

## Mortality Experience – the CMI SAPS Investigation

Steven Baxter  
for  
Brian Wilson, Chairman of CMI SAPS Mortality  
Committee

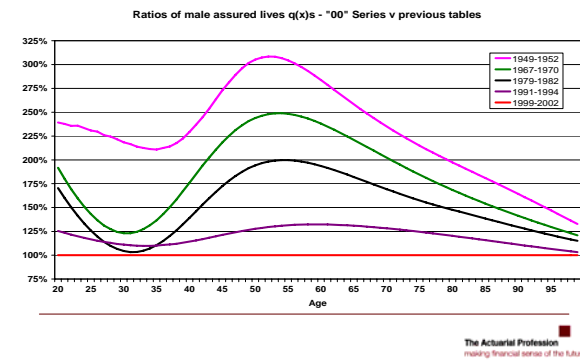
## Agenda

- Mortality tables
  - Background to SAPS Investigation
  - Importance of Continuous Monitoring
  - Latest SAPS Dataset Results
  - Graduation Work
- Projections
  - CMI Library of Projections

## CMI SAPS investigation

- Pilot investigation ... now formally part of the CMI
- Data collected from firms of consultants (acting as Scheme Actuary)
- 360+ validated submissions with 3.8m records to June
  - Just over 300 schemes – remainder are resubmissions
- Richer data than life office (currently), e.g. amounts and industry type
- Working Papers published to date: WP4, WP9, WP17 and WP29
  - all available on CMI pages of [www.actuaries.org.uk](http://www.actuaries.org.uk)

## Importance of “continuous”




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SAPS Investigation – analysis of data  
collected to 30 June 2007

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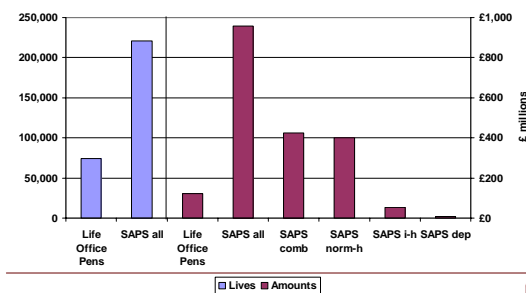
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## Data comparison – males

SAPS data to 30/06/07 compared to Life Office Pensioners 1999-2002 (Deaths)




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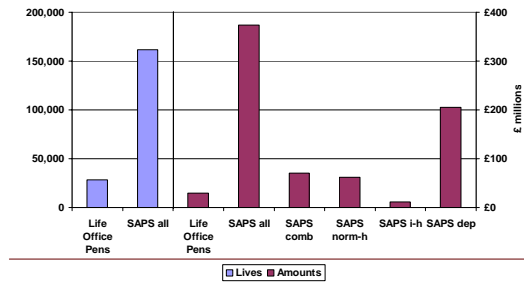
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## Data comparison – females

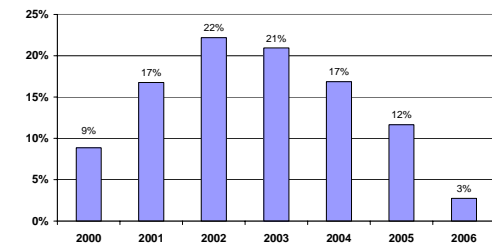
SAPS data to 30/06/07 compared to Life Office Pensioners 1999-2002 (Deaths)



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## Data by year –Males

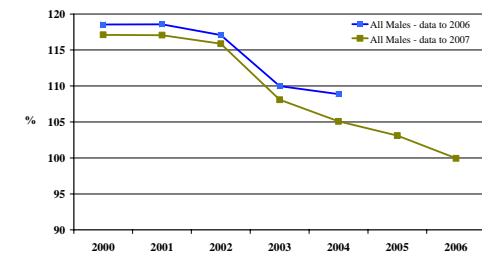
Data Volumes to 30 June 2007: Male ETR (Lives)



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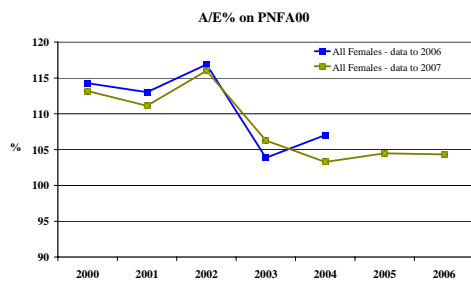
## The Big Picture –Males

A/E% on PNMA00



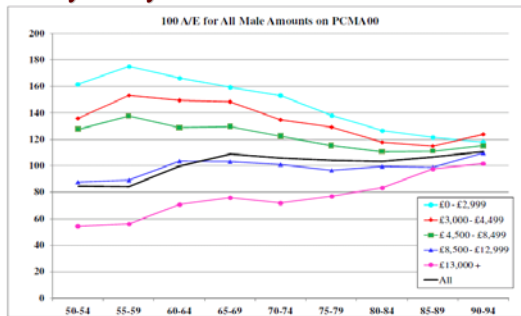
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## The Big Picture –Females



