Article from:

In the Public Interest

July 2014 – Issue 10

LIVING TO 100

INNOVATIONS IN RETIREMENT

By Kai Kaufhold

The triennial Living to 100 Symposium is a great source of inspiration and ideas across a range of actuarial practice areas, scientific disciplines and industries. The fifth Living to 100 Symposium was hosted by the SOA this January in Orlando, with a record-breaking number of participants from numerous countries around the globe. I would like to report on three innovative papers presented at Living to 100, which deal with three different views on retirement and longevity risk: an individual's, a life company's and a whole-sale risk management view.

DAVID BLANCHETT: ESTIMATING THE TRUE COST OF RETIREMENT

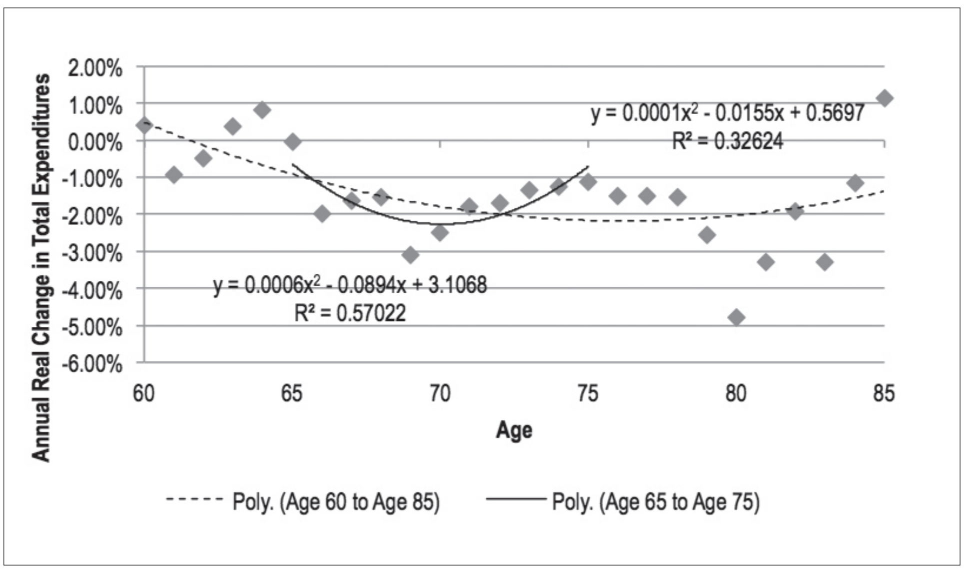
Let's start with real people. When you or I are trying to figure out how much we have to save for retirement, we have to consider three things: what will I spend during retirement, how much income will my savings earn and how long do I expect to live. Financial planners typically use some very basic assumptions to answer these questions. In his paper, David Blanchett of Morningstar demonstrates how some additional thought on these fundamental questions leads to different answers and—a rarity for investigators on retirement issues—there is actually some good news!

Tackling the first question about retirement expenditure, Blanchett notes that current models typically assume a target replacement rate, i.e. required post-retirement income as a percentage of pre-retirement income. This simplistic assumption does not take into account the fact that pre-retirement income typically increases with age throughout a person's work life. Furthermore, the Department of Labor's Current Population Survey shows that there are pronounced differences in age-related income patterns depending on level of education. Households with different levels of income also, typically, have different percentages of pre-retirement expenses dropping away after retirement. So, even the denominator in the replacement ratio is not easy to define.

Based on the Consumer Expenditure Survey of the Bureau for Labor Statistics, post-retirement consumption profiles vary significantly by age, where the most pronounced shift is the relative increase in healthcare costs at older ages. As a consequence, retirees are also subject to a different inflation risk than the general population, because medical inflation has, historically, by far outpaced the Consumer Price Index. Bringing this information together with longitudinal data from the RAND Health and Retirement Study (RAND HRS), the author is able to calculate the actual real change in consumption for retirees, by age, showing a pattern which he describes as the "retirement smile." Refer to Figure 1 below, which shows the year-on-year rates of change in total household expenditures against age. Immediately after retirement, consumption net of inflation sharply declines. Between ages 70 and 75, the rate of decline slows down but on average consumption still continues to decrease with age. This is where the good news comes in: assuming constant expenditure after retirement is too cautious. A more accurate model would show real post-retirement consumption going down.

