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Report for the Roundtable Discussion of the Mortality Assumption for the Social Security Trustees

I. Background and Summary

Social Security projects that life expectancy at birth in 2080 will be 83.5 (average of male and female in 2002 TR). Using a trend extrapolation method that has been widely accepted by demographers (Lee-Carter), and has been used by US Census, I project it will be 85.3, or 1.8 years higher**.** Put differently, Social Security projects that life expectancy will rise by 6.9 years from its current level of 76.6 (TR2002), and I project it will rise by 8.7 years. The difference is not large, and reflects a convergence between the Lee-Carter forecasts and the SSA forecasts over recent years. Lee-Carter has dropped somewhat, based on recent SSA data, and SSA forecasts have been raised somewhat. This 1.8-year difference in life expectancy would raise the 75-year Summary Actuarial Balance measure by .33% percentage points (based on sensitivity analysis in the Trustees Report). The Social Security Actuary, Jay Olshansky and the Lee-Carter projections all agree in expecting modest increases in life expectancy rather than the dramatic gains that some foresee. Figure 1 shows the sexes-combined forecasts by the Actuary and by Lee-Carter from 2001 to 2080. Figure 2 shows the convergence of Lee-Carter and SSA forecasts to 2075 made from various baseline dates from 1996 to 2001.

However, two important studies were published last Spring, showing that by some measures, there has been a tendency for international life expectancy to rise linearly by more than two years per decade over the past 40 years (White, 2002) or the last 160 years (Oeppen-Vaupel, 2002), suggesting that future mortality decline may be more rapid than the Lee-Carter method suggests. Also, a useful analysis of the contribution of smoking behavior to mortality trends (Pampel, 2002) suggests that slow female gains in the US may be temporary, and that the pace may pick up fairly soon. These articles merit careful consideration and will be discussed below.

II. Why I prefer the higher Lee-Carter projections to the Actuary's Projections

- **National statistical agencies in industrial countries, including Social Security, have systematically under-predicted gains in life expectancy and the growth of the elderly population.** Studies regularly find that projections by national statistical agencies in industrial nations have systematically under-predicted life expectancy gains, leading to an under-prediction of the numbers of elderly. This is true of the Social Security projections since 1950 as well, except for those done in the 1980s. (On Social Security projections, see Figures 3 and 4 below. See Lee and Miller (2001) for more details.)
- **Trend extrapolation has worked well so far, and would have worked well if done in the past.** This kind of projection predicts well what subsequently happened when

carried out hypothetically from earlier years in the US, France, Japan, Sweden and Canada (see Lee and Miller, 2001). Lee-Carter projections of life expectancy gains using this method published in 1992 are exactly on target according to NCHS mortality data, but are somewhat too high according to SSA mortality data, and are only slightly closer to the actual than are the Actuary's projections (see Figure 5, revised from last year's draft).

The 2001 Trustees Report states: "Any projection of the future is, of course, uncertain. The degree of uncertainty involved can be illustrated by imagining how difficult it would have been in 1925 to project the world of 1930, much less that of 2000." A US government projection of life expectancy done with base year 1930 (National Resources Committee, done by Thomson and Whelpton) projected life expectancy at birth of 65 years for 2000. A trend extrapolation projection (Lee-Carter) retroactively done in 1925 using data up to that year would have forecast life expectancy of 72 years at birth, reasonably close to the actual 77 years (Figure 4 and Lee and Miller, 2001), and would have had a much smaller error than the subjective forecast.

- **According to Social Security projections, US females will not attain the current life expectancy in Japan (84.9) until 2070.** This seems unduly pessimistic.
- **There is no evidence in the US or elsewhere that life expectancy is approaching a limit (see later note on female e0 and smoking); internationally there is accelerating mortality decline at old ages.** Mortality decline at the older and oldest ages has been accelerating, not slowing down, even in countries with higher life expectancy than the US. In other industrial nations with higher life expectancy, the rate of increase in life expectancy continues at a faster rate than in the US, showing no signs of decelerating as some upper limit is neared. Life expectancy in Japan is the highest in the world, and last year it increased by .3 years. The rate of mortality decline above age 80 in low mortality countries with good data has been accelerating, not slowing down, and it is old age mortality that matters most for future gains. A careful study of mortality trends at ages 80 to 100 in 19 countries with reliable data concludes that "In most developed countries outside of Eastern Europe, average death rates at ages above 80 have declined at a rate of 1 to 2% per year for females and 0.5 to 1.5% per year for males since the 1960s." (Kannisto et al 1994:794). OASSA (2002), however, projects a future rate of decline at ages above 65 of .7% per year, considerably less than the average pace in the Kannisto et al (1994) populations. Kannisto et al report that the rates of mortality decline at these high ages have been accelerating throughout the century. There is also little evidence that populations with lower mortality at these advanced ages are experiencing less rapid declines. A study by Horiuchi and Wilmoth (1995) of a smaller set of industrial nations reaches similar conclusions for mortality at ages 60 to 80 over recent decades.
- **Biomedical considerations do not conflict with trend extrapolation.** Some analysts argue that biological limits to mortality will make it increasing difficult to achieve gains in the future, as deaths from infectious disease have largely been overcome and the remaining causes of death have more to do with degenerative processes. They also point to new diseases such as AIDS, drug resistant strains of old diseases, and adverse mortality trends in Eastern Europe and sub-Saharan Africa. This is a reason to expect

