Continuous
Mortality Investigation

Institute and Faculty of Actuaries

CMI Research Update

Momentum Conference
2 December 2016

Deborah Cooper
Chair, CMI SAPS Committee

16 November 2016

Mission and vision

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.

Recent and ongoing work

- Investigations
  - Annuities – 08 tables finalised June 2015 (WP81)
  - Assurances – proposed 08 tables: accelerated critical illness released in May 2016 (WP89) and term assurance published October 2016 (WP92)
  - SAPS – industry analysis published Nov 2015 (WP86) and 2015 experience analysis published Feb 2016 (WP88)
  - experience paper due Q4 2016 and S3 targeted for release in 2019
- Projections
  - Proposed model released Summer 2016 (WP90/WP91)
  - *Model and calibration software available*
- High Age Mortality Working Party initial report October 2015 (WP85)

Self Administered Pension Schemes (SAPS)

SAPS activity

Date	Activity
2002 to 2006	Research and consultation
October 2008	**S1 Series tables released** (based on data covering 2000-2006)
April 2010 & May 2011	Annual experience updates covering 2001-2008 & 2002-2009
July 2011	Mortality improvements of self-administered pension schemes
May 2012	Analysis of mortality experience by industry classification
May 2012 & April 2013	Annual experience updates covering 2003-2010 & 2004-2011
April to May 2013	Consultation on proposed S2 Series tables
February 2014	**S2 Series tables released** (based on data covering 2004-2011)
July 2014	Annual experience update covering 2005-2012
December 2014	Annual experience update covering 2006-2013
November 2015	**Analysis of mortality experience by industry classification**
February 2016	**Annual experience update covering 2007-2014**

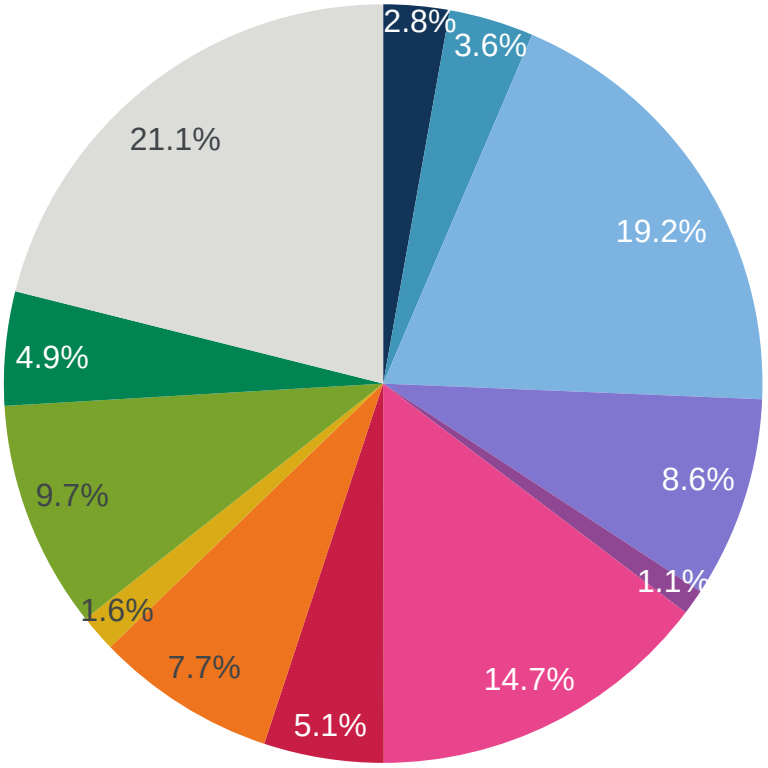
Industry analysis – classifications used

Code	Industry
51	Oil and gas
52	Basic materials
53	Industrials
54	Consumer goods
55	Healthcare
56	Consumer services
57	Telecommunications
58	Utilities
59	Financials
60	Technology
61	Public sector excluding local authorities
62	Local authorities
63	Miscellaneous

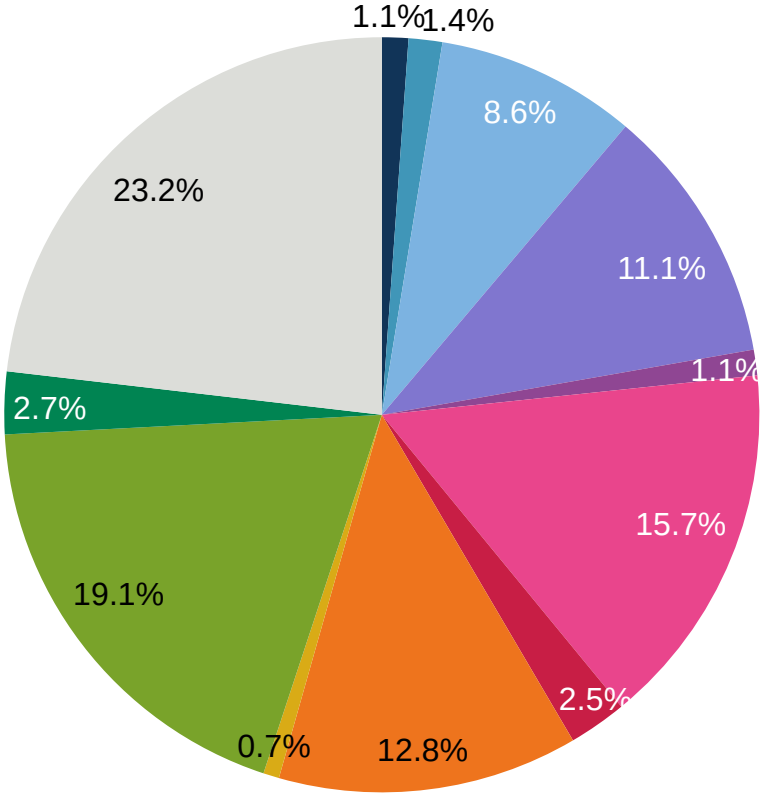
- SAPS industry classifications were updated in 2007 to bring them broadly in line with FTSE Actuaries Industry Sectors.
- The Coding Guide provides additional guidance on how to choose the most appropriate code including a detail breakdown of each of the high level codes.
- The SAPS industry for each scheme is chosen by the data contributor.

