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# HEDGING LONGEVITY RISK

**SVS Longevity Conference**

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J.P.Morgan

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# Overview

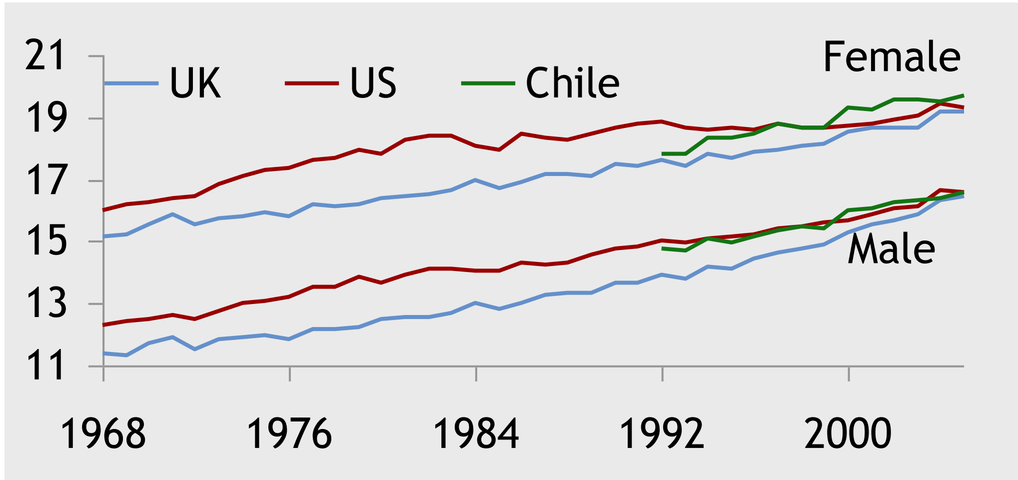
- **A new market for longevity and mortality risk is emerging**
  - Based on the capital markets
  - Involves insurance companies and pension plans as hedgers
- **Longevity risk transfer deal via the capital markets have been done**
  - Hedges have been traded
- **Customized Hedges**
  - Mimic reinsurance but in capital markets format
- **Standardized Index Hedges**
  - A new paradigm based on risk management rather than indemnification
  - Basis risk can be managed

# Longevity risk reflects the uncertainty in future life expectancy

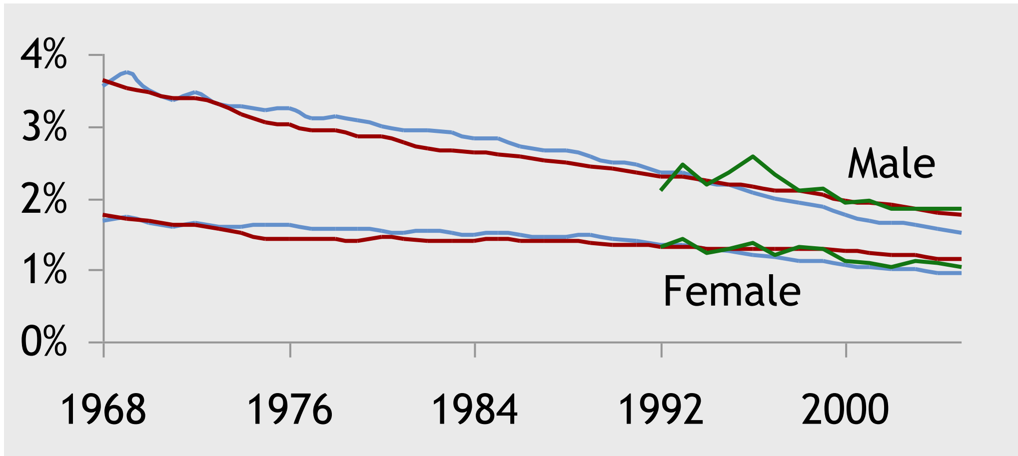
- **Life expectancy has been steadily improving**
  - Common trends across countries
  - Increasing longevity is driven by falling or "improving" mortality rates

- **Uncertainty in future improvements is trend-driven**
  - Usually a long-term, cumulative risk
  - Increases in longevity materialise gradually