deceleration of gains in the future. However, biology does not speak with one voice in this matter, and many if not most biomedical experts in this area believe that future gains in longevity will be more rapid than in the past. There are many important biomedical and behavioral approaches with the potential for dramatically increasing life expectancy in the future (stem cells, gene therapy, life style modifications, micro-nutrients, etc.). A National Academy of Sciences workshop on forecasting life expectancy (Stoto and Durch, 1993), including biomedical researchers, supported the approach of extrapolating rates of decline, while expressing reservations about the possibility of projecting by any means more than a few decades into the future. Given our current state of knowledge, the best guide we have to the future is past trends, which have been surprisingly regular over the last century, and international experience, which suggests at least a continuation and perhaps an acceleration, of long term trends in the US, at least at older ages.

III. Complications

- **2001 Trustees Report Shows Slow Improvement 1982-1998.** The 2001 Trustees Report points out that there has been a deceleration in the rate of decline of mortality in the past three decades. From 1968 to 1998 it was 1.28% per year, but from 1982 to 1998 it was only .65% per year, with a similar deceleration for death rates above age 65. It is true that the decline has been slower recently than during the spectacular period from 1968 to 1982, which itself followed an earlier period of stagnation. But the particular choice of dates in the Report maximizes the contrast. The rate of decline for the century as a whole was 1.10% per year according to the 2002 Report. Using the Actuary's data, I find the rate of decline from 1980 to 2000 was .9% per year, not very different. Furthermore, the Lee-Carter projection, using data from 1900 to 1989, is exactly on target for life expectancy in 2002 using NCHS data, although slightly high using Social Security data (see Figure 5). This shows that the 1990s conform fairly closely to the long-term trend. It is arguable that in the past, Social Security forecasters have been misled by paying to much attention to recent fluctuations such as the rapid decline 1968 to 1982, which led to a whole decade of over-predicting gains (see Figure 3).
- **Why has female mortality declined so slowly for the past 20 years?** Although the decline in overall mortality in the 1990s has been pretty much on trend, this masks a very significant slowdown for females over the past 15 or 20 years. Between 1990 and 2001, male life expectancy increased by 2.0 years, while female life expectancy increased by only .5 years. This slowdown reflects sex-specific patterns of smoking, and will be discussed below.

IV. Why Lee-Carter and the Actuary's Life Expectancy Forecasts may be too low: Linear Life Expectancy Trends

Three important articles on aggregate mortality trends were published in the Spring of 2002, with important implications for our perspective on modeling, forecasting, and interpreting mortality trends.

Oeppen and Vaupel (2002) show a remarkable linear trend in the highest national female life expectancy (at birth, period basis) from 1840 to 2000 (Transparency). To be sure, the

set of nations reporting credible life expectancy values has greatly expanded over this period, but that is unlikely to have mattered much for the results. Over this entire 160-year period, the record life expectancy consistently increased by .243 years of life per calendar year of time, or at the rate of 24 years per century. Extrapolation would lead us to expect a record female life expectancy of around 108 years at the end of the 21st century. When I take a closer look at their data, I find evidence of a slow-down in gains in the last 50 years. For example, between 1950 and 2000, the average increase in the male record was only 1.5 years per decade, while for females it was .23. The US trend for males since 1980 has actually been more rapid, at almost 2 years per decade, while for females it has been much less rapid, as noted earlier.

A closely related article by White (2002) finds a linear trend in average life expectancy for 21 industrial nations from 1955 to 1995, with an increase of .21 years of life per calendar year (Transparency).

Both Oeppen-Vaupel and White discuss the processes of catch-up and convergence. Oeppen-Vaupel note that some countries converge toward the leader (e.g. Japan), some have moved away from it (e.g. the US in recent decades), and some move more less in parallel to it. White finds that nations experience more rapid life expectancy gains when they are farther below the international average, and conversely, and therefore tend to converge toward the average. There has been no tendency for the rate of increase of average life expectancy to slow down. Based on the current position of the US, which is somewhat below the average (just as OV note show that the US is below the record line), White predicts that life expectancy will grow a bit more rapidly than the average rate of .21 years per year, perhaps at .22 years per year. At this rate, the US would reach a life expectancy of 83.3 in 2030—about 1.5 years above the Lee-Carter (1992) forecast, and about 3.8 years above the latest Social Security projection for that year.

