Determinants of the Subjective Survivorship Function

Ryan D. Edwards and Alice Zulkarnain*

October 1, 2012

Abstract

Length of life is a key indicator of well being, and expectations about longevity are important for life-cycle behavior. Earlier research shows that subjective survival probabilities reveal information about health and mortality; here, we also consider the age-shape of survivorship. We examine how subjective survivorship probabilities vary across age at a point in time in the U.S. Health and Retirement Study, how the level and shape of subjective survivorship compares with official life tables and changes with individual characteristics, how they evolve over time in response to new information like health shocks and parental death, and how they reflect actual mortality experiences in the panel. Beliefs can deviate from life tables but reflect relevant private information. The death of a same-sex parent appears to be more salient to individuals than physicians' diagnoses, but the latter are more predictive of future mortality and the shape of the survivorship curve.

Keywords Economics of Aging; Expectations; Health; Mental Health; Mortality
JEL Classifications: D84 · I1 · J14

*Edwards: Associate Professor of Economics, Queens College and the Graduate Center, City University of New York, CUNY Institute for Demographic Research, and NBER. Mailing address: Economics Department, Queens College, City University of New York, Powdermaker 300, 65-30 Kissena Blvd., Flushing, NY 11367, USA. redwards@qc.cuny.edu. Zulkarnain: the Graduate Center, City University of New York, and CUNY Institute for Demographic Research. This research was supported by research enhancement grant 90936 01 01 through Queens College. PRELIMINARY. Please do not quote without permission.

1 Introduction

The workhorse life-cycle model of economic behavior posits a central role for the length of life in understanding decisions of forward-looking consumers (Modigliani and Brumberg, 1954). Despite limitations, the life-cycle framework remains widely used and is useful in understanding an array of economic decisions (Browning and Crossley, 2001), especially in an era when detailed microeconomic data are available. The advent of the biennial Health and Retirement Study (HRS), a panel survey of individuals over age 50 in households first interviewed in 1992 (Juster and Suzman, 1995), has significantly enhanced our understanding of life-cycle behavior. Like several other modern surveys, the HRS asks respondents to report survivorship probabilities to a particular age x, hereafter $l(x)$. Since the beginning of the study, younger respondents were asked about survival to two future ages. Starting with the fifth wave (2000) of the HRS, respondents aged 65 and younger are asked to report the probability they will live to age 75 and the probability they will live to age 80.

Although these data are not life table probabilities, a number of studies have demonstrated how the information they reveal can be used to inform our understanding of individuals' health and mortality. Hurd and McGarry (1995, 2002) show that the subjective survivorship data in the HRS are predictive of future mortality and closely associated with health and the arrival of new information. Smith, Taylor and Sloan (2001) confirm this perspective. Elder (2007) agrees that the data predict actual mortality, but he also reveals systematic biases in subjective mortality forecasts during the panel that appear to be related to cognitive ability. Perozek (2008) reveals that HRS respondents correctly predicted a narrowing of the sex differential around the end of the 20th century while official forecasts had not. Delavande and Rohwedder (2011) use HRS data and analogous European data to examine trends in socioeconomic differentials in mortality. Other studies have revealed that subjective survivorship expectations in the HRS are important for economic choices and outcomes. Hurd, Smith and Zissimopoulos (2004) and Delavande, Perry and Willis (2006) examine whether subjective survivorship affects patterns of retirement and the claiming of Social Security benefits, finding results that vary in size but are consistent in sign. Gan et al.

(2004) report that subjective survivorship probabilities provide a better fit of observed data to life-cycle models than life table equivalents. Bloom et al. (2007) report that the level of household wealth rises with survivorship expectations in the HRS, but that retirement behavior and the length of working life are not as responsive. Salm (2010) shows that consumption growth is slower among HRS respondents who expect higher mortality rates, as a standard life-cycle model would predict. Hurd (2009) provides a recent review of this literature.

Earlier studies tend not to focus on the fact that younger HRS respondents reveal two subjective survivorship probabilities and are therefore crudely indicating the shape or slope of the subjective survivorship function, $l(x)$. The shape of $l(x)$ is interesting because it speaks to perceptions of uncertainty in remaining lifespan within the given interval (Tuljapurkar and Edwards, 2011; Edwards, 2012). A survivorship function with a steeper slope indicates more mortality and greater certainty around remaining length of life; the greater the reduction in survivorship probability between x_1 and $x_2 > x_1$, the likelier is death within the interval rather than later. Figure 1 depicts life-table survivorship functions by sex starting from age 60 from the period life table for the U.S. in 2000 provided by the Human Mortality Database, with marks at ages 75 and 80 to indicate what the HRS is seeking to measure on average, if mortality rates were to remain fixed at their 2000 levels. The slope of subjective survivorship between ages 75 and 80 is 4 percentage points steeper for men than for women, suggesting that men should perceive death as more likely within this age range.[1] Expected remaining years of life at age 60 in these data are 19.8 and 23.1 for men and women, respectively, which is suggestive of the same story but not as explicit.

In this paper, we explicitly examine the shape of the subjective survivorship function in HRS data with the ultimate goals of understanding its determinants and its practical impacts on behavior and outcomes. We begin with a descriptive analysis of the $l(x)$ curves that we see in the HRS, and we compare them to life-table $\ell(x)$ curves. Although the subjective survivorship data are characterized by a great amount of heterogeneity and exhibit pooling at focal responses like 0, 50, and 100, we find that the slope implied by the average responses

[1]For men aged 60 in these data, survivorship falls 0.171 from 0.683 to 0.513 between ages 75 and 80, a 25.0 percent decline. For women, the drop is 0.135, from 0.785 to 0.649, or a reduction of 17.2 percent.

is similar to that found in the period life table. While the average levels of $l(75)$ and $l(80)$ diverge from their life-table counterparts, especially among women, the slopes they imply are more accurate.

We next characterize the subjective survivorship function by modeling the two responses $l(75)$ and $l(80)$ as functions of basic demographic characteristics, physicians' diagnoses, and parental deaths. Our choice of covariates in the HRS is guided by a desire to search for exogenous sources of variation such as the arrival of new information about own health or the health of a parent or other family member. We believe the HRS may ultimately help us understand how mortality among kin more broadly might affect expectations, but for now we have focused on parental deaths, which are likely to be the most common death in the family at ages 50 to 65. We begin with simple cross-sectional regressions before harnessing time series identification in the panel. Our findings suggest that the death of the same-sex parent appears to have one of the strongest impacts on expectations and in particular on the shape of the survivorship curve.

Finally, we examine how mortality expectations in the panel conform to actual mortality experiences in two ways. First, we can directly examine survival to ages 75 and 80 among members of the original HRS cohort and their spouses, who have been in the survey for 18 years of observation since 1992 and were at comparable ages at the beginning of the panel. Small sample size impedes this analysis, but it still provides a direct assessment of one of the subjective survivorship questions asked in 1992. We assess total survivorship ex post in addition to the marginal effects of our set of covariates. Second, we can predict future survival for current participants of the HRS by using 5-year period mortality rates among 5-year age groups modeled by our set of covariates. While this is subject to the familiar problems of bias derived from substituting period for cohort rates, we view this as another legitimate check on the determinants of the subjective survivorship function.

Our preliminary results suggest that individuals place inordinate weight on the mortality experiences of same-sex parents relative to physicians' diagnoses. This may reflect rule-of-thumb behavior, salience, some other departure from textbook rationality, or it could reflect the emphasis doctors sometimes place on family health histories. Regardless of whether these shocks are real or merely perceived, we intend the next stage of our research to focus on assessing the impacts of these parental deaths through the shape of subjective survivorship on planning and outcomes. We also find sizable differences between actual survivorship in the original HRS panel and not only self-reported survivorship expectations but also the period life-table survivorship probabilities for men and women. While not surprising, these and other results suggest continued study of these topics is important for improving planning and well-being during retirement.

2 The Health and Retirement Study

Originally begun in 1992 with a representative sample of Americans born between 1931 and 1941, the Health and Retirement Study was expanded in its fourth wave in 1998 to include all individuals aged 50 and over.[2] In subsequent waves, the HRS has added new birth cohorts in order to maintain representative coverage of those ages. Spouses of respondents were included in the survey, with the result that individuals from neighboring birth years have also been followed in the panel. Respondents and spouses present in the first wave in 1992 number 12,651 and have birth years ranging from 1900 to 1969 around an average of 1936.

While not a large-scale dataset, the HRS remains a useful tool for studying mortality because of its length and depth. By the tenth wave in 2010, only 9 percent of the original HRS respondents had been dropped from the sample, while 26 percent had died. Another 8 percent were nonrespondents who were not known to have died.[3] In addition to significant mortality during the panel, the HRS offers rich cross sectional snapshots of health, well-being, and behavior in each wave. In particular, the HRS asks about an array of characteristics and health conditions, and it also asks respondents to report subjective survivorship probabilities.

[2]In 1998, the HRS absorbed its sister study, the Study of Assets and Health Dynamics Among the Oldest Old (AHEAD), which included individuals born before 1924. The missing cohort born between 1924 and 1930, the Children of the Depression (CODA) cohort, was also added in 1998, as were the younger War Babies (WB) cohort, born between 1942 and 1947

[3]As described in a technical HRS document online, the HRS strives to measure mortality among respondents and nonrespondents through direct interviewer contact and through matching to the National Death Index via the social security number. The NDI linkage process has occurred following each wave since 2000.

