A visualization of the FOXO3A ('Methuselah') gene section, which plays a key role in determining lifespan. It is also involved in lipid metabolism and cell death processes.

Longevity

CRObriefing

Emerging Risks Initiative – Position Paper

November 2010

CRO FORUM

1. Executive Summary

With few exceptions, longevity has been increasing throughout the world during the last century. Achieving longer lifespans is both a laudable objective and a true achievement for society. At the same time, improving mortality presents society with a real challenge in ensuring that all individuals have an adequate income throughout their old age. This challenge is borne by some combination of individual, employer, insurer and government stakeholders.

Longevity risk[1] is the risk that individuals live longer than anticipated, with consequent shortfalls in incomes. The uncertainty around the quantum by which future lifespans will increase poses a serious financial threat to individuals, employers that sponsor defined benefit pension funds and governments. Often, the holders of longevity risk are unaware of the extent of the financial threat. Longevity risk can result in pensioner poverty, as well as calls on governments to meet shortfalls. Funded global longevity risk exposure has been estimated in excess of €15 trillion, based on worldwide pension assets in OECD registered countries.

Biometric risk forms a core business of life insurers. Life insurers provide valuable longevity indemnity products (e.g., individual annuities, bulk annuities and longevity swap insurance) to allow individuals, employers and, more recently, governments to mitigate their longevity risk exposures. Insurers can benefit from the natural offset between longevity and mortality exposures, as well as from the diversification that longevity risk brings to their overall portfolio of risks. Great strides have been made in modelling, understanding and quantifying longevity risk.

Relative to the other direct stakeholders in longevity risk, the overall exposure of insurers to longevity risk remains small. Although insurers can and do offer the indemnity protection sought by the other direct stakeholders, their capacity to take longevity risk onto their balance sheets is small relative to global longevity risk exposure. A key challenge, thus, is to increase insurer's capacity to hold risk or to enable the transfer of longevity risk from insurers to the capital markets.

In summary:

- Global longevity risk exposure is very substantial. As populations age and awareness of the financial risk increases, there will be a growing demand for longevity risk mitigation solutions.
- Life insurers have an important role to play in providing indemnity solutions for longevity risk. However, their current capacity to take longevity risk onto balance sheet may be inadequate. Developing solutions to transfer longevity risk to the capital markets can help.
- All stakeholders in longevity risk will benefit from investor and population awareness of the risk, access to reliable population data to help model and quantify the risk and regulation which promotes a rigorous risk-based capital framework for both insurers and defined benefit pension funds.

Cover photo credit: through his trans-disciplinary project 'iGene Vision,' the Cologne artist & researcher Karsten Panzer PerZan is developing a meta-system of science and the arts, based on the binary codes of genetic DNA, digital number system and the archaic Chinese opus 'Yijing,' Book of Changes. The project uses a 3D color system as a mediator and transmitter. www.PerZan.de © PerZan – Cologne 2010.

2. Longevity: Trends and Challenges

Increasing life expectancy has been evidenced throughout the 20th century, and now into the 21st century, in all developed countries. In this section, we present an overview of how longevity has evolved and emerged to become a key systematic risk. We consider the nature and extent of the challenge posed by increasing longevity. We also offer some views on how longevity might develop in the future.

2.1 Longevity Landscape

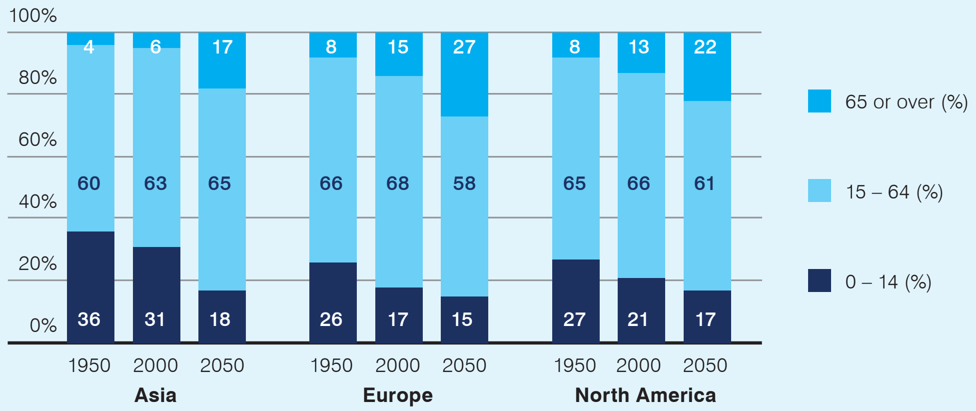
The emergence of increasing longevity as a key systematic risk is the result of substantial, albeit gradual, demographic changes over the last century. As birth rates have reduced, falling below the replacement rate across the developed world, and populations have enjoyed the benefits of preventative health measures and improved medical care, the population of the developed world over the age of 65 has increased both absolutely and proportionally. Further significant increases to the over-65 population are expected during the next 40 years (refer to Figure 2.1).

Society faces challenges in the wake of this demographic evolution which are underpinned by longevity risk. There is uncertainty over future life expectancy, about how healthy individuals will be during their retirement and, ultimately, around the costs to cater to the needs of increasingly elderly populations. Society must consider how these uncertainties will be met, who will bear the costs and when.

These global demographic changes are mirrored within the corporate sector. For companies with defined benefit pension funds, there is a trend for large former workforces to move to retirement with, in many cases, reduced active workforces to support the guaranteed benefits. This trend is particularly acute in the manufacturing sector. As the costs of funding defined benefit pensions increase, in part, as a result of increasing life expectancies, many companies are closing defined benefit pension funds and replacing them with defined contribution pension funds (refer to Figure 2.2). This has the effect of shifting the longevity risk from the corporate sponsor to the individual employee. For insurance companies, there is a demand for annuity products from the post-war baby boom generation that moves from accumulating wealth to seeking guaranteed income.

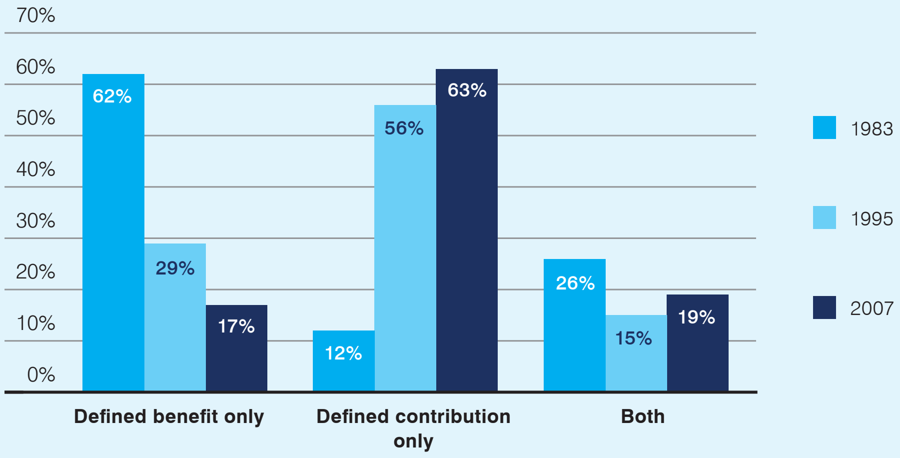
Thus, governments, employers that sponsor defined benefit pension funds, insurers and individuals all face the challenge of increasing longevity. The financial significance of longevity risk crystallised in the period of low inflation and low interest rates at the end of the 20th century. In other words, the recognition of increased lifetimes has occurred at the point at which financing the benefits for these increased lifetimes has become more expensive.