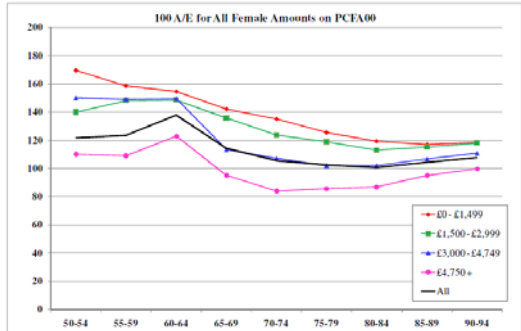
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## Analysis by Amount –Males – 100A/E



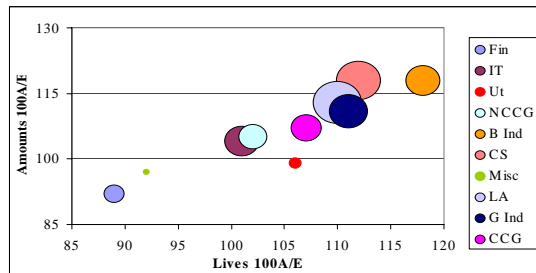
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## Analysis by Amount –Females – 100A/E



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## Analysis by Industry - Males



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SAPS Investigation - Graduating the data in to tables

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How many tables do you want?

As there are 1001 ways of splitting the data...

...we could produce 1001 different tables....

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## Amounts and Lives

- Almost every dataset that we have looked at shows distinctly different shapes for lives and amounts
- We are therefore looking to produce both lives and amounts tables for each dataset

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## Types of data

- Normal-health and Ill-health split, or
- Normal-health and Ill-health combined
- Pensioners and Dependants split, or
- Pensioners and Dependants combined
- Any of the above can be split by amount of pension

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## Current plans for females

Separate graduations for:

- All Pensioners (excluding dependants)
- Normal-health Pensioners
- Ill-health Pensioners
- Dependants
- All Pensioners (excluding dependants) – high amounts
- All Pensioners (excluding dependants) – low amounts

This will produce 12 tables (Lives and amounts)

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## Current plans for males

Separate graduations for:

- All Pensioners (excluding dependants)
- Normal-health Pensioners
- Ill-health Pensioners
- Dependants
- All Pensioners (excluding dependants) – high amounts
- All Pensioners (excluding dependants) – low amounts

This will produce 12 tables (Lives and amounts) – so 24 tables in all

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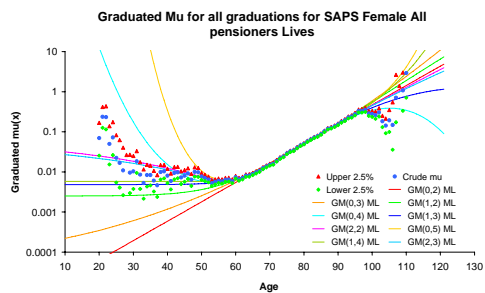
## Comments?

Is 24 sets of tables...

- too many?...
- ...if so, which would you drop and why?
- too few?...
- ...if so, which others would you like and why?

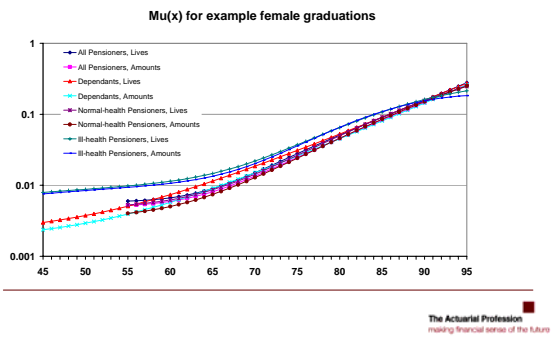
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## Example female graduations (1)



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Example female graduations (2)



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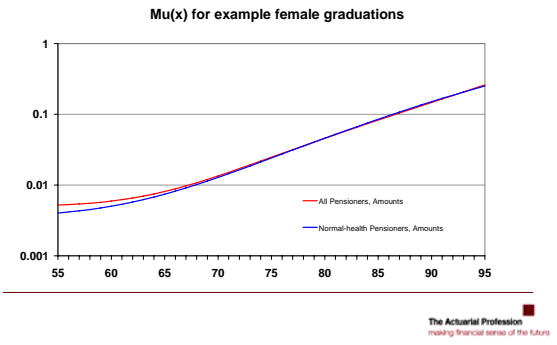
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Example female graduations (3)



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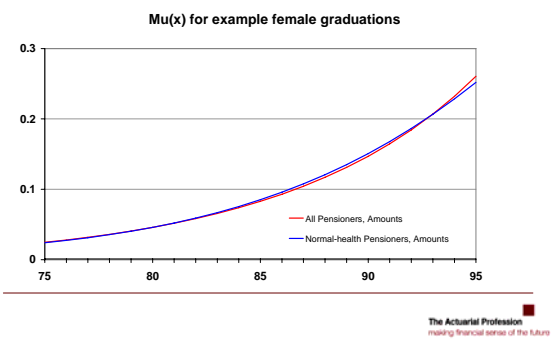
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Example female graduations (4)



