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Sharing Longevity Risk: Why Governments Should Issue Longevity Bonds

David Blake, Tom Boardman and Andrew Cairns

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The Pensions Institute
Cass Business School
City University
106 Bunhill Row London
EC1Y 8TZ
UNITED KINGDOM

http://www.pensions-institute.org/

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David Blake,
Pensions Institute
Cass Business School
106 Bunhill Row
London, EC1R 1XW
United Kingdom
(d.blake@city.ac.uk)

Tom Boardman,
Director of Retirement Strategy and Innovation, Prudential UK
and Visiting Professor, Pensions Institute
Prudential Assurance Company
3 Sheldon Square
London
W2 6PR
United Kingdom
(Tom.Boardman@prudential.co.uk)

Andrew Cairns,
Maxwell Institute and Department of Actuarial Mathematics and Statistics
School of Mathematical and Computer Sciences
Heriot-Watt University
Edinburgh, EH14 4AS
United Kingdom
(A.J.G.Cairns@ma.hw.ac.uk)

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Abstract

Government-issued longevity bonds would allow longevity risk to be shared efficiently and fairly between generations. In exchange for paying a longevity risk premium, the current generation of retirees can look to future generations to hedge their aggregate longevity risk. There are also wider social benefits. Longevity bonds will lead to a more secure pension savings market - both defined contribution and defined benefit - together with a more efficient annuity market resulting in less means-tested benefits and a higher tax take. The emerging capital market in longevity-linked instruments can get help to kick start market participation through the establishment of reliable longevity indices and key price points on the longevity risk term structure and can build on this term structure with liquid longevity derivatives.

Key words: Longevity risk, longevity bonds, public policy, political economy

JEL classifications: G22, G23, G24, G28, H11, H63, J11, J18

I. Introduction

Longevity Bonds pay declining coupons linked to the survivorship of a cohort of the population, say 65-year-old males; for example, the coupon payable at age 75 (i.e., 10 years after the issue date of the bond) will depend on the proportion of 65-year-old males who survive to age 75; they have no principal repayment. They are designed to hedge aggregate longevity risk.

Insurance companies and pension plan providers face the risk that retirees might on average live longer than expected. Longevity risk is a substantial risk that might adversely affect both the willingness and ability of financial institutions to supply retired households with financial products to manage wealth decumulation in retirement. In this paper, we explain how Governments issuing **Longevity Bonds** can act as a catalyst to facilitate the transfer of a proportion of this risk to the capital markets. We highlight the benefits that would flow from a transparent and liquid capital market in longevity risk, and we argue that there is an important role for Governments to play in helping this emerging market to grow. We also show how the Government might consider pricing **Longevity Bonds** in the face of potential demand from defined benefit and defined contribution plans and from annuity providers. Our line of reasoning comes from working in the UK, but we believe that what we argue here has validity for all countries with mature funded pension systems.

The UK pension fund industry is the second largest in the world by value, with assets of around 20% of those held in the USA. However, the UK lifetime annuity market is much larger than in the US – around 500,000 annuities are set up each year at a cost of £12bn, mainly as a result of the effective requirement to buy life annuities as part of DC (defined contribution) pension plan provision. Watson Wyatt predicts the UK at-retirement market for financial products such as annuities will grow by around 60% over the next 5 years.[1]

A well-functioning annuity market will become increasingly important as DC plans mature, not just in the UK, but in all countries where DC pension provision becomes the norm. The importance of DC pensions and, in turn, lifetime annuities is growing rapidly as Governments cut social security pensions and companies move away from DB (defined benefit) plans. DC plans *have to* work effectively if people are going to be prepared to save privately for their pensions. However, a growing weakness in DC plans is the inability of annuity providers to hedge the aggregate longevity risk they face. Aggregate longevity risk might affect the price and availability of annuities, as well as insurance company solvency. Every country with DC pension plans will sooner or later have to confront the problem of dealing with aggregate longevity risk

We therefore believe that the time is right for the UK and other Governments to set up a working party to undertake a cost-benefit analysis of the Government issuance of **Longevity Bonds.**

[1] Watson Wyatt Press Release July 2009

II. What is longevity risk?

Figure 1: Decomposition of longevity risk

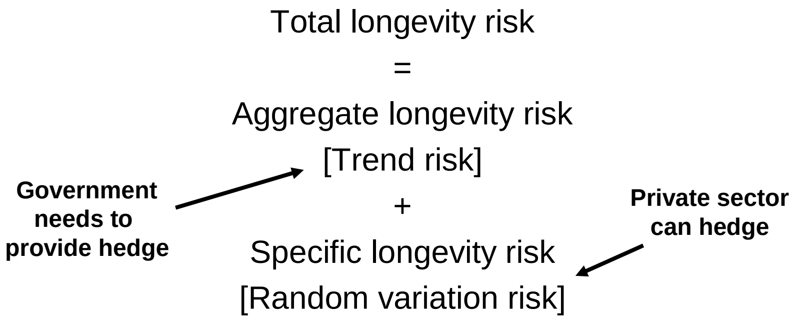

Figure 1 shows that longevity risk is driven by two underlying risks: random variation risk and trend risk. Random variation risk is the risk that individual mortality rates differ from the outcome expected as a result of chance – some people will die before their life expectancy, some will die after.[2] Trend risk is the risk that unanticipated changes in life-style behaviour or medical advances significantly improve longevity.[3]

Private-sector institutions can deal with a ‘specific risk’ like random variation risk by pooling and relying on the law of large numbers to reduce the variability of this risk. Trend risk, on the other hand, is, like inflation risk, an ‘aggregate risk’ that cannot be diversified away by pooling and, indeed, the more business an insurer pools, the bigger the relative impact of trend risk. The private sector is unable to hedge this risk effectively without a suitable hedging instrument. We will argue that there is a key

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[2] The mortality rate for a given age measures the frequency of occurrence of deaths of people of the given age in a defined population during a specified time interval, typically one year. Mortality rates are derived from crude death rates which are calculated as the ratio of deaths to the exposed population, i.e., the number of lives at the start of the period exposed to the risk of dying during a specified time interval, typically one year. A survivor (or survival) rate for a given age measures the proportion of people of the given age surviving a specified time interval. The survivor rate at age 65 equals (1 – mortality rate at age 65). Life expectancy measures the average number of years a person of a given age would live under a given set of mortality conditions. Life expectancy is usually computed on the basis of a life table showing the probability of dying at each age for a given population according to the age-specific death rates prevailing during a specified period. For example, life expectancy at 65 = 0.5 + (1-q65) + (1-q65)*(1-q66) + (1-q65)*(1-q66)*(1-q67) + ...+ (1-q65)* ... *(1-q120) and q120 is typically set to unity and q65 is the mortality rate at age 65 etc. We also need to distinguish between period life expectancy which makes no allowance for future improvements in mortality rates – and so assumes, for example, that q67 in the above formula will equal the mortality rate of today’s 67-year-olds – and cohort life expectancy which makes such an allowance – and hence will involve a lower q67 than used to calculate period life expectancy.

[3] Factors such as obesity and environmental degradation could eventually lead to a trend decline in life expectancy.

role for Governments to help the private sector by issuing **Longevity Bonds** – particularly by issuing bonds that provide 'tail risk' protection against trend risk – and by helping with the construction of national longevity indices.

III. Why should we be concerned about longevity risk and who bears it?

Longevity risk is borne by every institution making payments that depend on how long individuals are going to live. These include DB pension plan sponsors, insurance companies selling life annuities and Governments through the social security pension system and the final salary pension plans for public-sector employees. The situation is particularly acute for insurance companies operating in the European Union (EU) where a new regulatory regime, Solvency II, is due to be introduced in 2012.[4] The current Solvency II proposals, if adopted, will require insurers to hold significant additional capital to back their annuity liabilities if longevity risk cannot be hedged effectively or marked to market.

