



Institute
and Faculty
of Actuaries

User Forum: Graduation of Annuity data 2007-2010

CMI Annuities Committee

24 November 2014



Agenda

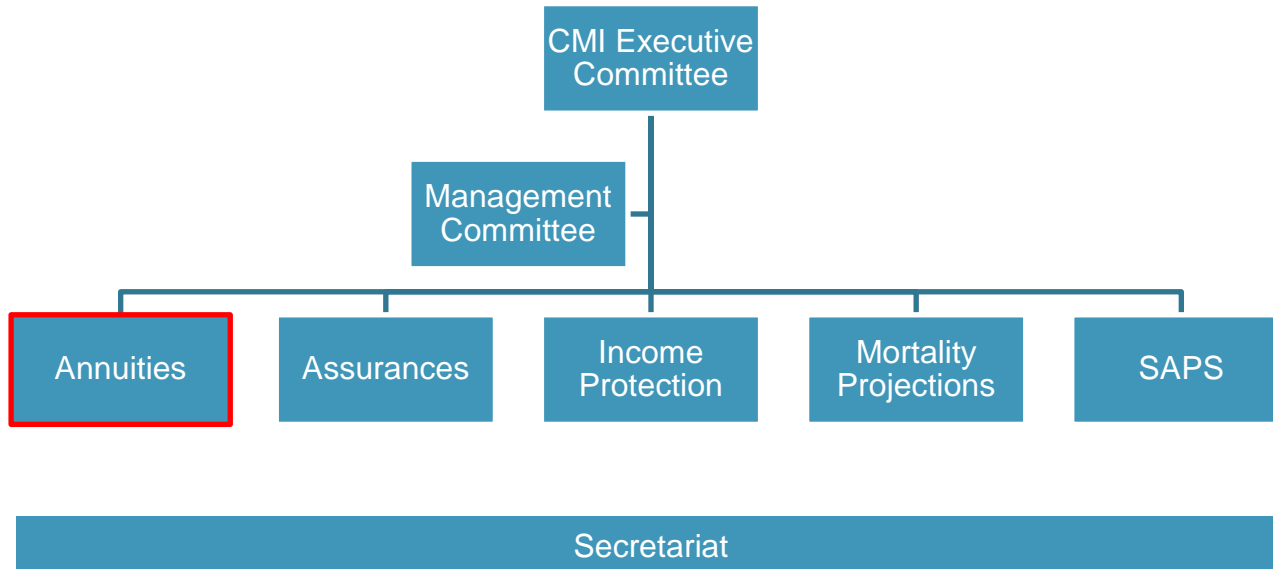
Introduction	Kevin Armstrong, Chairman, CMI Annuities Committee
Data collection and the 2007-2010 Annuity data	Dave Grimshaw, CMI Secretariat
Graduation process	Jonathan Hughes, CMI Annuities Committee
Proposed graduations	Kevin
Questions and discussion	
CMI_2014 update	Tim Gordon, Chairman, CMI Mortality Projections Committee
Next steps	Kevin

Annuities Committee

- Who are we?
 - Kevin Armstrong (Chairman) Aviva
 - David Bartlett
 - Karin Brown Prudential
 - Piero Cocevar Admin Re UK
 - Adrian Gallop GAD
 - Jonathan Hughes RGA
 - Robert Kairis Pension Insurance Corporation
 - Angus Macdonald Heriot-Watt University

Annuities Committee

- How we fit in



Change in CMI Committee structure

- Annuities Committee
 - Focus on annuities data and the issues of offices writing annuities
 - Assurances Committee now has responsibility for mortality under Term/Endowment/Whole Life/Critical Illness
 - SAPS Committee still a separate entity
- Rationale for the change
 - Better reflects the structure in most life offices
 - Simplifies communications with data contributors
 - Allows volunteer committee members to be more closely aligned to their areas of work
 - More focused CMI resource to expand the work on annuities

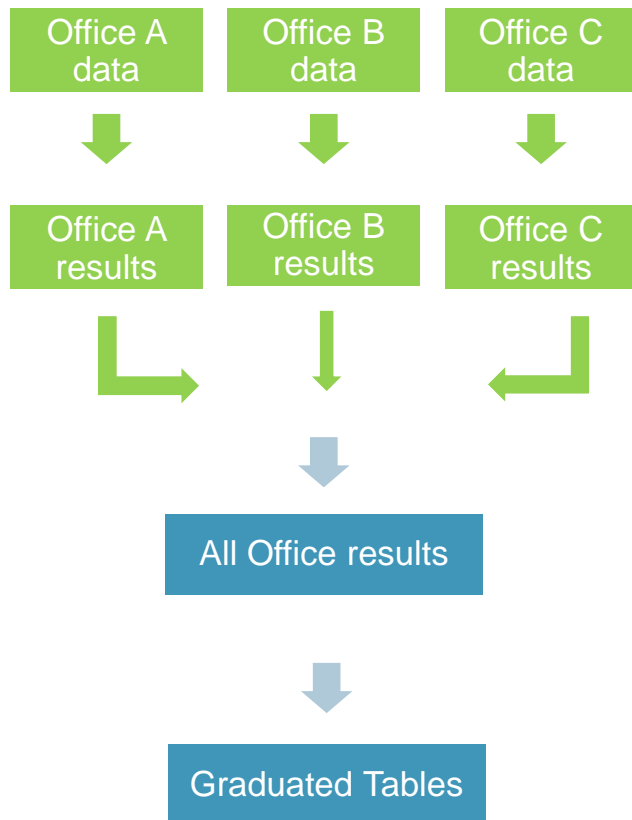
Hopes for today's Forum

- Disseminate information
 - Current proposals for graduations of 2007-2010 experience
 - CMI_2014
 - Other activity
- Receive feedback / comments
 - How do you use our outputs – practical applications?
 - Will the proposed graduations meet your needs?
- Open dialogue
 - No recording / attribution of comments

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Data collection process



- Offices submit data to the CMI secretariat
- We process the data and send individual office results back
- Once every (large) office has been processed, “All Office” results are issued
- Periodically, graduated tables are published using All Office data
- Committee members do not receive individual office results.

Data collection formats

Scheduled

- Used up to 2006
- Rigid format
- Minimal fields

Per Policy

- Used 2005 onwards
- Rigid format
- Large number of fields

Special exercise

- Used 2007-2011 (and 2012/3)
- Flexible format
- Minimal number of mandatory fields

Data collection formats: Scheduled data

- Census data – i.e. end-year in force plus deaths
- Total numbers by age (and duration) – no individual details
- Offices submitted data by “investigation”:

Investigation Number	Description
12	Life annuities in payment
21 / 23	Retirement annuities pre-vesting / post-vesting
22 / 24	Personal Pensions pre-vesting / post-vesting
31/71	Life office pensioners under insured group pension schemes, normal and late retirements
33/73	Life office pensioners under insured group pension schemes, early retirements
43	Widows / widowers of pensioners under insured group pension schemes

- 31 and 33 included amounts data and split by duration; others lives-only and all-durations
- Significant small-print; e.g. exclude lives who move overseas from 21 and 22

Data collection formats: Scheduled data

- Census data – i.e. end-year in force plus deaths
- Total numbers by age (and duration) – no individual data
- Offices submitted data by “investigation”

Investigation Number	Description
12	Life annuities in payment
21 / 23	Retirement pension schemes, normal and late retirements
22 / 24	Retirement pension schemes, early retirements
31 / 32	Retirement pension schemes, normal and late retirements
33 / 34	Retirement pension schemes, early retirements
35 / 36	Retirement pension schemes, normal and late retirements
37 / 38	Retirement pension schemes, early retirements
39 / 40	Retirement pension schemes, normal and late retirements
41 / 42	Retirement pension schemes, early retirements
43 / 44	Retirement pension schemes, normal and late retirements
45 / 46	Retirement pension schemes, early retirements
47 / 48	Retirement pension schemes, normal and late retirements
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87 / 88	Retirement pension schemes, normal and late retirements
89 / 90	Retirement pension schemes, early retirements
91 / 92	Retirement pension schemes, normal and late retirements
93 / 94	Retirement pension schemes, early retirements
95 / 96	Retirement pension schemes, normal and late retirements
97 / 98	Retirement pension schemes, early retirements
99 / 100	Retirement pension schemes, normal and late retirements

- In some cases, data is submitted in small-print; e.g. exclude lives who move overseas from 21 and 22

Data collection formats: Per policy data

- Intended to allow greater checking and richer analyses
- Individual benefit records
- Detailed information on each record; e.g.
 - Benefit amount at start and end of year and date of change
 - Benefit type to distinguish between normal / ill-health retirements and spouses
 - Combination of 4 fields to determine type of product
- Secretariat undertook detailed reconciliation of data within / between years and queried individual records

Data collection formats: Per policy data

- Intended to allow greater checking and richer analyses
- Individual benefit records
- Detailed information on each policy
 - Benefit amount at start of year
 - Benefit type (e.g. ill-health, early retirement, etc.)
 - Benefit start and end dates
 - Benefit change
 - Ill-health retirements
 - Determine type of product
- Took detailed reconciliation of data within 10 years and queried individual records

Data requirements too complex for some offices; those that did submit data had difficulty in resolving Secretariat's queries

Data collection formats: 2007-2011

- CMI recognised that Per Policy was a barrier for many offices; special data collection exercise launched:
 - To bring results “up-to-date”
 - To (re-)engage with offices
- Flexible format; still seeking individual benefit records e.g.
 - Date of birth/commencement – so CMI could calculate age and duration
 - Benefit amount (initial or current)
- Secretariat undertook high-level checking of data

2007-2011 data: timeline

- May 2012 – exercise launched at CILA
- June 2012 – first data received
- Sept 2012 – Secretariat started focussing on annuities, over assurances
- May 2013 – last data received
- Oct 2013 – Working Paper 70 / All Office results released

2007-2011 data: offices

Abbey Life

Aviva

Canada Life

Co-operative

Friends Life

Guardian Financial Services

HSBC

Legal and General

National Farmers Union

Pension Insurance Corporation

Reassure UK

Scottish Equitable

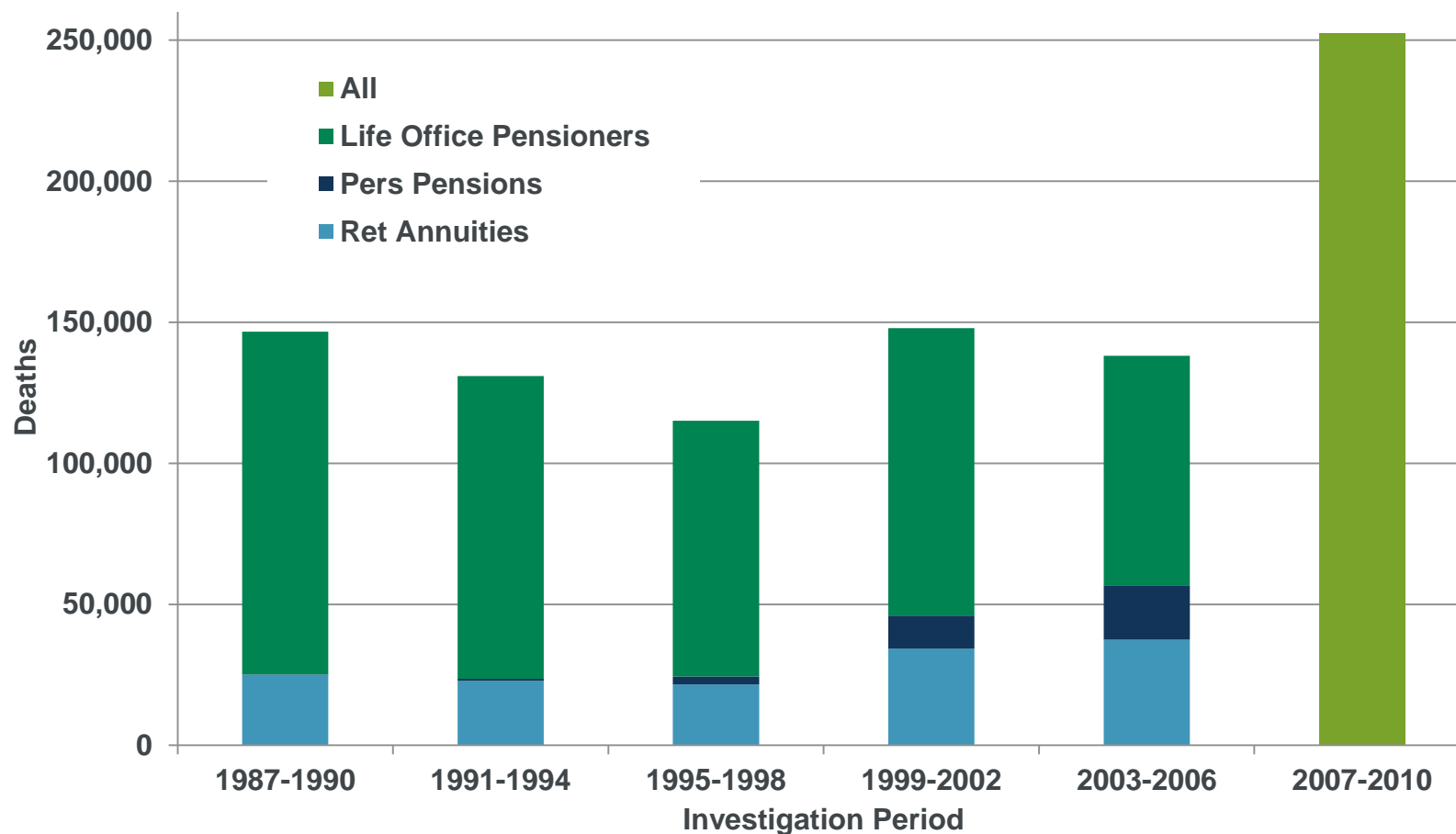
Scottish Widows

Standard Life

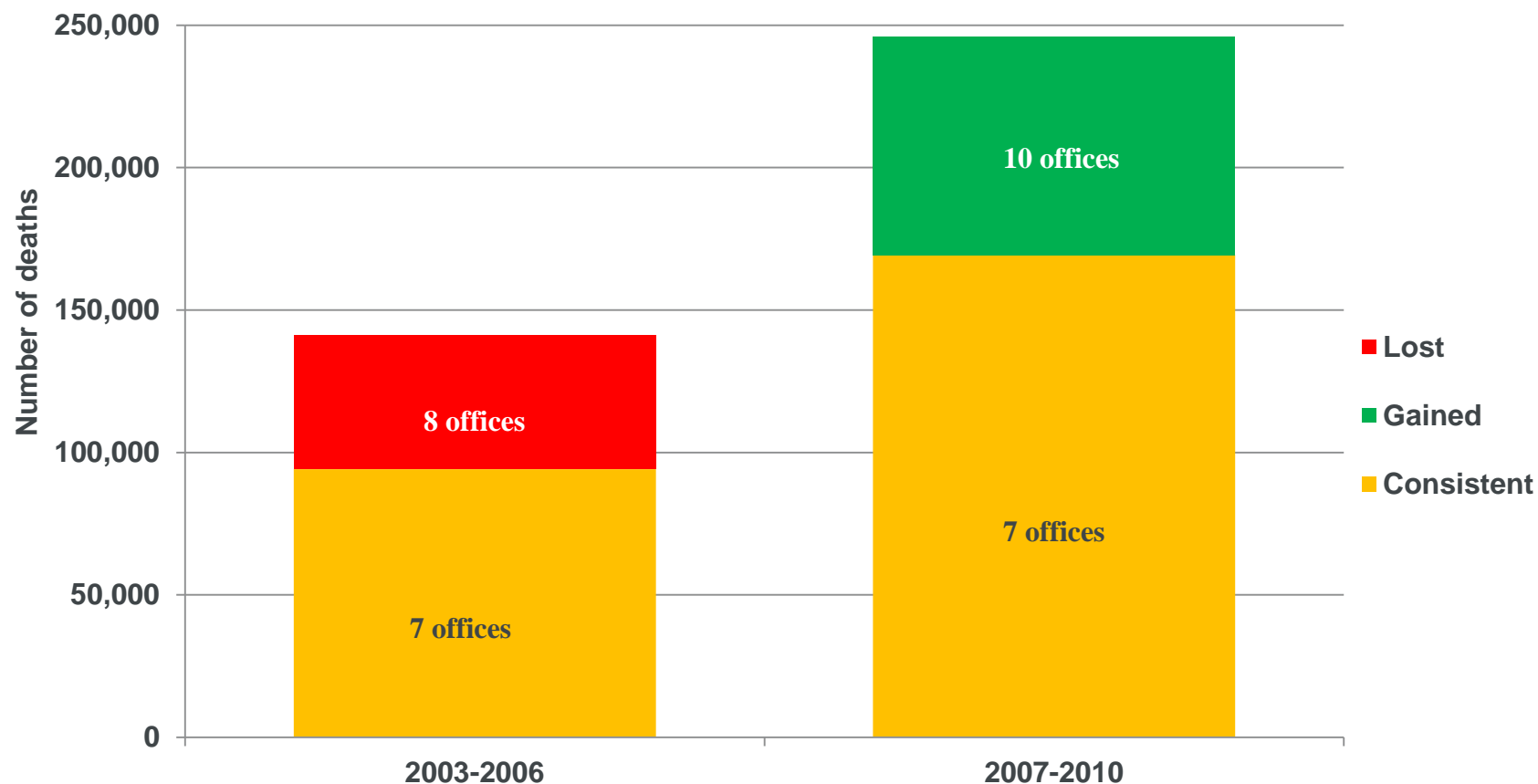
Zurich

THANK YOU!