Extrapolation of both OV and White would lead us to predict more rapid gains in longevity than are foreseen by Lee-Carter, which projects increases at the rate of .144 years per year between now and 2030, only two thirds as fast as .22 years per year in White, and perhaps .24 years per year in OV, although they make no forecast. Figures 6 and 7 show the forecasts by SSA and Lee-Carter for males and females, together with the extrapolated linear trends from Oeppen-Vaupel and White, both starting from the US level in 2001. The Lee-Carter model assumes that each age specific death rate declines at a its own constant rate. This would produce a slowing trend in life expectancy until a level near 80 is reached, and a nearly linear trend thereafter.

However, any forecast for the US must confront the fact that rates of improvement for females in the US have slowed dramatically over the past two decades. For example, between 1990 and 2001, males gained 2.0 years of life, but females gained only .5 years. That averages out to .125, more or less on trend for the LC projection, but raising serious questions nonetheless. From 1980 to 1990, there was a similar, but weaker, pattern (1.9 year gain for males versus 1.4 for females). This brings us to the third important paper, by Pampel.

V. Smoking and Slowed Female Life Expectancy Gains

Pampel (2002) shows that smoking behavior can account for the changing sex differential in mortality in 21 industrial nations, including the US. It explains, for example, why the rate of decline in female mortality in the US has slowed since 1980 or so, while that of males has returned to its earlier trend of relatively rapid improvement. Pampel (2002) examines the effect of smoking behavior on the sex differential in life expectancy in an international context, and concludes that smoking behavior does indeed lie behind the changing pace of mortality decline. Drawing on data in Pampel's Appendix (pp.98-99), I have calculated the results below, suggesting that smoking behavior lies behind US sex-specific trends.[1]

Table 1. Change in Sex-Specific US Mortality by Smoking and Non-Smoking Cause, 1975 to 1995 (deaths per thousand population age 35-69)

	Change in mortality between 1975 and 1995		
	Smoking	Non-Smoking	Total
Males	-1.48	-3.25	-4.72
Females	+0.47	-2.44	-1.97

Note that Total mortality has declined for both men and women, but more for men. Indeed, the annual proportional rates of decline for males and females are -.023 and -.017 from 1975 to 1995, with mortality for males declining faster by .0055 per year. ***The rate of decline between 1975 and 1995 for deaths not associated with smoking was actually faster for women, at 2.8%/yr versus 2.4%/yr.*** However, death rates associated with smoking actually increased for women while decreasing for men, which led to more rapid overall decline for men relative to women. ***Because the Lee-Carter method generally fits sexes-combined mortality, the slow-down in female gains has a strong effect on the forecasts for both females and males.***

It should be possible to draw on the analysis in this paper and related studies to incorporate past smoking behavior by sex in mortality forecasts. I believe that a) this would lead to projections of more rapid gains in female mortality in the future, but after how many years I am not sure; and b) lead to projections of more rapid gains for males as well, since the earlier slow gains would be seen as a transitory phenomenon.

I emailed Pampel to check whether this was an appropriate interpretation of his analysis, and he said it was. He said that the Surgeon General's report on Women and Smoking states that the percentage of male smokers in the U.S. started falling around 1965, while the female peak occurred around 1975 for current smokers and about 1985 for Ever-smokers. More careful analysis is called for, but these figures suggest that the benefits of lower smoking for women will follow those for men by a decade or two. The data and reasoning are preliminary, but such a conclusion seems plausible, and the possibility warrants careful research.

VI. Conclusion

I recommend that the forecast of future life expectancy continue to be raised, at least to the level of the Lee-Carter projection, or by about two years for sexes combined. However, I believe that the Lee-Carter method may itself be under-predicting future gains in life expectancy, for two reasons. First, and least controversially, I believe that female life expectancy will resume its former upward pace within a decade or so, after the effects of reduced smoking translate into lower mortality, or after women have completed their transition to a lower trajectory of life expectancy. Second, it is possible that the normal pace of life expectancy gains may be more rapid than the Lee-Carter method projects, with gains of 2 to 2.5 years per decade. I recommend careful study of the effect of smoking on life expectancy trends, and careful consideration of the apparent linear trend in life expectancy.

References

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[1] He provides data by sex for 1975 and 1995 on mortality for ages 35-69 for total mortality, smoking related mortality, and other mortality not due to smoking. Deaths associated with smoking are estimated by indirect methods based on lung cancer mortality, and are taken from Peto et al (1992 and 1994 – an article in Lancet and an OUP book). The basic idea is to use known rates of lung cancer for smokers versus nonsmokers, and find the proportions of these that would produce the observed total lung cancer rate at each age. Given these proportions, then cause specific death rates for smokers and nonsmokers are used to get the rest. It is assumed that half the mortality differential for the non-lung-cancer causes reflects smoking per se, and the other half is due to confounding factors.