2.1 The subjective survivorship questions

In each wave, the HRS has asked respondents to report a probability of living to at least one future age, and younger respondents are asked to self-assess survivorship at two future ages.[4] These questions are asked of individuals aged 65 and younger starting in 2000 and introduced in the following manner:

> Next I have some questions about how likely you think various events might be. When I ask a question I'd like for you to give me a number from 0 to 100, where "0" means that you think there is absolutely no chance, and "100" means that you think the event is absolutely sure to happen. For example, no one can ever be sure about tomorrow's weather, but if you think that rain is very unlikely tomorrow, you might say that there is a 10 percent chance of rain. If you think there is a very good chance that it will rain tomorrow, you might say that there is an 80 percent chance of rain.

Following ten other questions about probabilistic future events such as working or retiring, bequests, and inheritances, respondents are asked,

> What is the percent chance that you will live to be 75 or more?
>
> What is the percent chance that you will live to be 80 or more?

Individuals can refuse to answer or state they do not know, but the majority provide an answer that must resemble a probability between 0 and 100.[5] Of the age-eligible HRS respondents who are ask two survivorship questions, the vast majority reply to both, providing insight into the shape of their subjective survivorship functions.

Because the two survivorship readings derive from separate questions, a small number of the responses are internally inconsistent, In the 2000 wave, 2.2 percent of responses indicated

[4]The phrasing of these questions has evolved during the panel, but there is consistency starting in the 2000 wave. Then and later, respondents aged 65 or younger are asked about survival to age 75 and 80, while those over 65 are asked about survival to a future age that is a step function roughly equal to current age plus a number between 10 and 15. Prior to 2000, younger members of the HRS were asked about survival to 75 and 85, while the AHEAD respondents were asked about survival to a single future age as a function of current age.

[5]Of the 6,532 individuals between ages 50 and 65 in the 2000 wave, 5,616 (87 percent) reported a probability of living to 75, 291 did not know, 18 refused to answer, 507 were proxy interviews, and 100 were other missing data.

a higher probability of survival further in the future, an impossibility. A larger share, 32.2 percent, indicated a perfectly flat survivorship curve. These responses are arrayed along the 45 degree line in Figure 2, which plots the two subjective survivorship responses measured in the 2000 wave against one another. Two thirds of these "flat survivorship" cases were associated with the well-known focal responses found in these data: pooling at 0, 50, or 100, which is evident in Figure 2.

2.2 Subjective survivorship and period life tables

Earlier studies have shown that the subjective survivorship expectations in the HRS predict future mortality and appear to reflect relevant information like smoking and shocks to health (Hurd and McGarry, 1995, 2002; Smith, Taylor and Sloan, 2001; Elder, 2007; Perozek, 2008). Whether and to what extent the implicit slope of the subjective survivorship function may be similarly revealing is the subject of this paper.

Figure 3 depicts the average responses of age-eligible men and women between ages 50 and 65 in the 2000 wave of the HRS and compares the results to averages of survivorship probabilities from official NCHS period life tables, which are provided in the RAND distribution of the HRS data. There are notable differences in levels between life-table forecasts and subjective expectations, particularly for females, but this graphic reveals that average subjective survivorship functions are indeed downward sloping in age, and their slopes are if anything more similar than their levels to aggregates found in period life tables.

The similarity between male expectations and their period life table stands in stark contrast to the divergence between female expectations and theirs. Females expect a small advantage relative to men, on the order of 3 to 5 percentage points of survival probability, but in the period life table they actually enjoy survivorship that is 10 to 15 percentage points higher. This result is consistent with earlier findings (Hurd and McGarry, 2002).

2.3 Information relevant for future survival

A number of events may affect mortality expectations, but like Hurd and McGarry (2002), we focus primarily on physicians' diagnoses of new disease conditions, parental deaths, and widowhood. In all cases, we believe it is plausible that these events represent exogenous shocks to knowledge about the future quantity and quality of life. Given the mortality gradient in marital status (Preston and Taubman, 1994), we also examine the effects of divorce. While it is clear that all of these types of shocks could be expected, the two-year time interval between observations in the HRS makes it more likely that expectations will have changed in substantial ways between waves when an event is measured. In the cases of parental death and indicators of ever having been diagnosed with particular conditions, an additional methodological advantage is that these conditions are absorbing states. Widowhood may also be, but the state of divorce is probably less permanent.[6]

The set of physicians' diagnoses we consider are the eight concepts coded in the RAND distribution of the HRS file: high blood pressure or hypertension; diabetes or high blood sugar; cancer or any malignant tumor other than skin cancer; chronic lung disease such as bronchitis or emphysema; heart problems such as a heart attack, coronary heart disease, angina, congestive heart failure, or other heart problems; stroke or transient ischemic attack; emotional, nervous, or psychiatric problems; and arthritis or rheumatism. We measure whether an individual has ever reported these conditions, and we make no attempt to adjust the panel history when individuals dispute earlier records. An advantage of this set of conditions is that it includes a relatively clear falsification or placebo test: mortality due to arthritis or rheumatism in isolation is extremely unlikely, although they clearly affect quality of life. A similar argument might be applicable for psychiatric problems, but it seems likely that they independently predict mortality from suicide or other external causes.

There also are well-known socioeconomic gradients in mortality (Kitagawa and Hauser, 1973), but some research suggests that at older ages, causality tends more to run from health into socioeconomic status rather than the reverse (Adams et al., 2003). We control for differences in education, race, and Hispanic origin in the cross section, but these wash out of our fixed effects panel analysis.

[6]The HRS also measures the cumulative number of divorces, which we could use to define a variable measuring ever being divorced. In a future version of the paper we intend to explore this further.

2.4 Analytical strategy

Our analysis proceeds in four steps. First, we examine the determinants of subjective survivorship expectations $l(75)$ and $l(80)$ using ordinary least squares (OLS) in the cross section, focusing on men and women aged 50 to 65 in the 2000 wave of the HRS. Because of the well-known potential for omitted variables to bias cross-sectional estimates of marginal effects, we next turn to fixed effects (FE) and random effects (RE) estimation strategies using the HRS panel observed between 2000 and 2010 at ages 50 to 65. Across these samples, the average age tends to be roughly 60.

Third, we conduct our first validation exercise by examining actual cohort survivorship $\ell(75)$ and $\ell(80)$ in the panel among members of the original HRS cohort who have either died during the panel or reached ages 75 or 80 by 2010. The original HRS cohort was designed to be representative of individuals born between 1931 and 1941, who were aged 69 to 79 by 2010 and only just reaching the younger of the two target ages they were asked about in 1992, 75 and 85. Members of the 1931–1935 birth cohorts were also about 60 in 1992 and thus are roughly comparable to those aged 50 to 65 in the panel starting in 2000. For survival to age 80, we must examine individuals born between 1926 and 1930, all of whom are spouses of the original HRS cohort and thus predominantly male. Small sample size hinders this analysis especially for women. Mortality among these birth cohorts of the early 1930s or late 1920s is likely to be higher overall than for later cohorts, but the marginal effects may be more comparable.

Finally, we conduct a second validation exercise by constructing estimates of marginal effects on period $\ell(75)$ and $\ell(80)$ for men and women aged 60 based on five-year mortality in the HRS panel between 2000 and 2005 for five-year age groups. Period-based estimates such as this are subject to the usual criticism that they combine current experience across multiple birth cohorts to project future experiences for a single cohort. But this approach is feasible, and we believe it provides valuable insights.

3 Results

3.1 Cross-sectional determinants of subjective survivorship

Table 1 presents results of modeling expected survivorship to age 75 and 80, $l(75)$ and $l(80)$, in the cross section using the 2000 wave of the HRS. We model responses by males and females separately because patterns of disease incidence and cause-specific mortality varies by sex, and we also suspect that the salience of different information may vary by sex.

The top row confirms a positive effect of an additional year of age within the 15 year range from 50 to 65 in the sample. Survival to a particular year should be more likely with advancing age, and it is shown to be so here, with a small amount of variation. Race and ethnicity are correlated with responses in rather unexpected ways. African Americans state higher survival probabilities while Hispanics state the same (male) or lower (female), roughly the reverse of what we typically see in vital statistics. Years of education exert a uniform self-perceived protective effect, raising expected survivorship by about 1.5 percentage points at both future ages.

Currently being divorced has no statistically significant association with survivorship expectations, but being a widower reduced probabilities by 7 or 8 percentage points. Widows do not respond differently than other females.

Having a dead parent of either sex appears to reduce probabilities almost across the board, but there also appears to be a bias toward greater emphasis on the same-sex parent's death. For both males and females, the marginal effect on $l(80)$ is about twice as large for the same-sex parent, and a deceased father has no statistically significant association with $l(75)$ for females. The impacts of parental death appear slightly larger for males, but the differences are not consistently significant.

Practically all of the doctors' diagnoses are associated with reduced subjective survivorship. This is surprising in the case of diagnosed arthritis, which is not known to be fatal. Another surprise is that the marginal effect of diabetes, a manageable disease, is practically as large as those of other diseases and in some cases appears to be higher. Diabetes is comorbid with high blood pressure, heart problems, and stroke in these samples, as is arthritis, broadly speaking, but the largest Pearson correlation coefficients between conditions barely exceed 0.2, as shown in Table 2. These results raise the natural question of whether omitted variables may be important, which motivates the panel analysis to follow.

For most conditions, the anticipated impacts on survivorship at ages 75 and 80 tends to be statistically indistinguishable. This implies individuals expect shorter remaining life expectancy with these conditions, but there is no sign they alter their expectations about the shape of the survivorship function and thus uncertainty in remaining life. This is less true of parental deaths, which appear to reduce survivorship at 80 by more than at 75, presumably because some parents had lived past 75.

