Mortality Improvement: The Ultimate Onion

By Jay Biehl and Ed Hui

Mortality improvement (MI) is such an easy topic. Mortality has improved for at least 100+ years … what's so tough about that? But as with most topics like this, it is the nuances and subtleties that make this a very interesting topic to discuss. The goal of this article isn't to present any new wild approach to thinking about mortality improvement, but hopefully it will help to surface some less obvious issues that do exist with this topic.

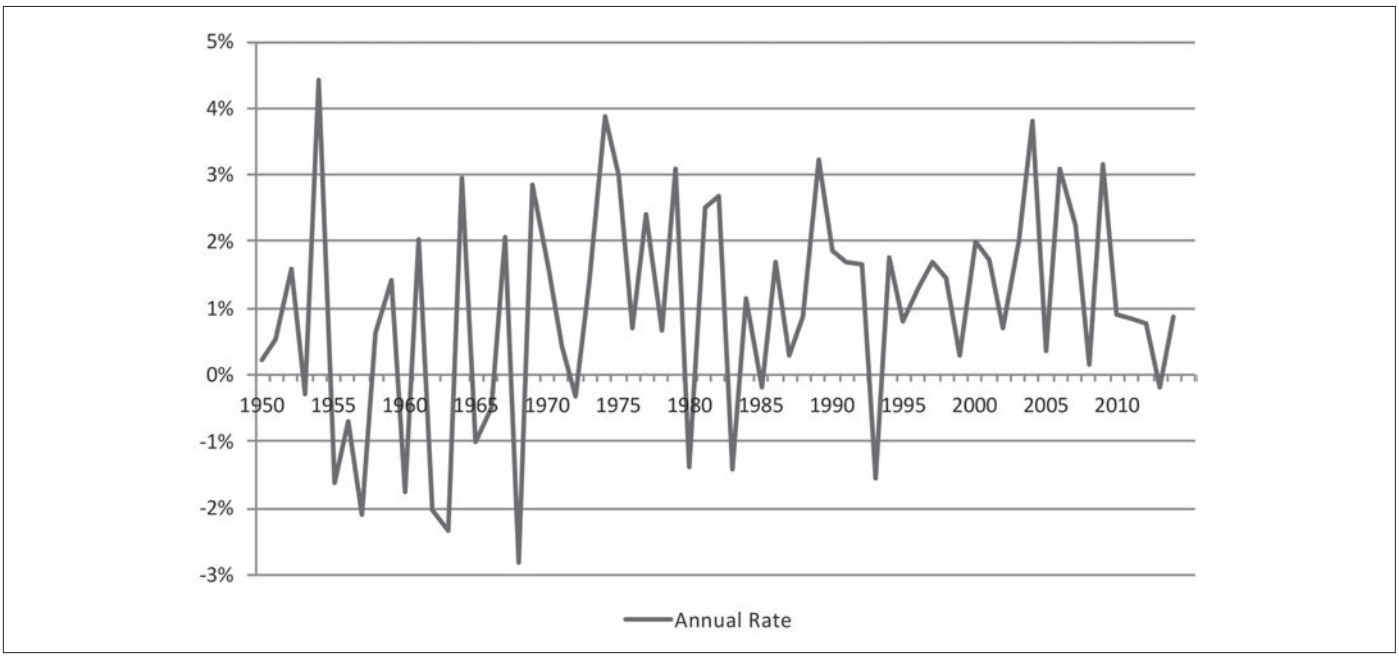
Population MI is quite easy to measure on a historic basis using either the Human Mortality Database (HMD) or data from the Social Security Administration (SSA). While easy to measure, these sources contain at least two significant shortfalls when looking for a basis to form an insured lives perspective. First, population measurements do not account for changes in smoking behavior, whereas insured experience needs to be analyzed on a smoker distinct basis. Clearly, the prevalence rate of smoking has been dropping for years, particularly since the initial Surgeon General's report in the early 1960s. According to the Centers for Disease Control and Prevention (CDC), the adult smoking prevalence is now roughly one-third of what it was immediately prior to the initial report. The decrease in smoking prevalence had a measurable impact on the amount of population MI observed through time. Second, there is basis risk as mortality improvement is impacted by the socioeconomic and age/gender distribution of the population as well as how underwriting and selection effects interplay with MI.

What percentile of the population equates to insured lives varies by age as the lower socio-economic classes die sooner resulting in generally higher average socio-economic status as age increases. For example, an insured life population can equate to roughly the top 25th–50th percentile from a socioeconomic perspective based upon research that we have done. The MI for this group has been greater than for the total population by roughly 0.5 percent to 1.5 percent points per year since 2001.