Figure 2.1 Emerging global demographic changes, showing age distribution of Asia, Europe and North America, 1950-2050



Source: United Nations, World Population Prospects 2008 Revision

Figure 2.2 US workers with pension coverage, by pension type, selected years



Source: Center for Retirement Research at Boston College

2.2 Longevity Drivers

Figure 2.3 sets out the increases in period life expectancy at age 65 for six developed countries over the last 50 years. The steady increase in longevity has been striking. The fundamental trends underpinning the increasing life expectancies are better understood when considering the underlying mortality rates.

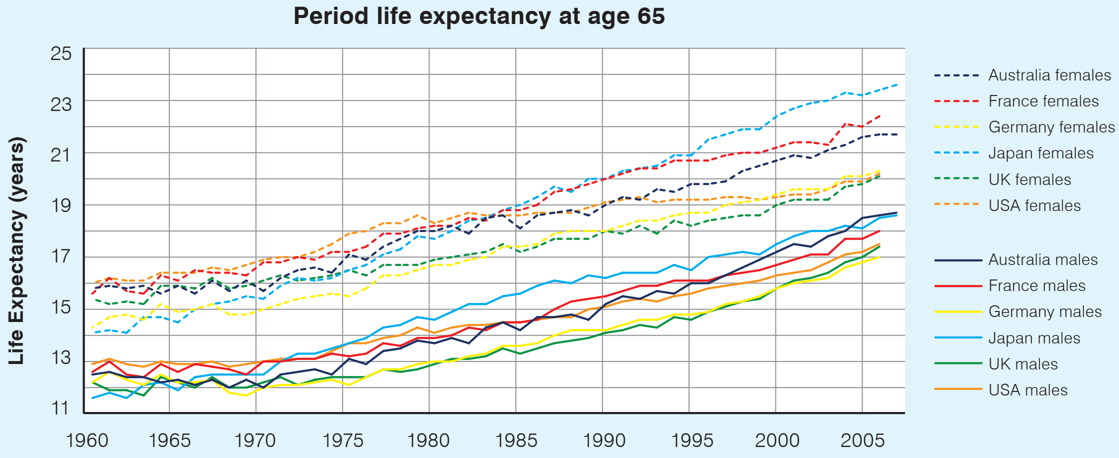
Figure 2.4 shows England & Wales male mortality rates by age, on a logarithmic scale. Corresponding period life expectancies at birth were 46 years in 1901, 66 years in 1951 and 76 years in 2001. All developed countries have followed similar patterns of decreasing mortality rates during the 20th century.

The first half of the 20th century saw substantial reductions in early life mortality, but limited improvement at old ages. The improvements in early life mortality resulted from improved hygiene and public sanitation, the introduction of new health measures, the adoption of widespread vaccination programmes and the development of antibiotics. As a result, by 1951, huge improvements in mortality rates had been seen at ages below 60.

The second half of the 20th century saw significant improvements in mortality rates at older ages. During this period, the main drivers of increasing longevity were socio-behavioural and improved medical care. Their effects have been particularly significant on cardiovascular related mortality, where reductions in smoker prevalence and medical advances have resulted in rapid improvements to mortality. The compound effect of these changes was reductions in mortality at immediate post-retirement ages comparable to the reductions at younger ages observed during the first half of the 20th century.

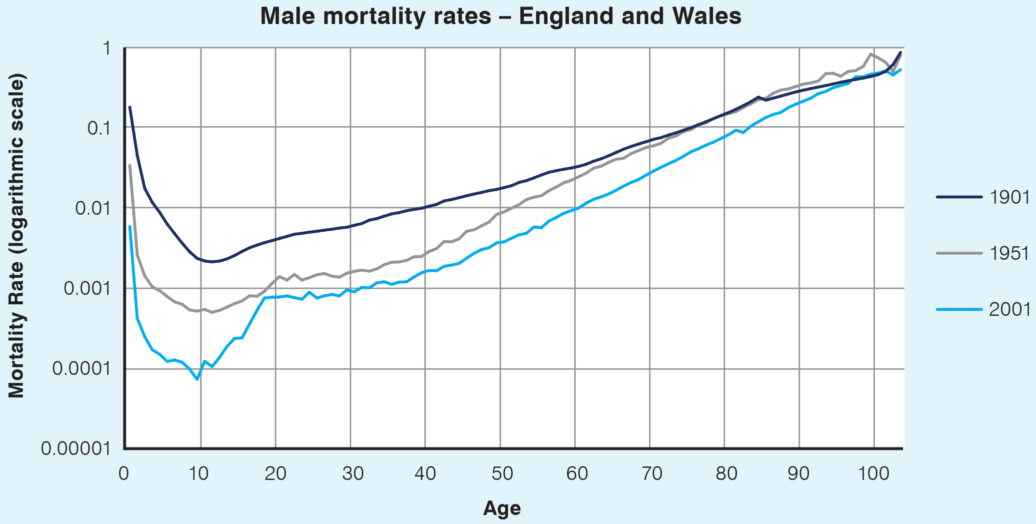
There remains an important question as to how likely it is that comparable changes will be observed at very advanced ages in the future. What is uncertain is the future impact of already observed changes, and the possible future interventions which may change mortality further.

Figure 2.3 Development of male and female period life expectancies at age 65 for select countries



Source: Human Mortality Database

Figure 2.4: England and Wales trends in mortality rates



Source: Human Mortality Database

2.3 Longevity Risk

Longevity risk[2] is the risk that individuals live longer than anticipated. Longevity risk can be divided into three material uncertainties, which are:

- volatility risk – the stochastic risk of individuals dying earlier or later than expected
- mortality level risk – the risk of misestimation of the current level of mortality for a given population and
- mortality trend risk – the risk of misestimation of future trends in mortality.

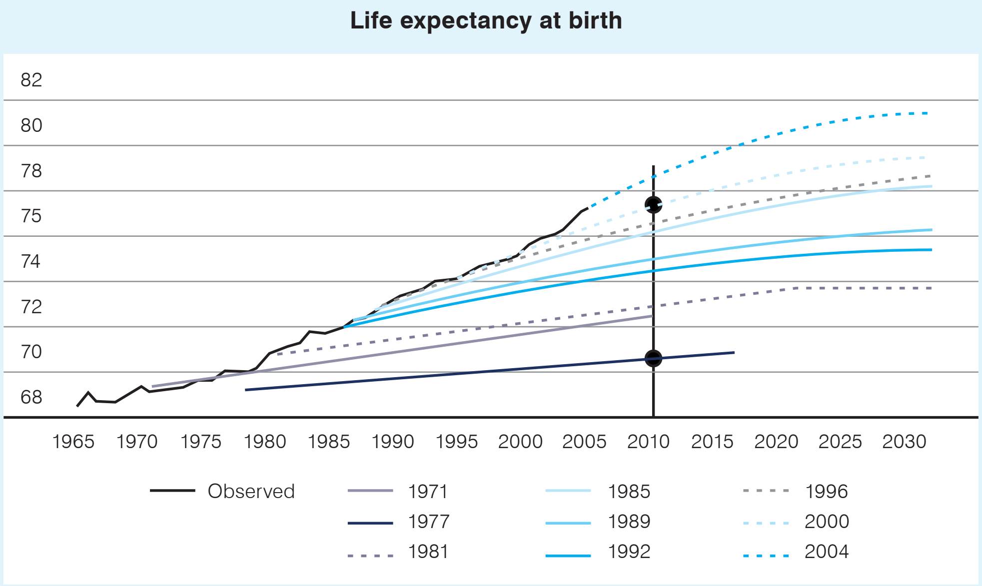
Volatility risk and mortality level risk are specific in nature. Thus, typical of insurance risks, their impact may be reduced through diversification. As such, it may be suitable to transfer pools of longevity risk to aggregators of that risk who can realise that diversification.