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




**Mortality rates for 65-year olds**



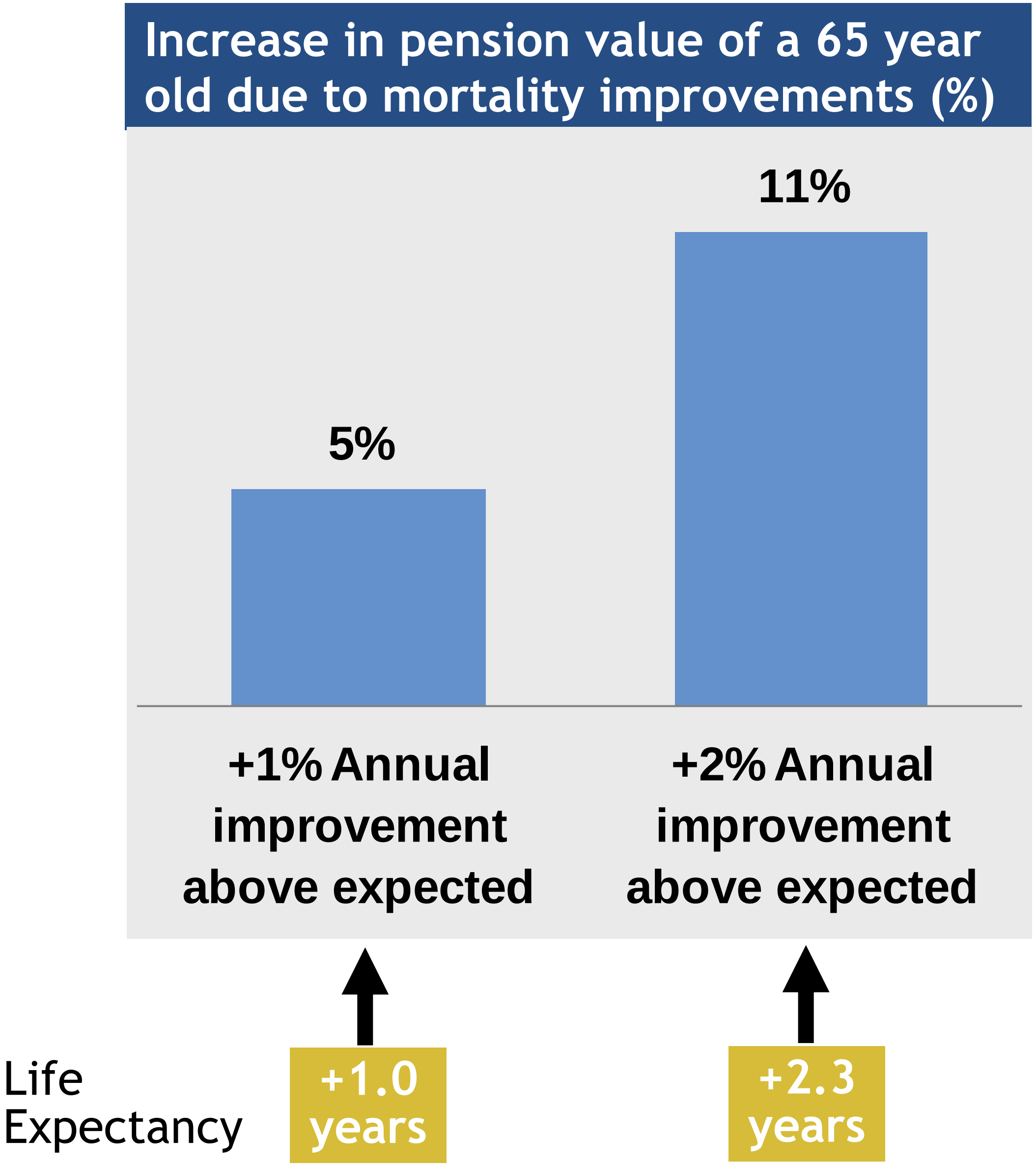

Source: LifeMetrics Index and Human Mortality Database

1. So-called "period" life expectancy assuming no further improvements in mortality

# The cost of providing a pension increases dramatically with increasing longevity

- The value of providing a pension depends on the **expected trend of future mortality improvements**

- **Longevity risk:**
  The risk is that the trend of mortality improvements is greater than expected



# Capital markets solutions for longevity risk transfer are complementary to insurance solutions

- **Insurance-based solutions**
  - Annuities
  - Longevity insurance

- **Capital markets-based solutions**
  - **Customized** longevity hedges
  - **Standardized (Index)** longevity hedges

## Longevity risk transfer format

- **Longevity Bond** (funded) vs **Longevity Swap** (derivative)
- **Customised** (longevity of beneficiaries) vs. **Standardised** (longevity index)

# Customized hedges vs. Standardized Index hedges



## Customized Hedge:

- **Tailored** to reflect actual longevity experience of the pension/annuitants
- Maturity of Hedge:
  - When last annuitant dies
- Indemnification paradigm

=> Exact hedge

## Standardized Index Hedge:

- **Standardized** to reflect national population longevity experience
  - But calibrated to match mortality sensitivity of liabilities
- Maturity of Hedge:
  - Finite
- Risk management paradigm