By any measure, longevity risk is a significant risk. Global pension private-sector liabilities are of the order of $25trn.[5] In the UK alone, private-sector DB pension liabilities exceed £1trn, DC pension assets amount to £450bn and insurance company annuity books exceed £125bn.[6] It has been estimated that every additional year of life expectancy at age 65 adds around 3 percent or £30bn to the present value of DB pension liabilities in the UK, with a similar impact on lifetime annuities.[7] The most recent estimates for UK state pension liabilities were £1,170bn in respect of social security pensions[8] and £770bn in respect of the unfunded pension plans of public-sector employees.[9] The most recent valuation of local authority pension liabilities came to £159bn.[10] This implies that UK government-backed longevity-linked liabilities exceed £2trn.

In addition to being extensive, longevity risk in the private sector is beginning to become concentrated, especially in the UK. Private-sector companies in the UK are moving rapidly away from DB pension provision. They are beginning to offload the legacy longevity risk that they still hold either by buying-in annuities from life companies to cover their pensions-in-payment or by undertaking bulk buy-outs of their liabilities, again with life companies.[11] In providing these indemnification solutions for DB pension plans, insurance companies are beginning to play a big role in aggregating longevity risk in the economy.

The DB plans in private-sector companies in the UK are being replaced with occupational DC plans – the equivalent of 401(k) plans in the USA – and, in so doing,

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[4] Solvency II is similar to the banks' regulatory regime Basel II, and its purpose is to align regulatory capital more closely with economic capital.
[5] OECD (2008).
[6] Pension Protection Fund and the Pensions Regulator (2008); Association of British Insurers.
[7] Pension Protection Fund and the Pensions Regulator (2006, Table 5.6).
[8] Office for National Statistics (2010): the figure is for 2003.
[9] Pre-Budget Report of the UK Government 2009; the figure is for March 2008.
[10] Local Government Pension Scheme actuarial valuation, 31 March 2007.
[11] Bulk-buyouts transfer the pension liabilities in corporate pension plans to insurance companies. This market began in earnest in the UK in 1999, when the Prudential Assurance Company did £1bn of business.

companies are passing the longevity risk back to their employees. So individuals should be concerned because there is a real risk that they will outlive their wealth – this is the specific risk identified in Figure 1 – if they do not hedge this risk by buying life annuities. In countries such as the UK, where it is effectively compulsory to annuitize DC pension pots by age 75 at the latest, it will again be life companies that provide these annuities.

So all the trends in pension provision – increasing demand from DB plans to use annuities to back their pensions in payment, the growing demand from DB plans for bulk buy-outs, the overall growth in both the number and size of DC pension funds and the associated growth in the number of pensioners with DC funds reaching retirement – are pointing to a big increase in demand for annuities provided by insurance companies.

There are two problems with this increased demand. First, there is the danger that this could result in an unhealthy concentration of risk amongst a small number of insurance companies. Second, there is insufficient capital in the insurance/reinsurance industry to deal with total global private-sector longevity risk. Under Solvency II, it is proposed that insurance liabilities are increased by the addition of a market value margin (MVM) reflecting the cost of capital to cover 'non-hedgeable' risks. For annuity companies this is principally longevity risk. It is currently proposed that in the absence of a hedging instrument for longevity risk, EU insurers will have to charge a 6% cost of capital above the risk-free rate when calculating the MVM. As a consequence of the long-dated nature of annuities, this calculation would result in the amount of capital held for longevity risk approximately doubling from current levels. The resultant extra capital would have to be passed on to customers and the money's worth of annuities could fall by up to 10%. A UK national newspaper has reported that one of the largest UK insurers, Legal & General, is considering the option of relocating its corporate headquarters outside of the EU ahead of the introduction of Solvency II.[12]

The only realistic way of handling these issues, at least for accrued pension liabilities, is to pass some of the risk onto Governments and the capital markets. The alternative is poorer value annuities, an annuity market prone to insolvency or, in the extreme, no private-sector annuity market at all. All Governments that have encouraged the growth of DC pension provision should be concerned about this. But, by issuing **Longevity Bonds,** Governments can help to overcome these problems.

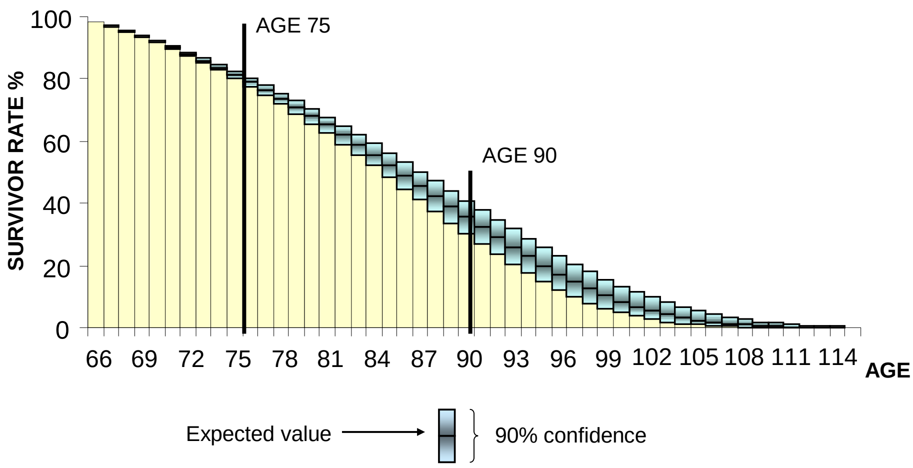
IV. How can Longevity Bonds hedge aggregate longevity risk?

In order to see how a **Longevity Bond** can hedge aggregate longevity risk, we need to both quantify longevity risk and identify where it is concentrated. Figure 2 presents a survivor fan chart[13] derived using the Cairns-Blake-Dowd (CBD) stochastic mortality model.[14] The fan chart shows the uncertainty surrounding projections of the number of survivors to each age from the cohort of males from the national population of England and Wales who are aged 65 at the end of 2006.[15] The bars indicate the 90%

[12] *Sunday Telegraph*, 20 December 2009.
[13] Blake et al. (2008).
[14] Cairns et al. (2006).
[15] The CBD model was estimated using data between 1991 and 2006.

confidence interval on the projected survivor rate for each age out to 115. The line in the middle of each bar indicates the expected proportion of the cohort to survive to each age. The Figure shows that there is little uncertainty out to age 75: we can be fairly confident that approximately 19% will have died by 75. The uncertainty peaks at age 93: the confidence interval band is widest at this age. The best estimate is that 36% will survive to age 90, but it could be anywhere between 30% and 41%. This is a very large range. The Figure also shows the extent of the so-called 'tail risk' after age 90: there is some probability – even if small – that some members of this cohort will live beyond 110.

Figure 2: Survivor fan chart - Males aged 65



Note: Derived from the Cairns-Blake-Dowd stochastic mortality model, estimated on English and Welsh male mortality data for 65-year olds over the period 1991-2006

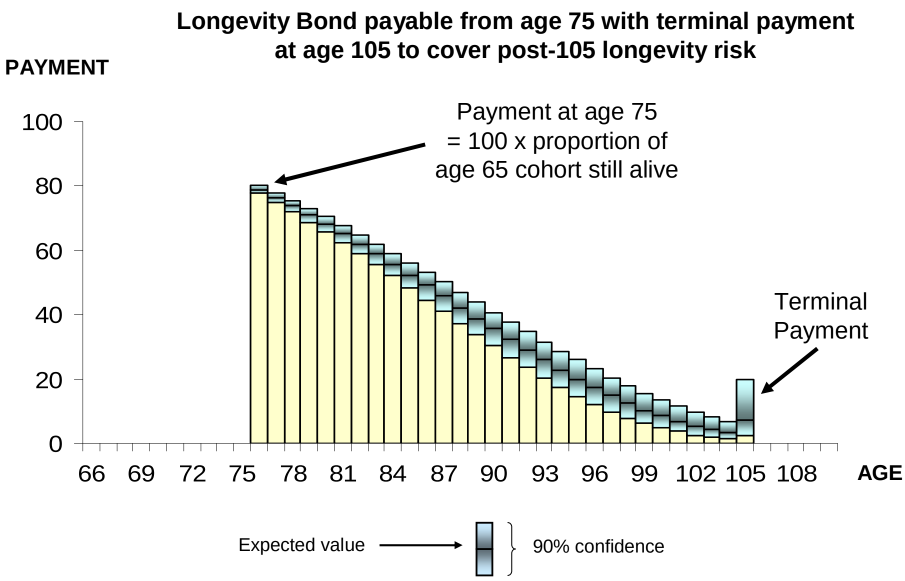
A survivor fan chart is very useful to a pension plan or annuity provider since it shows the likely range of pensioners or annuitants from a given birth cohort surviving to each age. If more survive to each age than was expected, the pension plan or annuity provider has to make higher total pension or annuity payments than was anticipated. The opposite holds if fewer survive to each age than was anticipated. The best estimate expectation of life is 20.5 years; the 5% confidence level expectation is 19.4 years and the 95% confidence level expectation is 21.8 years.

