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EXPECTATIONS, LIFE EXPECTANCY, AND ECONOMIC BEHAVIOR*

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The formation of individuals' horizons, which is central to the theory of life-cycle behavior, has been completely neglected. This is especially surprising, since the life expectancy of adults has recently increased rapidly in Western countries. This study analyzes responses to a questionnaire designed to elicit subjective expectations and probabilities of survival. People do extrapolate past improvements in longevity when they determine their subjective horizons, and they are fully aware of levels of and movements within today's life tables. The subjective distribution has greater variance than its actuarial counterpart; and the subjective variance decreases with age. The implications of these findings for optimal Social Security, for the construction of annuities, for the analysis of savings behavior, and for evaluating lifetime earnings are discussed.

> Americans are living longer than ever. The lowered death rate, well below what was being projected a few years ago, has enormous ramifications for the Social Security program, insurance actuaries, employers, politicians and economists [*Wall Street Journal,* October 25, 1979, p. 1].

I. INTRODUCTION AND BACKGROUND

Price expectations are central to modern macroeconomic theory. A large amount of empirical work has used survey data to analyze how expectations are formed (most recently, Jonung [1981]), and survey results have been used in analyzing inflation (see Turnovsky and Wachter [1972]). Central to the theory of the utility-maximizing consumer is the notion of the horizon. Yet there has been no comparable examination of how individuals form expectations about the horizons over which they maximize. This study begins to rectify this deficiency.

Several theoretical models have considered more than a fixed length of life: Yaari [1965] examined optimal lifetime consumption plans under the assumption of a known, unchanging vector of survival probabilities; Levhari and Mirman [1977] considered

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how consumption is affected by a mean-preserving change in lifetime uncertainty; and Arthur [1981] studied how changing actuarial survival probabilities affect life-cycle maximization. I use survey data to discover the shape of the entire distribution of subjective survival probabilities in order to examine whether empirical work can rely on current life tables, and whether increases in life expectancy that may motivate theoretical interest are incorporated in individuals' expectations.

Life expectancies of adults in developed Western nations have been increasing at a remarkably rapid pace in the last fifty years, though it is not clear that the maximum attainable age has increased [Fries, 1980]. (Throughout I use the term "life expectancy" to denote expected age at death.) This growth has been especially pronounced in the past decade. Consider the data in Table I for whites in the United States.[1] (These standard measures from life tables show life expectancies based on the mortality rates observed in *each year;* they do not show the probabilities of survival facing a particular cohort as it ages.)[2] They present a picture of moderate increases between 1930 and 1950, very slow increases from 1950–1970 (especially in the 1960s), and rapid increases in the 1970s. For example, life expectancy among adult whites aged 45 increased by over two years in the 1970s, the most rapid gain of any decade since 1910–1920. Similarly rapid increases have occurred in many other developed countries.[3]

The data from the life tables make it clear that the distribution of actuarial survival probabilities facing the consumer has been changing rapidly. Whether typical consumers are aware of

1. The changes are even more striking for nonwhites. For example, between 1939–1941 and 1980 average years of life remaining at age 25 increased by 7.6 among nonwhite males; among females the analogous figure is 13.1 years. (See *Vital Statistics of the United States* 1977, Volume II, Section 5, and unpublished data for 1980.)

2. A detailed description of the construction of life tables is provided in Keyfitz [1977].

3. Comparing data for males age 25, life expectancy was (1) 70.8 years in 1960–1962, 70.7 years in 1970–1972, and 71.8 years in 1978–1980 in West Germany; (2) 70.4 years in 1960–1964, 71 years in 1970, and 72.2 years in 1980 in France; and (3) 70.8 years in 1960–1962, 71.2 years in 1970–1972, and 72.2 years in 1978–1980 in England and Wales. For females the comparable figures are (1) 75.3, 76.1, and 77.9 in West Germany; (2) 76.6, 77.8, and 79.7 in France, and (3) 76.1, 76.9, and 77.8 in England and Wales. (See Statistisches Bundesamt, *Statistisches Jahrbuch für die Bundesrepublik Deutschland,* 1982; INSEE, *Annuaire Statistique de la France,* 1982 and, earlier editions; and HMSO, *Annual Abstract of Statistics,* 1983 and earlier editions. There is nothing inevitable about these increases; age-specific death rates *rose* in the Soviet Union between 1960 and 1975 for all adult age groups (U. S. Census Bureau, *International Population Reports,* Series P-95, No. 74, September 1980).

TABLE I

LIFE EXPECTANCY IN THE UNITED STATES, WHITES, 1929–1981

Age	Year	1929–1931	1939–1941	1949–1951	1959–1961	1969–1971	1979–1981
0	Male	59.1	62.8	66.3	67.6	67.9	70.8
	Female	62.7	67.3	72.0	74.2	75.5	78.4
25	Male	66.8	68.3	69.9	70.6	70.7	72.9
	Female	69.2	71.8	74.8	76.4	77.4	79.7
45	Male	70.3	70.9	71.9	72.3	72.5	74.6
	Female	72.4	73.9	76.1	77.5	78.5	80.6
65	Male	76.8	77.1	77.8	78.0	78.0	79.3
	Female	77.8	78.6	80.0	80.9	81.9	83.7
85	Male	89.0	89.0	89.3	89.3	89.6	90.3
	Female	89.2	89.3	89.8	89.7	90.5	91.7

Source 1929–1971, *Vital Statistics of the United States*, 1977, Volume II, Section 5. 1979–1981 are averaged from unpublished provisional life tables provided by the National Center for Health Statistics.

these changes and incorporate them into their subjective survival probabilities can be inferred from the survey data. Estimates of the effect of individual-specific factors on subjective life expectancy can also be obtained, and should be useful in future research that requires proxies for individuals' horizons.

