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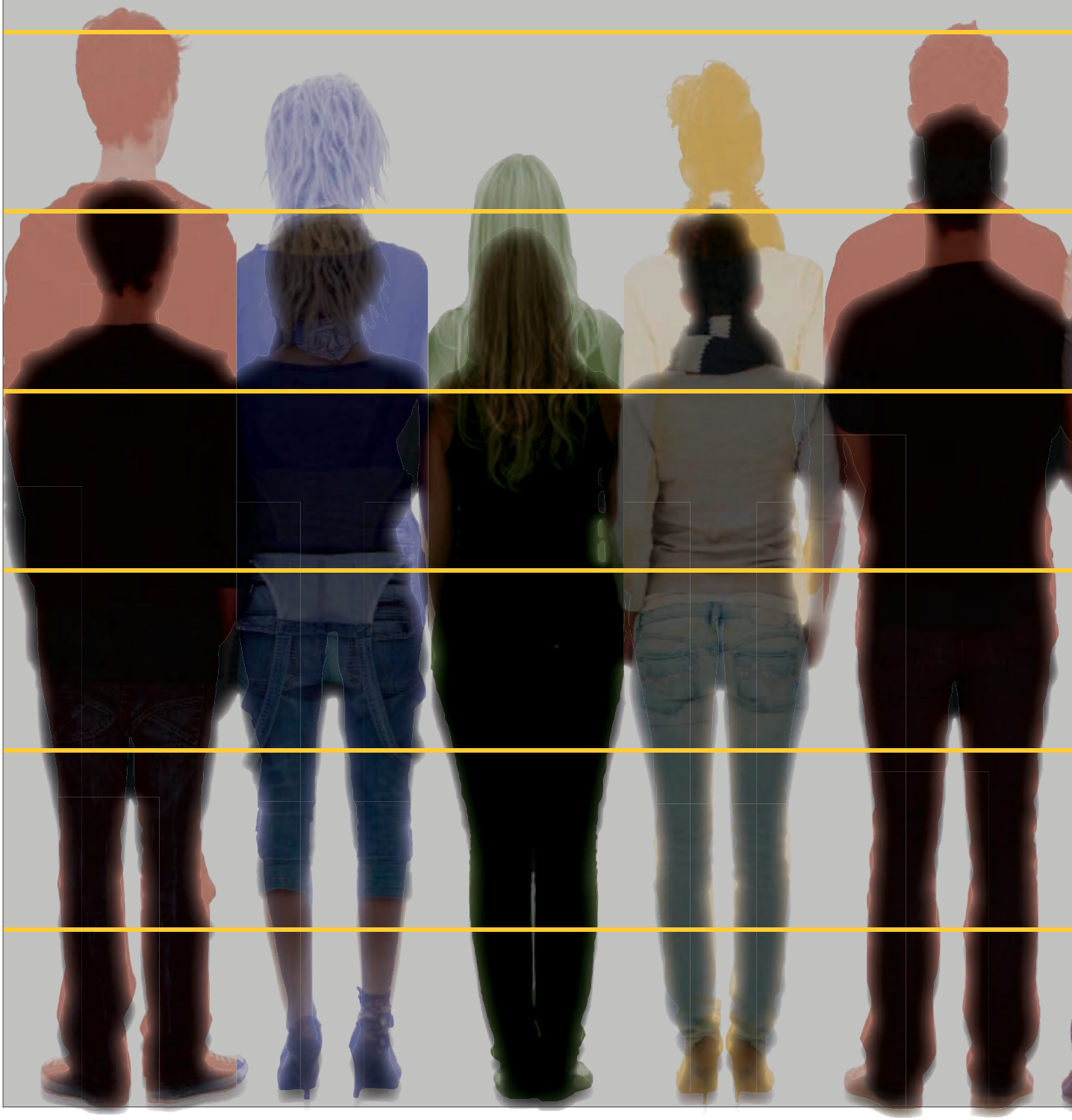