3.2 Panel determinants of subjective survivorship

Two common approaches to panel analysis are a generalized least squares (GLS) approach to modeling individual random effects (RE), and a least squares with dummy variables or fixed effects (FE) approach. The latter draws identification solely from changes in variables during the panel, which may be inefficient relative to the RE model.

Table 3 presents estimates from random effects regressions of subjective survivorship probabilities on pooled samples of individuals aged 50 to 65 observed between 2000 and 2010. With several small exceptions, results are virtually unchanged from the OLS estimates run on a single cross section shown in Table 1. Being African American now raises estimates for females as well, and the effect of widowhood is insignificant for both males and females.

All doctors' diagnoses significantly reduce expected survivorship across the board, again with roughly equal percentage point effects for $l(75)$ and $l(80)$. The effects of parental deaths are slightly attenuated compared to Table 1 but are all statistically significant, and the same-sex parental death pattern remains.

The RE estimator draws identification from longitudinal as well as cross-sectional variation within the panel, so it is noteworthy that the results are so similar to OLS estimates on the 2000 cross section. We would normally expect the sources of longitudinal variation, such as marital dissolution and various health shocks, to differ from the vast cross-sectional variation in mortality between socioeconomic groups, but we do not see that here.

Table 4, which shows the FE estimates using the same samples, reveals a starkly different picture altogether. All coefficients are attenuated, and all standard errors have risen. Parental deaths are still significant in only two or three of the eight places they could be, and in particular only for expected survivorship to age 80. Point estimates are still larger for the death of the same-sex parent than for the other parent, but those differences are no longer statistically significant.

About half of the doctors' diagnoses lose statistical significance in the fixed effects analysis, which is equivalent to a regression of first differences. In their analysis of the changes in subjective survivorship for both sexes combined between waves 1 and 2 of the HRS, Hurd and McGarry (2002) found that only the onset of cancer was statistically significant. In these data, the number of individuals in each regression is somewhat lower due to separating the sexes, but the sample size is much increased because of additional waves. Probably as a result, we see significance not only of cancer onset, across the board, but also evidence that lung disease, heart problems, stroke, and psychiatric problems are also associated with downward revisions in subjective survivorship. Oddly, the onset of arthritis is still significantly associated with downward revisions as well, which may reflect lack of awareness about the disease, coincidence with other diseases, or pessimism. Interestingly, the onset of diabetes is not associated with any change in survivorship expectations, even taking on a positive sign for men, which may instill some faith in the FE approach.

It is hard to know what to make of some of the more provocative positive results here, with stroke reducing $l(75)$ but not $l(80)$ only for men, and psychiatric problems performing similarly only for women. The incidence of stroke in the panel is similar across sexes, but females are almost twice as likely to report diagnoses of psychiatric problems. We are tempted to speculate that cognitive function might be an issue here, but that would not help explain the apparently missing effect of stroke on female $l(75)$. New diagnosis of lung disease also lowers female $l(75)$ and not $l(80)$, and it does not appear to significantly affect male forecasts.

These results suggest that the cross-sectional variation in these covariates must have been very powerful relative to the temporal variation in explaining subjective survivorship expectations. This is consistent with what we know broadly about how individuals update their expectations over time in the panel, namely that they do not increase them as much as advancing age should normally imply (Hurd and McGarry, 2002).

As might be inferred from the large differences between RE and FE coefficients, these RE models fail the Hausman specification test and suggest that the individual random effects are correlated with the right-hand-side variables. This implies inconsistency of the RE estimator in this context and leads us to favor the FE results.

3.3 Survival in the original HRS cohort

Our first validation exercise focuses on the "completed" mortality, such as it exists, among the original HRS cohort first surveyed in 1992. These individuals were asked essentially the same questions as our panel of younger respondents in the 2000 wave and later, so the mortality experiences of the first HRS cohort can be compared with the same covariates.

A key problem is that only about half of the original age-eligible HRS cohort, namely those born between 1931 and 1941, had lived long enough by the 2010 wave to fully inform us about survivorship to age 75, and none had reached age 80. Some spouses of the original cohort, especially the males, were however somewhat older and can inform us about both $\ell(75)$ and $\ell(80)$. We would ideally like to examine a single cohort's survivorship, but sample size hampers analysis of mortality among the original HRS spouses, especially in the case of females, who tend to be younger than their spouses.

As a result, we present two sets of estimates in Table 5, the one on the left modeling only $\ell(75)$ for the subset of HRS respondents born between 1931 and 1935, and the one on the right modeling $\ell(75)$ and $\ell(80)$ for respondents born between 1926 and 1930. The range of ages is smaller than in the 2000 cross section or the pooled data, but the average age is roughly the same.

Very few of the covariates near the top of the table are statistically significant, with the notable exception of years of education, which is strongly protective except perhaps for females born 1926–1930. There is evidence that being divorced reduces survivorship for both sexes; for the older cohorts who entered the survey as spouses, this relationship naturally does not exist. The same is probably true of widowhood measured in wave 1, which was rare. Neither of the parental death indicators are statistically significant in any of the samples shown here, although the coefficients are negative at least for the 1931–1935 birth cohort. Although more of the post-2000 panel had living parents at these ages than the original HRS cohort, the differences were not large: about 33 and 13 percent of the former had living mothers or fathers, respectively; for the latter, the shares were more like 32 and 10 percent. Overall sample size is certainly limited more here, however, even if the variation in parental death was similar, and that could help explain the statistical insignificance.

By contrast, many of the doctors' diagnoses are significantly associated with reduced actual survivorship. Here the surprise, or perhaps the tragedy, may be that diabetes diagnosis at baseline appears to have been a very important killer for these birth cohorts. Diabetes is consistently associated with reduced survivorship, on the order of 10 to 15 percentage points, and reaching a high of 32 among the small subsample of females born between 1926 and 1930. High blood pressure is also associated with reduced survivorship except among those older females. The cancer results are mixed and hard to interpret; it is dropped among older females because it perfectly predicts survival in the small sample. Lung disease and heart problems reduce survivorship among the younger birth cohorts here. Strokes are a strongly significant predictor of mortality across the board, sometimes with marginal effects approaching 50 percentage points.

Also notable are the null results especially for arthritis but also strikingly for psychiatric problems. Standard errors remain relatively large; these are not precisely estimated zero effects. But these findings confirm lay and medical knowledge that arthritis is not deadly, and they suggest that psychiatric problems may not independently cause death.

A final note on Table 5 concerns aggregate survival in the panel as compared to that implied by period life tables and to respondents' subjective expectations. These three statistics are shown at the bottom of Table 5, and the comparison reveals the familiar difference between period and cohort mortality and provides an altered perspective on the accuracy of subjective estimates. These individuals were not only pessimistic relative to official statistics in 1992; they were even more pessimistic relative to what actually happened to them.

Differences between average expected survivorship and average actual survivorship range between 10 and 15 percentage points, which is a very large error.

3.4 Period survival in the HRS

Another look at the determinants of objective mortality in the panel can be obtained by estimating the covariates of period mortality among several unrelated birth cohorts and extrapolating the determinants of cohort mortality. This technique relies on a familiar type of assumption, that the marginal effects at a particular age will not change over time, even though we know the mortality rates themselves tend to do so. The marginal effect of a covariate on survivorship to a particular age is then the exponentiated or geometrically cumulated marginal effects from the current age to that future age according to the period mortality model.

Tables 6 and 7 perform this exercise for males and females based on models of 5-year mortality starting in 2000 observed among 5-year age groups. One limitation that stands out immediately is that by ages 75–79, hardly any of the sample has living parents; thus it is impossible to estimate the marginal impacts of parental deaths on mortality at those ages. In order to construct a cumulative marginal effect of parental deaths on survivorship probabilities, we simply assume those marginal impacts are zero at those ages, a reasonable assumption given the circumstances that is also impossible to assess.

We construct the compounded marginal effect on survivorship to 75 and 80 starting from age 60, the average age in our other samples. These are shown in the two columns on the far right of Tables 6 and 7 along with their standard errors, which we compute using numerical methods. But we also report the results of modeling mortality at ages 50–54 and 55–59 for comparisons' sake.

In the top halves of Tables 6 and 7, what emerges is the apparent idiosyncrasy of marginal effects of these covariates across ages, including even years of education. Effects often cumulate to a significant impact on forecast survivorship that is similar in size to what we see in table 5 and earlier, but it is striking how uneven these effects appear to be across the life cycle. Part of this may be due to sample size constraints and the limited prevalence of mortality until later ages, but the lower half of both tables suggest that power is not so limited as to render the apparently stronger influences shown there insignificant as well.

Divorce seems to hurt males relatively more, but both sexes' survivorship to 75 or 80 appears to be significantly affected, with important negative impacts between age 70 and 74. In contrast to previous results, we see relatively large and significant negative impacts of widowhood on females' survival, but not for males. Perhaps most striking in the upper panel are the significant negative impacts of a deceased mother on both males and females, coupled with no signs of any effects of a deceased father for either. Here again, the effects of mother's death are scattered across the age range, and differently so for males and females.

In the bottom halves of Tables 6 and 7, we see that most doctor-diagnosed health conditions are statistically significant for actual survival at most ages in the panel. The exceptions are high blood pressure and arthritis, which do not appear to independently affect any of the age-specific mortality rates we consider. Diabetes tragically remains a key killer, and the accumulated marginal impacts on survivorship of cancer, lung disease, heart problems, and stroke run between 15 and 40 percentage points. In a turnabout from previous results, psychiatric problems appear to be deadly for males but not as much for females, with major impacts on mortality between 60 and 64 and again between 75 and 79.

