



Continuous Mortality Investigation

Institute and Faculty of Actuaries

CMI “S3” Series Mortality Tables

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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
- Further detail in CMI Working Paper 113 (and Working Paper 107).
- 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

Type	Gender	Lives	Amounts				
			All	Heavy	Middle	Light	Very Light
Pensioners	Male						
Pensioners	Female						
Normal health	Male						
Normal health	Female						
Ill-health	Male						
Ill-health	Female						
Dependants	Male						
Dependants	Female						

Range of tables – S3 compared to S2

Type	Gender	Lives	Amounts				
			All	Heavy	Middle	Light	Very Light
Pensioners	Male						NEW
Pensioners	Female				NEW		NEW
Normal health	Male				NEW		NEW
Normal health	Female				NEW	NEW	NEW
Ill-health	Male						
Ill-health	Female						
Dependants	Male	NEW	NEW				
Dependants	Female					NEW	NEW

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

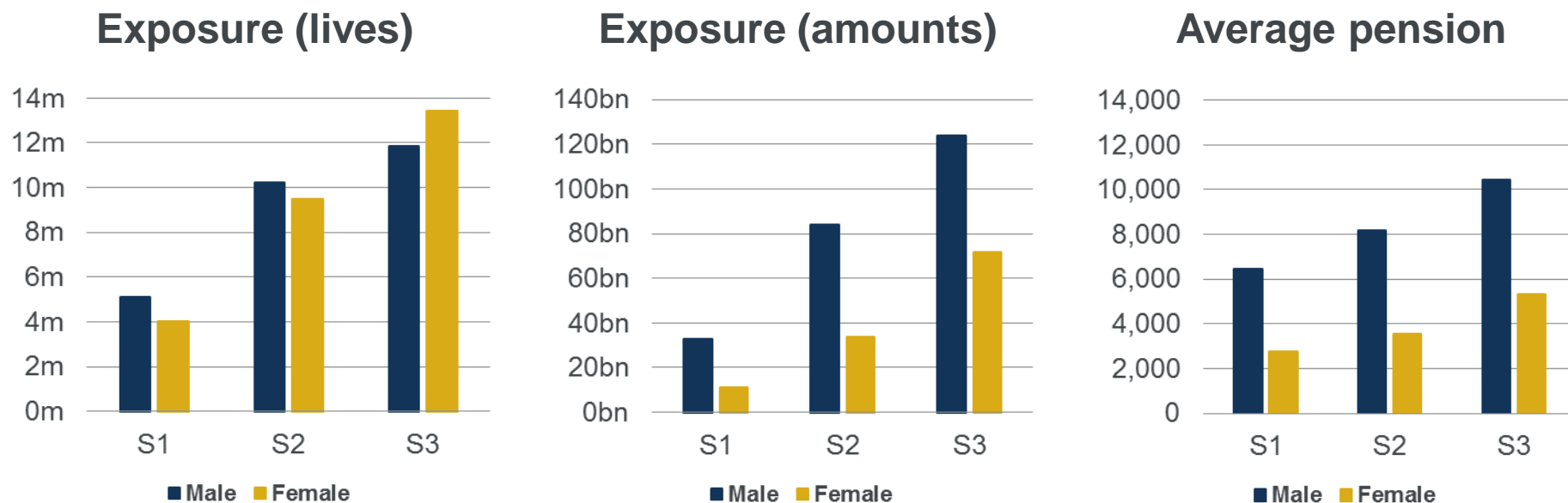
- Consultation responses included several requests for additional tables
- However, none had significant support and Committee generally felt these tables were unlikely to be widely used.
- Specific additional tables requested:
 - Additional lives-weighted tables
 - “Heavy” and “Middle” tables for female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