II. THE CONSISTENCY OF FORECASTS OF SURVIVAL

We examine how well subjective estimates of life expectancies and survival probabilities meet a particular set of criteria that define consistency, in the sense that they use available evidence and are internally consistent. We judge people's beliefs about their own distribution of survival probabilities by the following criteria:

1. Are their subjective survival distributions *consistent in shape* with actuarial survival distributions?

2. Actuarial life expectancy is higher for older people; do we then find that subjective life expectancies are higher for older people? Still more important on this issue of *demographic consistency,* is the representative individual's subjective life expectancy consistent with population averages?

3. Are subjective life expectancies *expectationally consistent*; that is, do people extrapolate past changes in survival probabilities in forming their own subjective distributions? In conjunction with demographic consistency, satisfying expectational consistency means that people can reproduce life expectancies from a

future cohort life table using all information available today. Together, (2) and (3) are a test of "rational expectations" in the context of life expectancy.

4. Is the importance people attach to inheritance and personal characteristics *objectively consistent* with evidence on their importance?

A. Data

The information used to analyze these four questions was culled from questionnaires sent to two groups of respondents.[4] The first was a set of 650 white male academic economists. One fourth of the sample consisted of all the associates of a well-known semiprivate organization devoted to empirical economics; the rest were randomly chosen from the American Economic Association, *Biographical Listing of Members,* 1978. Sixty-three percent of those surveyed returned usable responses. The respondents range in age from 26 to 65 and correspond with a growing population.[5]

The economists' sample has the attraction that the respondents are familiar with questionnaires and understand expectations and probabilities well; but this is a disadvantage insofar as it leads to answers that are unrepresentative of what a typical consumer would respond. Accordingly, questionnaires were sent to 975 people randomly chosen from the telephone directory of a medium-sized Midwestern SMSA. Among the 47 percent who responded, 363 were white males between ages 20 and 70. These men form the basis for the analysis in this study.[6] Given the sampling frame and the nonresponse rate (which was, however, very low for a mail survey), we cannot claim that the samples are representative. But they are quite broadly based; and the use

4. Robert Goldfarb and Ernst Stromsdorfer provided helpful advice in the construction of the questionnaire. The data are available upon request from the author.

5. The people chosen from the *Listing* consisted of all those with surnames beginning with particular letters. The age distribution of these respondents was 26–29, N = 29; 30–34, N = 76; 35–39, N = 75; 40–44, N = 68; 45–49, N = 60; 50–54, N = 34; 55–59, N = 40; 60–65, N = 29.

6. All households listed at bottoms of columns in the local telephone directory were surveyed. The age distribution of these respondents was 20–24, N = 22; 25–29, N = 50; 30–34, N = 64; 35–39, N = 43; 40–44, N = 28; 45–49, N = 24; 50–54, N = 43; 55–59, N = 31; 60–64, N = 29; 65–70, N = 29. The questionnaire was the same as that sent to economists except that (1) survival probabilities were elicited with questions styled as "how many chances in ten. . . ?" and (2) the respondent was asked to list his height and weight. To maintain comparability with the economists sample, this latter information is not presented in this paper; but no results are modified qualitatively when these measures are included.

of two sharply differing populations allows a good test of the robustness of any results.

The questionnaire (see the Appendix) provided responses on $(x + e_x^s)$, subjective life expectancy, and on p_{60}^s and p_{80}^s, subjective probabilities of survival to ages 60 and 80, respectively.[7] Additional questions allowed the construction of variables used to test for objective consistency. Included are measures reflecting the experience of the consumer's parents and grandparents, and others reflecting his own actions. In the former group is a vector of dummy variables indicating the number of parents and grandparents who died of natural causes before age 60, and another indicating the number who survived to age 80. In the latter group are three dummy variables indicating if the person: (1) smokes more than five cigarettes per day; (2) engages in vigorous exercise more than once a week; and (3) had in the past been diagnosed as having an illness that could be fatal.

Table II presents sample statistics of the subjective estimates of life expectancy and survival probabilities. Also shown are sample statistics describing values of actuarial data, based on the 1980 life tables, on p_i^0 and $(x + e_x^0)$, linked to each respondent's current age. Most noteworthy among all our results is the excess of $(x + e_x^s)$ over $(x + e_x^0)$, the actuarial life expectancy, in both samples and in subsamples stratified by age. At the very least this suggests that subjective life expectancy reflects life expectancy from today's life tables. That subjective exceed actuarial life expectancies may even imply that the respondents extrapolate past increases in longevity.

