The Life and Death Balance
Mitigating solvency capital requirements through hedging mortality and annuity exposure

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Investigating Future Mortality: Blending Medical & Actuarial Science for Life & Longevity Risk Management
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Agenda

- Overview of the Longevity-Mortality Hedge
- Example Portfolios
- Hedging Trend Risk
- Hedging Shock Risk
- Combining Trend and Shock Risk
- Risk Transfer Strategies
- Conclusions
Overview of the Longevity-Mortality Hedge
Overview of the Longevity-Mortality Hedge

An insurer writing both longevity and mortality business can expect some degree of natural hedge:

- **If life expectancy increases**
  - *Annuity losses* (more pension payments)
  - *Life gains* (more premium income, less or more distant death benefit payouts)

- **If an excess mortality event occurs:**
  - *Life losses* (increased / accelerated death benefit payouts and loss of premium income)
  - *Annuity gains* (a certain number of pension contracts go away)
Example Portfolios
Annuity Book is Older

- **Annuity Book**
  - Mean age: 68
  - Liability: £1bn

- **Whole Life Book**
  - Mean age: 35
  - Coverage: £10bn
Life Book Mortality Is Lighter

- Life book base mortality ~60% of annuitant mortality

![Graph showing Life mx / Annuity mx vs Age](image_url)
Life Book Has Longer Duration

- Annuity book duration: ~10 yrs
- Life book duration:  >20 yrs
Increasing mortality with age sustains death benefit payments over 4 decades

Premium income decays with policy lapses
Hedging Trend Risk
Life Book Sensitive to Cumulative Mortality Improvement Over Longer Time Frame

- Only death benefits sensitive to trend
Life Book Sensitive to Mortality Improvement over Wider Age Range

- Change in liability under a 1% per-annum trend shock at each age

![Graph showing change in liability for Annuity Book and Life Book over different age ranges. The x-axis represents Trend Shock Age, and the y-axis represents Change in £. The graph shows that the Life Book is more sensitive to mortality improvement over a wider age range, with peaks at around age 80.](image-url)
Trend Risk Correlation in range of -25% to -50%

<table>
<thead>
<tr>
<th>Annuity Liability (£ billion)</th>
<th>Life Liability (£ billion)</th>
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<tbody>
<tr>
<td>-0.250</td>
<td>0.975</td>
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<tr>
<td>-0.225</td>
<td>0.950</td>
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<td>0.350</td>
<td>0.375</td>
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</table>

Risk Capital: p95 of run-off PV (£ million)

| Annuity | 30 |
| Life    | 30 |
| Life + Annuity | 30 |
| Saving  | 15 |

Risk Capital: p99.5 of best estate at $t_0 + 1$ (£ million)

| Annuity | 25 |
| Life    | 25 |
| Life + Annuity | 30 |
| Saving  | 07 |
Trend Risk Hedge – from £60m of risk capital to £42m to £30m

- ~£10bn of whole life coverage provides a material trend risk hedge against a £1bn annuity book

- Assuming independence: £60m of risk capital (£30m against each book) can be pooled to give a diversified risk capital of £42 million

- SII permits a -25% correlation between longevity and mortality trend risk: frees up an extra £6 million bringing the diversified capital to £36 million

- In current example economic risk capital falls to £30 million (-50% correlation)
Hedging Shock Risk
Pandemic Impacts Vary By Age

Emerging infectious disease excess mortality

- Flat
- Young&Old
- Middle Aged

Life

Annuity

% of Exposure

Age

Emerging infectious disease excess mortality

- 5-9
- 10-15
- 15-19
- 20-24
- 25-29
- 30-34
- 35-39
- 40-44
- 45-49
- 50-54
- 55-59
- 60-64
- 65-69
- 70-74
- 75-79
- 80-84
- 85-90
- 90-95
- 95+

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Shock Mortality Losses Strongly Offset by Annuity Gains

annuity £5bn : £10bn life

\[ \rho = -98\% \]

p99.5 of annuity + life PV

annuity £Xbn : £10bn life

Life Liability £bn

Annuity Liability £bn

Life + Annuity Reserve £m

Expected Annuity Liability £bn
Shock Risk Hedge – as Annuity PV approaches Parity with Life Cover, Shock Risk is Neutralized

- ~£6m of risk capital held at the 1-in-200 level against shocks on £10bn of whole life coverage

- Conversely annuity book with liability of £5bn stands to gain ~£6m from a 1-in-200 pandemic

- As annuity book grows > £6-7bn, begin to expect a gain in the event of a pandemic

- As annuity book reaches £10bn only negligible potential for a pandemic loss remains

- Solvency II framework doesn’t recognize shock hedge: life cat module only applies to portfolios that are short mortality
Combining Trend and Shock Risk
Run-off Trend and Shock Risk

- £1.2bn of annuity hedges
- £10bn of life – hedge dominated by trend risk offset

\[ \rho = -45\% \]
1-year Shock Risk with Run-Off Trend Risk

- £1.6bn of annuity hedges
- £10bn of life – hedge still dominated by trend risk offset

- Reserves at p99.5 of shock (1st yr only) & p95 of trend
Assuming £10bn of life coverage:

- **Trend risk:** optimally hedged by ~£1bn annuity book
- **Shock risk:** optimally hedged by >£10bn annuity book
- **Trend + Shock Risk:** optimally hedged by ~£1bn annuity book
Risk Transfer Strategies
Targeting an Optimal Mix of Mortality and Longevity Risk

- Insurer with an over concentration of Longevity Risk is in a strong position to digest complementary Mortality Risk and vice-versa

- Complementary risk can be acquired via reinsurance, insurance linked securities etc. targeting an optimal mix of mortality and longevity risk

- Unwanted risk can be disposed of via the same mechanisms
Risk Swap: 50% Reduction in Risk Capital … For Free!

### Before Swap

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<th>Long Co.</th>
<th>Mort Co.</th>
<th>Mort Co.</th>
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<tr>
<td></td>
<td><strong>Annuity Bk</strong></td>
<td><strong>Life Book</strong></td>
<td><strong>Annuity Bk</strong></td>
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<td><strong>Size (£bn)</strong></td>
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<td>0</td>
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<tr>
<td><strong>Shock Capital (£m)</strong></td>
<td>-</td>
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<td>-</td>
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<tr>
<td><strong>Trend Capital (£m)</strong></td>
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<tr>
<td><strong>Total Risk Capital</strong></td>
<td><strong>80</strong></td>
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### After Swap

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<tr>
<td><strong>Shock Capital (£m)</strong></td>
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<td>-</td>
</tr>
<tr>
<td><strong>Trend Capital (£m)</strong></td>
<td>40</td>
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<td>40</td>
</tr>
<tr>
<td><strong>Total Risk Capital</strong></td>
<td><strong>38</strong></td>
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Conclusions

- Life and annuity are well diversified lines of business.
- Risk between each is correlated at < 0%.
- Solvency II recognizes the trend risk offset which can be leveraged for regulatory capital reductions.
- In addition, firms writing both annuity and life may be able to free up economic risk capital by looking holistically at trend and shock risk across all lines of business.
- Risk swaps are a cost efficient method for attaining a more efficient capital position.
Hedge analysis techniques and benefits are included in the RMS whitepaper on Solvency II.

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