Industry analysis – exposure

Male exposure by industry

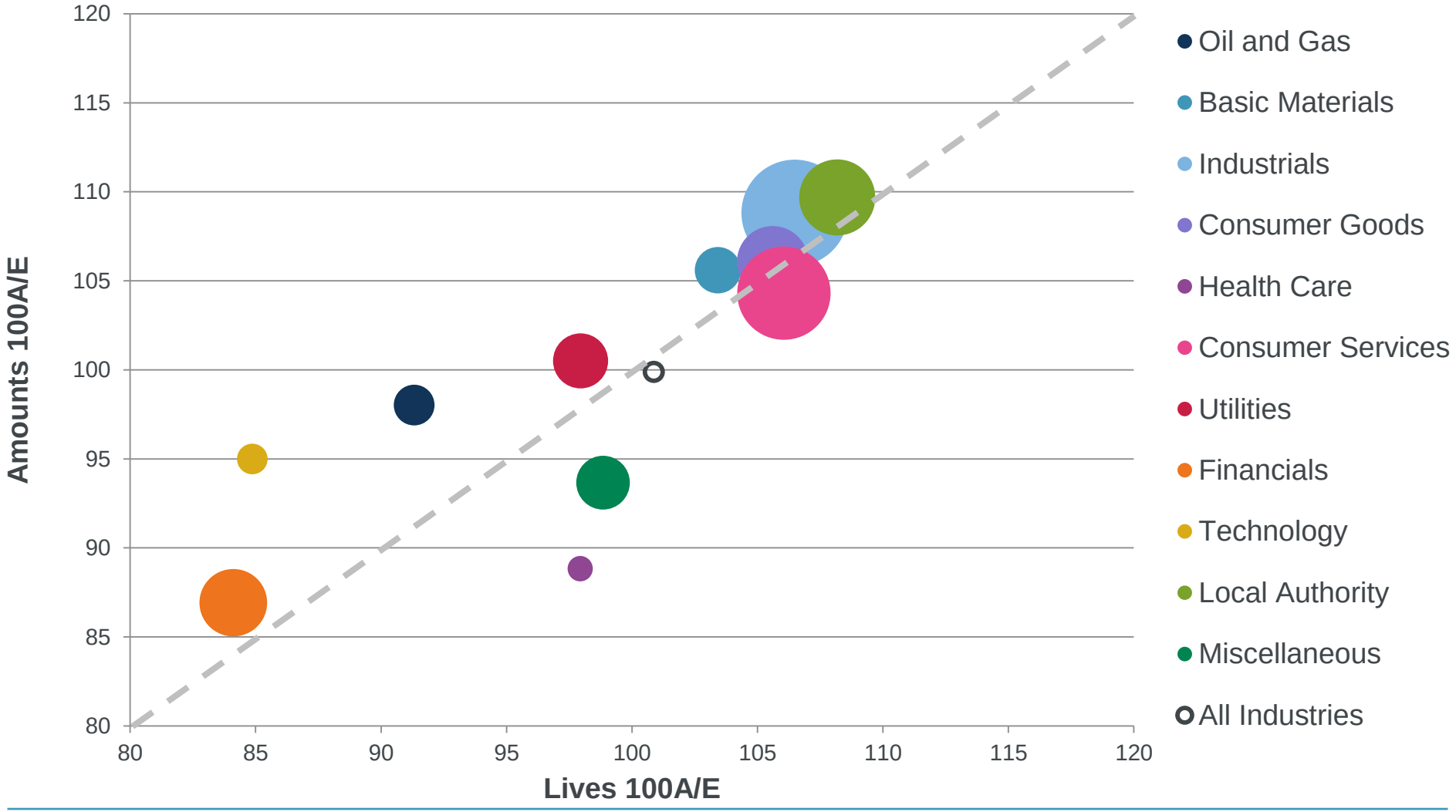


Female exposure by industry

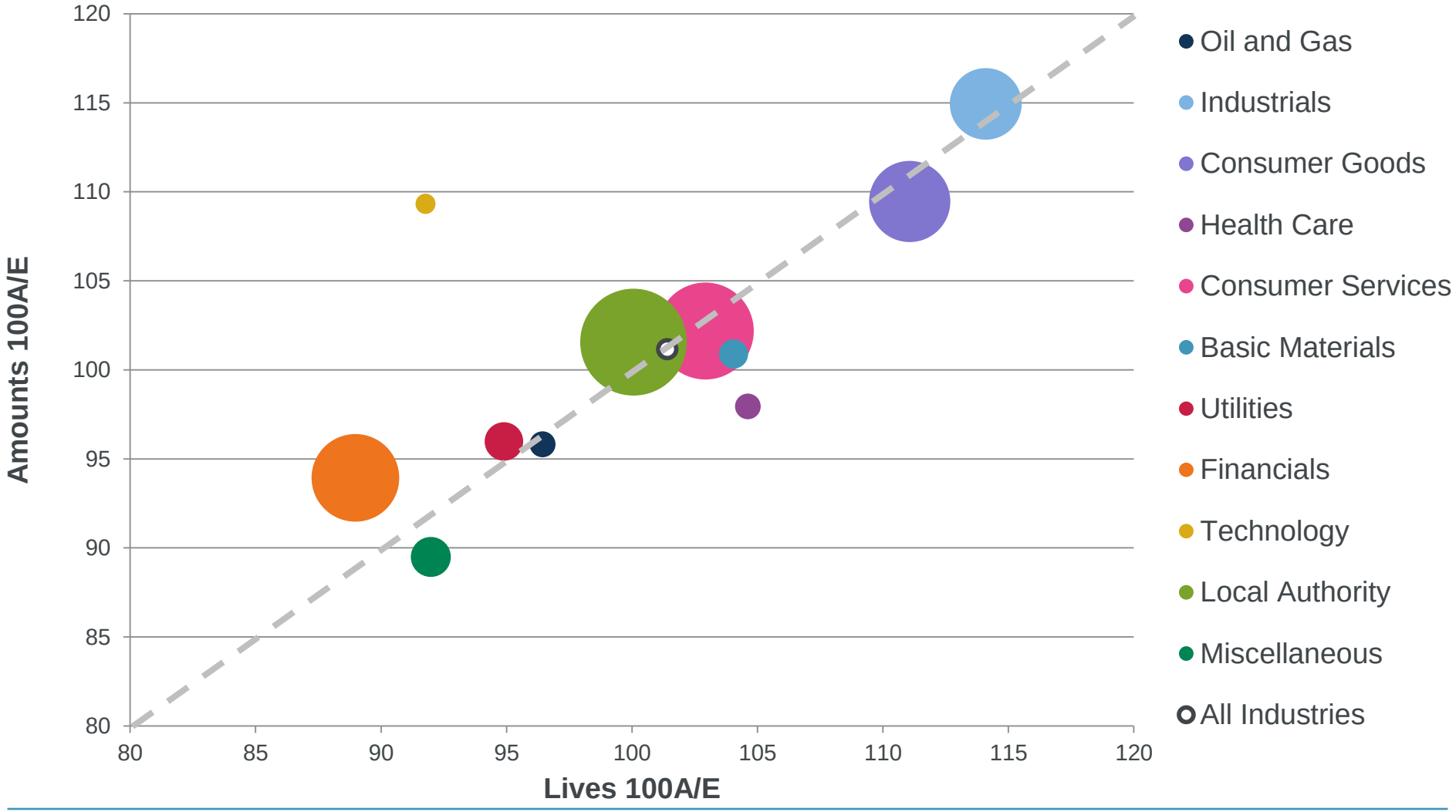


- Oil and Gas
- Basic Materials
- Industrials
- Consumer Goods
- Health Care
- Consumer Services
- Utilities
- Financials
- Technology
- Local Authority
- Miscellaneous
- Not Included in Industry Analysis

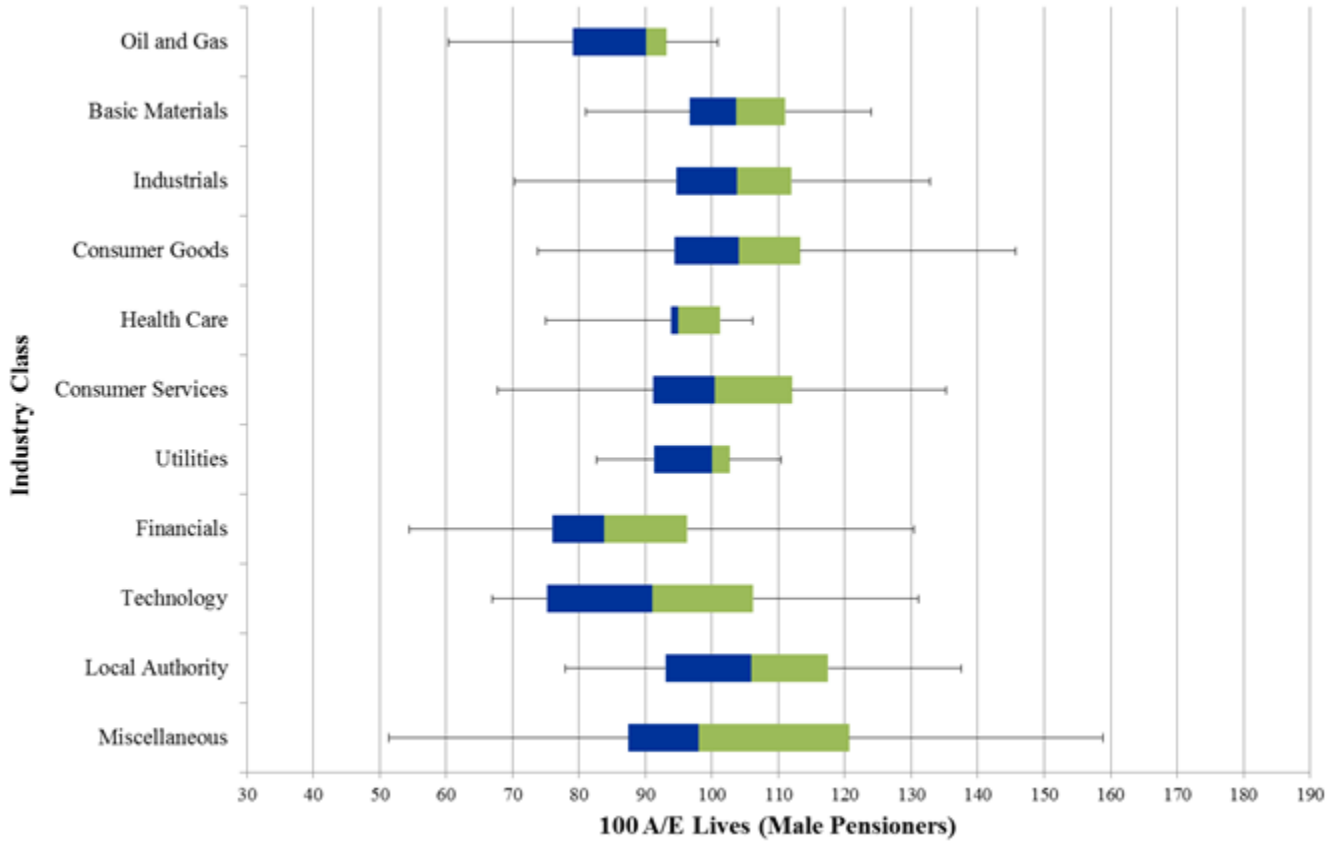
Industry analysis – male experience vs S2



Industry analysis – female experience vs S2



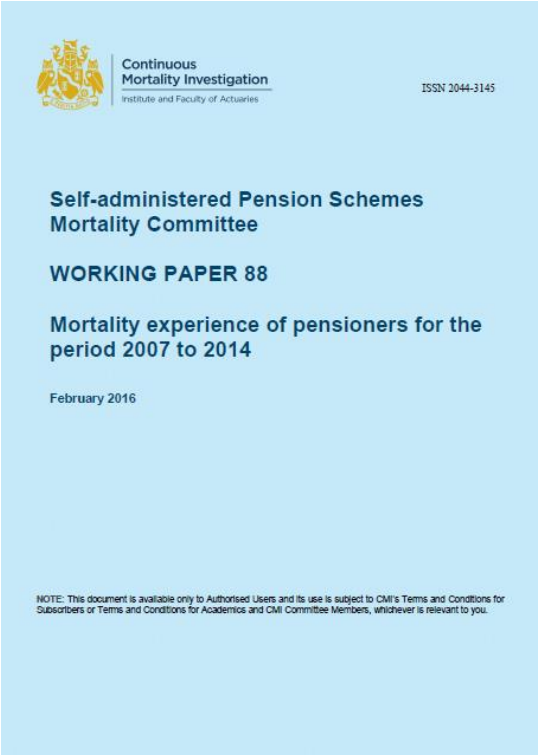
Industry analysis – Variation of male pensioner lives vs S2



Experience Analysis - Overview

Working Paper 88

- Covers 8 year period from 2007 to 2014
- Data submitted by 30 June 2015
- Modest decrease compared to 2006 to 2013 (WP 76)
  - 2.5% decrease in lives weighted exposure
  - 1% decrease in number of deaths
- Published on 24 February 2016
- Executive summary released publicly
- Main paper and data files are subscriber only


Continuous Mortality Investigation
Institute and Faculty of Actuaries

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Self-administered Pension Schemes Mortality Committee

WORKING PAPER 88

Mortality experience of pensioners for the period 2007 to 2014

February 2016

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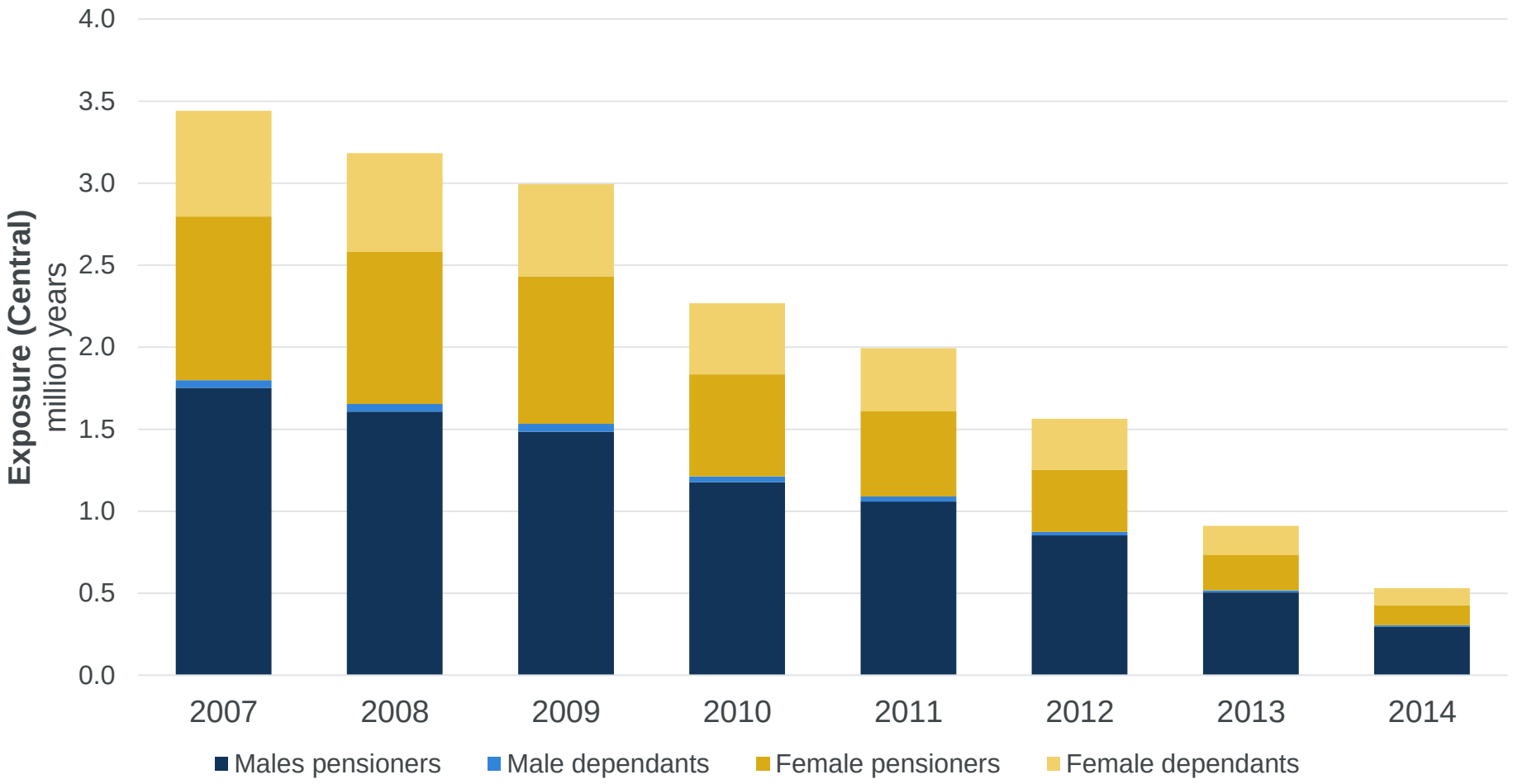
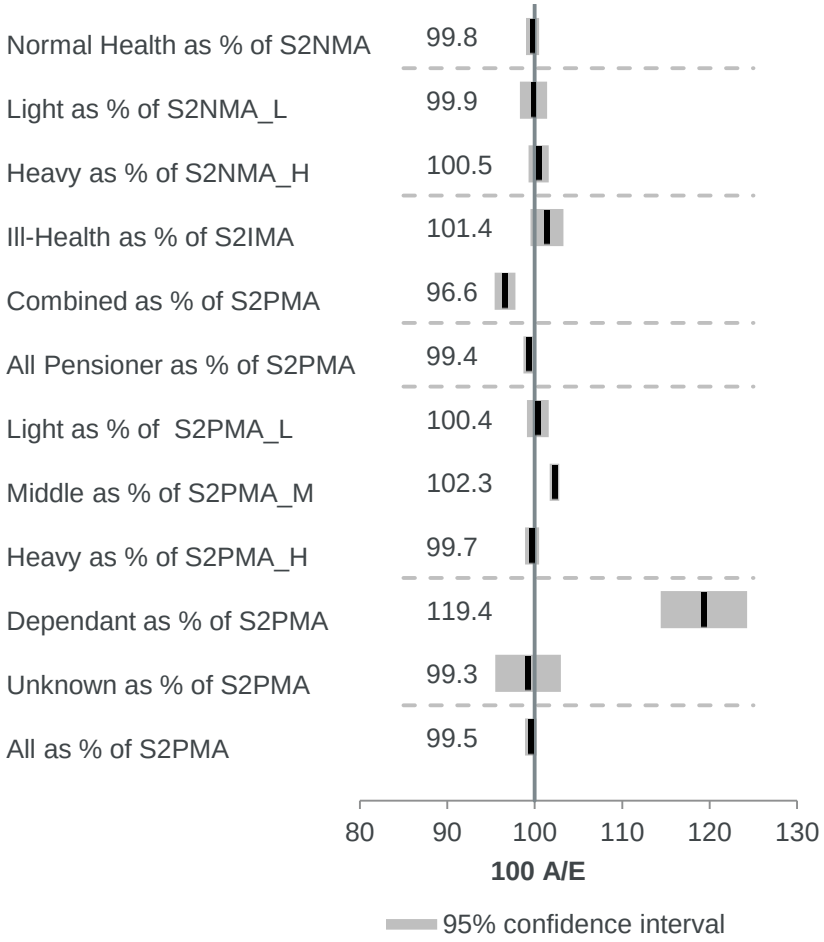
Experience Analysis - Data: By calendar year