Though subjective exceeds actuarial life expectancy in both younger and older subsamples, the subjective probability of survival to age 60 is less than the actuarial probability in the former subsamples, and in subsamples of 40–55 year-olds. This reversal hints that the shapes of actuarial and subjective survival distributions may differ. Finally, mean subjective expectations and survival probabilities differ from their actuarial counterparts by very similar magnitudes in the two samples. For example, in the sample of economists, $(x + e_x^s) - (x + e_x^0) = 1.59$, while in the SMSA sample it is 1.87 years. These two differences are not significantly different from each other. However, the smaller figure for the

7. Where possible in this section, I use notation that has become standard among demographers. Thus, for example, what I denote later as p_{60}^0 is the ratio of l_{60} to l_x from the life tables for white males in 1980.

TABLE II

MEANS AND THEIR STANDARD DEVIATIONS

	Economists			SMSA sample		
Ages	26–39	40–65	26–39	20–39	40–70	20–70
$x + e_x^s$	75.91	76.41	76.19	75.81	77.74	76.79
	(0.48)	(0.48)	(0.34)	(0.65)	(0.59)	(0.44)
$x + e_x^0$	73.49	75.47	74.60	73.24	76.56	74.92
	(0.02)	(0.09)	(0.07)	(0.04)	(0.15)	(0.12)
p_{60}^{s} [a]	83.58	82.76	83.15	80.27	82.05	80.90
	(0.81)	(1.17)	(0.70)	(1.25)	(2.32)	(1.15)
p_{60}^{0} [a]	84.43	87.94	86.13	83.95	88.78	85.66
	(0.05)	(0.18)	(0.13)	(0.06)	(0.23)	(0.17)
p_{80}^{s}	37.83	40.78	39.49	42.21	45.97	44.12
	(1.69)	(1.82)	(1.26)	(1.96)	(2.37)	(1.54)
p_{80}^{0}	33.63	36.28	35.12	33.44	38.61	36.06
	(0.02)	(0.16)	(0.11)	(0.02)	(0.33)	(0.22)
AGE	33.66	49.76	42.71	30.61	54.59	42.76
	(0.27)	(0.48)	(0.49)	(0.37)	(0.61)	(0.73)
$N =$	180	231	411	179	184	363

a. Only persons less than 56 are included. All probabilities are written as percents, here and in Table III.

economists is inconsistent with the sparse evidence on differences in longevity by broad occupation and education category.[8]

B. Consistency of Shape

As one method of examining the shape of the subjective distributions, we fit the Weibull survival function,

8. Data on mortality by occupation are collected only infrequently, but they support this view clearly. In 1950 in the United States, age-specific mortality rates of male college professors in ten-year age groups between 25 and 64 were roughly half those of all males, and only about two thirds of those of all professionals. (U. S. Public Health Service, *Vital Statistics Special Report,* Volume 53, No. 2, p. 82.) In England and Wales in 1959–1963 the figures for males in age groups between 25 and 64 present essentially this same pattern. (HMSO, *Decennial Supplement to the Registrar General's Report,* 1961, *Occupational Mortality Tables,* pp. 97, 99, 192.) Rosen and Taubman [1979] present results on a recent sample of older men showing much lower mortality rates among those with more education. Whether this evidence applies to a particular well-educated group—economists—cannot be inferred from studies that use broad categories.

$$(1) \qquad P_i\ (t|p^s_{60,i};p^s_{80,i};x_i) = \exp\left[-((t - x_i)/\theta_i)^{c_i}\right], \qquad t > x_i,$$

where i is a respondent, c_i and θ_i are parameters, and P is the probability of survival to age t.[9] (This transformation of $p^s_{60,i}$ and $p^s_{80,i}$ is an exact fit: there are two parameters and two observations on each person. However, insofar as there are random errors in individuals' subjective survival probabilities, there will be randomness in the $P_t(t)$ and in any estimated moments of the distribution they imply.) The fitted c_i and θ_i from (1) are then used to generate a distribution of subjective survival probabilities from which each respondent's subjective mean and variance can be calculated.

Men 56+ are excluded from this analysis because their response on p^s_{60} cannot be used. Among the remaining 349 men (276 in the SMSA sample), the Weibull distribution described the pair $(p^s_{60,i},p^s_{80,i})$ well for 83 (82) percent.[10] The average variance of the fitted subjective Weibull distributions based on (1) was 285.5 (375.4 in the SMSA sample). Yet the variance of a Weibull distribution fitted to the 1980 survival probabilities for white males with the age distributions of men in these subsamples was 187.9 (189.6 in the SMSA sample).

Among the over 80 percent of men aged 55 or less whose subjective survival probabilities are characterized well by a Weibull distribution, subjective distributions are flatter than the actuarial distribution. Since in these subsamples the implied means of the fitted distribution differed little from the means of $x + e^0_x$, we may infer that the shape of the subjective survival distribution

9. Elandt-Johnson and Johnson [1980] discuss the application of this distribution by demographers to characterizing survival probabilities implicit in life tables.