=> Cheaper, more liquid

**Standardized has advantages of simplicity, cost & liquidity**

# LifeMetrics is a toolkit for longevity risk management

lifeMetrics
www.lifemetrics.com

**LifeMetrics Toolkit**

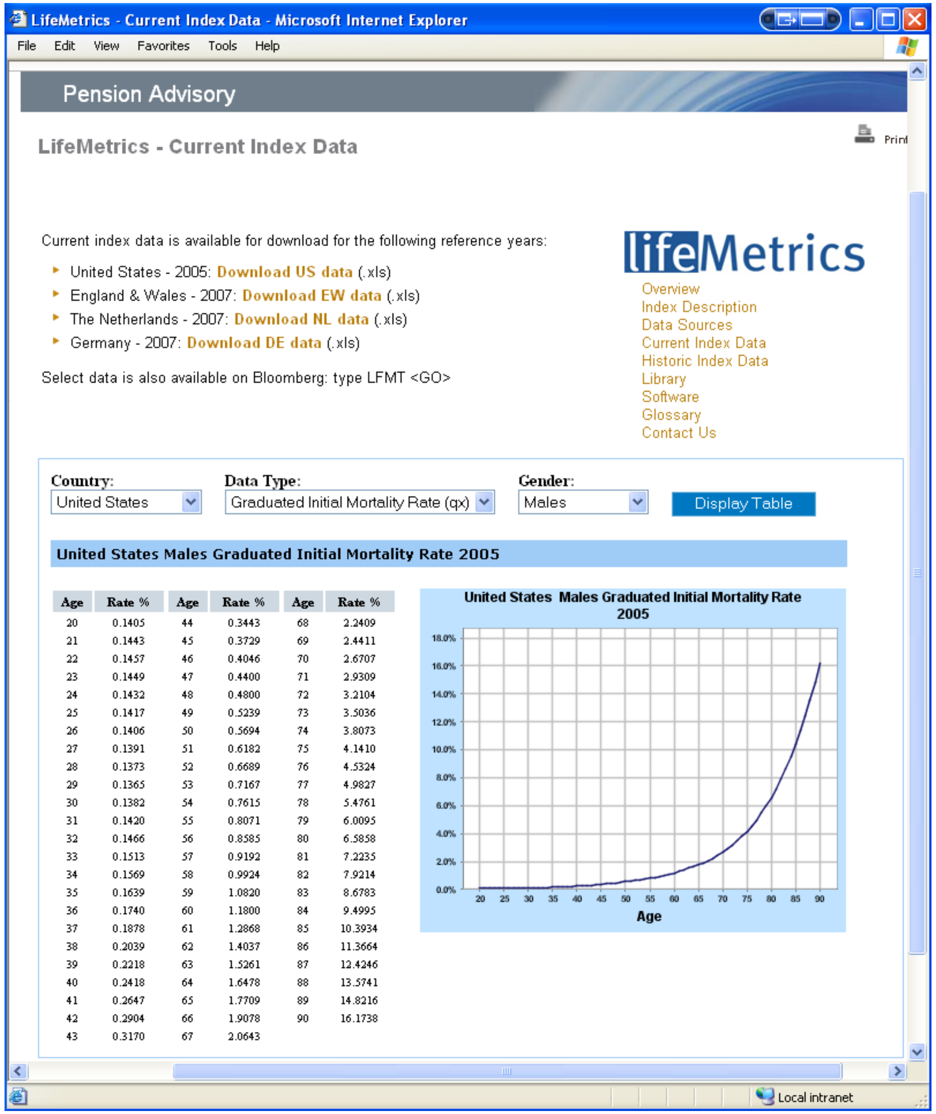
- **Launched by J.P. Morgan in March 2007 - free to all**
  - **Longevity Index**
    - Longevity and mortality indices – national population
    - England & Wales, US, the Netherlands and Germany
  - **Framework**
    - Documents and analytics for risk management
  - **Software**
    - Tools for modelling and forecasting mortality

**Features**

- Open-source, transparent, non-proprietary and free
- Independent Calculation Agent
- Independent Advisory Committee

# LifeMetrics Index:
# Current and historic data available on website and Bloomberg

- **www.lifemetrics.com**
- **Bloomberg: LFMT <GO>**
- Designed for trading:
  - Increases visibility of longevity risk
  - Provides a standardised reference for longevity hedges
- Broken down by age, gender, country, metric
- Full documentation
- Free, no login needed



LifeMetrics - Current Index Data - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Pension Advisory