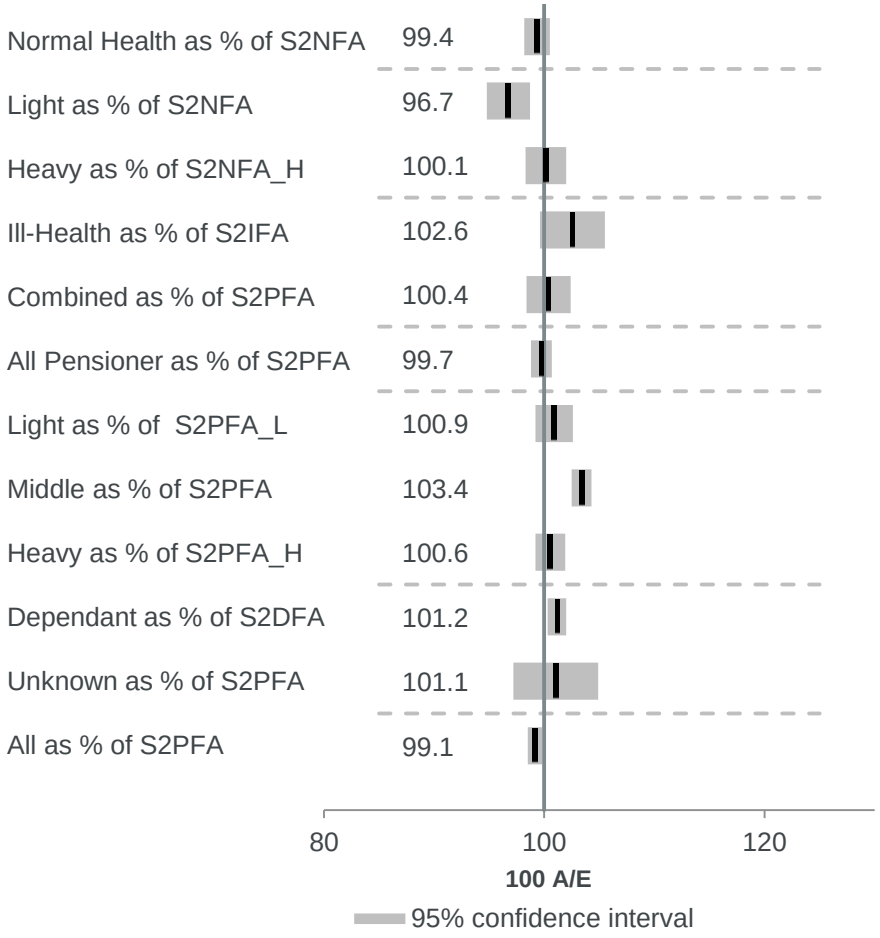


Experience Analysis - Results: By group (amounts)