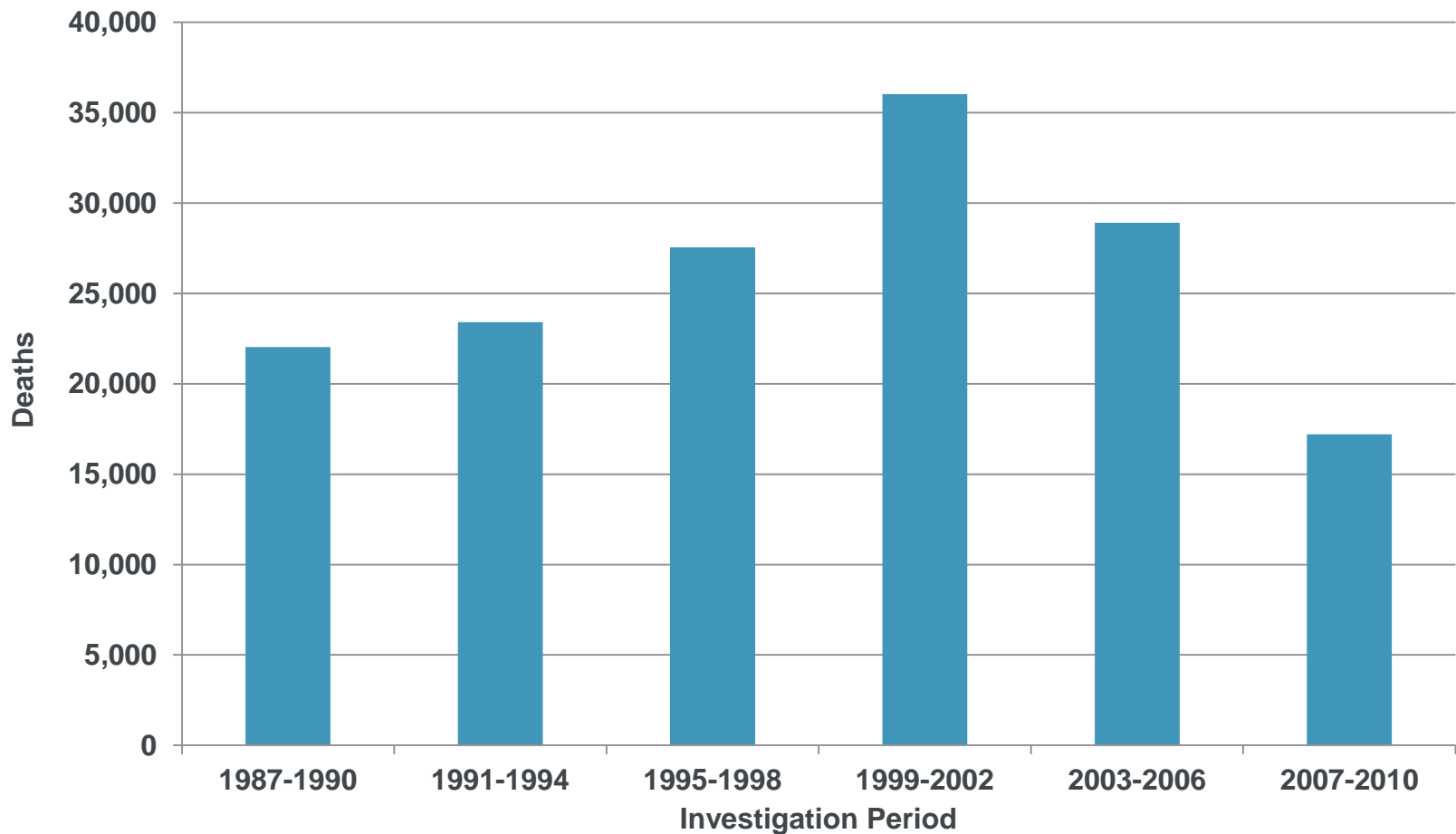
Data Volumes: Pension annuities in payment



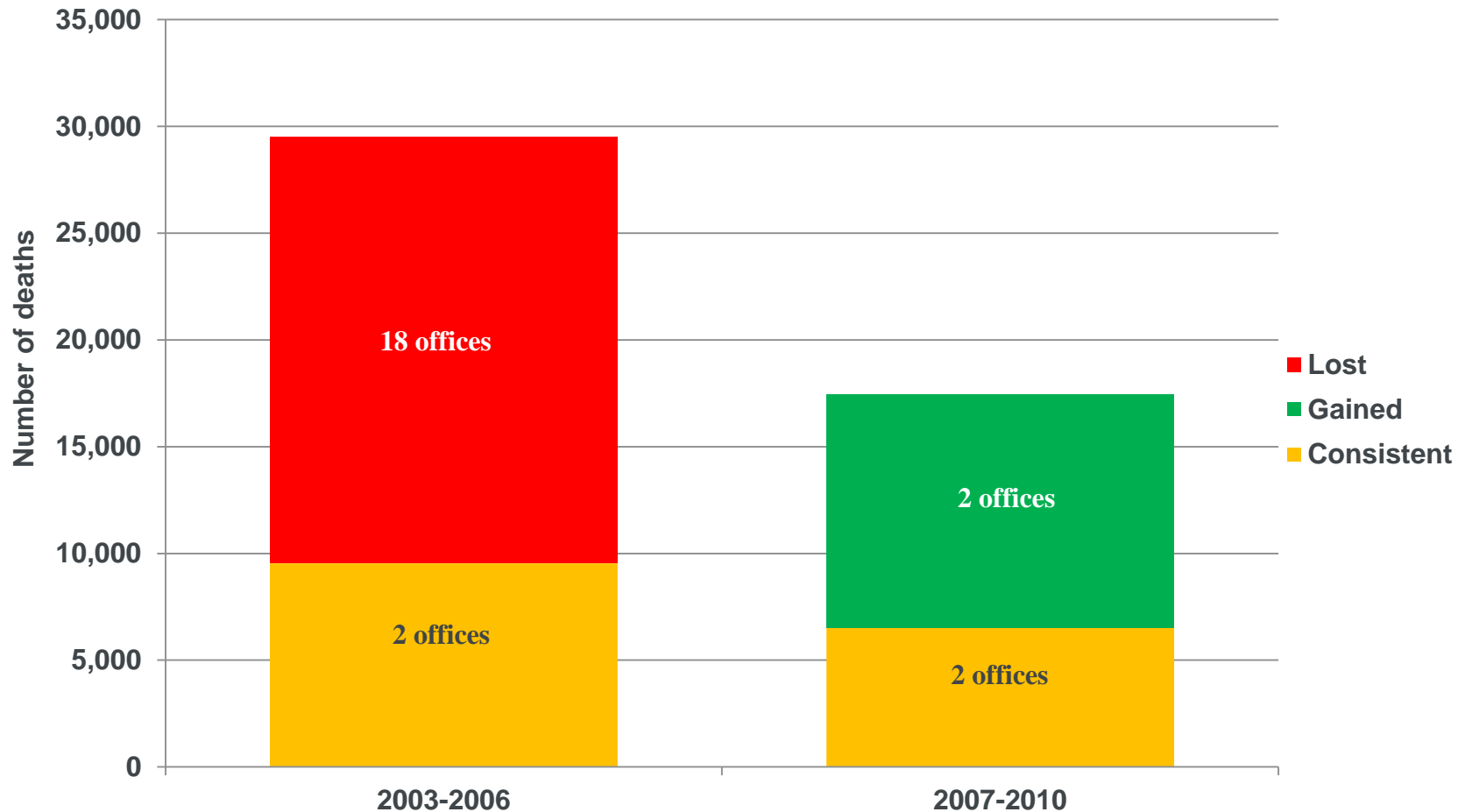
Change in mix of offices: Pension annuities in Payment



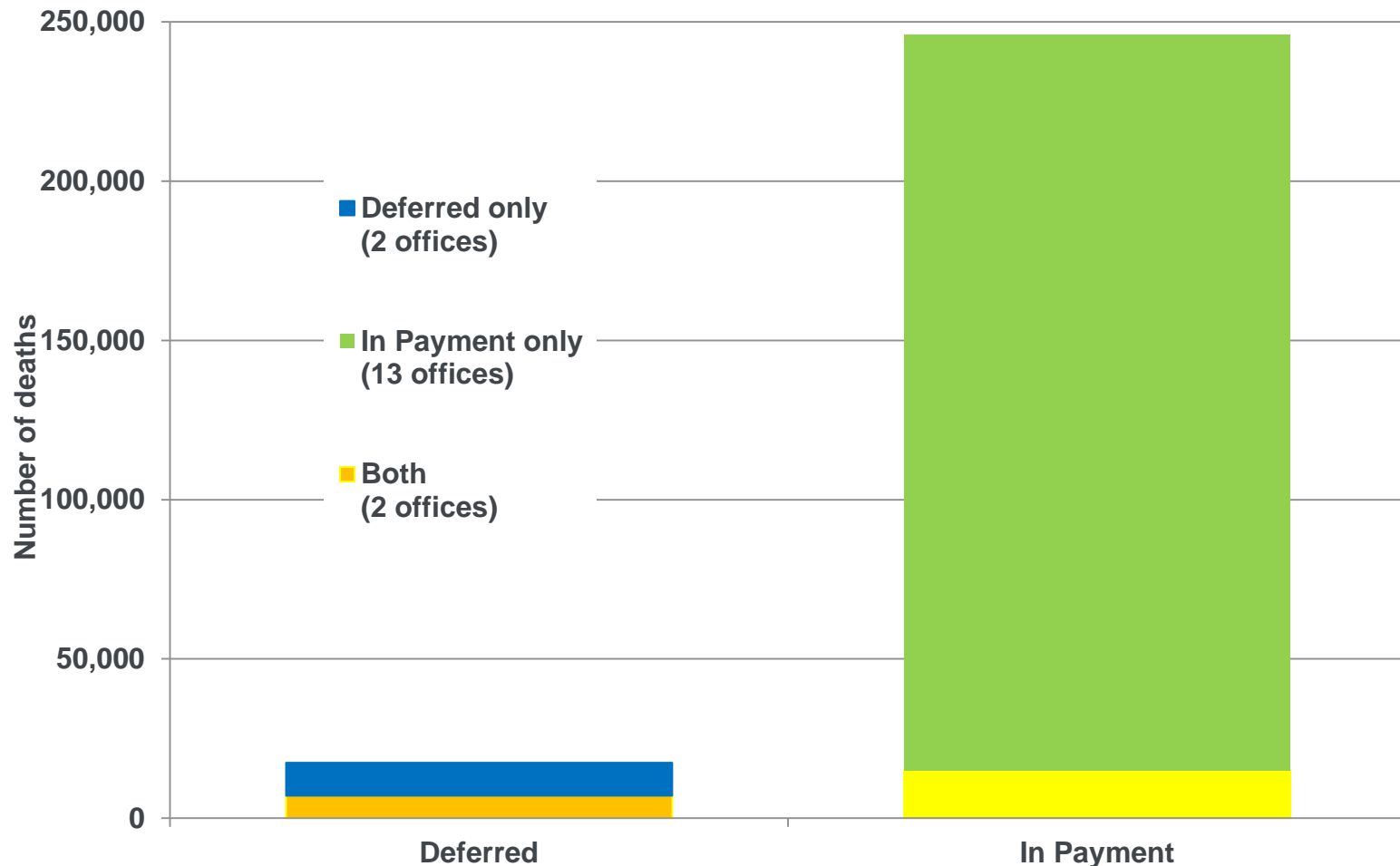
Data Volumes: Deferred Annuities



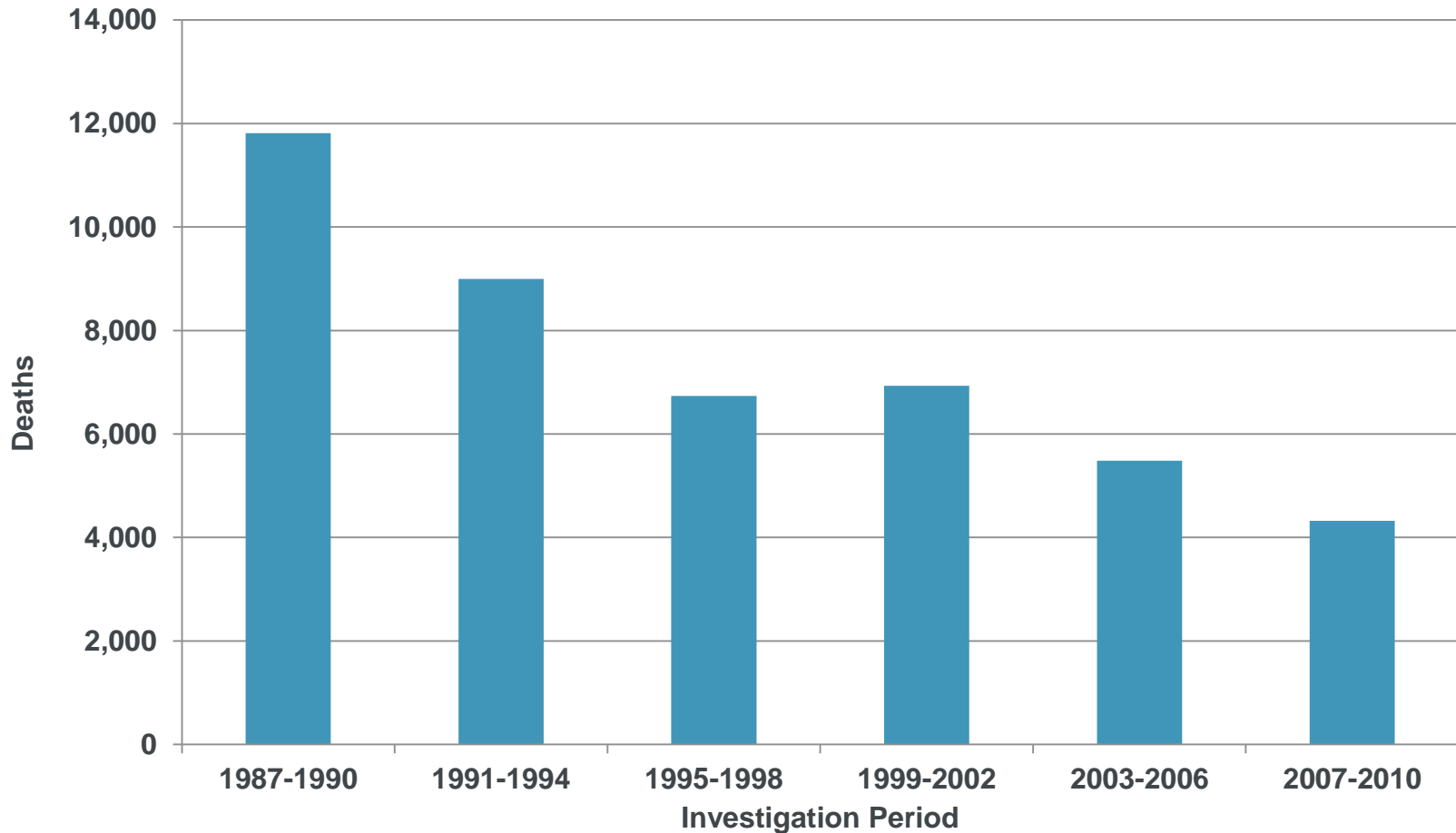
Change in mix of offices: Deferred annuities



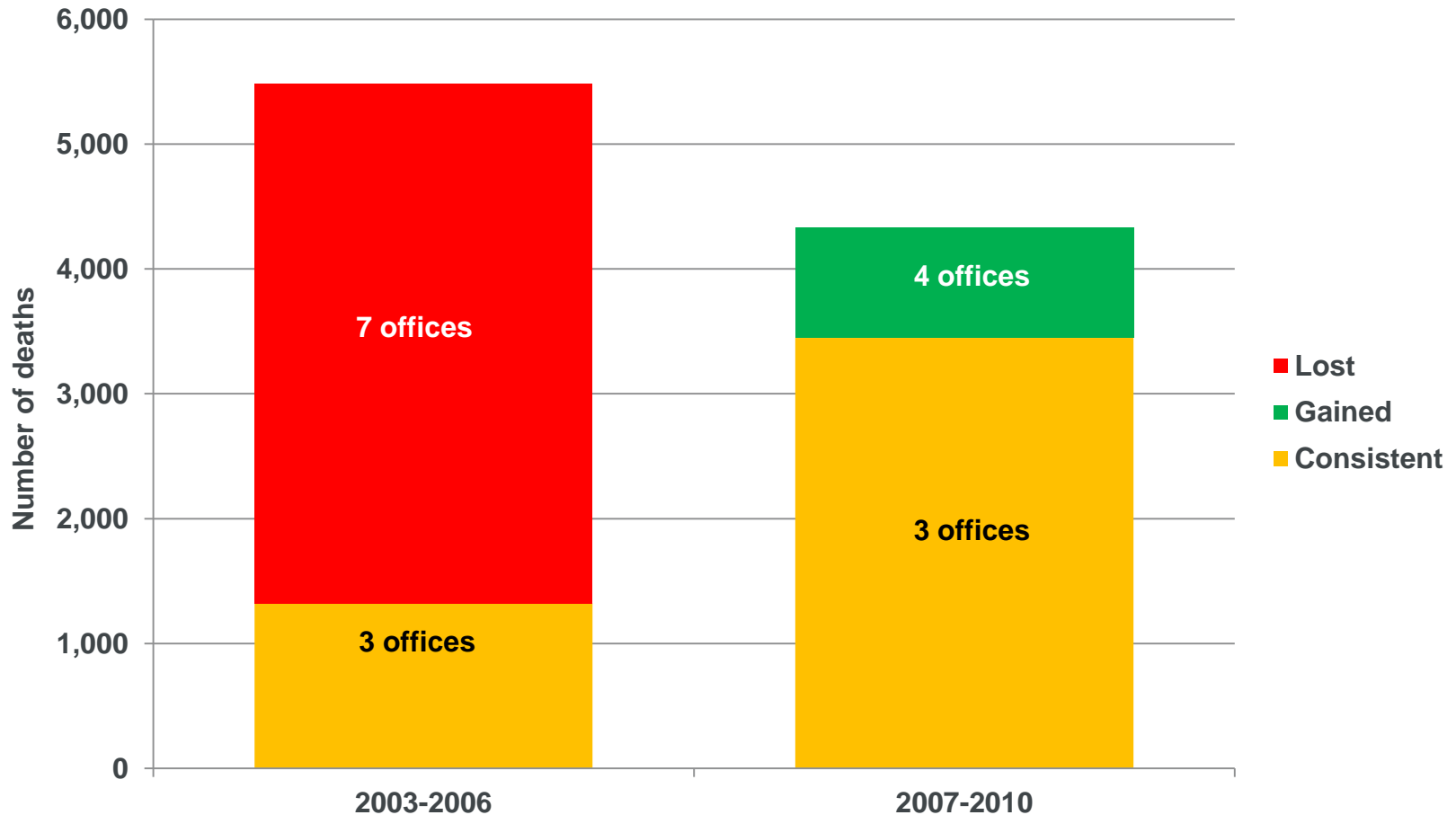
Pension annuity data submitted by number of offices



