Milliman
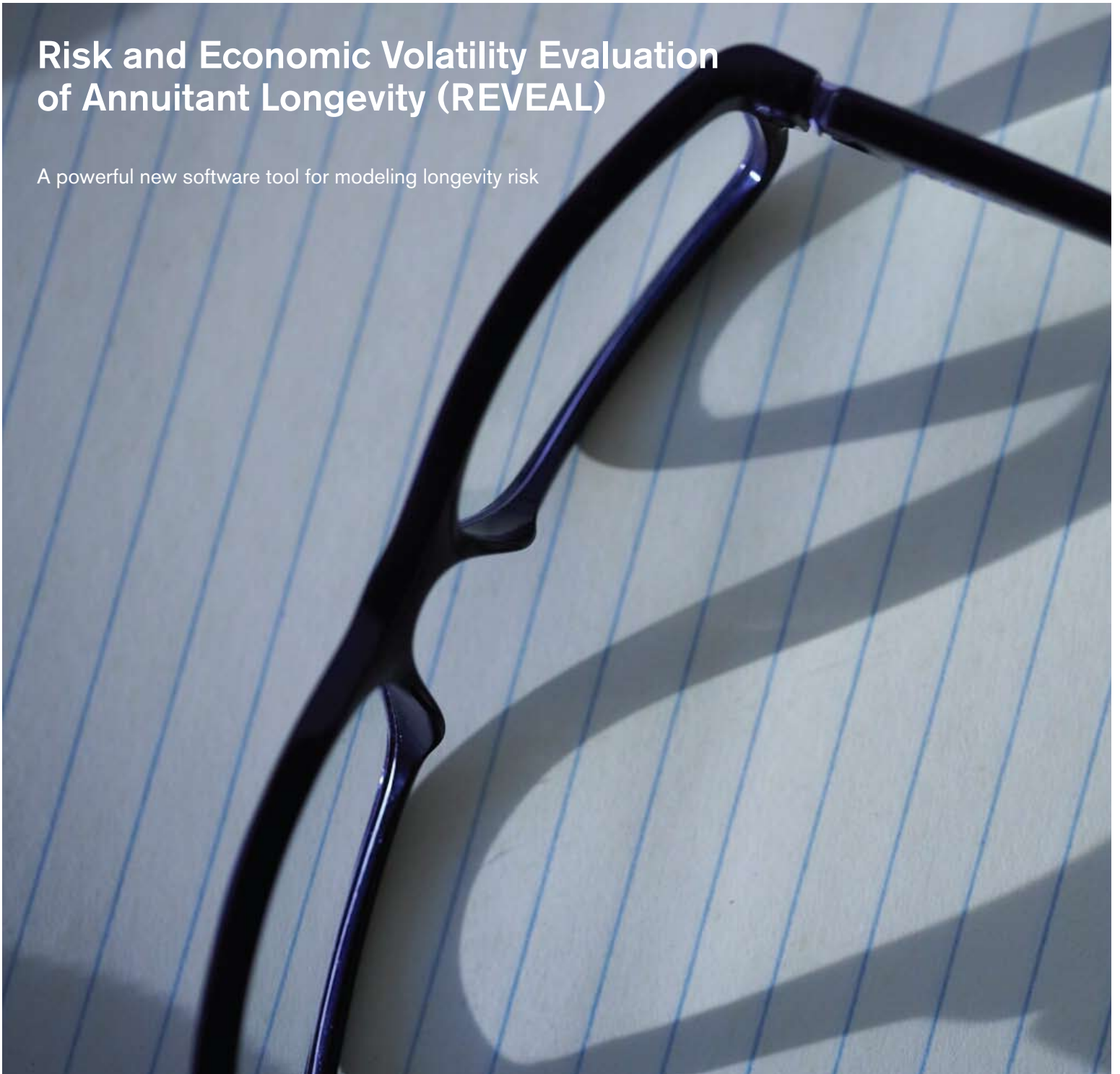
Risk and Economic Volatility Evaluation of Annuitant Longevity (REVEAL)