4 Discussion

We believe the fixed effects estimates presented in Table 4 provide the most meaningful insights into how individuals between 50 and 65 translate information about parental deaths, own marital status, and own disease conditions into their own subjective survivorship expectations. Random effects estimates and OLS results are also informative but appear to reflect substantial omitted variable bias and cannot provide much help toward understanding the determinants of the subjective survivorship function.

Evidence from the HRS panel between 2000 and 2010 suggests that men and women implicitly update their survivorship forecasts in response to some types of new information but not others. Based on comparisons to patterns in actual mortality within the panel, we find that individuals appear to commit what we might call both Type 1 and Type 2 errors: revising down their survivorship probabilities when they should not, and not revising them downward when they should.

In the cross section and in a panel analysis with individual random effects, we find that almost every kind of negative event we consider is associated with reductions in expected survivorship, but we are skeptical about causality. Notable exceptions are widowhood and divorce, which our analysis suggests are in fact correlated with elevated mortality. Years of age and education are the positive influences we suspect they should be. It is noteworthy that the more educated appear to know they will live longer, a logical finding, but it is also possible that they are just less pessimistic. The sample in general and females in particular tend to significantly underestimate their future survivorship relative either to period or cohort life tables.

Our fixed-effects estimates reveal fewer significant responses in subjective survivorship to the arrival of information, although similar overall patterns emerge. Parental deaths are strong predictors of reductions in expected survivorship, and the death of a same-sex parent is more salient. Among doctors' diagnoses, onset of cancer is most consistently significant for subjective survivorship, followed by heart problems and lung disease. As was also true in the RE and OLS results, each of these conditions tends to reduce survivorship at 75 and 80 by about 5 percentage points, with limited evidence that the impact is larger at age 75. Stroke appears to reduce only $l(75)$ among men, while lung disease operates similarly for women. Males' expectations appear to narrowly pass the falsification test of no effect of the onset of arthritis, but for females its negative effects on both $l(75)$ and $l(80)$ are strongly significant. Interestingly, there are no detectable effects on expectations of the onsets of high blood pressure or diabetes for either sex. To be sure, both conditions are certainly responsive to treatment and to behavioral changes, and it is unlikely that either diagnosis would prompt a physician to discuss future survival.

Estimates of the actual determinants of survivorship from the HRS panel do not speak entirely of one voice, but they agree on several key points, and one of them is that diabetes appears to be independently deadly in the HRS. The effects of high blood pressure are less clear, but the marginal effects of diabetes is among the largest and also has one of the smallest standard errors of all the conditions. Among men and women at every age below 80, its correlation with mortality is large and significant, and the same is true for cohort mortality among members of the original HRS cohort. To be sure, our fixed-effects models of subjective survivorship are identified exclusively through the onset of new disease, while our mortality analysis lumps old and new cases together. Especially in the case of chronic and incurable diseases like diabetes, it is certainly plausible that the duration of exposure affects mortality. But the same is likely true about cancer, and although mortality risks associated with cancer and diabetes are roughly equivalent in Tables 6 and 7, we only see significant reductions in survivorship expectations with new cancer diagnoses in Table 4. We speculate that this may be because we believe physicians are more likely to discuss survival with new cancer patients.

The complete absence of any independent effect of arthritis on mortality in Tables 5, 6, and 7 is reassuring due to the nonfatal nature of the disease. But taken in juxtaposition with the fairly robust evidence that diagnosis of arthritis reduces subjective survivorship especially for females, this result also reveals a potentially significant miscalculation. Because arthritis is somewhat more prevalent among women, we speculate this pattern could be partly responsible for their large and apparently systematic underestimation of future survivorship.

Perhaps the most striking divergence between the determinants of subjective and actual survivorship concerns the role of parental death. We find limited evidence that the timing of parental death matters for actual mortality, especially for cohort mortality. In our analysis of period mortality, we find that the death of a mother reduces male survivorship rather continuously between ages 50 and 70, but we find no significant impact of the death of a father. For females, the only significant effect we find is associated with maternal death and in only one age group. Overall, these results provide scant validation to the behavior we see in the data, in which paternal deaths change men's survivorship expectations and maternal deaths affect women's. While perhaps 25 percent of the variation in longevity is genetic (Herskind et al., 1996; Christensen and Vaupel, 1996; Christensen, Johnson and

Vaupel, 2006), and it is true that boys inherit X-chromosomes only from their mothers, but the literature reports no evidence that the inheritability of longevity may be sex-specific. We speculate that the death of a same-sex parent is simply more salient, perhaps because physicians may be more likely to ask about same-sex family health history, or because the offspring may formally adopt sex-specific roles in the kinship network previously held by the deceased parent.

But what we find interesting about the reaction of subjective survivorship to parental death is that it is one of the few events that appears to change the shape of the subjective survivorship curve, as opposed to leaving it unaffected or raising or lowering it without changing the slope. When a parent of a 50 to 65 year old dies in our panel, that parent has likely lived to an age past 75. Individuals who perceive this information to be salient are likely to raise $l(75)$ relative to $l(80)$ because either they expect to at least live as long as the parent, or no longer, or both. We find in the data that they tend to reduce $l(80$, even though they should probably ignore the information.

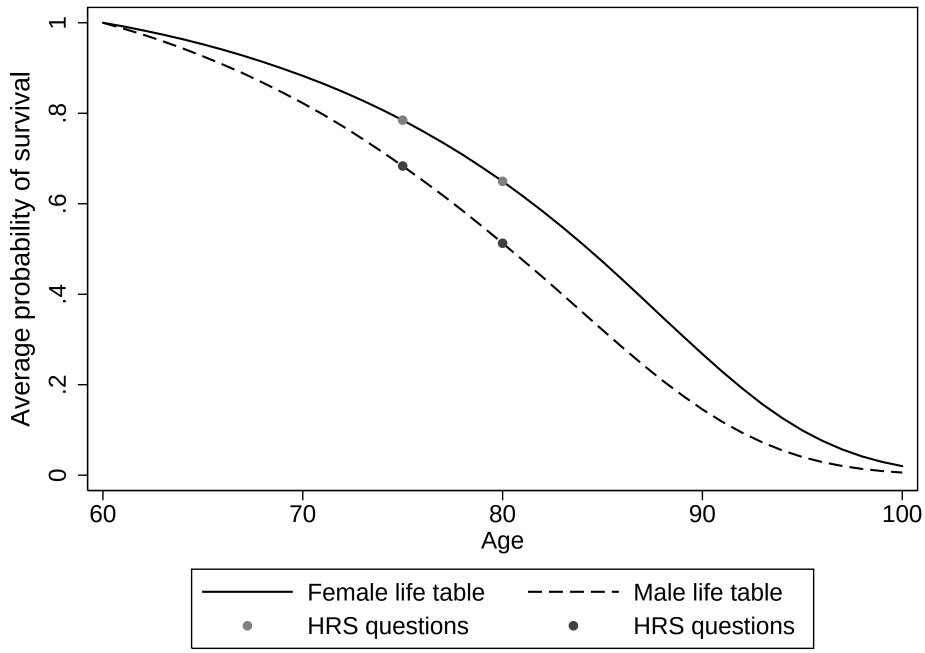
We find a few other signs that the shape of the subjective survivorship function may change with the arrival of particular types of information, but patterns are not consistent across sex. In the fixed effects estimates in Table 4, both lung disease and psychiatric problems lower $l(75)$ but not $l(80)$ for women but does little for men, while stroke lowers $l(75)$ but not $l(80)$ for men but does little for women. The sizes of these effects are comparable to the impacts of parental death, and we believe all are interesting and worth exploring further as we search for behavior explanations and outcomes associated with these results.

Our analysis of changes in actual survivorship as functions of the events we consider here is hampered by low statistical power in the cohort analyses of $\ell(75)$ and $\ell(80)$ in Table 5. The patterns in period mortality that emerge in Tables 6 and 7 suggest that several types of doctors' diagnoses may reduce $\ell(80)$ by more than $\ell(75)$ and thus make remaining life more certainly short. Lung disease appears to do this most convincingly, steepening the slope by about 10 percentage points for both males and females. We interpret these period results with some caution because they draw identification off cross-sectional variation.

These findings potentially have implications for both research and for policy. We are interested in understanding how shocks to longevity expectations may influence behavior across the life cycle but in particular at these ages prior to retirement. In particular, we speculate that saving and retirement planning may respond to changes in the perceived distribution of remaining years of life. We also suspect that household structure, inter-vivos transfers, and bequests may be interesting outcomes to examine. This study suggests that some types of information appear to prompt changes in survivorship expectations, which raises the obvious question of what happens next. We intend to answer that in future research using the rich data of the HRS.