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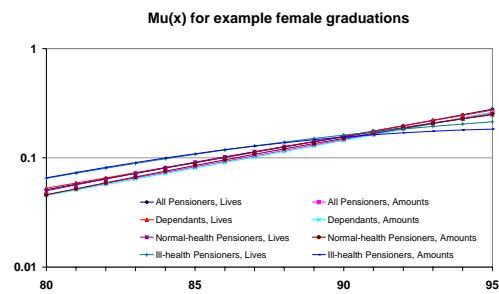
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## Example female graduations (5)



## Example female graduations (6)

Restrictions may need to be made on the shape of the curves so that inconsistencies are minimised:

- Amounts lighter mortality than Lives at all ages (?)
- N-h pensioners lighter than all pensioners combined (?)
- Ill-h pensioners heavier than all pensioners combined (?)
- Females lighter mortality than males at all ages (?)
- High amounts group must be lighter at all ages than 'all' group etc

Some curves are very similar – do we need all?

## Example female graduations (7)

After sorting out these issues it remains to consider how curves should look in areas of sparse data:

- In particular between ages 90 and 120, and
- Between ages 50 and 60 for n-h retirees, and
- From age 16 to 60 for ill-h retirees and dependants

## Example female graduations (8)

Finally:

- Are you happy for some graduations to start at age 50; or
- Should all graduations start at age 16 with smoothing into assured lives data as happened for the "00N" series tables?

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The CMI "library" of mortality projections

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## Mortality Projections – the background

- "92" Series tables included projection of future mortality
  - Single projection basis, derived from past trends
  - Quickly found to understate actual mortality improvements
  - Plus evidence had emerged of a "cohort effect"
- CMI published the "interim cohort projections" late 2002
- Mortality Projections Working Party established to explore possible projection methodologies for use with the "00" Series tables
  - April 2006 – Working Paper 20 – Penalised-spline models
  - March 2007 – Working Paper 25 – Lee-Carter models

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## Recent CMI research: P-splines

- Regression model fitted to past data
  - P-splines impose a penalty on differences in adjacent co-efficients
  - Choice of penalties determines balance between smoothness and closeness of fit
- Model fitted to a surface, either:
  - age and calendar year (Age-Period) or
  - age and year of birth (Age-Cohort)
- Fitting process provides:
  - Fitted  $\log(\mu) \Rightarrow$  mean values
  - Standard deviations  $\Rightarrow$  determine confidence intervals

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## Recent CMI research: Lee-Carter

- Structured time-series model
$$\log \mu(x, t) = a(x) + b(x)k(t) + e(x, t)$$
- No allowance for parameter uncertainty...
  - ...so CMI have introduced through bootstrapping
- Basic model does not capture cohort effects
  - Poor fit when back-testing from 1992
  - Renshaw & Haberman Lee-Carter APC model
$$\log \mu(x, t, c) = a(x) + b_1(x)k(t) + b_2(x)I(c) + e(x, t, c)$$
  - Introduces extra parameter to model cohort effects

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## Mortality Projections – making the CMI's work more accessible

- CMI recognised its research not accessible to many actuaries
- Task Force formed to:
  - Illustrate the CMI's recent research to make it more accessible
  - Propose terminology to facilitate disclosure of mortality projections
  - Develop sets of projections which can be used as benchmarks
- Membership of Task Force included life and pensions actuaries

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## Mortality Projections – the “library”

- Task Force constructed a “library” of projections
  - “Library” comprises of a “spreadsheet” with numerous projections and a supporting document
  - Projections can be combined with any base table
- Library published in draft with the supporting document as CMI Working Paper 27
- Consultation document including specific questions for feedback

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## Mortality Projections – the “library”

Initial “library” of projections includes:

- Existing projections:
  - “92” Series
  - Cohort Projections
  - ONS population projections
- Variations on existing projections in current use:
  - Imposing a minimum improvement on a Cohort Projection
  - Using a percentage of a Cohort Projection
- Examples of P-spline and Lee-Carter projections

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## The “library”: Illustrating the choice of projection

Not seeking to standardise how projections are illustrated ...

...but some commonality of language and illustrations may be helpful

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## Future Updates

- Updates for:
  - New data
  - Intuitive scenarios
  - New methodologies
- Draft criteria are that new projections must be:
  - A worthwhile addition to the current library
  - Publicly available
  - Clearly described and documented
  - Independently Peer Reviewed.

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## Mortality Projections – the “library”

- What will the “library” achieve?
  - Single source of “recognised” projections
  - Standardisation of terminology for these
- What will the “library” not achieve?
  - No guidance on choice of projection

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## Recap of questions posed:

### SAPS Graduations

- Are the 24 sets of graduated tables:
  - The right number?
  - The right tables?
- Treatment of inconsistencies
  - What restrictions should be placed on the curves?
- Treatment of sparse data
  - How to treat ages below 60 and over 95
- All tables from age 16 or some to start at age 50?

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