Longevity Bonds – a Financial Market Instrument to Manage Longevity Risk

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INTRODUCTION

Life expectancy has been increasing over the last centuries. Naturally, it is positive that people live longer, but this also means that they must reconsider their savings in order to maintain a satisfactory standard of living when they retire. If people outlive their reserves, they will at some point have to reduce their standard of living.

Since the exact time of death is not known, there will always be some uncertainty regarding the savings required. Many pension schemes include life annuities, so that the pension companies make fixed monthly payments during the remaining part of the policyholder's life[1]. This transfers the longevity risk[2] from the individual policyholder to the pension company. If life expectancy increases more than expected, pension companies will have to pay out more than projected, resulting in a loss to those companies.

With a view to managing the uncertainty related to future life expectancy, various players have sought to develop financial instruments that are indexed to the longevity of the population. These new instrument types, known as longevity bonds, transfer the risk in connection with higher life expectancy to investors in the financial markets.

The market for the issuance of longevity bonds has received considerable attention in the financial press. However, neither issuers nor investors have so far fully embraced the instrument. Against that background, this article discusses the prospects for future use of such instruments. The underlying considerations behind the products are outlined in the first section, followed by a status of the current usage in the second section. The third section analyses supply and demand factors governing the limited use, and finally, the fourth section examines the potential for establishing a market for longevity bonds and discusses why there is no basis for government involvement.

[1] In Denmark, life annuity schemes constitute a relatively large share of the pension schemes, but the ratio is declining. See ATP *Faktum No. 27* (in Danish only), December 2005.

[2] In the following, risk is reviewed in relation to management of longevity risk in the pension sector.

IMPROVEMENT PER DECADE IN LIFE EXPECTANCY IN OECD COUNTRIES
1960-2000 Table 1

Country	At birth	At 65
Canada	1.9	1.0
Denmark	1.2	0.6
France	2.2	1.3
Netherlands	1.3	0.7
Italy	2.6	1.2
Spain	2.5	1.1
Sweden	1.7	0.9
UK	1.7	1.0
USA	1.8	0.9

Note: Life expectancy is measured as a weighted average of life expectancy at birth and at 65, respectively, calculated on the basis of estimated mortality rates. The improvement in life expectancy is the growth rate between 1960 and 2000.
Source: Human Mortality Database, OECD and Antolin (2007).

BACKGROUND

In many OECD countries, life expectancy has increased by up to 2.6 years per decade over the last half century, cf. Table 1. The higher life expectancy has been achieved following substantial declines in the mortality rates of both the young and the old.[1]

Despite of the positive message contained in this information, it is a challenge for the population, pension companies and policymakers to implement mechanisms that can alleviate the implications of higher longevity. At the centre of the discussion is the possibility that the life expectancy of e.g. younger generations may far exceed the present projections, which may have social implications[2]. If people outlive the capital that has been saved they will have to reduce their standard of living sooner or later.

Life expectancy has been increasing during the last centuries and projections show that this will continue for future generations in the western world, supported by new, improved healthcare treatments, among other things. Many governments have this issue on the agenda and contingent planning has been initiated in order to prepare for the change in demographics. Some of the measures implemented in OECD countries include later retirement and incentives for higher savings. In many countries the possibility of postponing the retirement age of future generations has been considered[3].

Thus, at the centre of the discussion is the speed and magnitude of these changes, and not the direction. In other words, the main issue is

1 Gillian Tett and Joanna Chung, Death and the salesmen, *FT Magazine* 24/25 February 2007.
2 See, for example, Mervyn King (2004).
3 Danish Welfare Commission, *Future welfare – what are other countries doing?* (in Danish only), 2005.