Dataset

Dataset

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

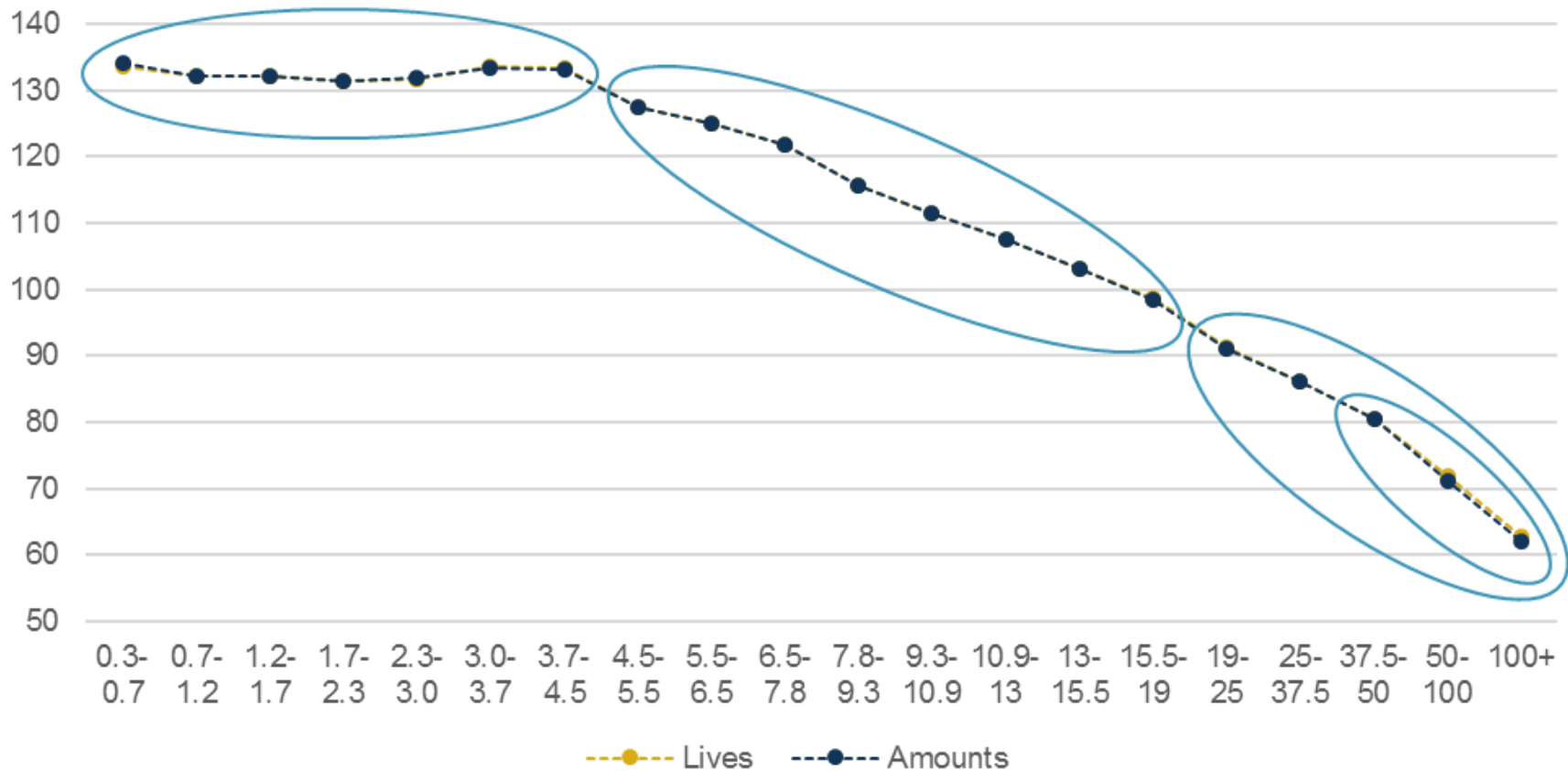


- S3 dataset is much larger than S2

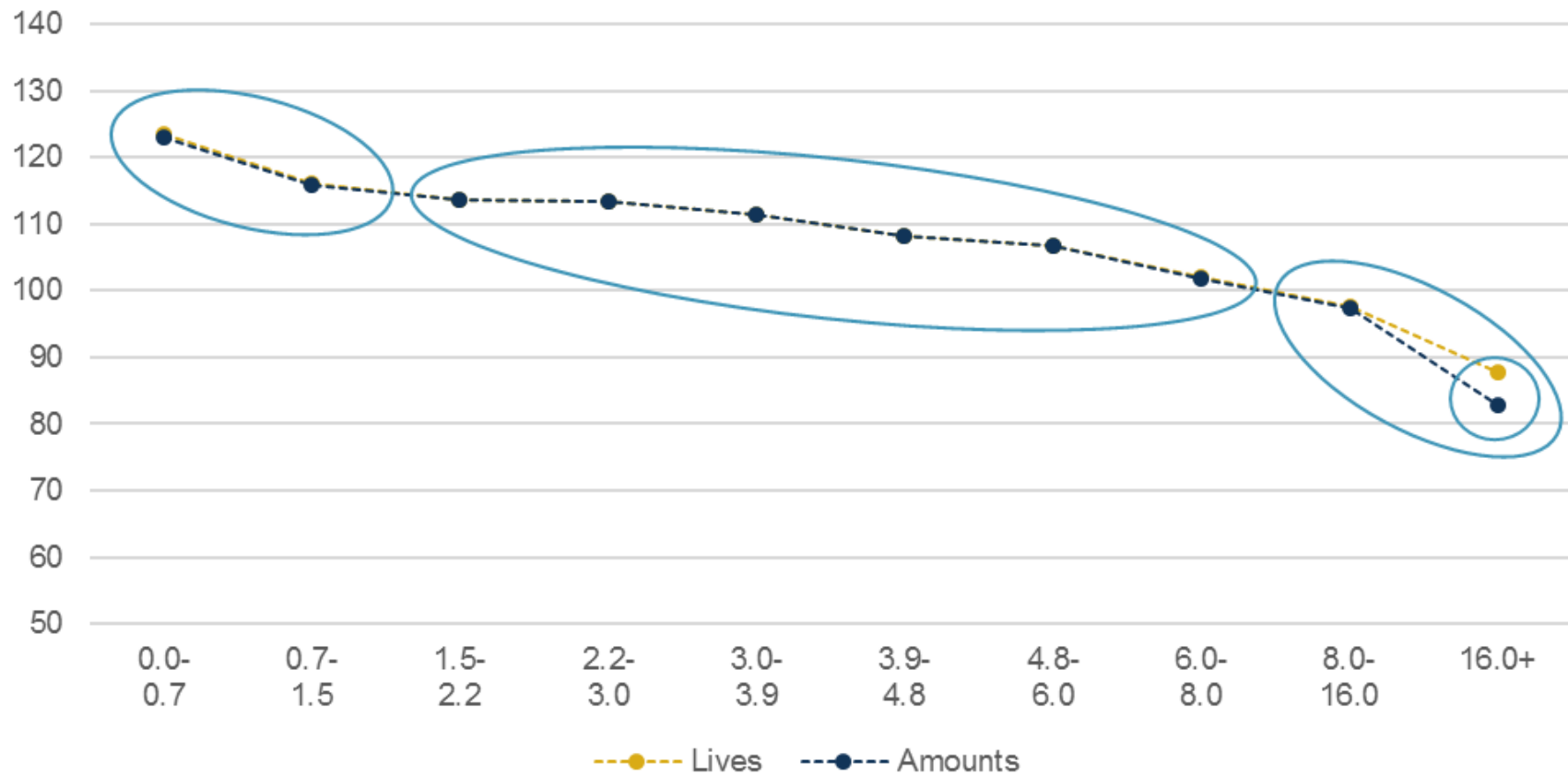
Amount bands

- 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

Gender	Band	S2 Series		S3 Series	
Male	Heavy	0 – 1,700	(19%)	300 – 5,000	(40%)
Male	Middle	1,700 – 14,750	(65%)	5,000 – 20,000	(45%)
Male	Light	14,750+	(16%)	20,000+	(15%)
Male	Very light	n/a	n/a	40,000+	(3%)
Female	Heavy	0 – 850	(22%)	0 – 1,000	(19%)
Female	Middle	850 – 5,500	(60%)	1,000 – 8,000	(58%)
Female	Light	5,500+	(18%)	8,000+	(23%)
Female	Very light	n/a	n/a	16,000+	(6%)

Note: Percentages relate to lives-weighted Pensioner experience.

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/Es shown in table:

	Pension band	100A/E vs S3PxA_L	100A/E vs S3PxA_VL
Male Pensioners	£20,000 to £40,000	106.1	118.6
Male Normal health	£20,000 to £40,000	105.9	119.1
Female Pensioners	£8,000 to £16,000	104.8	112.9
Female Normal health	£8,000 to £16,000	103.2	107.8
Female Dependants	£8,000 to £16,000	103.8	108.8

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_K
 - Analysis shows S3 not overly sensitive to choice of S_K
- Mortality Projections Committee have released consultation on CMI Model parameterisation in Working Paper 114
 - Value of S_K may be lower for CMI_2018

Selection of formulae

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

$$m_x = \exp(b_0 + b_1x + b_2x^2 + b_3x^3) \quad \text{Males}$$

$$m_x = \exp(b_0 + b_1x + b_2x^2 + b_3x^3 + b_4x^4) \quad \text{Females}$$

- 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.