10. The other observations were dropped because the mean implied by the c_i and θ_i exceeded 100 years (or, in a few cases, because $p^s_{80,i} \geqslant p^s_{60,i}$). This occurred for persons whose subjective survival probabilities to ages 60 and 80 differed slightly, resulting in absurdly high implied survival probabilities beyond age 90. In those cases the Weibull clearly does not describe the subjective survival distributions very well. Among those included in this analysis, though, the description is quite good. The mean of the fitted Weibull, $x + e^*_x$, is quite close to $x + e^s_x$—75.20 versus 74.62 among economists, 75.37 versus 74.21 in the SMSA sample. Among the economists a bivariate regression of $x + e^*_x$, the Weibull mean, on $x + e^s_x$ yielded a slope of 0.93, not significantly different from one. In the SMSA sample the slope was 0.79, significantly different from one, but still indicating a fairly close association between e^*_x and e^s_x. These close approximations imply that analyzing the moments of the fitted distributions (in this section and in Section III) is justified by the data.

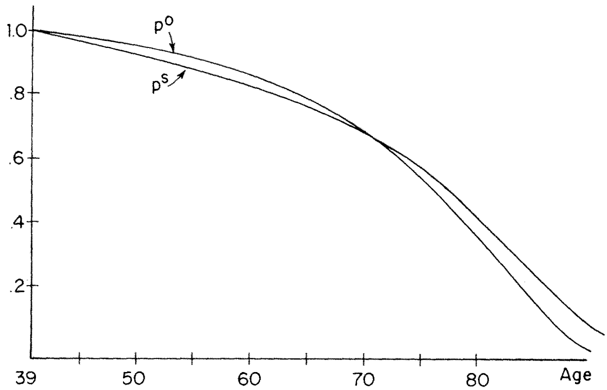

FIGURE I

Actuarial and Subjective Survival Functions

relative to the actuarial is as described by Figure I (drawn for a man age 39, the mean in the economists' subsample). The subjective distribution is flattened relative to the actuarial distribution.

Additional evidence on this point is offered by direct comparisons of p^s_{60} to p^0_{60}, and p^s_{80} to p^0_{80}. All men in the samples aged 20–55 are included in this analysis. Table III presents the mean differences between the subjective and actuarial probabilities of survival to ages 60 and 80. In both samples the respondents are pessimistic about survival to age 60, but are optimistic about surviving to age 80. This corroborates the finding on the relative

TABLE III

TESTS OF MEAN DIFFERENCES IN $p^s - p^0$

	Sample[a]	
	Economists	SMSA
$p^s_{60} - p^0_{60}$	−2.98	−4.76
	(−4.15)	(−4.08)
$p^s_{80} - p^0_{80}$	4.06	7.84
	(2.96)	(4.65)

a. t-statistics are in parentheses here and in Tables IV–VI.

flattening of the subjective distribution: since $p^s_{60} < p^0_{60}$, while $p^s_{80} > p^0_{80}$, Figure I characterizes the shape of the subjective distribution relative to the actuarial.

The relative flatness of subjective survival distributions is in some ways surprising. Each individual has information about his own health and family history. Coupled with the information contained in the actuarial survival distribution, this personal information should reduce the variance of the subjective distribution to below that of the actuarial distribution (since a conditional variance must be less than an unconditional variance). That this does not occur indicates that the respondents do not have a good idea of the shape of the actuarial distribution.

Inconsistency in shape in the form of a relatively flat subjective distribution suggests that empirical work involving life-cycle behavior cannot correctly use actuarial survival probabilities. Instead, it should at least skew these around e^0_x so that they have greater variance. Thus, studies examining life-cycle consumption or saving (e.g., Blinder *et al.* [1981] and Skinner [1981]) will go awry using actuarial measures, for they will overestimate near-term survival and underestimate (compared with people's subjective distributions) survival from 60 until very old age. So too, studies that construct measures of lifetime earnings (e.g., Irvine [1981]) to be used in empirical work on life-cycle models should employ weighted sums of earnings with weights based on actuarial data adjusted for the greater variance we have found.

C. Demographic and Expectational Consistency

The sample statistics in Table II suggested that on average the respondents' subjective life expectancies are roughly coincident with today's life tables.[11] To evaluate the demographic and expectational consistency of subjective horizons formally, consider the equation,

$$x + e^s_x = \beta_0 + \beta_1[x + e^0_x] + \beta_2 DEL_x, \tag{2}$$

where DEL_x is the forecasted change in life expectancy a white male age x can expect based on improvements in life tables from

11. The conclusion that subjective expectancies correspond closely to actuarial is further strengthened by the sparse evidence from the 63 white females aged 20–70 who responded to the SMSA survey. For them the mean $x + e^s_x = 79.80$, within two standard errors of the mean $x + e^0_x = 80.97$, and significantly above the $x + e^s_x$ reported in the sample of males.

1940–1980.[12] Essentially DEL_x is an adjustment to the current life table that converts it to a forecasted cohort life table.

Four null hypotheses can be considered:

H1 (Noise): $\beta_1 = \beta_2 = 0$;

H2 (Demographic Consistency): $\beta_1 = 1, \beta_0 = \beta_2 = 0$;

H3 (Expectational Consistency): $\beta_1 = 0, \beta_2 = 1$; and

H4 (Demographic and Expectational Consistency): $\beta_0 = 0$, $\beta_1 = \beta_2 = 1$. Columns (1)–(3) and (8)–(10) of Table IV present the standard errors of estimate of $x + e^s_x$ for H1–H3, along with β_0 for H1 and H3. Columns (4) and (11) present an alternative to H4 that does not constrain β_0. The four null hypotheses are nonnested. We examine the standard errors of estimate to determine which null hypothesis describes the data best, and whether alternative hypotheses might be preferred. Inspection of the standard errors within each sample suggests that H4, joint demographic and expectational consistency, describes both data sets better than any of the other three hypotheses. However, the significant constant terms in each sample imply that, while forecasts do reflect both the effects of age and of extrapolative expectations, they also contain an upward bias beyond that.