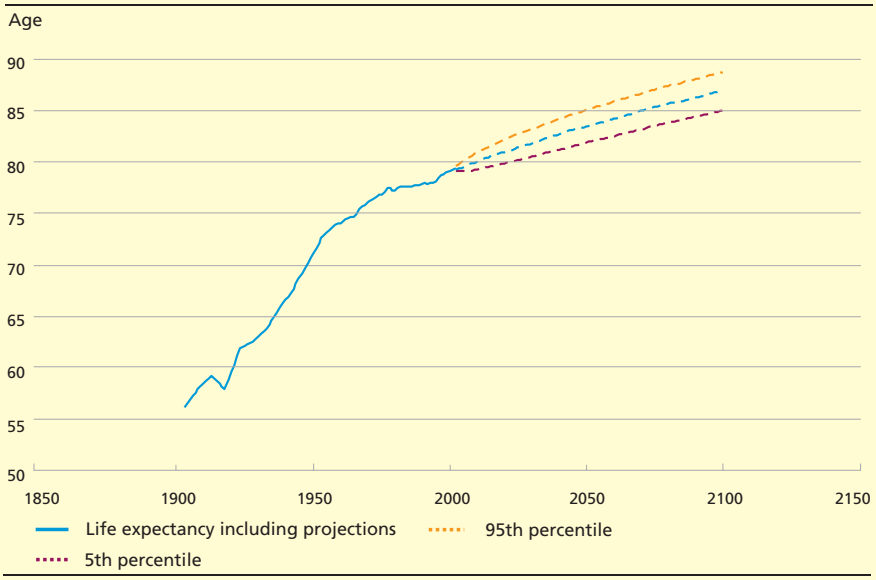
HIGHER LIFE EXPECTANCY – UNEXPECTED VERSUS EXPECTED Box 1

Model projections show that life expectancy in Denmark will follow an upward trend in the period until 2100.[1] From the risk management perspective of the pension companies, the risks associated with higher life expectancy stem from the uncertainty related to the prediction of the precise number of years the individual policyholder will live. If policyholders outlive the projections, pension companies will realise losses.

Chart 1 illustrates life expectancy for women, as well as the related uncertainty, illustrated by the 5th and 95th percentiles. In other words, in 2100 life expectancy will be around 87 years, while the uncertainty, expressed as a 90 per cent confidence interval, will be ±2 years.

The pension sector manages the two effects differently; higher life expectancy is addressed by reducing payments to policyholders, while deviations are handled through specific risk premiums which are part of the general provisions of pension funds.

EXPECTED AND UNEXPECTED DEVELOPMENT IN LIFE EXPECTANCY FOR WOMEN IN DENMARK Chart 1



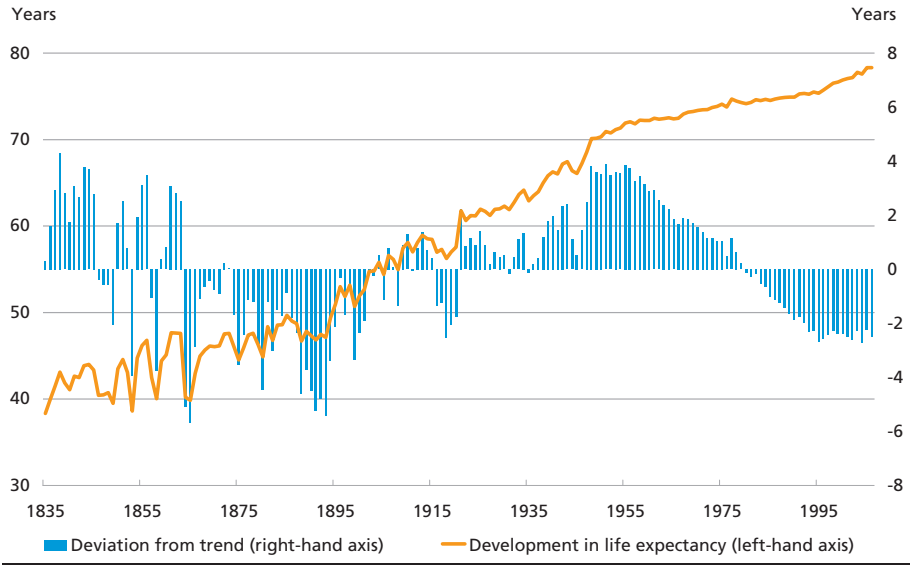
[1] Haldrup (2004). For men, an upward trend is also seen in the period until 2100.

that the life expectancy of present generations may deviate substantially from the course projected today, cf. Box 1.