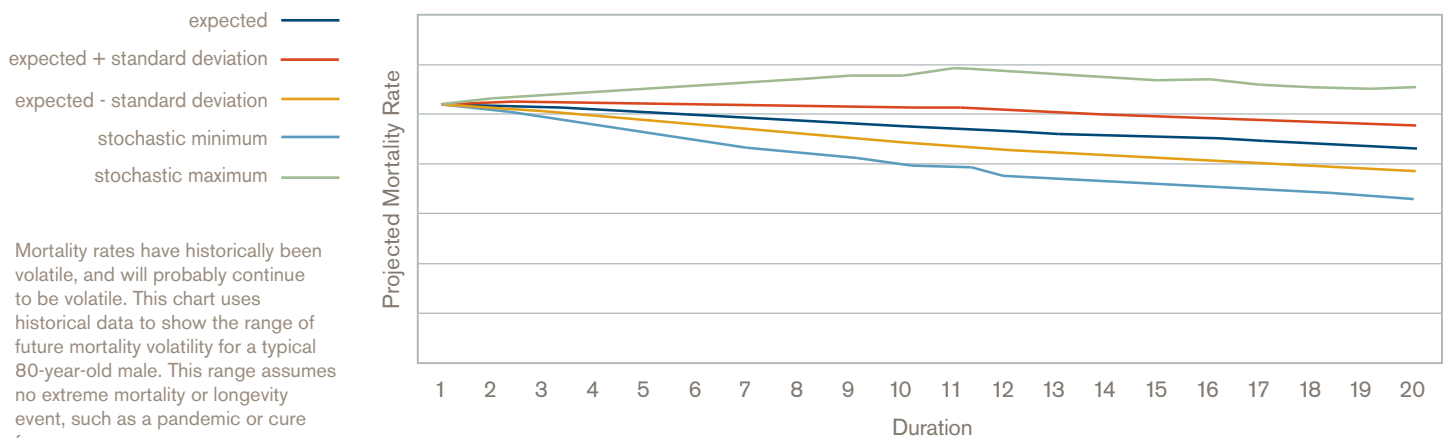A powerful new software tool for modeling longevity risk

A DYNAMIC FUTURE MORTALITY ASSUMPTION

- **REVEAL** is a new software model that can provide insurance companies with a more dynamic and sophisticated approach to analyzing pension closeout and immediate annuity longevity risk (including guaranteed living benefits and the payout phase of deferred annuities).

- **REVEAL** can perform stochastic cash-flow projections and economic liability valuations with volatility using a wide range of variables—including volatility in the mortality rate itself.

- **REVEAL** can deterministically modify underlying mortality rates by causes of death to reflect actual medical breakthroughs and projected medical advancements.

- **REVEAL** offers insurers a more robust tool than either deterministic or stress test approaches for valuing pension closeout and annuity liabilities.

- **REVEAL** analyzes the likelihood of stress variables occurring and imparts valuable insights into mortality assumptions and other scenarios, allowing management to make better and more informed decisions when it comes to pricing products, negotiating closeouts, and establishing capital levels.

DEMOGRAPHIC, MEDICAL, REGULATORY, AND ECONOMIC TRENDS DEMAND NEW TOOLS LIKE REVEAL

- **The Baby Boomers are retiring:** The first Boomers turned 62 in 2008 and large numbers will retire over the next decade. They will want to minimize the risk of outliving their assets by acquiring immediate annuities. REVEAL can provide a range of profit scenarios based on various margins and volatility assumptions.

- **Declining asset values and new regulatory requirements and accounting standards are straining the funding of many defined benefit pensions, thereby encouraging pension fund closeouts:** The Pension Protection Act of 2006 (PPA) and the Financial Accounting Standards Board's (FASB) new standard No. 158 are encouraging some private and government employers to offload their pension liabilities to insurance companies. To price these closeouts with confidence, purchasers may desire access to more robust valuations than those possible from deterministic approaches or stress testing alone.

- **Enterprise risk management is increasingly on the minds of decision makers:** Insurers are looking at how risks are correlated and paying increased attention to the potentially

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)

Mortality rates have historically been volatile, and will probably continue to be volatile. This chart uses historical data to show the range of future mortality volatility for a typical 80-year-old male. This range assumes no extreme mortality or longevity event, such as a pandemic or cure for cancer.

catastrophic risks that lie in the tail of their distributions. Recent history shows that previously "unthinkable" risks can come to pass, and companies are looking to build a more prudent approach to tail risk into their larger risk-management strategy. Economic capital is fast becoming a significant factor for pricing and liability risk analysis. REVEAL offers a useful new method of determining economic capital.

- **Rating agencies are looking more deeply at risk:** At least one major rating agency has already instituted an enterprise risk management system, requiring insurance companies to put active risk-management procedures in place or face possible downgrading. REVEAL could be an important tool for managing longevity risk and meeting those higher risk-management standards.

