPP	47,977	87.5	3,297	15,462	52,753	54,848

Source: Author's tabulations of SIPP and CEX data. All amounts are in 1984 dollars.

between the ages of 50 and 81, almost 9 percent are top coded. Although the top coding should not affect the assignment of wealth percentiles and correction factors, it may induce a substantial amount of downward bias in mean wealth-age profiles.

In Table 7 we assess the extent of this bias by comparing total financial wealth as measured in SIPP with the sum of the four components measured in the CEX. As expected, total financial wealth as measured in SIPP is higher than in the CEX. However, the percentage of households reporting zero assets is very similar in the two data sets, while mean and various percentiles are about 30 percent lower in the CEX than in SIPP.

Mirroring the SIPP analysis, we select a sample of married couples where the head is aged 50 or older. For each couple, we use the observed data on their financial wealth to assign them to wealth percentile within an age group. As means (and other measures of location) will be computed within cohort and calender year groups, we assign wealth rankings within cohort-calendar year groups, not on cohort alone as in the SIPP analysis. There is some degree of arbitrariness in the way one deals with the ''bunching'' of observations with zero wealth. We have distributed households uniformly to the wealth percentiles between zero and the first percentile corresponding to an observation with positive wealth. We have treated these in other ways and the results were qualitatively similar.

In Figure 3, we present corrected and uncorrected average wealth-age profiles form the CEX. On the left panel we plot the uncorrected averages. These are obtained by dividing the observations in the 1982–95 surveys into five-year cohorts on the basis of their year of birth. The first cohort is formed by those households with a head born between 1900 and 1904, the second between 1905 and 1909, and so on. In the figure, each connected segment represents a cohort, followed as it ages between 1982 and 1995. Because the sample covers 14 years and the cohorts are defined by five-year intervals, we observe more than one cohort at each age. Differences among the observed age profiles are partly due to cohort and partly to year effects.

The right panel presents wealth profiles that are corrected for differential mortality. We use estimates of the model in Column 4 of Table 6, using financial wealth and the low-wealth spline. Given the parameter estimates, we compute a correction factor for each observation in the data using Equations 2 and 3. As a result of the positive relationship we estimate between longevity and wealth, poorer households within an age group are assigned a higher weight. The weights are used to obtain adjusted or corrected wealth-age profiles.

The evidence in the left panel of Figure 3 is consistent with what is known about the accumulation of wealth: there is no strong evidence of wealth decumulation in the data. One can interpret at least part of the vertical distance between the profiles of different cohorts at overlapping ages as arising from cohort effects that are likely to bias cross-sectional age profiles.[24] From the right panel of the figure it is evident that the adjustment is quite substantial. However, the adjustment is not enough to generate a substantial decline in the last part of the life cycle.

The number of lines and the noise present in the data make it very difficult to assess the extent of the correction for differential mortality. For this reason, in Figure 4 we smooth out the data. In particular we regress the means on a 5th order polynomial in age and cohort specific intercepts. We then plot the smoothed polynomials for the corrected and uncorrected profiles with an arbitrary intercept. We do this separately for the data in the two panels of Figure 3. The differences in the profile make evident the extent of the correction implied by the estimated coefficients.

Alternatively we can compute the ratio between the adjusted and unadjusted figures over different age intervals. From these computations we find that the corrected age profile is about 83 percent of the uncorrected between ages 70 and 74 and about 79 percent between ages 75 and 79.

VI. Conclusions

The two main contributions of this paper are the identification and estimation of a relationship between wealth and mortality and the use of such a relationship to correct estimates of the wealth-age profile using a time series of repeated cross sections. In correcting average wealth-age profiles we have to take into account the fact that differential mortality affects the probability to survive to the observed age via the wealth distribution at previous ages, which is not observed.

We assume that mortality depends on the relative position in the wealth distribution. In order to use our estimates to correct the wealth-age profile it is necessary to make an additional assumption that, together with our model of mortality, allows us to relate the observed wealth position to the wealth position at previous ages.

In the paper, we estimate our model of mortality using a large panel of U.S. households and identify significant effects of wealth on mortality. While most of the differences in mortality rates are between the lowest 20 percent of the wealth distribution and the rest of the population, significant effects remain even for the higher part of the distribution.

The correction of wealth-age profiles can provide useful insights into the debate about asset decumulation by the elderly. We correct the wealth-age profile estimated

24. A word of caution is needed here. The data from different cohorts at the same age, obviously, refer to different points in time. The difference, therefore, can either be interpreted as a consequence of cohort or time effects. A simple example of time effects that affect all cohorts in the same fashion are unexpected capital gains.