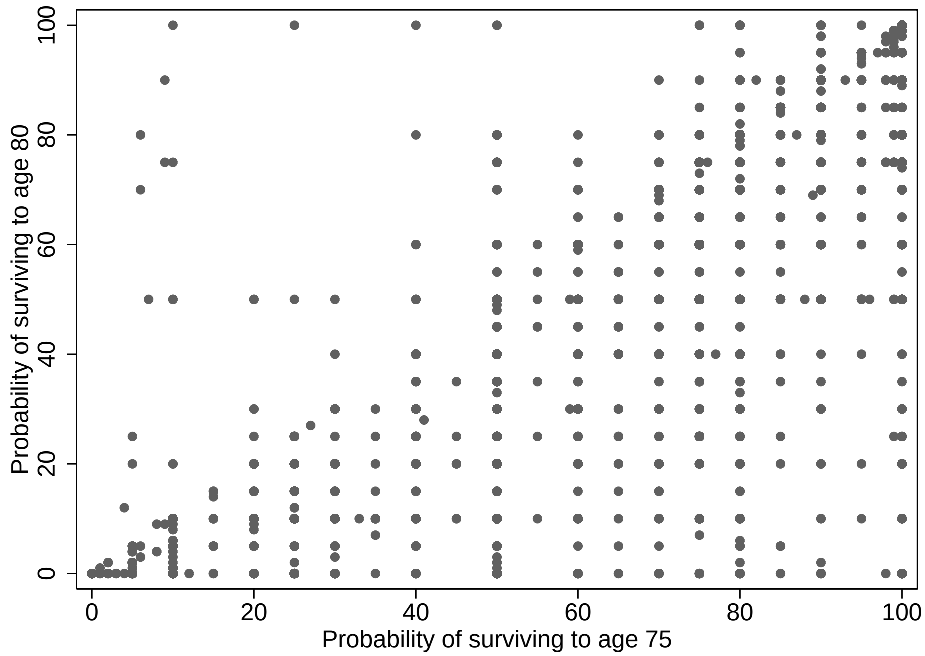
We also think our results are interesting because of what they reveal about popular awareness of longevity risks and how targeted information campaigns might improve understanding of a key life-cycle planning parameter. As outsiders translating these findings into potentially useful medical advice, we speculate that informing patients more fully about the longevity risks of diabetes and arthritis, and about the limits to inherited longevity, may be welfare improving.

Figure 1: Survivorship at age 60 for U.S. males and females in the 2000 life table



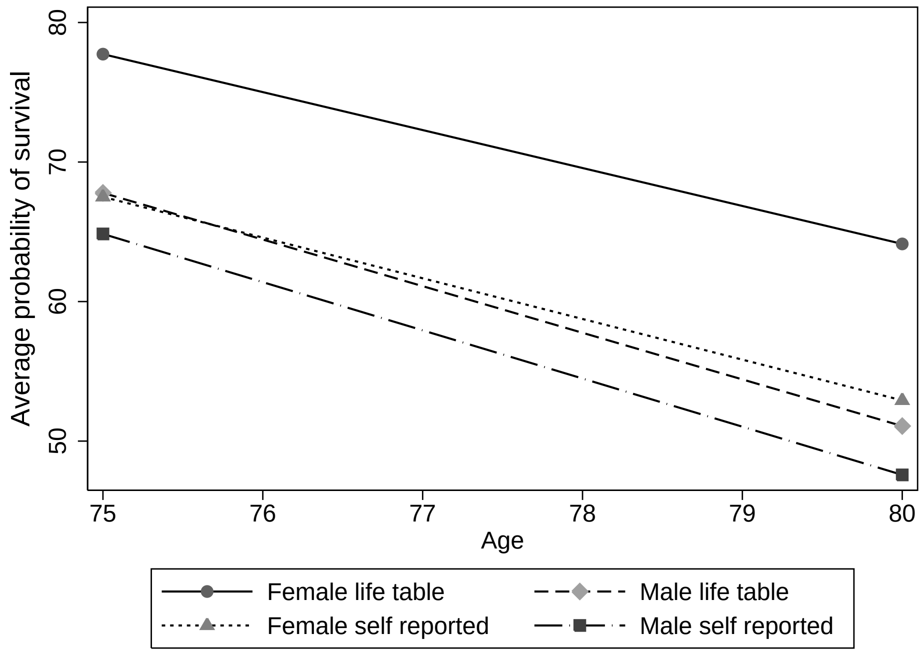
Source: Human Mortality Database.

Figure 2: Scatterplot of subjective survival to age 80 versus subjective survival to age 75 in the 2000 wave of the HRS



Source: Health and Retirement Study wave 5 (RAND file) and authors' calculations.

Figure 3: Subjective and life-table survivorship for U.S. males and females in the 2000 wave of the HRS



Source: Health and Retirement Study wave 5 (RAND file) and authors' calculations.

References

Adams, Peter, Michael D. Hurd, Daniel McFadden, Angela Merrill and Tiago Ribeiro. 2003. "Healthy, wealthy, and wise? Tests for direct causal paths between health and socioeconomic status." *Journal of Econometrics* 112(1):3–56.

Bloom, David, David Canning, Michael Moore and Younghwan Song. 2007. The effect of subjective survival probabilities on retirement and wealth in the United States. In *Population Aging, Intergenerational Transfers and the Macroeconomy*, ed. Robert Clark, Naohiro Ogawa and Andrew Mason. Northampton, MA: Elgar Press pp. 67–100.

Browning, Martin and Thomas F. Crossley. 2001. "The Life-Cycle Model of Consumption and Saving." *Journal of Economic Perspectives* 15(3):3–22.

Christensen, Kaare and James W. Vaupel. 1996. "Determinants of longevity: genetic, environmental, and medical factors." *Journal of Internal Medicine* 240(6):333–341.

Christensen, Kaare, Thomas E. Johnson and James W. Vaupel. 2006. "The quest for genetic determinants of human longevity: challenges and insights." *Nature* 7(6):436–448.

Delavande, Adeline, Michael Perry and Robert J. Willis. 2006. "Probabilistic Thinking and Social Security Claiming." *Michigan Retirement Research Center Working Paper* 2006-129.

Delavande, Adeline and Susann Rohwedder. 2011. "Differential Survival in Europe and the United States: Estimates Based on Subjective Probabilities of Survival." *Demography* 48(4):1377–1400.

Edwards, Ryan D. 2012. "The Cost of Uncertain Life Span." *Journal of Population Economics* forthcoming.

Elder, Todd E. 2007. "Subjective survival probabilities in the Health and Retirement Study: Systematic biases and predictive validity." *Michigan Retirement Research Center Working Paper* 2007-159.

Gan, Li, Guan Gong, Michael Hurd and Daniel McFadden. 2004. "Subjective Mortality Risk and Bequests." *NBER Working Paper* 10789.

Herskind, Anna Maria, Matthew McGue, Niels V. Holm, Thorkild I. A. Sørensen, Bent Harvald and James W. Vaupel. 1996. "The heritability of human longevity: a population-based study of 2872 Danish twin pairs born 1870–1900." *Human Genetics* 97(3):319–323.

Hurd, Michael D. 2009. "Subjective Probabilities in Household Surveys." *Annual Review of Economics* 1(1):543–562.

Hurd, Michael D., James P. Smith and Julie Zissimopoulos. 2004. "The Effects of Subjective Survival on Retirement and Social Security Claiming." *Journal of Applied Econometrics* 19(6):761–775.

Hurd, Michael D. and Kathleen McGarry. 1995. "Evaluation of the Subjective Probabilities of Survival in the Health and Retirement Study." *Journal of Human Resources* 30(supp):s268–s292.

Hurd, Michael D. and Kathleen McGarry. 2002. "The Predictive Validity of Subjective Probabilities of Survival." *The Economic Journal* 112(482):966–985.

Juster, F. Thomas and Richard Suzman. 1995. "An Overview of the Health and Retirement Study." *Journal of Human Resources* 30, supplement:S7–S56.

Kitagawa, Evelyn M. and Philip M. Hauser. 1973. *Differential Mortality in the United States: A Study in Socioeconomic Epidemiology.* Cambridge, MA: Harvard University Press.

Modigliani, Franco and Richard Brumberg. 1954. Utility Analysis and the Consumption Function: An Interpretation of Cross-Section Data. In *Post-Keynesian Economics*, ed. Kenneth K. Kurihara. New Brunswick, NJ: Rutgers University Press pp. 388–436.

Perozek, Maria. 2008. "Using subjective expectations to forecast longevity: Do survey respondents know something we don't know?" *Demography* 45(1):95–113.

Preston, Samuel H. and Paul Taubman. 1994. Socioeconomic Differences in Adult Mortality and Health Status. In *The Demography of Aging*, ed. Linda G. Martin and Samuel H. Preston. Washington: National Academy Press pp. 279–318.

Salm, Martin. 2010. "Subjective mortality expectations and consumption and saving behaviours among the elderly." *Canadian Journal of Economics* 43(3):1040–1057.

Smith, V. Kerry, Donald H. Taylor and Frank A. Sloan. 2001. "Longevity Expectations and Death: Can People Predict Their Own Demise?" *American Economic Review* 91(4):1126–1134.

Tuljapurkar, Shripad and Ryan D. Edwards. 2011. "Variance in Death and Its Implications for Modeling and Forecasting Mortality." *Demographic Research* 24(21):497–526.