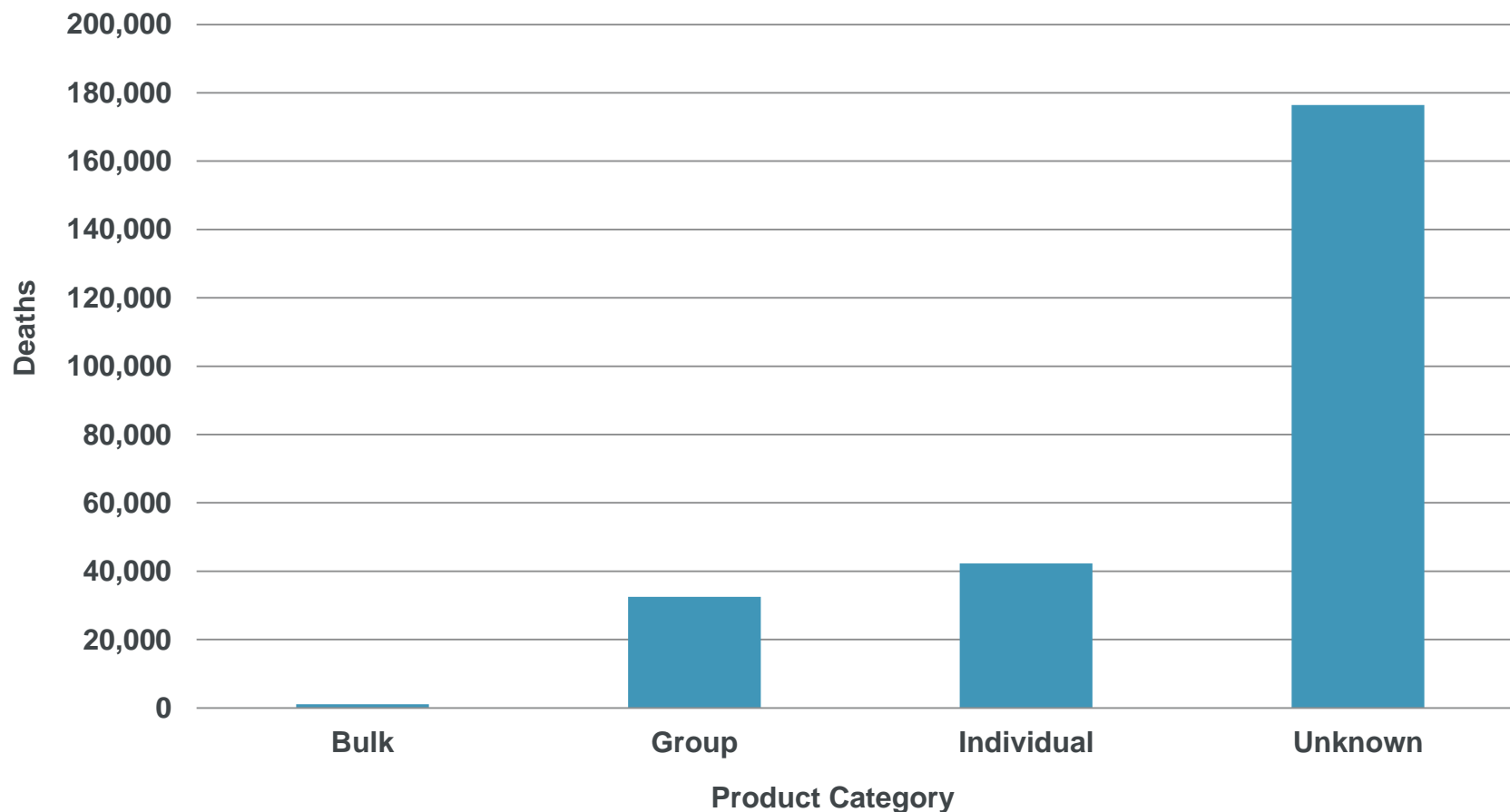
Data Volumes: Life Annuities



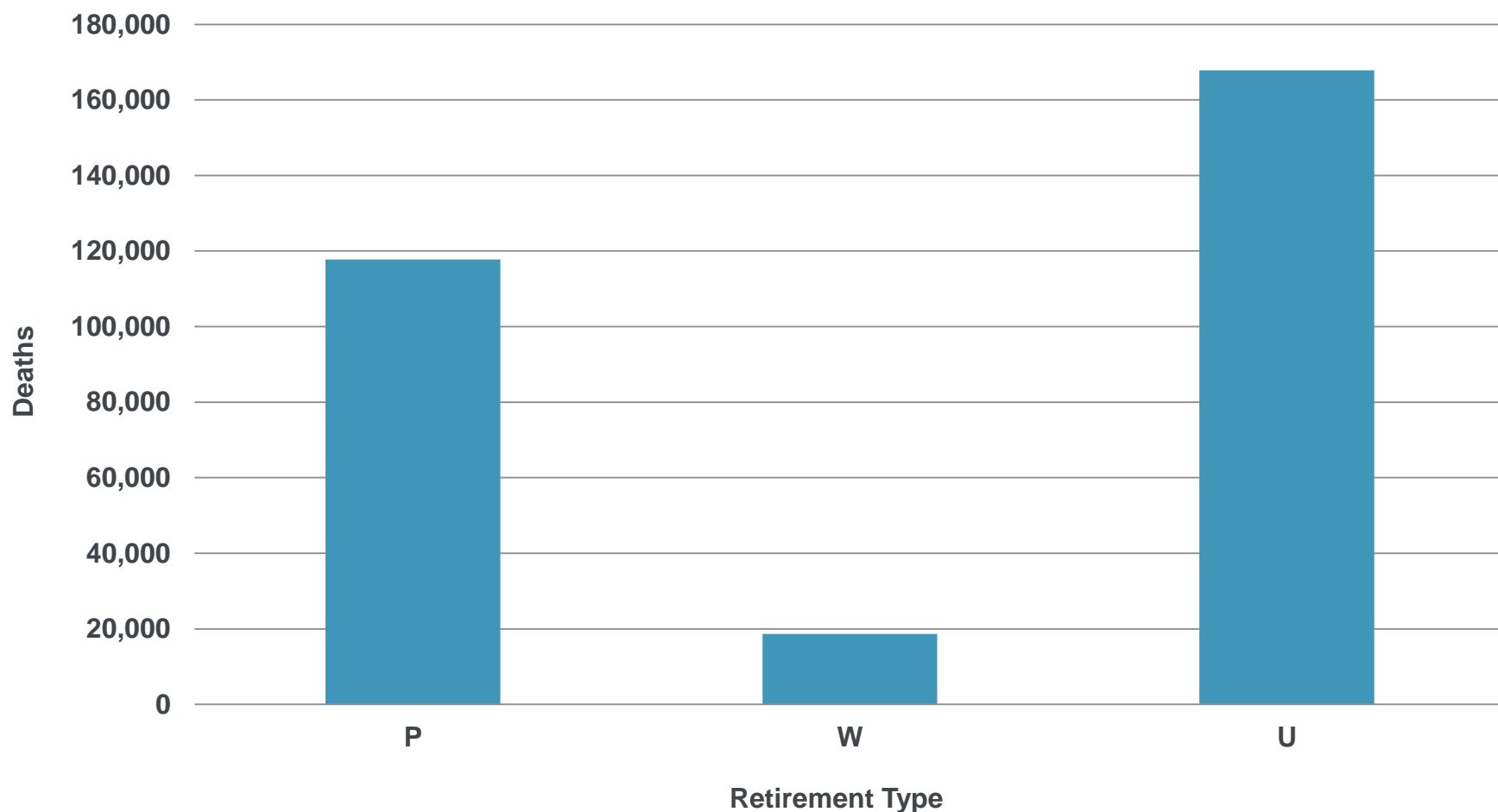
Change in mix of offices: Life Annuities



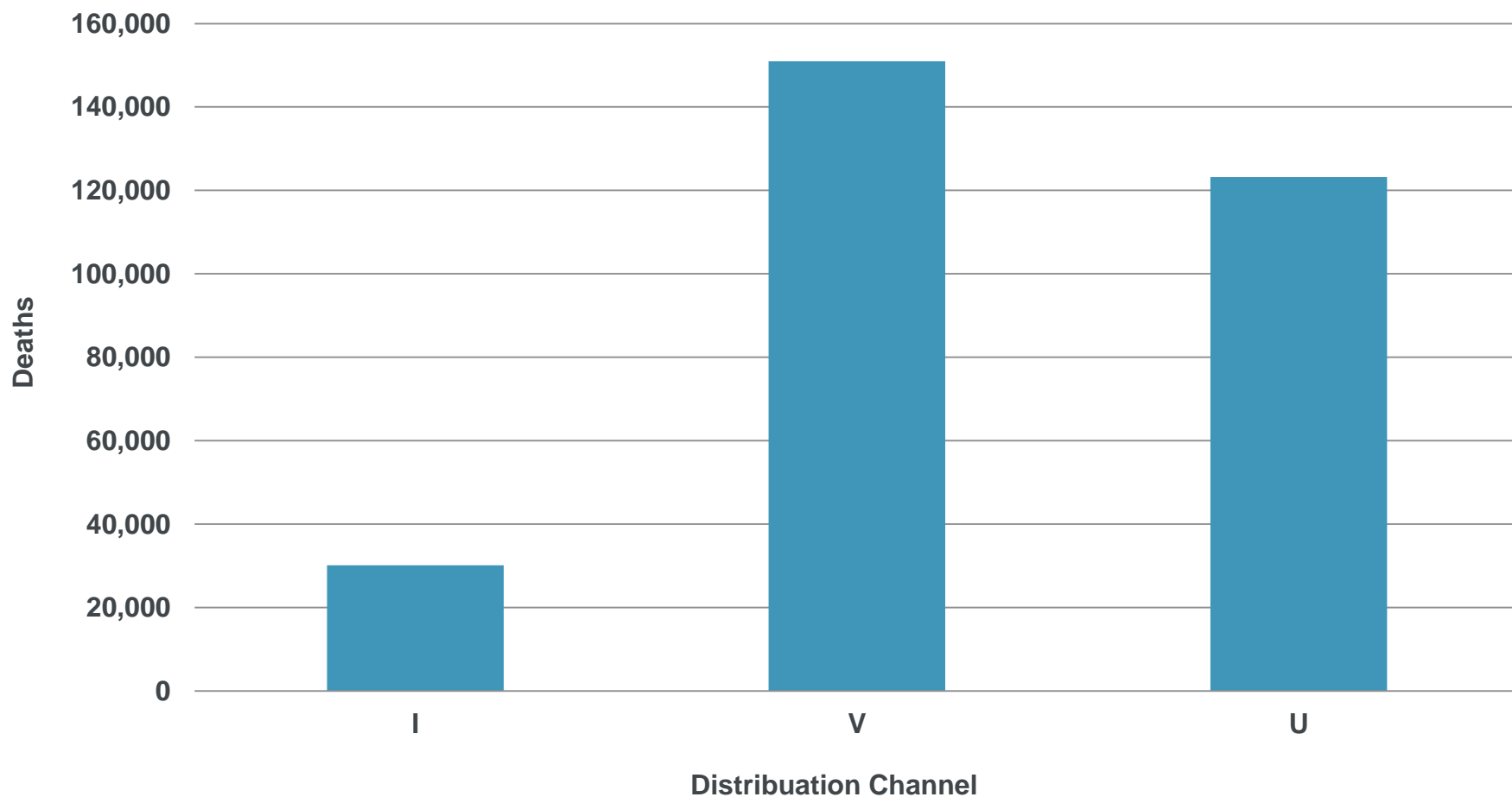
2007-2010 Pension annuities in payment by Product Category



2007-2010 Pension annuities in payment by Pensioner Type



2007-2010 Pension annuities in payment by Distribution Channel



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1 Process followed to create graduation proposals

2 Principles followed when creating graduations

3 Detailed example: PMA

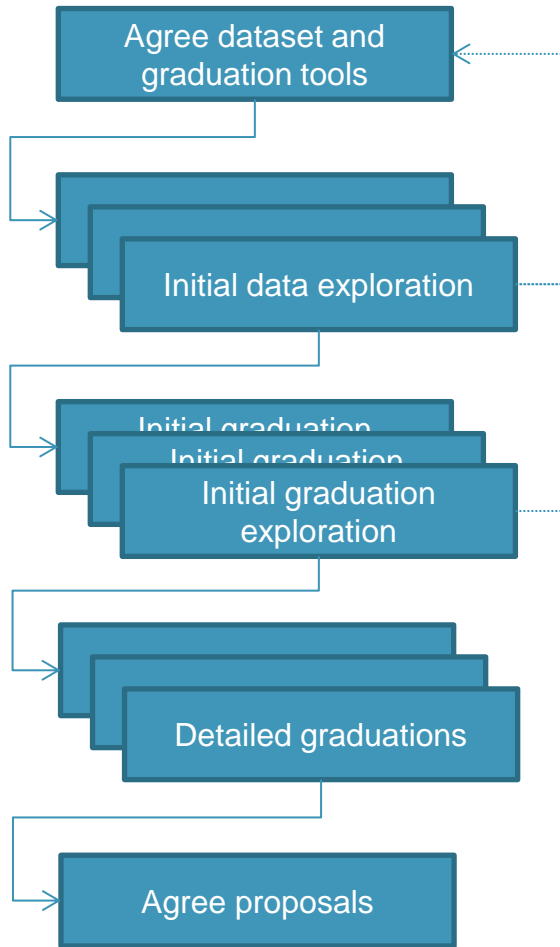
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1 Process followed to create graduation proposals

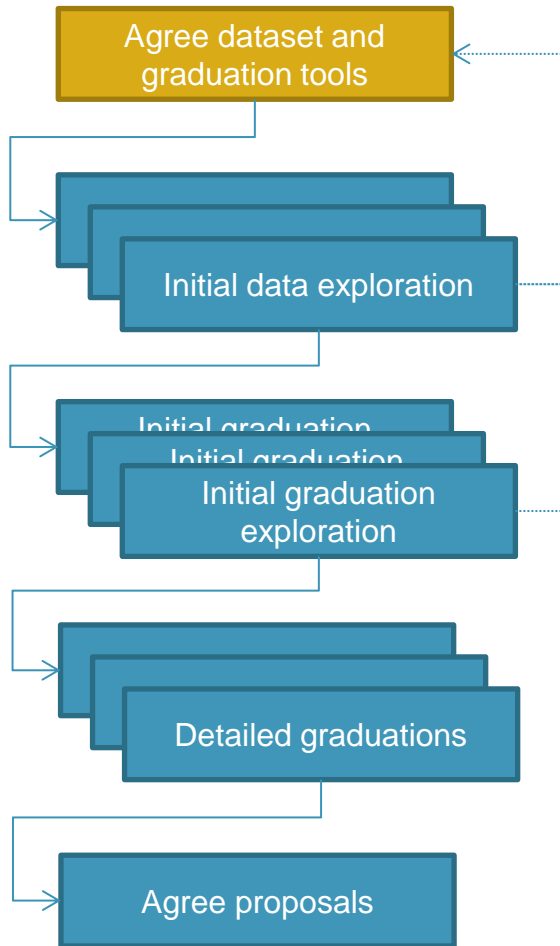
2 Principles followed when creating graduations

3 Detailed example: PMA

Process



Process



Data cleansing completed by Secretariat (mainly pre-All Offices results)

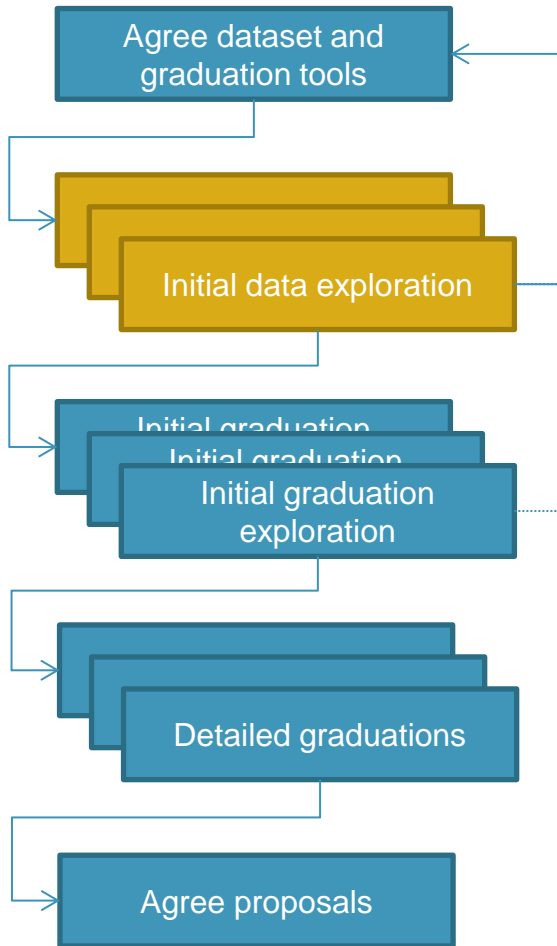
Results summaries analysed by Committee to identify potential data issues, including GLM analysis by various factors