The developing market in pension risk transfer in the United Kingdom offers a supporting example. Here, corporate sponsors of defined benefit pension funds (whose primary business is not longevity insurance) with significant mortality level risk can transfer the risk to the insurance sector. A strong case for aggregating mortality level risk in this manner can be made once the very wide range in pensioner life expectancy is considered. For example, in 2007 the period life expectancy of a male aged 65 in England & Wales varied between 15.5 years and 23.1 years by local authority[3]. This variance would result in pensioner liability differentials of 35%. Similarly, in 2003 the period life expectancy of a male aged 65 in England & Wales varied between 14.1 years and 18.3 years by social class[4]. This variance would result in pensioner liability differentials of 20%.

Mortality trend risk[5], unlike the other two risks, is largely systematic in nature. The underlying drivers are similar across the developed world. This can create challenges for the management of the risk since there is minimal scope for risk reduction through geographical diversification.

Figure 2.5 presents a summary of an analysis of life expectancy extrapolations from the United Kingdom national population projections. What is clear is that projections of period life expectancies at birth have been consistently overtaken by actual life expectancies for over three decades, leading to substantial revisions to forecasts approximately every five years. One can only conclude that mortality trend risk is very material.

Figure 2.5 United Kingdom trends and projections of male period life expectancies



Source: Chris Shaw, 'Fifty Years of United Kingdom National Population Projections: How Accurate Have They Been?', Population Trends, 128, Office for National Statistics, 2007

2.4 Future Trends in Longevity

There is considerable controversy regarding future lifespan extension, the underlying biological limits and the resultant potential scale of longevity risk. This is not surprising, considering our inability to predict correctly life expectancies even a decade into the future (refer to Figure 2.6). The fundamental views representing opposite ends of the spectrum are summarised below:

1. **Limited lifespan paradigm.** There are functional limits to life expectancy whereby limiting sources of early years mortality still leaves the individual body prey to mechanical degradation and ultimate failure[6].
2. **Mortality reduction paradigm.** Mortality is still highly plastic at advanced ages[7,8] with continuous steady increases in life expectancy and delays to senescence showing no evidence of approaching a limit.

These paradigms provide competing, but not contradictory, views of life expectancy and leave considerable uncertainty in what is probable or even likely over the next couple of decades.

Some studies into the elimination of certain diseases (such as cancer) on a standalone basis, for example, have shown that their elimination may still have only a limited impact on improving life expectancy[9]. A more recent line of inquiry has been to study the biological process of aging itself. Aging is the common final pathway which controls age-related diseases. Regenerative medicines, such as stem cell therapies or applied nanotechnology, offer a possibility for more significant shifts in medical intervention over a longer time scale. To date, however, there is limited evidence showing the potential to increase human lifespan thus. Additionally, the costs associated with implementing new medicines and therapies may prove to be, at least initially, prohibitive to widespread uptake. As such, reasonable expectations of significant impacts from these sources might be of the order of 20 years or more. Even discounting such interventions, there remains, nonetheless, significant uncertainty on mortality trends over shorter timescales which will affect current pensioner populations.

The historic drivers of increasing life expectancy at older ages have been ones which have taken place over many decades. It may be reasonable to expect that any new developments that have material effects on life expectancy will, similarly, require significant time to manifest. Such developments would be expressed either through lifestyle changes or via new therapeutic advances. Some of the factors underlying such developments are listed in Figure 2.6.

Figure 2.6 Factors which may influence future longevity trends

	Factors which could increase longevity	Factors which could reduce longevity
Lifestyle	• Fewer smokers • Improved diets • Regular exercise	• Rise in obesity • More stress • Less physical activity
Medicine	• Development of drugs tackling life-threatening conditions (e.g., statins) • Lower accident mortality • Discovery of an effective gene therapy	• Viruses and bacteria develop resistance to available drugs
Disease	• Improved survival rates of, for example, cancer or heart disease	• New diseases/viruses evolve • Pandemics • Diabetes

Countervailing Trends

While longevity risk is predominantly concerned with increasing life expectancies, there are some countervailing trends to consider. Over short durations, the effects of increased obesity, alcohol consumption and recreational drug taking may prove damaging to life expectancies. Over longer durations, there will be challenges ahead from climate change, pressure on water resources and new pathogens, as well as the increasing prevalence of conditions specific to an aging population, such as Alzheimer's disease. During the last 30 years more than 30 new pathogens have been identified, including HIV, new variant CJD and SARS. A significant proportion of these is derived from human-animal transmission and represents a material change in the risk landscape. Over the same period, social and political upheaval in the former Soviet Union coincided with a significant reduction in life expectancy. Some of these trends which reduce life expectancy may not have significant impact on current pensioner populations.

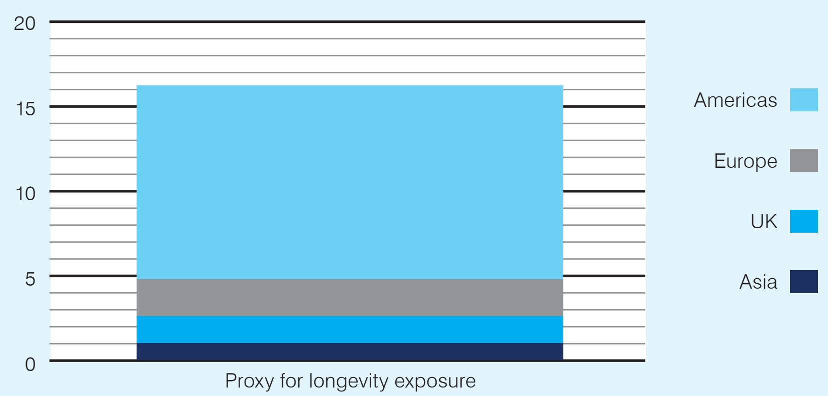
3. Exposures and Consequences for the Insurance Industry

Global longevity risk exposure is very substantial. For OECD registered countries, this exposure, as measured by the total assets currently backing future pension and annuity guarantees, is estimated to be over €15 trillion (refer to Figure 3.1). Approximately 90% of this exposure is related to defined benefit pension funds, with the remaining 10% related to insurance contracts. Insurers' exposure is dominated by markets with compulsory annuitisation (the United Kingdom, in particular). Figure 3.2 illustrates how, in addition to employers that sponsor defined benefit pension funds and insurers, governments and individuals are also exposed to longevity risk, as well as the interactions between the key stakeholders in longevity risk.

Insurers' longevity risk exposure is tied to variants of the lifetime annuity product, which has been purchased both by individuals and defined benefit pension funds to mitigate their own longevity risk. In this section, we consider the factors underpinning demand for lifetime annuities, along with the modelling, reserving and capital considerations for insurers. In section 4, we consider the specific products available to defined benefit pension funds.

