The Life-Annuity Offset
Quantifying the Benefits
of a Diversified Portfolio

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RMS LifeRisks
Agenda

- Longevity Risk – where does it belong?
  - Perspective of the annuity writer
  - Perspective of the life insurer

- Quantifying the Life Annuity – Offset
  - Trend Risk
  - Shock Risk

- Constructing a Diversified Portfolio
  - Balancing mortality and longevity risk
  - Risk transfer
Longevity Risk  Where does it belong?
Longevity Risk: the path to security

Corporate Pensions

Capacity

Insurer / Reinsurer

Capital Markets
Corporate wants to Transfer Longevity Risk on $10bn of Annuities
Where should it go?

US Corporate with $10bn in pension liabilities

Pension Risk

Acme Pension
or

Acme Life Insurance

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About the Transaction: a buy-out style risk transfer

Transfer from US Corp to Insurer

(1) pension obligations
(2) assets to cover expected value of pension obligations
(3) risk premium

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About the Risk: US Pensions in Payment

- Mean Liability: $10bn
- Std Liability: 3% of mean
- Location: US
- Mean pensioner age: 70
How attractive is this risk?
The Case for Acme Pension: 
*weak diversification from existing risks*

Risk correlation $\rho=90\%$
Acme Pension’s Marginal Capital Requirement is Significant

- **US Corp Annuity Risk**: $500m (risk capital in)
- **Marginal Risk Capital Required by Acme Pension**: $500m
- **Risk Premium paid by US Corp**: $200m

Duration = 10 yrs

Yield = base rate + 340bps

Risk capital investment by Acme Pension: $500m

Risk premium paid by US Corp: $200m

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The Case for Acme Life

**strong diversification / offset from existing risks**
Acme Life’s marginal capital requirement is negligible: $150m of risk premium can be realized as income

Duration of liabilities = 10 years

$150m (risk premium – risk capital out)

$50m (risk capital out)

<table>
<thead>
<tr>
<th>% of Liabilities Transferred</th>
<th>US Corp Annuity Risk</th>
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</thead>
<tbody>
<tr>
<td>0%</td>
<td>$200m Risk premium paid by US Corp</td>
</tr>
<tr>
<td>1%</td>
<td>$50m Risk Premium</td>
</tr>
<tr>
<td>2%</td>
<td>Marginal Risk Capital Required by Acme Life</td>
</tr>
<tr>
<td>3%</td>
<td>Longevity Risk</td>
</tr>
<tr>
<td>4%</td>
<td>5%</td>
</tr>
<tr>
<td>$50m</td>
<td>Risk Capital out</td>
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<tr>
<td>$200m</td>
<td>Risk Premium paid by US Corp</td>
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Quantifying the Life Annuity Offset
Correlated Mortality => Correlated Liability

RMS Risk Models

Longevity Model

Excess Mortality Model

Positively Correlated Mortality Forecasts

Negatively Correlated Gains / Losses

Life Book Mortality

$q_{x,t}$

Annuity Book Mortality

$q_{x,t}$

Life Liability

Annuity Liability

$\rho$

$\rho$

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Perils Impacting Life and Annuity Business

**Trend Risk**
Adverse trends in mortality rates may evolve over time owing to progress in medicine and lifestyle

**Shock Risk**
Catastrophic shocks to mortality can occur as point processes in any given year
Simulate correlated mortality trends owing to lifestyle and medical progress impacting multiple portfolios.
How to Simulate Correlated Mortality Trends?

