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Financial Risk Management of Pension Schemes
– An Economic Capital Approach

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University of Kent

Queen’s University Management School, December 9, 2011
Agenda

1. Introduction
2. Economic Capital of a Life Insurance Annuity Firm
3. Economic Capital of Universities Superannuation Scheme
4. Conclusion
Introduction

1. Introduction
   - Background
   - Pensions Change
   - Decline of UK Defined Benefit (DB) Pension Schemes

2. Economic Capital of a Life Insurance Annuity Firm

3. Economic Capital of Universities Superannuation Scheme

4. Conclusion
Recent history and developments:
- Basel 2, 3 and Solvency 2.

Increased scrutiny of occupational pension schemes:
- Ageing population.
- Lower expected real investment returns.
- Unstable financial markets.

Regulatory differences:
- No formal capital requirements for pension funds.
- Pension funds subject to funding and not solvency standards.

Need for an effective unifying framework to monitor and manage risk across the entire financial services sector.
UK DB pension schemes:
- based broadly on years of service, an accrual rate and final salary;
- in their rudimentary form date back to late 16th century;
- predominant occupational pension schemes until 1980s;
- prove their value to employees.

UK DC pension schemes:
- based on contributions paid and investment returns earned;
- have become more favoured since 1980s;
- due to the rapid growth of the financial markets;
- and also being more flexible and easily transferable.

Regulatory developments for DB pension schemes:
- European Commission Call for Advice (2011) aims for introduction of risk-based Solvency 2 type regime.
### Decline of UK Defined Benefit (DB) Pension Schemes

Table: Distribution of UK DB pension schemes by status. (Source: The Purple Book (2006–2010))

<table>
<thead>
<tr>
<th>Scheme status</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open</td>
<td>43%</td>
<td>36%</td>
<td>31%</td>
<td>27%</td>
<td>18%</td>
</tr>
<tr>
<td>Closed to new members</td>
<td>44%</td>
<td>45%</td>
<td>50%</td>
<td>52%</td>
<td>58%</td>
</tr>
<tr>
<td>Closed to future accruals</td>
<td>12%</td>
<td>16%</td>
<td>17%</td>
<td>19%</td>
<td>21%</td>
</tr>
<tr>
<td>Winding Up</td>
<td>1%</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
</tr>
</tbody>
</table>
Decline of UK Defined Benefit (DB) Pension Schemes

**Table:** UK DB pension schemes funding statistics. (Source: The Purple Book (2006–2010))

<table>
<thead>
<tr>
<th>Year</th>
<th>Total assets (£billion)</th>
<th>Total liabilities (£billion)</th>
<th>Funding level</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>818.2</td>
<td>887.5</td>
<td>92.2%</td>
</tr>
<tr>
<td>2007</td>
<td>853.0</td>
<td>914.1</td>
<td>93.3%</td>
</tr>
<tr>
<td>2008</td>
<td>857.0</td>
<td>955.4</td>
<td>89.7%</td>
</tr>
<tr>
<td>2009</td>
<td>780.4</td>
<td>1109.5</td>
<td>70.3%</td>
</tr>
<tr>
<td>2010</td>
<td>926.2</td>
<td>1074.4</td>
<td>86.2%</td>
</tr>
</tbody>
</table>
Agenda

1. Introduction

2. Economic Capital of a Life Insurance Annuity Firm
   - Definition of Economic Capital
   - The Stochastic Model – Economic Variables
   - The Stochastic Model – Demographic Variables
   - Life Insurance Annuity Example

3. Economic Capital of Universities Superannuation Scheme

4. Conclusion
Economic Capital of a Life Insurance Annuity Firm

Definition

Economic capital

- ... is the amount of capital, or excess assets, required
- ... to ensure that the market value
- ... balance sheet of the firm remains solvent,
- ... over a specified time horizon,
- ... with a prescribed (high) probability.
The Stochastic Model – Economic Variables

Figure: Graphical model of the economic variables.

Model calibrated using historical data from 1900–2000 (source: Dimson, Marsh & Staunton (2002)).
Mortality studies in the UK have extensively documented the
- cohort,
- age-related and
- period-related improvement effects for both males and females.

Our approach to mortality modelling:
- Start with the base mortality tables PMA92Base and PFA92Base.
- Project base tables forward to 2008 using middle cohort improvement factors.
- Future projections involve introducing stochastic uncertainty around the central mortality projection using the approach of Sweeting (2008).
Life Insurance Annuity Example – Assumptions

- Annual pension of £17,329.
- Joint life last survivor annuity.
- At inception both lives aged 70.
Economic Capital of a Life Insurance Annuity Firm

Annuity Example – 90% Equity + 10% Bonds

Liability and Economic Capital (£ '000)

Duration (years)

Liability
95th percentile
99th percentile
99.5th percentile
Annuity Example – 100% Bonds

Liability and Economic Capital (£ '000)

Duration (years)

- Liability
- 95th percentile
- 99th percentile
- 99.5th percentile
Introduction

Economic Capital of a Life Insurance Annuity Firm

Economic Capital of Universities Superannuation Scheme
- Definition of Economic Capital – Revisited
- Universities Superannuation Scheme (USS)
- Membership Statistics
- Model Points
- Results

Conclusion
Definition

Economic capital

- ... is the excess of assets, valued on a market value basis
- ... over best estimate liabilities in respect of accrued benefits
- ... required to ensure that assets exceeds liabilities
- ... on all future valuation dates over a specified time horizon
- ... with a prescribed (high) probability.
Retirement age is 62 for both males and females.