LifeMetrics - Current Index Data

Print

Current index data is available for download for the following reference years:

- United States - 2005: Download US data (.xls)
- England & Wales - 2007: Download EW data (.xls)
- The Netherlands - 2007: Download NL data (.xls)
- Germany - 2007: Download DE data (.xls)

Select data is also available on Bloomberg: type LFMT <GO>

lifeMetrics

Overview
Index Description
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Current Index Data
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Country: United States | Data Type: Graduated Initial Mortality Rate (qx) | Gender: Males | Display Table

**United States Males Graduated Initial Mortality Rate 2005**

| Age | Rate % | Age | Rate % | Age | Rate % |
|---|---|---|---|---|---|
| 20 | 0.1405 | 44 | 0.3443 | 68 | 2.2409 |
| 21 | 0.1443 | 45 | 0.3729 | 69 | 2.4411 |
| 22 | 0.1457 | 46 | 0.4046 | 70 | 2.6707 |
| 23 | 0.1449 | 47 | 0.4400 | 71 | 2.9309 |
| 24 | 0.1432 | 48 | 0.4800 | 72 | 3.2104 |
| 25 | 0.1417 | 49 | 0.5239 | 73 | 3.5036 |
| 26 | 0.1406 | 50 | 0.5694 | 74 | 3.8073 |
| 27 | 0.1391 | 51 | 0.6182 | 75 | 4.1410 |
| 28 | 0.1373 | 52 | 0.6689 | 76 | 4.5324 |
| 29 | 0.1365 | 53 | 0.7167 | 77 | 4.9827 |
| 30 | 0.1382 | 54 | 0.7615 | 78 | 5.4761 |
| 31 | 0.1420 | 55 | 0.8071 | 79 | 6.0095 |
| 32 | 0.1466 | 56 | 0.8585 | 80 | 6.5858 |
| 33 | 0.1513 | 57 | 0.9192 | 81 | 7.2235 |
| 34 | 0.1569 | 58 | 0.9924 | 82 | 7.9214 |
| 35 | 0.1639 | 59 | 1.0820 | 83 | 8.6783 |
| 36 | 0.1740 | 60 | 1.1800 | 84 | 9.4995 |
| 37 | 0.1878 | 61 | 1.2868 | 85 | 10.3934 |
| 38 | 0.2039 | 62 | 1.4037 | 86 | 11.3664 |
| 39 | 0.2218 | 63 | 1.5261 | 87 | 12.4246 |
| 40 | 0.2418 | 64 | 1.6478 | 88 | 13.5741 |
| 41 | 0.2647 | 65 | 1.7709 | 89 | 14.8216 |
| 42 | 0.2904 | 66 | 1.9078 | 90 | 16.1738 |
| 43 | 0.3170 | 67 | 2.0643 | | |



**Chilean Index will be produced using the same robust framework**

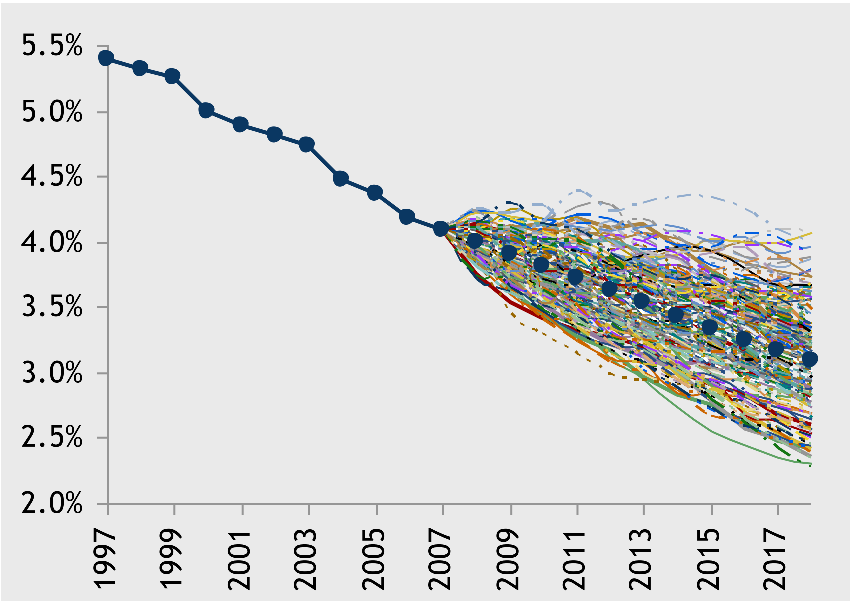
# Software and research resources available from website