Secretariat needed to investigate data by individual office to identify underlying issues

Agreed any changes to datasets to allow graduation work to begin

Graduation tool created by Secretariat and demonstrated to Committee

Process



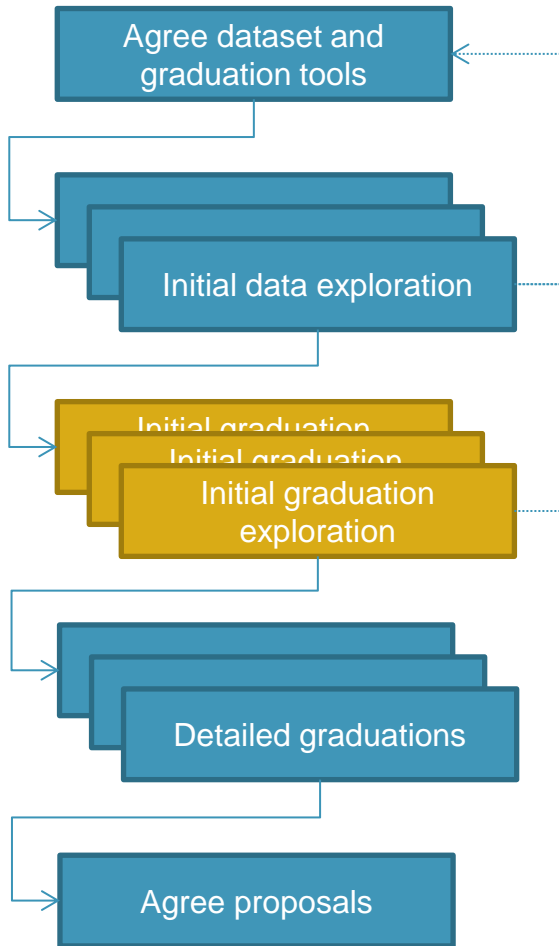
Dataset divided into subsets to speed analysis

Deeper look into data:

- Volumes when split by duration, amounts band etc
- Crude mortality results at a detailed level

Identified splits likely to be amenable to graduation

Process

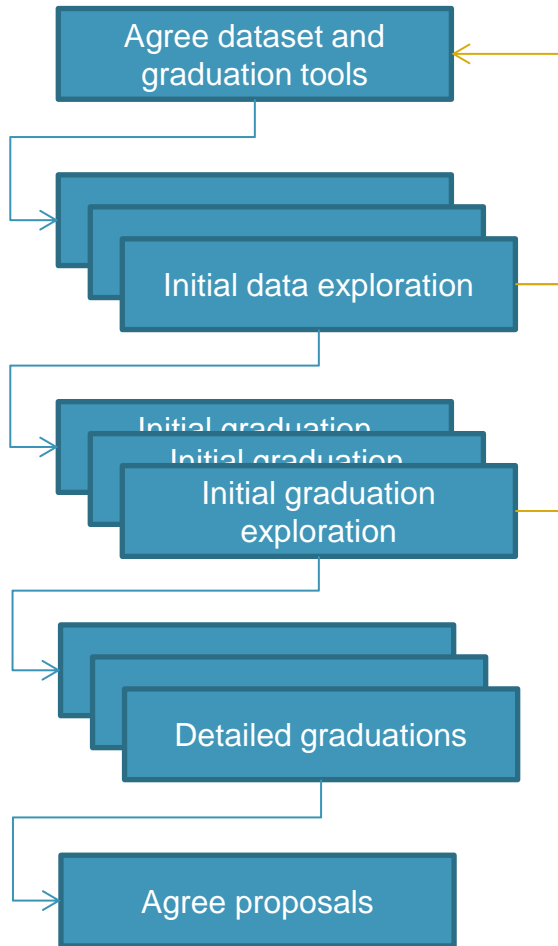


Ran datasets through graduation tool

Used the full range of graduation methodologies available in the tool

Identified likely methodologies for each dataset

Process

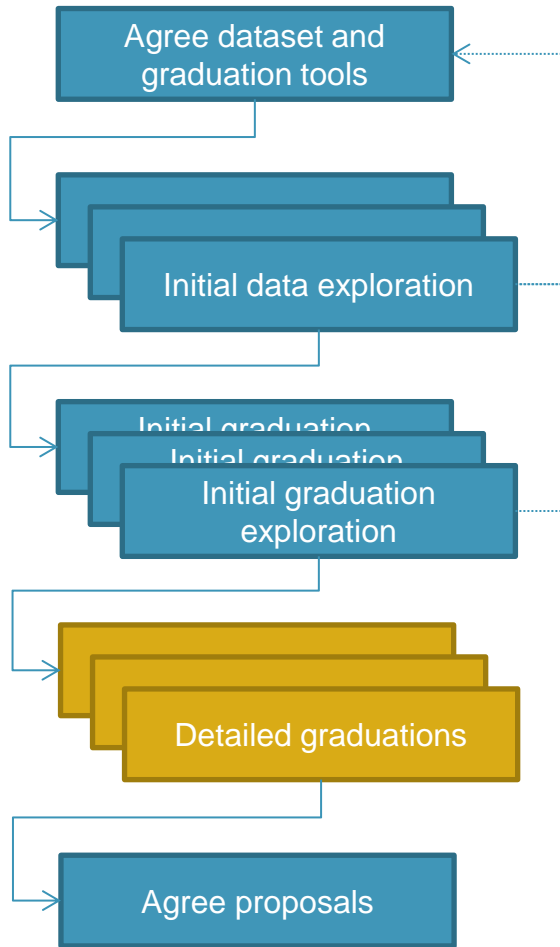


Initial work by subgroups identified new issues:

- Anomalies in the data
- Improvements to the graduation tool

Changes discussed with the rest of the Committee and tools / data recirculated to subgroups

Process

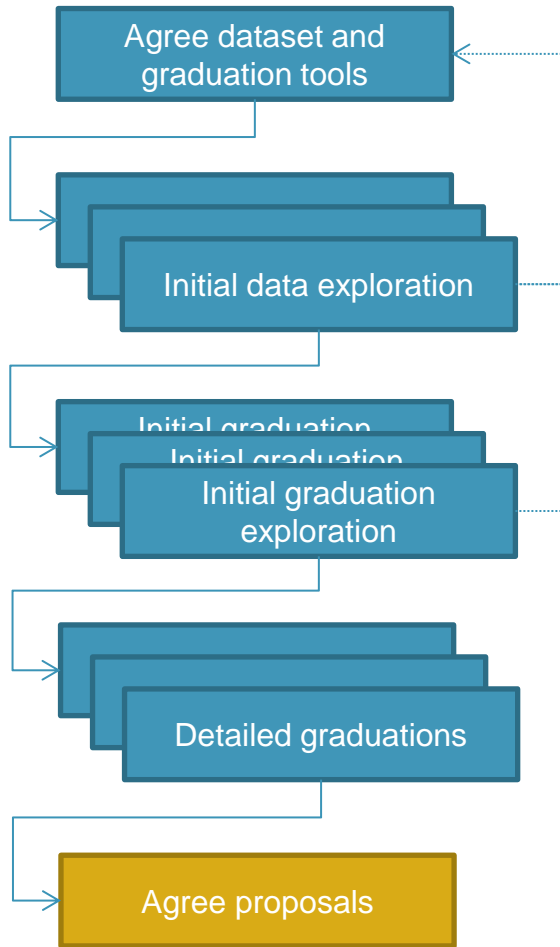


Subgroups used graduation methodologies identified in initial explorations to create each graduation

Created proposals for:

- Graduations
- Additional analyses

Process



Each subgroup's proposals discussed by whole Committee

Questions identified to raise with user forum

Section contents

1 Process followed to create graduation proposals

2 Principles followed when creating graduations

3 Detailed example: PMA

Principles

A Use maximum data

B Consider materiality

C Fit the data

D Favour parsimony

E Ensure consistency

Principles

A Use maximum data

Graduate across the broadest range of ages as possible

B Consider materiality

Amend proposals later if credible data gives unusual results

C Fit the data

D Favour parsimony

E Ensure consistency

Principles

A Use maximum data

B Consider materiality

C Fit the data

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E Ensure consistency

Consider the portfolio composition of business likely to be modelled with the graduations

Compare annuity value differences for alternative graduations

Principles

A Use maximum data

B Consider materiality

C Fit the data

D Favour parsimony

E Ensure consistency

Use the suite of statistical tests available to assess graduation suitability

Also visual inspection relative to crude mortality rates

Plausibility of mortality shape

Principles

A Use maximum data

B Consider materiality

C Fit the data

D Favour parsimony

E Ensure consistency

Where graduations materially the same, favour a simpler model and parameterisation

Principles

A Use maximum data

B Consider materiality

C Fit the data

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E Ensure consistency

Unusual differences between graduations should be evident from the crude mortality rates

Principles

A Use maximum data

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C Fit the data

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E Ensure consistency

It was rare to find a graduation that could satisfy every criteria

Compromises were usually required somewhere

Section contents

1 Process followed to create graduation proposals

2 Principles followed when creating graduations

3 Detailed example: PMA

Detailed example

Example: PMA

- Pensions in payment
- Males
- Amounts* (for most of this example, but Lives results used at times as well to illustrate differences)

* To make the statistical tests more meaningful, we divide the Amounts exposure for each record by the average Amounts per life in each age band.

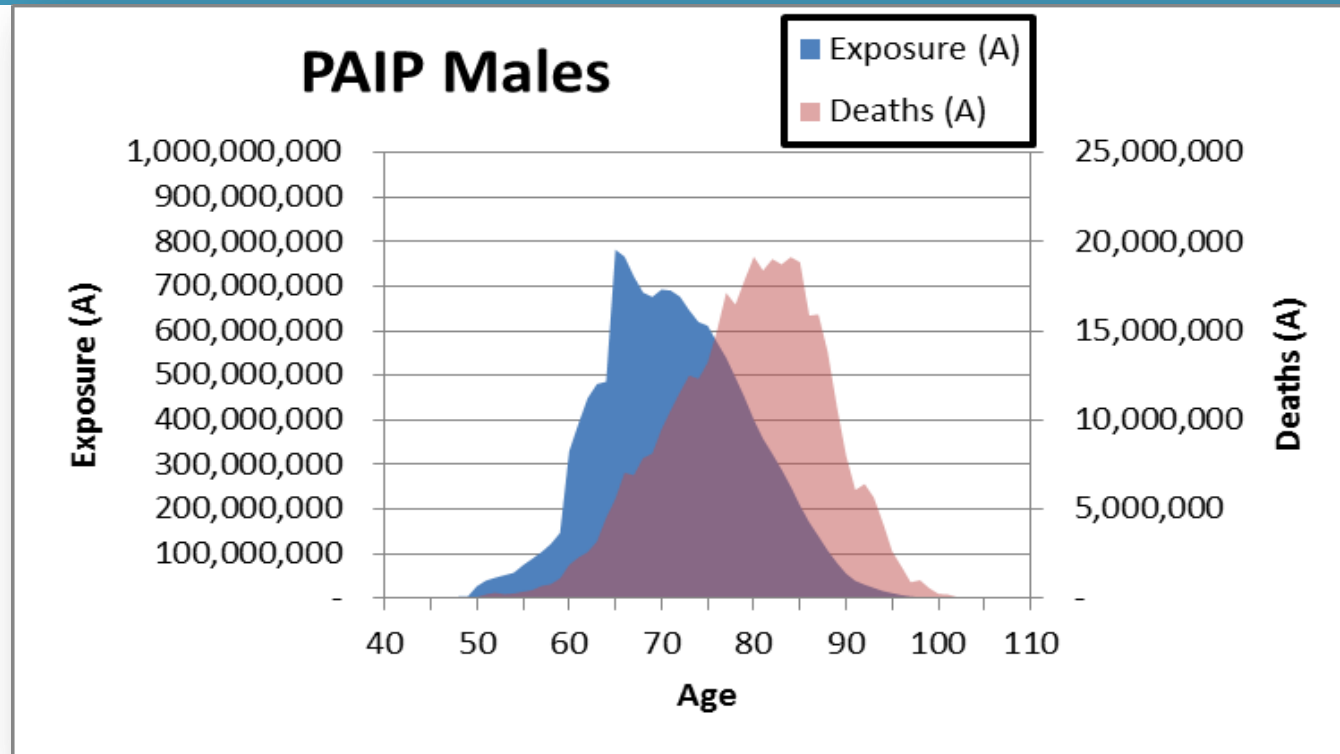
Large dataset

Numerous splits possible

Good illustration of many typical issues encountered

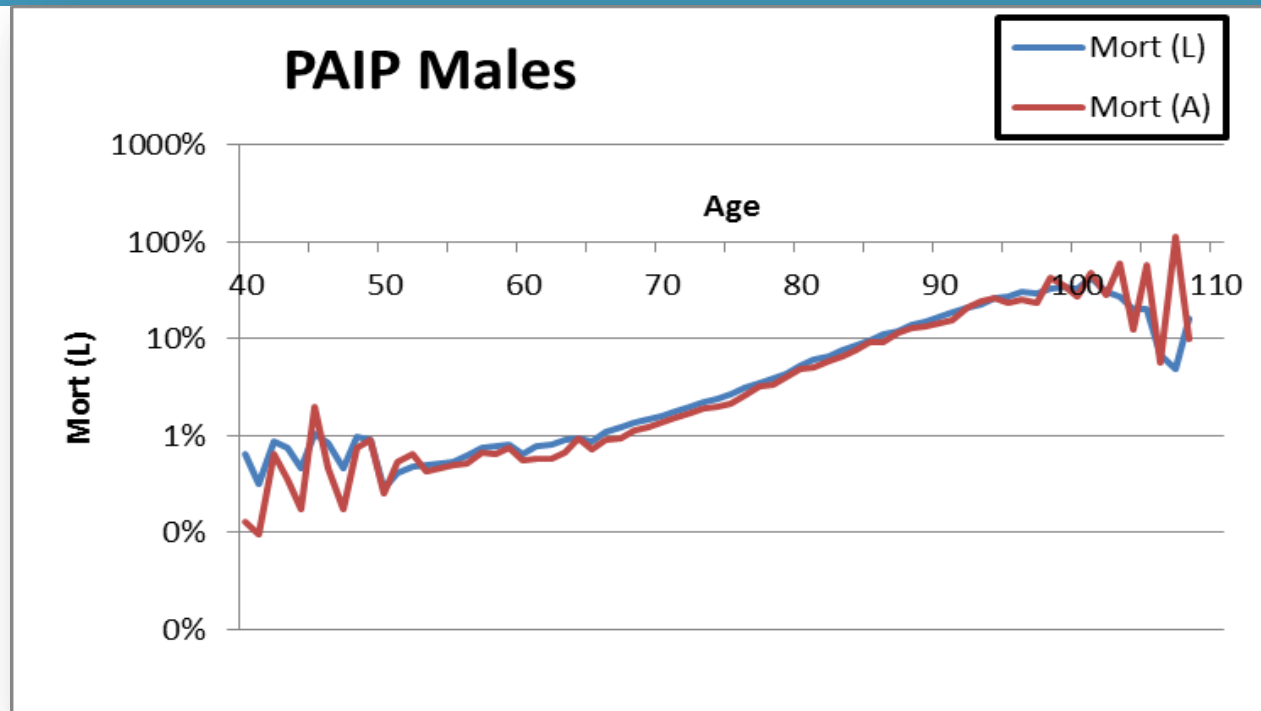
Detailed example

Data exploration



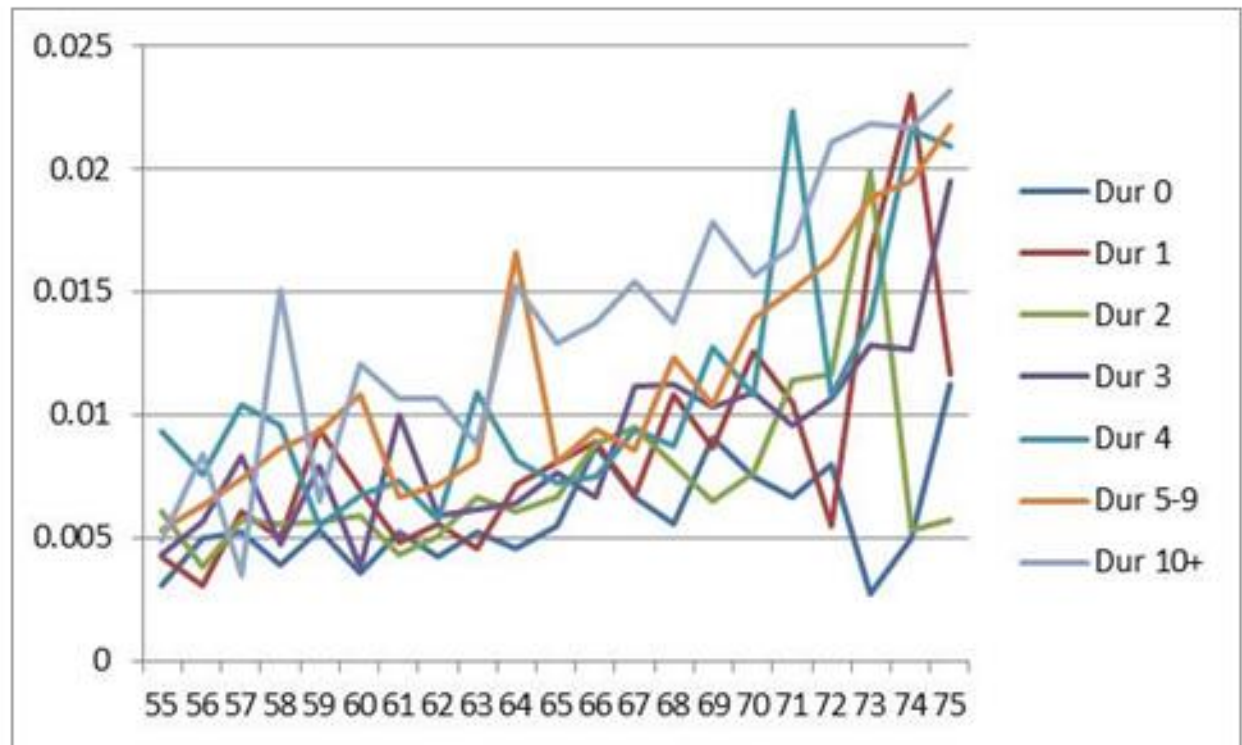
Detailed example

Data exploration



Detailed example

Data exploration



Detailed example

Data exploration conclusions

- Data credible from ~50 to ~100
- Mortality differences observed by Amounts band and Duration
- Combine some Amounts band for analysis