Figure1. Forecasts of sexes-combined e(0): 2001-2080

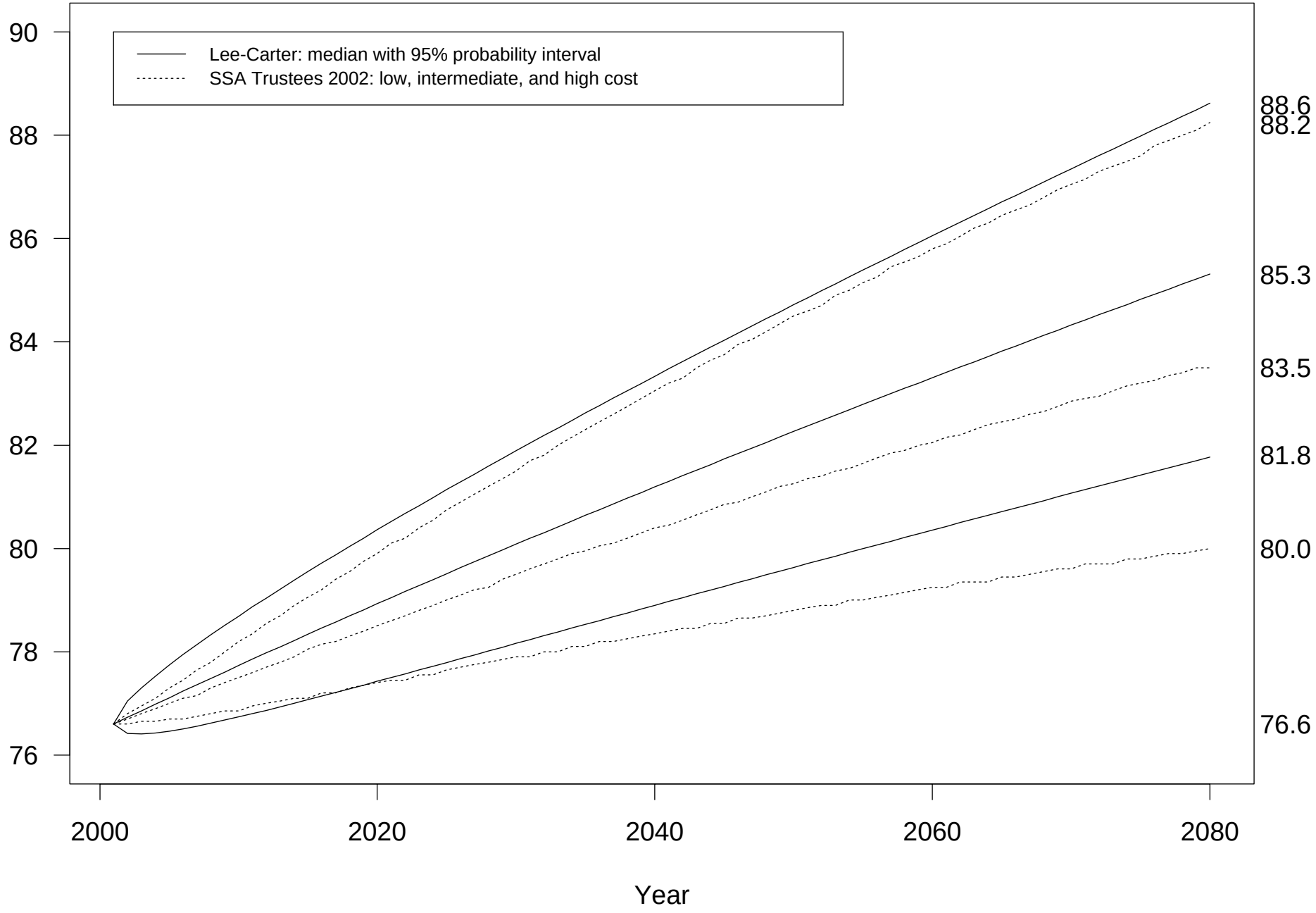

Figure 2. Forecast of sexes-combined e(0) in 2075