- **Traditional valuation techniques do not reflect volatility in the mortality assumptions. People are living longer:** Advances in healthcare and a greater public awareness of the advantages of a healthful diet and lifestyle are combining to enable longer, healthier lives. While these are positive trends, they can have

a negative impact on future profitability if they are not part of the analysis when establishing pricing for annuities or pension closeouts.

REVEAL introduces an important new tool into the U.S. pension closeout and immediate annuities market (including guaranteed living benefits and the payout phase of deferred annuities) just in time to meet the challenges of these growing trends.
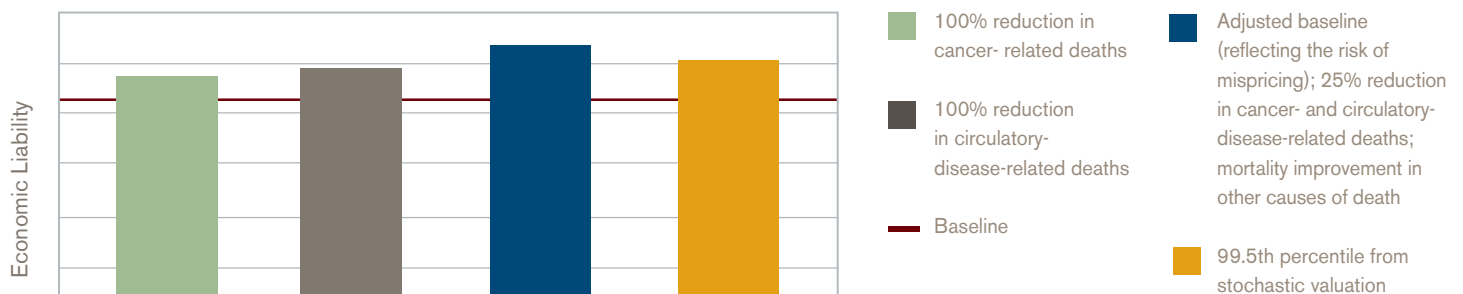
HOW REVEAL WORKS

REVEAL allows for sophisticated projection of the underlying mortality assumption.

Deterministic adjustments in mortality rates by individual causes of death can be used to reflect actual medical breakthroughs and projected medical advancements.

Users can employ their own mortality assumption or use one of the many defined mortality and mortality improvement tables available. An added benefit is the ability to determine periods for calculating population mortality improvement rates by age and gender.

Economic liability values at various stress levels

- **100% reduction in cancer-related deaths** (light green)
- **100% reduction in circulatory-disease-related deaths** (grey)
- **Baseline** (dark red line)
- **Adjusted baseline** (reflecting the risk of mispricing); 25% reduction in cancer- and circulatory-disease-related deaths; mortality improvement in other causes of death (dark blue)
- **99.5th percentile from stochastic valuation** (orange)

The chart illustrates economic liability values at various stress levels. Items tested relate to mispricing of the underlying mortality table, high levels of mortality improvement, partial or entire cures for certain diseases, and combinations thereof. Stress tests are helpful in keeping the perspective of understanding economic capital statistics derived from the stochastic process reflecting volatility in underlying mortality assumptions.

After determining the underlying mortality assumption, REVEAL performs stochastic economic liability valuations, incorporating volatility in the many variables that can affect profits and cash flows over time, including:

- Baseline mortality assumptions.

- Mortality improvement assumption, reflecting correlations among age groups and gender over user defined periods of time.

- Dates of death for participant and spouse (given stochastically determined mortality assumption).

- Cause-of-death reduction scenarios—stress improvements in the following various causes of death (e.g., 1% chance in a given year that death rates from cancer decrease by 25%):

  — infections and parasitic disease
  — neoplasms
  — endocrine, nutritional, and metabolic
  — circulatory disease
  — respiratory disease
  — digestive disease
  — genitourinary disease
  — external causes
  — other causes

- Benefit elections, payment start dates, future salary inflation, and other variables that affect pension cash flows.

- Economic liability functionality based on U.K. mortality tables and U.K. population mortality improvement rates is also available.

STOCHASTIC VS. DETERMINISTIC MODELING AND STRESS TESTING

Deterministic methodologies accept a single future mortality rate assumption. A stochastic approach evaluates potential outcomes by allowing for random variation of one or more inputs, generally based on probability distributions and fluctuations observed in historical data over a defined period of time.