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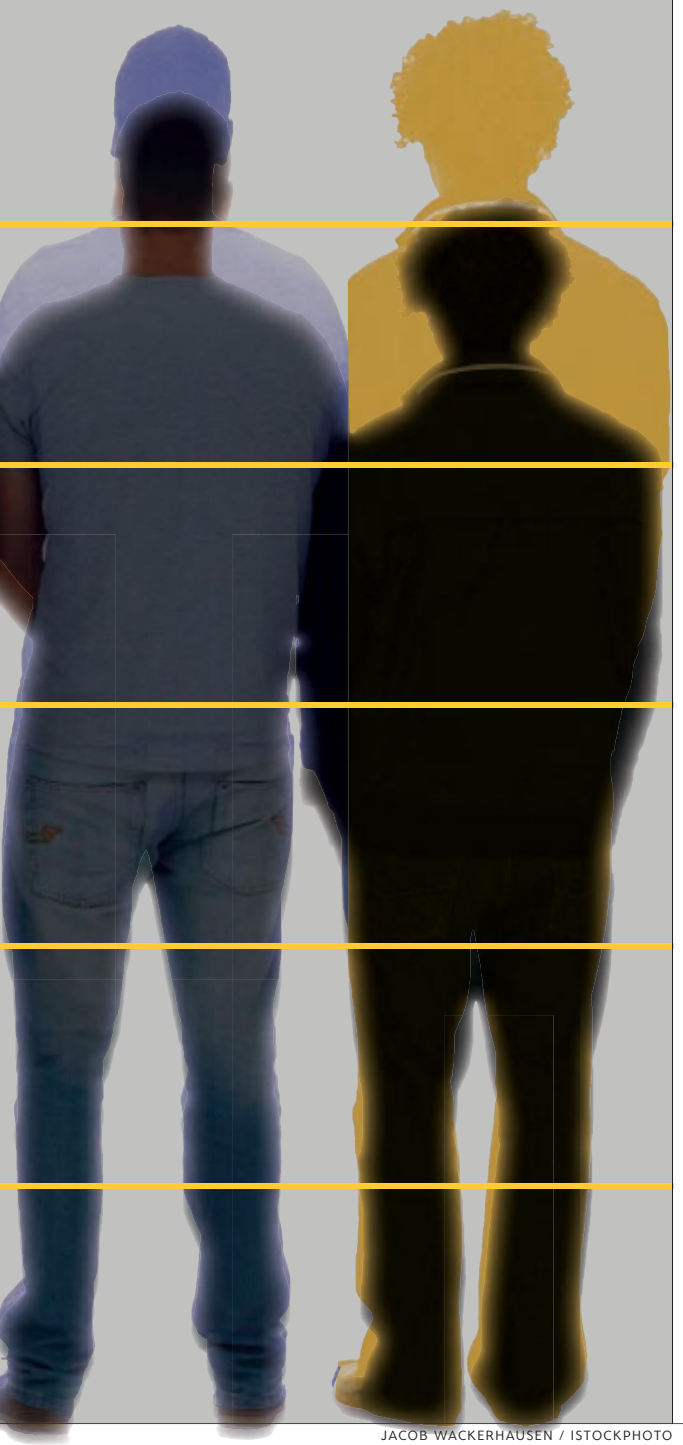

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Managing Mortality Risk

What impact will volatility in future mortality assumptions have on the valuation of life contingent liabilities?

by Stuart Silverman

IN RECENT YEARS, modeling volatility of life and annuity products has focused largely on the uncertainty of economic factors such as a spike in interest rates or a sudden shift in credit spreads. As current market conditions have shown, there were good reasons for this attention. But the intensity of focus on economic factors may have caused many insurers to lose sight of the emerging mortality and longevity risks now on their books. In the years ahead, this risk is likely to grow, and as it does, insurers may find that the volatility of future mortality is a significant risk they cannot ignore. The ability to assess this risk is perhaps just as important.

Think about it. If the mortality of a sufficiently large population were truly static, then the mortality trend of the U.S. population would be constant and move in step along a well-defined path. But it doesn't. These variations can have profound implications for life insurers that have promised to pay death benefits through life insurance or annuity payments through products that provide a lifetime of income to retirees.

The Root of Volatility

Mortality and longevity risks can stem from a number of sources. The greatest variation between pricing and actual experience may arise from inappropriate assumptions. Applying a baseline mortality assumption developed from a large diversified population—such as generic industry experience—can produce huge variations in results if the risk profile of the insured population is different from that of the baseline population.