We will now show how a **Longevity Bond** with the following characteristics can help to hedge aggregate longevity risk:

- The bond pays coupons that decline over time in line with the actual mortality experience of a cohort of the population, say 65-year-old males from the national population: so the coupons payable at age 75, for example, will depend on the proportion of 65-year-old males who survive to age 75
- Coupon payments are not made for ages for which longevity risk is low: so, for example, the first coupon might not be paid until the cohort reaches age 75 (such a bond would be denoted as a **Deferred Longevity Bond**)
- The coupon payments continue until the maturity date of the bond which might, for example, be 40 years after the issue date when the cohort of males reaches age 105

- The final coupon incorporates a terminal payment equal to the discounted value of the sum of the post-105 survivor rates to account for those who survive beyond age 105. The terminal payment is calculated on the maturity date of the bond and will depend on the numbers of the cohort still alive at that time and projections of their remaining survivorship. It is intended to avoid the payment of trivial sums at very high ages
- The bond pays coupons only and has no principal repayment.

Figure 3: Deferred Longevity Bond for male aged 65 with 10-year deferment



Note: See note to Figure 2

Figure 3 shows the possible range of coupon payments on a **Deferred Longevity Bond** based on the national population of English and Welsh males who were aged 65 at the end of 2006. Such a bond would provide a hedge for the aggregate longevity risk faced by pension plans and annuity providers. If population survivorship is higher at each age than was expected, the bond pays out higher coupons. This is what pension plans and annuity providers need to help match the higher than expected pensions and annuity payments they need to make. If, on the other hand, survivorship is lower at each age than was expected, the bond pays out lower coupons. But the pension plans and annuity providers are not likely to mind this, since their pensions and annuity payments are also likely to be lower.

However, it is important to recognize that the bond will only provide a perfect hedge for the aggregate longevity risk faced by pension plans and annuity providers if the plan members and annuitants have exactly the same mortality experience over time as the cohort underlying the bond. If the plan members and annuitants have a mortality experience that differs from that of the national population, this will introduce basis risk.[16] In practice, there will always be some basis risk. One reason for this is that

[16] This is the risk that the 'underlying' – in this case, the survivor rates of the particular population being hedged – does not move in line with the hedging instrument – which, in this case, depends on the survivor rates of the national population.

pension plans and annuity books have far fewer members than the national population and will therefore experience greater random variation risk than the national population and this is likely to cause the mortality experience of a sub-population to diverge from that of the national population over time, even if they have the same mortality profile at the outset.

Another reason is that most pension plans and annuity books will not have the same mortality profile as the national population, even to begin with. There can be differences in age, gender and socio-economic composition. Different birth cohorts have different survivor rates to each age. While survivor rates to each age tend to increase over time, in line with the trend improvement in longevity, they do not do so uniformly: some birth cohorts experience faster improvements than others.[17] Females, on average, live longer than males. Professionals tend to live longer than white-collar workers who in turn tend to live longer than blue-collar and manual workers. But it is not simply the differences in life expectancies between these various groups that are important, it is unexpected changes in the trends in their survivorship experience that causes basis risk.

Yet another reason for basis risk involves the difference between ‘lives’ and ‘amounts’. A population longevity index[18] will weight each life equally, but members of the higher socio-economic groups will tend to have higher pensions and annuities than members of the lower socio-economic groups. They are also more likely to have multiple annuities. The directors of a small manufacturing company are likely to represent a large share of the company’s pension plan liabilities and are more likely to live longer than the average member. All these factors will increase basis risk and its complexity.

In theory, there could be a **Longevity Bond** for both males and females, for each age and for each socio-economic group. Such granularity of the **Longevity Bond** market would allow a high degree of hedge effectiveness to be achieved. But it would also result in negligible liquidity or pricing transparency: the more bonds there are, the less trading there will be in each bond and the less frequently the bonds will be priced. As is the case in other markets – especially derivatives markets – a small number of suitably designed bonds should provide an appropriate balance between hedge effectiveness, liquidity and pricing transparency.[19]

Not only are **Longevity Bonds** useful for hedging aggregate longevity risk once pensioners have retired, they could be used to hedge aggregate longevity risk and long-term investment risk in the period leading up to retirement. A typical DC plan will use a life-style (or life-cycle) investment strategy. This involves a high weighting in equities in the early stages of the accumulation process in order to benefit from the equity risk premium. There is then a systematic switch to less volatile assets, typically long-dated fixed-income bonds, during the final stages of the accumulation process – the so-called glide path to retirement – in order to reduce the volatility of the lifetime retirement income secured at retirement. While the fixed-income bonds hedge the

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[17] Willetts (2004), Richards et al. (2006).
[18] This is an index based on the mortality experience of the national population.
[19] See the discussion in section 8 of Blake et al. (2006).

interest-rate risk in the purchase of an annuity,[20] they do not hedge the longevity risk.[21]

Both interest-rate risk and longevity risk could be hedged along the glide path if plan members invested in a fund containing **Longevity Bonds**. This would give plan members greater certainty of income in the run up to retirement. This follows because the price of future lifetime annuities (at the member's retirement date) should be highly correlated with the value of this fund which will rise if longevity improves faster than expected or if long-term interest rates fall, and reduce if longevity expectations decline or interest rates rise. The fund might be a better way of providing income security from a DC pension plan at retirement than the alternative of purchasing deferred annuities, since the annuity provider might have to hold significant capital against the deferred annuities it sold (at least this is true in the UK), the cost of which would have to be passed onto the member.

V. Why should the Government issue Longevity Bonds?

In principle, **Longevity Bonds** could be issued by private-sector organizations. It has been argued that pharmaceutical companies would be natural issuers of **Longevity Bonds**, since their revenues are positively linked to survivorship: the longer people live, the more they will spend on medicines.[22] While this is true, the scale of the demand for **Longevity Bonds** far exceeds conceivable private-sector supply from companies such as pharmaceuticals. Further, there would be significant credit risk associated with the private-sector issuance of an instrument intended to hedge an aggregate risk many years into the future. In practice, the only realistic issuer of **Longevity Bonds** in scale is the Government.[23]

We believe that there are three important reasons why the Government should engage in sharing longevity risk with the private sector. It:

- has an interest in ensuring there is an efficient annuity market
- has an interest in ensuring there is an efficient capital market for longevity risk transfers
- is best placed to engage in intergenerational risk sharing, such as by providing tail risk protection against aggregate trend risk.

A. An efficient annuity market for pensioners

The Government has an interest in ensuring there is an efficient annuity market, given its desire to encourage retirement savings in DC pension plans that rely on annuities to turn pension savings into guaranteed lifetime retirement income. If the private

[20] Since annuity providers buy bonds to make the annuity payments, annuities are subject to interest-rate risk. If interest rates fall, bond prices rise and this will reduce the amount of the annuity that can be paid from a given lump sum.
[21] If longevity improves at a higher rate than that expected along the glide path, this too will reduce the amount of the annuity that can be paid from a given lump sum.
[22] Dowd (2003).
[23] The first suggestion for Governments to do this was made in Blake and Burrows (2001).

sector is unable to hedge aggregate longevity risk, it increases the likelihood that insurance companies stop selling annuities or increase annuity prices which would reduce pensioner income in retirement.

