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THE ROLE OF LONGEVITY INDICES AND MORTALITY DERIVATIVES

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lifeMetrics

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Overview

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- **Longevity hedging via the capital markets is now possible**
  - Pension plans can hedge longevity risk without buying annuities
- **A new market for longevity risk is emerging**
  - Investors are showing increasing interest in longevity-linked investments
  - Pension plans and insurance companies are actively evaluating hedging
- **Obstacles to market development are being addressed**
  - Standardisation
  - Education
- **Messages for pension fiduciaries:**
  - Longevity risk should be measured and this can be done quite easily
  - You don't have to transfer 100% of the longevity risk for hedging to be worthwhile
  - Index hedges can be highly effective: Basis risk can be managed

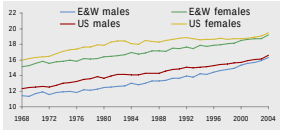
JPMorgan

Longevity risk reflects the uncertainty in future life expectancy

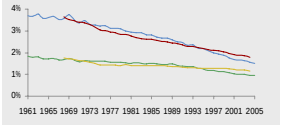
- **Increasing life expectancy is a challenge for pension plans**
  - E.g. each additional year of life expectancy adds 3-4% to the value of UK pension liabilities

- **Mortality improvements drive longevity risk**
  - Increasing life expectancy has been driven by falling, or "improving", mortality rates

Life expectancy for 65-year olds in years[1]



Mortality rates for 65-year olds



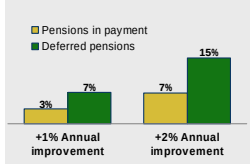
Source: LifeMetrics Index (E&W = England & Wales)
1. So-called "period" life expectancy assuming no further improvements in mortality

Increasing longevity creates a larger financial liability for a defined benefit pension plan

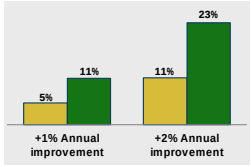
- The value of pension liabilities depends on expectations for the **trend of future mortality improvements**
- If the trend of mortality improvements is greater than expected this poses a huge risk

Increase in liability value due to unexpected mortality improvement

Fixed benefits (%)



Inflation-linked benefits (%)



Longevity appears to be a good candidate to become a new market

Because longevity exposure:

- **Is transferable in principal**
- **Is economically significant:** >£10 trillion globally
- **Cannot be hedged in existing markets**

But market development also requires:

- **Standardisation to create liquidity**
  - Standardised Index
  - Standardised instruments
- **Education**
  - Longevity is an unfamiliar risk
  - Perceived as more complex than it is

The two sides of the market are hedgers (pension plans) and investors

- **Investors are prepared to invest in longevity**

A market for longevity risk is emerging

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

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What is LifeMetrics?

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

Features

- Transparent, non-proprietary, open-source and freely-available
- International
- Advisors: Watson Wyatt Worldwide and The Pensions Institute

Current and historic data available on website and Bloomberg

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- **www.lifemetrics.com**
- Designed to:
  - Increase visibility of longevity risk
  - Provide a standardised reference for longevity hedges
- Broken down by age, gender, country, metric
- Full documentation also available from the website
- Free, no login needed

Historical mortality data forms the basis for pricing and risk management

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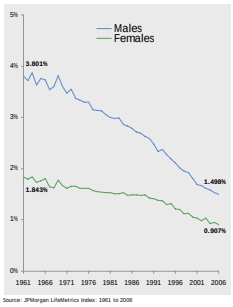
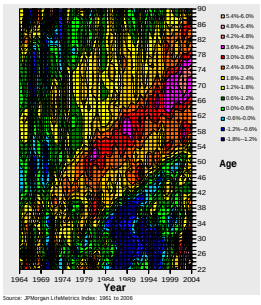
Mortality rates for E&W aged 65



Source: JPMorgan LifeMetrics Index: 1961 to 2006

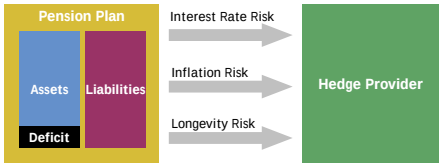
E&W Males: 1-year mortality improvements



Source: JPMorgan LifeMetrics Index: 1961 to 2006

Framework for hedging pension longevity risk

- **Hedging framework**
  - Hedge the sensitivity in the value of liabilities to changes in mortality rates
  - Minimises the basis risk between longevity of members and longevity associated with hedge
- **Longevity hedging is a natural extension to hedging other liability risks**
  - Such as inflation and interest rate risk