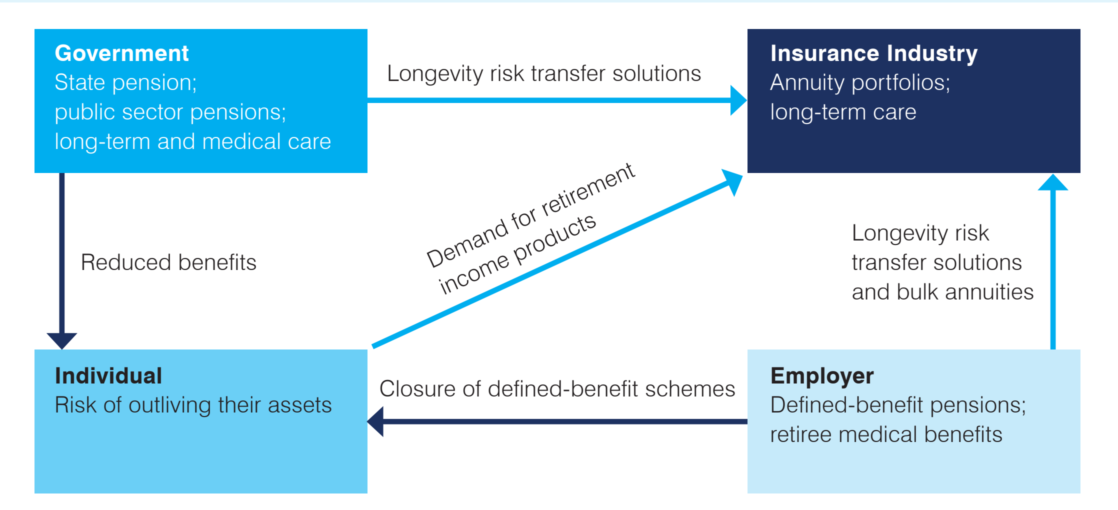
Figure 3.1 Funded global longevity risk exposure, as measured by total pension assets in OECD registered countries

Pension assets (€ trillion)



Source: OECD data

Figure 3.2 The holders of longevity risk



Source: Swiss Re

3.1 Demand for Lifetime Annuities

The ongoing demand for lifetime annuities will vary considerably across developed markets and will depend on a number of underlying factors. However, given the shifts in demography and the tendency to longer life expectancies (outlined in Section 2), together with the sheer size of defined benefit pension fund longevity exposure, it is reasonable to expect that there will be an aggregate increase in demand for lifetime annuities. This increase in demand could challenge insurers' capacity to support longevity risk. The key drivers for increasing demand are outlined below.

In all developed markets, occupational pension fund sponsors are moving from defined benefit to defined contribution provision. Figure 2.2 demonstrates the rapid pace at which this is taking place in the US. Occupational pension provision in other developed markets is following a similar pattern. This fundamental shift creates demand for lifetime annuities in two respects. First, the closure of defined benefit pension funds is often associated with the purchase of a bulk annuity[10] from an insurer. Second, the shift to defined contribution pension funds will result in future pensioners with assets that they may choose to, or be compelled to, convert into a lifetime annuity.

The demand for lifetime annuities will also correspond to the degree of compulsion to annuitise and the availability of other options to secure a retirement income. Markets with compulsory annuitisation, like the United Kingdom and the Netherlands, have a very large and active lifetime annuity market. Where pensioners have choices about how they secure an income in retirement (e.g., via phased withdrawal products or reliance on income from other assets), then preferences for liquidity, pensioner education, adverse selection and inertia will all affect the size and vibrancy of the lifetime annuity market.

Thus, for the majority of developed markets which do not have compulsory annuitisation, the motivation offered to annuitise will be important. Governments should be concerned to offer suitable motivation[11]; the alternative is to face the risk that pensioners run out of money before they die and, as a result, become dependent on state support.

Finally, the demand for lifetime annuities will be, to a degree, linked to the supply, variety and sophistication of products offered by insurers, all of which affect their appeal to pensioners. For example, standard lifetime annuities have been offered with guaranteed payments on death, contingent dependant benefits, surrender options and incomes which may escalate in line with an index or at a fixed rate. An open market option, introduced in the United Kingdom in 1975, encouraged retiring individuals to seek the best available lifetime annuity rates in the market. Enhanced and impaired lifetime annuities, which are underwritten and, consequently, provide superior lifetime annuity rates, have been offered in the US and United Kingdom for over a decade. During this time, the enhanced lifetime annuity market in the United Kingdom has grown to over €2 billion of annual premium and almost a 20% share of all lifetime annuities sold to individuals. A further example of product innovation is the recent introduction of postcode annuity pricing in the United Kingdom, where an individual's postcode is now regularly used by insurers as a rating factor. Postcodes are a proxy for social class, and life expectancy can vary significantly by both social class and geographical region.

3.2 Modeling Techniques and Data

The sophistication of annuity pricing and reserving varies across developed markets. It tends to depend on the size of the annuity market, the availability of data, product features and regulatory requirements. Essentially, however, the modelling of annuities reflects three key basis items. These are the base mortality assumption, the mortality trend assumption and the real interest rate assumption. In this context, the real interest rate is the difference between the nominal yield on the assets backing the annuities and the escalation rate of the annuities.

These three items together fundamentally determine the exposure to the longevity risk and the potential consequent asset shortfalls. The extent to which the base mortality assumption is wrong corresponds to mortality level risk. Similarly, the extent to which the mortality trend assumption is wrong corresponds to mortality trend risk. Figure 3.3 demonstrates the interaction of these assumptions, showing the potential variability in the present value of payments on a non-profit annuity. These assumptions, clearly, can have significant pricing and reserving implications for holders of longevity risk. The real interest rate assumption is important because lifetime annuities, and the corresponding longevity risk, have a very long duration.

Figure 3.3 Impact of longevity assumptions and real interest rates on the present value of annuity payments. The figures relate to a typical 65 year-old male and are shown relative to the 3% pa real interest rate with no future mortality improvements scenario.

Impact of longevity assumptions and real interest rates
(percentage change on net present value of annuity payments)

		Real interest rate (pa)		
Longevity assumption		**0.0%**	**1.5%**	**3.0%**
A	No future mortality improvements	34%	15%	0%
B	Future mortality trend using a current model	51%	27%	8%
C	As B, but base mortality assumption misestimated by 10%	57%	32%	12%
D	As B, but mortality trend assumption misestimated by 1% pa	61%	34%	13%

The base mortality assumption is commonly set with reference to an age and gender specific standard mortality table. Standard mortality tables may be derived from general population data or from select populations (e.g., occupational subgroups). For example, in the United Kingdom, the Office for National Statistics (ONS) regularly produces population mortality tables, while the Continuous Mortality Investigation (CMI) periodically produces mortality tables separately for insured lives and for pension fund lives. The shape and magnitude of mortality rates differ between the tables, reflecting the different longevity characteristics of the underlying lives. Selective effects (e.g., in the US and United Kingdom, selective effects arise from the availability of enhanced and impaired lifetime annuities) must be considered carefully when setting the base mortality assumption.