A consequence of the above is that Governments might find themselves having to pay additional means-tested benefits to supplement pensioners' incomes, as well as receiving lower income tax and expenditure taxes (such as Value Added Tax in the UK) from pensioners due to their lower incomes.[24] This will, *ceteris paribus*, lead to higher taxes on the working population. This outcome will therefore not be popular with workers or pensioners. Further, workers are likely to reduce savings into DC pension plans. Those that do continue to save in DC plans will face even greater uncertainty about their prospective pension income, since an efficient private-sector annuity market might no longer be in existence when they retire.

B. An efficient capital market for longevity risk transfers

The capital markets have a key role to help ensure there is an efficient annuity market and to reduce concentration risk. It can therefore also be argued that the Government has an interest in ensuring there is an efficient capital market for longevity risk transfers. There are two areas where Government support is required.

First, the Government can help with the construction of national longevity indices. It is for reasons of accuracy that longevity indices would most likely have to be based on national mortality data. A key component of the success of the new capital market will be the timely publication of accurate and independently calculated longevity indices. The longevity indices would cover mortality rates, survivor rates and life expectancies for both males and females.

Only the Government has access to the information necessary to produce these indices on account of the legal requirement to report deaths and related information such as dates of death and birth and gender to an official agency, which in the UK is the General Register Office of Births, Marriages and Deaths. Further, only the Government has access to the information needed to estimate the size of the exposed population. In the UK, this is currently derived from decadal censuses with annual updates between censuses based on reported deaths and estimated migration flows. However, the resulting estimates are not accurate enough at high ages. It is important to be able to track a cohort over time, particularly at high ages: the Government is in a unique position to do this, since it makes social security pension payments to almost every old person and needs to keep good records to do this. While longevity indices based on social class would be useful, the social class of a deceased person is not recorded at the time of death and while attempts have been made to construct social class indices, based on factors such as zip code or post code, these lack the accuracy of national indices. A similar argument would hold for longevity indices based on amounts rather than lives.

Second, the Government can make an important contribution by issuing **Longevity Bonds** to facilitate price discovery, thereby encouraging capital market development.

[24] Many of the people buying annuities in the UK are also on means-tested benefits. Any reduction in annuity payments arising from more onerous capital requirements resulting from insurers being unable to hedge longevity risk will *immediately* increase means-tested benefits.

Longevity risk is not currently actively traded in the capital markets, so we do not have a good estimate of its market price or premium.[25] But if the Government issued a small number of **Longevity Bonds**, this would help to establish and maintain the market-clearing ‘price points’ for longevity risk at key ages and future dates, and hence establish a market price for longevity risk. In other words, the bonds would help to establish the riskless term structure for survivor rates for ages above 65 for future years.[26] There is a clear analogy with the fixed-income and index-linked (TIPS in the US) bond markets. In these markets, the issue of Government bonds helped to establish the riskless term structures for interest rates and inflation rate expectations, respectively, for terms out to 50 years or more. The private sector was then able to issue corporate fixed-income and index-linked bonds with different credit risks (AAA, AA etc) and establish credit term structures above the riskless benchmark curves.

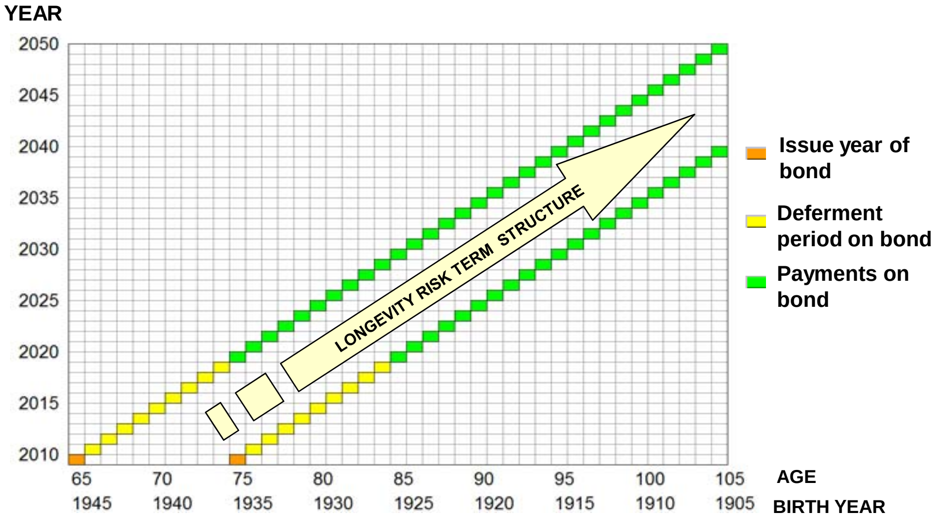
The longevity risk term structure is more complex than either the interest rate or inflation term structures, since it is two-dimensional – involving age as well as time – whereas the latter are one-dimensional, involving only time. The longevity risk term structure is therefore a two-dimensional surface, rather than a line: cohorts move diagonally across the surface over time, getting one year older with every passing year, with some members of the cohort dying each year. This is demonstrated in Figure 4 which shows the cash flows on two **Deferred Longevity Bonds**: one bond based on male lives from the national population aged 65 and one bond based on male lives from the national population aged 75. Each bond is specified by four dates: the birth year of the cohort being tracked (e.g., 1945), the issue date (e.g. 2010), the first payment date (e.g., 2020) and the last payment date (e.g., 2050).[27] There is a corresponding mortality term structure for females, so **Longevity Bonds** are also identified by gender (M or F).

[25] The longevity risk premium is paid by the **Longevity Bond**’s buyer to the bond’s issuer to remove aggregate longevity risk. It therefore results in a lower coupon that the bond’s issuer has to pay the bond’s buyer for purchasing the bond, thereby lowering the effective yield on the bond.

[26] Currently, the survivor rates for future years are based on model projections, such as the CDB model. Figure 2 illustrates this for males aged 65 at the end of 2006. The theoretically fair price of a **Longevity Bond** could therefore be determined using the CBD model. However, with a traded market in **Longevity Bonds**, a market view of future survival rates would replace model projections and the resulting price points would be used in determining the market price of the bonds. Pricing-to-market would replace pricing-to-model.

[27] If a strips market in **Longevity Bonds** develops – as happens with fixed-income and index-linked bonds – then hedgers could buy the subset of the coupon payments that most closely meets their hedging requirements, rather than having to buy the whole bond. In addition, if the individual coupons in Figure 4 are traded separately, this will allow more accurate determination of the price points for longevity risk along the diagonals of the longevity risk term structure.

Figure 4: Longevity Bond cash flows across ages and time



The establishment of a market price for longevity risk would be particularly useful for EU insurance companies operating under Solvency II. The maximum longevity risk premium that an annuity provider would be willing to pay to buy a **Longevity Bond** would be related to the level of capital that the Regulators agree can be released as a result of holding the **Longevity Bond** to back annuity liabilities.[28]

The establishment of price points will also help to facilitate the capital market development of longevity swaps[29] and other longevity derivatives similar to the interest-rate and inflation swaps that developed in the fixed-income and index-linked bond markets. Market participants were able to use market interest-rate and inflation expectations, rather than projections from models. The same would happen in the longevity swaps market. The longevity swaps market began to develop in the UK in 2007-09 with eight publicly announced swaps involving six annuity providers and two pension funds. A number of global investment banks and reinsurers intermediated the deals – J.P. Morgan, Deutsche Bank, RBS, Credit Suisse, Goldman Sachs and SwissRe – and the longevity risk was passed through to investors – such as insurance-linked securities (ILS) investors, hedge funds and endowments – attracted by a new

[28] It will also be related to the basis risk that remains unhedged and potentially the size of any illiquidity premium contained in the price of **Longevity Bonds**. If **Longevity Bonds** are not actively traded, investors will demand an illiquidity premium to hold them and the Regulator might be reluctant to accept that the bonds' prices can be used for mark-to-market pricing for capital release purposes.