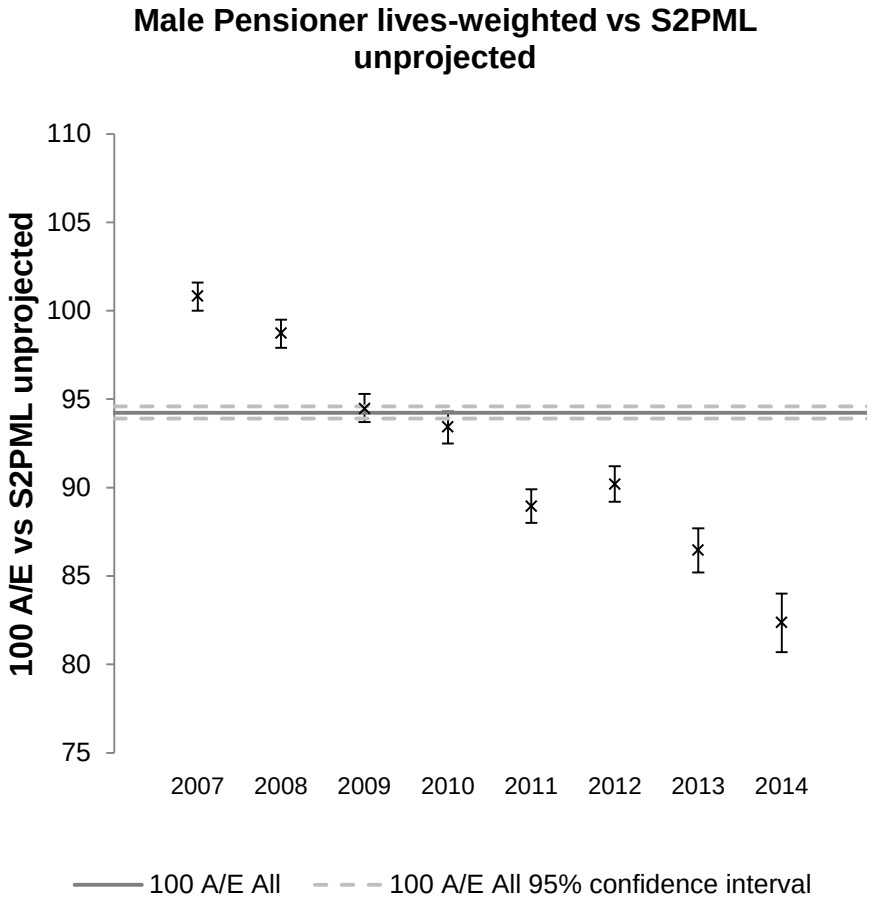
Males projected using CMI_2015

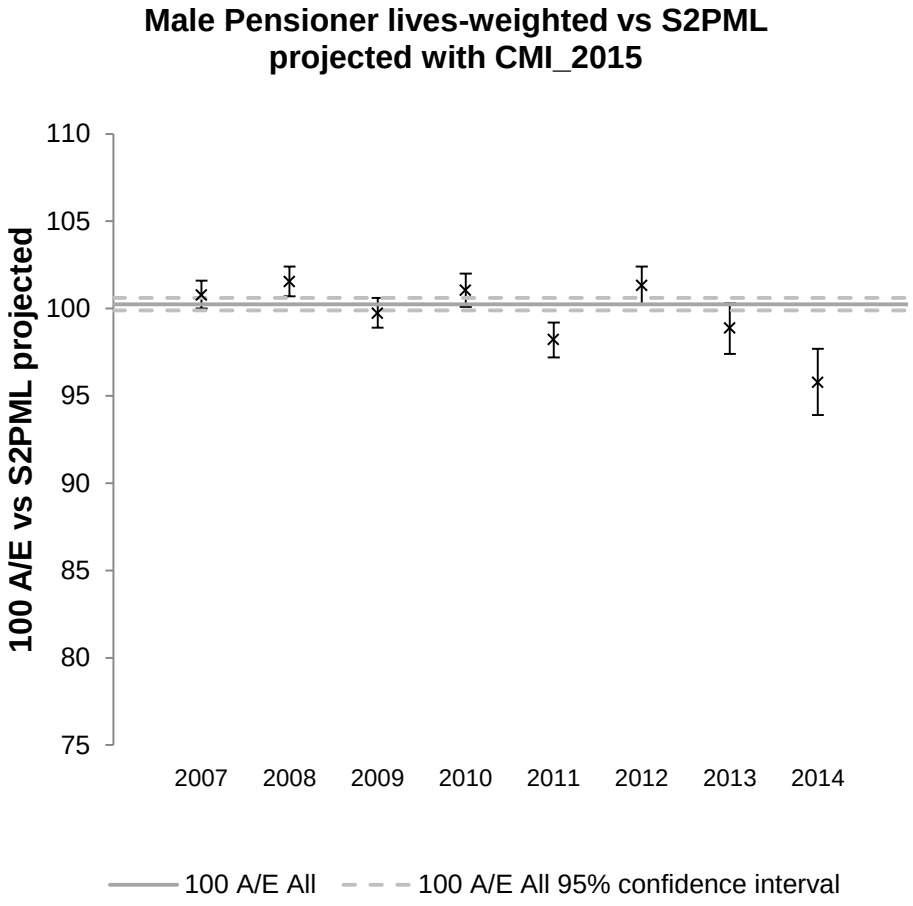


Females projected using CMI_2015

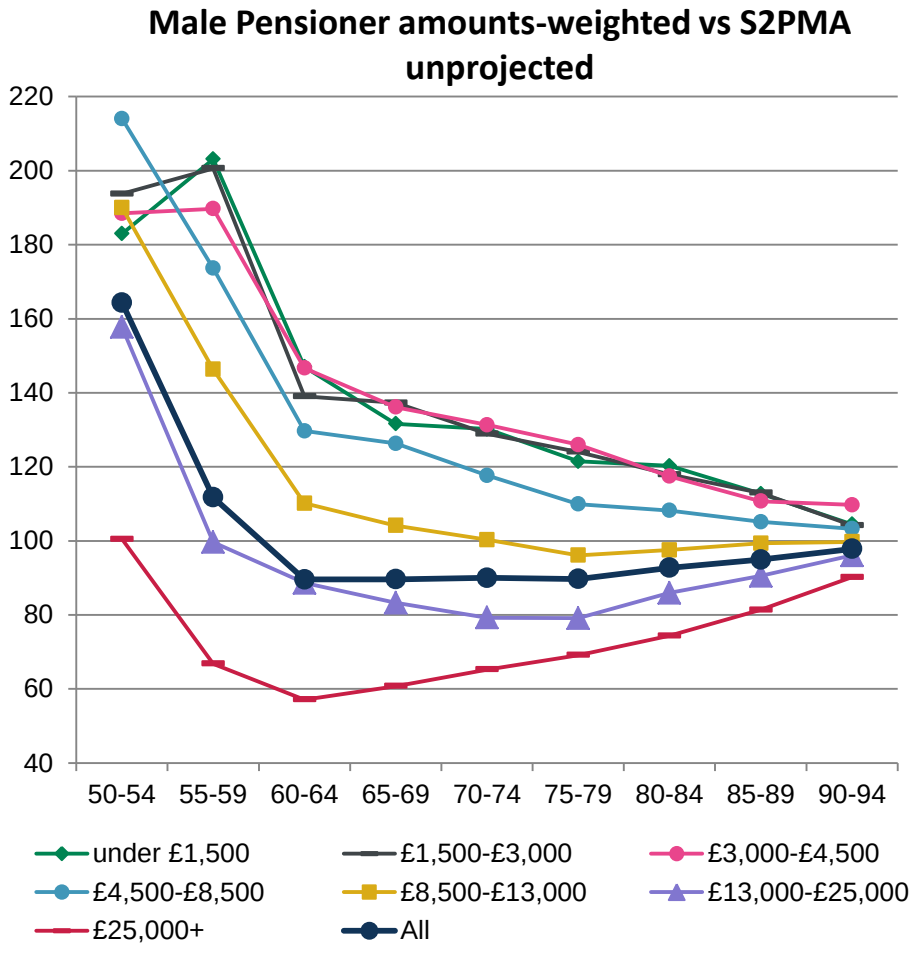


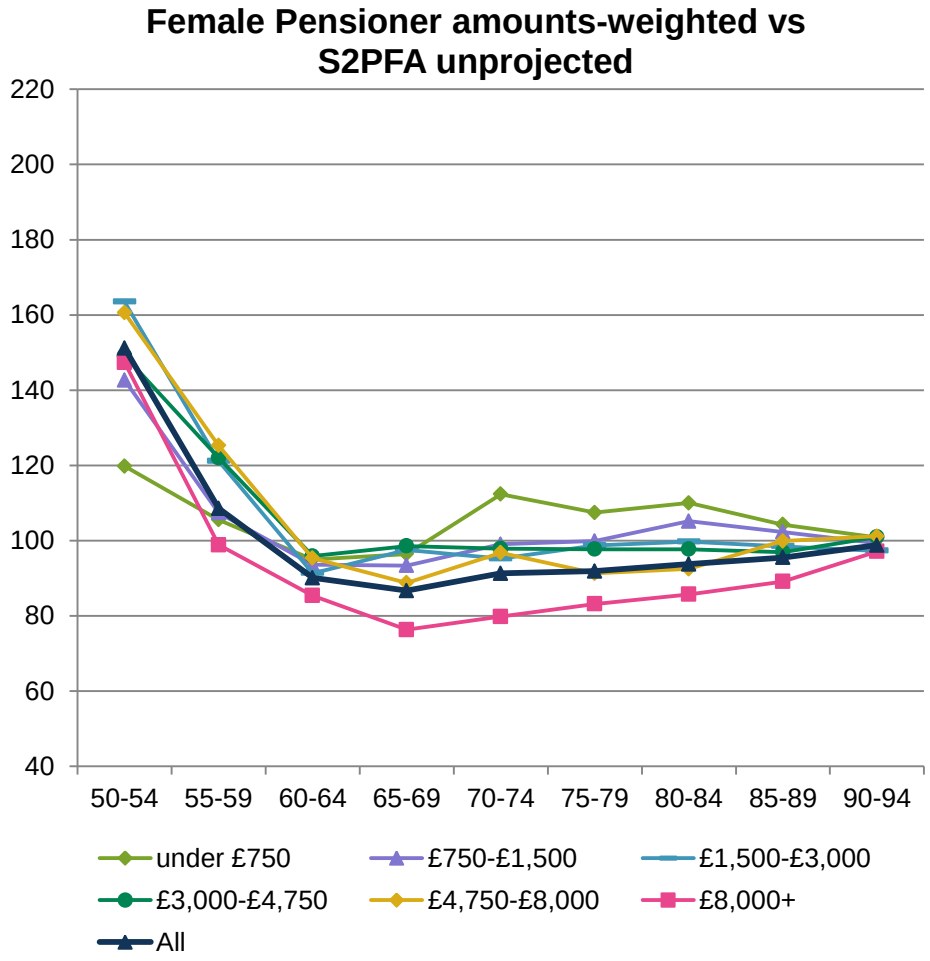
Experience Analysis - Results: By calendar year (lives)





Experience Analysis - Results: By pension amount (amounts)





What next?

- Analysis of public sector data
- Mortality improvements of self-administered pension schemes?
- S3 tables
  - Considering co-graduation
  - Awaiting HAMWP recommendations for high ages
  - No plans to release S3 for at least next 2 years

High Age Mortality Working Party

16 November 2016

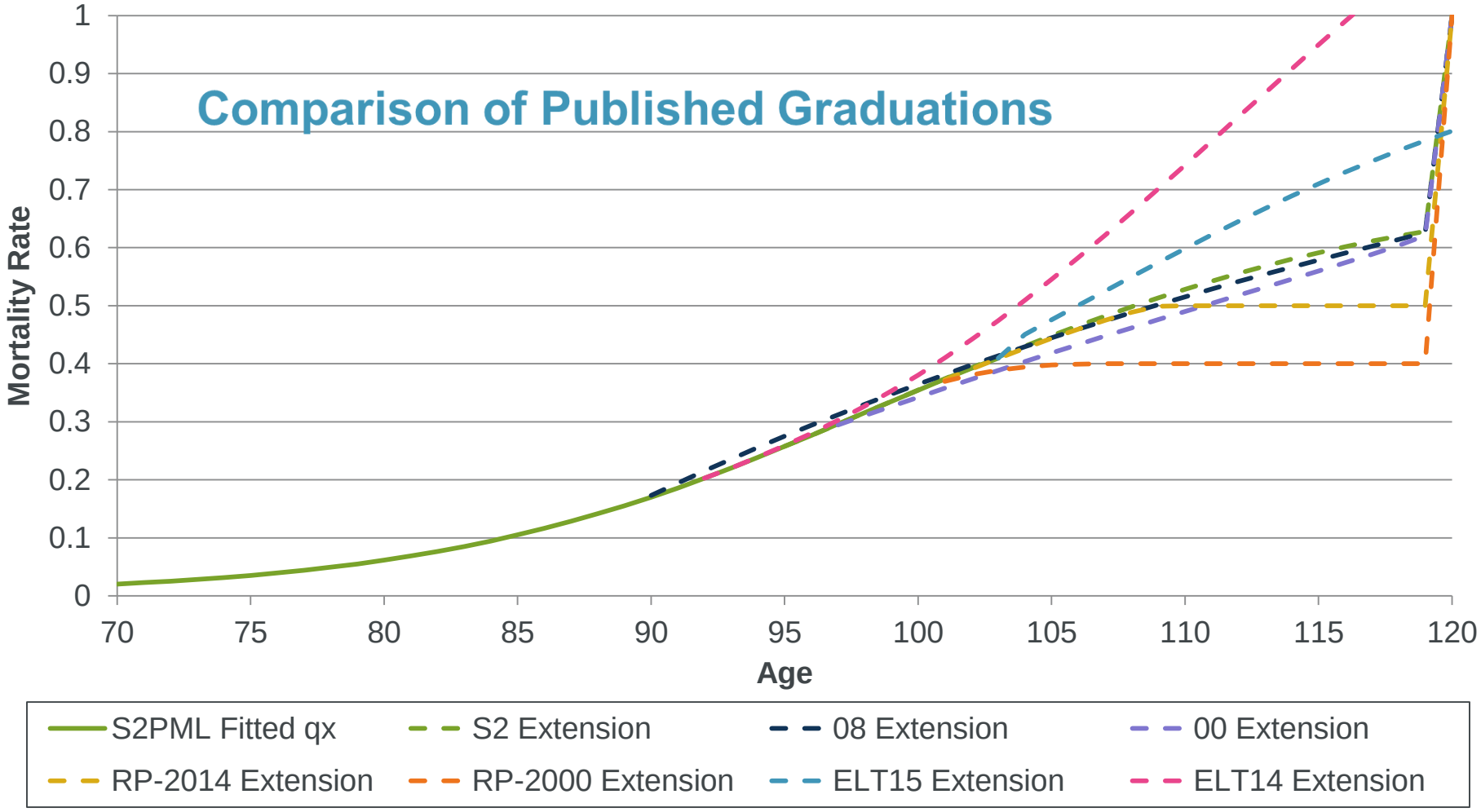
Phase 1: Initial findings

- Working Paper 85 released October 2015

- Key results:
  - Concerns about data quality
  - Population mortality at older ages (>90) appear to be understated
  - Wide variation in approaches used to model high age mortality

- https://www.actuaries.org.uk/learn-and-develop/continuous-mortality-investigation/cmi-working-papers/mortality-projections/cmi-wp-85

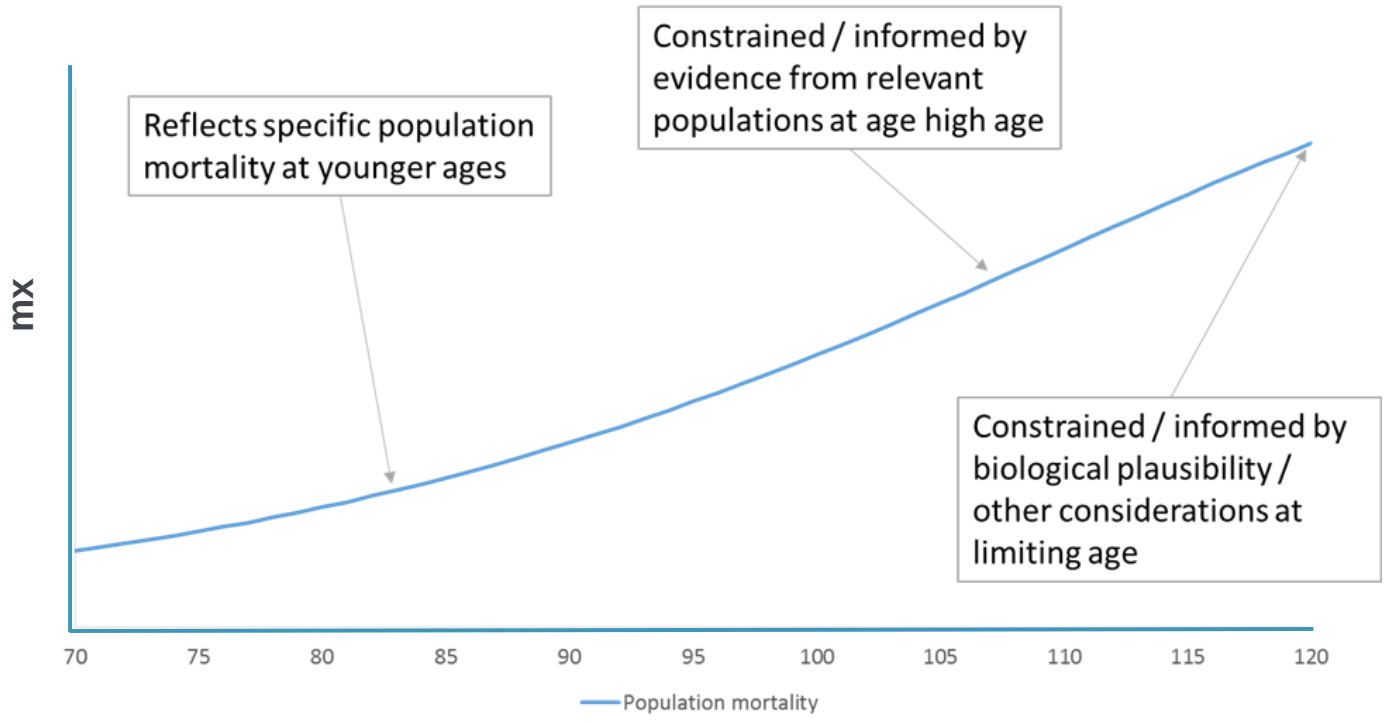
“Closing” mortality rate tables



Strand 1: Areas explored

- The very highest ages
  - What is the evidence?
  - What is our thinking on a proposed approach?
- Extending graduations
  - Do different groups converge?
  - If so, what is typical shape of convergence?
- What is our current thinking on a proposed approach?