The mortality trend assumption, which reflects the extent of future mortality improvements, is a relatively recent feature of annuity pricing and reserving models. Many developed markets were making no allowance for mortality trend well into the 1990s. Current approaches for projecting mortality trend include extrapolative and explanatory-based methodologies. The former applies some form of extrapolation of historically observed mortality rates, while the latter applies causal forecasting (e.g., by looking at historically observed rates of mortality split by cause of death and projecting these into the future by considering, for example, current and expected developments in medicine). Both methodologies rely, to some degree, on expert opinion and judgement (e.g., to determine the long-term mortality trend assumption towards which the projected rates of mortality improvement converge). The past decade has seen a huge proliferation of available mortality trend models, both deterministic and stochastic in nature. However, at present, there is no general consensus on the choice of methodology, or on the most appropriate techniques to apply to a given methodology for setting the mortality trend assumption. Indeed, there remains a fundamental challenge in capturing the social and biological drivers of mortality in a mortality projection model.

The availability of credible, relevant, recent and reliable mortality experience data is central to mortality basis setting. Essentially, the better the data (with regard to the above characteristics), the smaller the uncertainty around the mortality basis. Several techniques for setting the base mortality assumption exist. One common approach is to assess the base mortality assumption using the underlying observed mortality in the specific population under consideration, or, where this is not available, annuitant claims experience data from a comparable population of lives. The mortality trend assumption is more difficult to assess because annuitant data tend to be limited in respect of the volume required for modelling mortality improvement rates and also because very few satisfying techniques exist. Using national population data to assess trend mortality is one solution to accessing sufficient data volume. At very advanced ages, where there is a lack of credible data even at national population level, some extrapolative assumption is typically applied to both the base mortality and mortality trend assumptions.

3.3 Reserving and Capital Implications

The coupling of the systematic nature of longevity risk with a long duration poses particular risk management challenges and, necessarily, capacity limits on this risk for insurers.

In some developed markets, the regulatory capital requirements are, arguably, poorly aligned with the underlying longevity risk. This misalignment can result from reliance upon outdated standard mortality tables and simplistic retrospective approaches to mortality improvements. Measures that serve more clearly to identify longevity risk (e.g., the disclosure of life expectancy in accounting for annuitant benefits) would both help to ensure that the risk was appropriately managed and to encourage the increased transparency of longevity risk management.

Insurers will tend to hold more appropriate levels of regulatory capital under regulatory regimes which encourage the development of internal risk management models that capture the real dynamics of longevity risk. Such models should recognise that, for the relatively large portfolios of annuitant lives typically held by insurers, longevity risk is dominated by the mortality trend risk. Importantly, the underlying drivers and expression of mortality trend risk are over many years.

Solvency II Framework

The Solvency II Framework represents a new set of regulatory requirements for insurance firms that operate in the European Union. It is scheduled to come into effect in 2013, replacing the Solvency I Framework that has been in place since the early 1970s. Solvency II introduces a comprehensive framework for defining required solvency capital levels, for ensuring good governance and risk management, and for encouraging transparent disclosure. Insurers will have a choice in setting their solvency capital on the basis of prescribed stress tests or on the basis of an internal risk model (such a model will require the approval of the local regulator in advance of its use for setting solvency capital). Either way, the minimum solvency capital requirements will need to withstand a 1 in 200 year event. For longevity risk solvency capital, current QIS 5 (the fifth Quantitative Impact Study) guidance provided by CEIOPS (Committee of European Insurance and Occupational Pensions Supervisors) has a prescribed stress of an immediate reduction in all mortality rates by 20%. This stress represents a shock on the base mortality level, but does not capture the risk of the long-term dynamic of mortality trends. Because the underlying drivers and expression of mortality trend risk are over many years, such a stress does not fully capture the real dynamics of longevity risk.

4. Current Risk Mitigation Solutions

Holders of longevity risk already have several options for mitigating their exposures. Current risk mitigation solutions overwhelmingly result in transferring longevity risk to insurers and reinsurers, who remain the long-term holders of this risk. In this section, we focus on these solutions, while in section 5 we explore the prospects for transferring longevity risk to the capital markets. Figure 4.1 illustrates the various approaches available to mitigate longevity risk.

We now discuss the current options available to the corporate sponsors of defined benefit pension funds for mitigating longevity risk exposure. This is done by reference to the United Kingdom pension market, which is the most active. Individual, insurer and government holders of longevity risk may also opt to mitigate their longevity risk exposure using analogous solutions.

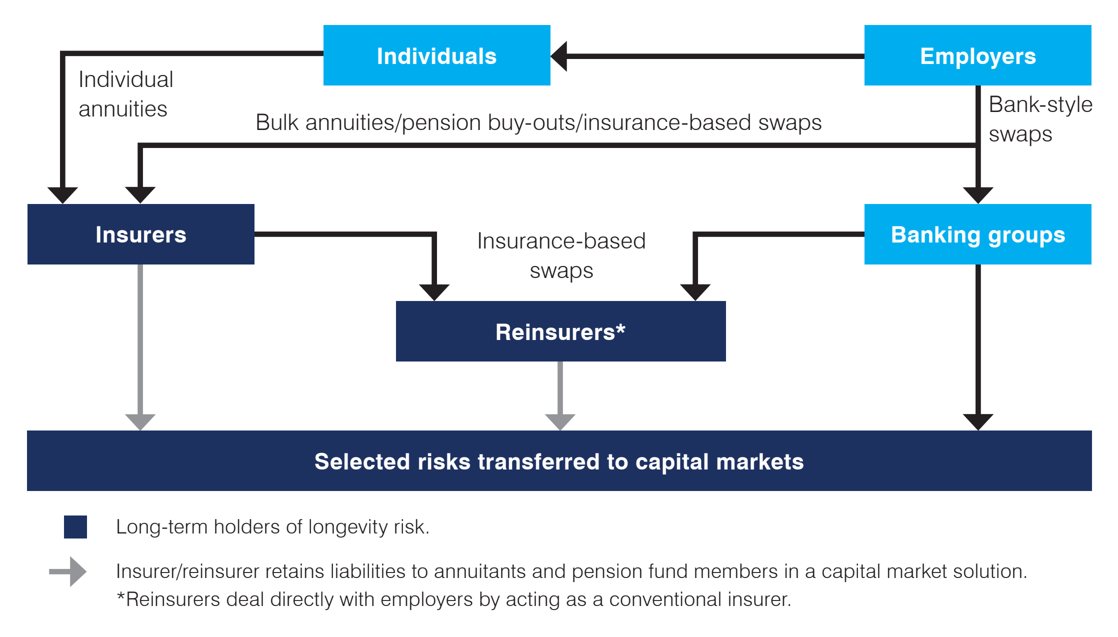
Of course, it is possible for defined benefit pension funds to manage longevity risk exposure by changing the benefit structure of the pension fund. In many cases, this has been the preferred option (refer to Figure 2.2, highlighting the move from defined benefit to defined contribution pension funds). Changing the benefit structure of a defined benefit pension fund can introduce risk sharing with members, reducing the burden on the sponsoring employer. However, such structural changes generally only apply to future benefit accruals for current and future employees (i.e., exposures to previously accrued pension rights remain unchanged). Similarly, governments may opt to manage their longevity risk exposure by reducing promises to pay state pensions, benefits to state employees and healthcare expenses. To this end, a number of governments are in the process of increasing state retirement ages, thereby shifting longevity risk to individuals.

The three main types of longevity risk protection currently offered to defined benefit pension funds are:

- bulk annuities,
- indemnity longevity swaps and
- standardised longevity swaps.

Each of these is discussed further, in turn, in sections 4.1 through 4.3.

Figure 4.1 Longevity: current risk mitigation solutions. 'Employers' relates specifically to sponsors of defined benefit pension funds, which can reside both in the private and public sectors.