Life expectancy in Denmark has not increased at a constant rate, cf. Chart 2. There have been substantial fluctuations during the period. For example, the pandemic influenza in the 1920s has been viewed as one of the factors that improved the life expectancy of subsequent generations. Conversely, obesity is seen as a factor which may reduce the life expectancy of present generations[1].

[1] Jacob S. Siegel, *The Great Debate on the Outlook for Human Longevity: Exposition and Evaluation of Two Diverging Views*, Society of Actuaries, 2005

DEVELOPMENT IN LIFE EXPECTANCY IN DENMARK 1835-2006 Chart 2



Note: Life expectancy is measured as a weighted average of life expectancy at birth, calculated on the basis of estimated mortality rates. Over the above period, life expectancy has increased by an average of 3 months per year, and the deviation from the trend is measured on the basis of this average growth rate.
Source: Human Mortality Database.

Implications for the pension sector

In general, past projections have underestimated the fact that people live longer. In practice this implies that pension companies need to make additional provisions in order to address the shortfall. Given that pension companies have made long-term commitments, they need to manage the longevity risk[1].

Before 2000, there was awareness of this issue, but high returns had helped to alleviate the problem. Due to poor equity market performance and low interest rates in the following years, it became evident that decades of improvements in life expectancy had become a challenge for the pension industry[2].

Moreover, many countries have introduced new pension regulation, requiring pension fund managers to update their pension plan assumptions and apply a mark-to-market approach in the valuation of the risks embedded in the pension plans[3]. Finally, many pension companies have implemented new risk management techniques, known as asset liability

1 Ted Clarke, *Living with the Risks – Is your pension deficit what it seems?*, Prudential, 2007.
2 Hermes: BT Pension Scheme: *A decade of outperformance*, 2007.
3 Since 1 January 2005, listed insurance companies have been subject to the International Financial Reporting Standards (IFRS).

management (ALM), which imply a closer linkage between pension fund assets and liabilities.

Against this background there is an increasing interest in analysing new instruments that can be used to hedge against longevity risk. The pension industry has for some time struggled with other risk factors such as the management of interest rate risk, and in many defined benefit pension schemes inflation is also an embedded risk element. In both cases there exist a range of financial instruments, such as cash products (bonds with maturities of up to 50 years, and inflation-linked bonds) and derivatives (interest-rate swaps and inflation-linked swaps) that offer the pension industry options for managing such risk factors.

In relation to longevity risk, the application of capital market instruments has been limited. So far the pension industry has used other types of hedging tools which can basically be divided into three categories:

1) Self-insurance and implicit coverage

Typically pension funds have managed liabilities related to longevity risk without specific hedging instruments. Thus, the exposure to longevity risk has been part of their overall risk management. However, life insurance companies that enter into contracts with both pension and insurance elements have been able to obtain some degree of hedging.

After an insurance event such as pandemic influenza there will normally be a negative correlation between insurance and pension claims. The claim from insurance policies increases, but at the same time future payments on pension policies are reduced because the lives of the policyholders were shorter than initially forecasted[1].

2) Reinsurance

Traditionally, reinsurance companies have provided capital to life insurance companies and pension funds seeking hedging opportunities. However, longevity risk is so specific that reinsurance companies have so far been reluctant to undertake business unless it was part of an existing client relationship. Nevertheless, factors such as increasing demand from insurers and pension funds plus better modelling of longevity risk may increase reinsurers' appetite for this business[2].

