

Introduction

The Basis Risk Question

- We consider two populations with forces of mortality $\mu_1(x, t)$ and $\mu_2(x, t)$ at age x in year t , that is from time $t-1$ to time t .
- Assume that the first force of mortality is associated with the population for England and Wales.
- The second force of mortality can be associated with the actual lives underlying a portfolio identified for hedging,
- The problem is: given a pre-defined hedging instrument whose value is governed by changes in μ_1 , how effective is that instrument for hedging the liabilities of the pension fund or insurance company?

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The Group

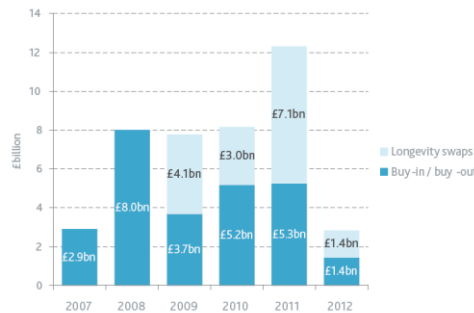
- LBRWG set up in December 2011 to think about the problem
- Joint group consisting of LLMA members and Actuarial Profession Affiliates

Name	Affiliation	LLMA or laFoA representative
Kevin Armstrong	AVIVA	LLMA
Peter Banthorpe	RGA	laFoA
Robert Bugg	Milliman	laFoA
Andrew Gaches	Hymans Robertson	laFoA
Torsten Kleinow	Heriot Watt University	laFoA
Jessica Mosher	AXA	LLMA
Pretty Sagoo (Chair)	Deutsche Bank	LLMA

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Overview: UK Longevity Market

- Proportion of buy outs/ buy ins/ indemnity swaps show that popularity of swaps is growing but index based hedging remains limited



Source: Hymans Robertson

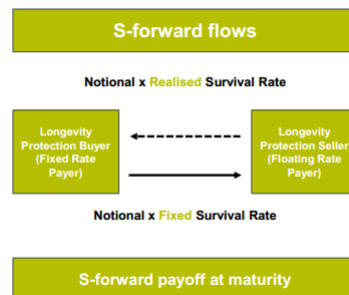
- Of deal flow shown, only £70m notional in 2011 was index-linked (Pall Pension deal – E&W Population linked)
- AEGON transaction in March 2012 on €12bn was also index-linked (Dutch Population Mortality)

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Benefits of Index Based Swaps: Why aren't they more popular for hedging risk?

Benefits

- Lower Cost
- Faster Execution
- Potential for liquidity
- Transparent
- Flexible structure



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Obstacles to Index Based Swaps: Progress made and remaining barriers

Addressed

- Standardization and transparency
 - Standardization of basic derivatives (q/s-forwards)
 - Launch of LLMA Indices
- Knowledge and education
 - Mainstream exposure
 - LLMA pricing framework
- Long-term nature of risk
 - Emergence of innovative structures appealing to both hedgers and investors

Outstanding

- Basis Risk
 - Cost-benefit analysis
 - Assessment of hedge effectiveness
 - Allowance for capital reduction (Solvency II)

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Types of Basis Risk: Three Main Categories

Demographic

- Socio-economic status
- Lifestyle
- Geography

Sampling

- Small population
- Large annuity amounts

Structural

- Choice of reference age and genders
- Duration of hedge

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Assessment of Basis Risk: Main Steps and Questions to Answer

Historical Analysis

- What relationship have the two populations demonstrated in the past?
 - Empirical assessment
 - Establish an underlying link