Table 1. Cross-sectional covariates of subjective survivorship in the 2000 wave of the HRS

	Endogenous variable: Expected survivorship probability to age 75 or to age 80			
Covariate measured	Males		Females	
at baseline (1992)	75	80	75	80
Age in years	0.00819***	0.00950***	0.00594***	0.00814***
	(0.00146)	(0.00157)	(0.00104)	(0.00118)
African American	0.0607***	0.0999***	0.0141	0.0306**
	(0.0174)	(0.0194)	(0.0129)	(0.0141)
Hispanic	-0.0220	-0.0206	-0.121***	-0.100***
	(0.0222)	(0.0247)	(0.0192)	(0.0199)
Years of education	0.0141***	0.0143***	0.0163***	0.0175***
	(0.00188)	(0.00200)	(0.00169)	(0.00187)
Divorced	-0.0163	-0.00179	0.00642	0.00618
	(0.0171)	(0.0183)	(0.0124)	(0.0142)
Widowed	-0.0750**	-0.0714**	-0.00212	-0.000269
	(0.0357)	(0.0344)	(0.0140)	(0.0153)
Mother dead	-0.0426***	-0.0441***	-0.0401***	-0.0667***
	(0.0108)	(0.0121)	(0.00856)	(0.00959)
Father dead	-0.0580***	-0.0848***	-0.0156	-0.0249**
	(0.0142)	(0.0159)	(0.0109)	(0.0123)
Doctors' diagnoses: Ever had				
High blood pressure	-0.0225**	-0.0149	-0.0188**	-0.0183*
	(0.0106)	(0.0116)	(0.00856)	(0.00973)
Diabetes	-0.0668***	-0.0732***	-0.0719***	-0.0769***
	(0.0166)	(0.0168)	(0.0143)	(0.0151)
Cancer	-0.0390*	-0.0305	-0.0577***	-0.0661***
	(0.0211)	(0.0220)	(0.0142)	(0.0155)
Lung disease	-0.111***	-0.0956***	-0.0864***	-0.0887***
	(0.0238)	(0.0228)	(0.0169)	(0.0182)
Heart problems	-0.0982***	-0.106***	-0.0828***	-0.0683***
	(0.0145)	(0.0149)	(0.0143)	(0.0156)
Stroke	-0.0880***	-0.0789***	-0.0419*	-0.0534**
	(0.0275)	(0.0268)	(0.0247)	(0.0267)
Psychiatric problems	-0.0878***	-0.0747***	-0.0337***	-0.0491***
	(0.0190)	(0.0185)	(0.0114)	(0.0125)
Arthritis	-0.0183*	-0.0222*	-0.0368***	-0.0469***
	(0.0108)	(0.0119)	(0.00821)	(0.00938)
Years of birth	1935-1949	1935-1949	1935-1949	1935-1949
Average age in 2000	59.2	59.2	58.3	58.3
Survivorship to age …	**75**	**80**	**75**	**80**
Actual in panel	--	--	--	--
Period life table	0.679	0.511	0.777	0.641
Self-reported	0.648	0.475	0.675	0.528
Observations	2,740	2,740	4,255	4,255
Unique individuals	2,740	2,740	4,255	4,255
R-squared	0.107	0.099	0.121	0.113

Notes: Robust standard errors calculated using the Huber/White sandwich estimator appear in parentheses. Asterisks denote significance at the 10% (*), 5% (**), and 1% (***) level. Each column presents marginal effects from a separate OLS regression of a subjective survivorship expectation expressed from 0 to 1 for survival to a particular age. A coefficient of 0.01 represents a one percentage point increase in survivorship probability. Data are drawn from the 2000 wave of the Health and Retirement Study (HRS) as distributed in the RAND file version L. The doctor-diagnosed conditions are 1) high blood pressure or hypertension; 2) diabetes or high blood sugar; 3) cancer or a malignant tumor of any kind except skin cancer; 4) chronic lung disease except asthma such as chronic bronchitis or emphysema; 5) heart attack, coronary heart disease, angina, congestive heart failure, or other heart problems; 6) stroke or transient ischemic attack (TIA); 7) emotional, nervous, or psychiatric problems; and 8) arthritis or rheumatism. Period life table survivorship statistics are provided in the RAND HRS file and are derived from official NCHS statistics. Due to data availability, the 2006 official life table is used for 2008 and 2010.

Table 2. Pearson correlation matrix between doctors' diagnoses in the 2000 wave of the HRS

Men aged 50-65	High blood pressure	Diabetes	Cancer	Lung disease	Heart problems	Stroke	Psychiatric problems	Arthritis
High blood pressure	1.000							
Diabetes	0.193	1.000						
Cancer	0.009	0.018	1.000					
Lung disease	0.063	0.043	0.037	1.000				
Heart problems	0.148	0.131	0.072	0.105	1.000			
Stroke	0.129	0.124	-0.003	0.045	0.143	1.000		
Psychiatric problems	0.100	0.069	0.055	0.142	0.116	0.098	1.000	
Arthritis	0.133	0.066	0.070	0.133	0.116	0.066	0.121	1.000

Women aged 50-65	High blood pressure	Diabetes	Cancer	Lung disease	Heart problems	Stroke	Psychiatric problems	Arthritis
High blood pressure	1.000							
Diabetes	0.212	1.000						
Cancer	0.031	-0.008	1.000					
Lung disease	0.063	0.068	0.055	1.000				
Heart problems	0.179	0.159	0.037	0.170	1.000			
Stroke	0.141	0.114	0.002	0.097	0.169	1.000		
Psychiatric problems	0.102	0.083	0.044	0.187	0.145	0.091	1.000	
Arthritis	0.182	0.086	0.054	0.145	0.135	0.096	0.167	1.000

Notes: See the notes to Table 1 for a description of the variables, which are binary indicators of having ever had a doctor diagnose the particular condition. The samples are the same as shown in Table 1.

Table 3. Covariates of subjective survivorship among respondents aged 50-65 in the HRS panel between 2000 and 2010, random effects

	Endogenous variable: Expected survivorship probability to age 75 or to age 80			
	Males		Females	
Covariate	75	80	75	80
Age in years	0.00849***	0.00924***	0.00590***	0.00731***
	(0.000761)	(0.000804)	(0.000623)	(0.000694)
African American	0.0656***	0.118***	0.0301***	0.0750***
	(0.0110)	(0.0121)	(0.00831)	(0.00922)
Hispanic	-0.0107	0.0120	-0.0785***	-0.0686***
	(0.0133)	(0.0134)	(0.0117)	(0.0124)
Years of education	0.0162***	0.0126***	0.0189***	0.0174***
	(0.00127)	(0.00133)	(0.00111)	(0.00123)
Divorced	-0.00983	-0.00577	-0.00700	-0.00147
	(0.00989)	(0.0102)	(0.00733)	(0.00773)
Widowed	-0.00718	-0.0251	-0.00964	-0.0104
	(0.0189)	(0.0179)	(0.00804)	(0.00852)
Mother dead	-0.0290***	-0.0357***	-0.0342***	-0.0580***
	(0.00610)	(0.00662)	(0.00503)	(0.00563)
Father dead	-0.0343***	-0.0595***	-0.0170***	-0.0245***
	(0.00799)	(0.00882)	(0.00651)	(0.00741)
Doctors' diagnoses: Ever had				
High blood pressure	-0.0219***	-0.0211***	-0.0240***	-0.0266***
	(0.00612)	(0.00627)	(0.00483)	(0.00543)
Diabetes	-0.0403***	-0.0405***	-0.0465***	-0.0479***
	(0.00845)	(0.00800)	(0.00740)	(0.00778)
Cancer	-0.0524***	-0.0465***	-0.0516***	-0.0489***
	(0.0115)	(0.0104)	(0.00863)	(0.00913)
Lung disease	-0.0545***	-0.0609***	-0.0698***	-0.0611***
	(0.0133)	(0.0127)	(0.00937)	(0.00986)
Heart problems	-0.0710***	-0.0673***	-0.0516***	-0.0485***
	(0.00861)	(0.00830)	(0.00779)	(0.00817)
Stroke	-0.0652***	-0.0448***	-0.0340***	-0.0319**
	(0.0130)	(0.0123)	(0.0118)	(0.0130)
Psychiatric problems	-0.0630***	-0.0467***	-0.0412***	-0.0446***
	(0.00982)	(0.00947)	(0.00623)	(0.00675)
Arthritis	-0.0219***	-0.0277***	-0.0297***	-0.0345***
	(0.00601)	(0.00645)	(0.00479)	(0.00526)
Years of birth	1934-1955	1934-1955	1934-1957	1934-1957
Average age in panel	59.1	59.1	59.1	59.1
Survivorship to age …	**75**	**80**	**75**	**80**
Actual in panel	--	--	--	--
Period life table	0.702	0.461	0.795	0.592
Self-reported	0.626	0.440	0.668	0.511
Observations	13,252	13,252	19,722	19,722
Unique individuals	4,751	4,751	6,612	6,612
R-squared (overall)	0.1207	0.1222	0.1328	0.1318

Notes: Robust standard errors calculated using the Huber/White sandwich estimator appear in parentheses. Asterisks denote significance at the 10% (*), 5% (**), and 1% (***) level. Each column presents marginal effects from a separate GLS random-effects (RE) regression of a subjective survivorship expectation expressed from 0 to 1 for survival to a particular age. A coefficient of 0.01 represents a one percentage point increase in survivorship probability. Data are drawn from the 2000, 2002, 2004, 2006, 2008, and 2010 waves of the Health and Retirement Study (HRS) as distributed in the RAND file version L. See the notes to Table 1 for notes regarding variables. All regressions include time dummies.

