THE EUROPEAN ACTUARY

THEME: LONGEVITY

TRIANNUAL MAGAZINE OF THE ACTUARIAL ASSOCIATION OF EUROPE

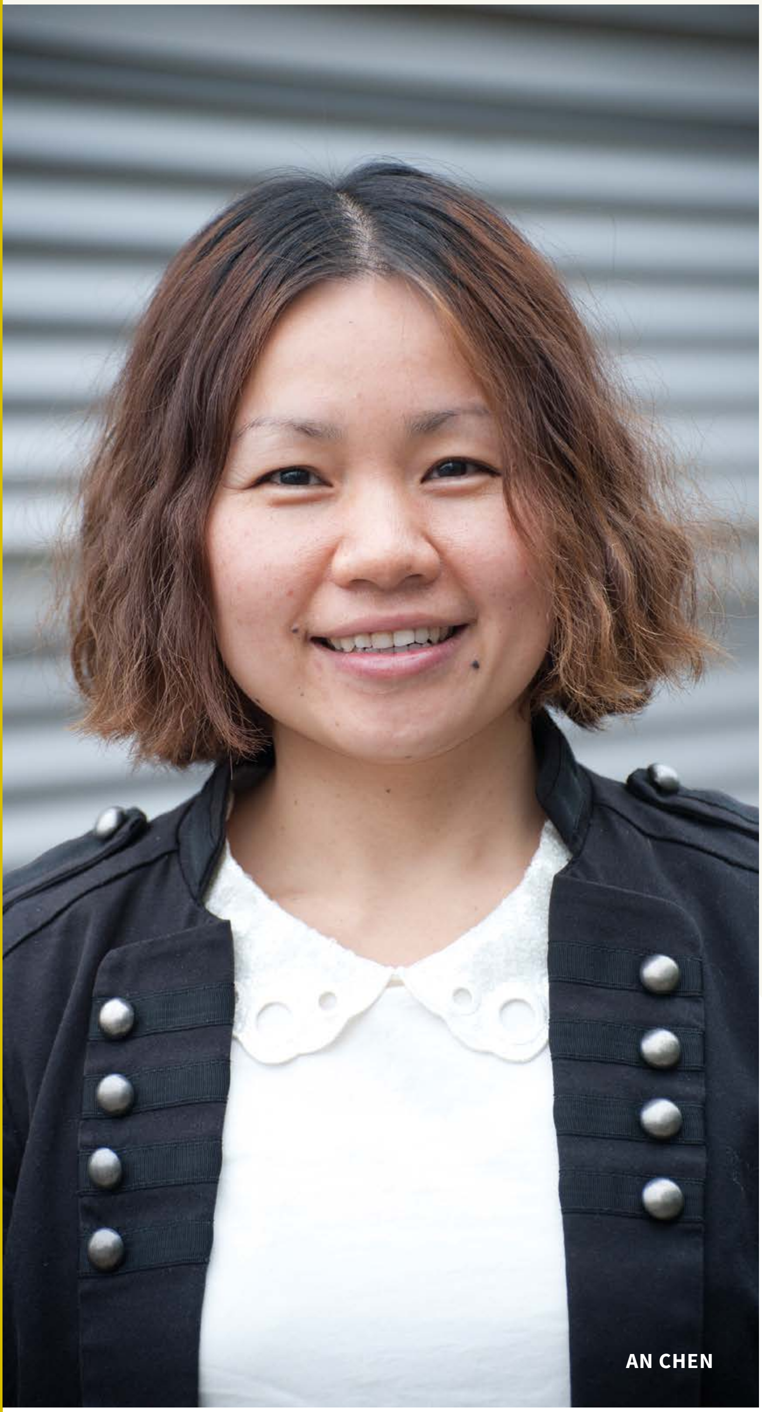
aae actuarial association of europe

Nº 18
OCT 2018

LONGEVITY IMPACT

ON LIFE INSURERS IN LOW INTEREST RATE ENVIRONMENT

BY **ANNA RITA BACINELLO, PIETRO MILLOSSOVICH** AND **AN CHEN**



AN CHEN

Over the last few decades, one of the major societal challenges has been the changing demographics due to our aging society. While birth rates remain low, life expectancy has increased continuously for many years. Apart from this, one of the main consequences of the credit crunch crisis in 2007/2008 has been the transition to a long-lasting phase of extremely low interest rate regimes in many developed countries. These two aspects have brought some trouble on life insurers all over the world, particularly on those providing long-term investment guarantees or lifelong benefits, as these have put a severe strain on life insurers' balance sheets by perceptibly inflating the market values of the liabilities.