3) Sale to external buyout funds

In recent years, companies with defined benefit schemes (primarily in the UK) have been looking for alternative risk transfer solutions, and

1 Richards (2004).
2 Richards (2004).

more are expected to follow suit in the coming years. According to a survey by PwC, 11 per cent of UK companies with defined benefit schemes are considering the option of selling off their pension obligations within the next 5 years[1]. The set-up may take various forms; however, the key underlying model is that companies transfer the portfolio of pension contracts to an external investor that will assume the contractual obligations. In the last couple of years, the UK has seen the establishment of around 20 new investment companies specialising in this area.[2]

STATUS FOR ISSUANCE OF LONGEVITY BONDS

The evolution of financial market instruments has brought a number of new risk-diversification options to the attention of investors. Most notable has been the development in credit markets, where a multitude of products have been introduced during the last decades. This reflects, among other things, an interest in developing products that can help financial institutions to hedge against various types of risk. Experience from other markets has generated an interest in developing capital market products that can also help diversify longevity risk.

Nevertheless, issuance of longevity bonds has so far been limited. A few reinsurance companies have used capital market instruments to transfer risk from pension and life insurance companies to investors in financial markets. The most developed market is based on mortality-linked derivatives, which in some respects resemble longevity bonds, but are nevertheless significantly different in that they are based on mortality rates, while longevity bonds are based on survivor rates, cf. the Appendix.

Since 2003 some companies have issued mortality-linked securities, cf. Box 2. In addition, anecdotal evidence suggests that a number of investment banks have been active in setting up similar structures, but these transactions have been established on the basis of private placements[3].

Issuance of longevity bonds has not taken place so far, even though there has been an indication of strong interest from the pension sector. In 2004, the EIB aimed to launch a longevity bond with a value of GBP 540 million which was intended for UK life insurance companies and pension funds. The structure was initiated in partnership with BNP Paribas and Partner Re, which ultimately were the final assumers of the

1 PricewaterhouseCoopers, PwC pensions survey: Tracking the views of key decision makers, Autumn 2007.
2 Phillip Inman, More firms seek to sell off their pension schemes as costs rise, *The Guardian*, 19 October 2007.
3 IFR, *UK longevity risk hot spot*, 10 June 2006.

ISSUANCE OF MORTALITY-LINKED SECURITIES Box 2

In 2003, Swiss Re established a special purpose vehicle (Vita Capital) that issued USD 400 million in 3-year notes. In 2005, Vita Capital issued a second note with an outstanding amount of USD 362 million and 5-year maturity. In December 2006, Vita III was launched with an outstanding volume of USD 700 million in tranches with 4- and 5-year maturities. The key objective was to replace Vita I, which expired at the end of 2006.[1]

In 2006, Scottish Re raised USD 155 million via Tartan Capital in 3-year notes.[2] Osiris Capital was arranged by Swiss Re, but on behalf of the AXA Group, which was the ultimate buyer of protection in 2006. The outstanding volume was EUR 345 million and the maturity was 4 years.[3]

[1] Swiss Re.
[2] Scottish Re.
[3] IFR, Taking a view on mortality, 21 October 2006.

risk. The launch received much attention in the financial press because the deal was considered to be the first of its kind and had an innovative set-up. However, it never reached the market. Besides technical issues such as design problems, anecdotal evidence indicates that pension funds and life insurance companies did not subscribe to the deal, primarily because coverage was considered to be too expensive, see Box 3.

The above-mentioned capital market transactions have all been focused on hedging the pension sector's longevity risk. In addition, a number of bonds have been issued, predominantly in the USA, with the purpose of funding life insurance business or funding regulatory capital

EIB LONGEVITY BOND PROJECT Box 3

In November 2004, the European Investment Bank announced plans to issue the first longevity bond that would offer coverage for UK pension schemes and life insurers with exposure to longevity risk for the male population of England and Wales. The initial size of the note was GBP 540 million and the maturity of the bond would be 25 years.

Although the bond was launched by the EIB, issuance was arranged and managed by BNP Paribas. Under this structure BNP would effectively bear the investment risk and the longevity risk would be covered by Partner Re that had concluded an agreement with BNP. The bond would still be rated AAA, equivalent to the EIB rating, and thus purchasers of coverage would have an AAA counterparty risk.

The issue was withdrawn in late 2005 without being issued, primarily because the pension industry found the price of coverage on longevity risk too high. In addition, other factors were mentioned such as missing mandates in the pension industry and concerns about basis risk between the index embedded in the bond and the longevity risk faced by insurance and pension funds.

