Financial Risk Management of Pension Schemes – An Economic Capital Approach

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Agenda

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

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

Economic Capital of a Life Insurance Annuity Firm

Economic Capital of Universities Superannuation Scheme

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.
Pensions Change

- 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...

- 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.
Annuity Example – 90% Equity + 10% Bonds

Liability and Economic Capital (£ '000)

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

Duration (years)

0 10 20 30 40 50

0 50 100 150 200 250 300
Annuity Example – 100% Bonds

Duration (years)

Liability and Economic Capital (£ '000)

- 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
Economic Capital of a DB Pension Scheme

**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.
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 (millions)</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>Dependents</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>
### 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></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>Total</td>
<td>£28,536.4m</td>
<td>£28,135.3m</td>
</tr>
</tbody>
</table>
Base Case – Model Points

Active member – Aged 30

Active member – Aged 50

Deferred member – Aged 44

Pensioner – Aged 70
Economic Capital of Universities Superannuation Scheme

Results

Base Case – Full Scheme

![Graph showing Liability and Economic Capital](image)
Sensitivity Analysis – EC at 95th Percentile Levels

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

Economic Capital (£ billion)

Duration (years)
### 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>
Open Scheme

Economic Capital of Universities Superannuation Scheme

Results

Liability and Economic Capital (£ billion)

Duration (years)

Liability

95th percentile

99th percentile

99.5th percentile

P Tapadar (University of Kent)
Conclusion

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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.
REFERENCES


