CMI “S3” Series Mortality Tables

Matthew Fletcher
Chair, SAPS Committee
Overview

• The CMI SAPS Committee issued final “S3” Series tables on 5 December 2018.

• Key features:
  – New “Very Light” and male Dependants tables
  – Changes to composition of dataset; more public sector data
  – Changes in methodology e.g. graduation formulae and extension methods
  – Review of amount bands


• Experience analysis and industry analysis to follow in 2019.
Agenda

• Overview
• Tables in the final “S3” Series
• Dataset
• Method
• Results
• Analysis
  – Public and private sector
  – Industry sector
• Comparison with the “S2” Series
• Summary
Overview
Overview of SAPS

- SAPS (Self-Administered Pension Schemes) investigation started in 2003.
  - Consultancies submit data on behalf of clients with over 500 pensioners
- Publications
  - Annual reports on mortality experience
  - Ad hoc analyses (e.g. industry analysis)
  - Mortality tables
    - “S1” (as at 1 Sep 2002) issued in 2008 based on 2000-2006 data
    - “S2” (as at 1 Jan 2007) issued in 2014 based on 2004-2011 data
    - NEW “S3” mortality tables
      - “S3” (as at 1 Jan 2013) based on 2009-2016 data
      - Proposed “S3” issued for consultation alongside Working Paper 107 in June 2018
      - Final “S3” issued alongside Working Paper 113 in December 2018
Responses to WP 107 consultation

• SAPS Committee received twelve responses to Working Paper 107
• Mainly from pension consultancies
• Feedback related to fifteen consultation questions
• Responses generally in favour with the Committee’s proposals
• We will summarise responses to key questions throughout this presentation
Tables in the final “S3” Series
Range of tables – in S2

<table>
<thead>
<tr>
<th>Type</th>
<th>Gender</th>
<th>Lives</th>
<th>Amounts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>All</td>
<td>Heavy</td>
</tr>
<tr>
<td>Pensioners</td>
<td>Male</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pensioners</td>
<td>Female</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal health</td>
<td>Male</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal health</td>
<td>Female</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ill-health</td>
<td>Male</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ill-health</td>
<td>Female</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dependents</td>
<td>Male</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dependents</td>
<td>Female</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

10 December 2018
### Range of tables – S3 compared to S2

<table>
<thead>
<tr>
<th>Type</th>
<th>Gender</th>
<th>Lives</th>
<th>Amounts</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pensioners</td>
<td>Male</td>
<td></td>
<td></td>
<td>All</td>
<td>Heavy</td>
<td>Middle</td>
<td>Light</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal health</td>
<td>Male</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ill-health</td>
<td>Male</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dependants</td>
<td>Male</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

10 December 2018
Q4: Are there any extra S3 tables that you think should be published?

- Consultation responses included several requests for additional tables
- However, none had significant support and Committee generally felt these tables were unlikely to be widely used.
- Specific additional tables requested:
  - Additional lives-weighted tables
  - “Heavy” and “Middle” tables for female Dependents
  - Separate public and private sector tables (discussed further under Q14)
  - All-members (Pensioners and Dependents) tables.
- Request to change naming convention for Very Light tables from “V” to “VL”

Committee agreed not to publish any additional tables but have updated naming convention to “VL”.

10 December 2018
Dataset
Dataset

- S3 dataset covers experience from 1 January 2009 to 31 December 2016
  - 452 pension schemes

- S3 dataset is much larger than S2
Amount bands

- Amount band limits were increased by inflation between S1 and S2.
- For S3 we considered them from first principles. Aim was for:
  - relatively consistent mortality within bands;
  - distinct mortality between bands;
  - large enough bands so that mortality is estimated reliably; and
  - ideally, the same number of bands as S2.
Relative mortality by amount (males)
Relative mortality by amount (females)
## Amount bands