Kai Kaufhold is managing director, Ad Res Advanced Reinsurance Services GmbH in Hürth, Germany. Kai can be reached at *kai.kaufhold@adreservices.com*.

Figure 1: Changes in total household expenditure against age.



Source: RAND Health and Retirement Study.

CONTINUED ON PAGE 26

To me, the greatest merit of the paper is that it shows how important and worthwhile it is to apply actuarial principles to the question of retirement planning.

Further investigation shows that this general pattern applies in a different way to different socio-economic groups. Blanchett differentiates between high- and low-net worth households, and also between high- and low-spending households. For instance, households with a relatively low income, which spend a relatively high portion of their income pre-retirement, will likely see a much stronger reduction in post-retirement consumption. The data is not conclusive about whether this is simply because these households run out of funds after retirement, or whether their pre-retirement spending behaviour was especially high for reasons which ceased to be relevant after retirement. Another group of households are those with high net worth but low pre-retirement spending. These households apparently increase their post-retirement consumption at rates in excess of inflation. This may be driven by availability of funds or possibly also by more available time, which is likely to have been a scarcer resource for many affluent individuals before they retired.

Bringing everything together in a model combining the retirement spending curve with stochastic mortality and asset performance models, Blanchett estimates a safe withdrawal rate, relative to an individual's risk aversion. Overall, he finds that traditional simple models are likely to overstate the required target retirement savings by up to 25 percent.

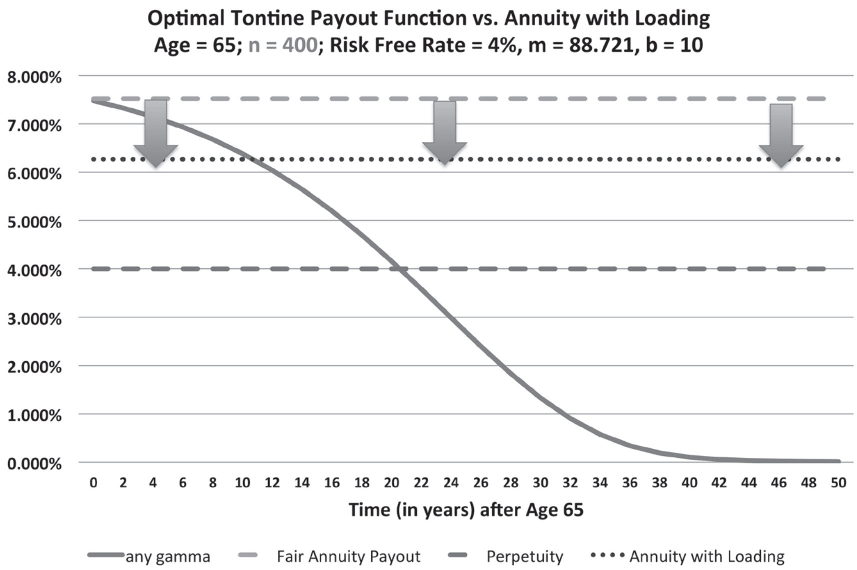
To me, the greatest merit of the paper is that it shows how important and worthwhile it is to apply actuarial principles to the question of retirement planning, from the individual consumer's perspective, because the needs of retirees vary across different parts of the population.

MILEVSKY, SALISBURY: OPTIMAL RETIREMENT TONTINES FOR THE 21ST CENTURY

A tontine annuity is an investment where the proceeds are shared among the surviving members of a pool of investors. If you are an investor and unlucky enough to die earlier than the others, your share is distributed among the other investors. If, on the other hand, you are the lucky person who outlives everyone else in the pool, you get all remaining funds. Tontines are named after their inventor, an Italian banker in the 17th century called Lorenzo Tonti. Since around 1910, tontines have been banned in the United States. A less well-known historical fact is that at the beginning of the 20th century nearly every second U.S. household owned a tontine insurance policy to support the household members through retirement. The authors give an historical overview of the tontine product concept, explaining its merits and how it fell into disrepute. They then apply economic utility theory to compare life annuities and tontines, and derive optimal payout profiles for an annuity and a tontine. Their findings make intuitive sense: without inflation, the optimal annuity structure is a constant payout rate, while the optimal tontine payout profile has a decreasing structure, which is somewhat in line with the decreasing survival curve. The optimal tontine payout structure, however, depends on the size of the pool of lives on which the tontine is based and also on the individual's aversion to longevity risk. The more risk an individual investor is willing to take, the more a tontine payout profile can be back-loaded. Expressed in a different way: The more an investor believes that he or she will outlive the other members of the tontine pool of lives, the more he or she will be willing to back-load the tontine payout profile.