- A stochastic approach generates many important statistics to understand economic liability values:

  — average stochastic value
  — standard deviation of value
  — percentile values
  — contingent tail expectations
  — cash-flow patterns
  — economic liability values for all future years

- A stochastic approach can assist in understanding the probability of occurrence of a particular deterministic stress scenario.

- A stochastic approach can assist in understanding the effect of medical advancements on the future value of pension closeout or immediate annuity liabilities.

**THE IMPACT OF VOLATILITY:
A HYPOTHETICAL ANNUITANT PROJECTION
COMPRISING A BLOCK OF SINGLE-PREMIUM
IMMEDIATE ANNUITIES RANGING IN AGE
FROM 65 TO 85**

The following charts provide a clear picture of
how including volatility in the underlying
assumptions can affect projections of future
economic liability value.

Both charts calculate future economic liability
values (present value of future cash flows) using
a stochastic approach. Chart 1, with volatility
only in dates of death and given a static mortality
assumption (i.e., with no volatility reflected in the
mortality rates), appears to show future liability
values that are relatively stable and predictable.
Chart 2 reflects a dynamic future mortality
assumption (i.e., volatility in the future mortality
rates). Mortality rate volatility assumptions are

Chart 1
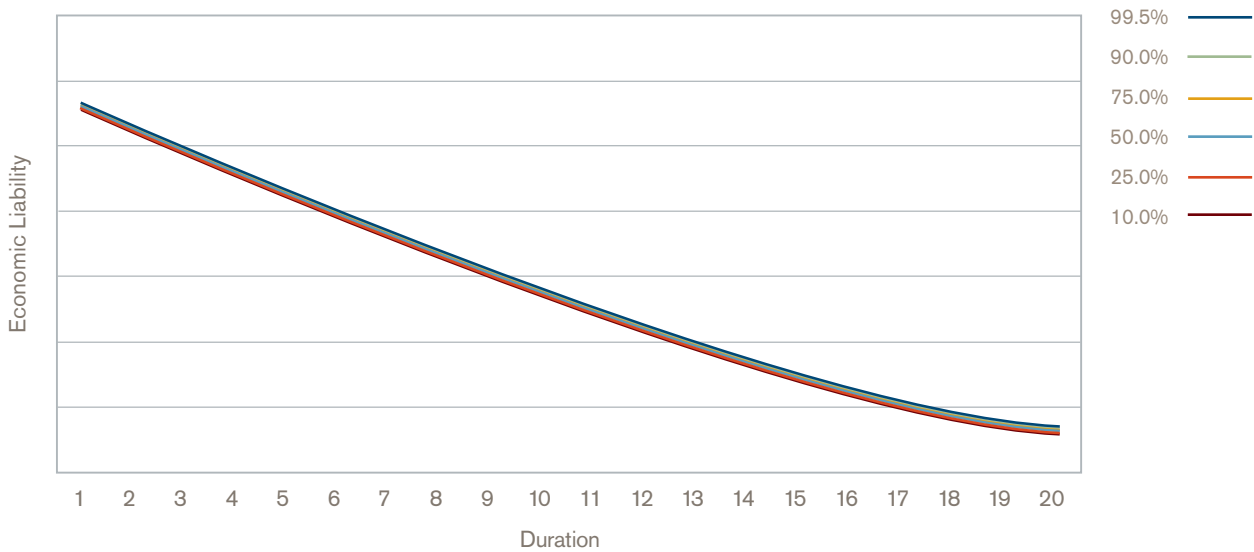Distribution of scenarios by economic liability at each future duration

