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# LONGEVITY HEDGING VIA THE CAPITAL MARKETS

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## Overview

- Longevity hedging via the capital markets is now possible
  - Pension schemes can now hedge longevity risk without buying annuities
  - Insurers & reinsurers can transfer longevity risk with financial instruments as well as with (re)insurance contracts
  - Transactions have been done
- A new market for longevity risk is emerging
  - Key players are pension schemes, insurers, reinsurers and investors
  - Longevity Indices help to address market obstacles
- Key messages:
  - You don't have to transfer 100% of the longevity risk for hedging to be worthwhile
  - Longevity Index hedges can be highly effective: Basis risk can be managed



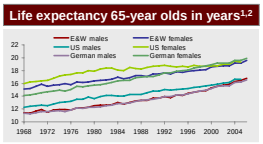
## Agenda

- **Framework for longevity hedging in the capital markets**
- Longevity indices
- Practical example

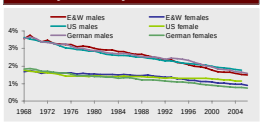
## Longevity risk reflects the uncertainty in future life expectancy

- **Increasing life expectancy is a challenge for pension schemes (and insurance annuity providers)**
  - E.g. each additional year of life expectancy adds 3–5% to the value of UK pension scheme liabilities
- **Falling mortality rates drive rising life expectancy**
  - Common trend across countries
  - Common trends within countries

**Life expectancy 65-year olds in years[1,2]**




**Mortality rates 65-year olds[2]**




[1] So-called "period" life expectancy assuming no further improvements in mortality
[2] Source: LifeMetrics Index (E&W = England & Wales)



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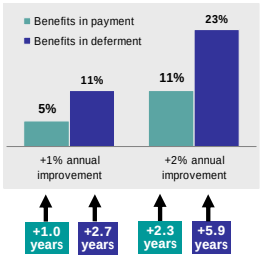
## Increasing longevity creates a larger financial liability for a defined benefit pension scheme

- The value of pension scheme liabilities depends on the expected trend of future mortality improvements
- This also applies to annuity exposures held by insurers
- **Longevity risk:**
  The risk is that the trend of mortality improvements is greater than expected

**Increase in liability value[1] due to mortality improvement[2] (%)**




[1] Liabilities are inflation (LPI) linked
[2] Examples based on male pensioner aged 65 and male deferred pensioner aged 45. Source: LifeMetrics Index



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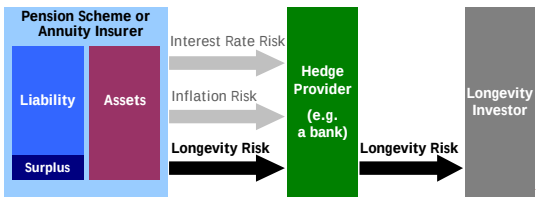
## Framework for hedging longevity risk via the capital markets

- **Hedging framework**
  - Hedge changes in cash flows or value of liabilities due to unexpected changes in mortality rates
- **Longevity hedging is a natural extension to hedging other liability risks**
  - Such as inflation and interest rate risk



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## There two broad categories of capital markets longevity risk hedges, both of which will transact

| Customised hedge | Standardised Index hedge |
|---|---|
| ■ Tailored to reflect actual longevity experience of the pension/annuitants | ■ Standardised to reflect national population longevity experience<br>■ But calibrated to match mortality sensitivity of liabilities |
| ■ Structured as a cash flow hedge | ■ Structured as a value hedge |
| ■ Maturity of hedge:<br>■ When last member/annuitant dies | ■ Maturity of hedge:<br>■ Finite: e.g. 10 or 20 years |
| ■ Indemnification paradigm | ■ Risk management paradigm |
| => Exact hedge | => Cheaper, more liquid |

**Standardised Index hedge has advantages of simplicity, cost and liquidity**



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## Advantages and disadvantages of customised vs. standardised longevity hedges

| | Customised hedge | Standardised index hedge |
|---|---|---|
| Advantages | ■ Exact hedge | ■ Cheaper<br>■ No requirement to provide data<br>■ More liquid<br>■ Shorter maturity (generally) so counterparty credit risk is limited |
| Disadvantages | ■ More expensive<br>■ Must provide detailed data on benefits and mortality experience<br>■ Poor liquidity<br>■ Longer maturity (generally) leading to larger counterparty credit risk | ■ Not an exact hedge<br>■ Residual risk (basis risk)<br>■ But this can be managed |



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## Treatment of customised longevity hedges for regulatory capital purposes in UK insurers

