Chapter 6

Forecasting Life Expectancy: The SCOPE Approach

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This note outlines a method for forecasting life expectancy. The method is based on the idea of structured conditional probabilistic estimation; it “scopes” out the range of possibilities the future may hold. I first described this SCOPE method at a workshop organized by Juha Alho several years ago in Finland.¹ It is a kind of scenario method – with probabilities attached to scenarios, with scenarios structured conditionally, and with the possibility of stochastic scenarios. It is a simple method, and it is by no means original; many other people have used a similar approach in various settings. This method might be helpful to those who want to forecast life expectancy. This note summarizes my presentation.

To be concrete, suppose the goal is to forecast female life expectancy at birth in Sweden in 2050. In the year 2000, the expected life span for Swedish women was just over 82 years. What will it be in the middle of the twenty-first century?

A central point of uncertainty is whether the kind of progress and development in Sweden that has marked the past couple of centuries will continue until 2050. Perhaps the future will be characterized by poverty, misery, and a shorter life expectancy. Coming decades could bring nuclear war, massive biochemical terrorism, epidemics more deadly than the AIDS epidemic, catastrophic environmental change, lasting economic depression, or some other disaster or combination of disasters that might cause female life expectancy in Sweden to plummet far below its current level of more than 82 years, perhaps even down to zero. These possibilities are indicated in the figure below. My “guesstimate,” given my current knowledge and the limited amount of time I have spent researching and thinking about this

¹In addition, I very briefly presented one simple version of it in the last paragraph on page 195 of Lutz, Vaupel and Alberg (eds.) (1998).

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question, is that there is a 15% chance that life expectancy will decline in the future. If it does, then my best guess is that the mean value – of the range of possible life expectancies in 2050 – is 70 years, which is close to the current value of female life expectancy in the world as a whole. Discussions among a group of experts and systematic consideration of various scenarios would undoubtedly produce values different from 15% and 70 years, but these values illustrate the approach.

Suppose calamity is averted, with probability 0.85. Then the next major uncertainty would seem to be whether life expectancy is approaching a looming limit. This limit does not have to be an ultimate cap that will hold forever. It simply has to be some ceiling that Swedes will not be able to exceed by 2050. Perhaps there really is some biological limit to life expectancy of 85 or so. Current evidence suggests that this is unlikely, but it might be true. More plausibly, perhaps it will be impossible to make much progress in reducing death rates at very old ages. To achieve such reductions, new kinds of biomedical breakthroughs will be required, and these breakthroughs may not be forthcoming, at least over the next half century. Furthermore, there may be practical impediments to further reductions in mortality. For instance, taxpayers may not be willing (or able) to pay for the required interventions if there are too few workers to support increasing numbers of retired people. For illustrative purposes, suppose the probability of some such scenario is 20% and that, conditional on this, life expectancy in 2050 will be 85 for Swedish females. Of course, it might not be precisely 85, but suppose that 85 is the average value of the fairly narrow range of possibilities permitted by this line of thinking. Again, debate and systematic calculation would lead to values other than 20% and 85 years, but these values provide a suggestive example.

The final possibility, in my simple probability tree, is that the future will be roughly the same or perhaps even better than the past. The uncertainty here might be structured as follows:

- One possibility is that the pace of age-specific mortality improvement over the next half century will be similar to the pace of improvement over the last 50 or 100 years. This is the general idea underlying the Lee-Carter-Tuljapurkar time-series method of forecasting life expectancy and Juha Alho has also done research along this line.² I am not sure what the latest results are if this approach is applied to Swedish females, but to be specific, suppose the mean value of predicted life expectancies in 2050 is 92.5.
- A second possibility is that the pace of life-expectancy increase over the next half century will be similar to the rate of increase over past decades. Jim Oeppen and I studied the rise in the expectation of life over the last 200 years. We discovered that “best-practice” life expectancy, *i.e.*, female life expectancy in the country that held the record, had risen linearly by 3 months per year from 1840 to 2000. Over this entire period, Sweden has been either at or near the top. Currently, the life expectancy of Japanese women is almost 85 years, whereas that of Swedish females is a bit more than 82 years. Thus, the current gap is between two and a half and three years. If the trend of the past 160 years continues for the next half century, then life expectancy in 2050 will reach a record 97.5. If time-series methods are applied to the data, then there will be some small band of uncertainty around this value; the band will be narrow because the trend over the past 160 years has been remarkably linear. I have not applied time-series methods to the data, however, and I am not sure exactly how wide the range of uncertainty will be. In any case, a greater source of uncertainty will involve the gap between Swedish and record life expectancy in 2050. In the figure below, I assume that the mean value of this gap is 3 years, yielding a life-expectancy estimate of 94.5.
- Finally, the third possibility is that mortality improvements will accelerate in the future. Biology and biomedicine may be on the verge of unprecedented breakthroughs in knowledge about specific diseases and about the aging process itself – many knowledgeable scientists are of this opinion. Specifically, instead of increasing by 2.5 years per decade, life expectancy may increase by 3, then 4, and then 5 years per decade over the next three decades and perhaps by 6, 8, or even 10 years per decade in the 2030s and 2040s. Since the sum of $3 + 4 + 5 + 7 + 9$ is 28, female life expectancy in Sweden in 2050 may be 110 years rather than the current 82 years or so. In the figure below, I suggest a range from 100 to 120 years if mortality improvements accelerate, with a mean value of 110. This is really just a guess, and some informed discussion and structured debate might yield quite a different picture. For illustrative purposes, however, a value of 110 may not be inappropriate.

What is the chance that the future will be like the past in terms of age-specific mortality change, that the future will be like the past in terms of life expectancy

²See Lee and Carter (1992: 659); Tuljapurkar et al. (2000); Alho (1998).

change, or that the future will bring an accelerated rate of increase in life expectancy? The trend in best-practice life expectancy is so regular that I assigned a probability of 40% to a continuation of this trend, and I gave each of the other two possibilities a 30% chance. Folding the tree back, these values lead to a mean life expectancy of 98.5 if the future is like the past or even better. If there is no disaster, then the mean is 95.84. All factors considered, the mean is 92.0. (The calculations just happened to produce a value close to this nice round number).

The future is enveloped in uncertainty, and there is a wide probability distribution around this value of 92.0, stretching from 0 to 120 in the tree below. This predictive distribution could be estimated. Some components of uncertainty could be assessed by expert judgement. Other components, as noted above, could be estimated by time-series methods. A structured conditional probability tree, of the kind shown below, could be used to organize the forecasting problem. And that is the concept underlying the SCOPE approach.

References

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