Detailed example

Exploratory graduations

Numerous methodologies available within the graduation tool:

“Single table”	G(s) GM(r,s) B-spline P-spline
“Co-graduation”	Co(r,s) CoT(r,s)
GLM	GLM

Detailed example

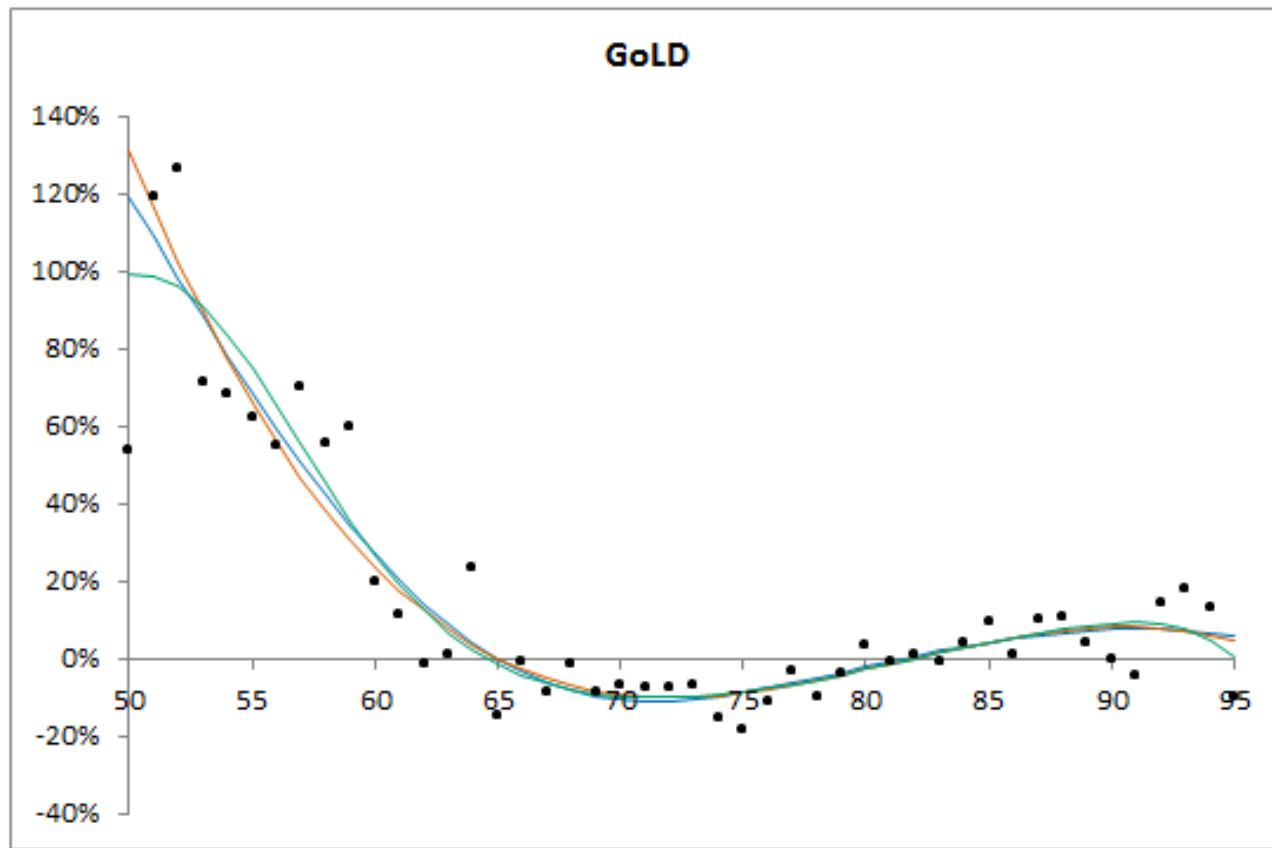
Exploratory graduations

TABLE 1- PML/PFL/PMA/PFA Annuity rates for different graduation models and age ranges

Formula	Parameters	MinAge	MaxAge	Annuity type	PML	PFL	PMA	PFA
GM(r,s)	(r=0,s=5)	50	100	a65 (to 95)	18.87	21.35		21.84
GM(r,s)	(r=0,s=4)	50	100	a65 (to 95)	18.86	21.34		21.84
GM(r,s)	(r=0,s=3)	50	100	a65 (to 95)	18.87	21.33		
GM(r,s)	(r=1,s=5)	50	100	a65 (to 95)	18.87	21.35	19.73	
GM(r,s)	(r=1,s=4)	50	100	a65 (to 95)	18.87	21.35		
GM(r,s)	(r=1,s=3)	50	100	a65 (to 95)	18.88	21.35		
GM(r,s)	(r=2,s=5)	50	100	a65 (to 95)	18.87	21.35		21.83
GM(r,s)	(r=2,s=4)	50	100	a65 (to 95)	18.87	21.34		21.84
GM(r,s)	(r=2,s=3)	50	100	a65 (to 95)	18.88	21.23		21.85
B-spline	knot space 4	50	100	a65 (to 95)	18.87	21.34	19.72	21.82
P-spline	knot space 4	50	100	a65 (to 95)	18.87	21.34	19.72	21.82
GM(r,s)	(r=0,s=5)	60	100	a65 (to 95)	18.87	21.34	19.72	21.83
GM(r,s)	(r=0,s=4)	60	100	a65 (to 95)	18.88	21.34		21.84
GM(r,s)	(r=0,s=3)	60	100	a65 (to 95)	18.86	21.30		21.82
GM(r,s)	(r=1,s=5)	60	100	a65 (to 95)	18.87	21.34	19.73	21.83
GM(r,s)	(r=1,s=4)	60	100	a65 (to 95)	18.88	21.35		21.84
GM(r,s)	(r=1,s=3)	60	100	a65 (to 95)	18.89	21.35		21.84
GM(r,s)	(r=2,s=5)	60	100	a65 (to 95)	18.87	21.34		
GM(r,s)	(r=2,s=4)	60	100	a65 (to 95)	18.87	21.34		21.82
GM(r,s)	(r=2,s=3)	60	100	a65 (to 95)	18.87	21.34		
B-spline	knot space 4	60	100	a65 (to 95)	18.88	21.34	19.72	21.82
P-spline	knot space 4	60	100	a65 (to 95)	18.88	21.34	19.72	21.82
GM(r,s)	(r=0,s=5)	65	100	a65 (to 95)	18.88	21.34	19.74	21.84
GM(r,s)	(r=0,s=4)	65	100	a65 (to 95)	18.88	21.34		21.84
GM(r,s)	(r=0,s=3)	65	100	a65 (to 95)	18.90	21.34		21.85
GM(r,s)	(r=1,s=5)	65	100	a65 (to 95)	18.88	21.34		21.84

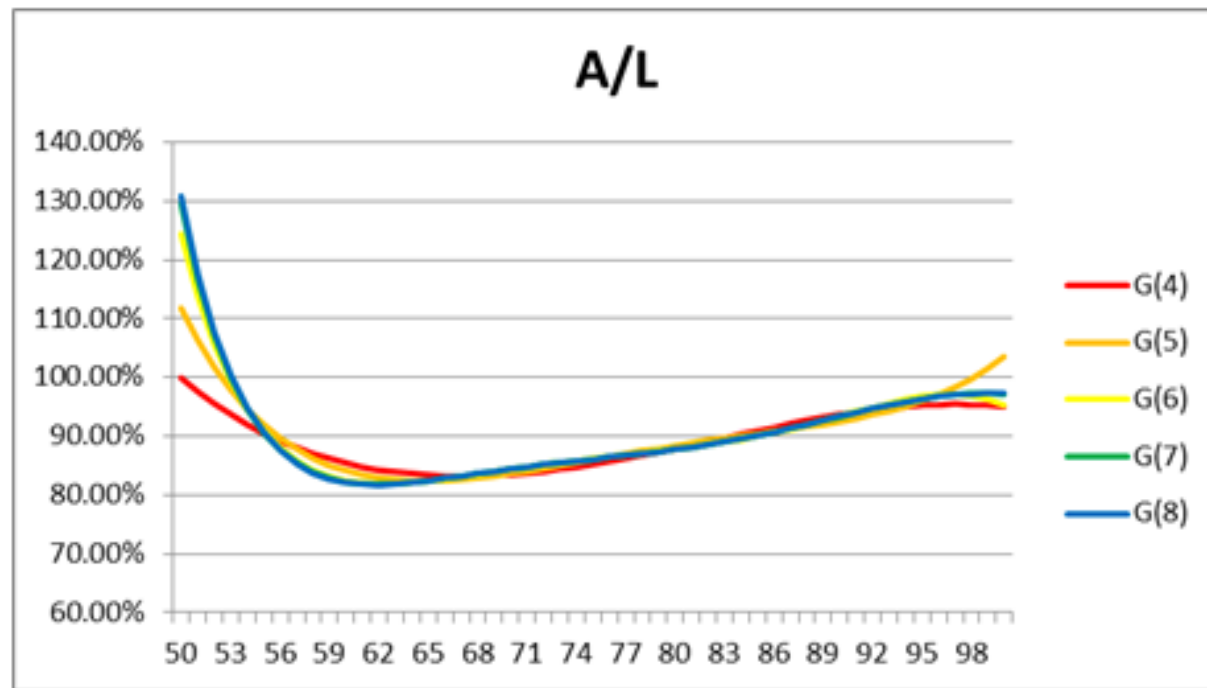
Detailed example

Exploratory graduations



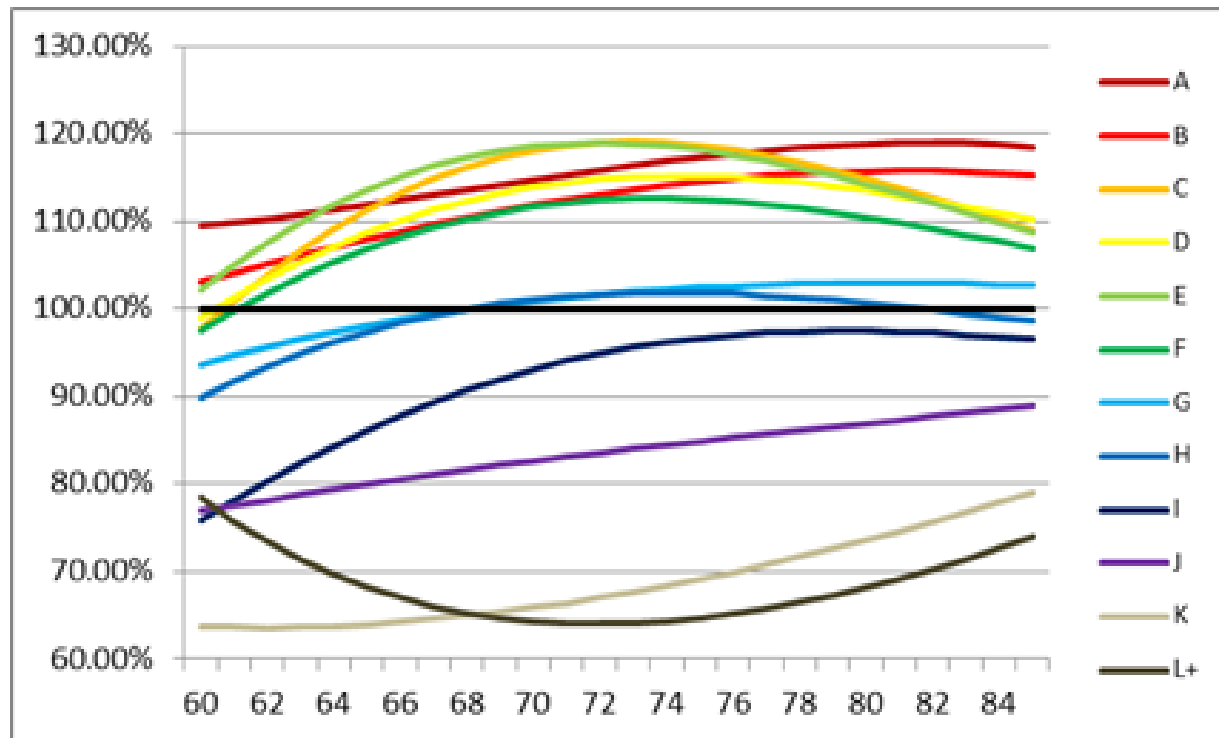
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Exploratory graduations



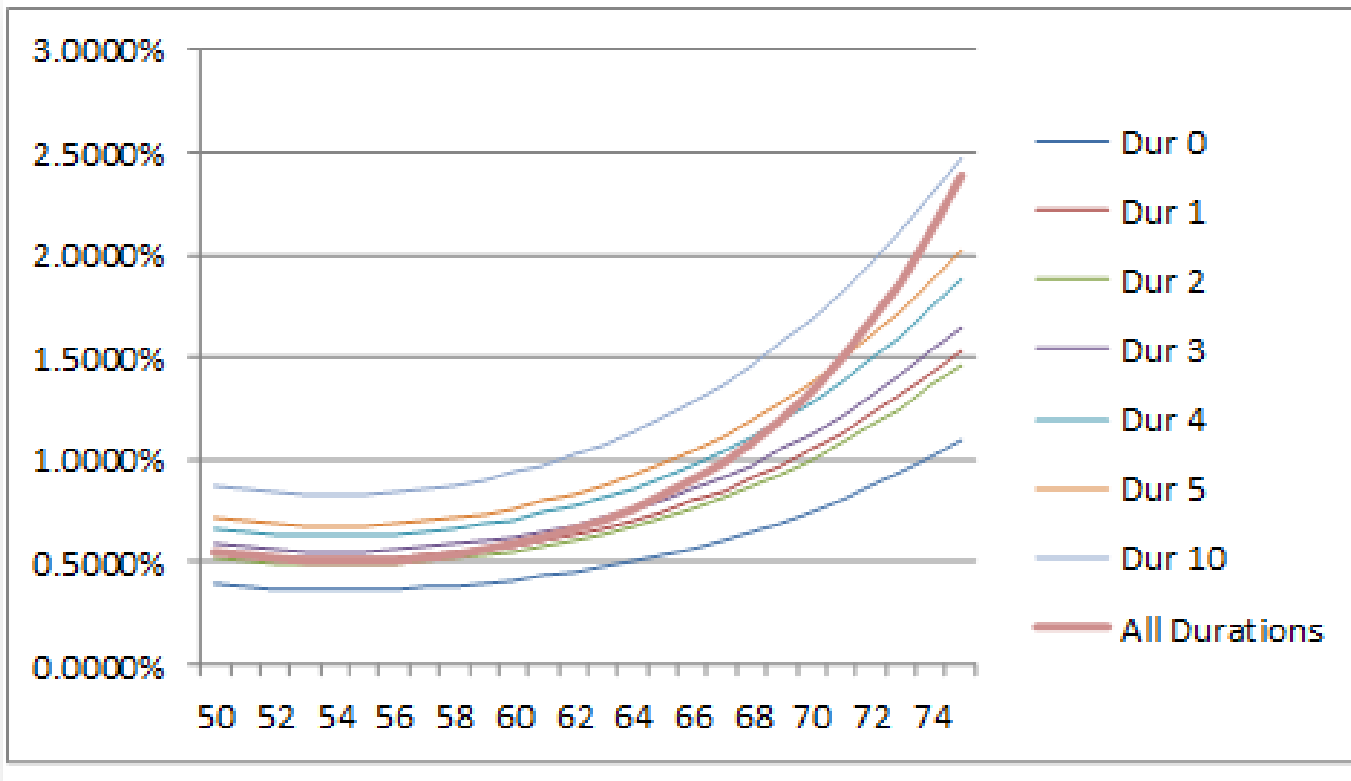
Detailed example

Exploratory graduations



Detailed example

Exploratory graduations



Detailed example

Exploratory graduations conclusions

- Amounts results significantly different from Lives and credible, so perform separate graduation (but check convergence at older ages)
- Well-fitting models from different methodologies generated similar annuity values, so favour G(s) models as most simple
- Most differences result at the extremes of the age range; treat these via extrapolation methodology?
- Information criteria tend to reduce even as parameter numbers increase to an unhelpful size
- Chi-squared and overdispersion tests nearly always failed; K-S probabilities also often low for most parameter choices
- Results by Amounts band had improved overdispersion test results

Detailed example

Detailed graduations

A Use maximum data

B Consider materiality

C Fit the data

D Favour parsimony

E Ensure consistency

Detailed example

Detailed graduations

A Use maximum data

B Consider materiality

C Fit the data

D Favour parsimony

E Ensure consistency

Credible data and relatively stable mortality rates
from age 50 to 100

Detailed example

Detailed graduations

A Use maximum data

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C Fit the data

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E Ensure consistency

We propose G(5) as the PMA graduation because:

- It passes most of the relevant statistical tests.
- Its annuity value and shape is consistent with higher parameter graduations.
- In the interests of parsimony, we wish to minimise the number of parameters.
- When we extrapolate the table to younger ages, it appears an upward-sloping GOLD chart is the best fit to that data.