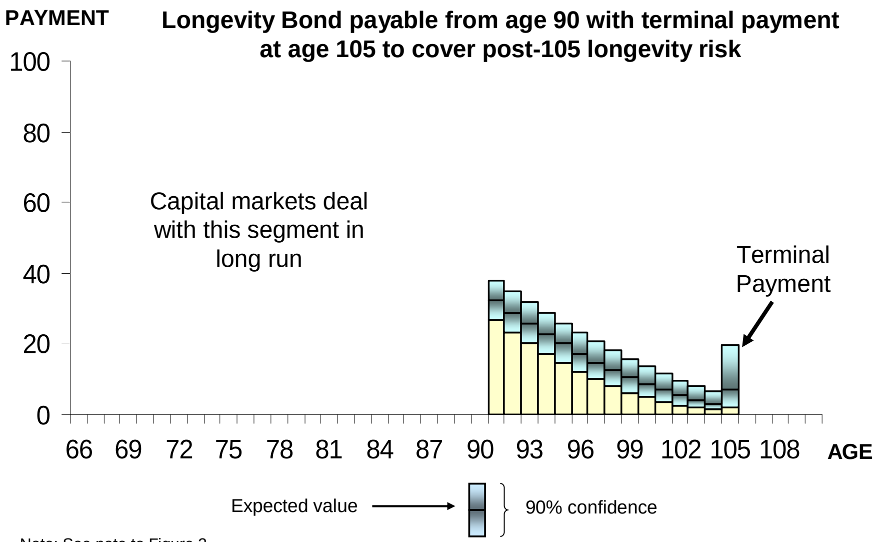
[29] A longevity swap exchanges fixed for floating survivor rates over the tenor of the swap. The fixed rate might be set equal to the expected rates in Figure 2 plus the longevity risk premium. The floating rates are the realized rates which could be above or below the fixed rate. Each year, the pension plan or annuity provider pays the fixed rate and receives the floating rate and thereby locks in the cost of the pension or annuity payments. The first suggestion for longevity swaps – or survivor swaps – was made in Dowd et al. (2006).

asset class that is uncorrelated with traditional asset classes, such as equities, bonds and real estate.[30]

C. Intergenerational risk sharing

The Government is one of the few agencies in society that can engage in intergenerational risk sharing on a large scale and enforce intergenerational contracts.[31] This is important, given that longevity risk is a risk that crosses a number of generations. This is how the intergenerational risk sharing operates. The Government would receive a longevity risk premium by issuing **Longevity Bonds**. In effect, the current retired population pays future generations an insurance premium to hedge its aggregate longevity risk. If, in equilibrium, the risk premium is sufficient to ensure that the generation bearing the risk is adequately compensated, then each generation is treated fairly.

Figure 5: Deferred Tail Longevity Bond for male aged 65



Note: See note to Figure 2

A key role for Government in this context is to provide a hedge for aggregate longevity risk by providing tail risk protection against trend risk. Once the market for **Longevity Bonds** has matured, in the sense of producing stable and reliable price points in the age range 65-90, the capital markets can take over responsibility for providing the necessary hedging capacity in this age range using longevity securities and derivatives. All that might then be needed would be for the Government to provide a continuous supply of **Deferred Tail Longevity Bonds** with payments starting from age 90 in order to allow pension plans and insurers to hedge their tail

[30] It has been reported that there has been ‘a sudden wall of demand’ for longevity swaps in the second half of 2009 from UK pension plans in the UK according to *Pensions Week* (23 November 2009) with quotes for around £60bn worth of swaps during the previous 6-8 months.
[31] In the private sector, long-term contracts can involve significant credit risk as mentioned above and collateralization can introduce significant frictional costs

risk.[32] Figure 5 illustrates the cash flows on such a bond. These bonds will be necessary on a permanent basis, since the capital that annuity providers would be required by the Regulator to post in order to cover this risk would be very high in the absence of a close matching asset. The bonds are also necessary because the investors who have recently become interested in taking the other side of the longevity swaps market have no appetite for hedging long-duration tail longevity risk.

D. Dealing with a counter-argument

While we feel we have put forward a number of strong arguments supporting the case for Government issuance of **Longevity Bonds**, we do need to acknowledge and refute an important counter-argument. Concerns have been raised that Governments are not natural issuers of **Longevity Bonds** because of their large existing exposure – in excess of £2trn in the case of the UK Government – to longevity risk.

We would argue that the Government's exposure to unanticipated longevity improvements through the issuance of **Longevity Bonds** is – or at least could be – well hedged. First, the Government receives a longevity risk premium from issuing the bonds. Second, in the event that the risk premium proves to be insufficient, the Government can reduce its State pension spend and increase its pre-retirement tax take by raising the State pension age. The next generation might have to work longer, but will, in any case, be a fitter generation and so be able to earn more income which, in turn, will produce more tax. Third, since the issuance of **Longevity Bonds** should result in a more efficient annuity market and hence higher incomes in retirement, this should also result in an increase in the tax take and help to reduce the amount of means-tested benefits. The higher tax take and lower means-tested benefits arising from a more efficient annuity market post-Solvency II applies to the lifetimes of all pensioners buying an annuity, whereas the tail risk protection provided by **Deferred Tail Longevity Bonds** applies only to those surviving over 90, some 25 years in the future.

Overall, once the Government is only issuing **Deferred Tail Longevity Bonds**, the risk will be very manageable and consistent with the Government's role of facilitating intergenerational risk sharing. We believe that there could be a significant cost-benefit to the Government from the issuance of **Longevity Bonds** and therefore a strong, indeed overwhelming, case for the Government to issue **Longevity Bonds.**

VI. What is the potential demand for Longevity Bonds?

The demand for **Longevity Bonds** is driven principally by the growth of DC pensions and the growing maturity of DB plans. The market in DB longevity risk management is new and there is a significant programme currently being implemented in the UK by investment banks and actuarial consultants to educate DB pension plan trustees and annuity providers about the benefits of longevity risk hedging. Although the investment banks have an incentive to talk up the market, the demand is genuine. We believe that the potential demand for **Longevity Bonds** is substantial.

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[32] Pension plans and annuity providers might still be willing to invest in Government-issued **Longevity Bonds** covering the age range 65-90 if they are competitively priced compared with capital market hedges.

In the UK alone: of the £1trn in DB private-sector pension liabilities, around £500bn relate to pensions in payment; of the £450bn in accumulated DC pension assets, £150bn relate to people over age 55; and insurance companies are committed to making annuity payments valued in excess of £125bn over the lifetime of the payments.

We believe that a suitable initial issuance of **Longevity Bonds** (with 10-year deferment) by the UK Government could be four bonds: LBM(65,75), LBF(65,75), LBM(75,85) and LBF(75,85).[33] The size of each bond issue will depend, in part, on price and this will be considered in the next section. However, the total issuance is likely to be small in relation to the overall size of the Government bond market and is unlikely to become a principal funding source for Government.[34] Nevertheless, the issuance will have significant value, since it will improve the efficiency of the annuity market as well as providing a useful risk management tool for DB plans.

VII. Pricing considerations

Ultimately, the demand for **Longevity Bonds** will depend on their price. Demand will be higher the closer the Government offers the bonds at true economic cost, i.e., charges a fair, but not excessive, longevity risk premium. It is right that the Government seeks to charge a fair risk premium on **Longevity Bonds** because this ensures intergenerational fairness. The expected cost of the longevity risk should be borne by those whose retirement incomes will be derived from the bonds.

Some might argue that the Government should seek to charge a risk premium in excess of the economic cost. For example, if, in a Solvency II world, insurance companies writing annuity business end up having to hold capital in excess of true economic levels, because they are unable to hedge longevity risk, then they might be prepared to pay a premium price for **Longevity Bonds** if, by doing so, they can reduce their capital requirements. This would obviously depend on the Solvency II treatment of **Longevity Bonds** and the capital reduction that the Regulators would allow. However, it would be short sighted of the Government to seek to exploit this situation. If insurance companies can reduce their capital requirements to closer to economic capital levels, then this should result in higher annuity values with the consequent benefits to Government, pensioners and savers already highlighted.

