Mortality-linked investment products

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Background

In recent years there has been increasing interest in financial instruments where the return is based on mortality or life expectancy. These bonds are of interest to insurance companies and pension funds, which have enormous liabilities for pension and annuity payments which continue until death.

Most insurance liabilities are covered by reinsurance, where another insurer – often a multi-national to benefit from diversification – assumes part of the risk. This is common for death and disability claims. However, many reinsurers have been unwilling to take on annuity reinsurance because of the inherent uncertainty and the long time horizon. Limited reinsurance solutions are sometimes available, but currently cover a very small part of these liabilities.

Forecasting future trends in longevity is notoriously difficult. If the actuary of the insurance company or pension fund considers that forecast improvements have been underestimated and need revision (or is forced to make a revision by the regulators), the effect on the balance sheet can be considerable.

Financial instruments with an insurance connection are not new. Catastrophe bonds offer a solution in case of extreme situations, mainly in the field of property/casualty cover. However, these are related to a one-off event whose effect can usually be measured within a defined time period. For longevity there are additional considerations. If members of the fund live longer than anticipated in the pricing basis, there are a number of consequences:

1) The current amount of payments will be higher than expected.
2) The liability for future pension payments will also increase.
3) Additional longevity of dependants or disabled lives may have implications for death and disability covers.

Financial markets are able to issue such instruments, because from their point of view additional diversity is generated. Another consideration is that some commercial activities might expect to profit from increased longevity (retirement homes, pharmaceuticals etc.), and investment in such companies might be an appropriate hedge.

Description of longevity bonds and other instruments

Blake et al. [1] wrote a comprehensive paper which includes the fairly limited developments by 2006. They describe in detail a longevity bond issued by BNP Paribas: “The face value of the issue was £540 million and the bond had a 25-year maturity. The bond was an annuity (or amortising) bond with floating coupon payments, and its innovative feature was to link the coupon payments to a cohort survivor index based on the realised mortality rates of English and Welsh males aged 65 in 2002. The initial coupon was set at £50 million.” The payouts on this bond were intended to replicate the pension payments which would be paid to this “index” population during their lifetimes over the ensuing 25 years. The paper

states that the terms were set so that investors would be asked to pay an additional 20 basis points (over and above the usual investment curve) in order to hedge their longevity risk.

There is of course a fundamental difference between the solutions offered by reinsurance and by financial instruments. A reinsurance contract relates specifically to the lives covered by the fund. An exceptional event may be specific to a certain fund (e.g. claims for individuals with a high level of cover) or more general (e.g. claims resulting from natural catastrophes), but in both cases the reinsurance is effective. However, the return on a mortality-based financial contract is based on an external index which may or may not be appropriate to the experience of the fund. Even if the index relates to the population of the country of residence of all the fund members, there is no guarantee that their mortality will change in the same way. The hope is that in the long term the behaviour of the insured population and the index population will at least be similar.

A drawback of the contract described above is that it is limited in time. Even if the population is completely matched, the fund will have no protection for excess payments from 2027 onwards, to fund members still alive at age 90. Around 15% of 65-year-old males can expect to live beyond 90, and for females the proportion is higher. A "classical longevity bond" which continues payouts as long as some members of the index population survive would be more effective.

Other types of contract, described in the above paper, are:
Zero-coupon longevity bonds – providing a series of annual payments.
Geared longevity bonds, which enable users to meet their hedging demands for a much reduced capital outlay.
Deferred longevity bonds – with payouts starting from a date in the future (where there is greater uncertainty).
Mortality swaps - defined as an agreement to exchange one or more cash flows in the future based on the outcome of at least one (random) survivor or mortality index.
Mortality futures – which might be traded on a futures and options exchange. The discussion is mainly theoretical.

An inherent problem in such contracts is the choice of mortality index. Mortality tables are published infrequently, compared to financial indices, and attempts to produce timely data may encounter problems of unreported deaths. Choices are: national population statistics, data from different classes of insured lives published by the Continuous Mortality Investigation Bureau of the Institute and Faculty of Actuaries, or (in special circumstances) the hedger's own mortality experience. Each choice has its disadvantages. Techniques of data smoothing, which are a matter of judgement and are likely to change over time, lead to delays in publication and are liable to affect the results.