Obviously there is an infinite number of alternative hypotheses to H1–H4. The results of specifying some of these are shown in columns (5)–(7) and (12)–(14) of Table IV. None of these specifications produced a lower $\hat{\sigma}_\varepsilon$ than did H4, nor did additional alternative specifications.[13] We may conclude that, though neither demographic nor expectational consistency alone describes the data very well, together they characterize people's subjective life expectancies quite well. The respondents in both samples are aware of movements along a constant life table and do extrapolate past changes in the life table when forming their subjective ho-

12. First-order autoregressions

$$e^0_{x,t} = a_x e^0_{x,t-10} + v_t, \qquad t = 1940, \ldots, 1980,$$

were estimated for ages $x = 20, 25, \ldots, 85$. Based on the estimated a_x, the forecast $\hat{e}^0_{x+j,\ 1980+j}, j = 10, 20, \ldots$, were calculated. Then

$$DEL_x = \sum_j [l_{x+j}[\hat{e}^0_{x+j,\ 1980+j} - e^0_{x+j,\ 1980}]]/\sum_j l_{x+j},$$

where the l_{x+j} are the numbers of persons age x in 1980 who are expected to survive to age $x + j$, based on the 1980 life table. For $x = 20, 25, \ldots, 70$, the values of DEL_x are 1.84, 1.66, 1.53, 1.18, 1.02, 0.73, 0.59, 0.36, 0.33, 0.25, and 0.24. Within five-year age intervals DEL_x was interpolated linearly.

13. Specifying $\beta_0 = 0, \beta_1 = 1$, yielded $\hat{\sigma}_\varepsilon = 6.841$ (8.258 in the SMSA sample); for $\beta_0 = 0, \beta_2 = 1, \hat{\sigma}_\varepsilon = 6.840$ (8.253); and for $\beta_1 = 1, \hat{\sigma}_\varepsilon = 6.847$ (8.262).

TABLE IV

DETERMINANTS OF SUBJECTIVE LIFE EXPECTANCY: TESTS FOR DEMOGRAPHIC AND EXPECTATIONAL CONSISTENCY

	Economists							SMSA sample						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
β_0	76.19	0	75.28	0.67	0	23.36	−13.30	76.79	0	75.84	.91	0	27.81	32.84
	(223.43)		(218.82)	(2.00)		(1.34)	(−0.31)	(174.92)		(170.80)	(2.11)		(1.89)	(0.99)
β_1	0	1	0	1	1.01	0.71	1.18	0	1	0	1	1.01	0.65	0.59
					(93.37)	(3.03)	(2.12)					(87.94)	(3.34)	(1.40)
β_2	0	0	1	1	1.29	0	1.85	0	0	1	1	1.28	0	−0.30
					(1.61)		(0.93)					(1.62)		(−0.17)
$\hat{\sigma}_\varepsilon$	6.922	6.859	6.980	6.840	6.847	6.854	6.840	8.366	8.276	8.465	8.252	8.263	8.252	8.263

rizons. People do use all past and current information on life expectancy in forming their estimate of their future longevity; but they tend to be more optimistic about their longevity than extrapolation of the past forty years of improvements in the U. S. life tables suggests they should be. Rational expectations formation with a slight bias toward optimism describes the horizon that the consumer has available for use in planning life-cycle behavior.

D. Objective Consistency

To examine whether individual variation in subjective life expectancies is related to objective characteristics other than life-table data, I added a vector Z consisting of the dummy variables discussed in part A to equation (2). Table V shows the estimates of the expanded equation in the two samples. The coefficients on the three dummy variables for old grandparents suggest that each additional grandparent who survived to age 80 adds to the respondent's subjective life expectancy. Conversely, the coefficients on the dummy variables for young grandparents (with the insignificant exception of the second grandparent in the SMSA sample) imply that each additional grandparent who died of natural causes before age 60 reduces the subjective life expectancy. Similar responses are observed for the variables representing early and late decedents among parents, with the latter showing particularly strong positive effects.[14]

Whether this huge reliance on forebears' longevity is justified is unclear from the data. Certainly there is little evidence from twins studies of pure genetic effects [Hrubec-Neel, 1981]. The evidence on nongenetic familial effects is much stronger. (Dublin *et al.* [1949] summarize early studies. Hammond *et al.* [1971] use a large panel to show that the mortality rate from cardiovascular disease among men 40–69, whose parents both died before age 70, is at least 1.5 times that of similar men whose parents lived to age 80; the mortality rate from other causes is at least 1.2 times as high.) To the extent that these familial effects are not reflected

14. It is possible that rising longevity induces a correlation between the dummy variables for forebears' age at death and the age of the respondent. However, when the equations presented in Table V were reestimated over subsamples of persons below or above age 40, the estimates did not change significantly.