- **Pillar I: Now little distinction between reinsurance and derivatives or other financial instruments with comparable financial effect:**
  - **INSPRU 1.2.77A (relates to cashflows used in determining mathematical reserves)**: *reinsurance and contracts of reinsurance include analogous non-reinsurance financing agreements, including contingent loans, securitisations and any other arrangements in respect of contracts of insurance that are analogous to contracts of reinsurance in terms of the risks transferred and the finance provided*
- **Pillar II: Emphasis is on economic effect, not legal form**

| Illustrative impact | Existing Pillar I | Pillar II |
|---|---|---|
| Assets | = | = |
| Technical provisions | +/- (depends on hedge vs reserving basis) | ++/- (depends on hedge vs realistic basis) |
| Capital requirement | +/- (LTICR is 4% of technical provisions) | - - (sharp drop in ICA longevity risk component) |
| Day 1 impact on excess capital | -/+ (the mirror image of effect on technical provisions) | + (effect of fall in ICA often greater) |

**Little distinction between reinsurance and derivatives or other similar structures**
**At implementation, hedges often benefit Pillar II (& Solvency II) rather than Pillar I**



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## Treatment of standardised index longevity hedges for regulatory capital purposes in UK insurers

- **Pillar I:**
  - Hedge mainly operates through asset side of calculations
  - Existence of the hedge may affect choice of prudent levels of future improvements in determining mathematical reserves
- **Pillar II:**
  - Hedge mainly operates through asset side of calculations
  - Hedge may give a mark on the expected rate of systemic future improvements reflected in realistic liabilities
  - Main effect is to reduce impact of longevity risk component of ICA

| Illustrative impact | Existing Pillar I | Pillar II |
|---|---|---|
| Assets | - (bid/offer) | - (bid/offer) |
| Technical provisions | +/- (depends on hedge vs reserving basis) | ++/- (depends on hedge vs realistic basis) |
| Capital requirement | +/- (LTICR is 4% of technical provisions) | - - (sharp drop in ICA longevity risk component) |
| Day 1 impact on excess capital | --/+ (more likely to be down by reason of bid/offer) | + (effect of fall in ICA often greater) |

**Operation of hedge is mainly through asset side of balance sheet**
**At implementation, hedges benefit Pillar II (and Solvency II) rather than Pillar I**





## Treatment of longevity hedges in occupational pension schemes

- **Customised hedge:**
  - More likely to be applied to alter calculation of liabilities
- **Standardised hedge:**
  - More likely to operate through asset side of balance sheet
  - May affect choice of assumptions in determining liabilities
    - Specifically mortality improvements, but not base tables
- **Effect of hedge:**
  - No equivalent (yet) to Pillar II/Solvency II for insurers, hence limited day-1 benefit in terms of regulatory recognition
  - Impact is economic risk reduction
    - Reduces the effect of future fluctuations in longevity on the scheme
    - Protects against trend of mortality improvements steepening in excess of best estimate





## How do capital markets and insurance longevity solutions compare?

**Insurance/reinsurance risk transfer**

- **"Indemnification"**
- **Insurance regulatory framework**
- **Regulatory capital relief for insurers generally more favourable currently**
- **Insurers & reinsurers more amenable to customised longevity risk profiles**
- **Credit counterparty risk generally higher**

**Capital markets risk transfer**

- **"Risk management"**
- **Banking regulatory framework**
- **More flexibility**
- **More liquid**
- **More potential counterparties**
  - Not just insurers and reinsurers
- **More market capacity**
  - More potential end-holders of risk
- **Lower credit counterparty risk**

**In general, any insurance-based solution can be replicated in capital markets format and vice versa**

## Longevity bonds vs. longevity derivatives

| Longevity bond | Longevity derivative |
|---|---|
| ■ **Requires up-front payment to purchase bond** | ■ **No up-front payment typically** |
| ■ **Credit exposure to bond issuer is significant** | ■ **Credit exposure mitigated by collateral posting** |
| ■ **Significant impact on asset mix**<br>■ Requires a large proportion of assets to be switched into the bond | ■ **Minimal impact on asset mix**<br>■ Only impacts asset allocation via constraints on assets allowed as collateral |
| ■ **Low return investment**<br>■ Unless combined with another risk, e.g., low-rated credit | ■ **Similar to other derivatives**<br>■ E.g. interest rate swaps and inflation swaps |

**Derivatives offer many advantages for longevity hedging**





## Agenda

- Framework for longevity hedging in the capital markets
- **Longevity indices**
- Practical example





## "LifeMetrics" is a toolkit developed to help measure and manage longevity risk

**What is LifeMetrics ?**

- **Launched by JPMorgan in March 2007 and freely available from the website**
  - **Longevity Index**
    - England & Wales, US, Netherlands and Germany
  - **Framework**
    - Methods and analytics for risk measurement and management
  - **Software**
    - Tools for modelling and forecasting mortality

