2023 Living to 100 Discussant Comments Life Expectancy Analysis

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Life Expectancy Analysis

First of all, let me congratulate these two authors, Dale Hall and Lijia Guo, on two very good papers. I certainly enjoyed reading them. But, Dale, I have to comment that if people are discussing changes in life expectancy at the cocktail parties you are going to, you are hanging out with a different crowd than I am. That is not happening at the cocktail parties that I go to.

Period versus Cohort Life Expectancy

Let me begin my discussion with Mr. Hall's paper. As he points out, period life expectancy is the universally used measure of overall average mortality that we hear about in the news. One of the reasons that it is universally used is because it is based on what actually happened. We have actual data on deaths and lives exposed from which the period life expectancy is calculated. Yes, there are data limitations and the manipulations required to do the calculation are complex, but there is no need to gaze into a crystal ball to calculate a period life expectancy.

The term "life expectancy" is really a misnomer. We don't really expect that babies born in 2022 will live to age 76 on average. We expect that they will live longer than that because we expect that mortality will improve on average over the next 70 years. Perhaps calling it the average age at death would be closer to what it is, but that's still not right. We don't take the ages of everyone who died and take the average. We apply observed mortality rates to a standardized population to get the period life expectancy.

We expect mortality to improve over time, but how much? This is the question that Mr. Hall is trying to address by creating a structure for building mortality improvement into the life expectancy calculation. The resulting cohort life expectancy is clearly a more realistic estimate of how long we think babies born in a particular year will live, on average. The downside is that a significant amount of judgment is involved. Mr. Hall used the word "objective" many times in his talk, but it is not objective at all. Judgment is involved in every step of the calculation, including the choice of baseline mortality.

If you choose as your baseline mortality the most recent population mortality, the same basis that is used to calculate the period life expectancy, that would be objective. But we all know that mortality in 2020 was unusually high, making it a very bad starting point for estimating what we expect in the future. Some of the Society of Actuaries committees that I am on are grappling with the question of what to do with this mortality spike that we know is in our data, but we expect that it will go away. Mr. Hall's suggestion to address this issue is to start with baseline mortality that is a weighted average of the most recent year mortality and the prior year mortality. The weights are chosen subjectively and include the possibility of using just the prior year mortality. If you use this method to set your baseline mortality, you are already introducing subjective judgment into the calculation of life expectancy.

The choice of a long-term mortality improvement scale is a pure guess. We have observed consistent mortality improvement for more than a century, not quite every year over the prior year, but close to it. Obviously, we did not observe mortality improvement in 2020 or 2021, so if you were trying to estimate the mortality for 2020 based on the data you had in 2018, you would have been very wrong, even if you assumed no mortality improvement. Selecting a long-term mortality improvement scale is purely a subjective judgment, even if you set the entire scale to 0 and assume that there will be no more mortality improvement after some point in the future.

Mr. Hall's method uses recent data to estimate the short-term mortality improvement scale, but that doesn't mean that this scale accurately predicts mortality changes in the short term. The selection of a short-term mortality improvement scale may be informed by recent data, but it is still a subjective judgment.

Finally, having selected both a short-term mortality improvement scale and a long-term mortality improvement scale, you need to choose a method for connecting the two. This is also a subjective judgment. So you have this entire series of subjective judgments that you need to make to create a mortality improvement scale to use for calculating cohort life expectancy.

Actuaries are comfortable making such judgments. Actuaries have been estimating and using mortality improvement scales since the Society of Actuaries was founded in 1949. The 1949 Annuitant Mortality Table was the first table to be formally published with a mortality improvement scale. All the annuitant and pensioner mortality tables published since then have included a recommended mortality improvement scale.

The reason that actuaries have been using mortality improvement scales in the calculation of annuity and pension liabilities for more than 70 years is that even in 1949 actuaries were already aware that failure to do so would result in a material understatement of those liabilities.