The inherent volatility in baseline mortality assumptions is compounded by the difficulty in predicting improvements in mortality. Over the past 50 years, life expectancy has increased, largely because of a decrease in deaths from cardiovascular-related diseases in the older population. These improvements

have been consistently underestimated by insurers, resulting in mortality gains on insurance products and losses in payout annuities.

Will this trend continue? Some experts believe that the huge gains in life expectancy that occurred over the past century can't be repeated. Others believe that they will accelerate. But because of extremely low death rates among the young, any gains in life expectancy for insured populations will most likely come from improvements in the mortality rates of people who are age 65 years or older. Given the age of the U.S. population, this uncertainty is of particular concern to those with exposure to mortality and longevity risks.

Whether or not these long-term gains continue may be less important than the fact that the huge strides in longevity over the past 50 years occurred in fits and starts. Over some 10-year periods, improvements in life expectancy surged ahead, while at other times they inched along. This type of unevenness could have an adverse effect on cash-flow patterns.

Adding to the uncertainty in future mortality assumptions is the possibility of a breakthrough medical advancement that could substantially boost life expectancy. Over the past 20 years, cholesterol-lowering drugs and new surgical procedures have helped to reduce heart-related deaths by more than 50 percent. The decoding of the human genome is now providing researchers new insights into the workings of the human body, and researchers are only beginning to tap the potential benefit of nanotechnology in treating many mortal diseases. It's important to consider newly released medical treatments and advanced medical research when predicting future mortality rates.

How will changes in lifestyle affect mortality in the future? Many experts say that physical activity—a vital component to good health—has taken a back seat to the convenience afforded by computers and other electronic gadgetry in many developed countries. This has happened at a time when obesity and diabetes rates have surged in the United States. Could lifestyle choices push mortality rates up in the years ahead, or will health-mindedness and improved nutrition further extend life expectancy? Pandemics, dirty bombs, terrorism, and the emergence of an antibiotic-resistant virus each have the possibility of shocking the mortality curve in ways that could have profound implications for life insurers.

As mortality rates trend from year to year, it may be hard to appreciate the dramatic shifts that could occur as mismatches in mortality assumptions and mistimed improvements in life expectancy or unforeseen medical advancement move an insurer's actual results further and further from those originally projected.

FIGURE 1 Distribution of Scenarios by Economic Liability at Each Future Duration

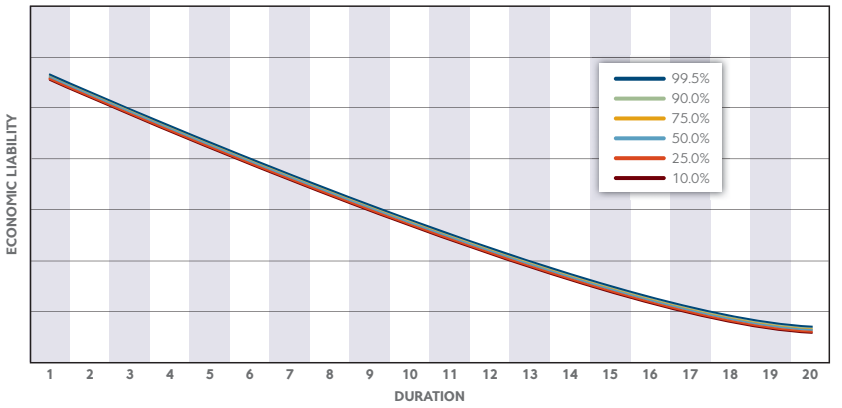
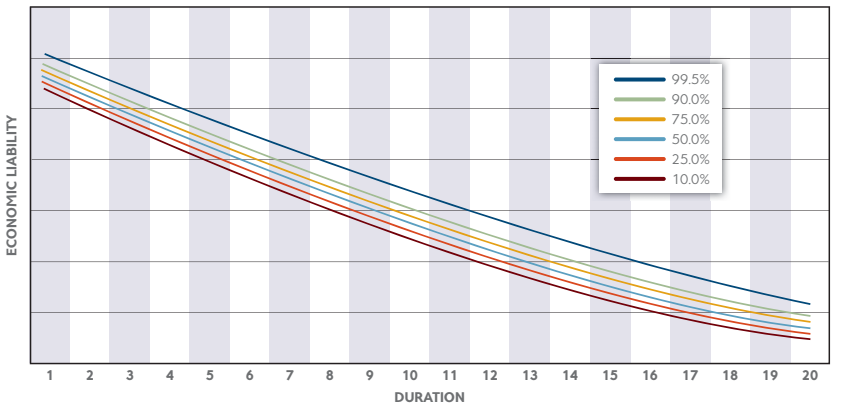