Investors must also pay attention to the credit risk, which would appear to be more significant than for traditional reinsurance, at least with well-established international reinsurers with a high degree of risk diversification.

One of the authors produced a short slide projection with some of the main points [2], and there is additional information in a related paper by the same authors [3].

At the IAA meeting in Tallinn, Estonia, in 2009, Mark Tardif presented a detailed update of developments [4]. The market for these products has expanded, due to increased need to hedge longevity risks (with an exposure estimated at $20 trillion!), and also the benefit of reduced capital requirements in some jurisdictions. Credit Suisse and J.P. Morgan have created longevity indices, updated annually based on population mortality. In contrast, Goldman Sachs produced an index based on mortality of a fairly small group of insured lives (this was discontinued in 2010 due to poor take-up).

Mark Tardif's presentation mentions that market solutions include cash flow hedging through survivor swaps/forwards, capital hedging through short-dated reverse mortgage bonds or long-dated convertible securities (contingent on drift of mortality improvements), and mortality swaps.

Pricing mechanisms

A leaflet published by the Life & Longevity Markets Association [5] describes the mechanisms used to price some of these instruments. Inputs to the pricing mechanism are: structure of the product, data on the reference lives, base mortality rates, expected mortality improvements, and the risk premium, in addition to the economic discount rates. A major point of uncertainty is naturally the choice of mortality improvement model. Another leaflet from the LLMA [6] describes the pricing of the S-forward (survivor forward), which is "an agreement between two counterparties to exchange at a future date (the maturity of the contract) an amount equal to the realized survival rate of a given population cohort, in return for a fixed survival rate agreed at the inception of the contract". A more recent publication [6a] describes the creation of framework for building longevity indices. The Society of Actuaries published a brief summary on the subject [6b].

Market transactions

At a presentation to the Longevity conference in Frankfurt in 2011, Guy Coughlan [7] listed some major transactions in the market:

Date	Hedger	Provider	Type	Description
Jan 2008	Lucida	J.P. Morgan	Value hedge	10-year q-Forward (LifeMetricsIndex)
July 2008	Canada Life	J.P. Morgan	Cash flow hedge	40-year survivor swap
Feb 2009	Aviva	Royal Bank of Scotland	Cash flow + value hedge	10-year collared survivor swap + final commutation payment
Jan 2011	Pall UK Pension Fund	J.P. Morgan	Value hedge	10-year q-Forward (LifeMetricsIndex)

Coughlan describes the q-Forward method and mentions more recent developments in another paper [7a], which also gives a comprehensive review of the different ways in which longevity risks can be measured and managed.

Examples of two recent large transactions reported with great fanfare on financial information websites are [7b] (a £1 billion longevity swap transaction completed by Deutsche Bank AG for five of the Carillion pension funds) and [7c] (a £3.2 billion swap for the armaments manufacturer BAE, covered by Legal and General and Hanover Re).

Additional research

A paper by Prof. P.J. Sweeting [8] considers a number of criteria that longevity indices would need to fulfil to provide an optimal solution, and the forms of liquid derivatives that could be used to hedge the risk. The paper includes a stochastic analysis of possible mortality developments, which highlights the potential volatility of these instruments.

In a paper to the Society of Actuaries, Cox and Lin [9] show how a mortality swap might be used to provide the benefits of natural hedging. The subject is also investigated by Friedberg and Webb [10].

Deutsche Bank has recently published a more general survey of insurance-linked securities, with some reference to mortality and longevity [11].

A case study by Cairns et al. [12] examines the effectiveness of customized longevity hedging and index hedging, and suggests that, at least for medium and large pension plans, index hedges are a suitable medium.

Regulatory supervision

The financial impact of these new products seems to have raised some concern with the supervisory authorities.

The problems of supervising longevity risk are mentioned in a discussion paper by the Basel Committee on Banking Supervision [13], noting inter alia:

- Supervisors should seek to ensure that holders of longevity risk under their supervision have the appropriate knowledge, skills, expertise and information to manage it.
- Supervisors should take into account that longevity swaps may expose the banking sector to longevity tail risk, possibly leading to risk transfer chain breakdowns.

The implication seems to be than financial institutions should be more aware that taking on such risks is more akin to insurance than banking, and appropriate risk management is essential.

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