Application of mortality improvement in the calculation of life insurance liabilities was not adopted at the same time because it was conservative to overstate those liabilities, leaving more room for profits to emerge in the future. That has recently changed within the life insurance industry, and mortality improvement is now commonly used in the calculation of life insurance liabilities, too.

Even without the inclusion of a formal mortality improvement assumption in the calculation of life insurance liabilities, mortality improvement is still embedded in those liabilities. The Society of Actuaries uses mortality improvement estimates in the creation of valuation mortality tables, such as the 2015 VBT (Valuation Basic Table). For the 2015 VBT, the experience period was 2002 to 2009, so mortality improvement was applied to the best fit mortality rates calculated from the data to estimate the mortality rates in 2015.

Life insurance valuation regulations have changed significantly since the adoption of principles-based reserves. The current valuation manual published by the National Association of Insurance Commissioners permits the application of a mortality improvement scale in the estimation of current mortality. Current mortality is estimated by applying mortality improvement to the most recently approved valuation mortality table, currently the 2015 VBT, to get a reasonable estimate of mortality as of the valuation date. New in 2023 is the acceptability of including an assumption for future mortality improvement, so you may now assume that mortality after the valuation date will continue to get better.

As Mr. Hall mentioned, the Society of Actuaries has published the Mortality Improvement Model, MIM-2021, which is a tool that actuaries can use to develop a mortality improvement assumption to apply in the valuation of life insurance, annuity or pension liabilities.

In his paper, Mr. Hall points out that life expectancy is also materially misstated when mortality improvement is ignored. I agree, and I think it is a good idea to calculate cohort life expectancies instead of period life expectancies when comparing mortality experience or mortality tables from one market to the next or from one period to the next. The cohort life expectancy is a better estimate of what we would actually expect the future lifetime to be for a particular market and period. However, because of the extensive judgment involved in producing such estimates, I think it will be difficult to sell this idea outside of the actuarial profession.

Life Expectancy by Socioeconomic Factors

Let me now turn to Dr. Guo's paper. This paper is exciting because it uses Census tract-level data. Ideally, as actuaries we would like to have seriatim data that include all the potential predictors of mortality associated with each individual in the study, the dates each individual was observed in the study, and if and when each person died. This is the kind of data that we have for individual life insurance mortality studies. However, many potential predictors of mortality are not in our insurance data, often because we are not allowed to collect those data. So getting mortality data at the Census tract level is a big improvement over county-level mortality data, which was a big improvement over state-level mortality data. The socioeconomic characteristics of the people in a Census tract are likely to be more homogeneous than they are at the county level.

Of course, drilling down to the Census tract level also means that the data are thinner than at the county level. The median number of individuals in a Census tract is about 4,000, with a range of 2,000 to 8,000. Seventy percent of all Census tracts have fewer than 5,000 people in them. By comparison, a Society of Actuaries mortality study will have tens of millions of life-years exposed and hundreds of thousands of deaths. Here we are trying to measure mortality for a group of 5,000 lives or fewer. Using six years of data definitely helps, since that will bring the exposure in most Census tracts to 20,000 life-years or more, but that is still not much exposure from which to calculate a life expectancy.

I studied the US Small-Area Life Expectancy Estimates Project (USALEEP) model underlying the data that Dr. Guo used, because she was starting with life expectancies by Census tract that were produced by this model. I wanted to know how these life expectancies were estimated. I learned that there are about 84,000 Census tracts in the US, and about 67,000 of these Census tracts were included in the USALEEP project. For most Census tracts, the life expectancy is not directly calculated from the deaths and life-years exposed in that Census tract.

The Centers for Disease Control (CDC) created the USALEEP model by taking only the largest Census tracts, those with at least 5,000 lives exposed during the 2010 to 2015 study period, with the further constraints that there had to be at least one death in each of the 11 age groups and the mortality pattern by age group for the Census tract had to make sense. In other words, the average mortality had to be lowest in the childhood ages and more or less steadily increasing by age group after that, but elevated for infant mortality. If the mortality pattern in the Census tract did not meet this general pattern, the life expectancy for that Census tract would not be calculated from its own exposures and deaths. That left about 4,600 Census tracts with 5,000 or more lives, at least one death in each age group and a sensible mortality pattern.