FIGURE 2 Distribution of Scenarios by Economic Liability at Each Future Duration



Predicting Mortality

Volatility has traditionally been factored into life insurers' determination of liabilities through sensitivity testing that shifted future mortality improvement rates up or down. But these largely deterministic analyses have failed to measure the probability that the assumptions used in the sensitivity test will occur. In a sense, insurers have been forced to manage around a bare-bones outline of trend when potential volatility of their mortality assumptions calls for a full-screen image.

Just how dramatic are the variations in liabilities associated with mortality using static versus dynamic mortality assumptions?

Consider the differences in cash-flow projections for the large hypothetical block of single-premium immediate annuities shown in Figures 1 and 2. Both

FIGURE 3 Ratios of Scenarios Economic Liability to the Average Economic Liability at Each Future Duration

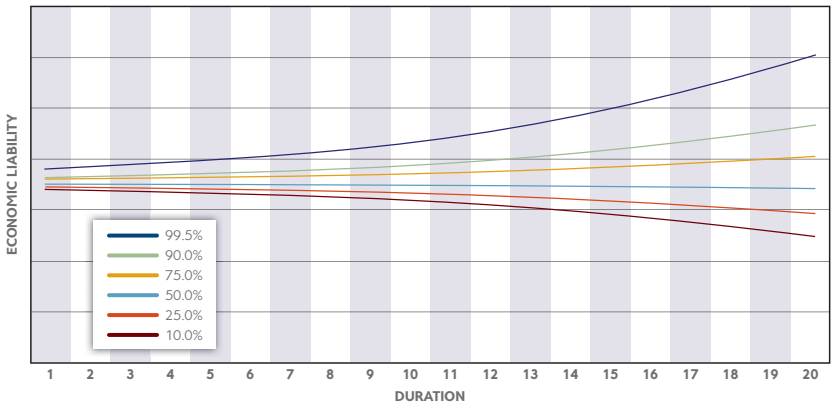
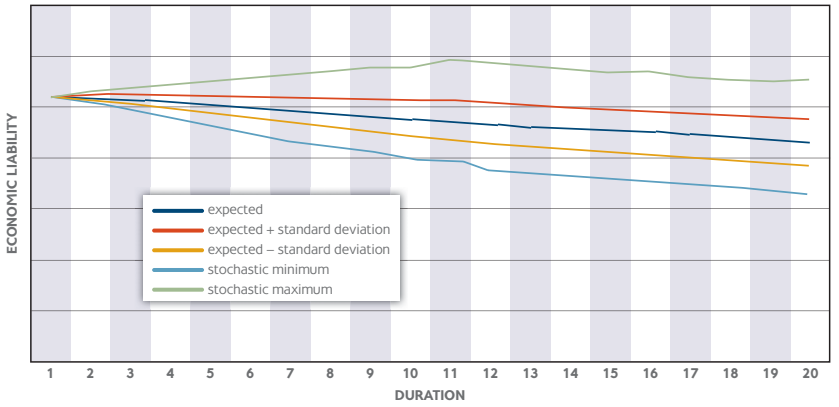


FIGURE 4 80-Year-Old-Male Projected Mortality Rate—reflecting volatility based on historical levels of mortality improvement in the U.S. (excluding potential extreme mortality or longevity events)



sets of calculations were made using a stochastic process, but the economic liabilities in Figure 1 were developed using static mortality rates that reflected variability in dates of deaths but no volatility in mortality rates, while the liabilities in Figure 2 were calculated using rates based on historical levels of volatility in mortality improvement trends. Further, the liabilities in Figure 2 reflect the risk of a pandemic occurring as well as the possibility of future medical advances that could reduce deaths in certain diseases.