Chart 2
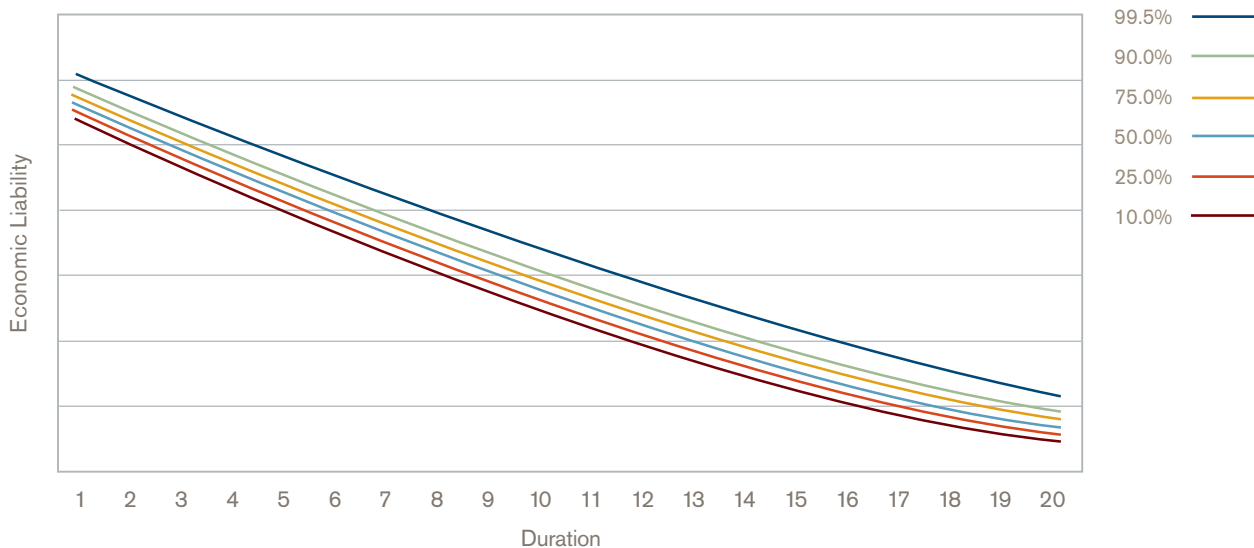Distribution of scenarios by economic liability at each future duration

Chart 3
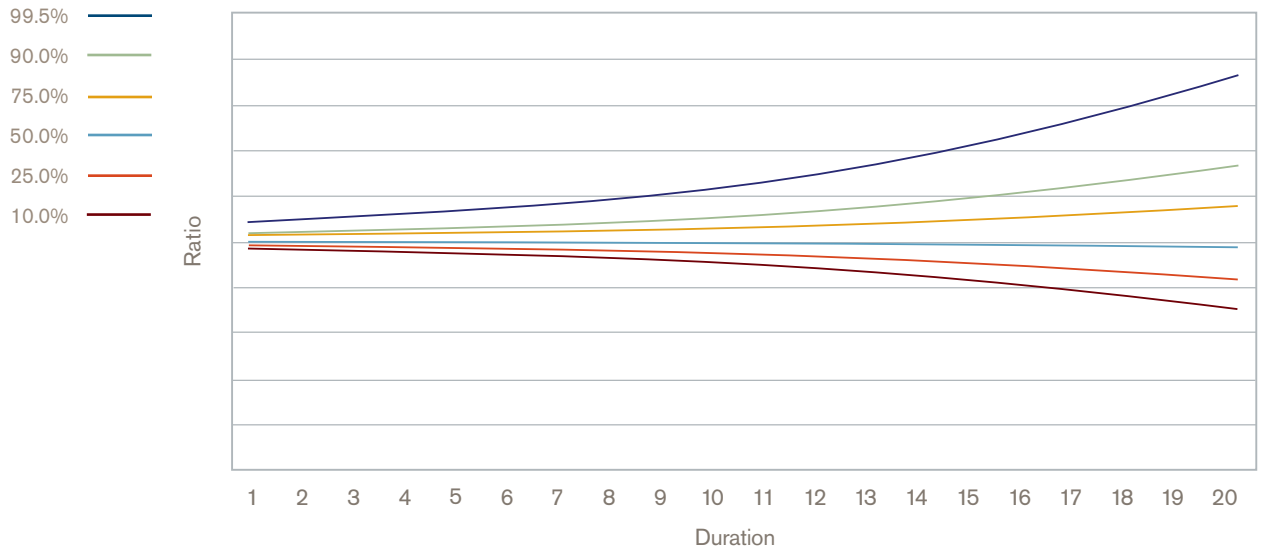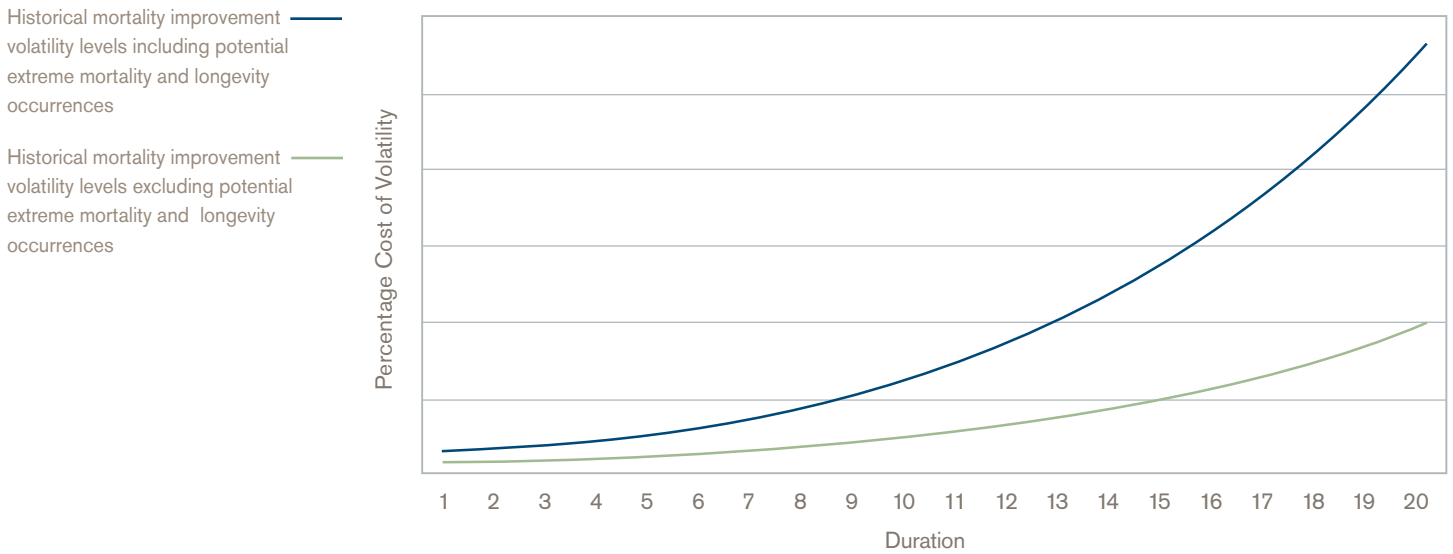Ratio of scenarios economic liability to the average economic liability at each future duration