**Features**

- **Transparent, non-proprietary, open-source and freely-available**
- **Independent Calculation Agent**
- **Independent Advisory Committee**
- **Advisors: Watson Wyatt Worldwide and The Pensions Institute**

## Current and historic data available on website and Bloomberg

www.lifemetrics.com

**Bloomberg:** LFMT <GO>

- Broken down by age, gender, country, metric
- Fully documented
- Free, no login needed
- Can be used in longevity hedges




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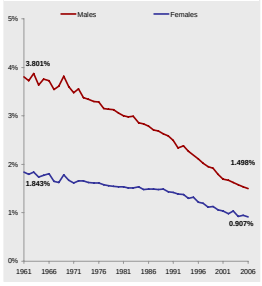
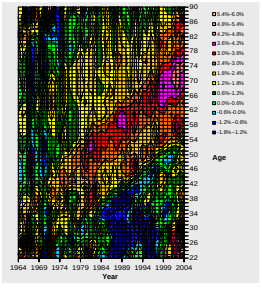
## Historical mortality data forms the basis for pricing and risk management

**Mortality rates for E&W aged 65** [1]




**E&W males 1-year mortality improvements**[1]




[1] Source: JPMorgan LifeMetrics Index: 1961 to 2006



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## Other "longevity" indices are proprietary

**"Credit Suisse Longevity Index"** [1]

- US index, primarily focused on life expectancy
- Broad index – based on US national population
- Proprietary – not publicly available

**Goldman Sachs "QxX"** [2]

- US index based on "life settlements" pools
- Narrow index – based on a reference pool of 46,290 US lives aged 65+
  - Contains idiosyncratic risk of specifically selected individuals
- Proprietary – not publicly available
- Designed for investments
  - Not for hedging longevity risk in pension plans or annuity books

[1] Source: www.credit-suisse.com/ib/en/fixed_income/longevity_index.html
[2] Source: www.QxX-index.com



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## Agenda

- Framework for longevity hedging in the capital markets
- Longevity indices
- **Practical example**





## Standardised index hedges can be tailored to specific pension plans & annuity portfolios

- Create hedge to take account of the **specific profile of your liability** in terms of:
  - Age profile
  - Gender profile
  - Benefit structure
  - Specific mortality table

**Pension Plan Member Data**

- **Age profile**
- **Gender profile**
- **Benefit structure**
- **Specific mortality table**

**Longevity Hedge**

| Age 40-49 Males | Age 50-59 Males | Age 60-69 Males | Age 70-79 Males | Age 80-89 Males |
|---|---|---|---|---|
| Age 40-49 Females | Age 50-59 Females | Age 60-69 Females | Age 70-79 Females | Age 80-89 Females |

**Provides effective hedges of liability value**

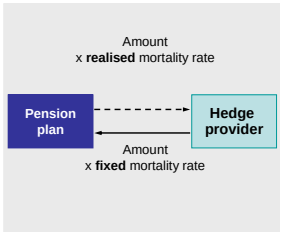




## Example: Index-based longevity hedge can be built from a simple mortality derivative called a "q-Forward"

- **"Building-block" approach**
  - Standardised hedging building-blocks called "q-Forwards"
  - Building-blocks are combined to provide an effective hedge for a specific portfolio
- **Payments exchanged at maturity**
  - No up-front payment
  - At maturity the pension plan receives a fixed mortality rate and pays a floating mortality rate

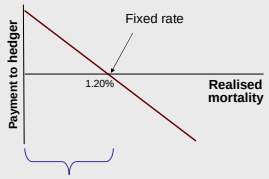
**q-forward: Hedge building-block**



## "q-Forwards" pay out when mortality is lower than expected

- **Payout at maturity**
  - Compensates for increase in value of the pension liability
  - Although it has a fixed maturity it hedges impact of risk on all cash flows beyond maturity
  - Hedges the **unexpected improvements** in mortality
- **Net result**
  - The future value of the liability is "locked in"

**Payout from q-Forward**




Lower realised mortality results in a payout to offset the increase in liabilities



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## Sample term sheet for a q-Forwards

**Term sheet for a single q-Forward**

| | |
|---|---|
| Notional amount | GBP 50,000,000 |
| Trade date | 31-Dec-07 |
| Effective date | 31-Dec-07 |
| Maturity date | 31-Dec-17 |
| Reference year | 2016 |
| Fixed rate | [1.2000%] |
| Fixed amount payer | JPMorgan |
| Fixed amount | Notional amount x Fixed rate x 100 |
| Reference rate | LifeMetrics graduated initial mortality rate for 65-year-old males in the reference year for England & Wales national population. Bloomber ticker: LMQMEW65 Index <GO> |
| Floating amount payer | ABC Pension Plan |
| Floating amount | Notional amount x Reference rate x 100 |