Source: T. Cox (BNP Paribas) and F. Blumberg (Partner Re), Longevity bonds, 2005 Life Convention, Barnett Waddingham LLP, Longevity bond to be issued by the EIB, 2005 and *Financial Times*, Changing attitudes mean there is more life left in longevity bonds, 22 November 2006.

requirements. These transactions have used a securitisation set-up in which asset-backed securities have been structured on the basis of a pool of life insurance policies. In general, these transactions are aimed at financing traditional life insurance business without having a specific focus on hedging longevity risk. The bulk of the outstanding volume has been linked to such structures, cf. Chart 3.

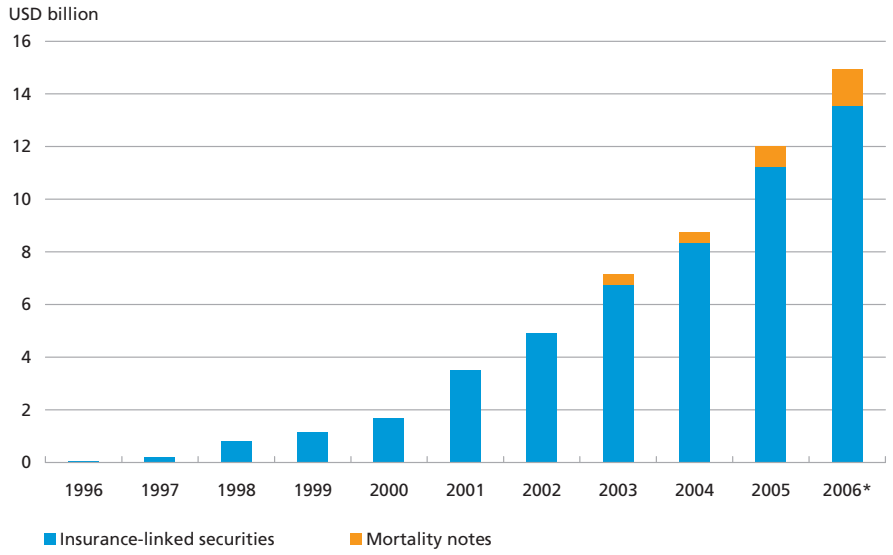
INTEREST IN LONGEVITY BONDS AMONG INVESTORS AND ISSUERS

Notwithstanding the appealing characteristics of longevity bonds, the market has not evolved. A number of factors have contributed to the slow growth in longevity bonds; factors related that are applicable to both buyers and sellers. In general, the market is short of investors in longevity risk, and capital needs to be attracted by offering alluring risk-adjusted returns. In addition, some externalities may hinder the development of markets. A factor such as the outstanding volume is often essential for a market to develop, but once the volume has passed a critical level, growth may potentially be very high. In the following the various factors behind the lacklustre evolution will be illustrated.

General capital market considerations

Viewed in retrospect, the most successful launches of new capital market instruments during the past decade have been undertaken in an envir-

INSURANCE-LINKED SECURITIES AND MORTALITY NOTES Chart 3



Note: The data for insurance-linked securities is based on information until the end of August 2006. The data includes accumulated issuances since 1996.
Source: Swiss Re and IFR.

onment where initially there was a fair balance between participants with buying and selling interests. If markets are relatively biased towards one side, it may be difficult to launch a product due to lack of interest in and understanding of business characteristics. Consequently, the price will typically be established at a level that is not deemed attractive.

In the case of longevity bonds, the most obvious challenge is the lack of natural investors who would benefit from an unexpected rise in life expectancy. Pharmaceutical companies and care providers are often mentioned as examples of investors with a natural interest in assuming this risk[1]. These sectors would be exposed to losses if life expectancy decreases, and thus the companies would be able to hedge their own exposures by issuing longevity bonds.