Desirable features



- Plausibility
- Data compatibility
- Cohort features
- Robustness of fit
- Uncertainty assessment
- Trend allowance
- Smooth progression

Mortality deceleration: Two camps

Gavrilov & Gavrilova (2015)

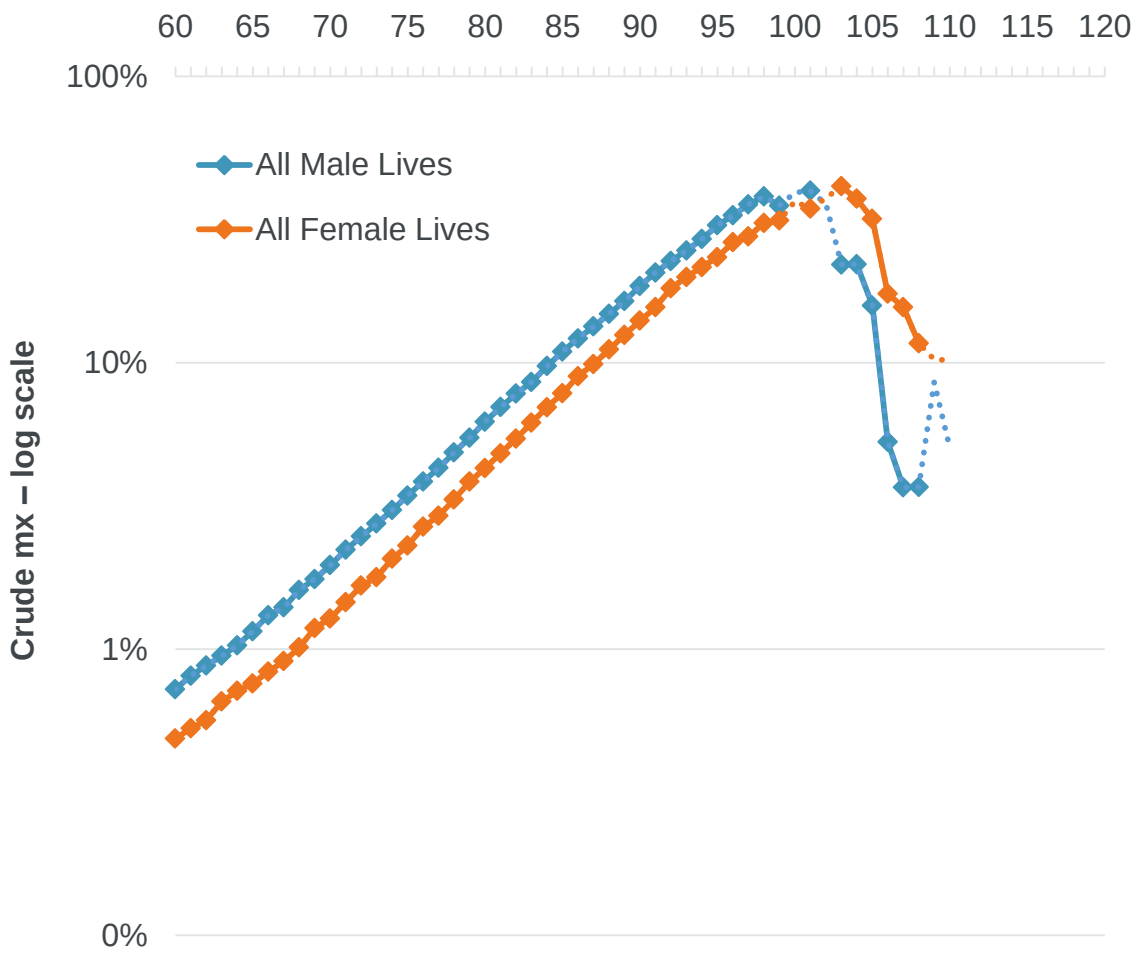
- Little evidence of mortality deceleration at high age in IDL supercentenarian dataset
- Factors explaining observed deceleration include:
  - Aggregation of birth cohorts resulting in homogeneous groups
  - Inaccurate age reporting resulting in downward bias
  - Common assumptions on high age mortality breaking down

- Ouellette and Bourbeau Study (2014)
  - Canadian death rates using church parish registers
  - Greater certainty on DOB information from baptismal certificates

Do we see convergence?: CMI data (i)

SAPS: Gender

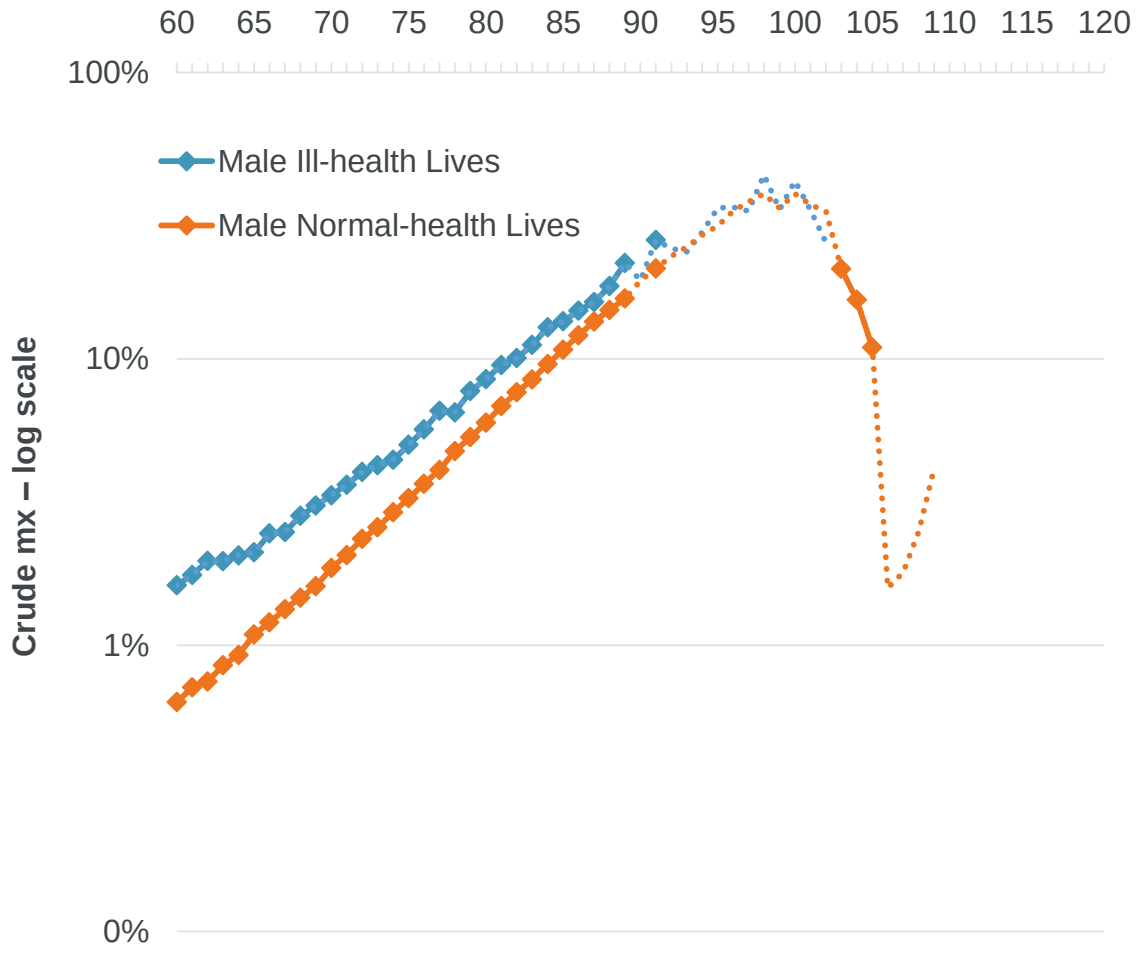
- Evidence of convergence
- Not fully converged by 101
- Data unreliable at 100+ (S2 graduated to age 95)



Do we see convergence?: CMI data (ii)

SAPS: Retirement Health

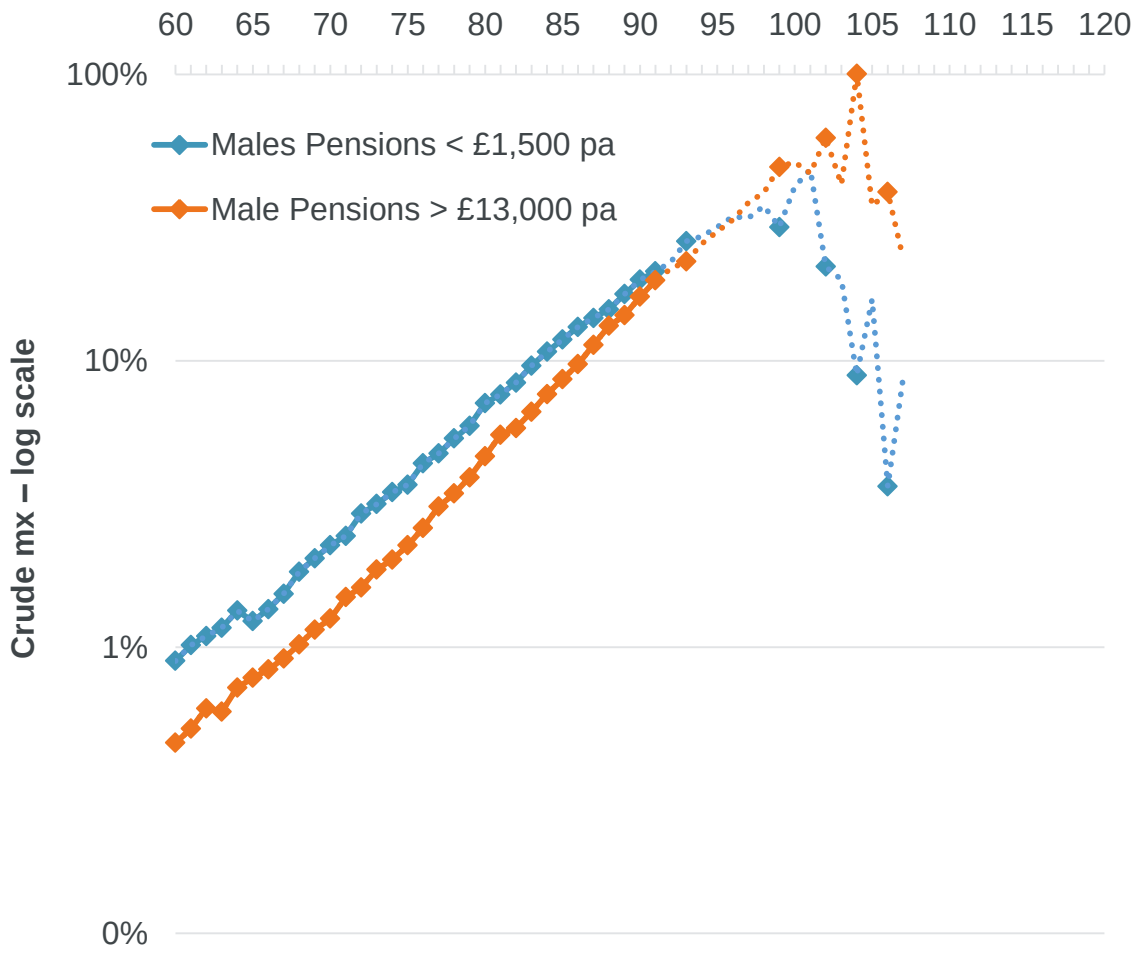
- Evidence of convergence
- Not fully converged by 91
- Possibly converged by high 90s?