Source: Swiss Re

4.1 Bulk Annuities

The bulk annuity is the traditional way of dealing with defined benefit pension fund risk. It involves the purchase, from an insurer by the pension fund, of a group of immediate and deferred lifetime annuities to cover the exposures in the pension fund exactly. Payment is by way of a single premium. All risks, including exposure to longevity risk are transferred from the defined benefit pension fund to the insurer.

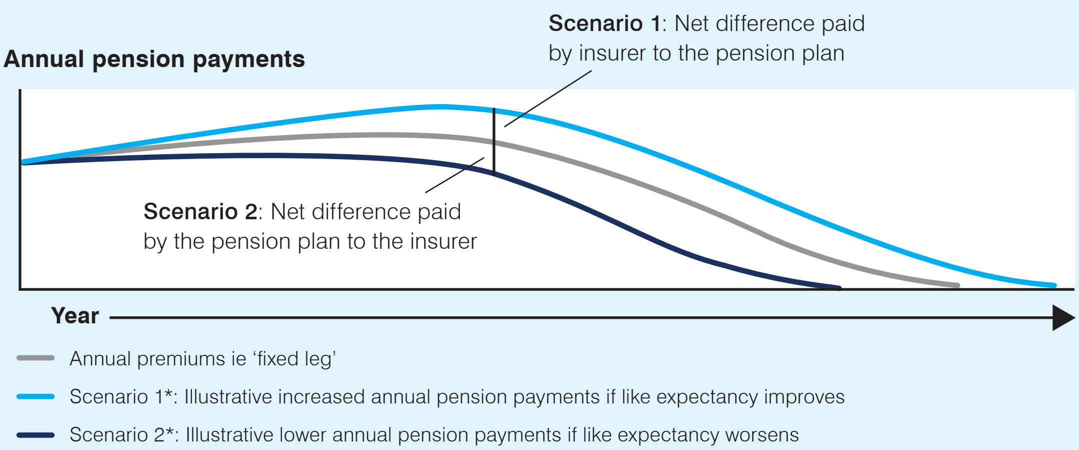
Bulk annuities have existed for decades with thousands of cases having being transacted. In 2009 alone, over 160 bulk annuities were purchased at a total value of €4.4 billion[12]. However, traditionally, bulk annuities have not been regarded as a means for effective risk management for ongoing defined benefit pension funds, and so were commonly only used for pension funds in termination. To some extent, this was because they were perceived as expensive, which itself was a consequence of the actuarial valuation methods applied to defined benefit pension funds, relative to those used by insurers. The pension fund valuations tended to give much lower ongoing pension liabilities than the bulk annuity premium because of divergent views on longevity and discount rates, as well as differential capital requirements between defined benefit pension funds and insurers.

Around 2006, new capital was attracted into the United Kingdom pension market, with a number of new insurers being established to write bulk annuity business. This coincided with an increasing regulatory and financial burden on defined benefit pension funds. Active marketing by the new entrants brought bulk annuities onto the agenda of many pension fund trustee boards. Also, bulk annuities that had been available in the past were made more accessible following efforts to improve communication and understanding of product features. For example, a clear distinction was made between a 'buy-out' (a bulk annuity contract in which the pension fund members hold policies with the insurer) and a 'buy-in' (a bulk annuity contract owned by the pension fund to match its liability relating to pension plan members). This increased activity in the bulk annuity market and related product development has been well received, as it makes available a secure method for pension funds to match and, in the case of a buy-out, exit their obligations.

4.2 Indemnity Longevity Swaps

In insurance form, the indemnity longevity swap can effectively be considered as a bulk annuity but with the premium spread over 50 or 60 years, rather than payable up front as a single premium (refer to Figure 4.2). The actual pension payments are met by the insurer, which fully mitigates the longevity risk exposure of the defined benefit pension fund to the covered members. The underlying assets remain with the defined benefit pension fund. Thus, the defined benefit pension fund retains the investment opportunity, and, importantly, can execute a longevity swap even if underfunded. The indemnity longevity swap allows the defined benefit pension fund to transfer only the longevity risk at a known cost that can be funded over a long time horizon.

Figure 4.2 Workings of a longevity swap



* ie. 'floating leg'
Simulated figures – not based on any actual pension plan

Source: Swiss Re

Typically, the 'floating leg' (i.e., the actual pension payments) and the 'fixed leg' (i.e., the annual premiums) are netted off, so that only a small payment is exchanged between the parties each year. Where pensions are linked to an inflation index (the norm in the United Kingdom), both the floating leg and the fixed leg of the swap are normally also indexed.

Despite the name 'swap,' longevity swaps can be written as insurance policies, with insurers, or in derivative form, with banking groups. To date, most transactions have been via the insurance route, rather than in derivative format. Where longevity swaps are written in derivative form, the risk written by the derivatives carrier has typically been simultaneously transferred to reinsurers. It is also normal for longevity derivatives to have some carve outs from the risk transfer to ensure it is not classified as insurance.

Longevity Swap Transactions

The first longevity swaps were written by defined benefit pension funds in 2009. The publicly announced transactions with defined benefit pension funds that have been concluded to date are summarised in Figure 4.3. Longevity risk capacity, thus far, has been provided by a limited number of reinsurers.

Figure 4.3 Publicly announced longevity swap transactions with defined benefit pension funds, demonstrating the value of liabilities transferred and the parties with whom the longevity risk has ended up.

Longevity risk cedent (date of transaction)	Value of liabilities transferred	Longevity risk transferred to	Ultimate longevity risk carrier
Royal & Sun Alliance (Jul 2009)	€2.2bn	Goldman Sachs/ Rothesay Life	Pacific Life Re
Babcock International (Jun/Sep/Dec 2009)	€1.4bn	Credit Suisse	Pacific Life Re/Royal Bank of Canada/RGA
Royal Country of Berkshire (Dec 2009)	€1.2bn		Swiss Re
BMW (Feb 2010)	€3.5bn	Deutsche Bank/ Abbey Life	Hannover Re/Pacific Life Re/ Partner Re
British Airways (Jul 2010)	€1.5bn	Goldman Sachs/ Rothesay Life	Pacific Life Re

4.3 Standardised Longevity Swaps

A standardised longevity swap is a derivative contract whose payoffs depend on how future mortality in a standard population develops. Importantly, the payoffs refer to a different population to that of the defined benefit pension fund members. The derivative must be carefully calibrated in order for the payoff to offset the impact of future changes in longevity. Some basis risk, however, will inevitably remain with the defined benefit pension fund. The basis risk is a consequence not only of the different populations, but also of other factors, including model risk (i.e., a model is used to generate the calibration), other demographic risks (e.g., proportions married risk, for any spouse dependant benefits, is not covered) and structural risks (e.g., if the maximum tenor of the swap was 20 years, then the effectiveness of the contract at long durations may be limited).

No defined benefit pension funds to date have publicly announced the use of standardised longevity swaps to mitigate their longevity risk, although a number are known to be exploring index structures. Index swaps may offer some potential advantages over indemnity longevity swaps. Advantages can include lower initial and ongoing data requirements, quicker execution and, in theory, greater liquidity. The main disadvantage, relative to indemnity longevity swaps, is that some basis risk remains with the defined benefit pension fund.