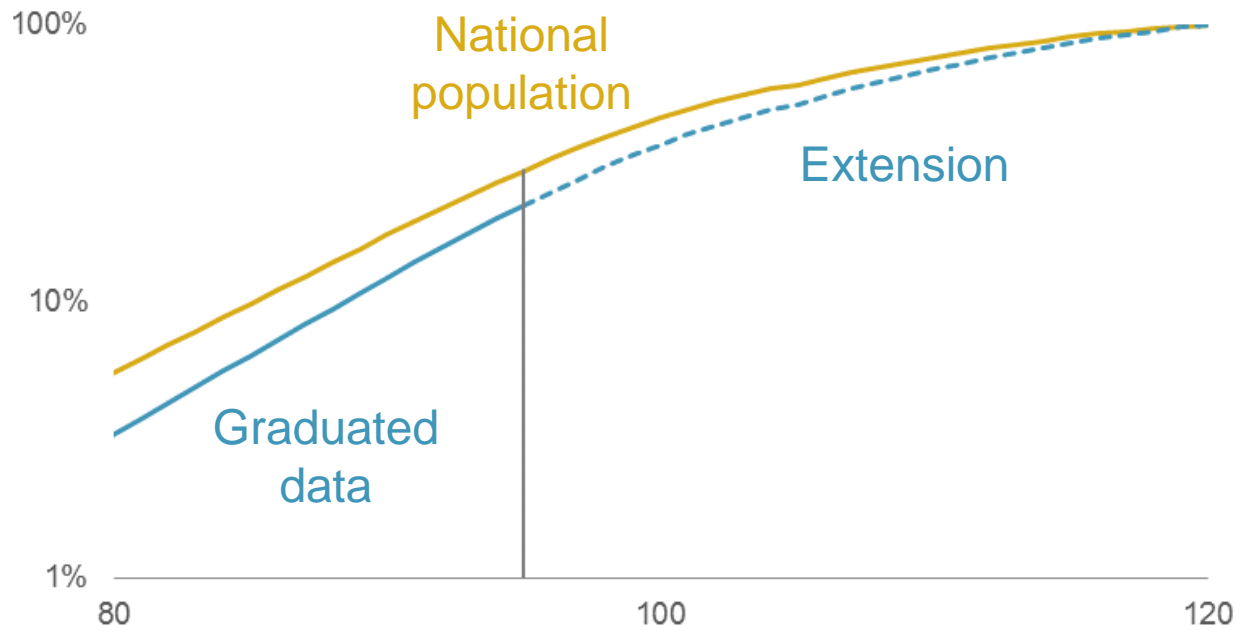
Low age extensions

- 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.

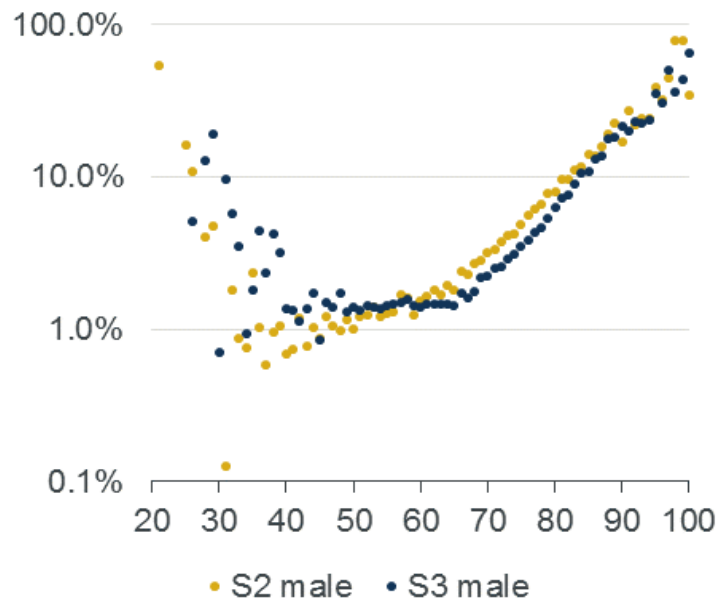


Consultation responses were supportive of high age methodology.

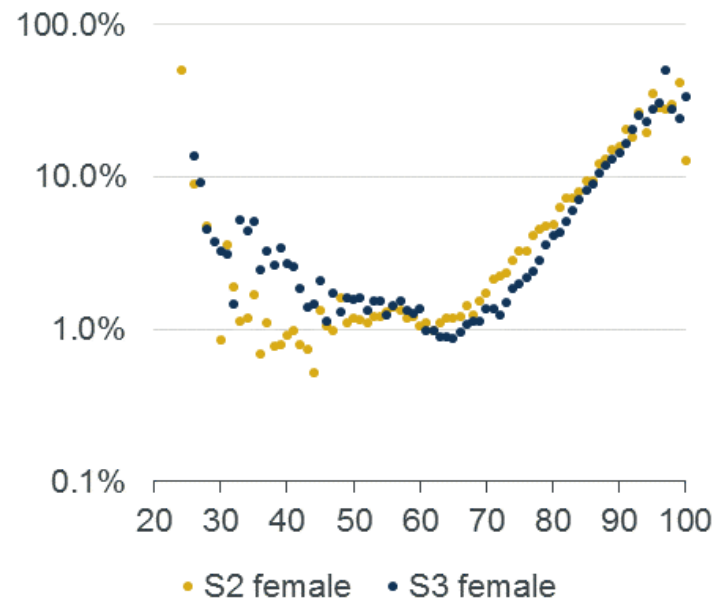
III-health tables – age range for graduation