The adoption of fair value based accounting standards for insurers, e.g. the full implementation of the Solvency II framework in the European Union in 2016, has enhanced the transparency of their balance sheets by tying assets' and liabilities' values to the actual (or hypothetical) prices they could be exchanged for in a liquid market. On the other hand, the application of these accounting standards has stressed the exposure of life insurers' balance sheets to a variety of financial and biometric factors, with a consequent effect on capital requirements. This is again particularly relevant for providers of long-term investment guarantees or lifelong benefits.

Traditional life insurance products offering fixed life contingencies have been replaced long ago by more competitive contract structures, with-profits in the UK and participating policies with guarantees in Europe and the US, where insurers share part of their returns with the policyholders. Usually, the policyholders are promised to receive a minimum return even when market performance is poor. This minimum rate of return is set at issuance on a very conservative basis, so that the implicit value of such a guarantee is small. However, given the long-term nature of the contract, guarantees that are initially far out of the money may become highly valuable due to adverse movements in market rates of return and/or an unexpected rise in the length of life. The increasing costs of these guarantees could become unsustainable and eventually compromise the financial stability of the insurance companies. A notable example is given by Equitable Life, the world's oldest life insurer. Therefore, an accurate contract design and careful assessment of all the risks involved, along with the interactions between them, are crucial.

LONGEVITY RISK AS EXPLICIT MODEL COMPONENT

Our approach aims at shedding some light on the interplay between two key risk factors affecting most life insurance products, namely the biometric and the investment risks. In our examinations, longevity risk is explicitly incorporated on a portfolio level in the stylized contingent claim model of a life insurance company issuing participating contracts and being subject to default risk. So far, most of the related literature has focused on financial risks only, as it is implicitly assumed that diversifiable biometric risk can be completely eliminated by pooling a large portfolio and systematic biometric risk, that is longevity risk, is absent. Longevity risk has been emphasized as a main factor influencing life insurance portfolios only in relatively recent years. Stochastic mortality models have been developed to explicitly allow for the uncertainty surrounding future survival rates. In our stylized framework, a stochastic force of mortality is introduced that is obtained by randomly rescaling a deterministic intensity. By this simple modelling, the mortality risk can be split into two components. The first component is given by the unsystematic risk that can be diversified away through pooling. In other words, this risk component tends to disappear for large enough portfolios. The second component is instead given by a systematic part that hits all policies in the same direction. In our case, this second component can be identified in the so-called longevity risk that is the risk of an overall unanticipated decline in mortality rates. When it is present, even with a large portfolio, there is a residual part of risk that cannot be eliminated.

SIGNIFICANT IMPACT OF LONGEVITY RISK

Our thorough analysis of contract components and fair participation rates explores in detail the interplay of guarantees, market regimes, mortality assumptions and portfolio sizes. Overall, our results stress the predominance of systematic over diversifiable risk in determining fair participation rates. The main findings can be summarized as follows: First, idiosyncratic biometric risk vanishes even in small portfolios. In other words, when homogeneous contracts are pooled together, diversification becomes fully effective with relatively small portfolio sizes. Second, longevity risk has a very substantial impact on the market values of the participating life insurance liabilities. The relative size of this impact on the fair participation coefficients is particularly relevant when systematic biometric risk is paired with a low interest rate environment, and is preserved when the solvency capital or the pricing rule is adjusted to reflect the portfolio size. Specifically, our results are quite worrying as they show that, under low interest rate levels, yet not even close to those currently experienced, the costs of offering guarantees may be hardly sustainable. Finally, our detailed analysis provides some useful guidance on the possible actions a life insurer could take in order to mitigate the effect of longevity risk. The insurance company can either increase the volatility of the assets or decrease the magnitude of the surpluses distributed to the policyholders to maintain the fairness of the contracts. In other words, continued improvement in life expectation will make currently offered surplus participation rates unsustainable.