Detailed example

Detailed graduations

A Use maximum data

B Consider materiality

C Fit the data

D Favour parsimony

E Ensure consistency

Table 1 – Proposed amount bands

Amount bands	% Lives	% Amounts
£0-£999	62%	14%
£1,000 to £2,499	30%	37%
£2,500+	7%	49%
Total	100%	100%

Detailed example

Detailed graduations

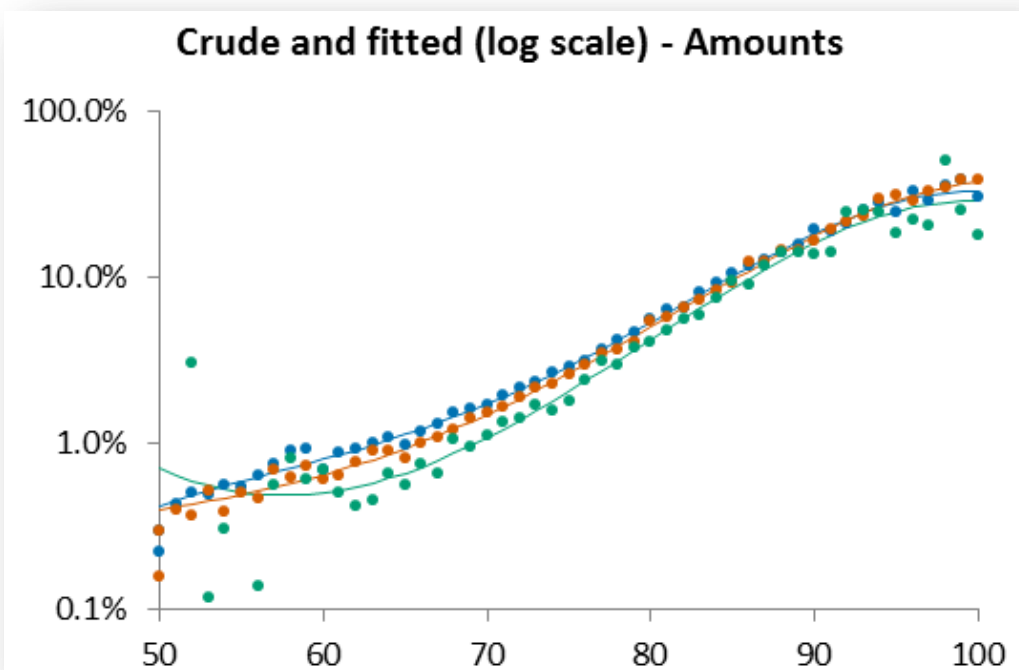
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Detailed example

Detailed graduations

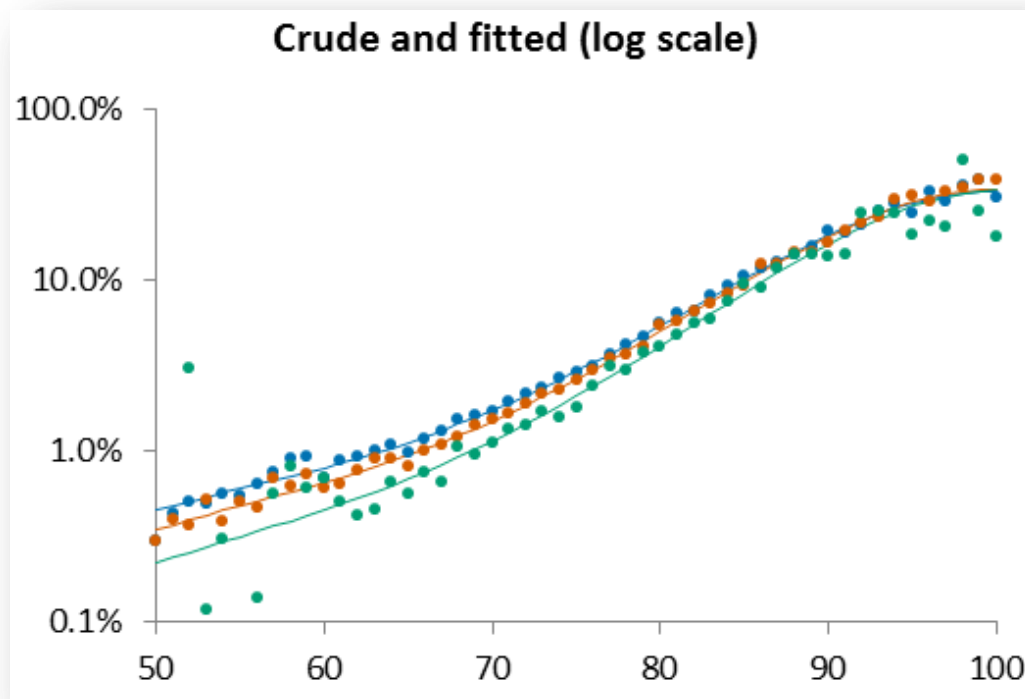
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Detailed example

Detailed graduations

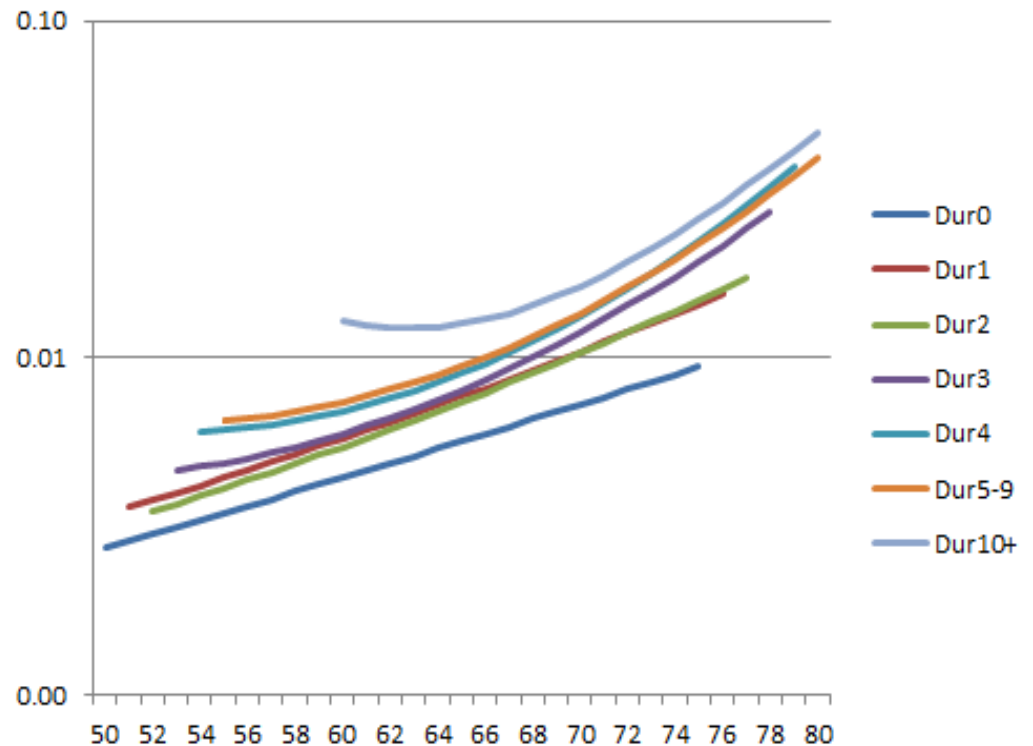
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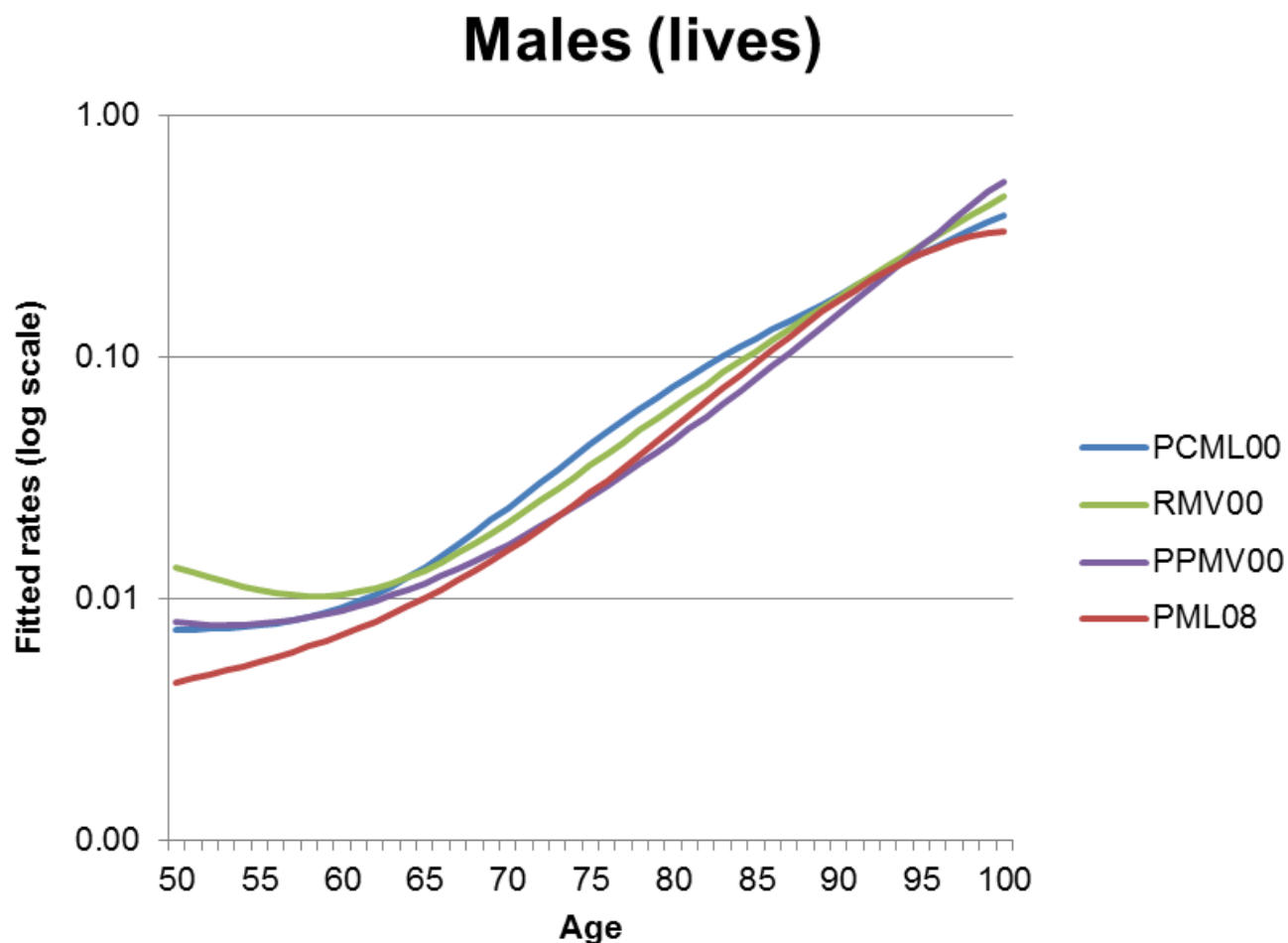
Proposed graduations (1/2)

“00” Series		“08” Series	
Name	Description	Description	Additional information
IML00	Immediate Annuitants, males, lives	Life Annuitants, males, lives	Experience for amounts vs lives
IFL00	Immediate Annuitants, females, lives	Life Annuitants, females, lives	Experience for amounts vs lives
PNML00	Pensioners, males, Normal, lives	Pension Annuitants, males, lives	Experience by duration Experience by distribution channel
PEML00	Pensioners, males, Early, lives		
PCML00	Pensioners, males, Combined, lives		
RMV00	Retirement Annuitants, males, vested		
PPMV00	Personal Pensioners, males, vested		
PNFL00	Pensioners, females, Normal, lives	Pension Annuitants, females, lives	Experience by duration Experience by distribution channel Widows/pensioners experience
PEFL00	Pensioners, females, Early, lives		
PCFL00	Pensioners, females, Combined, lives		
RFV00	Retirement Annuitants, females, vested		
PPFV00	Personal Pensioners, females, vested		
WL00	Widows, lives		

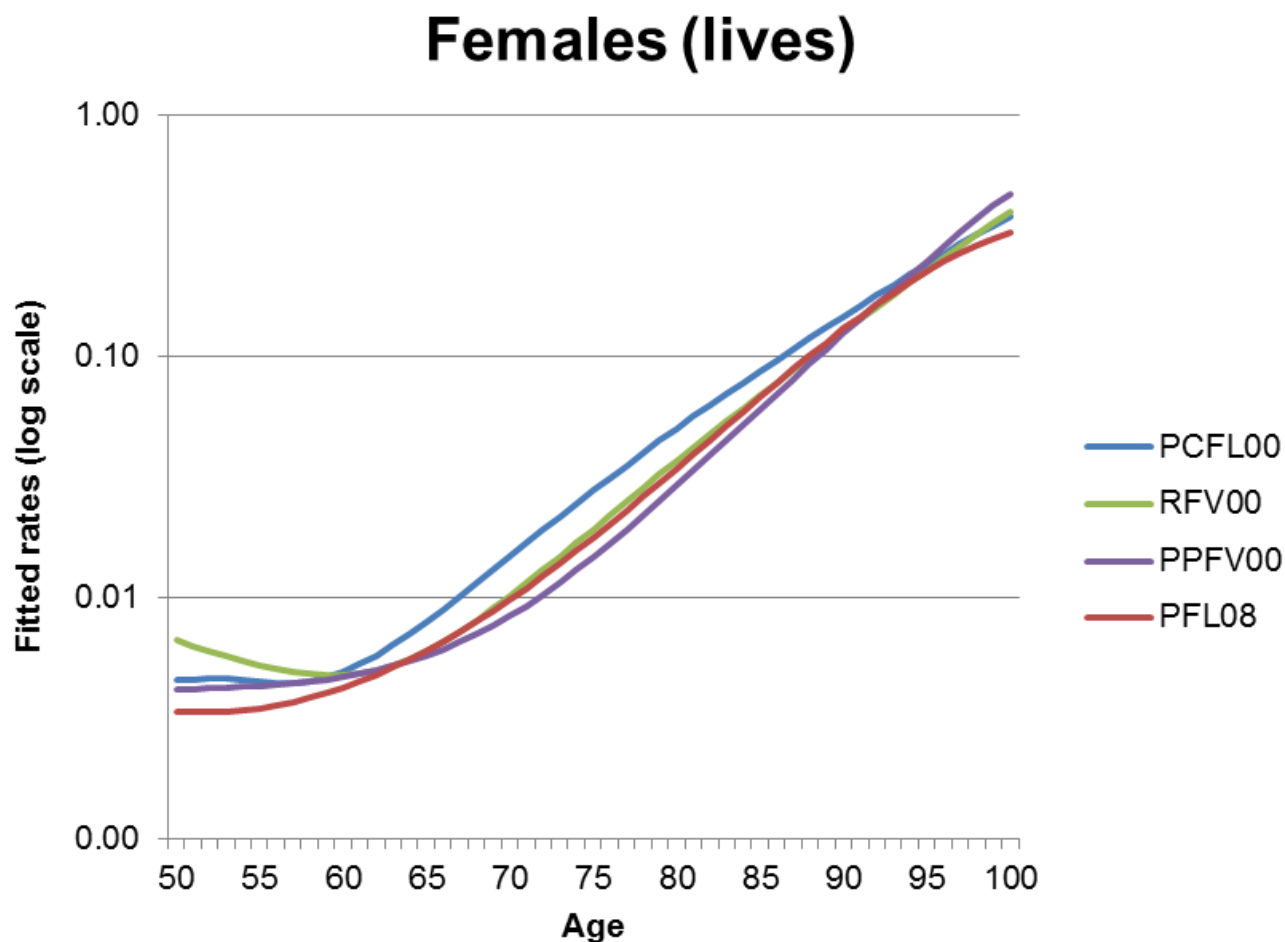
Proposed graduations (2/2)

“00” Series		“08” Series	
Name	Description	Description	Additional information
PNMA00	Pensioners, males, Normal, amounts	Pension Annuitants, males, amounts	Experience by duration
PEMA00	Pensioners, males, Early, amounts		Experience by distribution channel
PCMA00	Pensioners, males, Combined, amounts		Experience by amount band
PNFA00	Pensioners, females, Normal, amounts	Pension Annuitants, females, amounts	Experience by duration
PEFA00	Pensioners, females, Early, amounts		Experience by distribution channel
PCFA00	Pensioners, females, Combined, amounts		Experience by amount band
WA00	Widows, amounts	Deferred Pensioners, males (lives)	Widows/pensioners experience
RMD00	Retirement Annuitants, males, deferred		[None]
PPMD00	Personal Pensioners, males, deferred		
RFD00	Retirement Annuitants, females, deferred	Deferred Pensioners, females (lives)	[None]
PPFD00	Personal Pensioners, females, deferred		
RMC00	Retirement Annuitants, males, combined		[None]
RFC00	Retirement Annuitants, females, combined		
PPMC00	Personal Pensioners, males, combined		
PPFC00	Personal Pensioners, females, combined		