- III-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



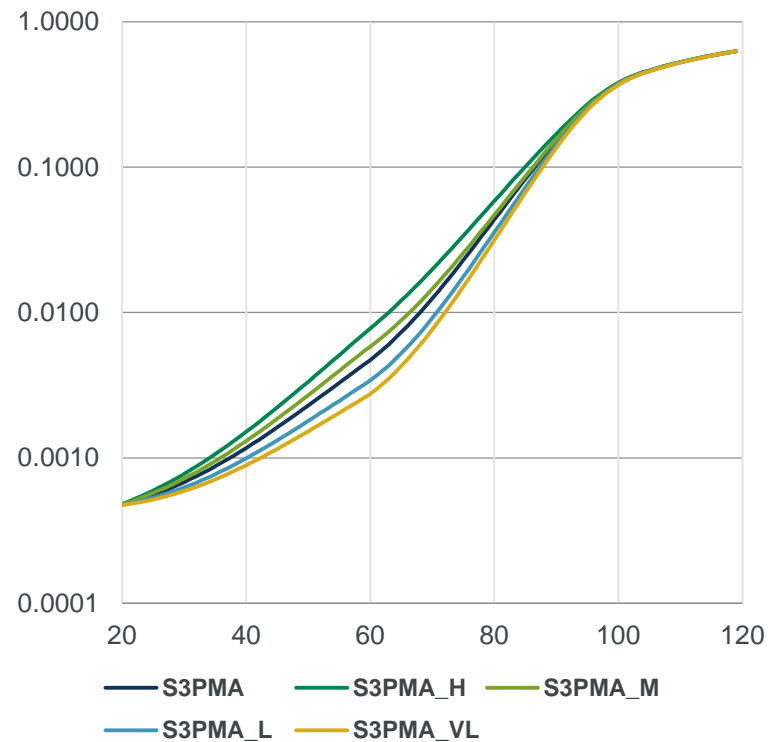
Female Pensioners



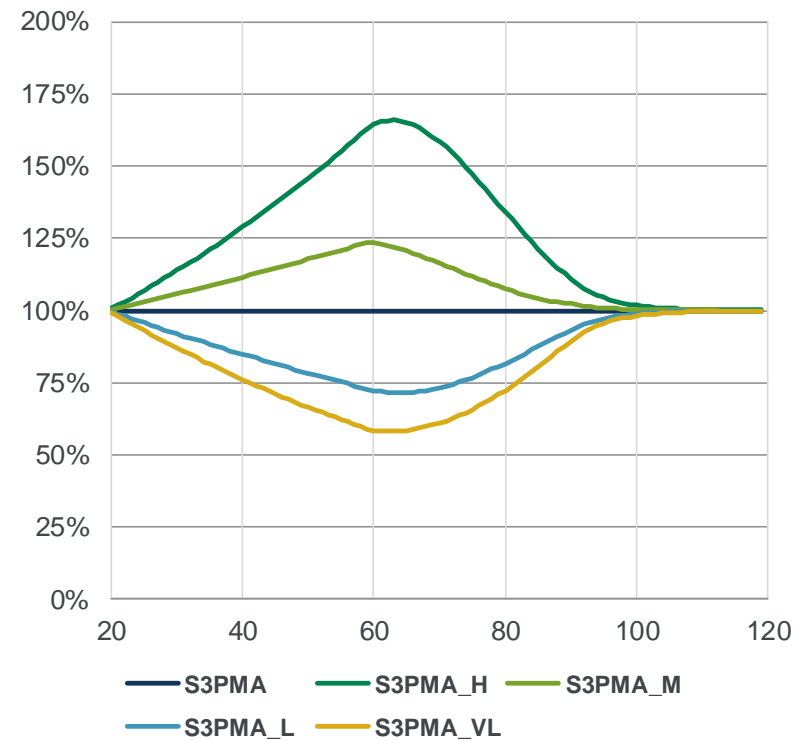
Results

Male Pensioner amounts tables

Mortality (q_x) on a logarithmic scale

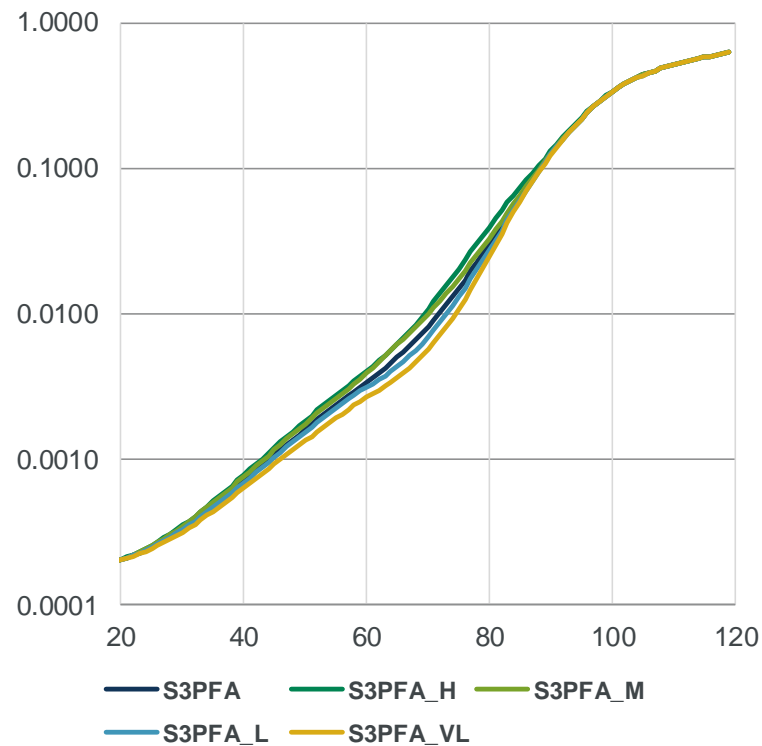


Mortality relative to S3PMA

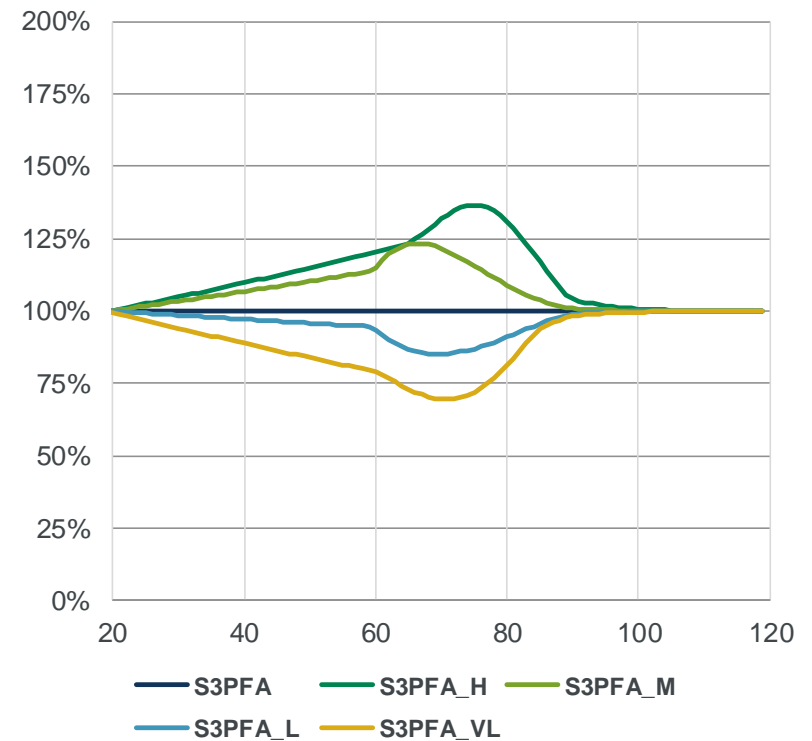


Female Pensioner amounts tables

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:

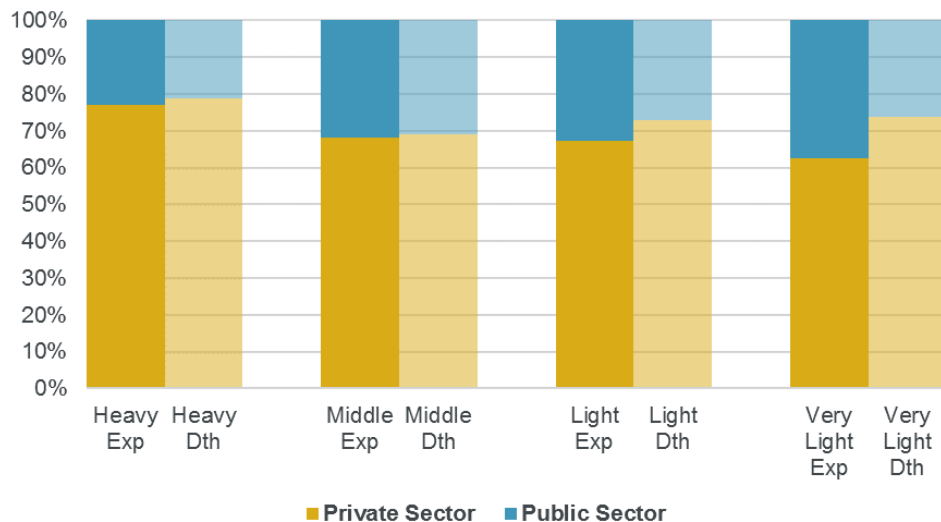
	Table	Males	Females
All	S3PxA	24.9	27.2
Heavy	S3PxA_H	22.4	25.8
Middle	S3PxA_M	24.2	26.6
Light	S3PxA_L	26.3	27.7
Very Light	S3PxA_VL	27.1	28.3