It is high time for life insurers to fully perceive the important role of longevity risk!

REFERENCE

"The impact of longevity and investment risk on a portfolio of life insurance liabilities" (2018) in European Actuarial Journal (ICA 2018 Best Paper Award in "Aspects of long-term savings: uncertainty in low real returns, longevity and inflation"), **link.springer.com/content/pdf/10.1007%2Fs13385-018-0175-5.pdf**

Table 1: *Fair participation rate δ for different values of $E[\Delta]$ and the case with deferred whole life annuities guaranteeing each survivor the continuous payment ρ per year starting a fixed maturity date T for a large portfolio.*

	$E[\Delta] = 0.4$				$E[\Delta] = 0.8$				$E[\Delta] = 1.2$			
ρ	$\delta\%$	V_0^g	V_0^b	V_0^d	$\delta\%$	V_0^g	V_0^b	V_0^d	$\delta\%$	V_0^g	V_0^b	V_0^d
5.0	90.28	43	48	3	95.69	33	57	1	97.65	28	63	1
7.5	69.16	65	33	11	85.11	50	42	5	91.33	42	49	3
10.0	32.76	87	23	22	66.14	67	31	11	79.64	56	38	7
12.5	—	108	17	36	37.33	84	24	20	61.63	70	30	13
15.0	—	130	12	52	—	100	18	30	36.41	84	24	20

V_0^g is the initial market value of the guaranteed payments, V_0^b the initial market value of the bonus payment, and V_0^d the initial market value of the default option.

Table 2: *Fair participation rate δ for different values of $E[\Delta]$ and risk free interest rate r for the case with deferred whole life annuities guaranteeing each survivor the continuous payment $\rho = 10$ per year starting a fixed maturity date T for a large portfolio.*

	$E[\Delta] = 0.4$				$E[\Delta] = 0.8$				$E[\Delta] = 1.2$			
$r\%$	$\delta\%$	V_0^g	V_0^b	V_0^d	$\delta\%$	V_0^g	V_0^b	V_0^d	$\delta\%$	V_0^g	V_0^b	V_0^d
1	—	196	6	108	—	140	10	59	—	113	15	39
2	—	129	13	52	8.17	97	19	28	45.47	79	25	17
3	32.76	87	23	22	66.14	67	31	11	79.64	56	38	7
4	76.54	59	36	8	87.93	47	45	4	92.75	40	51	2
5	92.21	40	50	3	95.96	33	57	1	97.60	28	62	1

V_0^g is the initial market value of the guaranteed payments, V_0^b the initial market value of the bonus payment, and V_0^d the initial market value of the default option.

For the numerical results we have used the parameters:

- m Gompertz law of mortality, fitted to the survival probabilities ${}_tp_{40}^*$ implied by the projected life table IPS55 currently used in the Italian annuities market

$$m(t) = \lambda c^{x+t}$$

  with $x = 40, \lambda = 2.6743 \cdot 10^{-5}, c = 1.098$.
- Δ Gamma distributed with $\text{Var}[\Delta] = 0.1$ and the following scenarios:
  - $E[\Delta] = 0.4$ extreme longevity improvement scenario
  - $E[\Delta] = 0.8$ moderate longevity improvement scenario
  - $E[\Delta] = 1.2$ slight mortality worsening scenario
- instantaneous assets return normally distributed with mean $r = 0.03$ and $\sigma = 0.15$
- maturity $T = 25$;
- initial individual assets per contract $w_0 = 100$;
- initial contribution ratio $\alpha = 0.7$;

ANNA RITA Bacinello is a full professor of mathematical methods for economics and for actuarial and financial sciences at the Department of Economics, Business, Mathematics and Statistics “Bruno de Finetti” of the University of Trieste, Italy.

PIETRO MILLOSSOVICH is a senior lecturer in actuarial science at the Faculty of Actuarial Science and Insurance within the Cass Business School of the City, University of London, UK. He also holds a position at the University of Trieste.

AN CHEN is a full professor in insurance economics at the Faculty of Mathematics and Economics of Ulm University and a research fellow at Netspar.