TABLE V

DETERMINANTS OF SUBJECTIVE LIFE EXPECTANCY, INCLUDING Z

	Economists	SMSA sample
Constant	22.09	30.46
	(0.53)	(0.94)
$x + e_x^0$	0.70	0.63
	(1.28)	(1.50)
DEL_x	2.21	−0.21
	(1.18)	(−0.12)
Old grandparents:		
1	0.65	0.28
	(0.78)	(0.28)
2	2.07	1.05
	(2.34)	(0.89)
3 or 4	2.62	1.44
	(2.54)	(0.97)
Young grandparents:		
1	−2.10	−0.70
	(−2.88)	(−0.68)
2	−2.43	−0.13
	(−2.16)	(−0.07)
3 or 4	−5.39	−4.87
	(−1.64)	(−1.20)
Old parents:		
1	3.01	1.27
	(2.92)	(0.95)
2	5.94	4.14
	(4.26)	(1.87)
Young parent(s)		
1 or 2	−1.78	−2.64
	(−2.18)	(−2.09)
Smoke	−1.92	−3.47
	(−2.00)	(−2.98)
Exercise	0.08	0.93
	(0.12)	(1.05)
Illness	−3.96	−5.65
	(−3.94)	(−3.93)
$\hat{\sigma}_\varepsilon$	6.392	7.911

in smoking and exercise behavior, they will be accounted for in the expanded version of (2) by the variables representing forebears' longevity. The size of the effects implied in Table V, though, seems far too large: subjective life expectancy of a person whose parents both survived to 80 is 7.72 years (6.78 in the SMSA sample) greater than that of someone whose parents died of natural causes before age 60. This compares with the 2.1-year difference based on the epidemiological evidence suggested by Sehnert [1975, p. 132] and similarly low figures implied by Hammond *et al.* [1971].

The effects of personal behavior on subjective life expectancy are consistent with the available evidence of their effect on longevity. People in both samples appear aware of the detrimental effects of smoking: the coefficients on this variable are quite close to what is suggested by studies of its effects on longevity [Preston, 1970]. Similarly, though the economists attach no importance to exercise, the SMSA sample shows some recognition of its effects.[15] Finally, the illness variable, essentially a control for a variety of factors, has the expected negative effect.[16]

The comparisons of these results with evidence from biological studies suggest that the respondents overestimate the importance of their forebears' experience. That they do so is consistent with what Tversky and Kahneman [1974] call the "availability heuristic," an overreliance on readily available, *apparently relevant* information in determining one's subjective beliefs on an issue. Objective consistency is only partly satisfied. But people's overreliance on parents' experience in forming their own horizons can enable future research using micro data to proxy individual horizons at least partly by the respondents' parents' longevity.

15. That exercise increases longevity is suggested strongly by the studies discussed in Paffenberger and Hyde [1980].

16. A number of possible problems in the expanded version of (2) were examined. (1) There may be a simultaneity between e_x^s and smoking. While I cannot disprove this, in logit equations relating smoking to x and to all the dummy variables for parents' and grandparents' longevity, none of the latter set had a coefficient significantly different from zero. Similar logit equations for exercise yielded similarly insignificant results. (2) I specified Z so that the response to the longevity of male and female forebears is the same. When this restriction is relaxed, there is a lesser response to the experience of grandfathers than that of grandmothers; there is, though, a greater response to father's experience than to mother's. In any case the restriction that the responses be equal cannot be rejected statistically. (3) Finally, none of the conclusions changes when e_x^s and e_x^0 are substituted for $x + e_x^s$ and $x + e_x^0$ in (2).

III. The Determinants of Uncertainty About the Subjective Distribution

Much of the recent literature [Levhari and Mirman, 1977; Davies, 1981] stresses the role of uncertainty about the horizon, rather than its expected length, in explaining consumption profiles and saving behavior. This consideration suggests that it is worthwhile to try to extract whatever information our sample contains about the determinants of such uncertainty.

For each person included in the analysis of Section II.B (based upon the fitted Weibull distributions), the coefficient of variation of the implied subjective survival distribution was regressed against the variables in Z, age, and measures of the variance among each respondent's forebears' longevity. Since p^s_{60} and p^s_{80} are not deterministic, neither is the coefficient of variation of the Weibull distribution based on them. The error term in these regressions, which we assume is normal, is thus a complex transformation of the random components of p^s_{60} and p^s_{80}. The best-fitting forms of the equation are reported in Table VI. In unreported regressions the variables representing smoking, exercise, and illness had t-

TABLE VI

Determinants of Subjective Uncertainty About Survival

	Economists		SMSA sample	
	(1)	(2)	(3)	(4)
Constant	0.239	0.240	0.283	0.308
	(8.81)	(7.89)	(8.93)	(8.37)
Age	−0.0012	−0.0016	−0.0019	−0.0031
	(−1.77)	(−2.14)	(−2.25)	(−3.26)
Number of:				
Old grandparents		0.011		0.011
		(2.35)		(1.45)
Old parents		0.015		0.064
		(1.21)		(2.52)
Young grandparents		−0.0029		−0.0085
		(−0.40)		(−0.74)
Young parents		−0.0058		0.018
		(−0.46)		(0.88)
$\hat{\sigma}_\varepsilon$	0.0859	0.0851	0.1194	0.1175
N	288		225	

statistics with absolute values below 0.7; measures of the variance of forebears' longevity did not fit as well as the longevity variables themselves; and the continuous measures of the number of parents or grandparents dying young or surviving to age 80 produced lower $\hat{\sigma}_e$ than did the vectors of dummy variables included in Table V.

