Reinsurance of longevity: risk transfer and capital management solutions

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### Plan

<table>
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<th>Longevity risk. Where reinsurance can help?</th>
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Longevity risk: insured living longer than expected by pension/annuity provider

Female life expectancy at age 65

Switzerland:
Age at death distribution
Mortality evolution: changing drivers

Historical demographic regimes (Europe: up to mid-XVIII century)
- Prevalence of infectious diseases
- Significant fluctuations due to epidemics, famines (bubonic plague - mid. XIV century)
  - High mortality

Receding of infectious pandemics
(Europe: mid-XVIII century – beg. 1960's)
- The epidemics become rare
- Infectious diseases back off
- Mortality declines, fluctuations decrease

Cardio-vascular revolution
(Europe: from 1970s)
- Reduction infectious diseases contribute little to the increase of life expectancy
- Cardio-vascular diseases become the main driver of mortality decrease
- Society diseases make less deaths

A new stage? (mid 80-s +)
- Mortality reductions at increasingly older ages
- Treatment and prevention of cerebrovascular diseases
- Greater attention paid to the health of the elderly

Global Life
Longevity risk components

Random fluctuations

**RF1: intrinsic - volatility due to the oscillations around the trend:**
Year to year variation in mortality around a mean that is due to irregular trends in epidemics, weather etc.

**RF2: sampling risk - volatility due to portfolio’s size and heterogeneity:**
A small portfolio does not allow for a good mutualisation. Moreover, if annuity amounts are very heterogeneous, survival of a few particular annuitants can significantly change future cash flows.

*Death rates for the general population (ONS - red) and for pensioners (CMI - blue) on the log scale, females:*

![Graphs showing death rates for general population and pensioners from age 60 to 90]
Longevity risk components

**T: Trend**
The mortality improvement is not a diversifiable risk: it affects the whole portfolio and thus cannot be managed using the law of large numbers.

**L: Current mortality level estimation**
Estimation error based on observed mortality experience: the error is larger for small populations (or for poorly represented age groups).

*Increase in pension value due to the level or trend misestimation and additional investment return on the reserves needed to compensate for it*
(example based on the French table TGH05/TGF05 with flat interest rate of 3%):

<table>
<thead>
<tr>
<th></th>
<th>females</th>
<th>males</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Doubled improvements</td>
<td>Mortality level at 80% of the expected (SCR shock)</td>
</tr>
<tr>
<td></td>
<td>pension value</td>
<td>interest rate</td>
</tr>
<tr>
<td>65</td>
<td>+5.7%</td>
<td>+43bp</td>
</tr>
<tr>
<td>75</td>
<td>+5.2%</td>
<td>+55bp</td>
</tr>
<tr>
<td>85</td>
<td>+3.6%</td>
<td>+60bp</td>
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Longevity risk components

- RF random fluctuations
  - RF1 intrinsic
  - RF2 sampling risk
Longevity risk components:

- RF random fluctuations
  - RF1 intrinsic
  - RF2 sampling risk

- T trend
  - selected model
  - selected calibration period

Intrinsic fluctuations
Sampling fluctuations
Real trend
Error in trend estimation
Longevity risk components

- RF random fluctuations
  - RF1 intrinsic
  - RF2 sampling risk
- T trend
  - selected model
  - selected calibration period
- L current level estimation
Longevity risk: forecast uncertainty

- Impact of each risk component

**Short term forecast**
- RF - random fluctuations
- L - current level estimation

**Long term forecast**
- T – trend risk
- RF2 - sampling risk (for small portfolios)
How to decrease uncertainty?

- L - level estimation
- RF2 - sampling fluctuations
- RF1 - yearly variations in national mortality
- T - trend risk

- Lower margins due to “decreased uncertainty”
  (large volumes; geographical distribution)
- Expertise in longevity risk estimation and follow-up
- Tailor-made solutions based on Insurer’s requests

Size

- geographical distribution + mutualisation across ages
  - not diversifiable (could be partially offset by mortality products & geographical distribution)

- reinsurance
### Plan

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Ways to cover longevity risk

- Indemnity
- Quota-share
- Reinsurer
- Excess cover
- Exit option
- Longevity swap
- Index-based
- Term contract
- Until expiry
- Financial market
What impacts the choice of cover?

- Reserving level (Best Estimate or regulatory table? Assets?)
- Portfolio characteristics (size? in payment? part of deferred? …)
- Administration system
- Internal model / Solvency regime
- Diversification
Two categories of longevity hedge:

**Indemnity**

- reflects actual longevity experience of the insured portfolio –

Based on actual payments made to annuitants!
Choosing your type of hedge

**Index based**

- cost effective as less due-diligence required
- no charge on the administration system: no exchange of seriatim data, death certificates, etc.
- straightforward calculation of parties’ liabilities
- capital release
- exit option and recalibration sometimes possible
- more potential counterparties

- basis risk stays with the insurer: not a PERFECT hedge
- maturity: fixed (ex. 10 or 20 years)
- reliance on index availability

**Indemnity**

- PERFECT hedge as reflects actual longevity experience of the insured portfolio
- maturity: until the last member dies; but could be fixed
- capital release
- traditional counterparties and treaty wordings
- risk completely out of the balance sheet

- higher due diligence and monitoring cost
- generally no exit option
- less transparent for the investors
Longevity index & basis risk