4.4 Collateral Considerations

As transactional activity in bulk annuities and longevity swaps has increased, there has also been an increasing awareness of counterparty credit risk. Under buy-in bulk annuity contracts, the defined benefit pension fund has immediate counterparty credit exposure resulting from the single upfront premium being exchanged for a promise to meet future pensioner liabilities. Under a longevity swap, immediate counterparty credit exposure is negligible because the contract is an exchange of risk. However, small levels of counterparty credit exposure will develop over time if future longevity improves beyond expectations. The defined benefit pension fund should consider the materiality of the counterparty credit exposure together with the strength of the counterparty. Counterparty strength should be assessed not only with regard to available credit ratings (which proved fallible in the economic crisis of 2008-09), but also with respect to the strength of the regulatory regime in which the counterparty operates and the strength of the underlying risk capital framework.

5. Future Risk Mitigation Solutions

There are limits to the systematic risk that can be carried on insurance balance sheets. The sheer volume of global longevity risk exposure, estimated at over €15 trillion of assets backing future pension and annuity guarantees, will require considerably greater capital resource than that of the current insurance industry. In this section we consider how capital markets can be brought to bear on longevity risk, and also the requirements of the capital markets for them to become more active participants in this risk class.

5.1 Capital Markets – Moving from Passive to Active Players

Capital markets are already exposed to longevity risk. This arises, in order of importance, as a consequence of their direct investment in governments, corporate sponsors of defined benefit pension funds and annuity insurers. Capital markets' longevity risk exposure is predominantly indirect, generally passive and, in most markets, lacking in transparency. This lack of transparency results from poor disclosure and inadequate understanding of the assumptions underpinning longevity obligations. Capital markets solutions would benefit from increased visibility and greater investor education of the underlying longevity risk. This should enable capital markets to become more active players in longevity risk.

As demand and momentum to mitigate longevity risk increases, insurance capacity may come under pressure. This can lead insurers to look to transfer some of the risk to the capital markets, allowing insurers to be able to continue to provide indemnity longevity products. The failure to meet the demand for longevity risk transfer with an efficient risk transfer mechanism will drive up the cost of private provision for retirement income.

The growth of new entrant pension buy-out insurers within the United Kingdom has demonstrated the potential appetite to acquire longevity exposure by dedicated capital market investors. Furthermore, within the world of insurance linked securities, there is now established appetite for mortality risk through mortality bonds (e.g., Vita, Osiris and Nathan). Arguably, similar structures could be applied to longevity risk. Thus, there is an opportunity to develop an active market in longevity risk if the conditions for such a market are met.

5.2 Developing an Active Market in Longevity Risk

There are a number of pre-requisites for a liquid longevity risk market to develop in the long term. These include:

- increased market transparency through published, standardised longevity indices;
- convergence of views on how to assess future mortality improvement trend risk;
- development of a standardised contract specification; and
- the existence of secondary market liquidity for investor exit.

In this section, we consider how these requirements can be met, and how different bodies can contribute to this end.

Longevity indices

A dedicated longevity capital market requires reliable longevity indices. Such indices would provide the accepted benchmark for measuring the development of longevity within populations. Although a number of indices have already been launched by individual institutions (including Credit Suisse's mortality index, Goldman Sach's Qx.X, JP Morgan's Lifemetrics and Deutsche Borse's XPect Index), none have generated significant liquidity to date, and the first two have been discontinued. Timely publication of frequent, granular data is a prerequisite for a successful index. Improved data at population level will increase the credibility of indices. Inevitably, governments would be called upon to provide timely, consistent and unbiased mortality data, upon which reliable longevity indices can be constructed.

Future mortality improvement trends

Defined benefit pension funds, insurers and prospective capital markets investors in all markets currently have substantially differing views on future mortality improvement trends. This divergence of views results in pricing of longevity risk mitigation instruments that is, or that is perceived to be, incommensurate with the underlying longevity risk. For example, current capital markets models of longevity risk tend to incorporate spreads which are considerably higher than the levels at which insurers are carrying solvency capital. As a result, there has been a general failure for longevity risk transactions to clear in capital markets. This can be tackled via improved and consistent recognition of longevity risk in regulation, along with raising investor awareness. The objective of these would be to improve risk modelling and achieve some convergence of views on how to assess future mortality improvement trend risk.

Liquidity

Finally, a key requirement for functioning capital markets is liquidity. Liquidity enables investors to have an exit strategy, and tends to follow on from transparent and uniform instruments. To date, this has proved a significant barrier, since longevity risk arises as heterogeneous exposure to blocks of pensioners / annuitants with a variety of benefits and optionality. This can be addressed with those longevity risk takers able to quantify and hold capital against basis risk, transferring risk to the capital markets in standardised form, with other longevity risk takers continuing to prefer indemnity solutions.

Longevity linked bonds

In addition to providing timely and reliable population mortality data and encouraging consistent, robust regulation, governments should also consider issuing longevity linked bonds[13]. This would be a new type of government bond, where the coupon payable is linked to population survivorship, and would be instrumental in helping longevity risk takers to manage their portfolios. A good analogy already exists with the creation of inflation linked securities based upon a government collated index. Such securities have proved indispensable to institutions' management of liabilities that are inflation linked.

The issuance of longevity linked government bonds could provide a liquid longevity instrument. This would enable organisations to manage systematic longevity trend risk, and effectively transfer the risk to the government and the pricing of the risk to the wider capital markets. This is, undoubtedly, going to be challenging in an environment whereby governments are already heavily exposed to longevity and struggling to service their debts. However, in principal, the issuance could increase the efficiency of the underlying longevity market, which may lead to a decrease in the frictional costs of private sector provision of lifetime annuities and ultimately facilitate the transfer of longevity risk to the private sector from the state.

Life and Longevity Marketing Association

The Life and Longevity Marketing Association (LLMA – see www.llma.org) is a new promoter in the longevity risk transfer sphere. This is a consortium of interested insurers, reinsurers and banks who will build the necessary infrastructure to support a longevity risk transfer market, divorced from a specific company. It is expected that the launch of longevity indices not tied to any one company may generate better liquidity in the market. The LLMA aims to develop market consistent standards, methodologies and benchmarks to help structure the marketplace. The LLMA is expected to produce, initially, International Swap and Derivatives Association (ISDA) pro forma trade documentation, such as mortality and survivorship forwards on population indices. Collateral requirements would also be standardised and derived directly from the underlying indices. The independence of the LLMA lends it an important advantage over previous institutions whose attempts to initiate trading in longevity indices failed.

5.3 Longevity Risk Buyers

One of the key challenges of longevity risk is that there do not appear to be, beyond insurers, any natural holders of the risk. There are few capital markets investors where profits are positively correlated to an increase in longevity (e.g., arguably, pharmaceuticals or care providers). Such investors would provide very little capacity. This should not, however, be seen as a barrier to the longevity risk transfer market developing. Longevity is not obviously correlated with other financial market risks, including credit and equity risk, and is not exposed to sudden shocks like some of the property and casualty catastrophe bonds. Therefore, it could provide diversification against other asset classes and, as such, may be an attractive asset to certain institutional investors (assuming the rate of return to the investor fairly compensates for the risk transferred).

A fundamental challenge to finding willing capital markets investors is the duration of longevity transactions, coupled with how long mortality trends take to appear and be detected. Capital markets instruments are traditionally short to medium term, whereas the longevity protection sought could have a profile in excess of 30 years. In order to get investors interested in this longer duration investment, an efficient secondary market would be required to provide the investor with the ability to mark the transaction and with a potential exit at a fair market price. Alternatively, the development of innovative short term financial instruments (e.g., 5 or 10 year dynamic hedging solutions), if accepted in the market, could also be attractive to capital market investors.