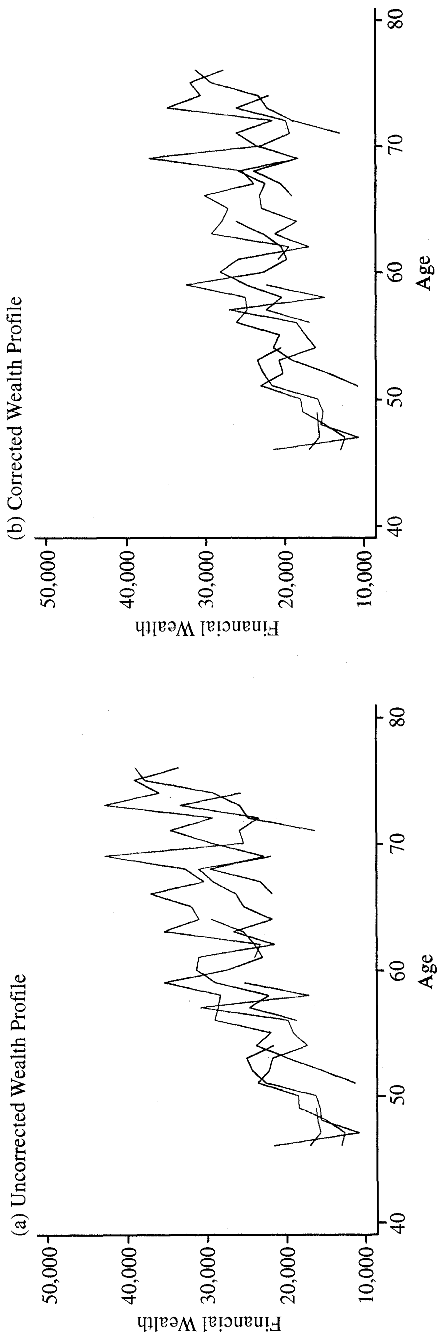

Figure 3
Corrected and Uncorrected Wealth Profile by Cohort and Age of Head of Household, Consumer Expenditure Survey 1982–95

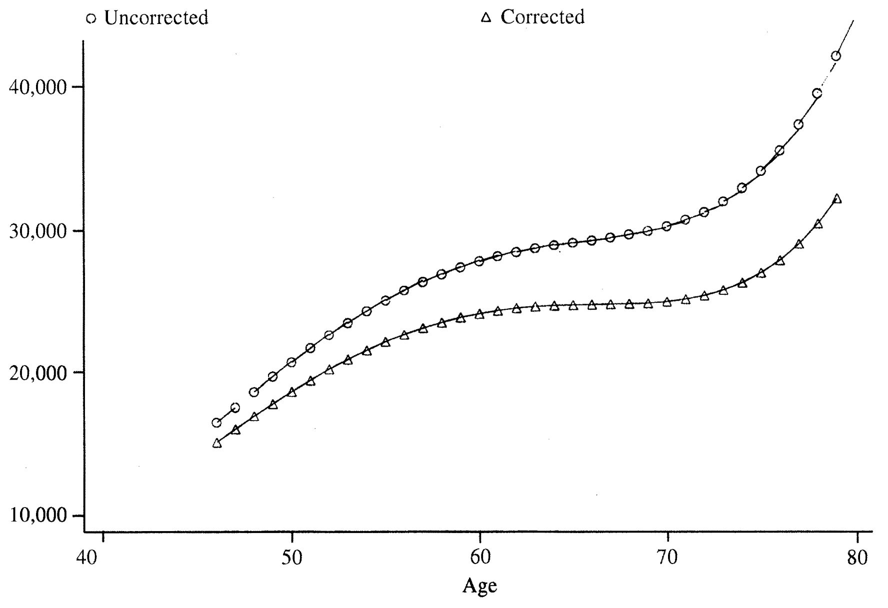

Figure 4
Smoothed Corrected and Uncorrected Wealth Profile by Age of Head of Household, Consumer Expenditure Survey, 1982–95

using a relatively long time series of cross sections and find the estimated mortality differential to be large enough to show up in a significant (statistically and economically) correction for the estimated wealth-age profile.

This is not the only possible application of our results. Whenever one uses synthetic cohort techniques to estimate the dynamic behavior of consumption, income, or any other economic variable, either to estimate structural models or in data description, the corrections proposed in this paper might be important. The techniques we describe can be used to correct the profiles for any variables from any data set that contains information on wealth.

To avoid explicitly modeling the differences in mortality between married and single individuals (which are known to be important) the paper focuses on married couples. Given the higher mortality and the lower level of wealth that characterizes single individuals, the relationship between wealth and mortality within this group is worth investigating. While the limited size of our sample precludes such a study, it constitutes an interesting topic for future research.

Appendix 1

Sensitivity Tests

There are many assumptions that we use in order to generate the age profiles adjusted for differential mortality. Here we consider the sensitivity of the results to these assumptions. Specifically, we examine the sensitivity to the noncrossing assumption and to the choice of 50 as the benchmark age.