Analysis – public and private sector

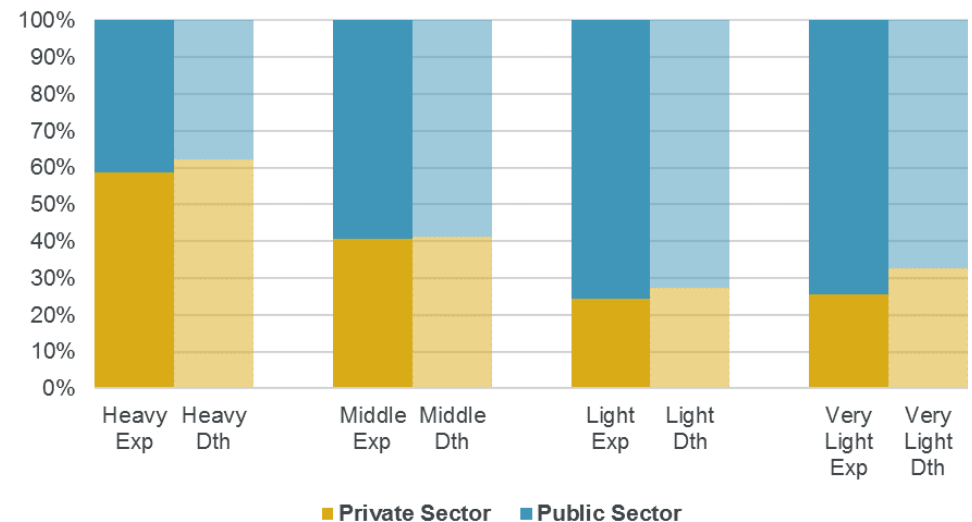
Data volume by sector and amount band

- 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

Males



Females



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	Flat scaling factor
Male Pensioners amounts	S3PMA	102.4% \pm 0.7%
Male Normal health amounts	S3NMA	104.7% \pm 0.9%
Male Dependants amounts	S3DMA	102.3% \pm 3.6%
Female Pensioners amounts	S3PFA	109.5% \pm 1.3%
Female Normal health amounts	S3NFA	112.1% \pm 1.7%
Female Dependant amounts	S3DFA	100.6% \pm 0.9%

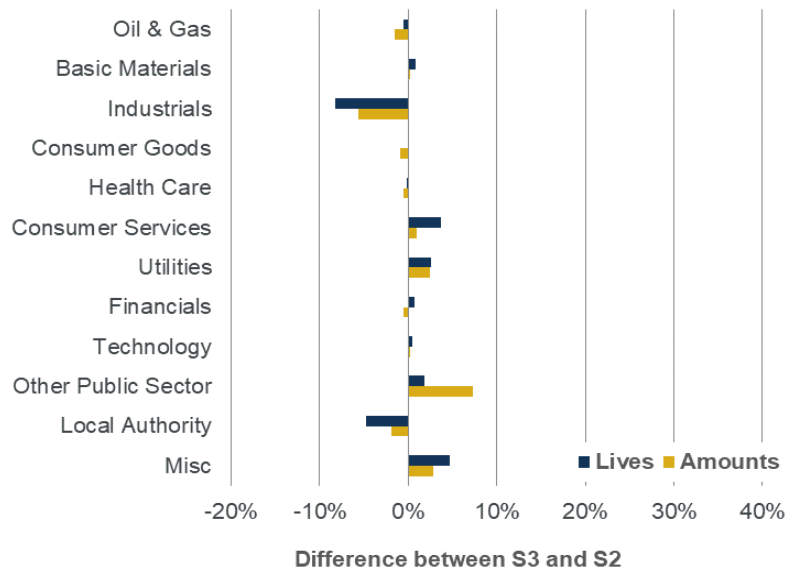
- Female Pensioners amounts scaling factor relative to S3PFA is quite high.
 - Scaling factor for Female Pensioners amounts relative to S3PFA_M is 100.8%.

Analysis – industry sector

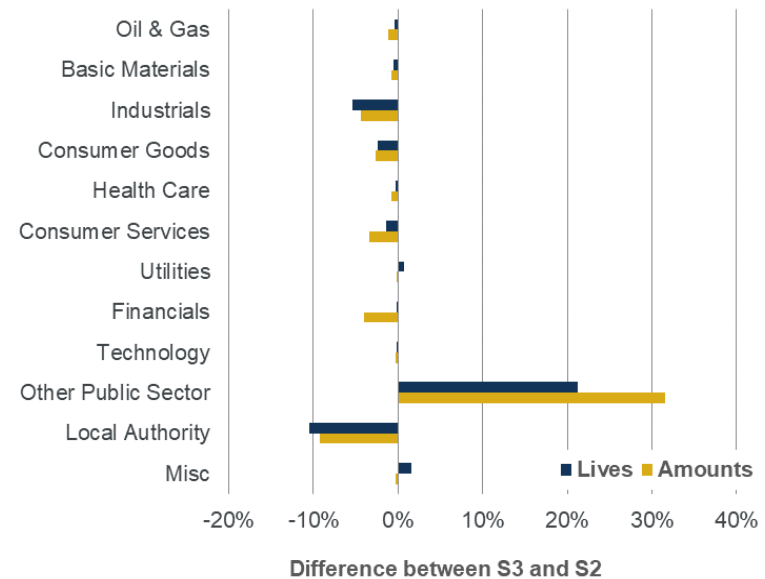
Initial industry analysis – change in composition of dataset