Table 4. Covariates of subjective survivorship among respondents aged 50-65 in the HRS panel between 2000 and 2010, fixed effects

	Endogenous variable: Expected survivorship probability to age 75 or to age 80			
	Males		Females	
Covariate	75	80	75	80
Age in years	0.00662	0.00708	0.00659	0.00781
	(0.00602)	(0.00604)	(0.00500)	(0.00542)
African American	--	--	--	--
Hispanic	--	--	--	--
Years of education	--	--	--	--
Divorced	0.0110	0.00922	-0.00406	-0.00007
	(0.0150)	(0.0153)	(0.0115)	(0.0111)
Widowed	0.0376	0.00599	-0.00539	-0.0147
	(0.0274)	(0.0251)	(0.0136)	(0.0136)
Mother dead	-0.00917	-0.0197*	-0.00221	-0.0200**
	(0.00965)	(0.0105)	(0.00814)	(0.00893)
Father dead	-0.0106	-0.0326**	0.00342	0.00121
	(0.0123)	(0.0134)	(0.0100)	(0.0111)
Doctors' diagnoses: Ever had				
High blood pressure	-0.00664	-0.00250	-0.00332	-0.00705
	(0.0100)	(0.00976)	(0.00752)	(0.00830)
Diabetes	0.00918	0.00193	-0.0142	-0.0123
	(0.0137)	(0.0123)	(0.0114)	(0.0118)
Cancer	-0.0439**	-0.0357**	-0.0492***	-0.0333**
	(0.0174)	(0.0152)	(0.0169)	(0.0163)
Lung disease	-0.0140	-0.0345*	-0.0382***	-0.0182
	(0.0196)	(0.0192)	(0.0146)	(0.0147)
Heart problems	-0.0406***	-0.0284**	-0.0247**	-0.0202
	(0.0149)	(0.0133)	(0.0121)	(0.0124)
Stroke	-0.0506***	-0.0179	-0.00541	0.00731
	(0.0180)	(0.0173)	(0.0171)	(0.0192)
Psychiatric problems	-0.0287*	-0.0182	-0.0346***	-0.0179
	(0.0153)	(0.0147)	(0.0102)	(0.0109)
Arthritis	-0.00963	-0.0171*	-0.0202***	-0.0190**
	(0.00951)	(0.0102)	(0.00747)	(0.00794)
Years of birth	1934-1955	1934-1955	1934-1957	1934-1957
Average age in panel	59.1	59.1	59.1	59.1
Survivorship to age …	**75**	**80**	**75**	**80**
Actual in panel	--	--	--	--
Period life table	0.702	0.461	0.795	0.592
Self-reported	0.626	0.440	0.668	0.511
Observations	13,252	13,252	19,722	19,722
Unique individuals	4,751	4,751	6,612	6,612
R-squared (overall)	0.0499	0.0644	0.0429	0.0437

Notes: Robust standard errors calculated using the Huber/White sandwich estimator appear in parentheses. Asterisks denote significance at the 10% (*), 5% (**), and 1% (***) level. Each column presents marginal effects from a separate fixed-effects (FE) regression of a subjective survivorship expectation expressed from 0 to 1 for survival to a particular age. A coefficient of 0.01 represents a one percentage point increase in survivorship probability. Data are drawn from the 2000, 2002, 2004, 2006, 2008, and 2010 waves of the Health and Retirement Study (HRS) as distributed in the RAND file version L. See the notes to Table 1 for notes regarding variables. All regressions include time dummies.

Table 5. Covariates of survival in the original HRS panel among men and women born before 1936

	Endogenous variable:					
	Actual survivorship to age 75		Actual survivorship to age 75 or to age 80			
Covariate measured	Males	Females	Males		Females	
at baseline (1992)	75	75	75	80	75	80
Age in years	0.0116	0.00353	0.00762	0.00601	0.0231	0.00255
	(0.00725)	(0.00576)	(0.0112)	(0.0127)	(0.0259)	(0.0286)
African American	0.00170	-0.0437**	-0.0399	-0.0708	0.162*	0.218*
	(0.0319)	(0.0219)	(0.0512)	(0.0600)	(0.0907)	(0.117)
Hispanic	0.0203	-0.0231	0.0838	0.0945	-0.0412	0.158
	(0.0450)	(0.0338)	(0.0782)	(0.0882)	(0.128)	(0.172)
Years of education	0.00714**	0.00689**	0.0126***	0.0141**	-0.00119	0.0275*
	(0.00337)	(0.00315)	(0.00485)	(0.00558)	(0.0127)	(0.0145)
Divorced	-0.0981**	-0.0479*	-0.351	-0.296	-0.224	-0.297*
	(0.0384)	(0.0252)	(0.224)	(0.274)	(0.148)	(0.177)
Widowed	-0.0242	-0.0367				
	(0.0682)	(0.0237)				
Mother dead	-0.0210	-0.0299	0.0111	0.0186	-0.0929	0.0275
	(0.0236)	(0.0194)	(0.0383)	(0.0436)	(0.0764)	(0.0863)
Father dead	-0.0244	-0.00439	-0.0802	-0.0246	0.153	0.127
	(0.0361)	(0.0297)	(0.0923)	(0.0959)	(0.125)	(0.148)
Doctors' diagnoses: Ever had						
High blood pressure	-0.0398*	-0.0671***	-0.0638**	-0.0620*	0.0465	0.00737
	(0.0227)	(0.0182)	(0.0323)	(0.0372)	(0.0740)	(0.0841)
Diabetes	-0.0908***	-0.120***	-0.104**	-0.152***	-0.181*	-0.323**
	(0.0301)	(0.0236)	(0.0439)	(0.0520)	(0.109)	(0.129)
Cancer	0.0387	-0.00900	-0.284***	-0.283***		
	(0.0512)	(0.0315)	(0.0609)	(0.0780)		
Lung disease	-0.169***	-0.0744***	0.0126	-0.101*	-0.138	-0.0717
	(0.0353)	(0.0279)	(0.0532)	(0.0600)	(0.0912)	(0.129)
Heart problems	-0.132***	-0.0485*	-0.0582	-0.0720	-0.0637	-0.0636
	(0.0259)	(0.0252)	(0.0378)	(0.0441)	(0.0904)	(0.109)
Stroke	-0.157***	-0.0968**	-0.166**	-0.253***	-0.319**	-0.487**
	(0.0520)	(0.0491)	(0.0675)	(0.0850)	(0.145)	(0.198)
Psychiatric problems	-0.0624	0.00280	0.0804	0.0213	-0.0623	-0.0261
	(0.0395)	(0.0257)	(0.0790)	(0.0872)	(0.0952)	(0.113)
Arthritis	0.00407	0.00156	-0.0124	0.0373	0.0733	0.0422
	(0.0228)	(0.0179)	(0.0323)	(0.0365)	(0.0708)	(0.0805)
Years of birth	1931-1935	1931-1935	1926-1930	1926-1930	1926-1930	1926-1930
Average age in 1992	58.7	58.7	63.3	63.3	63.0	63.0
Survivorship to age …	**75**	**75**	**75**	**80**	**75**	**80**
Actual in panel	0.726	0.810	0.754	0.615	0.798	0.672
Period life table	0.635	0.769	0.683	--	0.800	--
Self-reported	0.628	0.649	0.656	--	0.673	--
Observations	1,551	1,912	668	668	119	119

Notes: Robust standard errors calculated using the Huber/White sandwich estimator appear in parentheses. Asterisks denote significance at the 10% (*), 5% (**), and 1% (***) level. Each column presents marginal effects from a separate probit regression of actual survival to a particular age in the HRS panel. A coefficient of 0.01 represents a one percentage point increase in survivorship probability. Data are drawn from the 1992 wave of the Health and Retirement Study (HRS) as distributed in the RAND file version L, and subsequent mortality is drawn from successive waves up to 2010. Only individuals who either lived up to or past the indicated age or died previously are included in the regression. See the notes to Table 1 for notes regarding variables.

Table 6. Five-year survival among males by age group and covariate starting from 2000 in the Health and Retirement Study