Noncrossing Assumption

This is the most important assumption in our model. Although on the surface it may seem like an unattractive assumption, we have made several decisions in the sample selection and data construction in an effort to increase the likelihood that this assumption is valid. For example, we concentrate on one demographic group (married couples) in order to minimize the implications of shocks to wealth that may result from changes in family structure. We use the most comprehensive definition of wealth that is available in order to avoid problems that may result from changes in portfolio choice (such as cashing out home equity) that may characterize couples in retirement. Finally, we should stress once more that from a theoretical point of view, households with shorter life expectancies should be decumulating wealth faster, so that if the relationship between wealth and mortality is positive, the assumption should, on average, hold. The main problem we face is that for our technique to be valid, the assumption has to hold exactly. Because of the nonlinearity of our model, it is impossible to establish analytically the consequences of nonsystematic, random deviations from the noncrossing assumption. Because of this, we decided to perform some simulations.

To establish to what extent the noncrossing assumption can be held as a rough approximation of the data, we perform some simple calculations using the NLS of Older Men. This panel data set is comprised of a sample of about 5,000 men ages 45–59 in 1966, who were interviewed biannually through 1981. Data on household wealth was collected five times between 1966 and 1981.[25] We construct a subsample consisting of married couples where the head is age 50 or over and assign them, for each year wealth is observed, to wealth percentiles based on the same five-year age cohorts we used in our SIPP analysis. As in the SIPP analysis, we consider two definitions of wealth: financial wealth and total net worth. We then use this panel data on wealth percentiles to determine how often a couple changes rankings from one period to the next. This analysis shows that there is significant evidence in support of the noncrossing assumption. For example, among couples that survive through the final wealth assessment in 1981, using total net worth as the definition of wealth, about one-half of all couples experience a change in wealth percentile of five percentile points or less during the roughly five years that pass between wealth assessments. There is even less movement with financial wealth, where almost 70 percent of the surviving couples move less than five percentile points during the fifteen-year period between 1966 and 1981.

While this evidence provides strong support in favor of the noncrossing assumption, it is hard to translate that information into an understanding of how some (nonsystematic) crossing would affect the corrections for differential mortality. In order to examine the robustness of our results, we consider the consequences of introducing a random shock into the evolution of the wealth ranking. We calibrate the variance

25. Wealth is measured in 1966, 1969, 1971, 1976, and 1981.

of the shock using data from the NLS Older Men Panel[26] Our exercise is then performed in the following steps. First, before using current wealth percentile to determine the wealth percentile one year earlier, we add an iid mean zero error to each of the wealth percentiles and rerank the whole sample. Second, we use the transformed rankings and the estimates of the mortality equation to determine the wealth percentile for one year earlier. This is continued recursively, with a shock each year, until we get to the benchmark age. Third, we use this series of wealth percentiles to calculate a corrected weight for each observation. We repeat this experiment 100 times (for each observation in the sample) and then compare the weights so obtained to those obtained without the random shock.

The results of the Monte Carlo are very encouraging. The correlation coefficient between the weights assuming no crossing and the weights with random crossing averages about 0.9, and the corrected profiles look very similar to those presented above.

Benchmark Age

We assume that there is no difference in mortality before age 50. The results in the paper do not seem particularly sensitive to this choice of benchmark age. We have reestimated our model changing the benchmark age to 45 and 55 and the results are quite similar. This is primarily due to the fact that, empirically, there is not much difference in mortality rates across wealth classes in those age ranges.[27]

Appendix 2

The Consumer Expenditure Survey

The Consumer Expenditure Survey (CEX) is a rotating panel administered by the Bureau of Labor Statistics. Since 1980 the CEX is collected on a continuous basis. About 7,000 households are interviewed four times over a period of one year. The main purpose of the survey is to collect information on spending patterns which is ultimately used to compute the weights for the consumer price index (CPI). However, the CEX contains information on a large set of other variables. In the last interview, the households are asked a number of questions on their financial wealth. This is the information that we use. As mentioned in the text, the CEX contains information on four categories of financial wealth: checking accounts, saving accounts, U.S. saving bonds, and other bonds and equities. Each component is top coded at $100,000. In 1980 and 1981 they were top coded at $75,000 and if any component of either income or wealth was top coded all the other components would be masked. For

26. Specifically, we ran a regression of the wealth percentile in year t on the wealth percentile in year $t + j$ and an error term. We then used the estimated variance of the error in that regression to calibrate the model. We ran this regression for many different intervals of t and $t + j$ available in the data.

27. It may be that the difference in mortality rates across wealth classes is more pronounced at much earlier ages, such as in infancy and early childhood. It is not feasible to investigate this using these data sources.

this reason, we drop 1980 and 1981 from our sample. After 1981, the top coding is instead done on each component of income and wealth separately. Further details on the CEX survey and its wealth information can be found in Attanasio (1994).

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