Do we see convergence?: CMI data (iii)

SAPS: Pension Amount

- Evidence of convergence
- Not fully converged by 93
- S2_L/H extended from 90



Do we see convergence?: CMI data (iv)

- Typically see convergence between groups
- Typically not fully converged by age from which apply extensions
- Similar observations for CMI Annuities data

- Suggests extensions should allow for continued convergence

- But should look to other datasets to test if always see convergence

Proposed framework

- Start with “population” graduation with satisfactory extension to higher ages
  - For example, UK population data
- Graduate “portfolio” data
  - For example, SAPS
- Analyse convergence to “population” mortality
- Extend portfolio graduation so that assessed rate of convergence (could be nil) continues
- Sub portfolios (eg “heavy” or “light”) could be graduated and extended relative to the portfolio

Mortality Projections

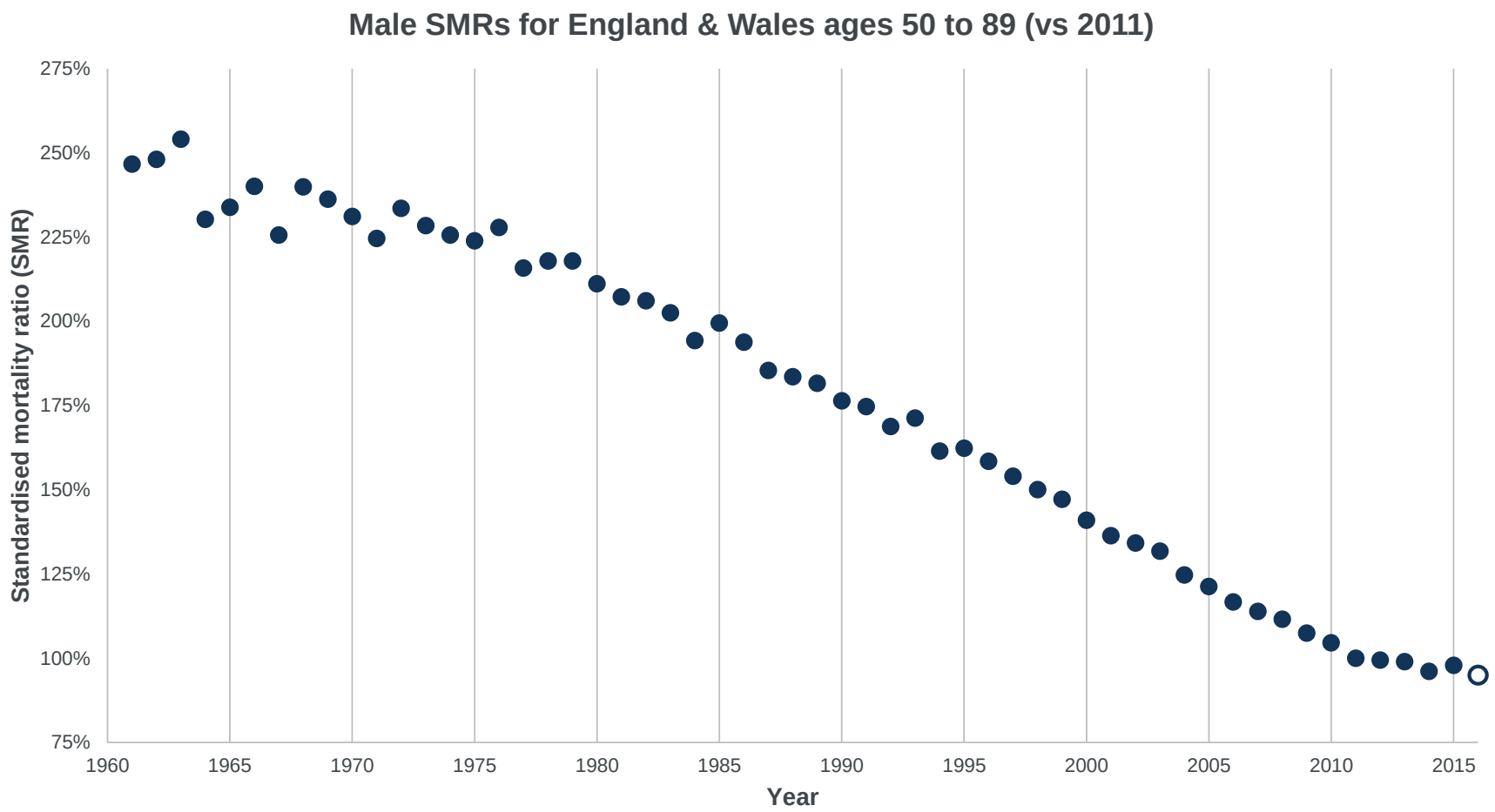
Analysing past mortality using SMRs

- Standardised mortality ratio (SMR):

$$\frac{\sum_{x=50}^{89}\left\{(\text{deaths})_{xt}\times\frac{(\text{exposure})_{x,2011}}{(\text{exposure})_{xt}}\right\}}{\sum_{x=50}^{89}(\text{deaths})_{x,2011}}$$

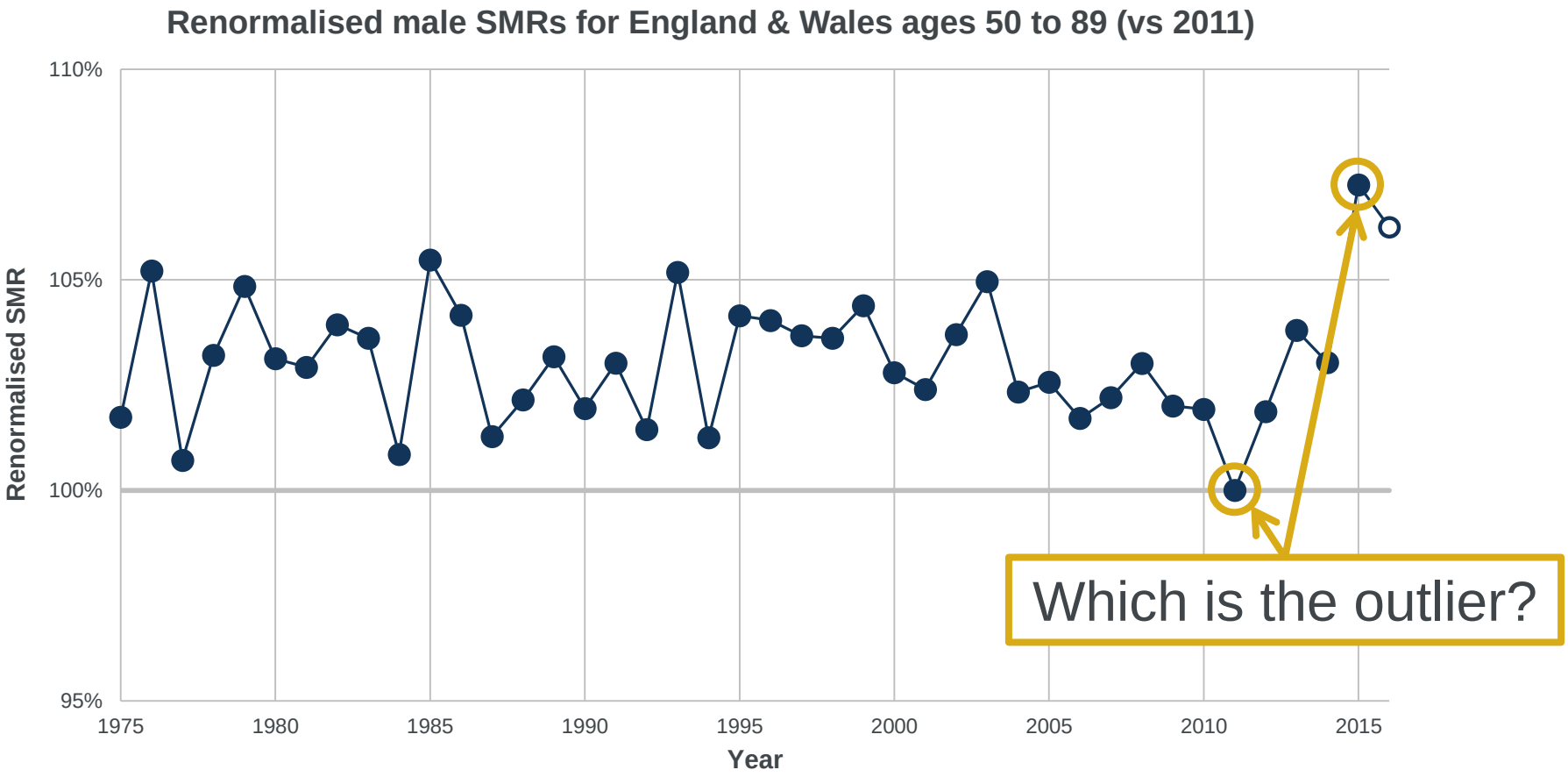
- Measure of ‘average mortality’ – useful to understand broad trend
- Use ages 50 to 89 – ONS data over age 90 is less reliable
- Comparable year to year – removes population change effects
- Not comparable males vs females – female population is older
- Trend lines chosen by reference to males – deliberately suggestive
- (2016 point is calculated by Aon Hewitt as ‘neutral’ – don’t rely on this)