6. Parting Thoughts

Longevity risk is a massive structural challenge facing aging populations. Failure to develop efficient means of risk transfer may increase the likelihood of pensioner poverty and the role of governments in managing the risk. As demographic structures reweight to older lives, limited time is left to restructure and mitigate longevity risk. The costs will inevitably rise with increasing supply of longevity risk and no obvious source of demand for the risk outside those insurers with significant exposure to long-dated mortality risk for which longevity risk provides a natural hedge to existing mortality trend risk exposure. The development of solutions which transfer longevity risk to the capital markets could provide some additional risk mitigation capacity.

Longevity risk is a fundamental social issue. To mitigate it fully requires inter-generational allocation which only governments have the capacity to perform equitably. The underlying demographic risk is an opportunity for the insurance industry to provide a key social utility. The insurance industry should continue to provide innovative insurance and financial market solutions to allow individuals and employers that sponsor defined benefit pension funds to mitigate their own longevity risk exposure. At the same time, the insurance industry will benefit from the wider actions of governments, in helping to raise awareness of the issue and ensuring a robust and rigorous regulatory framework, and of the capital markets, which may facilitate insurers' own systematic risk management. However, this social utility must operate within the constraints of limitations to longevity risk capacity and the timescale over which that capacity may be used.

Endnotes

[1] Throughout this paper, longevity risk is used as shorthand for the financial risk borne by individual, employer, insurer and government stakeholders in relation to longevity. Longevity of itself is neither bad nor undesirable.

[2] Throughout this paper, longevity risk is used as shorthand for the financial risk borne by individual, employer, insurer and government stakeholders in relation to longevity. Longevity of itself is neither bad nor undesirable.

[3] Office for National Statistics, United Kingdom.

[4] Office for National Statistics, United Kingdom.

[5] Note that future mortality shock events (e.g., a cure for all cancers) are a subset of mortality trend risk.

[6] 'The quest for immortality: science at the frontiers of aging' S.Jay Olshansky & Bruce Carnes.

[7] 'Biodemography of human aging' J.Vaupel Nature 464 pp536-542.

[8] 'Broken limits to life expectancy'. J.Oeppen and J.Vaupel Science 296 pp.1029-1031.

[9] Journal of Insurance Medicine 2005, 37(1), 'Modeling Disease elimination', K.Somerville and P. Francombe.

[10] Bulk annuities are defined and discussed further in Section 4.1.

[11] In practice, such motivation in markets like the United Kingdom and the Netherlands has been achieved via strong incentives in the tax system.

[12] 'Buy-outs, Buy-ins and Longevity Hedging: Q4 2009 and 2009 Update', Hymans Robertson.

[13] 'Sharing Longevity risk: Why governments should issue longevity bonds', PI –1002, David Blake, Tom Boardman and Andrew Cairns (March 2010) (http://www.pensions-institute.org/papers.html).

7. Appendix: Definitions

Biometric Risk
Underwriting risks covering all those relating to human life conditions, including death, disability and longevity.

Buy-in
The purchase of a bulk annuity contract with an insurance company as an investment to match some or all of a pension scheme's liabilities, and therefore reduce risk. Crucially, the liabilities remain in the pension scheme and the trustees retain responsibility for them.

Buy-out
The process whereby a pension scheme's liabilities are transferred to an insurance company using a bulk annuity contract and the obligation for the pension scheme to provide those benefits is ceased. Usually this covers the full liabilities of the pension scheme as a full buy-out and is followed by the wind-up of the pension scheme.

Cohort Life Expectancy
The number of years of life remaining to an individual were they to experience, over the course of their remaining life, the current mortality rates for a given reference population plus some allowance for expected mortality improvements in the future.

Defined Benefit Pension Fund
An occupational pension fund which provides a guaranteed regular pension to retiring members in exchange for regular contributions from active members and the corporate sponsor. Pension amounts are generally linked to the period of employed service and the salary level of the retiring member. Pensions from a defined benefit pension fund are analogous to lifetime annuities offered by insurers. Defined benefit pension funds bear all of the longevity risk of their individual members.

Defined Contribution Pension Fund
An occupational pension fund which provides a savings and investment vehicle allowing active members to make regular contributions into an account. Typically, the corporate sponsor also makes a contribution into active member's accounts. At retirement, each member uses the accumulated assets in their account to purchase a lifetime annuity (or other investment permitted by local pensions and tax regulations). In defined contribution pension funds, all of the longevity risk remains with the individual members.

Enhanced Lifetime Annuity
A type of lifetime annuity that pays the annuitant a higher income than a standard lifetime annuity, as a result of a lifestyle or medical factor which shortens the life expectancy of the annuitant. Underwriting considerations may include, for example, smoking status, body-mass index and medical history.

Escalation Rate
The rate of increase applied to lifetime annuities while in payment. This may be expressed as a fixed nominal rate of increase (e.g., escalation at 3% pa) or may be a rate of increase linked to an index, typically an inflation index (e.g., escalation in line with the Retail Price Index). Indexed annuities may have increases restricted by annual floors and caps.

Impaired Lifetime Annuity
A type of lifetime annuity that pays out a higher income than an enhanced annuity, as a result of an ongoing medical condition which significantly shortens the life expectancy of the annuitant. Underwriting considerations may include, for example, a history of heart attacks, heart surgery or angina, life threatening cancers, organ diseases, strokes and diabetes.

Lifetime Annuity
An insurance product which pays out a guaranteed regular income to the annuitant for their remaining lifetime in exchange for a single premium. The income may be level, escalating or tied to an index. There are many variants on this product, including enhanced and impaired lifetime annuities, group lifetime annuities (which apply to a specified group of annuitants) and deferred lifetime annuities (whereby the commencement of the regular income payment is deferred for a specified period). The product is often sold with additional features, such as guaranteed payments on death and contingent dependant benefits (e.g., a spouse's annuity payable for the remaining lifetime of the surviving spouse from the death of the main annuitant).

Mortality Level Risk
The risk of misestimation of base mortality levels (i.e., prior to allowing for any future mortality improvements).

Mortality Trend Risk
The risk of misestimation of future trends in mortality, particular with respect to underestimating the rates of future mortality improvements.

Period Life Expectancy
The number of years of life remaining to an individual were they to experience, over the course of their remaining life, the current mortality rates for a given reference population (assumes future mortality rates are unchanged from current mortality rates). This is a commonly used measure of life expectancy, and contrasts with another measure called cohort life expectancy (see definition above).

Real Interest Rate Risk
The real interest rate in the context of longevity risk is the difference between the nominal yield on the assets backing the annuities and the escalation rate of the annuities. The real interest rate risk is the risk of overstating the yield on the assets backing the annuities relative to the escalation rate of the annuities.

Specific Risk
Risk which can be mitigated through diversification.

Standard Lifetime Annuity
In markets which offer enhanced or impaired lifetime annuities, a type of lifetime annuity which applies to standard lives (i.e., those lives which do not have a shortened life expectancy as a result of lifestyle or medical factors, or more serious medical conditions). Standard lifetime annuities are not underwritten.

Systematic Risk
Risk which cannot be mitigated through diversification.

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– Raising awareness and promoting stakeholder dialogue.

– Developing best practice solutions.

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