- 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



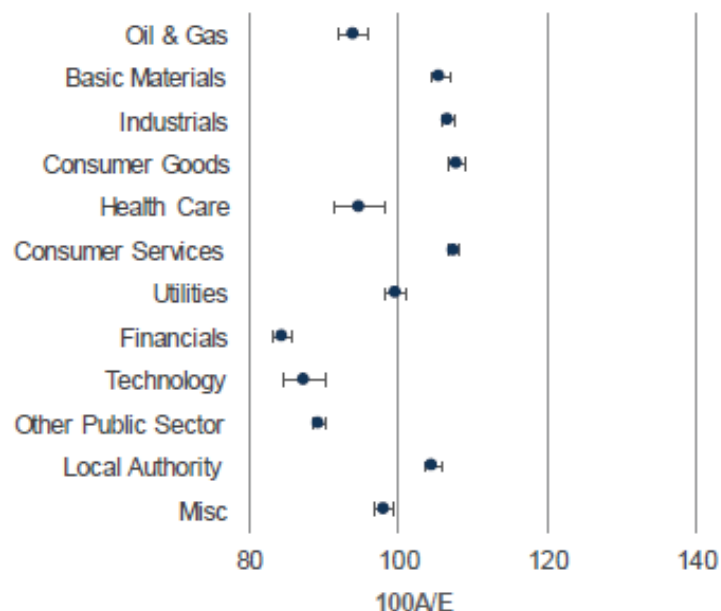
Female Pensioners



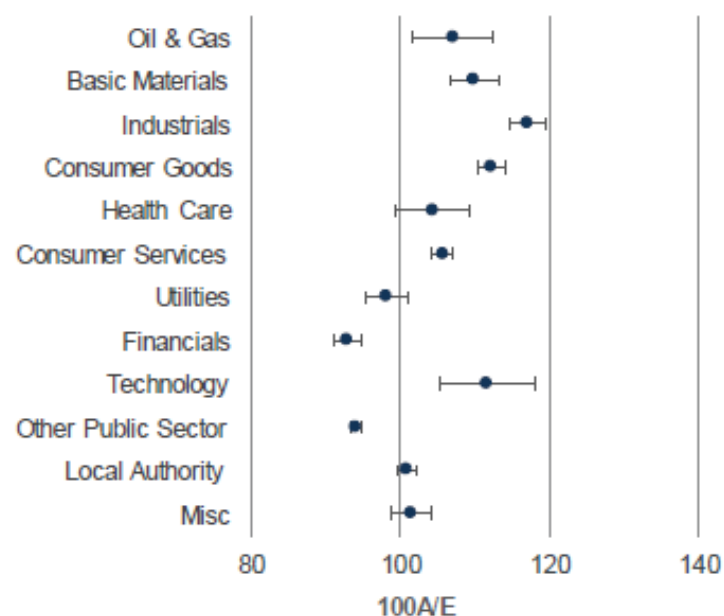
Initial industry analysis – experience by industry

- Experience varies significantly by industry
- Charts show 100A/Es by lives relative to S3PxL for each industry, including 95% confidence intervals:

Male Pensioners



Female Pensioners



Comparison with the “S2” Series

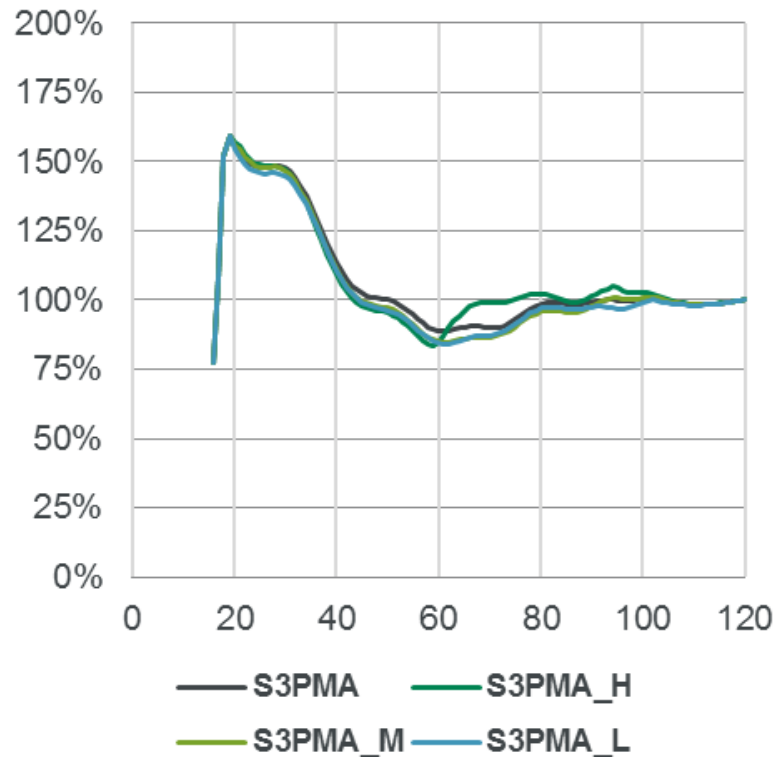
Changes from S2 to S3

- 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

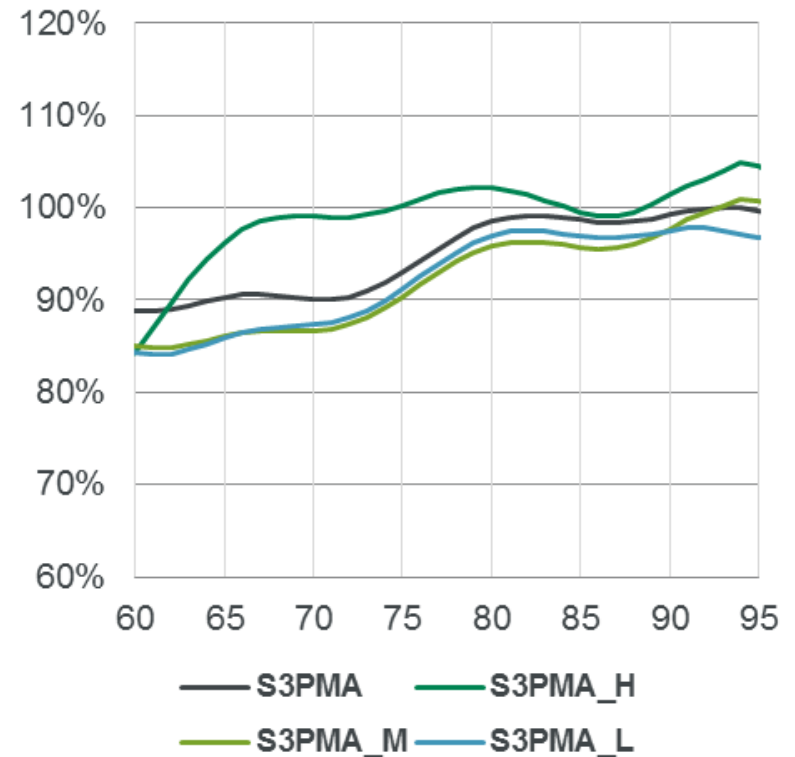
The Committee encourages users to consider whether similarly named S3 table is still appropriate when updating from S2 to S3.