Given the large size of the hypothetical population, ignoring volatility in mortality rates as was done in Figure 1 produces tail percentile values for future economic liabilities that are closely clustered around the median values. The convergence of values in Figure 1 contrasts sharply with those presented in Figure 2, which shows tail percentile values that vary significantly from the median values. By including volatility in mortality assumptions, we are able to obtain a clearer picture of the possible streams of present value of future annuity payments and their divergence—both up and down—from expected values.

Taking the comparison a step further, Figure 3 illustrates the economic liability of the tail values at each percentile (from the volatile mortality-assumption projection) as a percentage of the median value. Clearly, the economic liabilities based on volatile assumptions varied widely from the median, and these values vary more widely over time. The question arises: How useful are projections that rely on static mortality assumptions when considering tail risk?

Wide variations in life expectancies occur even if assumptions about extreme events, such as the development of revolutionary medical advancements or the possibility of a pandemic, are stripped away from the analysis. The chart in Figure 4 projects future mortality rates for an 80-year-old male developed using a stochastic process based only on historical levels of volatility in mortality improvement rates. As can be seen, recognizing that future mortality assumptions aren't static creates a significantly wider distribution of life expectancies. It makes sense to understand how this volatility can affect future liability payoffs when setting pricing and capital levels.

A Convergence of Forces

The uncertainty surrounding future mortality trends would seem to be reason enough to incorporate volatility into mortality assumptions, but there are also other forces at work.

Born between 1946 and 1964, the baby boom generation is just starting to retire at a time when the market no longer holds the promise of consistently favorable investment returns that in the past provided little motivation for annuitizing a lifetime of savings. Those growth years seem to have ended, leaving many of the 78 million baby boomers with a greater incentive to find ways of guaranteeing that they will not outlive their assets. The guarantee features of many annuities in the market today could provide just the solution for which retirees are looking. However, insurers should be aware of the potential range of liability values when pricing these longevity products.

The wave of retirement is happening at a time when a precipitous drop in asset values and new regulatory and accounting standards are prompting many employers to consider closing out their pension funds. These closeouts represent opportunities for insurers if the deals are priced appropriately to account for the longevity risk associated with the plan.

Some insurers may be relying on a natural hedge between their insurance and annuity portfolios. However, as events have shown, the inherent diversification benefits built into life and annuity business are seldom perfectly correlated. Perhaps the best example of the potential mismatch occurred during the 1918 pandemic when death rates for individuals in their 30s spiked, resulting in a surge of death claims for this cohort, while death rates for individuals above age 65 actually decreased. If such a phenomenon should occur, even without the drastic changes in mortality rates that may be seen during a pandemic, insurers could be put in a position of paying death claims without the offsetting benefit of the release in annuity reserves.

Improvements in mortality rates, which have been consistently underestimated, have also boosted insurers' bottom lines in the past. But will this trend continue? And if it does, will improvements in mortality rates be as large as they were?

Opposing trends (e.g., medical advancements vs. obesity trends and pandemic exposure) could intensify the mortality and longevity risks on insurers' books. How would an unexpected change in mortality affect insurers? And how might changes in mortality interact with unpredictable economic factors?

Insurers have already begun to look at the correlation of many market risks and to explore via stochastic processes the impact of previously unthinkable catastrophic events in the tails of the loss distributions as part of their enterprise risk-management practices.

This approach is likely to gain traction in the years ahead. At least one major rating agency has already instituted an enterprise risk-management system that requires insurance companies to adopt active risk-management procedures or face possible downgrade.

Rating agencies and management increasingly understand the value of stochastic models. Insurers have become adept at using stochastic analysis to better understand asset risk. However, if we expand the use of stochastic analysis to mortality and longevity risks, we may be able to shed more light on the embedded options and complex risks on the liability side of the balance sheet.

Actuarial models have grown more sophisticated over time. Before computers, we used commutation functions. Now we are using stochastic processing with volatile economic factors. We've come a long way. It makes sense that the next step is to perform stochastic processing with volatile mortality assumptions as well. If not, we risk missing hidden options implicit in the liabilities we have or plan to sell. □

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