We also believe that it is most unlikely that the desired market for **Longevity Bonds** will develop if the Government just focuses on insurers. The bonds will need to be priced to attract DB pension plans which do not currently face solvency capital requirements. DB plans which do not have a pressing need for a full buy-out using annuities (which will be subject to Solvency II capital via insurers) and which want to engage in risk management will only buy **Longevity Bonds** if they believe they are priced fairly (and cheaper than longevity swaps and other derivative longevity hedges provided by the private sector). So, if we want to ensure DB pension plans buy **Longevity Bonds** issued by the Government, the Government should not price them

[33] LBM(65,75) is a **Longevity Bond** for males aged 65, with the first coupon paid at age 75, etc.
[34] Total UK Government bond issuance will exceed £700bn over the next 5 years as a consequence of the fallout from the 2007-08 Global Banking Crisis.

above AAA. Members in DC pension plans life-styling in the run up to their retirement will have a choice between using long-dated bonds and **Longevity Bonds** and again many will be discouraged from using **Longevity Bonds** if the Government looks to charge a mark-up beyond the fair price. Other investors, including investment banks, will also be discouraged from buying **Longevity Bonds** if they believe the longevity risk premium is excessive, because they will fear that the bonds will eventually fall in value to reflect their true economic cost.

So for the market in **Longevity Bonds** to take off, we believe they should be priced according to economic capital principles. The analysis below is intended to initiate the process of defining what is the fair economic price. Our intention is not to determine that price; rather it is to indicate one possible approach and the issues that need to be resolved for determining what the fair price might be. The approach we have adopted builds on the insurance industry 'cost-of-capital method'.[35] This determines a risk margin for capital above the best estimate of the value of the liabilities. The best estimate of the value of the liabilities in our model is derived from the median scenario and, at any point in time, is the present value of the expected future coupons on the bond from the median scenario discounted at the risk-free rate. The cost-of-capital method involves four stages:

- determine the required credit rating for the bond
- project the longevity risk capital required for each year in the life of the bond to maintain the required credit rating
- multiply each annual capital requirement by a percentage cost of capital to give the cost of capital in money terms
- calculate the present value of each of these cost-of-capital amounts using a risk-free discount rate and sum to give the present value of the overall capital requirement.

The starting point for quantifying the minimum risk premium that the Government should charge to ensure intergenerational fairness is to consider the notional level of capital it would need to hold to achieve at least a AAA rating. It is important to realize that the Government will not actually hold this capital – unlike an insurer – but simply uses the notional required capital amount to calculate the cost of capital for each year of the bond's life. To calculate this notional capital, we ideally need to use stochastic mortality and interest rate modelling to determine the amount of notional capital that would apply throughout the duration of the bond to ensure the bond's payments would be made with a continuing AAA level of confidence.

Our first task is to derive the survival probability on AAA bonds. We assume a yearly survival probability of 0.9995 in the analysis below to reflect the high standard of security that would be associated with Government-issued **Longevity Bonds**. This is marginally higher than the annualized 20-year survival rates on AAA bonds of 0.9991 between 1970 and 2008 and 0.9994 between 1920 and 2008.[36]

[35] Chief Risk Officer Forum (2008).
[36] The desired survival probability could be higher if required.

Table 1: Distribution of life expectancies and Longevity Bond present values								
Quantile	**e65**	**PV(65,65)**	**PV(65,75)**	**PV(65,90)**	**e75**	**PV(75,75)**	**PV(75,85)**	**PV(75,90)**
0.005	18.77	94.68	88.02	60.36	10.96	93.28	79.06	66.04
0.01	18.93	95.22	89.14	63.55	11.07	93.94	81.34	69.40
0.025	19.17	95.97	90.81	68.42	11.20	94.81	83.82	73.22
0.05	19.37	96.57	92.19	72.44	11.34	95.67	86.48	77.63
0.5	20.51	100.00	100.00	100.00	12.03	100.00	100.00	100.00
0.95	21.82	103.65	108.39	134.43	12.79	104.57	114.76	126.10
0.975	22.07	104.34	109.98	141.43	12.94	105.37	117.62	131.67
0.99	22.38	105.12	111.73	150.07	13.14	106.57	121.17	138.73
0.995	22.57	105.63	113.03	155.36	13.28	107.31	123.87	143.24
Mean	20.53	100.03	100.09	101.25	12.04	100.05	100.19	100.65
Median annuity factor		12.619	5.222	0.675		8.420	2.106	0.815
Base coupon (£)		7.925	19.149	148.133		11.876	47.493	122.730

Notes: Derived from the CBD model estimated on English and Welsh male data for age 65 over the period 1991-2006. e65 and e75 = life expectancy at ages 65 and 75. PV(65,65) = present value of a bond with base coupon of £7.925 for a male aged 65, payable from age 65. PV(65,75) = present value of a bond with base coupon of £19.15 for a male aged 65, payable from age 75. PV(65,90) = present value of a bond with base coupon of £148.13 for a male aged 65, payable from age 90. The discount rate is assumed to be a risk free 4%. The median annuity factor is the present value of a base coupon of one unit payable yearly in arrears multiplied by the proportion of the cohort still alive at the end of each year, for the life of the annuitant from a given age. The base coupon is derived by dividing the median price of the bond (set as 100) by the median annuity factor. The actual coupon in each year a coupon is due is equal to the (rescaled) base coupon multiplied by the percentage of the population surviving between the bond's issue date and the coupon payment date.

We then used the CBD model to project 10,000 longevity scenarios for English and Welsh males aged 65 at the end of 2006 (as shown in Figures 2, 3 and 5) and these were, in turn, used to calculate 10,000 present values of the coupon payments on a range of different types of **Longevity Bond**. Table 1 shows the distribution of life expectancies for males aged 65 and 75 at the end of 2006, according to the CBD model and quantiles of the distributions of **Longevity Bond** present values, payable immediately (PV(65,65) and PV(75,75)), payable from age 75 (PV(65,75)), payable from age 85 (PV(75,85)) and payable from age 90 (PV(65,90) and PV(75,90)), respectively. For convenience, the median present value for each bond has been rescaled to £100 by adjusting the base coupon. A fixed risk-free discount rate of 4% is assumed throughout.[37] Further, no allowance is made for expenses and other operational risks, since we are looking to quantify the pure price of the risk premium for longevity.

We now need to determine the relevant quantiles of the distribution of present values to achieve a AAA rating. We do this at the undiscounted mean term of the expected

[37] A more sophisticated approach would stochastically model the risk-free term structure.

payments.[38] Table 2 shows the mean term on the issue date for a range of different bonds. The corresponding AAA quantiles are shown in the last column. These are found by raising the survival probability of 0.9995 to the power of the mean term.

Table 2: Mean term of Longevity Bonds and corresponding AAA quantiles on issue date of bonds

Longevity Bond	Mean Term	AAA quantile
LBM(65,65)	13.21	0.99341
LBM(65,75)	19.73	0.99018
LBM(65,90)	30.51	0.98486
LBM(75,75)	8.72	0.99565
LBM(75,85)	16.00	0.99203
LBM(75,90)	19.87	0.99011

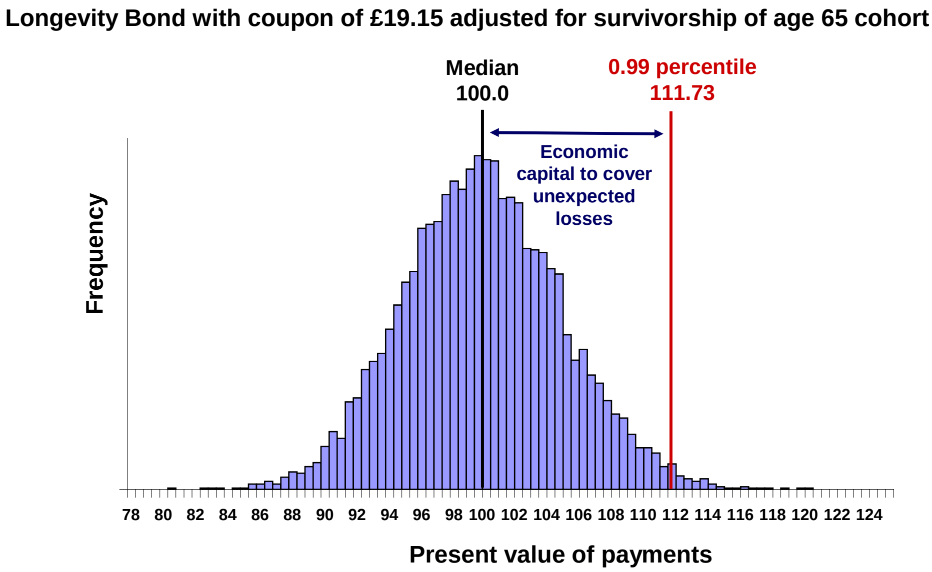
Notes: The mean term is found by summing the expected coupons on a bond weighted by the number of years ahead each coupon occurs and then dividing by the sum of the expected coupons. The corresponding AAA quantile is found by raising the survival probability of 0.9995 to the power of the mean term. For the LBM(65,65) bond, the mean term is 13.21 years and the corresponding AAA quantile is $0.9995^{13.21} = 0.99341$.