For each of these 4,600 Census tracts, an abridged life table was constructed from the average mortality rates by age group, and the life expectancy for that Census tract was calculated from that abridged life table. Remaining life expectancies by age group were also calculated for each of these Census tracts.

The CDC then constructed a regression model from these 4,600 census tracts to predict the average mortality rate by age group. The predictors in the regression model included geographic region, quartiles of median family income, population density and the proportions of the population in the Census tract that are non-Hispanic black, are Hispanic, and have earned a four-year college degree or higher.

For about 57,000 Census tracts, those for which at least half of the 11 age groups had at least one death, and for which the mortality pattern was sensible, the regression model was used to estimate the expected deaths by age group for the age groups with zero deaths. An abridged life table was then constructed from the combination of the estimated deaths with the actual deaths and exposures by age group.

For the remaining 5,000 census tracts, the mortality rates and life expectancy are based solely on the regression model.

So some of the data that Dr. Guo is using in her paper is the result of a model based on some of the same variables that she is examining. But she is also examining variables that are not in the USALEEP model, and most of her data reflect Census tract-level experience to some degree. This is an excellent approach for trying to understand the mortality impact of the socioeconomic characteristics that she studied in her paper.

I was particularly intrigued by the graph that Dr. Guo presented in her talk about the relative importance of the socioeconomic characteristics that she studied. The percent of Blacks/African Americans (hereafter "Black" or "Blacks" will be used for brevity) in a Census tract is by far the most significant predictor of life expectancy for that Census tract, even after controlling for median household income, percentage of home ownership and the social vulnerability index, which includes percent unemployment and percent without a high school diploma. The slope coefficient for the percent Black is –0.041 (depending on which set of variables is in the regression), so that means that if two Census tracts are identical in terms of all those other socioeconomic characteristics, but one has 20% more Blacks than the other, the one with more Blacks will have almost a full year less in life expectancy at birth.

I was puzzled by the fact that the graph showed the percent of Blacks to be the most important factor in predicting life expectancy, even though other factors had slope coefficients of larger magnitude. The reason for this is that the importance measure shown in the graph is proportional to both the slope coefficient and the standard deviation of the factor. The percent of Blacks by Census tract varies widely, probably all the way from 0 to 100%, so it has a large standard deviation. By contrast, the social vulnerability index does not vary quite as much between Census tracts, so it has a smaller standard deviation. The product of the slope coefficient with the standard deviation makes the percent of Blacks more important than the social vulnerability index as a predictor of life expectancy, even though the slope coefficient for the social vulnerability index is steeper.

The approach taken in this paper is an excellent way to study the effects of socioeconomic characteristics on mortality, and the findings are significant. The fact that data by Census tract are very thin is a challenge, but the approach taken by the USALEEP model addresses this. I particularly liked the inclusion of the social vulnerability index as a predictor of life expectancy and the finding that it had the steepest slope coefficient. This is a significant finding, and the finding that percent Black is the most important predictor after controlling for this is both surprising and significant.

I would like to make one observation to tie these two papers together. Dr. Guo is using period life expectancies in her paper, but if she were able to use cohort life expectancies instead, her results would be more pronounced. Work underway by the Society of Actuaries indicates that mortality improvement is also better for higher socioeconomic groups than lower ones, so the Census tracts with better mortality now would be expected to have even better mortality in the future.

One final observation that I would like to make is that actuaries have known about mortality differences by socioeconomic group for a very long time. The simple observation that mortality by amount is always significantly better than mortality by count is sufficient proof of this difference by socioeconomic group. That observation was made by actuaries before I was born.

Once again, I want to congratulate both authors on their excellent papers.

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