- Population basis risk

**Underlying portfolio population ≠ National population**

**Differences in:**
- Age and gender distribution
- Socio-economic profile
- Geographical distribution
- Size

**Differences in:**
- Current level of mortality
- Improvements of mortality
- Random fluctuations

Carefully constructing and rebalancing the hedge
Choosing a type of cover

**Longevity swap**
- Only biometric risk is transferred
- Annual predetermined cash flows are swapped for actual annuity payments
- Could be indemnity or index based
- Credit risk limited to longevity deviation

**Quota - share**
- Both longevity and asset risks are transferred (eventually split between different risk takers)
- Indemnity cover
- Higher credit risk

**Excess cover**
- Only biometric risk is transferred
- Extreme deviations are covered
- Solution mainly for capital relief
Choosing a counterparty/type of contract

Financial market
- Potentially liquid!
- More counterparties
- Collateral requirement more stringent
- Short maturity
- Execution risk

Reinsurer
- Traditional counterparty
- Maturity
- Collateral cost
- Less liquid

Why not both?
## Plan

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Example 1: Classical longevity swap

**Reinsurer**

Actual annuities

Fixed (predetermined) cash flow

**Insurer**

Realised cash flows

Fixed cash flow
Reinsurance pricing

Reinsurance price = Best Estimate liabilities = Cost of capital + Expenses

Uncertainty linked to longevity risk components & operational risk

L- mortality level + T - mortality trend

Global Life
RF – random fluctuation components : influence of portfolio heterogeneity

### Pension amount

<table>
<thead>
<tr>
<th>Gender</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Females</td>
<td>3 180</td>
<td>4 348</td>
<td>5</td>
<td>91 188</td>
</tr>
<tr>
<td>Males</td>
<td>4 463</td>
<td>5 416</td>
<td>5</td>
<td>75 013</td>
</tr>
</tbody>
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### Distribution of amounts

- 1% of the highest pensions account for 8% of the total volume
- 5% of the highest pensions account for 27% of the total volume
- 10% of the highest pensions account for 41% of the total volume
L - mortality level component: influence of portfolio heterogeneity

- Split the portfolio into homogeneous sub-groups:
  - Generally pension size is a good proxy to social class,
  - Keep the number of subgroups limited in order to maintain results significant,
  - Check against external datasets (ex. mortality by postcode).

- Example: 5 subgroups based on pension size. A/E ratio in lives and in amounts

<table>
<thead>
<tr>
<th>Pension size</th>
<th>A/E (lives)</th>
<th>A/E (amount)</th>
<th>Nb of deaths</th>
<th>Exposure (lives)</th>
<th>Exposure (amount)</th>
<th>% total (lives)</th>
<th>% total (amount)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 3 749</td>
<td>114%</td>
<td>112%</td>
<td>1 812</td>
<td>56 189</td>
<td>85 mln</td>
<td>67%</td>
<td>26%</td>
</tr>
<tr>
<td>3 750 – 7 499</td>
<td>98%</td>
<td>98%</td>
<td>263</td>
<td>15 220</td>
<td>81 mln</td>
<td>18%</td>
<td>24%</td>
</tr>
<tr>
<td>7 500 +</td>
<td>88%</td>
<td>85%</td>
<td>158</td>
<td>11 891</td>
<td>165 mln</td>
<td>14%</td>
<td>50%</td>
</tr>
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<th>Exposure (lives)</th>
<th>Exposure (amount)</th>
<th>% total (lives)</th>
<th>% total (amount)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 2 999</td>
<td>101%</td>
<td>102%</td>
<td>665</td>
<td>26 978</td>
<td>31 mln</td>
<td>73%</td>
<td>31%</td>
</tr>
<tr>
<td>3 000 +</td>
<td>86%</td>
<td>72%</td>
<td>115</td>
<td>9 879</td>
<td>70 mln</td>
<td>27%</td>
<td>69%</td>
</tr>
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Cost of capital

- Cost of capital is lower if good volume / high quality mortality experience provided by Client.

Example: Cost of capital linked to uncertainty in L-level estimation is 2.5 times higher for mortality experience based on 2000 deaths compared to that based on 300 deaths
Capital Solvency II: impact of reinsurance

(*) SCR estimated by standard formula
Insurer’s obligations

In order to propose the best price through limiting the operational risk for the reinsurer: strict requirements on the administration (especially if insurer keeps a very small retention)

- Certificates of existence and death certificates
- Financial penalties
- Right to audit
- List of data provided to SGL at outset and monthly
- Control of payments
- Termination rights due to persistent administrative breaches
- .....
Example 2: Index based solution for capital optimisation
Example 2: Index based solution for capital optimisation

- Scenario: Longevity is higher than expected and breaks the attachment point; Reinsurer makes a payment to the cedent.

- Possibility: Exit option after 5 years to recalibrate the index and optimise the economy of capital.
Example 3: Index-based solution for optimising capital through diversification

- Two counterparties, one overweight on longevity, another on pandemic risk: exchange of exposures

- Attachment points sufficiently far away to optimise capital release on both sides and minimise premium exchange: a win-win situation.
Scor Global Life added value

- Solutions tailored to your specific requirements
- Mortality analysis and forecasting
- Advise on claims payment monitoring
- High level expertise thanks to our R&D Centre on Longevity & Mortality Insurance
Thank you for your attention!