How we measure the past and how we make the movement from population to insured lives is really not the issue at all. The key is what is the expectation going forward and what are the implications of these assumptions. Alternatively said, fitting the past is different from predicting the future and it is a significant challenge for a model to do both well.

From a life insurance pricing and valuation perspective timing really matters and if anything is known about mortality

Figure 1
Age-adjusted Mortality Improvement Rates Ages 50–95; Males



Source: SOA; Mortality Improvement Scale MP-2016 Report

improvement, it is not a long smooth ride through time. While there is a preference to use a forward looking base MI vector that is quite smooth and predictable, historic MI is anything but. As noted in "SOA Longevity Webcast Series: Components of Historical Mortality Improvement Webcast" and shown in Figure 1 (pg. 24), the MI using Social Security Administration (SSA) data produced a mean mortality improvement of 1.0 percent looking over a 60+ year time horizon. Much more important, however, is the standard deviation of 1.6 percent. To put that in context, roughly one-sixth of the time, the annual improvement for this group of lives was more than 2.6 percent and roughly one-sixth of the time the annual improvement was less than -0.6 percent. Because this is population-based data, it is important to note that it was not adjusted for smoking prevalence.

But what is even more interesting is that by studying the past mortality improvement one can observe cycles occurring in the data. We went back to 1937 to demonstrate the cyclical nature of historic MI.

A power spectra shows the frequency of statistically significant oscillations in time-series. There is a broad statistically significant peak between frequencies (F) of 0.03 and 0.05 cycles per year observed when the line is above the 95 percent confidence interval mark. There is also a broad peak at lower frequencies that indicates the presence of a trend. The period = 1/F or 20–30 years for the peak in red. A signal with a period of 20–30 years has a time from peak to trough of 10–15 years noted as the relative points between F of .05 (20 years) and F of .1 (10 years).

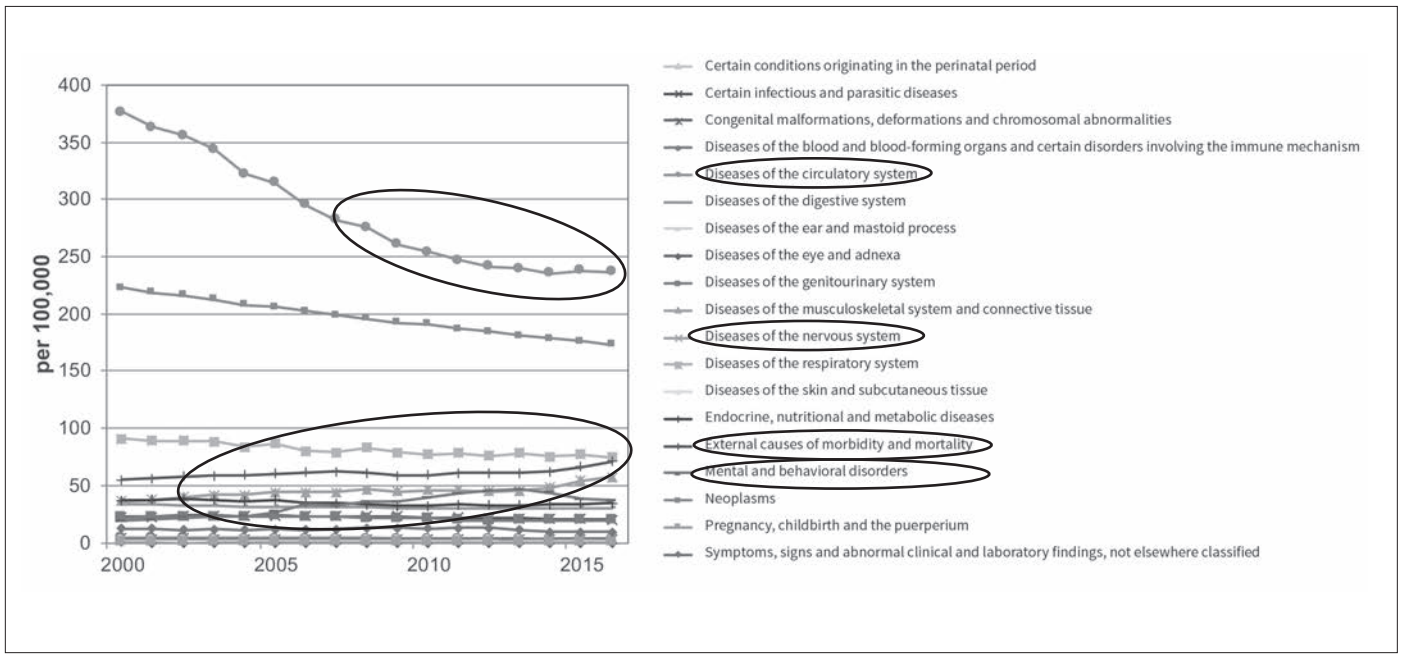
How one chooses to use this information is a different question, but one can see that mortality improvement has developed in cycles through time. While these cycles have occurred, there has been both a limited number of cycles as well as different root causes for each cycle. That makes anticipating the cycles into the future a difficult proposition at best and puts more emphasis on matching the timing of the expectations versus the reality of how mortality improvement plays out.