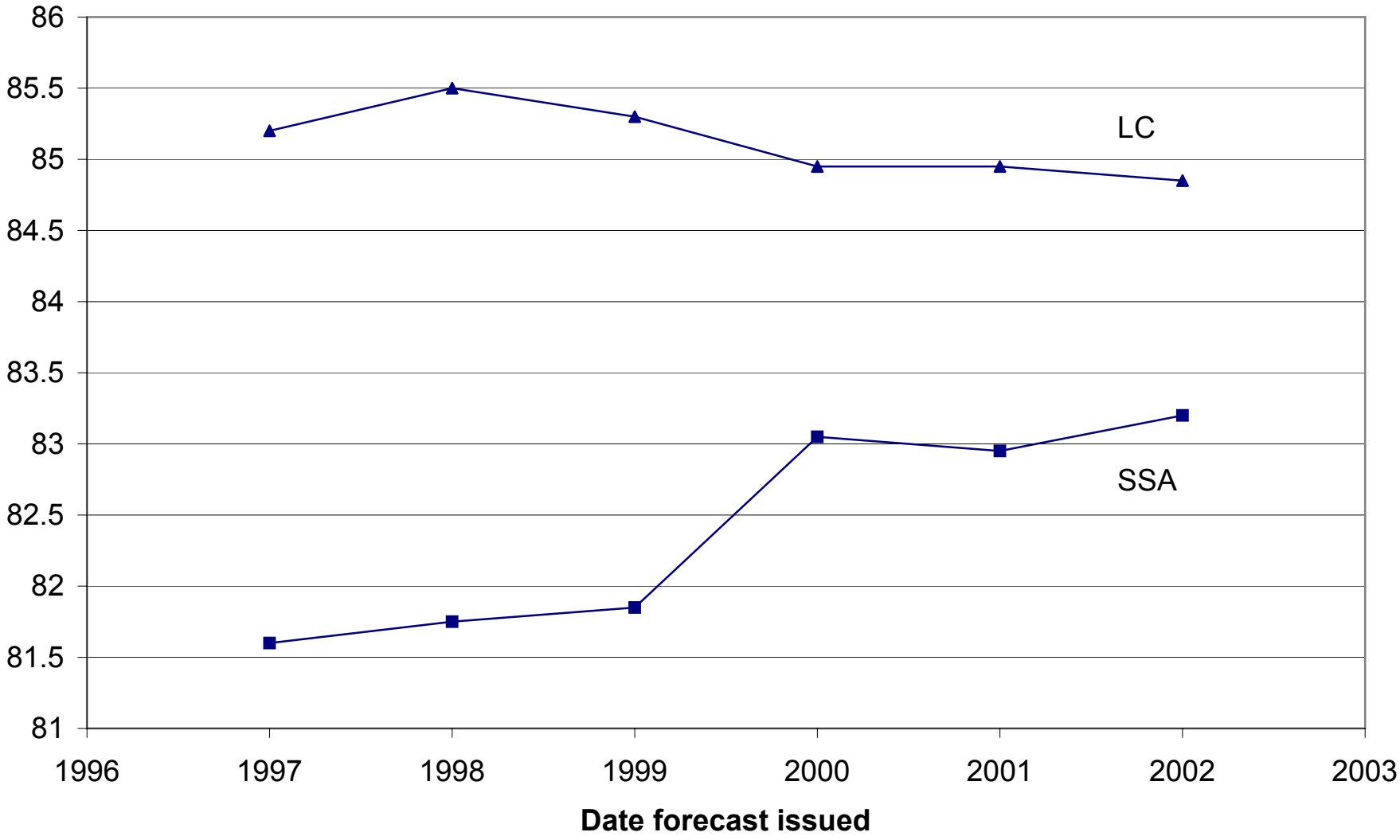

Figure 3: Average bias in forecasts of life expectancy

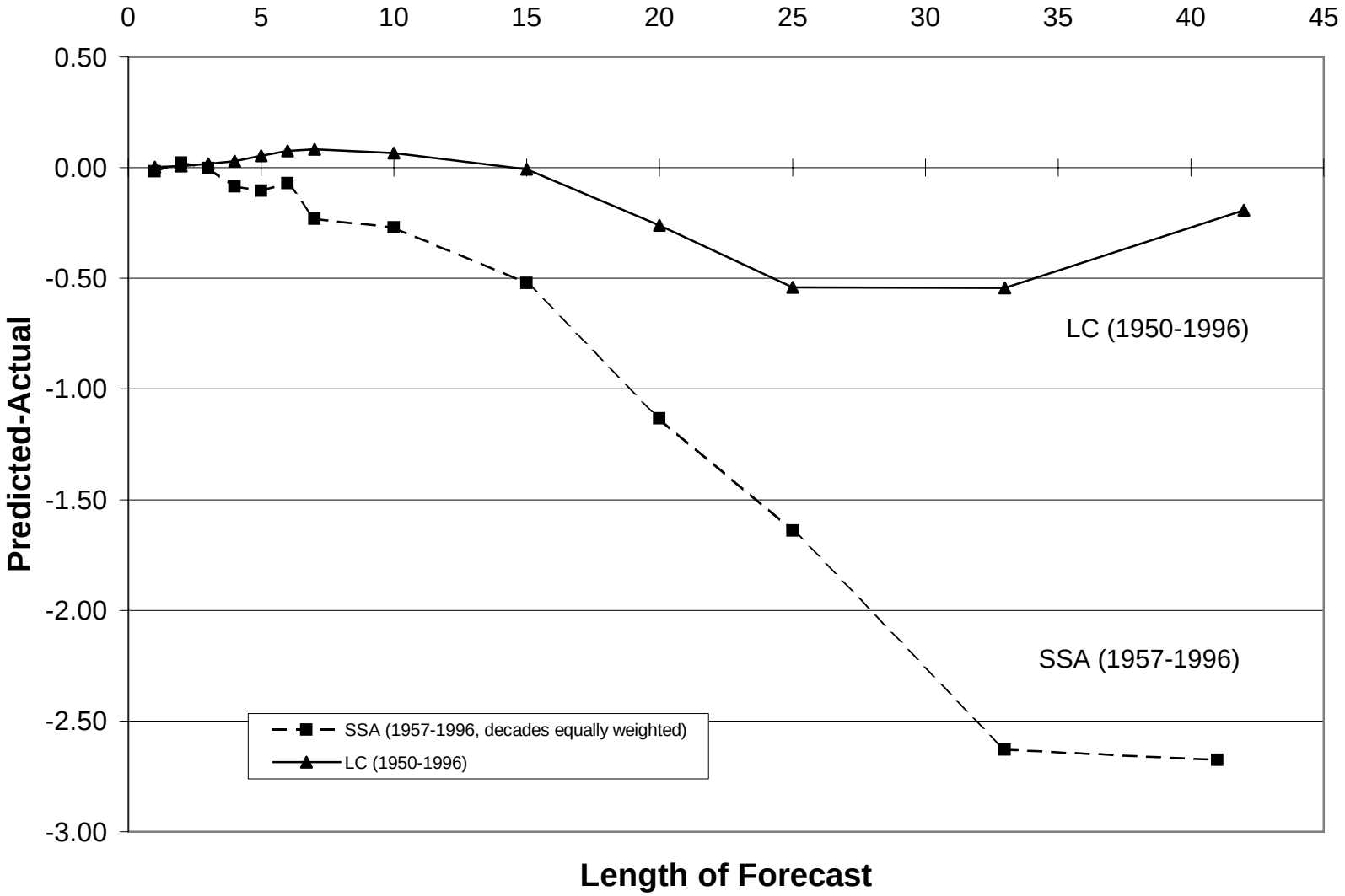

Figure 4: LC and SSA e(0) Forecast for 1998, by Forecast Date