<table>
<thead>
<tr>
<th>Gender</th>
<th>Band</th>
<th>S2 Series</th>
<th>S3 Series</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>Heavy</td>
<td>0 – 1,700</td>
<td>(19%)</td>
</tr>
<tr>
<td>Male</td>
<td>Middle</td>
<td>1,700 – 14,750</td>
<td>(65%)</td>
</tr>
<tr>
<td>Male</td>
<td>Light</td>
<td>14,750+</td>
<td>(16%)</td>
</tr>
<tr>
<td>Male</td>
<td>Very light</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Female</td>
<td>Heavy</td>
<td>0 – 850</td>
<td>(22%)</td>
</tr>
<tr>
<td>Female</td>
<td>Middle</td>
<td>850 – 5,500</td>
<td>(60%)</td>
</tr>
<tr>
<td>Female</td>
<td>Light</td>
<td>5,500+</td>
<td>(18%)</td>
</tr>
<tr>
<td>Female</td>
<td>Very light</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

Note: Percentages relate to lives-weighted Pensioner experience.

10 December 2018
Q5: Do you agree with the proposed amount bands?

• Majority of respondents content with amount bands so Committee agreed to retain these.

• Some comments on Very Light tables being a subset of Light tables.

• Committee concluded Light tables are sufficient for most purposes but complementary dataset analysed and 100A/E's shown in table:

<table>
<thead>
<tr>
<th>Pension band</th>
<th>100A/E vs S3PxA_L</th>
<th>100A/E vs S3PxA_VL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male Pensioners £20,000 to £40,000</td>
<td>106.1</td>
<td>118.6</td>
</tr>
<tr>
<td>Male Normal health £20,000 to £40,000</td>
<td>105.9</td>
<td>119.1</td>
</tr>
<tr>
<td>Female Pensioners £8,000 to £16,000</td>
<td>104.8</td>
<td>112.9</td>
</tr>
<tr>
<td>Female Normal health £8,000 to £16,000</td>
<td>103.2</td>
<td>107.8</td>
</tr>
<tr>
<td>Female Dependents £8,000 to £16,000</td>
<td>103.8</td>
<td>108.8</td>
</tr>
</tbody>
</table>
Methods
Methods

• Key features:
  – Adjust the data to be at a common effective date, 1 January 2013
  – Graduate a limited age range where data is credible
  – Select graduation formulae which are consistent and ‘good enough’
  – Extend to lower and higher ages, using judgement

Methodology for final “S3” tables identical to proposed “S3” tables.
Adjusting data to a common effective date

• All S3 tables have an effective date of 1 January 2013, half way through the experience period.

• We adjusted the experience data, using the Core CMI_2017 model, before graduation.

• Consultation: agreed with approach - asked for more information on sensitivity to choice of $S_κ$
  – Analysis shows S3 not overly sensitive to choice of $S_κ$

• Mortality Projections Committee have released consultation on CMI Model parameterisation in Working Paper 114
  – Value of $S_κ$ may be lower for CMI_2018
Selection of formulae

- We used “G(s)” formulae; i.e. the logarithm of mortality is a polynomial:

  \[ m_x = \exp(b_0 + b_1 x + b_2 x^2 + b_3 x^3) \quad \text{Males} \]
  \[ m_x = \exp(b_0 + b_1 x + b_2 x^2 + b_3 x^3 + b_4 x^4) \quad \text{Females} \]

- We needed an extra parameter for female data to achieve an acceptable fit to the data.

- These formulae gave satisfactory results using a suite of statistical tests.

- The S1 and S2 series used more complex “GM(r,s)” formulae.

- We considered “co-graduation” of related tables, but found that this did not offer significant benefits.
Low age extensions

• The consultation for the S1 tables showed strong demand for tables starting at age 16, and we have done the same for S2 and S3.

• However, we note that:
  – We only collect pensioner data and, at younger ages, our data is likely to be ill-health retirements (or erroneously included); and
  – Tables do not reflect actual mortality rates of pension scheme members at younger ages.

• Actuaries should consider whether rates at younger ages are reasonable for purpose for which they are being used.

Consultation responses were generally comfortable with low age extension approach.
High age extensions

- We use the new CMI standard method, published in Working Paper 106.
- We assume that at high ages mortality for a specific SAPS population converges towards that of the national population.