Using the information in Tables 1 and 2, we can determine the initial notional capital that is required for a AAA rating and then use this to calculate the cost of capital for each year of the bond's life.

Take, for example, the LBM(65,75) bond (i.e., one based on males age 65 with payments starting at age 75). On the issue date, the mean term is 19.73 years and therefore the AAA capital requirement can be derived from the 0.99018 quantile (see Table 2), giving an initial capital requirement of 11.73% (see Table 1 – the 0.99 quantile is £111.73, while the median is £100). Figure 6 shows graphically the level of economic capital required for the first year.

[38] An alternative would have been to use the discounted mean term or duration of the bond. This, however, has the effect that it changes when the discount rate changes. This is inappropriate because the potential dispersion of projected cash flows, and hence the risk against which capital is being held, does not depend on interest rates. We did, however, examine the effect of using the discounted mean term with a fixed discount rate of 4% and it made very little difference to the final estimate of the longevity risk premium.

Figure 6: Distribution of 10,000 scenarios of the present values of 10-year Deferred Longevity Bond payments for males aged 65



Note: See note to Figure 2

For subsequent years, we continue to use the best estimate of the bond's coupons from the median scenario. However, we need to re-run the CBD model to produce new sets of 10,000 scenarios for each year in the future. In doing this, we assume that mortality rates follow the best estimate path from the median scenario up to the year (and associated age) that we are modelling and then we produce a new stochastic distribution of outcomes using drift and volatility parameters consistent with the CBD model used in the first year.

Although this results in a narrowing funnel of doubt as each year passes,[39] the mean term of the expected cash payments also reduces and this requires higher quantiles of the distribution to be used each year to maintain the desired AAA credit rating for the bond.[40] The net outcome of these opposing effects results in a lower capital mark-up percentage over time. Table 3 shows a subset of the mean terms, the resultant AAA quantiles and the capital mark-up percentages for LBM(65,75) and LBM(75,85) that can be applied to the series of best estimate liabilities derived from the median scenario.

It is therefore possible using the CBD model to calculate the notional required AAA capital holdings for longevity risk for each year for any bond. We now need to multiply each one of these by the cost of capital and a risk-free discount factor and sum this series to produce the required risk premium which can be expressed as a percentage of the expected bond price of 100. We can then convert this to an effective basis points reduction from the risk-free rate.

[39] As the age 65 and 75 cohorts grow older, the range of possible outcomes narrows.
[40] This follows because 0.9995 raised to the power of a lower mean term produces a higher quantile than 0.9995 raised to the power of a higher mean term as Table 2 shows.

Table 3: Mean term, AAA quantiles and resultant AAA capital as a percentage of best estimate liabilities						
	LBM(65,75)			**LBM(75,85)**		
Age	**Mean term**	**Quantile**	**Capital %**	**Mean term**	**Quantile**	**Capital %**
65	19.73	0.99018	11.73%			
70	14.73	0.99266	11.31%			
75	9.73	0.99515	11.01%	16.00	0.99203	21.81%
80	8.16	0.99593	10.34%	14.73	0.99266	20.70%
85	6.76	0.99663	10.05%	9.73	0.99515	19.89%
90	5.51	0.99725	9.66%	8.16	0.99593	18.31%
95	4.44	0.99778	9.04%	6.76	0.99663	17.05%
100	3.54	0.99823	8.52%	5.51	0.99725	15.82%
105	2.82	0.99859	8.07%	4.44	0.99778	13.98%
110	2.27	0.99887	7.57%	3.54	0.99823	12.90%

A critical factor in the process is to determine the appropriate cost of capital. This has been the subject of much debate in the run up to Solvency II where the annuity companies are currently expected to use a 6% risk premium when calculating their MVM. In the industry's view, this is intended to cover a number of risk factors associated with annuity provision, the most significant being non-hedgeable longevity risk.[41] The industry has therefore recommended a cost of capital in the range 2.5%-4.5% p.a., based on the cost of non-hedgeable risks and a capital level calibrated to a 0.995 survival probability over one year.[42] This approximately translates into a cost of capital in the range 1.67%-3% p.a., based on a 0.9995 annual survival probability.[43]

The upper end of this range is substantially higher than a Government would charge. This is because the longevity risk faced by Governments is lower than that faced by insurers because they have the benefit of having a more reliable estimate of current longevity exposures. They therefore have a more accurate starting point for modelling longevity improvement risk. They also face less random variability in trend improvements in longevity as Government-issued **Longevity Bonds** will be based on national population data. By contrast, the population relevant for insurers is a small and much more volatile subset of the national population. A case could therefore potentially be made for Government to use a cost of capital of around 2%.[44] [45]

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[41] Chief Risk Officer Forum (*op. cit.*), p. 16-18.
[42] Chief Risk Officer Forum (*op. cit.*), p. 8.
[43] Chief Risk Officer Forum (*op. cit*), Fig.1, p. 30.
[44] This would include an allowance for model risk, e.g., in the model used to project future mortality rates.
[45] An alternative approach to the cost-of-capital method used in this paper is the 'percentile method' which determines the level of capital needed to ensure that all payments can be met for a set percentage of all the scenarios. In the context of Solvency II, a probability of 75% has been suggested. By using the initial 10,000 present value scenarios from the CBM model, a 0.75 percentile risk premium can be determined and, in turn, an implied cost of capital can be calculated. In this case, the percentile method implies costs of capital of 2.11% for LBM(65,75), 1.75% for LBM(65,90) 2.77% for LBM(75,85) and 2.45% for LBM(75,90).

Table 4 shows the total risk premium for a number of **Longevity Bonds** for illustrative costs of capital of 2% and 3%. It also shows the corresponding basis points reductions from the risk-free rate. Take LBM(65,75) and a 2% cost of capital, for example. This bond has a total risk premium of 3.2%. This means that the issue price of the bond would be £103.20. The effective yield on the bond is equal to the risk-free rate less the basis points reduction, so the effective yield on LBM(65,75) is 3.821%.[46]

Table 4: Risk premiums and basis points reduction in yield on Longevity Bonds

Bond	2% cost of capital		3% cost of capital	
	Risk premium	Bps reduction	Risk premium	Bps reduction
LBM(65,65)	1.4%	13.4 bps	2.0%	20.0 bps
LBM(65,75)	3.2%	17.9 bps	4.7%	26.5 bps
LBM(65,90)	15.1%	48.7 bps	22.6%	70.8 bps
LBM(75,75)	1.2%	16.5 bps	1.8%	24.7 bps
LBM(75,85)	4.1%	27.6 bps	6.2%	40.8 bps
LBM(75,90)	8.2%	42.6 bps	12.4%	62.2 bps

Notes: The risk premium is the total for each bond. The basis points reduction shows the annual reduction from the assumed risk-free yield of 4%.

VIII. Who benefits from Government issuing Longevity Bonds?

Who benefits from Governments assisting in encouraging the optimal sharing of longevity risk? The simple answer is everyone. Everyone should benefit from having a market price for longevity risk and the ability to hedge aggregate longevity risk. But there are also more specific benefits.