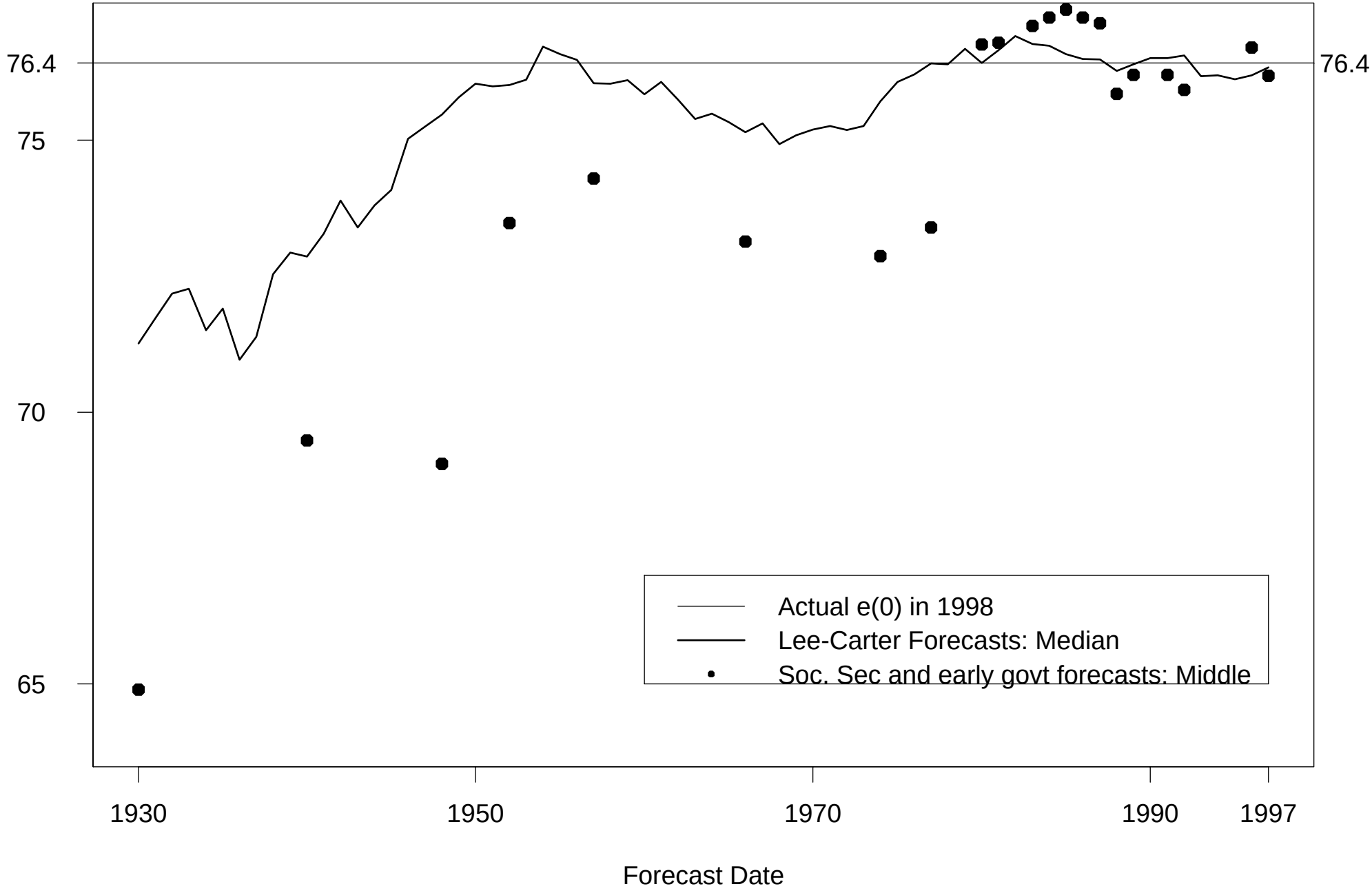

Figure 5. Lee-Carter and SSA forecasts of life expectancy from 1989 compared to SSA and NCHS data.