Consultation responses were supportive of high age methodology.
Ill-health tables – age range for graduation

- Ill-health tables graduated from age 60 for S3 (was from age 35 in S2) due to unusual shape of crude mortality rates in S3 as seen in charts:

**Male Pensioners**

<table>
<thead>
<tr>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1%</td>
</tr>
<tr>
<td>1.0%</td>
</tr>
<tr>
<td>10.0%</td>
</tr>
<tr>
<td>100.0%</td>
</tr>
</tbody>
</table>

**Female Pensioners**

<table>
<thead>
<tr>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1%</td>
</tr>
<tr>
<td>1.0%</td>
</tr>
<tr>
<td>10.0%</td>
</tr>
<tr>
<td>100.0%</td>
</tr>
</tbody>
</table>

- S2 male   - S3 male
- S2 female - S3 female
Results
Male Pensioner amounts tables

Mortality ($q_x$) on a logarithmic scale

Mortality relative to S3PMA

10 December 2018
Female Pensioner amounts tables

Mortality ($q_x$) on a logarithmic scale

Mortality relative to S3PFA
Period life expectancies

- Period life expectancies at age 60 for the S3 Pensioners tables are shown in the table below:

<table>
<thead>
<tr>
<th></th>
<th>Table</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>S3PxA</td>
<td>24.9</td>
<td>27.2</td>
</tr>
<tr>
<td>Heavy</td>
<td>S3PxA_H</td>
<td>22.4</td>
<td>25.8</td>
</tr>
<tr>
<td>Middle</td>
<td>S3PxA_M</td>
<td>24.2</td>
<td>26.6</td>
</tr>
<tr>
<td>Light</td>
<td>S3PxA_L</td>
<td>26.3</td>
<td>27.7</td>
</tr>
<tr>
<td>Very Light</td>
<td>S3PxA_VL</td>
<td>27.1</td>
<td>28.3</td>
</tr>
</tbody>
</table>
Analysis – public and private sector
Data volume by sector and amount band

- S3 dataset includes higher proportion of public sector data than S1 and S2
- Female data for middle, light and very light bands is dominated by the public sector
Q14: Do you agree with the decision not to produce separate public and private sector tables? (1)

• Majority of respondents supportive of decision not to publish separate tables.

• Points raised included:
  – Differences in public and private sector experience in SAPS dataset may not reflect whole population of public and private sector schemes
  – Other reasons, such as socio-economic and geographical factors may be better indicators of mortality
  – Expectation may be raised that e.g. public sector tables should be used for all public sector schemes
  – Some tables might no longer be viable, e.g. male Dependents
Q14: Do you agree with the decision not to produce separate public and private sector tables? (2)

- Two respondents were strongly in favour of separate public and private sector tables.

- Concerns about combined public and private sector tables included:
  - Consistency with S2: The Committee note public sector data has always been included in SAPS dataset.
  - Updating from S2 to corresponding S3 table: Committee agrees users should carefully consider choice of table when updating to S3. More on this later!

The Committee have retained their proposed approach of publishing combined public and private sector tables only.
## Private sector scaling factors

- Table shows flat scaling factors for private sector data relative to S3 tables, including 95% confidence intervals.

<table>
<thead>
<tr>
<th>Table</th>
<th>Flat scaling factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male Pensioners amounts</td>
<td>S3PMA</td>
</tr>
<tr>
<td></td>
<td>102.4% ± 0.7%</td>
</tr>
<tr>
<td>Male Normal health amounts</td>
<td>S3NMA</td>
</tr>
<tr>
<td></td>
<td>104.7% ± 0.9%</td>
</tr>
<tr>
<td>Male Dependants amounts</td>
<td>S3DMA</td>
</tr>
<tr>
<td></td>
<td>102.3% ± 3.6%</td>
</tr>
<tr>
<td>Female Pensioners amounts</td>
<td>S3PFA</td>
</tr>
<tr>
<td></td>
<td>109.5% ± 1.3%</td>
</tr>
<tr>
<td>Female Normal health amounts</td>
<td>S3NFA</td>
</tr>
<tr>
<td></td>
<td>112.1% ± 1.7%</td>
</tr>
<tr>
<td>Female Dependant amounts</td>
<td>S3DFA</td>
</tr>
<tr>
<td></td>
<td>100.6% ± 0.9%</td>
</tr>
</tbody>
</table>

- Female Pensioners amounts scaling factor relative to S3PFA is quite high.
  - Scaling factor for Female Pensioners amounts relative to S3PFA_M is 100.8%.
Analysis – industry sector
Initial industry analysis – change in composition of dataset

• To help users understand composition of S3 dataset, some initial industry analysis have been carried out.