Covariate measured at baseline (2000)	Endogenous variable: Males' 5-year actual survivorship at ages						Implicit actual survivorship probability starting from age 60 to age 75 or to age 80	
	50-54	55-59	60-64	65-69	70-74	75-79	75	80
Age in years	-0.0232***	-0.00204	-0.00890**	0.00266	-0.00175	-0.0222**	-0.0078	-0.0297**
	(0.00850)	(0.00427)	(0.00385)	(0.00660)	(0.00663)	(0.0106)	(0.0092)	(0.0139)
African American	-0.0177	0.00311	-0.0458***	-0.0381	0.0430	-0.0230	-0.0100	-0.0582
	(0.0205)	(0.0173)	(0.0166)	(0.0272)	(0.0386)	(0.0554)	(0.0496)	(0.0716)
Hispanic	-0.0123	-0.0249	0.0128	-0.0260	0.0536	0.0863	-0.0165	0.1404
	(0.0252)	(0.0203)	(0.0267)	(0.0355)	(0.0516)	(0.0710)	(0.0626)	(0.1121)
Years of education	-0.00350	0.00368*	0.00202	0.00247	0.0124***	0.00548	0.0181***	0.0228***
	(0.00242)	(0.00201)	(0.00210)	(0.00275)	(0.00336)	(0.00438)	(0.0042)	(0.0066)
Divorced	-0.00263	-0.0354**	-0.0457**	-0.0809**	-0.1820***	-0.0931	-0.2714***	-0.3258***
	(0.0187)	(0.0176)	(0.0206)	(0.0331)	(0.0492)	(0.0836)	(0.0434)	(0.0679)
Widowed		-0.0466	-0.0584**	-0.000999	-0.0101	0.00523	-0.0286	-0.0589
		(0.0319)	(0.0276)	(0.0446)	(0.0390)	(0.0412)	(0.0585)	(0.0721)
Mother dead	-0.0329*	0.0180	-0.0491***	-0.0645**	-0.0507		-0.1381**	-0.1511**
	(0.0192)	(0.0131)	(0.0163)	(0.0309)	(0.0630)		(0.0595)	(0.0599)
Father dead	-0.0102	-0.00315	-0.0324	0.00406	-0.0553	0.0610	-0.0186	0.0084
	(0.0255)	(0.0183)	(0.0321)	(0.0553)	(0.154)	(0.143)	(0.1616)	(0.2266)
Doctors' diagnoses: Ever had								
High blood pressure	-0.0228	0.00302	0.00995	0.00370	0.0387*	-0.0110	0.0443	0.0457
	(0.0139)	(0.0131)	(0.0128)	(0.0197)	(0.0234)	(0.0318)	(0.0318)	(0.0483)
Diabetes	-0.0309**	-0.0604***	-0.0355**	-0.0441*	-0.105***	-0.0953***	-0.1526***	-0.2423***
	(0.0155)	(0.0151)	(0.0150)	(0.0225)	(0.0265)	(0.0369)	(0.0292)	(0.0392)
Cancer	-0.0295	-0.0862***	-0.0706***	0.0197	-0.130***	-0.0915**	-0.1772***	-0.2377***
	(0.0229)	(0.0198)	(0.0196)	(0.0293)	(0.0278)	(0.0370)	(0.0346)	(0.0439)
Lung disease	0.00122	-0.0420**	-0.0363*	-0.0829***	-0.161***	-0.189***	-0.2517***	-0.3730***
	(0.0228)	(0.0203)	(0.0201)	(0.0285)	(0.0323)	(0.0428)	(0.0311)	(0.0397)
Heart problems	-0.00846	0.0226	-0.0537***	-0.0668***	-0.0970***	-0.0955***	-0.1831***	-0.2663***
	(0.0187)	(0.0181)	(0.0145)	(0.0202)	(0.0235)	(0.0317)	(0.0256)	(0.0342)
Stroke	-0.0330	-0.0631***	-0.0807***	-0.128***	-0.0351	-0.106***	-0.2294***	-0.2928***
	(0.0300)	(0.0194)	(0.0207)	(0.0261)	(0.0331)	(0.0401)	(0.0328)	(0.0432)
Psychiatric problems	-0.0274*	-0.0225	-0.0633***	-0.0376	-0.0304	-0.121**	-0.1246***	-0.2198***
	(0.0162)	(0.0173)	(0.0189)	(0.0304)	(0.0392)	(0.0489)	(0.0423)	(0.0566)
Arthritis	-0.0255*	-0.0205	0.00792	-0.000981	0.00865	-0.0183	0.0322	-0.0005
	(0.0135)	(0.0125)	(0.0133)	(0.0191)	(0.0230)	(0.0322)	(0.0309)	(0.0463)
Observations	463	1,080	1,810	1,297	1,150	831		
Pseudo R-squared	0.273	0.193	0.129	0.082	0.099	0.080		

Notes: Robust standard errors calculated using the Huber/White sandwich estimator appear in parentheses. Asterisks denote significance at the 10% (*), 5% (**), and 1% (***) level. Each of the first 6 columns presents marginal effects from a separate probit regression of actual 5-year survival in the HRS panel between 2000 and 2005. A coefficient of 0.01 represents a one percentage point increase in survivorship probability. Data are drawn from the 2000 wave of the Health and Retirement Study (HRS) as distributed in the RAND file version L, and subsequent mortality is drawn from successive waves up to 2006. Only mortality through 2005 is measured. See the notes to Table 1 for notes regarding variables. Columns 7 and 8 present implicit estimates of the marginal effects on survival from age 60 to either age 75 or 80 constructed by exponentiating the marginal effects, e.g., taking the geometric sum, between ages 60 and 75 or 80 and subtracting unity. Standard errors are calculated numerically assuming normally distributed standard errors.

Table 7. Five-year survival among females by age group and covariate starting from 2000 in the Health and Retirement Study

Covariate measured at baseline (2000)	Endogenous variable: Females' 5-year actual survivorship at ages						Implicit actual survivorship probability starting from age 60 to age 75 or to age 80	
	50-54	55-59	60-64	65-69	70-74	75-79	75	80
Age in years	-0.00240	-0.00131	-0.00393	-0.00743	-0.00841	-0.0229***	-0.0205***	-0.0419***
	(0.00307)	(0.00337)	(0.00268)	(0.00473)	(0.00537)	(0.00838)	(0.0073)	(0.0110)
African American	-0.00814	-0.00465	-0.00996	0.00215	-0.0147	0.0402	-0.0280	0.0218
	(0.0109)	(0.0117)	(0.0115)	(0.0176)	(0.0295)	(0.0418)	(0.0336)	(0.0575)
Hispanic	0.0212	0.0196	0.0155	-0.00850	0.0322	0.00871	0.0174	0.0514
	(0.0223)	(0.0180)	(0.0171)	(0.0268)	(0.0384)	(0.0501)	(0.0477)	(0.0768)
Years of education	0.00244	0.00377**	0.00404**	0.000661	0.00453	0.00678*	0.0066*	0.0160***
	(0.00169)	(0.00162)	(0.00176)	(0.00250)	(0.00318)	(0.00396)	(0.0040)	(0.0059)
Divorced	0.0144	0.0139	-0.0248*	-0.0189	-0.0724**	-0.0253	-0.1118***	-0.1305**
	(0.0198)	(0.0149)	(0.0127)	(0.0218)	(0.0319)	(0.0506)	(0.0342)	(0.0561)
Widowed	-0.00161	-0.0286**	-0.0311***	-0.0459***	-0.0184	-0.0255	-0.0921***	-0.1117***
	(0.0155)	(0.0123)	(0.0107)	(0.0150)	(0.0198)	(0.0249)	(0.0215)	(0.0313)
Mother dead	-0.00624	0.00528	-0.00368	0.0195	-0.121**		-0.1185**	-0.1010*
	(0.00821)	(0.00938)	(0.0116)	(0.0203)	(0.0541)		(0.0507)	(0.0527)
Father dead	-0.0119	-0.0144	0.00356	-0.0236	0.0481		0.0451	0.0398
	(0.0114)	(0.0147)	(0.0175)	(0.0437)	(0.128)		(0.1386)	(0.1381)
Doctors' diagnoses: Ever had								
High blood pressure	-0.00267	-0.0136	-0.00289	-0.0125	-0.0187	0.0168	-0.0405*	-0.0173
	(0.00837)	(0.00942)	(0.00970)	(0.0141)	(0.0189)	(0.0255)	(0.0224)	(0.0358)
Diabetes	-0.0212**	-0.0433***	-0.0437***	-0.0607***	-0.0763***	-0.113***	-0.1707***	-0.2523***
	(0.0102)	(0.0110)	(0.0105)	(0.0160)	(0.0228)	(0.0301)	(0.0238)	(0.0325)
Cancer	0.00335	-0.0495***	-0.0297**	-0.0559***	-0.0396	-0.0826***	-0.1076***	-0.1863***
	(0.0141)	(0.0122)	(0.0129)	(0.0180)	(0.0252)	(0.0311)	(0.0277)	(0.0372)
Lung disease	-0.0296*	-0.0268*	-0.0458***	-0.0771***	-0.0781***	-0.145***	-0.1874***	-0.2896***
	(0.0161)	(0.0138)	(0.0119)	(0.0189)	(0.0264)	(0.0332)	(0.0260)	(0.0348)
Heart problems	-0.0109	-0.00881	-0.0194*	-0.0378**	-0.0775***	-0.0501*	-0.1122***	-0.1679***
	(0.0121)	(0.0126)	(0.0112)	(0.0157)	(0.0206)	(0.0277)	(0.0246)	(0.0348)
Stroke	-0.0265	0.00689	-0.0535***	-0.0526***	-0.0505*	-0.177***	-0.1070***	-0.2845***
	(0.0168)	(0.0178)	(0.0138)	(0.0199)	(0.0273)	(0.0300)	(0.0310)	(0.0330)
Psychiatric problems	-0.0130	-0.0255**	0.00450	0.00653	0.000566	-0.0622**	0.0001	-0.0497
	(0.0107)	(0.0104)	(0.0108)	(0.0172)	(0.0252)	(0.0310)	(0.0303)	(0.0433)
Arthritis	0.0217**	0.00405	-0.00550	0.00204	-0.00776	-0.00886	-0.0055	-0.0198
	(0.00986)	(0.00969)	(0.0100)	(0.0147)	(0.0195)	(0.0266)	(0.0234)	(0.0354)
Observations	1,011	1,630	2,213	1,633	1,441	1,101		
Pseudo R-squared	0.143	0.157	0.128	0.100	0.076	0.101		

Notes: Robust standard errors calculated using the Huber/White sandwich estimator appear in parentheses. Asterisks denote significance at the 10% (*), 5% (**), and 1% (***) level. Each of the first 6 columns presents marginal effects from a separate probit regression of actual 5-year survival in the HRS panel between 2000 and 2005. A coefficient of 0.01 represents a one percentage point increase in survivorship probability. Data are drawn from the 2000 wave of the Health and Retirement Study (HRS) as distributed in the RAND file version L, and subsequent mortality is drawn from successive waves up to 2006. Only mortality through 2005 is measured. See the notes to Table 1 for notes regarding variables. Columns 7 and 8 present implicit estimates of the marginal effects on survival from age 60 to either age 75 or 80 constructed by exponentiating the marginal effects, e.g., taking the geometric sum, between ages 60 and 75 or 80 and subtracting unity. Standard errors are calculated numerically assuming normally distributed standard errors.