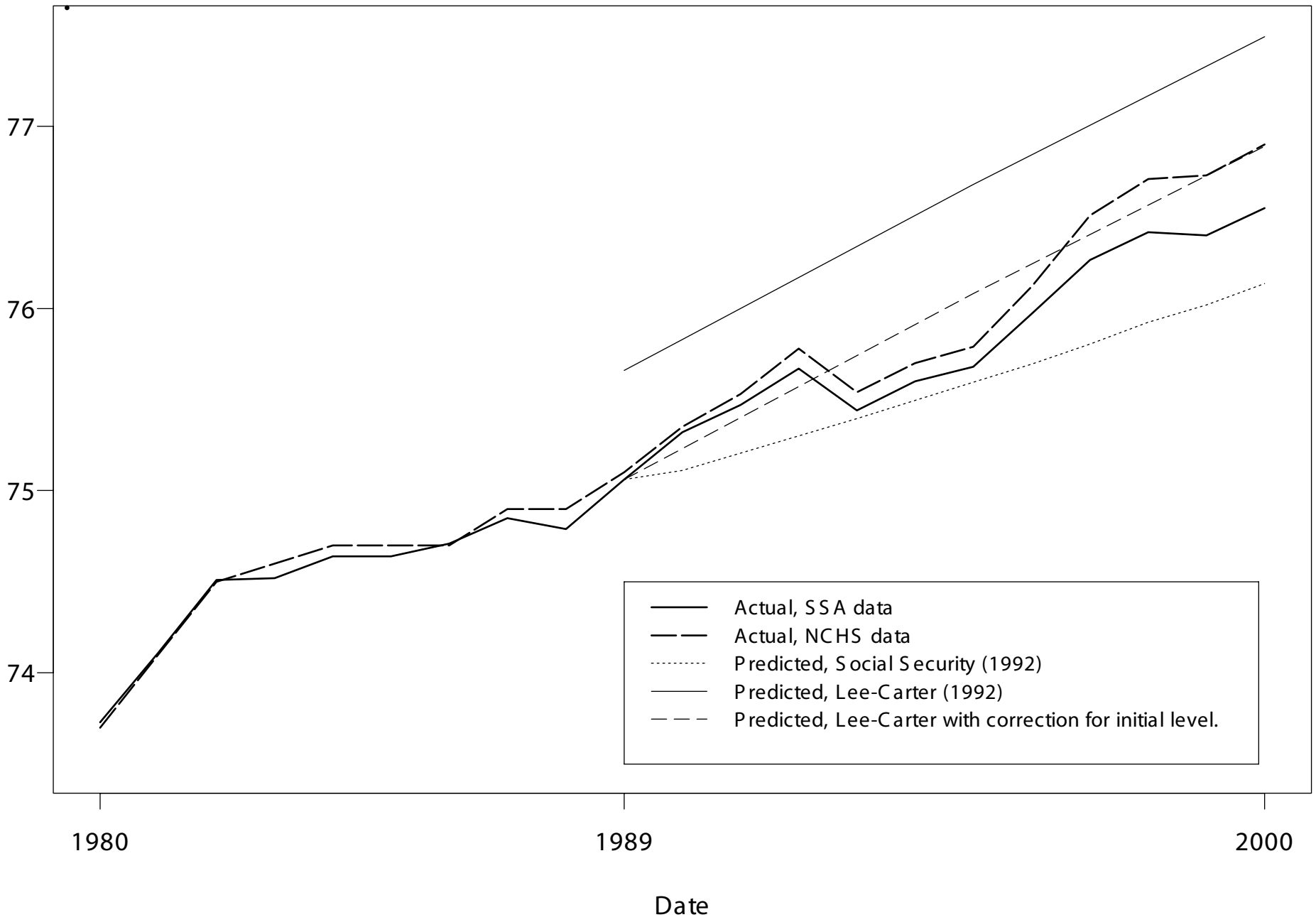

Figure 6. Life expectancy at birth for men: 2001 to 2080