In spite of the theoretical arguments, it is more than doubtful whether the natural investors would actually enter into these transactions, due to corporate governance considerations, among other things. For example, it is debatable whether a company would be able to explain to its shareholders how it can benefit from entering into transactions that may influence profits in a distant future. If this obstacle can be overcome, it is also uncertain whether the potential volume would be more than a drop in the ocean when compared with the overall demand in the pension industry.

Another challenge in relation to establishing a market for longevity bonds is that the underlying characteristics differ significantly from those of other types of financial instrument, such as mortgage-credit bonds, where the risk premium is determined on the basis of the development in the credit quality in the mortgage-credit market. The process related to development in life expectancy is characterised by a high duration and low volatility, particularly in recent years, cf. Chart 4.

If a comparison is made with the development in credit quality in the mortgage-credit market (illustrated by growth in GDP at factor cost), the duration is lower and the volatility substantially greater. The reason is that the economy has historically gone through complete business cycles in less than 10 years. Consequently, an investor in mortgage-credit bonds does not have to wait many years to realise whether the investment was profitable. In addition, economic indicators are frequently published, giving an idea of future developments.

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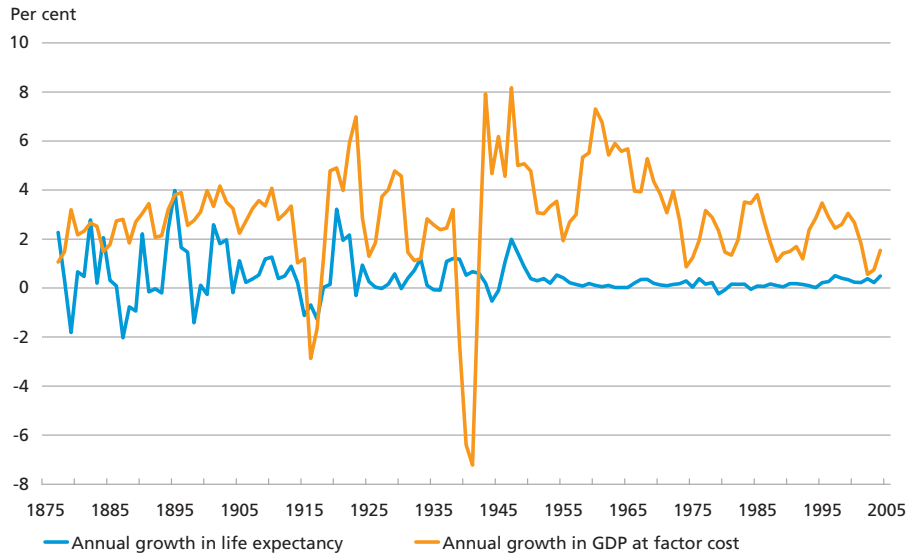
[1] European Pensions and Investment News: *Looking for a buyer in face of longer lives*, 4 December, 2006.

GROWTH IN DANISH LIFE EXPECTANCY AND ECONOMIC GROWTH IN DENMARK ILLUSTRATED BY THE CHANGE IN GDP AT FACTOR COST Chart 4



Note: Life expectancy is measured as a weighted average of life expectancy at birth, calculated on the basis of estimated mortality rates.

Source: K. Abildgren, Monetary Trends and Business Cycles in Denmark Since 1875, Working Paper 43, Danmarks Nationalbank, 2006, and Human mortality database.

Perspectives for investors in longevity bonds (hedging sellers)

Besides companies with a natural exposure to longevity risk, a number of other investors have also been mentioned in the debate about the issuance of longevity bonds. These are primarily investors that are already active in the asset management sector, including hedge funds, investment funds, etc. The low correlation between an unexpected increase in life expectancy and the yield on other financial instruments is typically cited as the major reason why longevity bonds would be attractive. The instrument would contribute to reducing the risk on the investors' aggregate investment portfolio, which means that the investors would require only limited risk premiums when investing in this instrument.

In contrast, the financial instruments presented so far have had a number of disadvantages. Primarily, they have been highly complex instruments with maturities in the range of 25 years or more. So far, it has been difficult to sell products that combine high complexity and long maturities. It has, at the same time, been difficult to reach agreement on some measure of standardisation, including how to estimate the future development in life expectancy and the related uncertainty[1].