So, where in the cycle are we currently?

It is widely known that changes in cardiovascular care has been a major driver in mortality improvement for the past 50 years. It has had a profound impact on mortality improvement not only because of the types of advances that have been made in terms of both medications and surgical procedures, but mainly because of the sheer number of deaths that are due to cardiovascular reasons. Improvements here appear to have materially stalled recently.

At the same time over the past several years, there have been upticks in causes of mortality that historically have had much less impact on insured life mortality but are affecting insured lives much more recently. Two of these things include deaths related to both suicide and from the opioid crisis. These types of deaths are affecting both higher ages and higher socio-economic classes than would have been intuited from historical observations. With growing physically isolationist lifestyles fostered through the social media-dominated world, one has to wonder whether these social maladies become more impactful

Figure 2
Analysis by Cause of Death: By UCD–ICD Chapter; U.S. Population



before viable solutions can swing the pendulum the other direction. These issues strike at the heart of insured level mortality.

In addition, it is not a stretch to look at the lifestyle of many Americans to see a more sedentary lifestyle and increased BMIs across the spectrum. This leads to many diseases including an increase in prevalence of diabetes among other diseases. These trends can be seen in Figure 2 (pg. 25).

Putting all these developments together, it comes as no surprise that mortality improvement has slowed over the past several years and in some pockets mortality improvement has actually been negative.

So, does that mean we should just throw in the towel and expect no future mortality improvement? Well, frankly that is up to each individual to consider in the context in which that assumption is being applied. But to us the authors, the answer is no. We've already shown that mortality improvement has rolled forward in a very cyclical nature and the causes of those cycles has varied from one to the next. Medical research follows the money, and so the ages and conditions for which the best advances are being made are in a constant flux. Will dementia be the next coronary disease in terms of amount and duration of improvement? Extrapolating the future locations of this improvement wave from where it has been in the past is not likely to be accurate. In addition, we now live in a very technologically driven era and the pace of that technology will only increase. So, what will the impact of this technology be? Well, first let us think about the types of things going on from the mapping of the human genome and understanding pre-disposition of disease long before the diseases manifest themselves, to wearable devices that monitor how many steps we walked, to sleep habits, to monitoring blood glucose, and the potential of what will come is endless. As medical science merges with the technology industry it is not implausible to see some version of Moore's law kick in where improvements occur in an exponential manner.

None of this is intended to guide the thinking of what mortality improvement should actually be. There are far smarter minds than ours that have spent a large part of their lives thinking and researching on this topic and there are still basically two camps.

These can be summarized as:

1. James Vaupel is the leading proponent of the view that the human life span is not fixed, but is a function of life expectancy and population size.
2. On the other hand, S. Jay Olshansky is the leading proponent of the view that human life can only be extended so long before it reaches the upper limits of the life span.

Mortality improvement can be characterized in a lot of ways around the pricing and valuation of the life insurance marketplace but **if** mortality improvement is anticipated, then the implication is very straightforward. Whatever the level of mortality improvement that is assumed and more important **when** it is assumed means that mortality improvement **must** develop in that exact manner in order to meet the underlying expectations.

Much of the actuarial work around life insurance products is fundamentally around a present value mentality. Whether on a pricing basis or on a valuation basis, discounting all future cash flows is a basic fundamental principle.

It's really too bad that life doesn't actually cooperate in a present value mentality. When earnings or experience develops can you separate out the difference between:

1. The mean was set inappropriately,
2. the deviation is normal volatility, and
3. the deviation was a misestimation of the expected mortality improvement.

And if it is the last, then should I refine the mortality improvement assumption and make it higher or lower? Should I expect that in times when mortality improvement slows down that eventually the cycle will turn and it will speed up? Should I view a reversion to the long-term mean regardless of short term changes? Can I even measure it on a block of insured lives and separate out the amount due to underwriting grade-off or that driven by policyholder behavior?

There are lots of ways to determine a mortality improvement assumption and to decide how far into the future one is comfortable with that assumption. But the ultimate challenge is really to set the long-term estimate while understanding that the entity must be able to manage certain volatility within tolerable risk boundaries along the way. ■

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