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Risk assessment of UK DB pension schemes

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University of Waterloo, June 2016

Acknowledgement: Institute and Faculty of Actuaries, UK, has provided a grant to support our attendance at this conference
Agenda

1. Introduction
2. Economic capital
3. Stochastic model
4. Model assumptions
5. Results
6. PPF
7. Conclusions
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Background

Regulatory developments
- Basel 2/3.
- Solvency 2.
- Pensions Regulations.

Pensions: Developments in the UK
- Private pension membership: 46% (1997) to 32% (2012).
- DB scheme membership: 34% (1997) to 8% (2012).

Questions:
1. Impact of capital requirements on individual DB pension schemes.
2. Role of the PPF for the risk management of the entire sector.
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Economic Capital Formulation

**Economic capital** is the excess of assets over liabilities in respect of accrued benefits required to ensure that assets exceed liabilities on all future valuation dates over a specified time horizon with a prescribed high probability.

**Notations:**

- $X_t$: Net cash flow of the scheme;
- $L_t$: Value of s179 liability of the scheme;
- $I_{s,t}$: Accumulation factor;
- $D_{s,t}$: Discount factor.

**Building blocks**

- $P_t = L_{t-1}I_{(t-1,t)} - X_t - L_t$: Profit vector, with $P_0 = -X_0 - L_0$.
- $R_t = \sum_{s=0}^{t} P_s I_{s,t}$: Accumulated retained profits until time $t$,
- $V_t = \sum_{s=t+1}^{T} P_s D_{t,s}$: Present value of future profits at time $t$. 
Eligible Scheme Cashflow and Capital Requirement

Capital requirement: \( C_t = \max \left[ \min_{s=t}^{T} V_s D_{t,s}, 0 \right] \).

Economic capital requirement: \( \rho(C_t) = \text{VaR}(C_t, p = 0.995) \).
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The individual economic random variables, $Z_{it}$s, are modelled as:

$$Z_{it} = \mu_{i} + Y_{it}, \text{ where } Y_{it} = \beta_{i} Y_{i(t-1)} + \varepsilon_{it} \text{ and } \varepsilon_{it} \sim N(0, \sigma_{i}^{2}).$$

The error terms

- are assumed to be independently distributed across time $t$;
- which are directly connected to each other are dependent;
- which are indirectly connected are still dependent, but more weakly so.
Stochastic model: Longevity

The mortality model used is developed in three steps:

**Step 1:** Set S1PM and S1PF as the baseline mortality tables for males and females respectively.

**Step 2:** Project these base mortality tables from year 2006 to year 2012 using the mortality projection table published by the Institute and Faculty of Actuaries.

**Step 3:** Finally, model the future stochastic mortality improvements starting from 2012 by modelling stochastic uncertainty around the central mortality projection (Sweeting (2008)).
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# Membership Profile

**Table:** Average membership profile of eligible schemes.

<table>
<thead>
<tr>
<th>Membership group (Members)</th>
<th>Number of schemes</th>
<th>Average membership</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Active</td>
<td>Deferred</td>
<td>Pensioner</td>
</tr>
<tr>
<td>A: (5-99)</td>
<td>2,260</td>
<td>6 (13%)</td>
<td>23 (52%)</td>
</tr>
<tr>
<td>B: (100-999)</td>
<td>2,828</td>
<td>56 (16%)</td>
<td>182 (52%)</td>
</tr>
<tr>
<td>C: (1,000-4,999)</td>
<td>824</td>
<td>384 (17%)</td>
<td>1,103 (49%)</td>
</tr>
<tr>
<td>D: (5,000-9,999)</td>
<td>192</td>
<td>1,231 (17%)</td>
<td>3,297 (46%)</td>
</tr>
<tr>
<td>E: (Over 10,000)</td>
<td>212</td>
<td>6,651 (19%)</td>
<td>14,763 (42%)</td>
</tr>
</tbody>
</table>
## Model Points

### Table: Eligible schemes model points.

<table>
<thead>
<tr>
<th>Membership types</th>
<th>Age</th>
<th>Gender</th>
<th>Accrued service/benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active</td>
<td>30</td>
<td>Male/Female</td>
<td>7 years past service</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>Male/Female</td>
<td>16 years past service</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>Male/Female</td>
<td>25 years past service</td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>Male/Female</td>
<td>34 years past service</td>
</tr>
<tr>
<td>Deferred</td>
<td>50</td>
<td>Male</td>
<td>Accrued pension of £3,000 per year</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>Female</td>
<td>Accrued pension of £1,500 per year</td>
</tr>
<tr>
<td>Pensioner</td>
<td>70</td>
<td>Male</td>
<td>Pension of £6,000 per year</td>
</tr>
<tr>
<td></td>
<td>70</td>
<td>Female</td>
<td>Pension of £3,000 per year</td>
</tr>
</tbody>
</table>
Assets, Liabilities and Investment Strategies

Table: Comparison of assets and liabilities.