Comparing the utility of a life annuity and a structured optimal tontine, the traditional fixed annuity usually wins out, as long as one does not factor in the frictional cost of capital, which the insurance company has to hold in the case of an annuity. The authors give a theoretical framework for this frictional cost, the indifference annuity loading, which one can view as the amount which a rational policyholder would be willing to pay for the longevity guarantee embedded within an annuity. Figure 2 illustrates the relationship between a payout annuity, an optimal tontine and a payout annuity with guarantee loading.

Figure 2: Comparison between payout annuity, payout annuity with guarantee loading and Optimal Tontine: annual rate of return against policy duration.



This paper is a useful and illustrative example of applying modern economic theory to insurance product design. ...

This paper is a useful and illustrative example of applying modern economic theory to insurance product design, especially because the authors introduce the concept of subjective survivorship, the influence of an insured's self-assessment of personal health (or information advantage) on the optimal product structure. By the way, this kind of anti-selection risk for life insurers selling annuities exists in an even more pronounced form in the United Kingdom, where some specialist companies offer higher annuity benefits to applicants with a record of poor health. This leaves other companies with healthier-than-average insured annuitants, whose life expectancies may be higher than what was originally priced.

Milevsky and Salisbury argue that tontines with appropriate payout structures should once more be allowed as a complementary retirement savings product, along with annuities. While the issuer of a life annuity provides the policyholder protection against longevity risk, the issuer of a tontine provides only the infrastructure for policyholders to pool their individual longevity risks, without guarantees. These two products could be seen as two ends of a continuous spectrum, along which there are products for every flavor of risk appetite.

LI, CHAN & LI: THE CBD MORTALITY INDICES—MODELLING AND APPLICATIONS

Switching gears from retirement product design to the field of mortality projection models, the next paper is relevant to companies and institutions who are concerned about wholesale longevity risk. For years, the feasibility of hedging longevity risk with standardized financial instruments has been discussed through various initiatives and numerous academic papers. Longevity risk is only slowly emerging as an asset class in the capital markets, because there is, still, a lack of transparency for investors and hedgers alike. Professor Li and his co-authors make an important, potentially game-changing contribution to this discussion.

CONTINUED ON PAGE 28

The authors propose a model-based mortality index framework, akin to the VIX implied volatility indices on the Chicago Board of Options Exchange, and identify criteria which the underlying mortality model needs to meet. One of the key criteria is invariance with respect to new data, which is met by the original Cairns-Blake-Dowd[1] ("CBD") model. This model, which has been studied widely in actuarial literature, also has the advantages of being both simple and intuitive.

The CBD model applies a logit transform to the mortality probability $q_{x,t}$:

$$q_{x,t} \longmapsto \text{logit}\left(q_{x,t}\right) := \ln\left(\frac{q_{x,t}}{1-q_{x,t}}\right)$$

and models the logistic mortality rate logit $\left(q_{x,t}\right)$ as a linear function of age.

$$\ln\left(\frac{q_{x,t}}{1-q_{x,t}}\right) = \kappa_t^{(1)} + \kappa_t^{(2)}(x-\bar{x})$$

The formula shown above contains two time-dependent parameters, $\kappa_t^{(1)}$, $\kappa_t^{(2)}$. $\bar{x}$ is the average age in the data set used to calibrate the mortality projection model. In most countries, this linear age model for period mortality is a reasonable approximation over the age range of interest for annuities and pensions, i.e. 60 to 95 years. $\kappa_t^{(1)}$ describes the level of mortality in time period t and $\kappa_t^{(2)}$ measures how steep the mortality curve is in the same year.