99.5%
90.0%
75.0%
50.0%
25.0%
10.0%

Ratio

Duration

Chart 4
Average economic liability with volatile assumptions / Average economic liability with static assumptions

Historical mortality improvement
volatility levels including potential
extreme mortality and longevity
occurrences

Historical mortality improvement
volatility levels excluding potential
extreme mortality and longevity
occurrences

Percentage Cost of Volatility

Duration

based on historical levels of volatility in mortality improvement rates and chances of medical advancements reducing deaths related to certain diseases. Chart 3 illustrates the economic liability values at various confidence intervals expressed as a percentage of the median liability value.

When volatility is not reflected in the mortality assumption, the tail percentile values are very close to the median value. When volatility in the mortality rates is reflected, the tail percentile values are significantly more than the median. In other words, when volatility is reflected in the analysis, there is a chance the present value of future annuity payments will be considerably more than originally anticipated.

Chart 4 illustrates the "cost of volatility." Assuming a static mortality rate suggests economic liability values that are less than the economic liability value from a stochastic process when a dynamic mortality assumption is assumed. This is a cost for which investors need to be compensated. Essentially, reflecting volatility in the underlying mortality assumption creates a wider distribution of what can occur, creating a greater number of both high and low economic liability value scenarios. However, there is more room for annuitants to live longer than to die earlier, creating an asymmetry. Thus the high economic liability values more than offset the low economic liability value scenarios, creating a cost due to volatility.

REVEAL – A dynamic new tool for a more demanding environment

If you would like to find out more about REVEAL, please contact Stuart Silverman in New York, +1 646 473 3108 or stuart.silverman@milliman.com.

Milliman

Milliman, whose corporate offices are in Seattle, serves the full spectrum of business, financial, government, and union organizations. Founded in 1947 as Milliman & Robertson, the company has 49 offices in principal cities in the United States and worldwide. Milliman employs more than 2,100 people, including a professional staff of more than 1,000 qualified consultants and actuaries. The firm has consulting practices in employee benefits, healthcare, life insurance/ financial services, and property and casualty insurance. Milliman's employee benefits practice is a member of Abelica Global, an international organization of independent consulting firms serving clients around the globe. For further information visit www.milliman.com.