Modeling

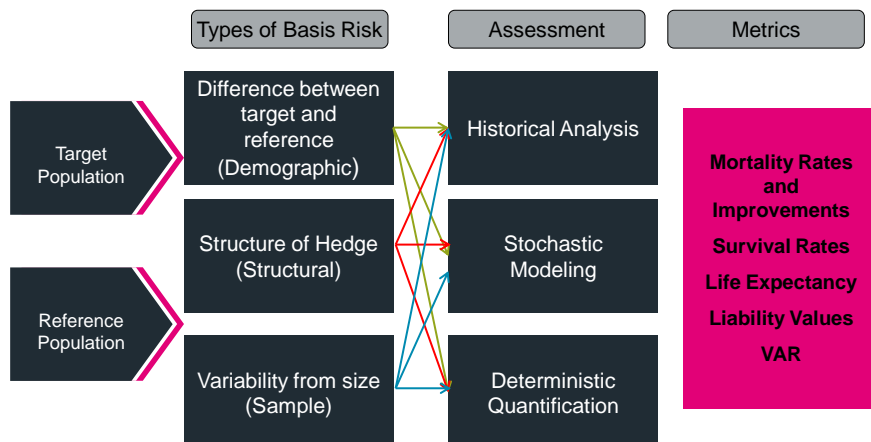
- What do you expect the future relationship to be?
 - Stochastic models
 - Two-population models

Measurement

- What measure to use for hedge effectiveness?
 - Deterministic quantification
 - Select appropriate metrics

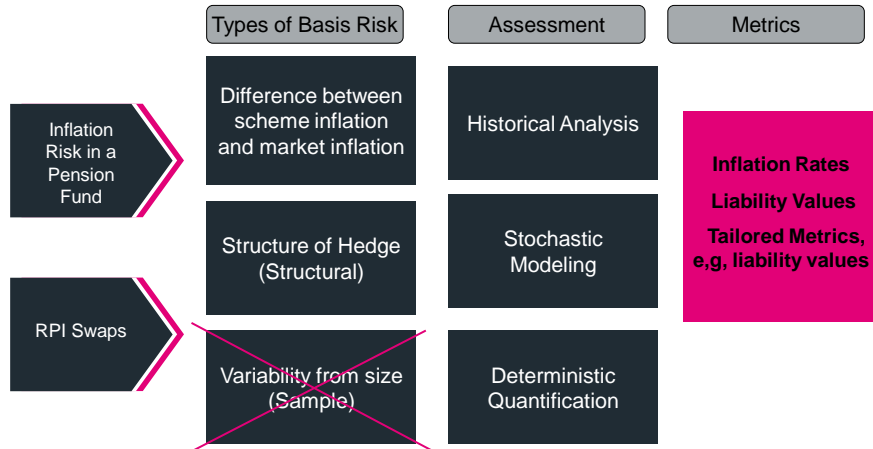
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Longevity Basis Risk



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Parallels with the Past: The early days of Inflation Risk hedging



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Assessment of Basis Risk: Historical Analysis

Objective

- Empirical assessment to link reference and target populations
- Understand key differences

Assessment

- Historical analysis of key metrics
 - Mortality rates
 - Life expectancy
 - Liability cash flows

Limitations

- Availability of historical data

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Assessment of Basis Risk: Modeling

Objective

- Predict future evolution of mortality for the two populations
- Model the underlying stable, long-term relationship

Assessment

- Stochastic two-population models
 - Derive long term trends from general population
 - Estimate difference in short term trends for the target population

Limitations

- Complexity of existing models
- Limited data for the target population to calibrate models

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Assessment of Basis Risk: Measurement

Objective

- Determine hedge effectiveness
- Cost-benefit analysis

Assessment

- Quantify risk reduction with metrics
 - Variance in value: $1 - \sigma^2_{(\text{Hedged Liability})} / \sigma^2_{\text{Liability}}$
 - Value at Risk: $1 - \text{VaR}_{(\text{Hedged Liability})} / \text{VaR}_{\text{Liability}}$

Limitations

- Necessary to select a metric consistent with hedging objectives
- Several dimensions should be considered in the decision to hedge

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Assessment of Basis Risk: What's missing?

- Easily transferable **assessment techniques**
- Long time series of **historical portfolio data**, especially for small schemes
- '**Rules of thumb**' for estimating basis risk given basic inputs (size, demographic, index)
- Widespread **knowledge of indices** and hedging **instruments** available
- Knowledge of **complex two-population** mortality models
- View on **hedge metrics** aligned with hedging objective

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The Longevity Basis Risk Working Group: The LLMA and the Institute and Faculty of Actuaries

Objective

- Define a practical methodology to assess basis risks for longevity transactions which is easily accessible to market practitioners

Work Performed

- Review of existing literature
- Identification of available inputs and desired outputs
- Simplified spreadsheet analysis

Conclusion

- Significant amount of research required
- Necessary to involve a consultancy or academic institute

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What are we trying to achieve?