The most striking result is the decline in the variance of the subjective distribution with age; the decrease is observed whether or not the equation is conditioned on forebears' longevity. This result should not be surprising: older people in the subsamples have avoided early death, a low-probability event that greatly increases the variance of observed lifetimes. It implies that the relationship between aging and the variance of the subjective survival distribution must be accounted for when examining age differences in the demand for life insurance. It also means that one should not treat the effects of aging in a life-cycle model independently of assumptions about its effects on uncertainty of survival (see Davies [1981]).

The results in columns (2) and (4) show fairly clearly that men with long-lived forebears are more uncertain about their subjective survival distribution, though men with forebears who died young are not less uncertain. Coupled with the results in Table V, these findings indicate that having early decedents among one's forebears shifts the subjective distribution to the left and narrows it (since the variance must decrease with reduced mean if the coefficient of variation is unaffected); having late decedents shifts it rightward and widens it. Thus, parents' longevity is partly a proxy for increased uncertainty about survival as well as for a more distant horizon.

IV. Conclusions and New Directions

Increases in life expectancy in the United States and other Western countries represent as important a demographic/labor-market change as do the often studied 1950s baby boom and the increased labor-force participation of married women from 1950–1980. This article has examined awareness of this demographic change by individuals as they project their life expectancy and survival probabilities, and studied whether their projections are based upon determinants that coincide with the evidence of epidemiological and demographic studies. Most important, I find that people do extrapolate changing life tables when they determine their subjective horizons, and they are aware of levels of and improvements within current life tables. However, their subjective survival probabilities imply that the subjective distribution is flatter and has greater variance than its actuarial counterpart; and the subjective variance decreases with age. They base their subjective life expectancies disproportionately on their relatives' longevity; and long-lived relatives increase the variance of the subjective distribution of survival probabilities.

In Sections II and III, I discussed some uses of the results in modifying theoretical and empirical work on life-cycle behavior. A large number of other implications arise from these findings. Assume that subjective survival distributions applied to economic decisions are, like those implied by our data, flatter than actuarial distributions. That flatness then means that actuarially fair insurance and annuity schemes can have nonneutral behavioral effects. The extent of the distortion can be lessened, and sellers of such plans can undercut their competitors, by offering plans based on flattened survival distributions that have the same expected value as their actuarial counterparts. Also, in a world with mandatory or customary retirement at age 65 or 70, flattened survival probabilities will lead people to invest more than otherwise in assets whose returns are concentrated during retirement rather than during the person's working years.

The existence of demographic and expectational consistency in the formation of subjective horizons suggests the use of *current* life expectancy in cross-section studies of aggregate savings (see, e.g., Feldstein [1977]) is incorrect. Instead, a variable based on an expected cohort life table must be used in such models. Time-series studies of savings and labor supply must also account for increasing life expectancy and its transformation into the subjective horizon that determines behavior.

The tremendous intergenerational transfer from workers to retirees implicit in today's Social Security system may have a basis as a social policy designed to maintain consumption of the elderly.[17] It might also be justified as compensation for an unexpectedly long retirement that resulted from underestimating the rapidly lengthening horizon. Our results, though, suggest that people can on average predict the horizon well. If there is a failure

17. Maintenance of consumption has only recently been dealt with analytically as the main goal of social insurance programs by economists interested in these programs (e.g., Hamermesh [1982] on unemployment insurance and Kotlikoff *et al.* [1982] and Hamermesh [1984] on Social Security).

to plan consumption during retirement that would justify intergenerational transfers under Social Security, it does not stem from an underestimate of the distance of the horizon.

Some work [Menchik and David, 1980] has shown that a bequest motive accounts for a substantial fraction of saving, though other studies [Blinder *et al.,* 1981] disagree. If people were unable to forecast their life expectancies well in the face of rising average longevity, observed bequests would fall short of those desired by the consumer ex post even in a world of perfect annuities markets. That people are able to forecast longevity well, as shown by the results on expectational consistency, suggests that observed bequests differ from desired bequests only because of imperfections in the market for annuities.

In any area of economic behavior where length or uncertainty of the horizon affects decisions, secular changes in longevity must be considered. However, modeling those changes cannot be done mechanically; as I have shown, they are processed into subjective survival estimates in ways that appear fairly complex. Empirical studies of life-cycle saving, investment in human capital, and labor supply ignore changing life expectancy and its effects on subjective horizons and survival probabilities at the expense of realism, and with the possible price of incorrect behavioral implications. Theoretical studies that treat actuarial data as directly motivating behavior may miss much of the potential richness of their models if they ignore how those data are transformed into the subjective probabilities that are the proximate determinants of the phenomena under study.

APPENDIX

QUESTIONNAIRE ON SUBJECTIVE LIFE EXPECTANCY

Page One

Please answer the questions on this page before going to the next page.
Please do not change the answers here once you have completed this page.