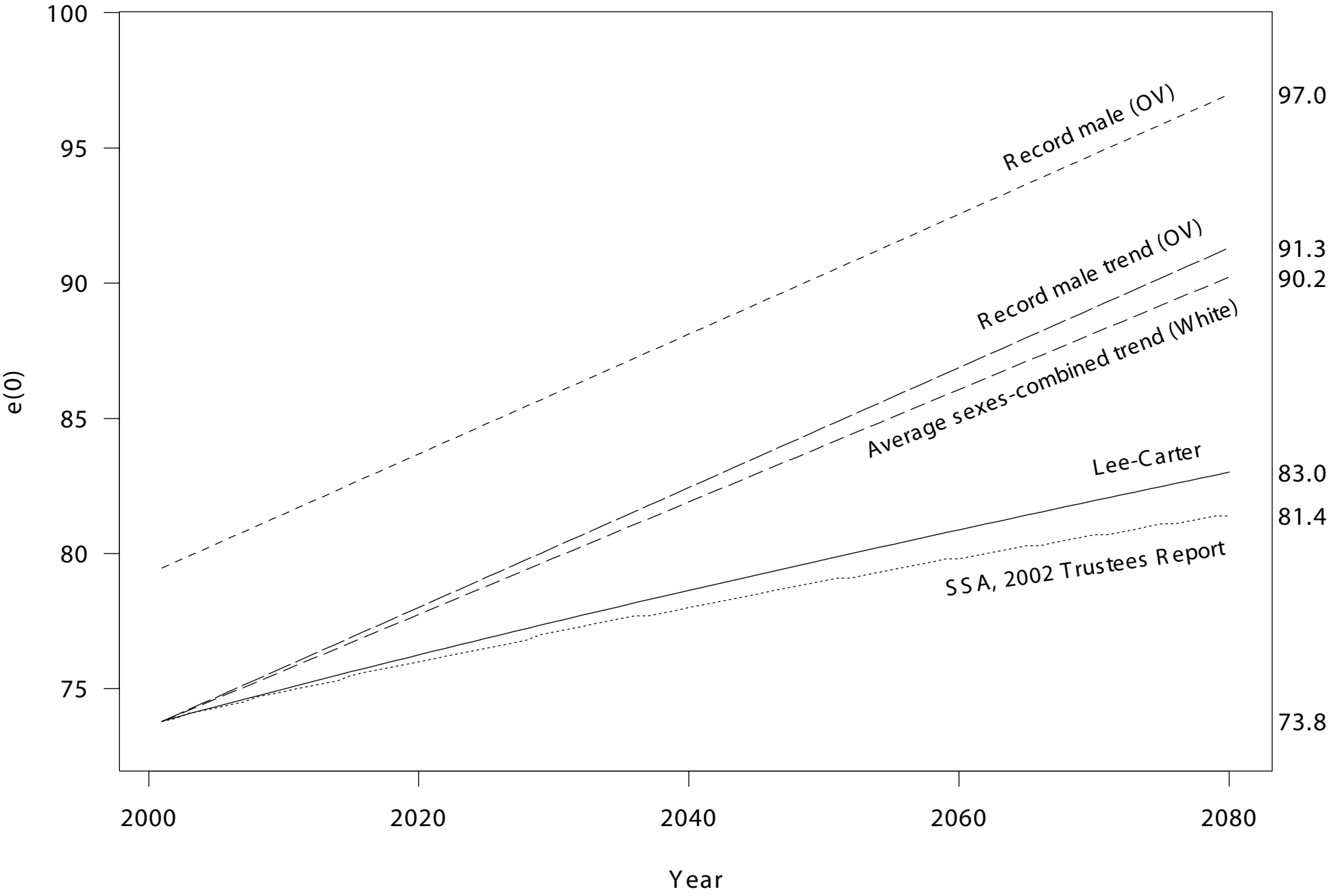

Figure 7. Life expectancy at birth for women: 2001 to 2080