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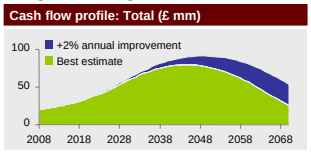
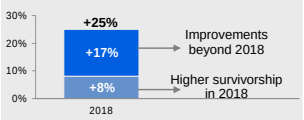
## Hedging longevity over a 10-year horizon to 2018 Case study: A young DB pension plan

- **Impact of unexpected mortality improvements of 2% per year**
- **Value impact in year 10**
  - Increase in 2018 liability value of **+25%,** of which…
  - 1/3 due to higher survival
  - 2/3 due to mortality improvements beyond 2018
- **Can hedge both components with a 10-year hedge**

**Cash flow profile: Total (£ mm)**




**Increase in liability value in 2018 (%)**



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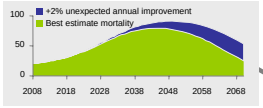
## Portfolio of building-blocks can provide an effective hedge of longevity risk

**Liability cash flows**

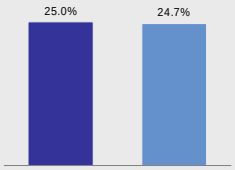



**Longevity Hedge**

| | | | | |
|---|---|---|---|---|
| Age 40-49 Male | Age 50-59 Male | Age 60-69 Male | Age 70-79 Male | Age 80-89 Male |
| Age 40-49 Female | Age 50-59 Female | Age 60-69 Female | Age 70-79 Female | Age 80-89 Female |

**Impact of increase in trend of mortality improvements**

Liability value change




Increase in liability in 2018 due to mortality improvements

Payoff for hedge in 2018

**Hedges are cost effective, relatively liquid and traded**

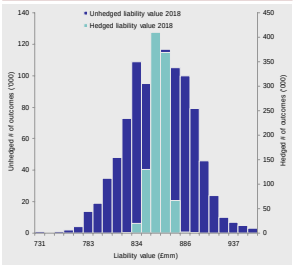




## Hedge effectiveness can also be measured stochastically

- **Hedge effectiveness is about risk reduction**
  - Quantifying how hedge reduces potential for **monetary loss**
  - Need to measure residual risk
- **Example**
  - Risk reduction = 86%
  - Residual risk = 14%

**Distribution[1] of liability value in 2018: Before and after hedging**




[1] Based on a stochastic mortality model

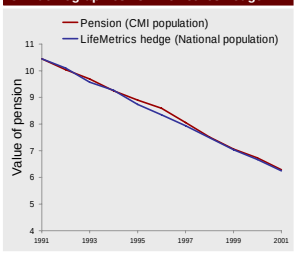




## The basis risk associated with standardised hedges can be measured and managed

- **Basis risk can be managed**
  - Short term movements in **mortality rates** have a low correlations
  - But movements in the **value** of pensions for different populations are correlated over the long term
- **Example**
  - Annuity for cohort of males with the same demographics as CMI Male assured lives
  - Hedge based on LifeMetrics
  - Values track very closely over the long term

**Pension value UK males aged 65 in 1991 CMI demographics vs. LifeMetrics hedge**




Source: CMI and LifeMetrics

## Lucida made a public announcement of their first-of-its-kind transaction for longevity hedging

**Press Announcement on Lucida Website, 15 February 2008**

***Lucida and JPMorgan first to trade longevity derivative***

*Lucida plc, a new insurance company formed to take on longevity risk and corporate pension schemes, recently announced a deal with JPMorgan to hedge longevity risk through a derivative contract linked to the LifeMetrics Longevity Index. The contract, the first of its kind involving an Insurer, signals continued progress in the development of what many believe to be a significant new market.*

*Jonathan Bloomer, Executive Chairman of Lucida, commented, "This innovative transaction demonstrates that Lucida is at the forefront of the emerging secondary market in longevity risk. By selectively entering into longevity swap contracts we can maximise the value we offer our clients. We look forward to being part of this market as it develops."*

**Financial News Online, 3 March 2008**

*"It is a partial hedge of longevity risk that we have taken on... The index allows you to trade on specific ages at specific points in the future." (Jan-Hendrik Erasmus, Lucida )*

Presented with the permission of Lucida plc



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  - Key players are pension schemes, insurers, reinsurers and investors
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- Key messages:
  - You don't have to transfer 100% of the longevity risk for hedging to be worthwhile
  - Longevity Index hedges can be highly effective: Basis risk can be managed