Male SMR



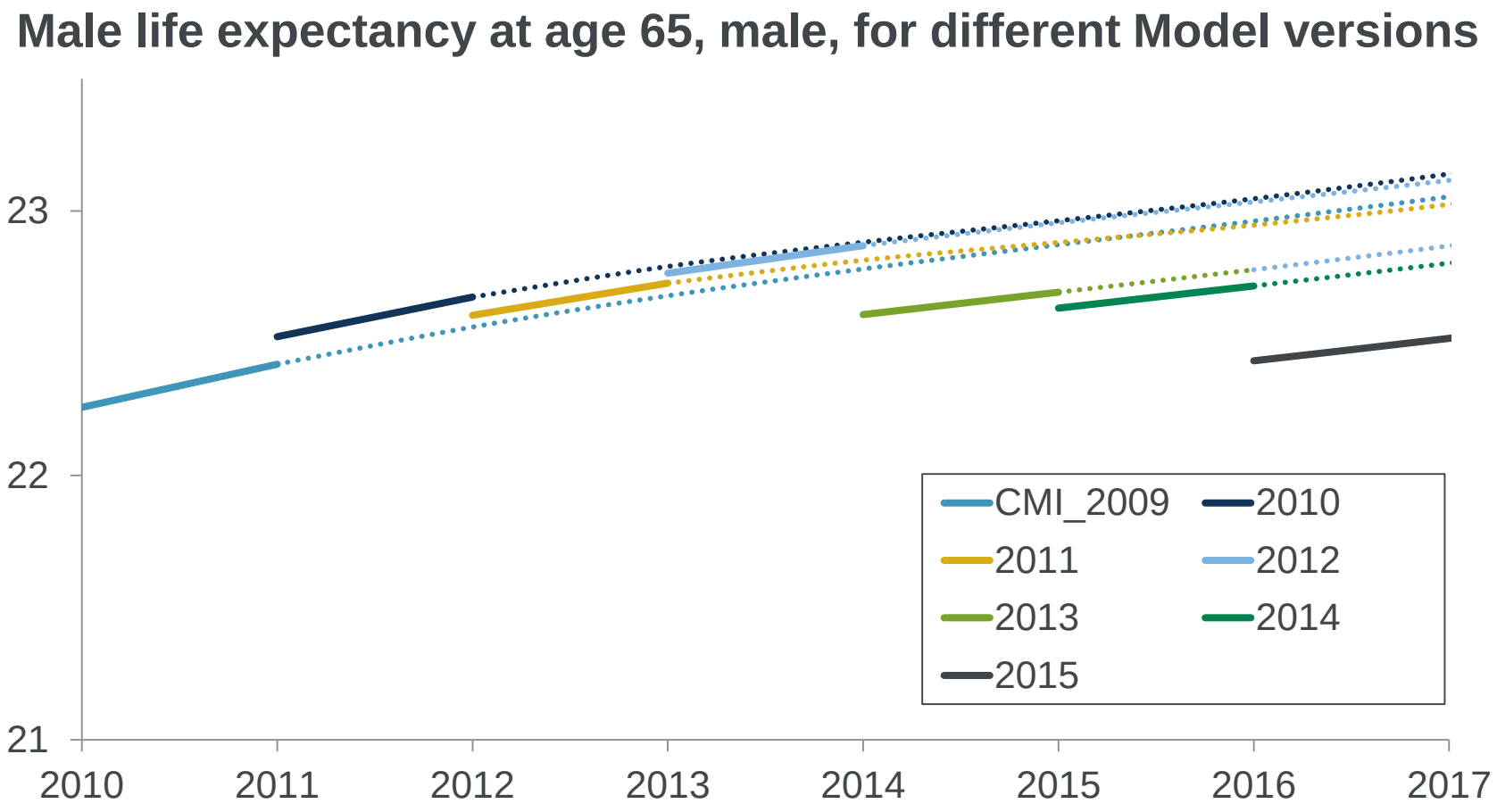
Calculations by Aon Hewitt using ONS data

Male SMR – renormalised



Calculations by Aon Hewitt using ONS data and the proposed CMI projection model calibrated to data to end 2015

Changes between CMI Model versions



Assumptions: S2PMA at 1 January 2007, projected using CMI_20yy_M[1.5%]

Consultation process

Date	Item
22 June 2016	Working Paper 90 published
29 June 2016	Edinburgh consultation meeting
11 July 2016	London consultation meeting
31 August 2016	Working Paper 91 published and model software released
30 September 2016	Responses to consultation due
November 2016	**Working paper summarising responses and revisions**
March 2017	Publish CMI_2016 (based on data to 31 December 2016)

Approach

This is an *evolution* of the model

This is *not the answer* – it's a flexible tool that's been made reasonable by

- building on the existing model, and
- exposure to actuarial review

This is *not a predictive model*

- Wide age range mitigates against a *simple* predictive model
- We're short on test data (by the nature of mortality improvement)

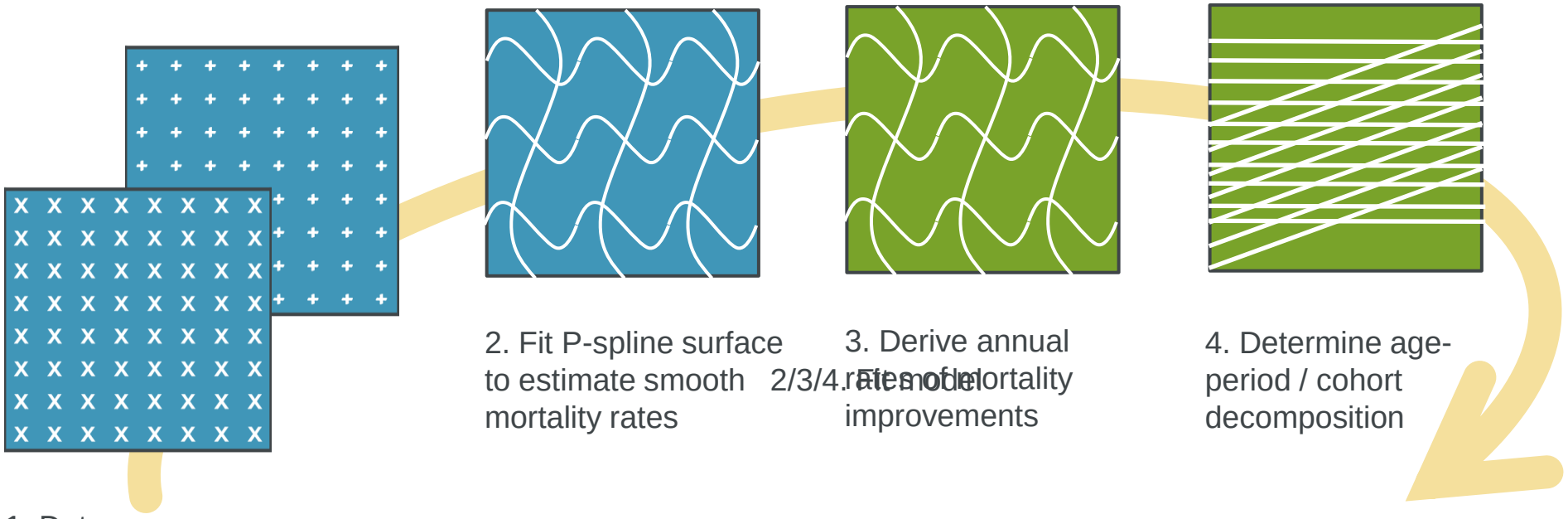
We have simplified where possible

- One step calibration vs smooth *plus* APC improvement split
- One software environment vs Excel/VBA *plus* R
- One smoothing step vs smooth *plus* step back

We have focussed on ease of use

- Allow users to incorporate views e.g. short term responsiveness
- Real time calibration

What's changed – big picture



1. Data
(a) Raw death and population data for England & Wales
(b) Population data at high ages constructed by CMI (using ONS methodology)
(c) CMI caps unlikely data points using a simpler method

2. Fit P-spline surface to estimate smooth mortality rates

2/3/4. Fit model

3. Derive annual rates of mortality improvements

4. Determine age-period / cohort decomposition

5. Projection
~~(a) Step back two years for initial rates~~
~~(b)~~ Sum separate projections of age-period and cohort components

Direction of travel is volatile

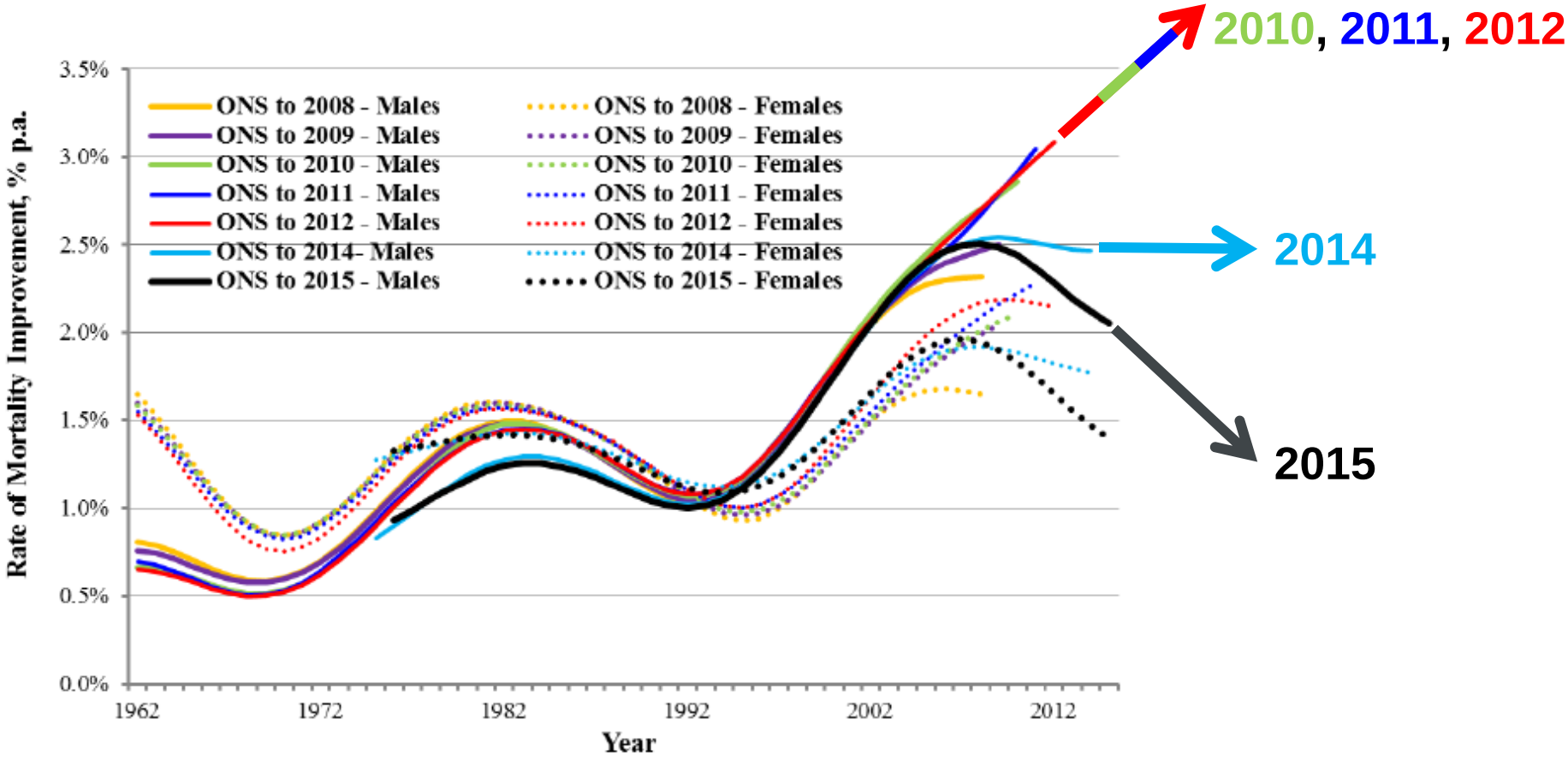
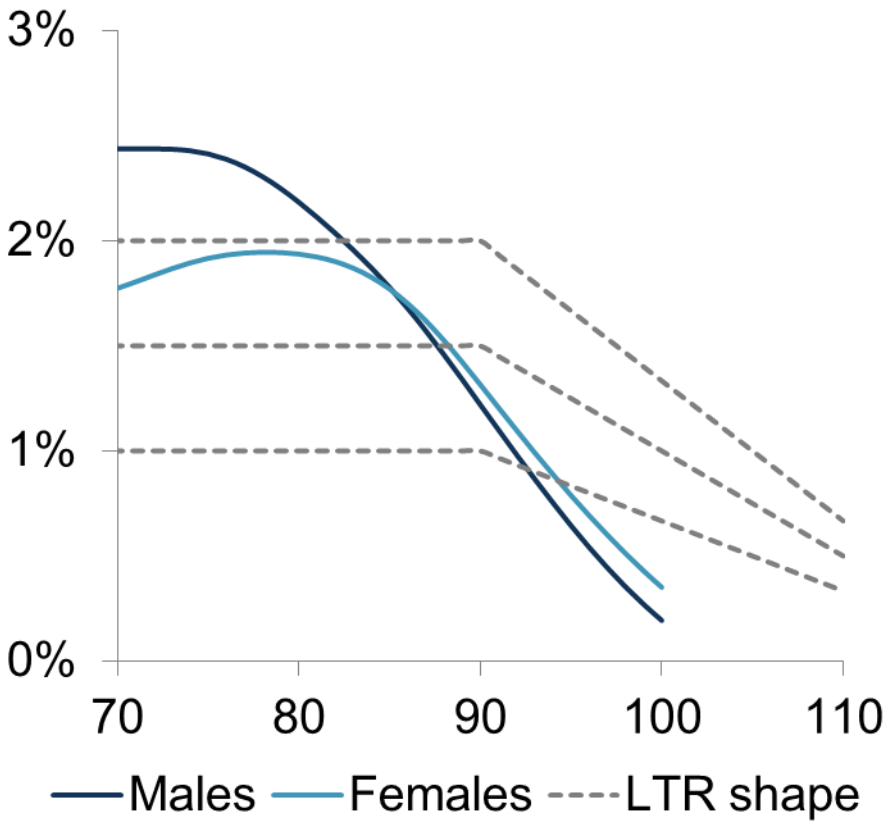