Male Pensioner amounts tables

All ages, relative to
projected equivalent S2 table

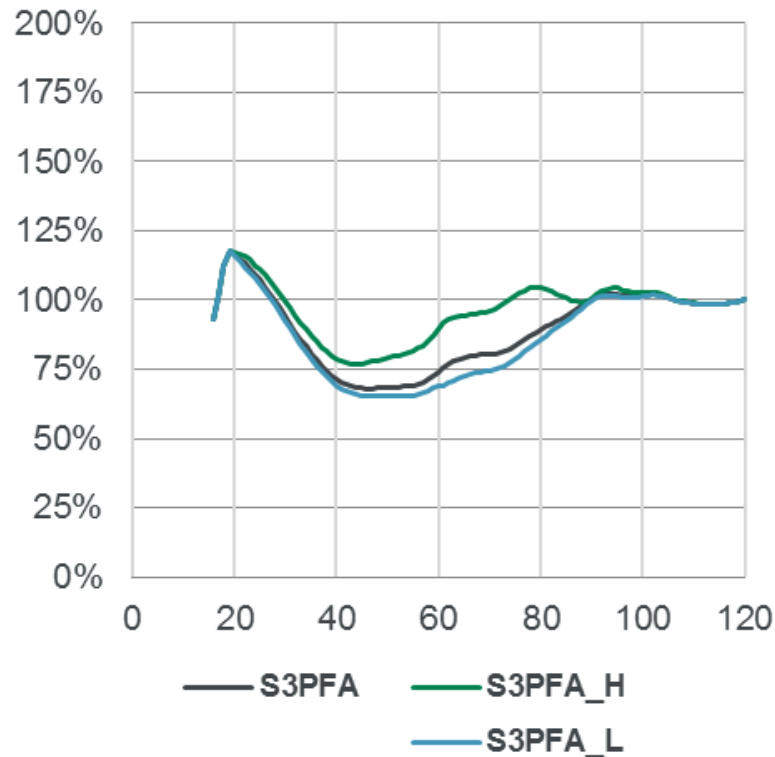


Ages 60-95, relative to
projected equivalent S2 table

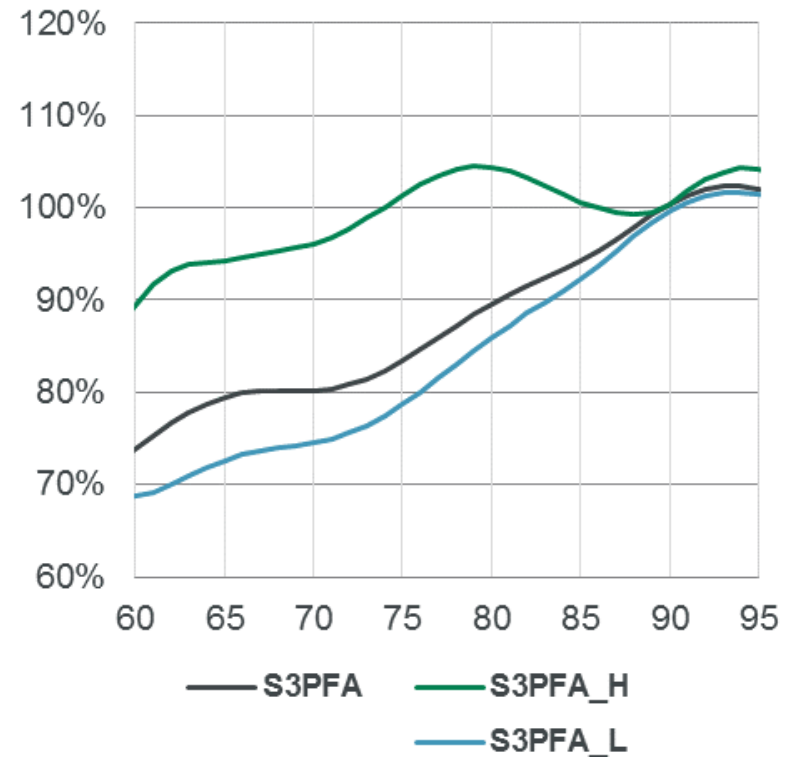


Female Pensioner amounts tables

All ages, relative to
projected equivalent S2 table



Ages 60-95, relative to
projected equivalent S2 table



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.



Questions



Comments



Continuous Mortality Investigation

Institute and Faculty of Actuaries

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10 December 2018

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_k) of 7.5?

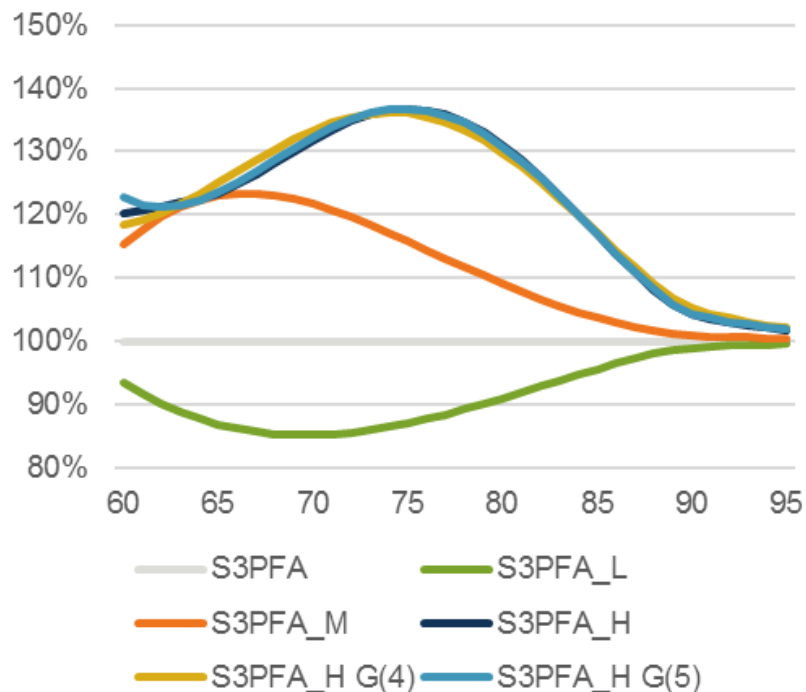
Working Paper 107 Consultation Questions

- 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?

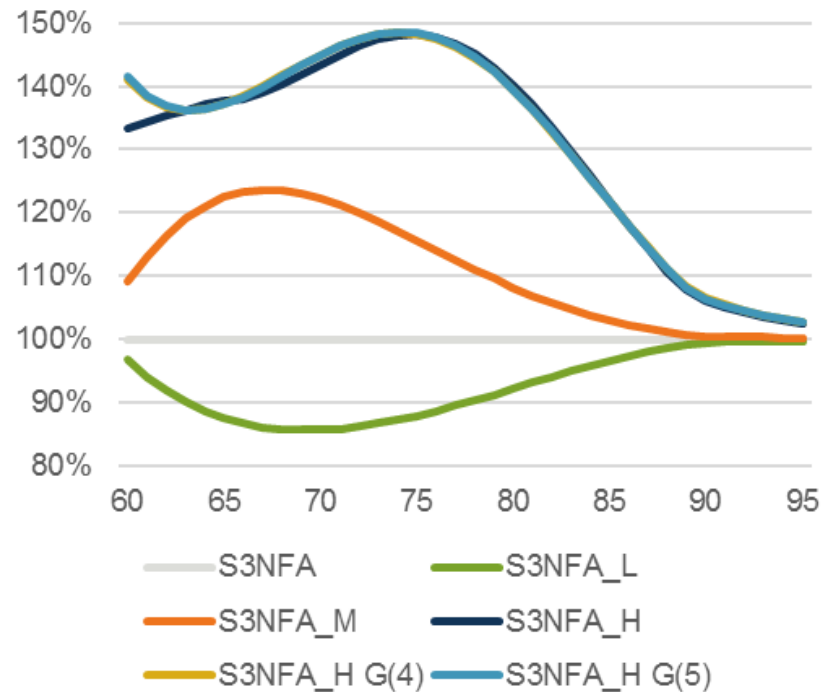
Female Heavy tables analysis of graduations