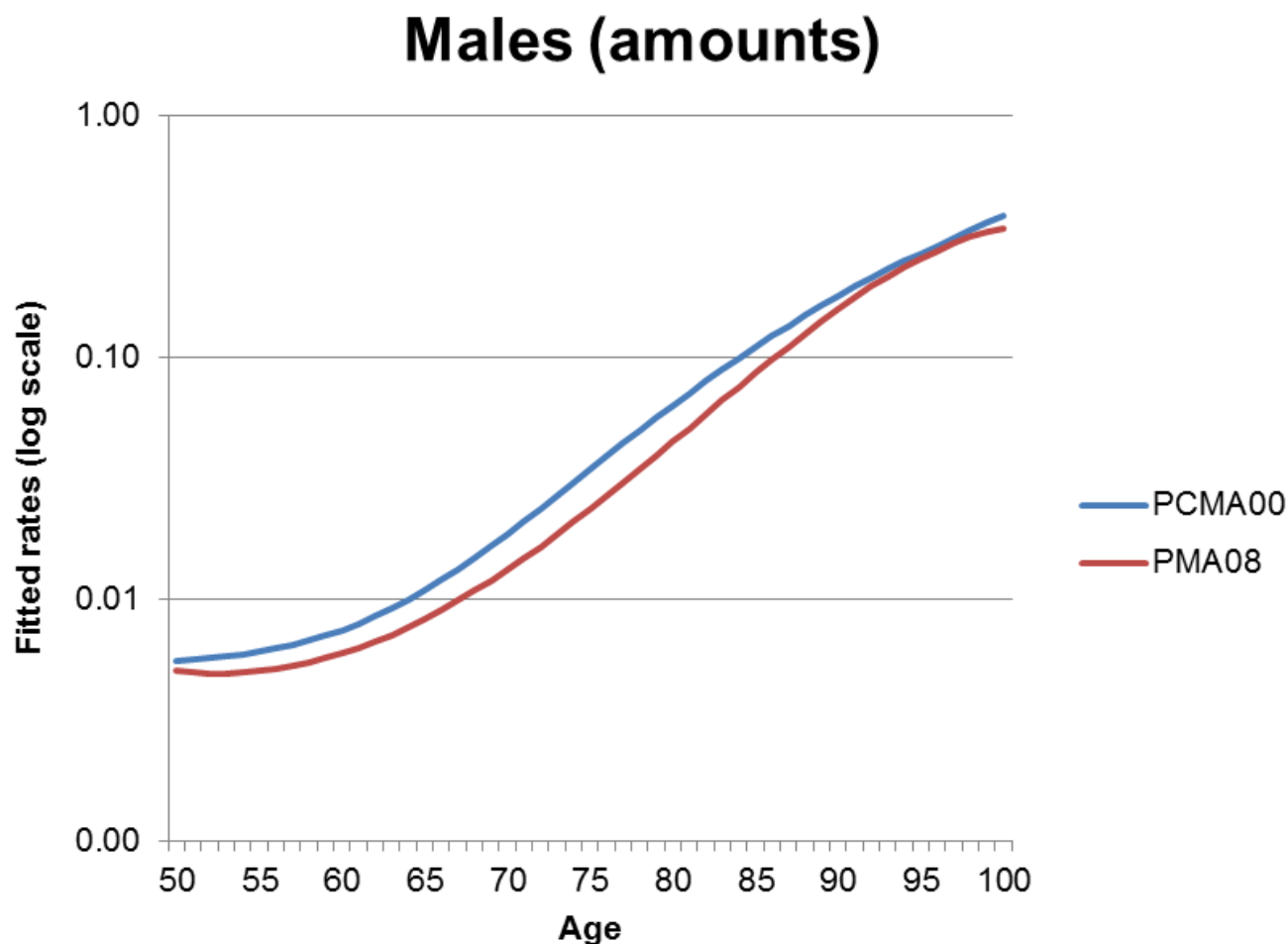
Proposed graduations – Pension Annuitants



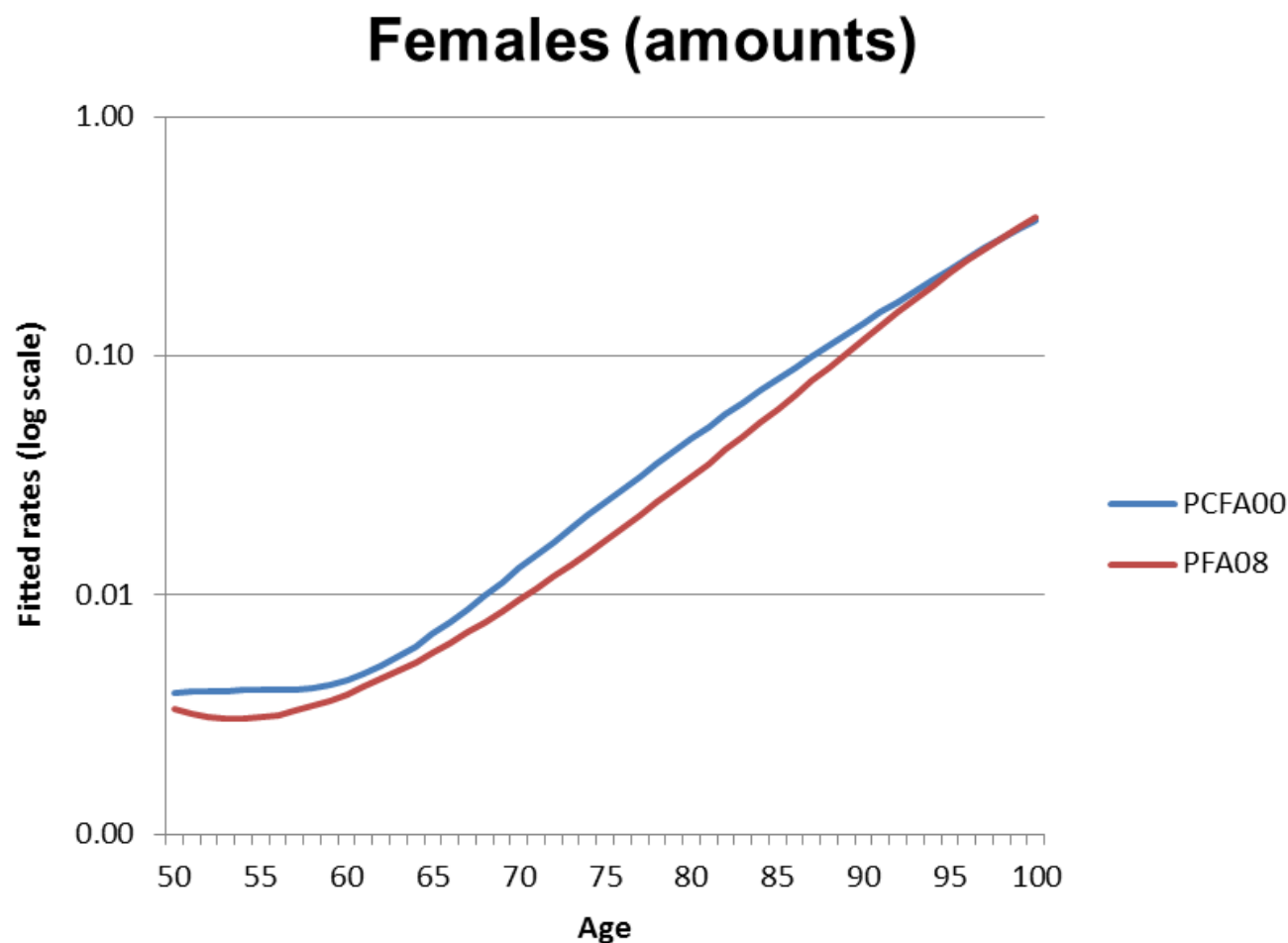
Proposed graduations – Pension Annuitants



Proposed graduations – Pension Annuitants



Proposed graduations – Pension Annuitants



Discussion questions:

Pension annuities in payment

Q1. Do you agree that there is a demand for new pension annuities in payment tables and, if so, do you have any comments on the proposed approach?

Q2. Do you have any comments on the proposal not to produce tables by duration if the Committee produces an indication of the selection effects?

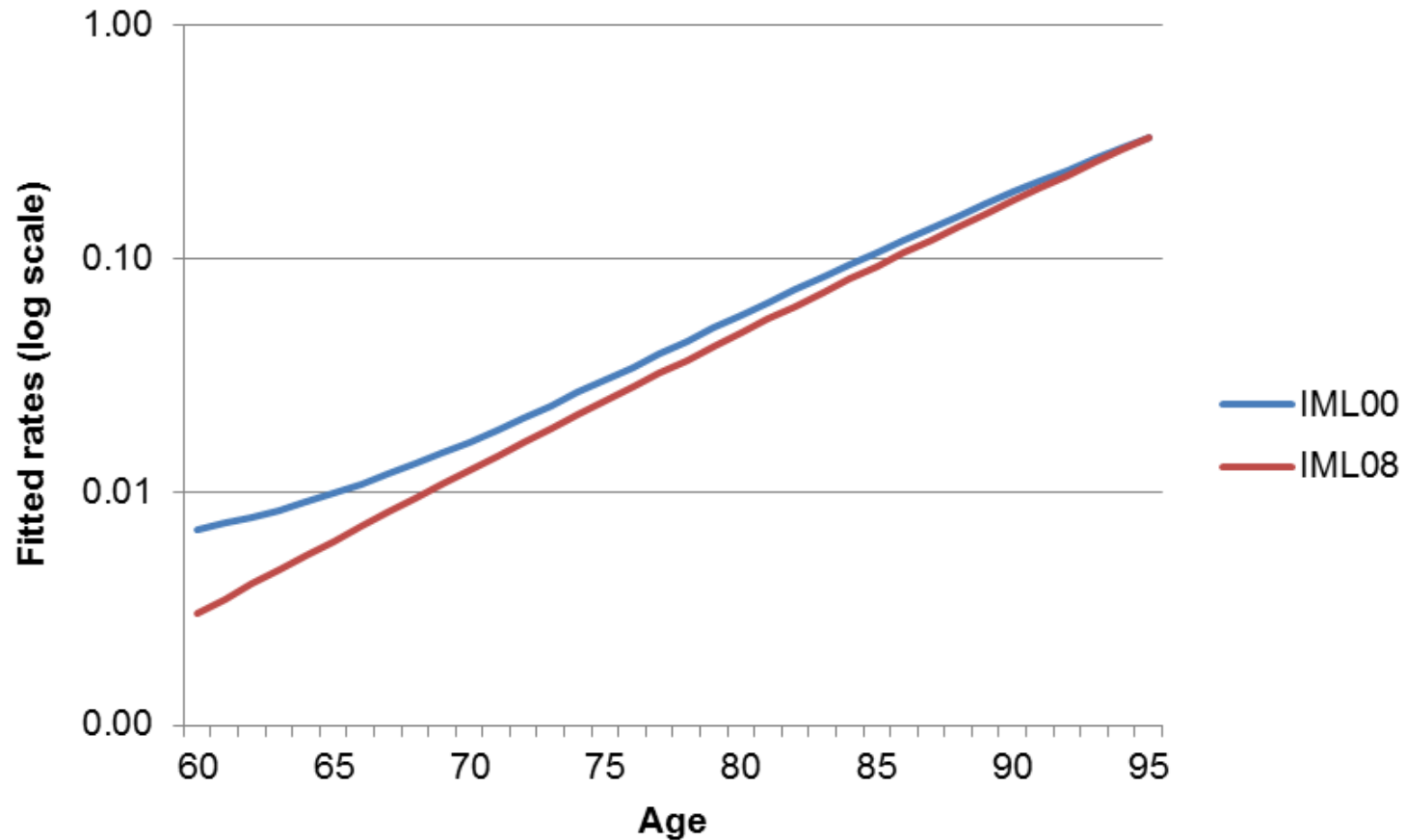
Q3. Do you have any comments on the proposal not to produce tables by distribution channel if the Committee produces an indication of the variation?

Q4. Would you prefer separately-graduated tables for different amount bands, or only a single “all amounts” table with supplementary information about the effect of amount on mortality?

Q5. Do you have any comments on the proposed approach to widows' / widowers' data?

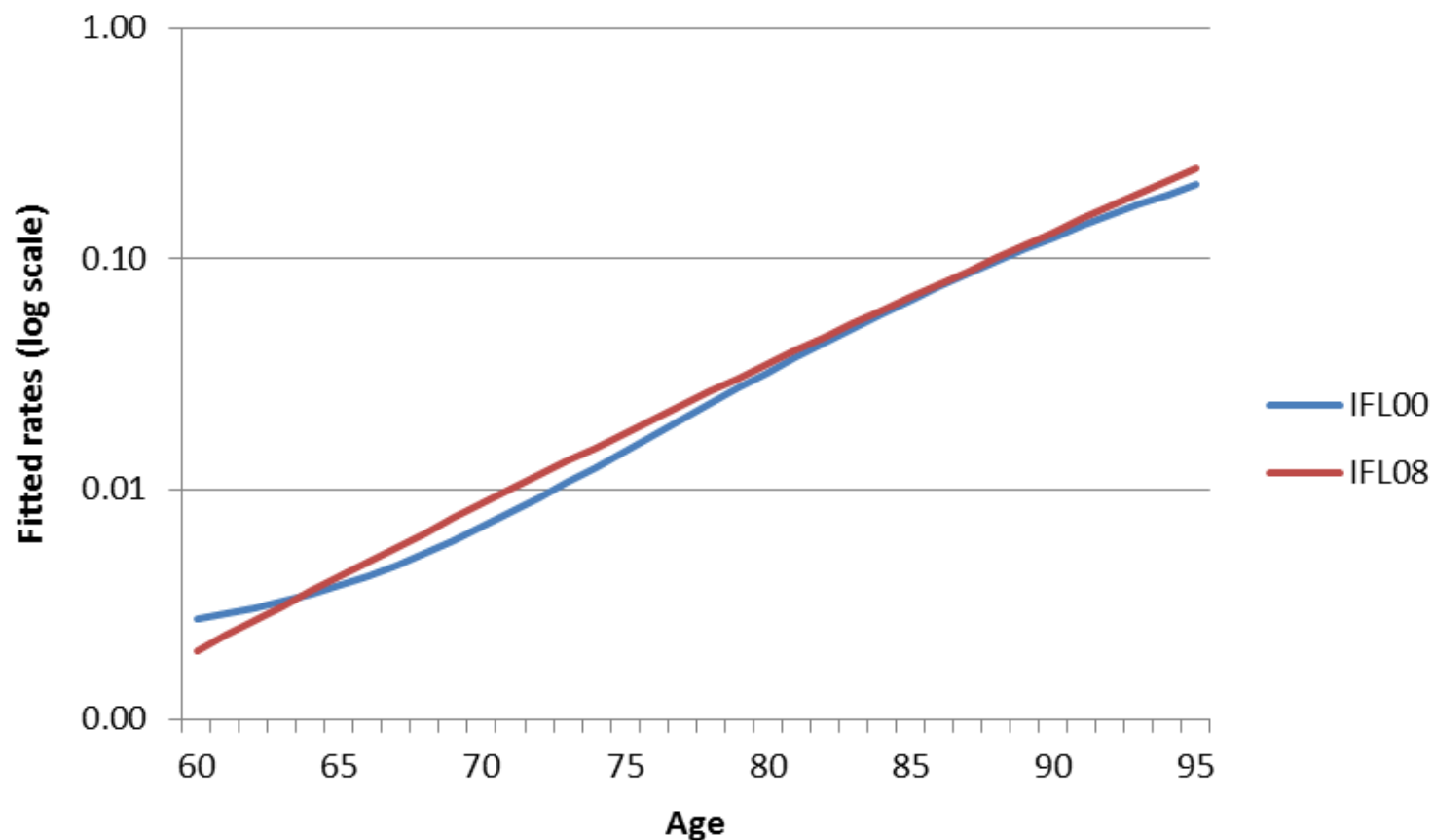
Proposed graduations – Life Annuitants

Males (lives)