The Government:

- Gains by having both a more secure DC pension savings market and a more efficient annuity market, resulting in less means-tested benefits and a higher tax take
- Should gain access to a new source of long-term funding which, by widening the investor base, lowers the cost of Government issuance
- Is able to issue bonds with a deferred payment structure to help its current funding programme and improve its cash flow
- Earns a market-determined longevity risk premium thereby further reducing the expected cost of the long-term national debt.

For DB pension plans:

- Have the opportunity to reduce longevity risks
- Can hedge longevity risk exposure prior to buy out.

[46] By using a discount rate of 3.821%, the present value of the coupon payments on the LBM(65,75) bond equals £103.20.

Insurers:

- Can potentially establish a mark-to-market longevity risk term structure and hence hold the optimal level of economic capital or at least hold capital closer to the economic level
- **Longevity Bonds** will help insurers to play an aggregating role in providing pension plans and individuals with longevity insurance, whilst being able to pass on a proportion of their risk to the capital market; this would reduce their longevity concentration risk and facilitate the spread of longevity risk around the capital markets.

The capital markets:

- Get help to kick start market participation through the establishment of reliable longevity indices and key price points on the longevity risk term structure
- Can build on this longevity risk term structure with liquid longevity derivatives.

Investors:

- Get access to a new (longevity-linked) asset class whose returns are uncorrelated with traditional asset classes, such as bonds, equities and real estate.

Regulators:

- A longevity risk term structure should help the insurers' Regulator (the Financial Services Authority in the UK) validate insurers' economic capital, thereby making regulation more robust
- A longevity risk term structure should help the pension plans' Regulator (the Pensions Regulator in the UK) to calculate any risk-based levy to a pension insurance plan[47]
- **Longevity Bonds** should help an orderly transfer of longevity risk from DB plans to the capital markets, thereby reducing reliance on an uncertain sponsor covenant and reducing concentration risk amongst insurers, and, in turn, giving comfort to the pension plans' Regulator.

Pension plan members:

- DB pension plan members potentially get better security
- DC pension plan members get better valued annuities which produce a higher lifetime income when they retire
- Further, individuals with DC pension plans would have a means of hedging the longevity risk associated with purchasing an annuity at retirement.

[47] The Pensions Regulator in the UK is responsible for the regulation of occupational DB and DC schemes and attempts to limit the number of DB schemes needing support from the Pension Protection Fund (which was based on the US Pension Benefit Guaranty Corporation).

IX. Growing support for Government issuance of Longevity Bonds

Support for Governments to issue **Longevity Bonds** is growing steadily, not only in the UK, where the situation is most immediate, but also internationally.

The UK Pensions Commission suggested the Government should consider the use of **Longevity Bonds** to absorb tail risk for those over 90 or 95, provided it exits from other forms of longevity risk pre-retirement which it has done by linking State pension age to increases in life expectancy and by raising the future State pension age to 68 by 2046. "One possible limited role for Government may, however, be worth consideration: the absorption of the 'extreme tail' of longevity risk post-retirement, i.e., uncertainty about the mortality experience of the minority of people who live to very old ages, say, beyond 90 or beyond 95."[48]

The UK Confederation of British Industry (CBI), which represents British employers, has argued: "Government should drive development of a market in longevity bonds, a similar instrument to annuities, by which the payments on the bonds depend on the proportion of a reference population that is still surviving at the date of payment of each coupon. This should be done through limited seed capital and supporting policy work on the topic. Government could also consider how best to match government bond issues to pension scheme needs, including the provision of more long-dated bonds and whether government should issue mortality bonds itself."[49]

The IMF states: "With regard to longevity risk, which most insurers and pension fund managers describe as unhedgeable, some authorities have considered assuming a limited (but important) portion of longevity exposure, such as extreme longevity risk (e.g., persons over age 90). In this way, by assuming the tail risk, governments may also increase the capacity of the pension and insurance industries to supply annuity protection to sponsor companies, pension beneficiaries and households, and facilitate the broader development of longevity risk markets."[50]

According to the OECD: "Governments could improve the market for annuities by issuing longevity indexed bonds and by producing a longevity index**."**[51]

Finally, the World Economic Forum has argued: "Given the ongoing shift towards defined contribution pension arrangements, there will be a growing need for annuities to enhance the security of retirement income. Longevity-Indexed Bonds and markets for hedging longevity risk would therefore play a critical role in ensuring an adequate provision of annuities."[52]

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[48] Pension Commission (2005, p. 229).
[49] *Redressing the Balance - Boosting the Economy and Protecting Pensions,* CBI Brief, May 2009.
[50] International Monetary Fund (2006).
[51] Antolin and Blommestein (2007).
[52] World Economic Forum (2009).

X. Next Step

The next step in this process is for Governments in countries with significant longevity risk exposure to set up a Working Party to undertake a cost-benefit analysis of the Government issuance of **Longevity Bonds**. The terms of reference of this working party should cover the benefits that would accrue, the scale of the longevity risk that Governments would be assuming, and the actions Governments can take to mitigate this risk. The working party should also work through the practicalities of issuing **Longevity Bonds**, including the construction of reference longevity indices, potential demand, pricing, liquidity and tax.[53]

References

Antolin, Pablo, and Hans Blommestein (2007), *Governments and the Market for Longevity-Indexed Bond*s, OECD Working Papers on Insurance and Private Pensions, No. 4, OECD Publishing, Paris.

Blake, David, and William Burrows (2001), "Survivor Bonds: Helping to Hedge Mortality Risk", *Journal of Risk and Insurance*, 68: 339-348.

Blake, David, Andrew J.G. Cairns and Kevin Dowd (2006), "Living with Mortality: Longevity Bonds and other Mortality-Linked Securities", *British Actuarial Journal*, 12: 153-228.

Blake, David, Andrew Cairns and Kevin Dowd (2008), "Longevity Risk and the Grim Reaper's Toxic Tail: The Survivor Fan Charts", *Insurance: Mathematics & Economics*, 42: 1062-66.

Cairns, Andrew, David Blake and Kevin Dowd (2006), "A Two-Factor Model for Stochastic Mortality with Parameter Uncertainty: Theory and Calibration", *Journal of Risk and Insurance*, 73: 687-718.

Chief Risk Officer Forum (2008), "Market Value of Liabilities for Insurance Firms: Implementing Elements for Solvency II", July.

Dowd, Kevin (2003), "Survivor Bonds: A Comment on Blake and Burrows", *Journal of Risk and Insurance*, 70: 339-348.

Dowd, Kevin, David Blake, Andrew G.J Cairns and Paul Dawson (2006), "Survivor Swaps", *Journal of Risk and Insurance*, 73: 1-17.

International Monetary Fund (2006), *The Limits of Market-based Risk Transfer and Implications for Managing Systemic Risks*, Washington DC.

OECD (2008) *Pension Markets in Focus*, Issue 5, December, Paris.

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[53] Longevity Bonds are annuity bonds with the coupon payment involving a return of capital element as well as an interest element. The tax treatment will therefore be more complicated than with a conventional bond.

Office for National Statistics (2010) *Pension Trends*: *Chapter 14 – Pensions and the National Accounts*, Newport.

Pension Commission (2005) *A New Pension Settlement for the Twenty-First Century*, HMSO: Norwich.

Pension Protection Fund and the Pensions Regulator (2006), *The Purple Book: DB Pensions Universe Risk Profile 2006*, Croydon and Brighton.

Pension Protection Fund and the Pensions Regulator (2008), *The Purple Book: DB Pensions Universe Risk Profile 2008*, Croydon and Brighton.

Richards, Stephen J., J. G. Kirkby, and Ian. D. Currie (2006), "The Importance of Year of Birth in Two-Dimensional Mortality Data", *British Actuarial Journal*, 12: 5–38.

Willetts, Richard C. (2004), "The Cohort Effect: Insights and Explanations", *British Actuarial Journal*, 10: 833–77.

World Economic Forum (2009) *Financing Demographic Shifts Project*, June, Geneva.