- 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

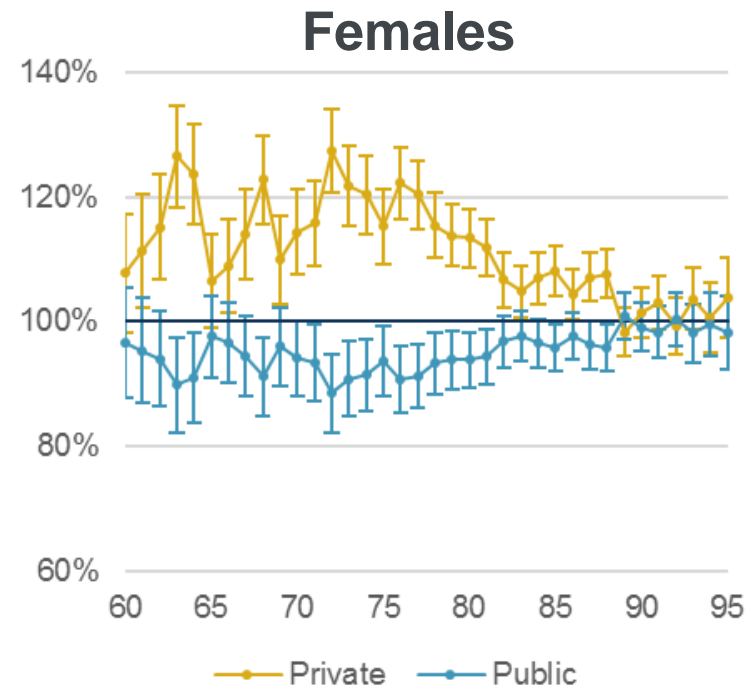
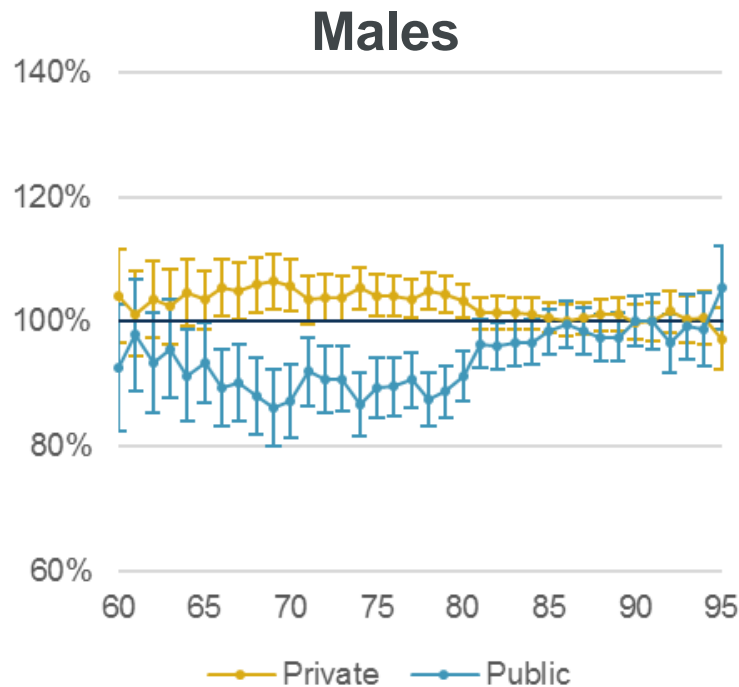
Private and public sector

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.

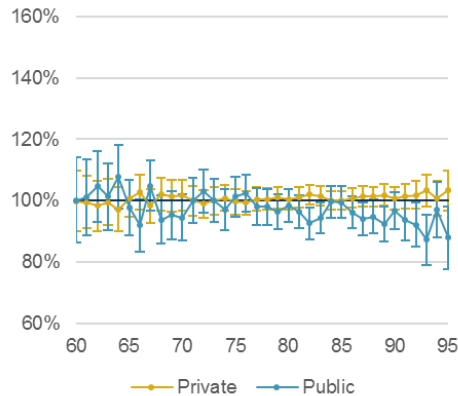
Relative mortality

- 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.

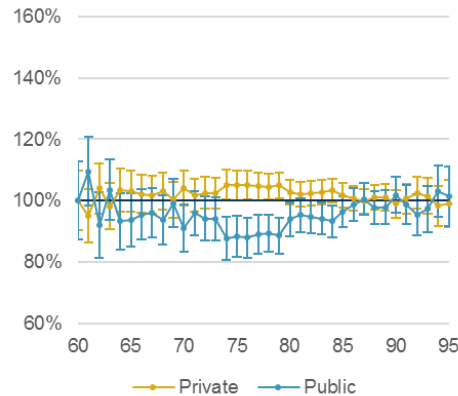


Relative mortality by amount band

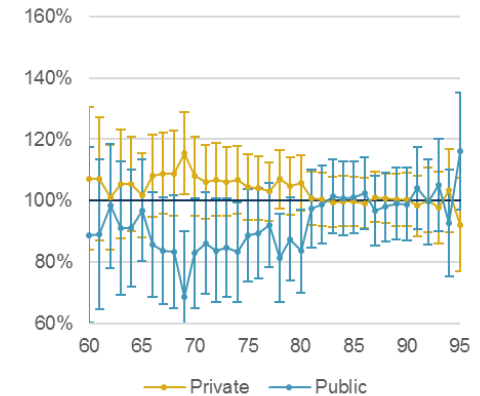
Male Heavy



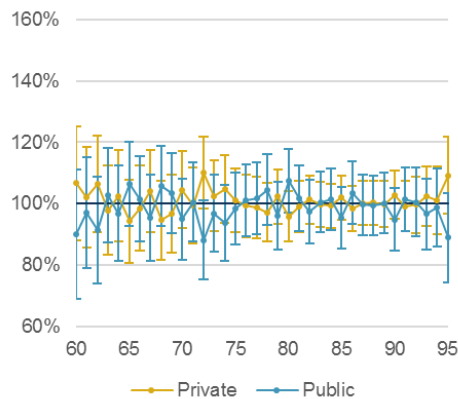
Male Middle



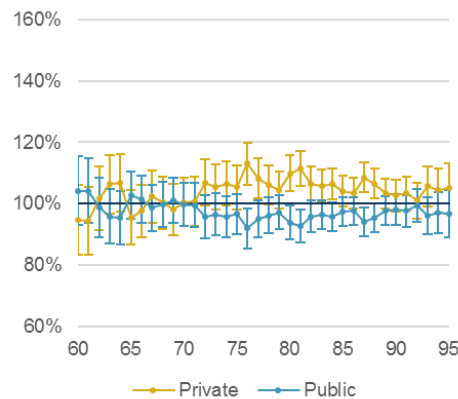
Male Light



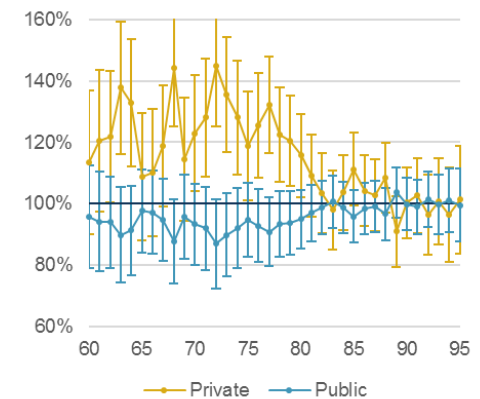
Female Heavy



Female Middle



Female Light



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)

	Heavy	Middle	Light	Very Light	All
Male private	-0.2%	-0.7%	-0.8%	-1.5%	-0.8%
Male public	+0.6%	+1.5%	+1.7%	+3.2%	+1.8%
Female private	-0.1%	-1.1%	-2.7%	-2.8%	-2.4%
Female public	+0.2%	+0.7%	+0.8%	+0.9%	+1.1%

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.