[1] JP Morgan (2007).

Against that background it has been difficult to build up a market since investors have had to accept that they were buying an instrument that could prove to be practically impossible to resell. In view of the long maturity of the product, investors would have limited opportunities to exit the transaction for many years. The lack of liquidity has led investors to demand a liquidity premium, so that the resulting price of hedging has been unattractive for the pension sector, despite the low correlation.

Perspectives for issuers of longevity bonds (hedging buyers)

So far, the pension sector has predominantly seen longevity risk as a factor that has been managed via internal risk-management systems. Capital provisions have been made as a general buffer against fluctuations in the value of pension commitments.

However, as the pension sector has increased its focus on risk management, it has also turned its attention to instruments for explicit management of the primary risk factors that a pension company is exposed to, including longevity risk.

In spite of this, the pension sector has not welcomed the launch of longevity bond. The reason may be that the instruments presented so far, such as the EIB's longevity bond, allow only partial hedging of the pension sector's exposure to unexpected increases in life expectancy. For example, the development in life expectancy may differ considerably from one socio-economic group to another, and between geographical areas, etc. Against this background, a Danish pension fund investing in the EIB's longevity bonds would not be able to fully hedge its exposure owing to the different developments in life expectancy in England/Wales and Denmark, cf. Box 3.

These issues reflect a dilemma, in that on the one hand pension funds want the closest possible correlation between hedging and exposure in order to avoid a basis risk, and on the other hand investors want instruments that are as standardised as possible.

Furthermore, pension funds are typically not yet empowered to enter into transactions that may involve less exposure to longevity risk. This is attributable to factors such as the uncertainty concerning the regulatory treatment of longevity bonds.

PERSPECTIVES FOR FUTURE DEVELOPMENT OF LONGEVITY BONDS

The lacklustre market for longevity bonds has led to considerations as to whether government issuers should intervene in this market. Traditionally, government issuers have an objective of covering the central gov-

ernment's financing requirement at the lowest possible long-term costs, subject to a prudent degree of risk. Furthermore, their aim is to facilitate the central government's access to the financial markets in the longer term and to support a well-functioning domestic financial market.

Consequently, it might be considered whether government issuers should get actively involved in the development of a market for longevity bonds. In some countries government issuers have in this way contributed to the development of bond segments with long maturities as well as inflation-linked instruments, cf. the 50-year issuances in France and the UK. This has provided a benchmark for private issuers of financial instruments in the same segments[1].

Likewise, it could be argued that the central government should issue longevity bonds in order to provide a benchmark that could support the development of a market for longevity bonds. However, it is difficult to imagine that sovereigns would be able to issue such longevity bonds on attractive terms[2]. Furthermore, the central government is already highly exposed to increasing life expectancy as extra government spending will be required to tackle the implications of demographic changes[3]. By issuing longevity bonds to pension funds, the government would therefore further increase their balance-sheet exposure.

Several pension funds have also indicated that they see the management of unexpected increases in life expectancy as an inherent challenge for the pension funds[4]. It could also be argued that the pension sector knows its clients better than the external investors and is therefore better equipped to manage the risk, rather than selling it off to investors in the financial markets.

One issue that has been pointed out in relation to the new products launched in the credit market has indeed been that it would, perhaps, be best that financial institutions manage the risks in relation to their commitments, instead of repackaging them and selling them off to financial investors. The same argument could be put forward in respect of longevity. On the other hand, by selling off, the pension sector disperses the risk to an investor group which may be better equipped to manage risk that is characterised by a low probability but a potentially high cost.