<table>
<thead>
<tr>
<th></th>
<th>Estimated</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assets</td>
<td>£1,018b</td>
<td>£1,027b</td>
</tr>
<tr>
<td>Liabilities</td>
<td>£1,218b</td>
<td>£1,231b</td>
</tr>
</tbody>
</table>

Table: Distribution of eligible scheme by investment strategies.

<table>
<thead>
<tr>
<th>Investment strategy</th>
<th>Asset allocation</th>
<th>Proportion of eligible schemes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Equities</td>
<td>Bonds</td>
</tr>
<tr>
<td>$L$</td>
<td>25%</td>
<td>75%</td>
</tr>
<tr>
<td>$M$</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>$H$</td>
<td>75%</td>
<td>25%</td>
</tr>
</tbody>
</table>

PPF broadly follows investment strategy $L$. 
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Aggregate Economic Capital for Eligible Schemes

As at 31 March 2012

Assets
£ 1,018 billion

Liabilities
£ 1,218 billion

Economic Capital
£ 1,231 billion
Results

Economic Capital: Eligible Scheme in A

Membership group A

Liability and economic capital (£ million)

- \( \rho_t^{AH} \)
- \( \rho_t^{AM} \)
- \( \rho_t^{AL} \)
- \( L_t^A \)

Year

0 2 4 6 8 10

2020 2040 2060 2080 2100
Eligible Schemes: Liability Comparison

$L_t^X/L_0^X$ as multiples of $L_t^A/L_0^A$ where $X=A,B,C,D,E$
Eligible Schemes: Economic Capital Comparison

\[ \rho_{t}^{XY} / L_{0}^{X} \text{ as multiples of } \rho_{t}^{AY} / L_{0}^{A} \text{ where } X=A,B,C,D,E \text{ and } Y=L,M,H \]
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PPF Cashflow and Capital Requirement

Capital requirement: \( C_t = \max \left[ - \min_{s=t}^{T} R_{s} D_{t,s}, 0 \right] \).

Economic capital requirement: \( \rho(C_t) = \text{VaR}(C_t, p = 0.995) \).
PPF: Some Additional Assumptions

- PPF levy: 0.072% of the total s179 liabilities.
- Amortisation period: 10 years.
- Funding cap: 120% of s179 liabilities.
- Insolvency rates:

<table>
<thead>
<tr>
<th>Membership group</th>
<th>Annual insolvency rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.60%</td>
</tr>
<tr>
<td>B</td>
<td>0.95%</td>
</tr>
<tr>
<td>C</td>
<td>0.90%</td>
</tr>
<tr>
<td>D</td>
<td>0.53%</td>
</tr>
<tr>
<td>E</td>
<td>0.72%</td>
</tr>
</tbody>
</table>
PPF: Base Case Results

PPF schemes liability and economic capital: Base case

<table>
<thead>
<tr>
<th>Year</th>
<th>Liability (£ billion)</th>
<th>Economic capital (£ billion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2040</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2060</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2080</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
PPF: Sensitivity Results

As at 31 March 2012

1: Base Case
2: 4–year Amortisation
3: 50% Buffer
4: (2) + (3)
PPF Takes Over All Schemes With Insolvent Sponsors

PPF takes over all schemes with insolvent sponsors

- **Base**
- **All schemes**
  - + 50% buffer and
  - 4-year amortisation
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Conclusions

Summary

- Aggregate economic capital requirement:
  - On eligible scheme basis: £1,200 billion.
  - For PPF: £35 billion.
- Reasonable capital buffer + shorter amortisation period can bring down the economic capital requirement further.

Need a holistic view, taking PPF into account, while devising regulations for defined benefit pension sector.

References