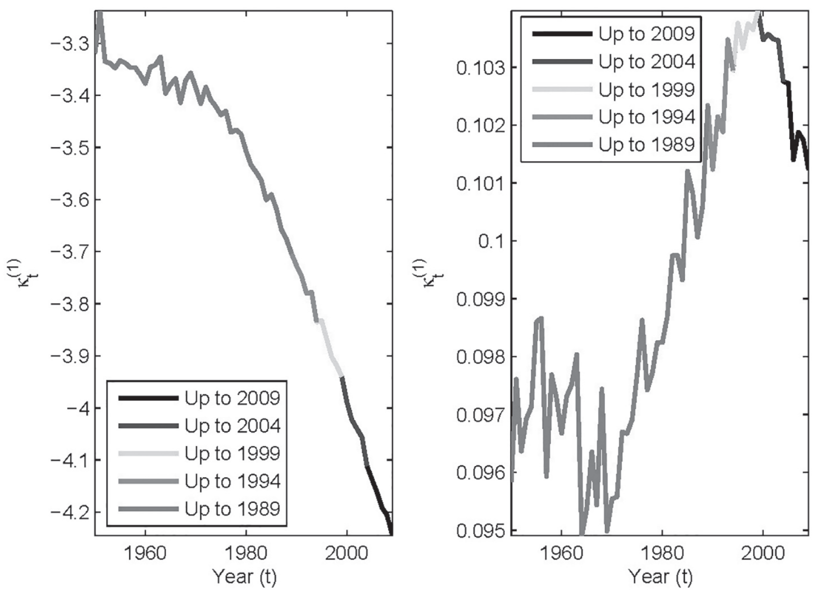
A reduction in the level of mortality as described by $\kappa_t^{(1)}$ equates to an improvement in mortality across all ages. An increase in the slope of the mortality curve, by contrast, is a reduction in mortality for younger ages paired with an increase for older ages.

The following chart shows results obtained for $\kappa_t^{(1)}$ and $\kappa_t^{(2)}$ applied to population mortality statistics for males in England and Wales.

The left chart in Figure 3 shows that over the entire time period from 1950 until 2009 the level of male mortality was generally decreasing in England and Wales, and at an accelerated pace since the mid-1970's. The right-hand chart shows that, since the mid-1970's, the mortality curve has become steeper and steeper, which means that mortality has been increasing more rapidly at younger ages than at older ages.

The authors use the intuition behind the two CBD indices to illustrate the sensitivity of a given population or portfolio to the level of mortality and the slope of the mortality curve. As illustrated in Figure 4, right, pension plans and companies selling life insurance are exposed to mortality trend risk in different ways. While faster mortality improvements increase the financial burden for pension plans and their sponsors, the opposite is true for life insurers, who profit from reductions in mortality rates on their life insurance book. For both types of institutions, older ages are more likely to have a greater financial impact than younger ages, because greater amounts of insurance are likely to be held by older poli-

Figure 3: CBD-Model estimates for time-varying parameters $\kappa_t^{(1)}$ and $\kappa_t^{(2)}$. Data: English and Welsh males. Sample periods: 1950 to 1989, 1994, 1999, 2004 and 2009.



cyholders and pension plans typically have a weighted average age between 70 and 75. That is why the lower half of the diagram shown in Figure 4 is most important.

Continuing from this intuition, the authors introduce the concept of joint prediction regions as a graphical measure for longevity and mortality risk. This makes it easy to compare the exposures in different countries, as shown in the following charts.

Comparing England and Wales population mortality to Canadian mortality, the spread of joint prediction regions for Canadian mortality is much narrower than for English and Welsh men. This means that the uncertainty around the level of mortality improvement appears to be less in Canada. However, there is a greater uncertainty with respect to the slope of mortality. This uncertainty will also make valuation of life insurance and pension risk difficult.

Based on the findings illustrated in Figure 5 and Figure 6, Canadian life insurers would be more at risk of overestimating mortality improvements than Canadian pension plans are of underestimating them, assuming they used a stochastic mortality projection model to estimate the improvements in the first place. This is because the joint prediction regions are tilted upper left to lower right.

The three articles summarized here will appear in the 2014 Living to 100 Symposium V Monograph, which will be published this summer. The innovations described by the authors demonstrate how much thought and creativity is necessary to understand longevity risk from the different perspectives of the individual, the insurance company and the risk manager. These three perspectives cover a whole "pyramid of retirement risk." The base of this retirement risk pyramid is formed by the financial needs of individuals after retirement. Building upon understanding