There two broad categories of 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 But calibrated to match mortality sensitivity of liabilities
Structured as a **cash flow hedge**	Structured as a **value hedge**
Maturity of Hedge: When last member/annuitant dies	Maturity of Hedge: Finite: E.g. 10 years or 20 years
Indemnification paradigm	**Risk management paradigm**

=> Exact hedge

=> Cheaper, more liquid

Standardised has advantages of simplicity, cost & liquidity

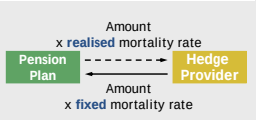
Advantages and disadvantages of customised vs. standardised longevity hedges

	Advantages	Disadvantages
Standardised	Cheaper than customised hedge Lower set up and operational costs More liquid, more easily unwound Shorter maturity (generally) so counterparty credit risk is limited	Not a perfectly exact hedge Population basis risk Roll risk at maturity
Customised	Exact hedge, no residual basis risk	More expensive than standardised Higher set up and operational costs: Poor liquidity, difficult to unwind Difficult to adjust for changes in benefits Longer maturity (generally) leading to larger counterparty credit

Example: LifeMetrics longevity hedges 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 carefully combined to provide an effective hedge for a specific portfolio

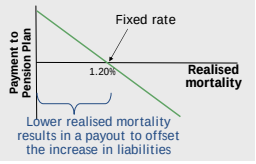
q-Forward: Hedge building-block



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

- **What are these building-blocks?**
  - Simple capital market instruments
  - Based on LifeMetrics Index
  - Involve exchange of realised mortality rate in a future period for a fixed mortality rate
  - Hedges unexpected improvements in mortality

Payout from q-Forward



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 Germany national population. Bloomber ticker: LMQMEW65 Index <GO>
Floating Amount Payer	ABC Pension Plan
Floating Amount	Notional Amount x Reference Rate x 100

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

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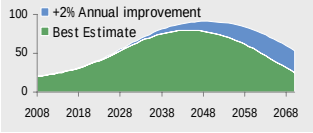
- **Impact of unexpected mortality improvements of 2% per year**

Value impact in year 10

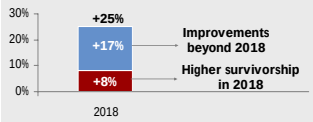
- Increase in 2018 liability value of **+25%**, of which...
- 1/3 due to higher survival
- 2/3 due to mortality improvements beyond 2018

Can hedge both components with a 10-year hedge

Cash flow profile: Total ($ mm)



Increase in liability value in 2018 (%)



Portfolio of building-blocks can provide an effective hedge of longevity risk for a pension plan

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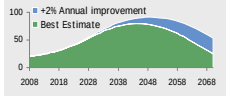
Pension liability cash flows

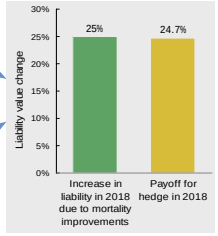


Hedge

Portfolio of LifeMetrics Hedge Building Blocks

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

Impact of increase in trend of mortality improvements



Hedges are liquid, cost effective and traded

Hedge effectiveness can also be measured stochastically

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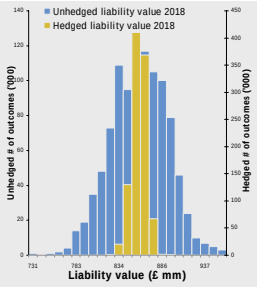
- **Hedge effectiveness is about risk reduction**
  - Quantifying how hedge reduces potential for **monetary loss**
  - Need to measure residual risk
- **Example**
  - Risk reduction = 86%
  - Residual risk = 14%

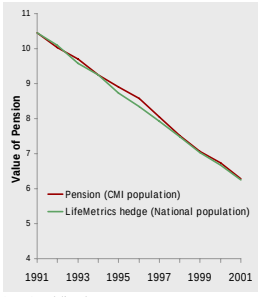
Distribution of liability value in 2018: Before and after hedging



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

Summary

- **Longevity hedging via the capital markets is now a reality**
  - Hedges are now available
- **A new market for longevity risk is emerging**
  - Key players will be pension plans and investors
- **Obstacles to market development are being addressed by LifeMetrics**
  - Standardisation
  - Education
- **Key messages**
  - Longevity risk should be measured and this can be done quite easily
  - You don't have to transfer 100% of the longevity risk for hedging to be worthwhile
  - Index hedges can be highly effective: Basis risk can be managed