• Charts show change in exposure between S2 and S3 by lives and amounts:

**Male Pensioners**

- Oil & Gas
- Basic Materials
- Industrials
- Consumer Goods
- Health Care
- Consumer Services
- Utilities
- Financials
- Technology
- Other Public Sector
- Local Authority
- Misc

**Female Pensioners**

- Oil & Gas
- Basic Materials
- Industrials
- Consumer Goods
- Health Care
- Consumer Services
- Utilities
- Financials
- Technology
- Other Public Sector
- Local Authority
- Misc

5 June 2018
Initial industry analysis – experience by industry

- Experience varies significantly by industry
- Charts show 100A/Es by lives relative to S3PxF for each industry, including 95% confidence intervals:

<table>
<thead>
<tr>
<th>Male Pensioners</th>
<th>Female Pensioners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil &amp; Gas</td>
<td>Oil &amp; Gas</td>
</tr>
<tr>
<td>Basic Materials</td>
<td>Basic Materials</td>
</tr>
<tr>
<td>Industrials</td>
<td>Industrials</td>
</tr>
<tr>
<td>Consumer Goods</td>
<td>Consumer Goods</td>
</tr>
<tr>
<td>Health Care</td>
<td>Health Care</td>
</tr>
<tr>
<td>Consumer Services</td>
<td>Consumer Services</td>
</tr>
<tr>
<td>Utilities</td>
<td>Utilities</td>
</tr>
<tr>
<td>Financials</td>
<td>Financials</td>
</tr>
<tr>
<td>Technology</td>
<td>Technology</td>
</tr>
<tr>
<td>Other Public Sector</td>
<td>Other Public Sector</td>
</tr>
<tr>
<td>Local Authority</td>
<td>Local Authority</td>
</tr>
<tr>
<td>Misc</td>
<td>Misc</td>
</tr>
</tbody>
</table>

5 June 2018
Comparison with the “S2” Series
Changes from S2 to S3

• Several respondents to Working Paper 107 asked us to highlight changes between S2 and S3.

• Key differences between S2 and S3 tables are:
  – Composition of SAPS dataset
  – Changes to amount band limits
  – Mortality improvements for pension scheme members in S3 dataset higher than general population over period between S2 and S3
  – Changes in formulae used to produce tables
  – Changes in graduation methods, e.g. high age and low age extensions

The Committee encourages users to consider whether similarly named S3 table is still appropriate when updating from S2 to S3.
Male Pensioner amounts tables

All ages, relative to projected equivalent S2 table

Ages 60-95, relative to projected equivalent S2 table

10 December 2018
Female Pensioner amounts tables

All ages, relative to projected equivalent S2 table

Ages 60-95, relative to projected equivalent S2 table

10 December 2018
Summary
Summary

- Final “S3” Series tables have been released.
- Majority of feedback to Working Paper 107 was supportive of Committee’s approach.
- No changes to table rates from proposed “S3” Series.
- Twelve new tables relative to S2, including new “Very Light” and male Dependants tables.
- Some changes in method relative to S2:
  - Graduation formulae are simpler and more consistent
  - New method for high age extensions
  - Adjustment to low age extensions
- Changes in the composition of the SAPS dataset between S2 and S3.
What is next?

• Experience analysis of 2010-2017 dataset to be released early 2019.
• Industry analysis paper to follow.

• CMI now collecting IMD data
  – If sufficient data collected, plan to analyse mortality experience by socio-economic class
  – CMI IMD tool released in November 2018, available on CMI website
  – Please include IMD with future submissions, if possible.
Working Paper 107 Consultation Questions

• Question 1: Do you agree with an interval of roughly five years between updates to SAPS mortality tables?

• Question 2: Do you agree with the principle of publishing all of the proposed S3 Series tables, even if two tables have similar mortality rates?

• Question 3: Are there any proposed S3 tables that you think should not be published? For example, do you think we should publish male Dependant tables?

• Question 4: Are there any extra S3 tables that you think should be published?

• Question 5: Do you agree with the proposed amount bands?

• Question 6: Do you agree with all tables having a common effective date of 1 January 2013?