For investors in the financial markets there are, however, a number of obstacles to be overcome before longevity bonds become a marketable instrument, and it is very likely that the final product design has not yet been developed. In any case, it is important to achieve a higher degree

1 *Danish Government Borrowing and Debt 2005*, chapter 9: Issuance of Long-Term Government Bonds.
2 Swedish National Debt Office, *Comment on Longevity bonds*: summary by Bo Lundgren, 2005.
3 The Danish Welfare Commission's main report 2006 (in Danish only).
4 European Pensions and Investment News: *Looking for a buyer in face of longer lives*, 4 December 2006.

of standardisation within the area. Several investment banks, including JPMorgan and Credit Suisse, have issued reports on this topic, thereby generating debate and awareness about the issue.[1] One of the critical themes raised is the development of better models for predicting life expectancy.

CONCLUDING REMARKS

Higher life expectancy will pose substantial challenges for pension funds in the coming years. In general, increasing life expectancy needs to be addressed via higher savings for the retirement age. Moreover, the uncertainty about projections of the future development in life expectancy implies that pension funds that have issued life annuities will have to manage the risk on their liabilities. In itself this is nothing new; pension funds have hedged their risks for many years. In recent years pension funds have, however, to a large extent implemented asset-liability management techniques, and thereby focused on almost complete hedging of risks not deemed to be part of their core business.

Viewed in that perspective, some pension funds, e.g. in the UK, have actively sought opportunities to hedge the balance-sheet risk, including the possibility of using longevity bonds. Nevertheless, the market for longevity bonds has not really taken off yet, although there have been a few experiments with products whereby investors assume the risk of an unexpected increase in life expectancy against receipt of a risk premium.

The extensive focus on the pension sector by several investment banks reflects investments in the development of various models. In view of the innovation seen in other financial areas, it is not impossible that a private market for longevity bonds will emerge, although not necessarily based on the product structures known today.

[1] JPMorgan (2007) and Credit Suisse Longevity index.

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APPENDIX

The following provides a description of the overall structure of the mortality-linked instruments issued to date, as well as a comparison with the EIB's proposal for issuance of longevity bonds[1].

Swiss Re Vita I

The overall concept is that the issuer (Swiss Re) seeks to hedge any risk arising from a substantial increase in the mortality rate. Viewed in isolation, the issuer achieves a gain on the instrument if the mortality rate, M_t, substantially exceeds a predefined index, M_0. On the other hand, the investor gains if the mortality rate, defined by M_t, is not extremely high. The maturity of the instrument is 3 years. The M_t index is defined as a basket of mortality rates in five countries with different weights – the USA (70 per cent), the UK (15 per cent), France (7.5 per cent), Switzerland (5 per cent) and Italy (2.5 per cent). The gender distribution is 35 per cent women and 65 per cent men, and the instrument has a broad age distribution.

The instrument pays a variable coupon, equivalent to LIBOR plus 135 basis points, on an ongoing basis. The part of the principal that is lost is determined using the following loss function:

$$L_t = \begin{cases} 0\ \% & M_t < 1.3\ M_0 \\ (M_t - 1.3\ M_0)/(0.2\ M_0)*100\ \% & \text{if } 1.3M_0 \leq M_t \leq 1.5M_0 \\ 100\ \% & 1.5*\ M_0 < M_t \end{cases}$$

Issuance takes place via Vita Capital, a special purpose vehicle. This structure entails a number of advantages, partly due to the transaction's status as an off-balance-sheet item, partly because it offers more favourable counterparty risks for the investor.

EIB longevity bond

The EIB's proposal for a longevity bond (that never reached the market) is constructed with a maturity of 25 years. The instrument hedges the pension fund against an unexpected increase in the survivor index for people in the age group 65-90 years. The bond has an annuity structure, with the annual coupon payments starting from the base of GBP 50 million. Subsequently each coupon payment reflects the percentage of the population of England and Wales aged 65 that is still alive each year until the 25 years have passed. If the survivor rate increases substantially, the pension fund will receive higher coupons.

The resulting overall coupon structure is as follows:

$r_t\ (S_t)$ = GBP 50 million * S_t for t = 1,2,….,25, where S_t is the survivor index in the year t.

[1] The description is based on Standard & Poors, Vita Capital Ltd.'s Principal-at-risk variable rate mortality catastrophe-indexed note, 2003, and Blake, Cairns, Dowd and MacMinn (2006).