A. Your age at your last birthday: _____ years.
B. Your sex: M _____ F _____
C. Your race: Black _____ White or Other _____
D. How old do you expect you will live to be? _____ years.
E. What is your subjective probability of living to at least age 60? _____%.
F. What is your subjective probability of living to at least age 80? _____%.

Page Two

Please answer each question as accurately as *your* knowledge of the facts allows.

1. a. Was your father born in the United States or Canada? Yes _____ No _____
   b. Is he still alive? Yes _____ No _____
   c. If you answered "Yes" on b; how old is he? _____ years.
   d. If you answered "No" on b; how old was he when he died? _____ years.
   e. Did he die of natural causes? Yes _____No_____

2–6. — These were identical to 1, except they asked about the respondent's mother and grandparents.

7. Do you smoke more than 5 cigarettes/day on average? Yes _____ No _____
8. Do you engage in vigorous exercise (tennis, running, swimming, etc.) more than once a week on average? Yes _____ No _____
9. Have you ever been diagnosed as having a medical condition that had a nonnegligible probability of being fatal? Yes _____ No _____

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REFERENCES

Arthur, W. B., "The Economics of Risks to Life," *American Economic Review,* LXXI (March 1981), 54–64.

Blinder, A., R. Gordon, and D. Wise, "Social Security, Bequests, and the Life Cycle Theory of Saving: Cross-Sectional Tests," Working Paper No. 619, National Bureau of Economic Research, 1981.

Davies, J., "Uncertain Lifetime, Consumption and Dissaving in Retirement," *Journal of Political Economy,* LXXXIX (June 1981), 561–77.

Dublin, L., A. Lotka, and M. Spiegelman, *Length of Life* (New York: Ronald Press, 1949).

Elandt-Johnson, R., and N. Johnson, *Survival Models and Data Analysis* (New York: Wiley, 1980).

Feldstein, M., "Social Security and Private Saving: International Evidence in an Extended Life-Cycle Model," in M. Feldstein and R. Inman eds., *The Economics of Public Services* (London: Macmillan, 1977).

Fries, J., "Aging, Natural Death and the Compression of Morbidity," *New England Journal of Medicine,* CCCIII (July 1980), 130–35.

Hamermesh, D., "Social Insurance and Consumption: An Empirical Inquiry," *American Economic Review,* LXXII (March 1982), 101–13.

——, "Consumption During Retirement: The Missing Link in the Life Cycle," *Review of Economics and Statistics,* LXVI (1984), 1–7.

Hammond, E. C., L. Garfinkel, and H. Seidman, "Longevity of Parents and Grandparents in Relation to Coronary Heart Disease and Associated Variables," *Circulation,* XLIII (Jan. 1971), 31–44.

Hrubec, Z., and J. Neel, "Familial Factors in Early Deaths: Twins Followed 30 Years to Ages 51–61 in 1978," *Human Genetics,* LIX (1981), 39–46.

Irvine, I. J., "The Use of Cross-Section Microdata in Life-Cycle Models," this *Journal,* XCVI (May 1981), 301–16.

Jonung, L., "Perceived and Expected Rates of Inflation in Sweden," *American Economic Review,* LXXI (Dec. 1981), 961–68.

Keyfitz, N., *Applied Mathematical Demography* (New York: Wiley, 1977).
Kotlikoff, L., A. Spivak, and L. Summers, "The Adequacy of Saving," *American Economic Review,* LXXII (Dec. 1982), 1056–89.
Levhari, D., and L. Mirman, "Savings and Consumption with an Uncertain Horizon," *Journal of Political Economy,* LXXXV (April 1977), 265–81.
Menchik, P., and M. David, "The Effect of Income Distribution and Redistribution on Lifetime Saving and Bequests," MSU Econometrics Workshop Paper No. 7915, 1980.
Paffenberger, R., and R. Hyde, "Exercise as Protection Against Heart Attack," *New England Journal of Medicine,* CCCII (May 1980), 1026–27.
Preston, S., "The Age Incidence of Death from Smoking," *Journal of the American Statistical Association,* LXV (Sept. 1970), 1125–30.
Rosen, S., and P. Taubman, "Changes in the Impact of Education and Income on Mortality in the U. S.," in Social Security Administration, Office of Research and Statistics, *Statistical Uses of Administrative Records* (Washington: Government Printing Office, 1979).
Sehnert, K., *How To Be Your Own Doctor—Sometimes* (New York: Grosset and Dunlap, 1975).
Skinner, J., "Empirical Estimates of the Cost and Incidence of the Interest Income Tax," unpublished paper, University of Virginia, 1981.
Turnovsky, S., and M. Wachter, "A Test of the Expectations Hypothesis Using Directly Observed Wage and Price Equations," *Review of Economics and Statistics,* LIV (Dec. 1972), 47–54.
Tversky, A., and D. Kahneman, "Judgement under Uncertainty: Heuristics and Biases," *Science,* CLXXXV (Sept. 1974), 1124–31.
Yaari, M., "Uncertain Lifetime, Life Insurance and the Theory of the Consumer," *Review of Economic Studies,* XXXII (April 1965), 137–50.