- Research papers on website
- Software available on website

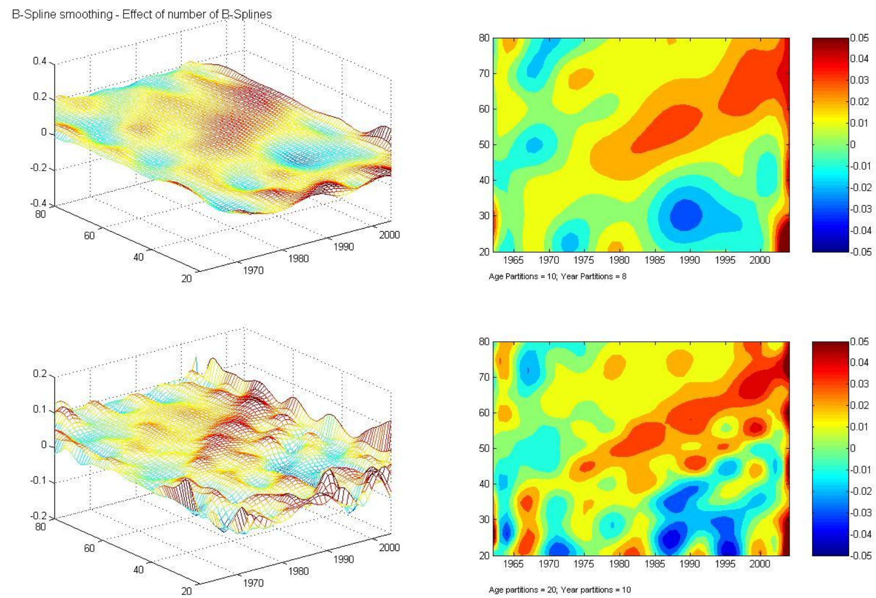
## Research mortality projection models

| Model | formula | |
|---|---|---|
| M1 | $\log m(t,x) = \beta_x^{(1)} + \beta_x^{(2)}\kappa_t^{(2)}$ | L-C |
| M2 | $\log m(t,x) = \beta_x^{(1)} + \beta_x^{(2)}\kappa_t^{(2)} + \beta^{(3)}\gamma_{t-x}^{(3)}$ | R-H |
| M3 | $\log m(t,x) = \beta_x^{(1)} + \kappa_t^{(2)} + \gamma_{t-x}^{(3)}$ | Currie |
| M4 | $\log m(t,x) = \sum_{i,j}\theta_{ij}B_{ij}^{ay}(x,t)$ | P-splines |
| M5 | $\text{logit } q(t,x) = \kappa_t^{(1)} + \kappa_t^{(2)}(x-\bar{x})$ | CBD |
| M6 | $\text{logit } q(t,x) = \kappa_t^{(1)} + \kappa_t^{(2)}(x-\bar{x}) + \gamma_{t-x}^{(3)}$ | CBD-x1 |
| M7 | $\text{logit } q(t,x) = \kappa_t^{(1)} + k(x-\bar{x}) + \gamma_{t-x}^{(3)}$ | CBD-x2 |
| M8 | $\text{logit } q(t,x) = \kappa_t^{(1)} + \kappa_t^{(2)}(x-\bar{x}) + \gamma_{t-x}^{(3)}(x_c - x)$ | CBD-x3 |

## Mortality rate simulations




## Surface of mortality projections



# Chile longevity bond:
# A standardized index hedge of longevity

- **The longevity bond is a long-dated UF-denominated amortizing bond**
  - Sponsored by the World Bank which is a counterparty to the transaction
  - Structured by J.P. Morgan
  - Partnership with SVS
- **Bond amortizes on the basis of a longevity index of Chilean annuitants**
  - The longevity index is constructed from SVS data on Chilean annuitants
  - The longevity index provides the longevity hedge
- **The longevity bond provides three benefits to insurers**:
  - A Longevity Hedge
  - An Attractive Investment
  - Capital Relief

# Outline of the longevity bond

1. Chilean life insurance company ("insurer") purchases a UF-denominated Longevity Bond issued by an SPV
   - Each year, the insurer receives a UF cash flow corresponding to the annuity payments associated with the longevity index
   - Longevity of insurer's annuitants is highly correlated with the longevity of the index
2. The SPV purchases a portfolio of bonds which are held in a collateral account
3. JPMorgan enters into a longevity swap with the World Bank/re-insurer to receive the actual Longevity Index level and pay the best-estimate in each year
4. The SPV enters into a swap with J.P. Morgan to exchange the bond cash flows for the UF Cashflows that are linked to the actual longevity index
5. The insurer receives annual UF payments linked to actual longevity index

# Chile longevity bond structure