- Benefits at retirement:
  
  \[
  \text{Annual pension} = \frac{1}{80} \times \text{Pensionable service} \times \text{Pensionable salary};
  \]
  
  \[
  \text{Lump sum payment} = 3 \times \text{Annual pension}.
  \]

- Annual pension is increased in line with RPI.
- Contribution rate: 16% employer + 6.35% employees.
- Investment: 90% real + 10% fixed.
### Membership Statistics

**Table:** Membership statistics of USS, all UK DB pension schemes and all UK open DB pension schemes.

<table>
<thead>
<tr>
<th>Membership status</th>
<th>USS</th>
<th>All UK DB schemes (millions)</th>
<th>All UK open DB schemes (millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active members</td>
<td>130,450</td>
<td>2.74</td>
<td>1.56</td>
</tr>
<tr>
<td>Deferred members</td>
<td>76,104</td>
<td>5.23</td>
<td>1.99</td>
</tr>
<tr>
<td>Pensioners</td>
<td>40,945</td>
<td>4.43</td>
<td>1.92</td>
</tr>
<tr>
<td>Dependants</td>
<td>8,951</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Total</td>
<td>256,450</td>
<td>12.40</td>
<td>5.48</td>
</tr>
</tbody>
</table>
## Model Points

### Active members

<table>
<thead>
<tr>
<th>Age</th>
<th>Number of members</th>
<th>Past service</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>35,257</td>
<td>5</td>
<td>£24,685</td>
<td>£23,069</td>
</tr>
<tr>
<td>40</td>
<td>35,257</td>
<td>9</td>
<td>£35,225</td>
<td>£30,912</td>
</tr>
<tr>
<td>50</td>
<td>35,257</td>
<td>13</td>
<td>£43,700</td>
<td>£37,515</td>
</tr>
<tr>
<td>60</td>
<td>24,680</td>
<td>17</td>
<td>£49,405</td>
<td>£43,366</td>
</tr>
</tbody>
</table>

### Deferred members

<table>
<thead>
<tr>
<th>Age</th>
<th>Number of members</th>
<th>Average deferred pension</th>
</tr>
</thead>
<tbody>
<tr>
<td>44</td>
<td>76,104</td>
<td>£2,044</td>
</tr>
</tbody>
</table>

### Pensioners

<table>
<thead>
<tr>
<th>Age</th>
<th>Number of members</th>
<th>Average annual pension</th>
</tr>
</thead>
<tbody>
<tr>
<td>70</td>
<td>40,945</td>
<td>£17,329</td>
</tr>
</tbody>
</table>
### Table: Comparison of accrued benefit liabilities.

<table>
<thead>
<tr>
<th>Category</th>
<th>Model points</th>
<th>USS 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active members</td>
<td>£15,159.1m</td>
<td>£14,774.6m</td>
</tr>
<tr>
<td>Deferred members</td>
<td>£2,312.5m</td>
<td>£2,229.3m</td>
</tr>
<tr>
<td>Pensioners</td>
<td>£11,064.8m</td>
<td>£11,131.4m</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>£28,536.4m</strong></td>
<td><strong>£28,135.3m</strong></td>
</tr>
</tbody>
</table>
Base Case – Model Points

Active member – Aged 30

Active member – Aged 50

Deferred member – Aged 44

Pensioner – Aged 70
Base Case – Full Scheme

The diagram illustrates the Liability and Economic Capital (£ billion) over the duration (years) for the University of Kent. The Liability is shown in black, and the economic capital at the 95th, 99th, and 99.5th percentiles are represented by red, green, and blue lines, respectively. The graphs show the capital requirements decreasing over time, with the 99.5th percentile having the highest capital requirement and decreasing the fastest.
Sensitivity Analysis – EC at 95th Percentile Levels

- Base scenario
- 100% Bond investment
- Reduced accrual rate
- Increased accrual rate
- Increased retirement age
- Longevity stress

Duration (years)

Economic Capital (£ billion)
Results Summary

Table: Ratio of USS scheme assets at 2008 actuarial valuation (£28,842.6m) to the sum of scheme best estimate liabilities and economic capital at time zero.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>95th</th>
<th>99th</th>
<th>99.5th</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base</td>
<td>94%</td>
<td>88%</td>
<td>86%</td>
</tr>
<tr>
<td>100% investment in bonds</td>
<td>58%</td>
<td>52%</td>
<td>50%</td>
</tr>
<tr>
<td>Accrual rate reduced to 1/120th</td>
<td>119%</td>
<td>112%</td>
<td>110%</td>
</tr>
<tr>
<td>Retirement age increased to 70</td>
<td>112%</td>
<td>104%</td>
<td>102%</td>
</tr>
<tr>
<td>Longevity stress</td>
<td>94%</td>
<td>88%</td>
<td>85%</td>
</tr>
</tbody>
</table>
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   - Summary
   - References
Summary

- Regulatory change is a driver for improvements all round.
- Economic capital is 60% of best estimate liability at the 99.5th percentile level for the base scenario.
- It shows the extent of risk inherent in guaranteeing long-term benefits while backing liabilities with volatile assets.
- Setting capital aside to match economic capital will be challenging, so de-risking DB pension schemes is more likely.
- A risk-sensitive economic capital approach can provide better clarity to help manage DB schemes in a transparent manner.