Figure 4: Interpretation of K1 and K2 risks

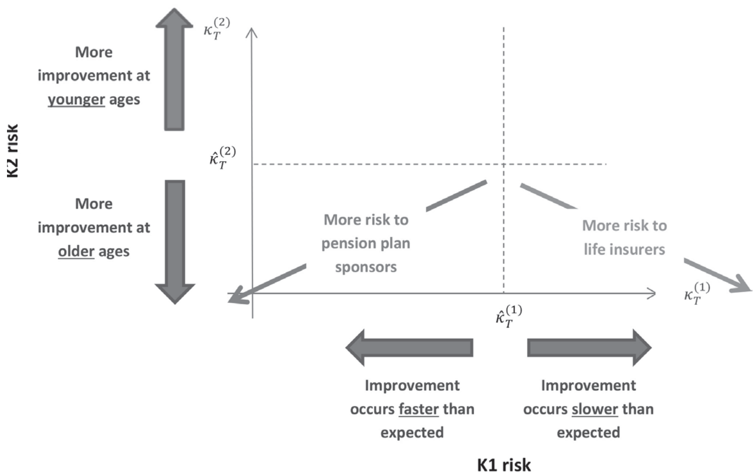
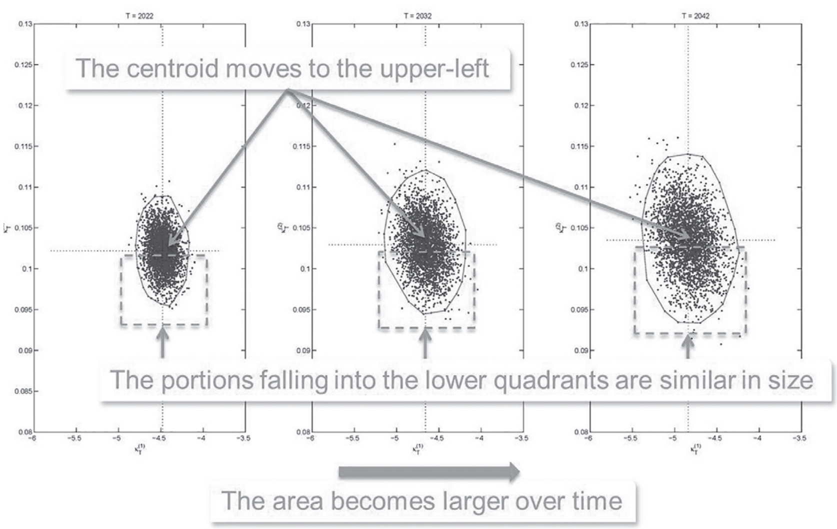
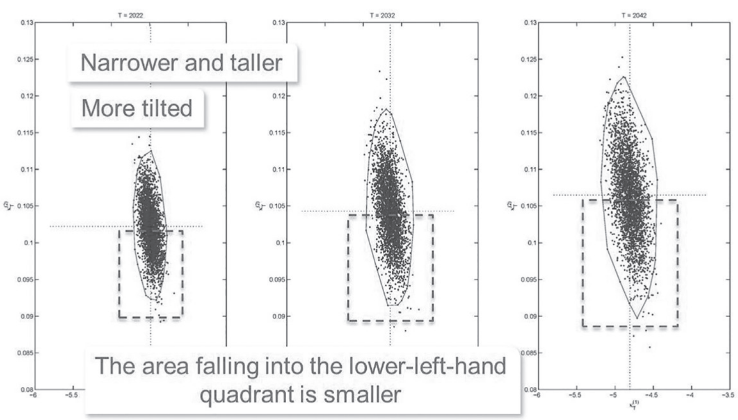


Figure 5: Two-dimensional plot of $\kappa_t^{(1)}$ and $\kappa_t^{(2)}$. Data from England and Wales, male mortality projected to 2022, 2032 and 2042. Stochastic projections of CBD indices using VARIMA(5,1,0) time series process.



CONTINUED ON PAGE 30

Figure 6: Two-dimensional plot of $\kappa_t^{(1)}$ and $\kappa_t^{(2)}$. Data from Canada, male mortality projected to 2022, 2032 and 2042. Stochastic projection of CBD indices using VARIMA(3,1,0) process.



these needs, we must offer products and solutions which cater to a range of socio-economic groups and risk appetites. In order to sustain such products over the many decades that our stakeholders require, the longevity risk which companies, employers and government institutions cover has to be understood and, ideally, actively managed.

ENDNOTES

[1] Cairns, A. J. G., Blake, D. and Dowd, K. (2006). A two-factor model for stochastic mortality with parameter uncertainty: theory and calibration, *Journal of Risk and Insurance*, **73**, 687-718.