Figure 14: Period Component of the Rate of Mortality Improvement, by year, dataset, and gender; England & Wales Population
Estimates derived by fitting APC models to smoothed mortality improvement rates

Current shape of long-term rate (LTR)

- Under the current Core assumption, the LTR applies up to age 90, and tapers to zero at 120
- This implies a sharp rise in improvements for centenarians in future, which is out of line with past experience

Mortality improvements by age
APCI age component and LTR shapes



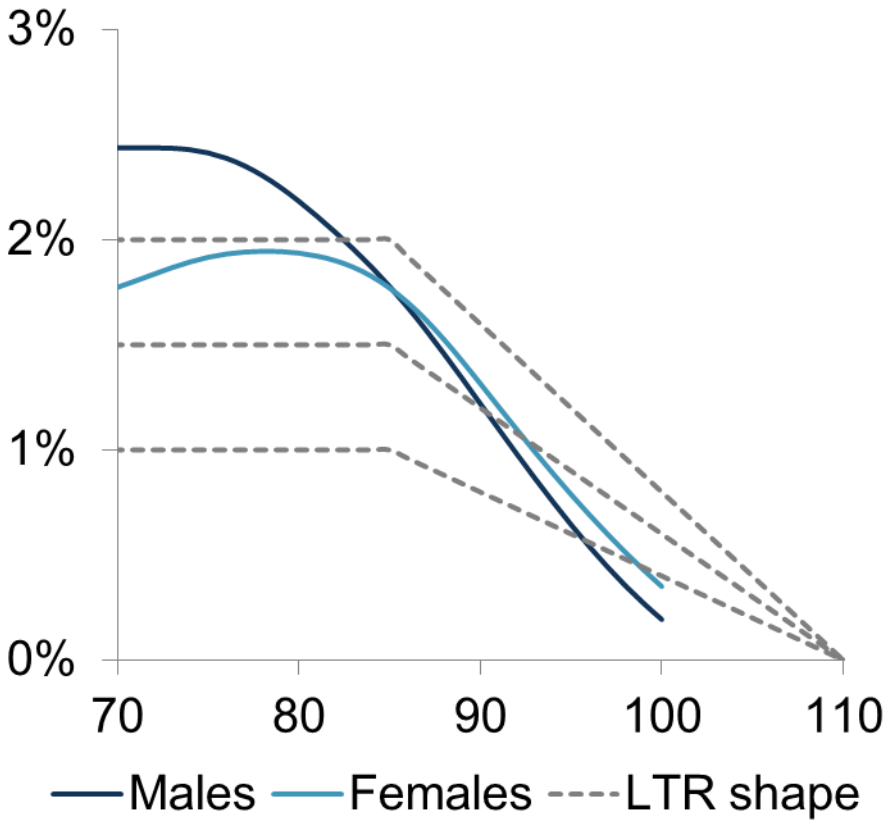
Proposed shape of long-term rate (LTR)

- We propose that the LTR applies up to age **85**, and tapers to zero at age **110**
- This implies a more modest rise in improvements for centenarians

Note

- **The objective is best estimate**
- **This still allows for higher improvements at later ages**

Mortality improvements by age
APCI age component and LTR shapes

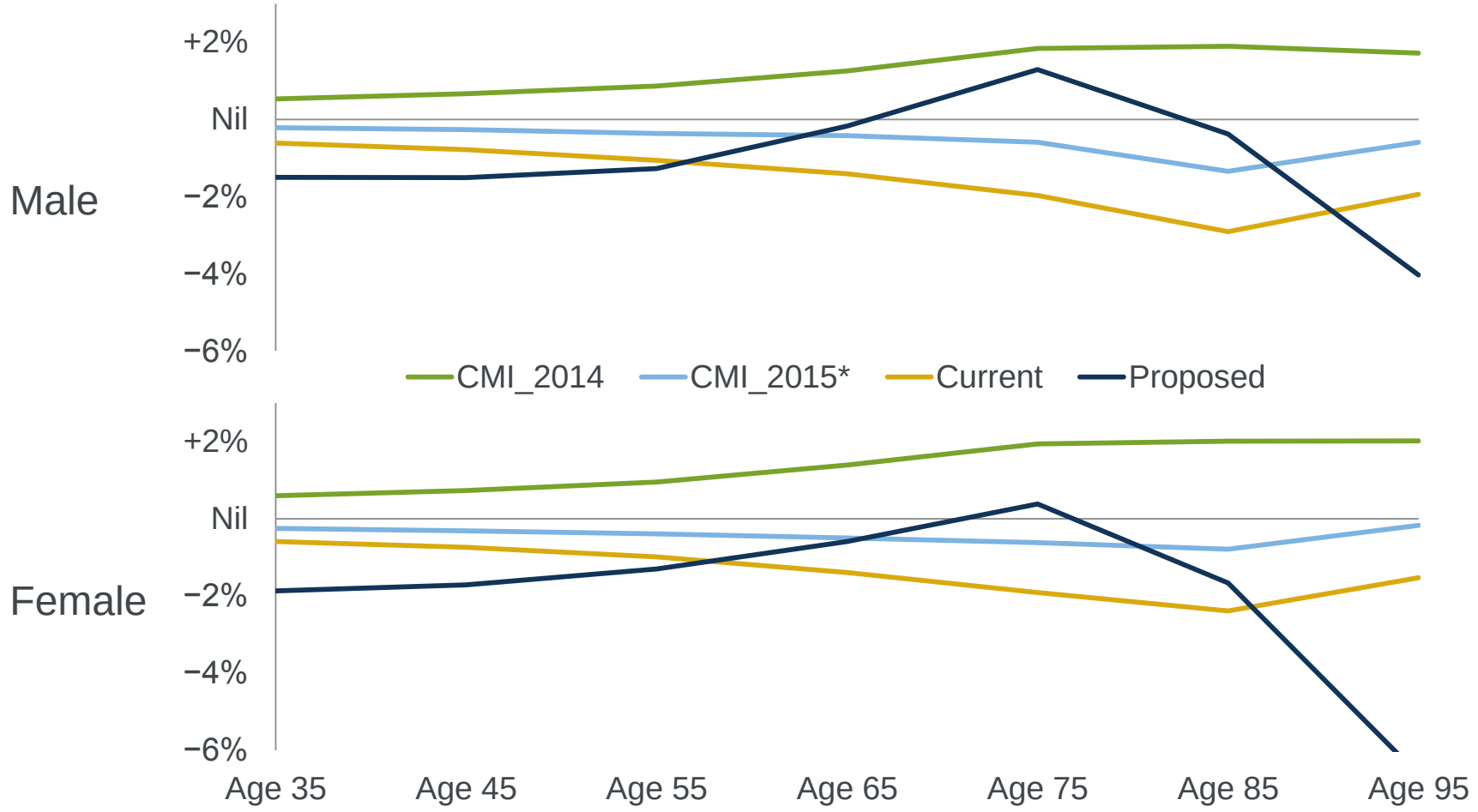


Life expectancy at end 2015 vs CMI_2015

Sex	Method	Age 35	Age 45	Age 55	Age 65	Age 75	Age 85	Age 95
Male	CMI_2014	+0.53%	+0.67%	+0.87%	+1.26%	+1.84%	+1.90%	+1.72%
	CMI_2015*	−0.21%	−0.26%	−0.36%	−0.42%	−0.59%	−1.34%	−0.59%
	Current	−0.61%	−0.78%	−1.06%	−1.41%	−1.97%	−2.91%	−1.94%
	Proposed	−1.50%	−1.51%	−1.27%	−0.17%	+1.29%	−0.38%	−4.03%
Female	CMI_2014	+0.60%	+0.73%	+0.95%	+1.39%	+1.94%	+2.01%	+2.02%
	CMI_2015*	−0.25%	−0.31%	−0.39%	−0.50%	−0.62%	−0.79%	−0.17%
	Current	−0.59%	−0.74%	−0.99%	−1.39%	−1.91%	−2.39%	−1.53%
	Proposed	−1.87%	−1.71%	−1.30%	−0.59%	+0.38%	−1.66%	−6.63%

- CMI_2014 = actual data to 30 September 2014 + initial year 2011
- CMI_2015 = actual data to 31 July 2015 + initial year 2012
- CMI_2015* = CMI_2015 + data to end 2015 (but still initial year 2012)
- ‘Current’ = CMI_2015* + initial year 2013
- ‘Proposed’ = data to end 2015 (no step-back applicable)

Life expectancy at end 2015 vs CMI_2015



Consultation and current MPC inclination

Issue	Consultation responses	MPC inclination
Overall	• Positive	
E&W or UK data?	• Some support for UK, but v strong concern over consistency and timeliness	• Use E&W data
LTR metric	• Concern re consistency vs previous model	• Use $\Delta \log m_{xt}$ per model
LTR tapering 85 to 110	• Concern about change and evidence	• As proposed, but provide more analysis
Responsiveness	• S_κ is unintuitive (and requires recalibration) • Analysis for selecting Core value simplistic • Approximately equal numbers disagreed re over vs under responsive	• This was black box beforehand • We share the concern, but note the lack of consensus • Use scenarios to aid intuition (one of which is CMI_2016) • No inclination to change from S_κ=7.5 (yet)
Identifiability constraints	• Concern about edge effects	• This is being reviewed
Name	• Numbering vs year of release	• Use CMI_2016

Questions

Comments

The views expressed in this presentation are those of the presenter.

Please send any questions, views or feedback to info@cmilimited.co.uk

Continuous
Mortality Investigation

Institute and Faculty of Actuaries

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