• Question 7: Do you agree with the method used to adjust the tables to the common effective date, including the use of the Core CMI_2017 Model with a period smoothing parameter ($S_κ$) of 7.5?
Working Paper 107 Consultation Questions

• Question 8: Do you agree with graduating the S3PFA_H and S3NFA_H tables from age 65, to avoid an artefact at ages 60-65?
• Question 9: Do you agree with graduating ill-health tables from age 60, rather than a younger age?
• Question 10: Do you agree with the method used for extensions to low ages?
• Question 11: Do you agree with the method used for extensions to high ages?
• Question 12: Do you agree with applying the high age extension method to a national mortality table for the United Kingdom, rather than England & Wales?
• Question 13: Do you agree that the tables should have a terminal age of 120; i.e. setting $q_{120} = 1$?
• Question 14: Do you agree with the decision not to produce separate public and private sector tables?
• Question 15: Do you have any other comments for the Committee?
Female Heavy tables analysis of graduations

• We investigated alternative graduations of female Heavy tables but found no significant improvement, as shown in charts:

Female Pensioners, Heavy

Female Normal health, Heavy
The CMI
Mission and Vision

The Continuous Mortality Investigation (CMI) is owned by the Institute and Faculty of Actuaries.

Mission

• To produce high-quality impartial analysis, standard tables and models of mortality and morbidity for long-term insurance products and pension scheme liabilities on behalf of subscribers and, in doing so, to further actuarial understanding.

Vision

• To be regarded across the world as setting the benchmark for the quality, depth and breadth of analysis of industry-wide insurance company and pension scheme experience studies.
Aims and Objectives

Aims and Objectives include:

• Publish **standard decrement tables** and projections (where appropriate) in line with the relevant actuarial standards for each product line

• Publish **papers detailing the methods** employed in producing the standard tables **and the research conducted** to justify these

• **Publicise the work of the CMI** to employees within subscribers and, where appropriate, more widely

• Obtain regular **feedback from subscribers** on what their needs are to ensure that output continues to remain valuable and relevant
Private and public sector
Public and private sector data

- All comments in this section relate to public and private sector data within the S3 dataset.

- Public and private sector schemes in the S3 dataset do not necessarily reflect all public and private sector experience.
  - e.g. if a few large schemes had not submitted data, the picture could look quite different.

- Within the SAPS dataset, variation by industry within the private sector data is greater than variation between public and private sectors.
Relative mortality

- Mortality is higher for the public sector subset of the S3 dataset than the private sector subset. The difference is greater for females than males, and for larger pension amounts.
Relative mortality by amount band

10 December 2018
Life expectancy

- Life expectancies are higher for the public sector subset of the S3 dataset, than for the private sector subset.

**Difference in temporary life expectancy (versus proposed tables)**

<table>
<thead>
<tr>
<th></th>
<th>Heavy</th>
<th>Middle</th>
<th>Light</th>
<th>Very Light</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male private</td>
<td>-0.2%</td>
<td>-0.7%</td>
<td>-0.8%</td>
<td>-1.5%</td>
<td>-0.8%</td>
</tr>
<tr>
<td>Male public</td>
<td>+0.6%</td>
<td>+1.5%</td>
<td>+1.7%</td>
<td>+3.2%</td>
<td>+1.8%</td>
</tr>
<tr>
<td>Female private</td>
<td>-0.1%</td>
<td>-1.1%</td>
<td>-2.7%</td>
<td>-2.8%</td>
<td>-2.4%</td>
</tr>
<tr>
<td>Female public</td>
<td>+0.2%</td>
<td>+0.7%</td>
<td>+0.8%</td>
<td>+0.9%</td>
<td>+1.1%</td>
</tr>
</tbody>
</table>

Note: The table shows difference in temporary life expectancy from 60-95, to avoid the impact of high age extensions.
Conclusion

• Experience in the S3 dataset may not reflect differences between all public and private sector schemes. Relative levels of mortality and life expectancy could look quite different, depending on which schemes’ data is submitted.

• We have only published ‘combined’ tables, rather than separate private or public sector tables.

• Users of these tables should consider whether they are appropriate for the schemes that they advise.

• Users may find an amount band table a more appropriate starting point for carrying out a mortality experience investigation than an All pensioners table.