5 drivers of mortality improvement – “Vitagions”
Vitagions Reduce Mortality Over Time

- Maximum reduction possible ($V_{\text{max}}$)
- Slowest Trend
- Expected Trend
- Fastest Trend

Lifestyle

E.g. reduction due to Lifestyle advances

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Vitagion Reductions Combined Multiplicatively

\[ m(x, t) = m(x, t_0) \cdot \prod_{j=1}^{5} F_j(x, t) \cdot \text{cohort term} \]
Vitagions Have Correlated Impacts on Portfolios
Correlation Depends on Portfolio Demographics

Vitagion Correlation is sensitive to:
- Country
- Gender
- Age
- Business type

Medical intervention has the highest correlation globally among all Vitagions
ρ = -75 %

Whole Life

Annuity Book

Standalone Annuity Risk

Combined Risk
Loss ($units)

Small duration of Group Life book leads to lower trend risk correlation
Framework for Quantifying Shock Offset

Simulate mortality shocks simultaneously impacting multiple portfolios

- Infectious Disease
- Terrorism
- Natural Hazards
- Residual Loss

Life Contracts
- Book A
Life Contracts
- Book B
Annuity Contracts
- Book C
How To Simulate Correlated Mortality Shocks?

Infectious disease pandemics are the primary driver of excess mortality
How To Simulate Correlated Mortality Shocks?

Incidence
If a pandemic impacts my life book, will it also impact my annuity book?

Severity
Should I expect a similar magnitude of loss in my different portfolios?
Pandemic Incidence: close to 100% correlation

Pandemics are Global Events

- Modern travel patterns ensure the rapid global spread of a pandemic virus

- Assume all portfolios will be impacted to some extent in the event of a pandemic outbreak
Correlation in Severity: Depends on Demographics

Correlation Factors

- **Age**: different types of virus preferentially target different age groups

- **Gender**: males & females can be differentially impacted on account of biological differences and gender specific societal roles

- **Country**: similar countries can experience divergence outcomes due to inherent stochasticity in the progression of a pandemic and the efficacy of counter measures
Characteristic profile: Residual immunity of the elderly
- Pandemic targeting the working-age population.
- High loss in Group Life (working-age exposure), but negligible gain in Annuity (older exposure).

\[
\rho = -80\% 
\]
Constructing a Diversified Portfolio
I want to balance my mortality book with annuities…

How much do I need?

Factors to consider:
- Trend risk offset
- Shock risk offset
How Much Annuity Business..
To balance a $10bn life book?
I’m Reaching Capacity on Annuities….

What now?

Corporate Pensions

capacity

Insurer / Reinsurer

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**Longevity / Mortality Cat Bonds**

Buying Capital Relief in the Capital Markets

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**Insurer/Sponsor**

Wants protection against high mortality improvement

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**Investor**

Seeks spread for shouldering some longevity risk

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**Longevity Cat Bond**

Rating: BB+
Basic Parametric Structure
Principal at risk from shock to mortality trend

Loss of principal depends on general population mortality

General Population Mortality

Principal reduction = 0%

Principal reduction = 100%
How Much Tail Risk might I Securitize?

What are the costs / benefits?

(1) Mortality / longevity Risk
(2) Big Premium

Acme Insurance

(1) Tail Risk
(2) Small Premium

Capital buffer against retained risk tied up for 10 years

Low yielding fixed income assets

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Reduction in Risk Capital….

But at What Price?

Does the cost of securitizing the tail pay for itself in risk capital relief?
Cost per $1 of Capital Relief

- Assume investors require $E[\text{loss}] + 1\sigma$ to cover the tail
- Assume insurer holds capital to a 1in1000 solvency standard
Is $0.15 per $1.00 of capital relief value for money?

(a) no tail insurance: capital needed $930m

$730m (risk capital in)  
Duration = 10 yrs  
Yield = 5%  
$730m + $200m  
(risk capital & premium release)

(b) insure alpha = 10%: capital needed $380m

$180m + $70m (risk capital + tail insurance in)  
Duration = 10 yrs  
Yield = 7%  
$180m + $200m  
(risk capital & premium release)
Can Securitizing The tail Pay for Itself in Risk Capital Relief?

\[ \text{price} = E[\text{Loss}] + 0.8\sigma \]

\[ \text{price} = E[\text{Loss}] + \sigma \]

\[ \text{price} = E[\text{Loss}] + 1.2\sigma \]

Yield

Duration of liabilities = 10 years

alpha

risk capital release

risk capital + insurance price in

alpha

No insurance

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Thank-you

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