(Very!) Simplified Case Study

Hedge Portfolio Assumptions

Hedge Portfolio Assumptions

Hedge Instrument	S-Forward
Maturity	10y
Reference Age	60y
Strike (survival) rate	83.8%
Hedge Contract Notional	£205,000

Annuity Portfolio Assumptions

Annuitant Ages	60, 65, 70,75,80,85
Annuity Amounts	£1000
Total Annuity Value after 1 year	£60,400

Projection Details

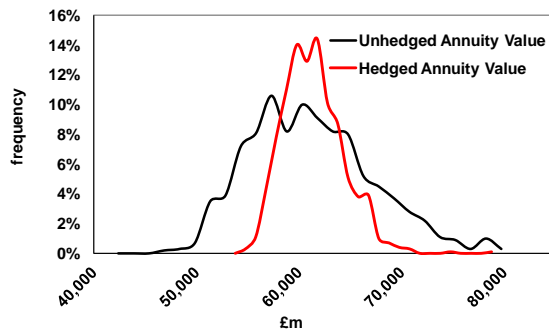
Model	Lee Carter
Calibration Period	1946-2005
Hedge Population Calibration Data	E&W
Annuity Population Calibration Data	E&W
Number of Simulation Paths	1000

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What are we trying to achieve?

Simplified Case Study

Distribution of Annuity Values at t= 1 year



No demographic basis!
No sampling risk!
Lots to do.....

Pre- Hedge Overlay

PERCENTILE	99.5%
Average Annuity Level	60,397
VaR level	77,734
Capital Required	17,337

After Hedge Overlay

Average Annuity Level	60,886
VaR level	69,429
Capital Required	8,543
Hedge Effectiveness	50.73%

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What are we trying to achieve?

The Biggest Challenge

- The biggest challenge is how to model the demographic risk.
- Given the typical inputs for a pension scheme or annuity book:

<i>Pre- Hedge Overlay</i>
Target Population Size – Number of individuals
Target Population Annuity/Pension Amounts
Geographic location
Historical mortality experience information if available

- How do we simulate the two populations? (Hedge and portfolio)
- How are their mortality diffusions related?
- If $\mu_1(x, t)$ is the force of mortality for *E&W*, we need to generate $\mu_2(x, t)$ (mortality for the pool).
- If $\mu_2(x, t) = f(\mu_1(x, t))$ where f is an appropriate function, what form should f take?

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The Longevity Basis Risk Working Group: Proposal for Research Funds

Stage 1

- Invitation to tender, inviting consultancies and academic institutions to submit detailed proposals for research

Stage 2

- Given approval of funding sponsors:
- Phase1
 - Delivery of a detailed methodology for measuring longevity basis risk and a thorough description of process, strengths and limitations
- Phase 2
 - Specification of metrics and a practical framework for quantifying longevity basis risk

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The Longevity Basis Risk Working Group: Deliverables

Phase 1

- **Background research**
 - Review evidence of the differences in mortality improvement for various sub-populations
 - Socioeconomic groups
 - Geographic locations
 - Review existing models to structure relationship between the mortality of the two groups
- **Projection methodology**
 - Produce detailed specifications of proposed modeling methodology
 - Detail the strengths and limitations of proposed methodology given objectives of the working group

Phase 2

- **Quantification**
 - Define metrics and framework to quantify results
- **Case Study**
 - Apply model and framework on a practical, realistic, illustrative example

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The Longevity Basis Risk Working Group: Next Steps

- **Produce a tender document to distribute to respondents**
 - Background and expectations for the assignment
 - Research and deliverables required
 - Expected timelines
 - Required information in response to tender
- **We will approach multiple parties (Mainly Consultants and Academic Institutions).....**

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The Longevity Basis Risk Working Group: Next Steps

- **Would you like to tender?**
- **Please get in touch!**



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Questions or comments?

Expressions of individual views by members of The Actuarial Profession and its staff are encouraged.

The views expressed in this presentation are those of the presenter.



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