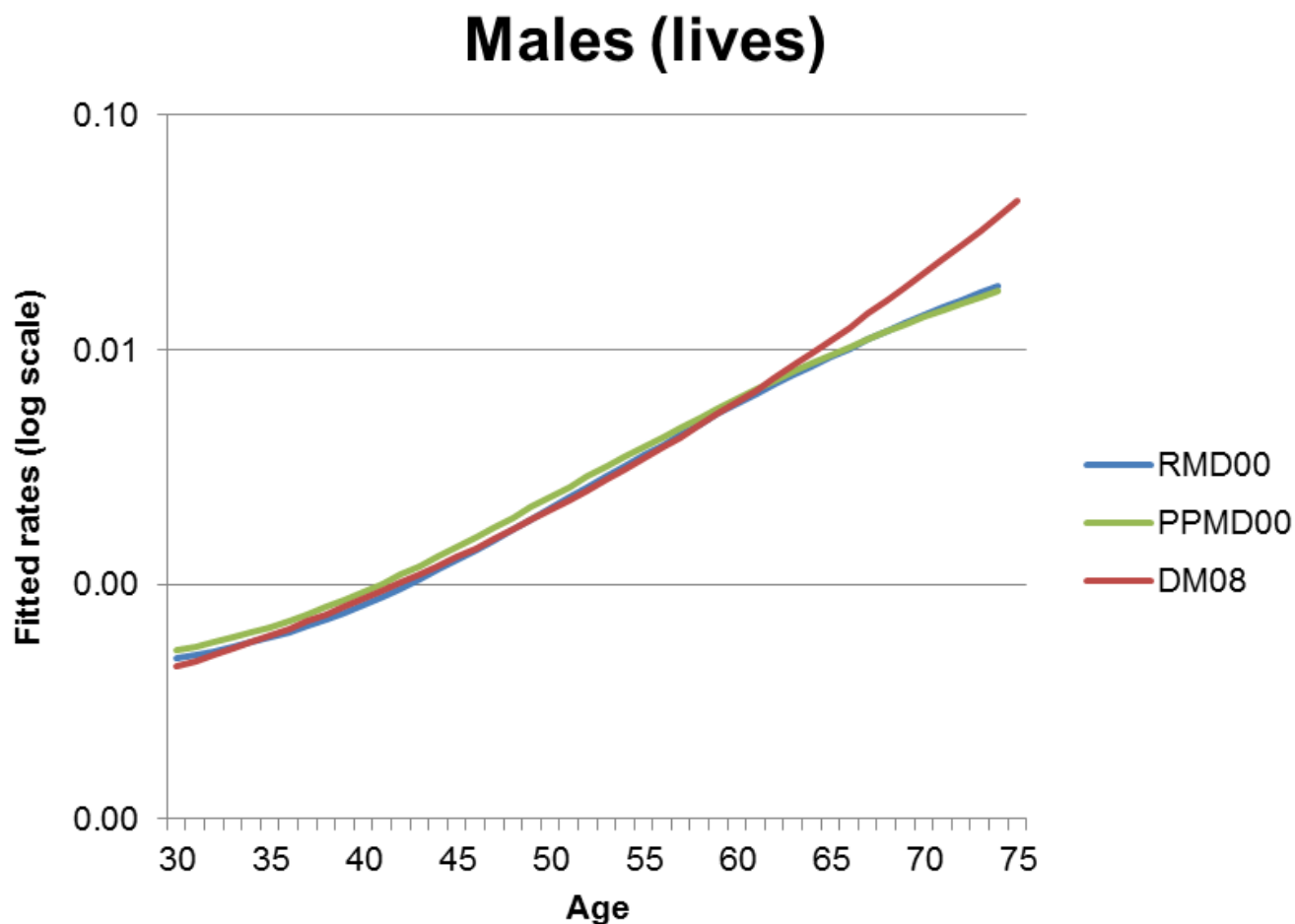


Proposed graduations – Life Annuitants

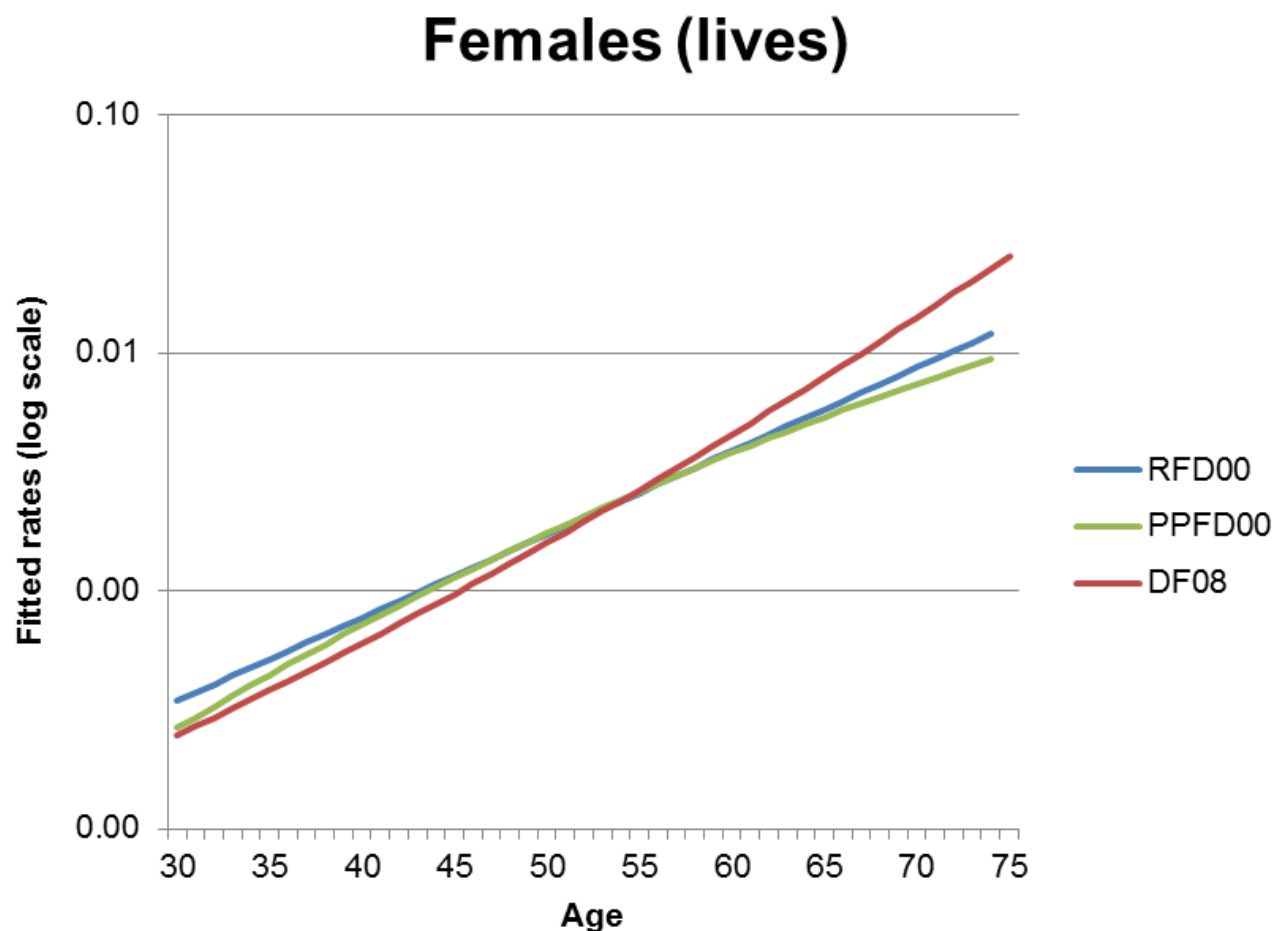
Females (lives)



Proposed graduations – Deferred Annuitants



Proposed graduations – Deferred Annuitants



Discussion questions:

Life annuities and Deferred annuities

Q6. Do you think there is a demand for a life annuities table and, if so, do you have any comments on the proposed approach?

Q7. Do you think there is a demand for a deferred annuities table and, if so, do you have any comments on the proposed approach?

Q9. Is there any need to extend the pensions in deferment tables above age 75?

Discussion questions:

Extensions to older and younger ages

Q8. Do you have any strong views about how tables should be extended to the oldest ages?

Q10. Do you have any strong views about how tables should be extended to the youngest ages?

Agenda

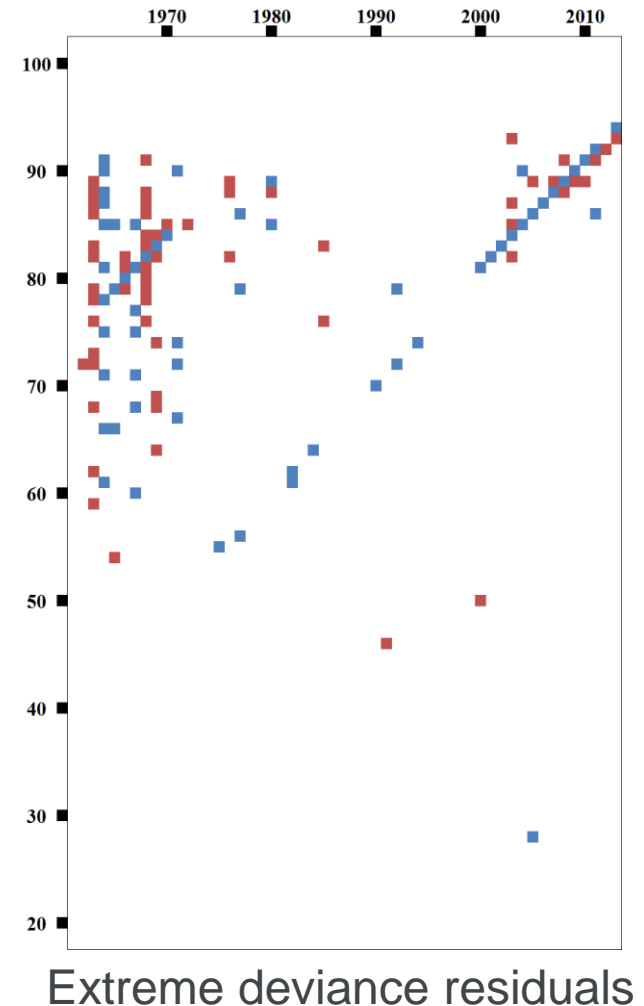
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Data collection and the 2007-2010 Annuity data	Dave Grimshaw, CMI Secretariat
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Next steps	Kevin

The CMI Model

- Previously:
 - CMI_2009 was released following consultation in 2009
 - Annual re-calibrations for CMI_2010 to CMI_2013 to allow for extra years of data
 - Structure of the Model unchanged
- CMI_2014:
 - Model structure still unchanged
 - Changes to calibration of Initial Rates of Improvement.

Concerns over population data quality

- The P-spline model fits the data less well than would be expected (overdispersion), particularly:
 - 1960s calendar years
 - 1919 birth cohort
- Informed by:
 - CMI GMWP analysis
 - Cairns et al, “Phantoms never die” (2014).



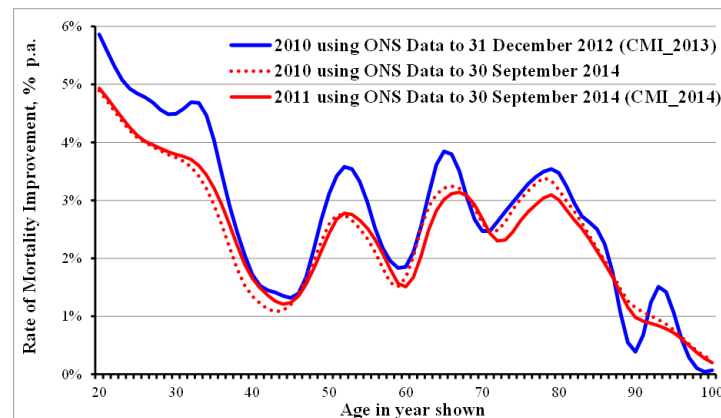
Changes to calibration of Initial Rates

- Changes because of population data quality:
 1. Start from 1974 since earlier data is of less good quality; and use a rolling period (eg expected that CMI_2015 will start from 1975)
 2. Adjust exposure data for age/year cells which are anomalous (with a 1-in-10,000 probability); particularly the 1919 cohort
 3. Allow for overdispersion when fitting the p-spline model, leading to a smoother fit
- Additional data used for calibration:
 4. Including data for 1 January 2013 to 30 September 2014. More up to date, and reduces volatility due to 2013/14 experience.

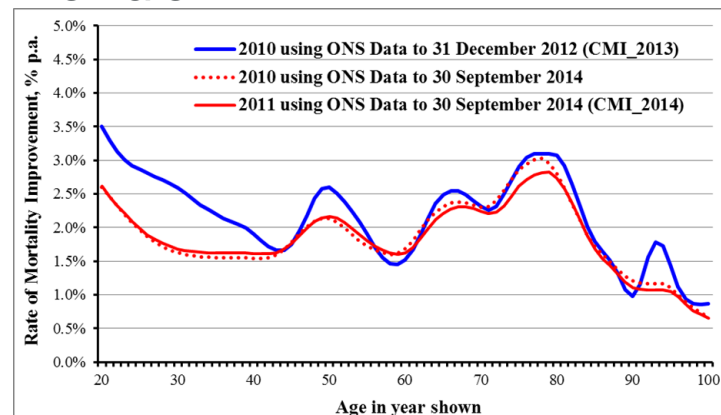
Mortality improvements in 2013 and 2014

- Crude improvements of $\approx 0\%$ in 2013 and 4-5% in 2014
- **CMI_2014** improvements lower than **CMI_2013** at most ages
- **CMI_2014** improvements have less extreme cohort effects, due to changes in calibration method.

Male

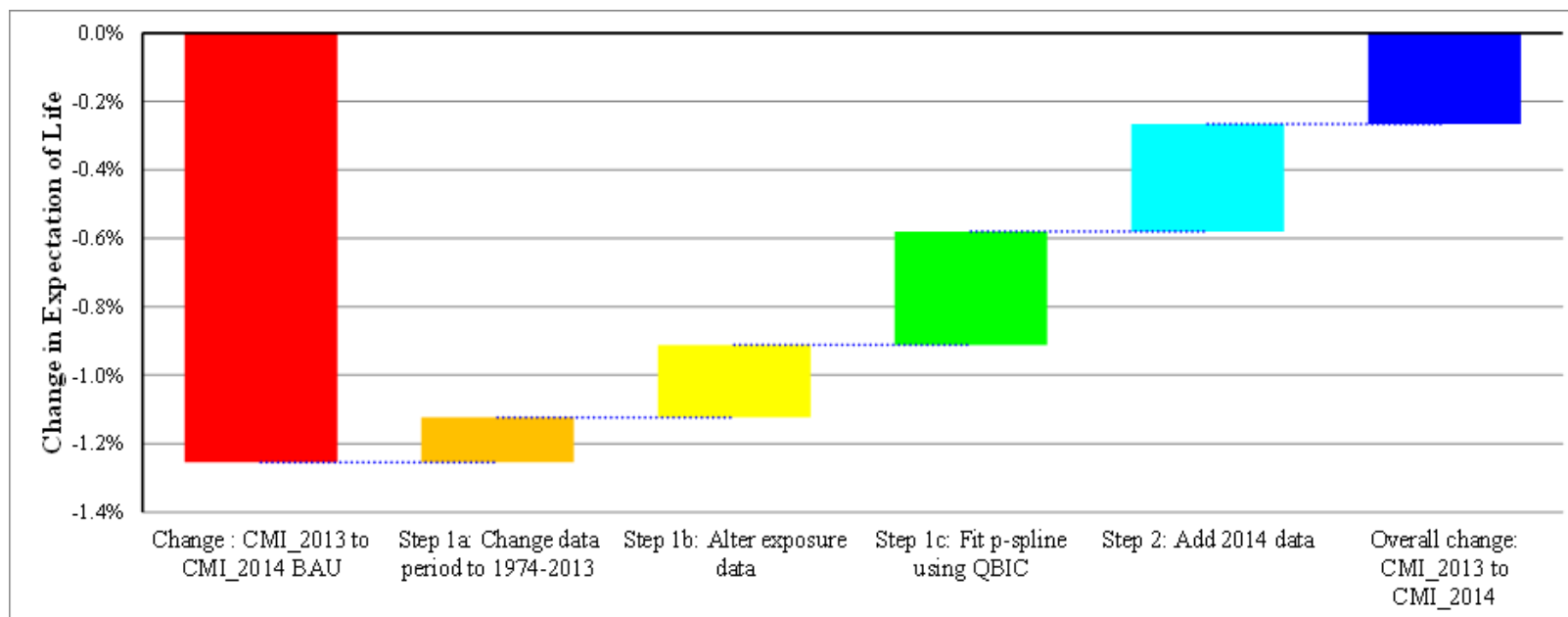


Female



Impact on life expectancy

- Most ages see a modest fall in life expectancy
- Changes to CMI_2014 method lead to a lower fall than under a “business as usual” method.



Male age 65: Life expectancy falls by 0.3%

Future versions of the Model

- The Committee continues to consider further areas:
 - Stability versus responsiveness: how much the Model should change due to one year of additional data
 - Guidance for users: updated information to help Subscribers set assumptions including the long-term rate
 - Mortality improvements for pension scheme and annuity portfolios compared to the national population
 - Coherent modelling of improvements for males and females, and sub-populations
- May lead to further changes in CMI_2015 or CMI_2016
- Feedback always welcome: projections@cmilimited.co.uk

Agenda

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Next steps (1/2)

- Reflect on today
 - Areas of strong consensus or ranges of views
 - Any changes in the proposed graduations?
 - Any further analysis required?
- Consult on proposed graduations
 - Proposed graduated tables
 - Extensions to younger / older ages
 - More detail on methodology, statistical tests, etc..
 - Target by end-2014 – but dependent on tables required

Next steps (2/2)

- Incorporate feedback
 - Proposed graduated tables
 - Extensions to younger / older ages
 - More detail on methodology, etc..
- Graduated “08” Series tables
 - Graduated tables
 - Accompanying working paper
 - Target by end-Q1 2015 – again dependent on tables required
- What’s next?
 - Enhanced Annuities
 - All-Offices results for standard annuities for 2011 (and 2012)
 - Individual Offices’ experience by GLM?
 - Where do you, the users, feel the CMI can add most value?

Future Forums?

- Disseminate information
 - Current activity
 - Progress with data receipt / processing
 - Areas being developed
- Receive feedback / comments
 - Step-back review of the outputs
 - How do users use our outputs – practical applications?
 - Is this fulfilling the needs of users?
 - What else might we be doing?
- Feedback always welcome: annuities@cmilimited.co.uk

Questions

Comments

Expressions of individual views by members of the Institute and Faculty of Actuaries and its staff are encouraged.

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

Any queries or feedback to Annuities@cmilimited.co.uk.

Disclaimer and statutory information

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