The Actuarial Profession
making financial sense of the future

Current Issues in Pensions
DEVELOPMENTS IN LONGEVITY

Bristol	24 February 2006
London	7 March 2006
Edinburgh	14 March 2006
London	3 April 2006

Developments in Longevity

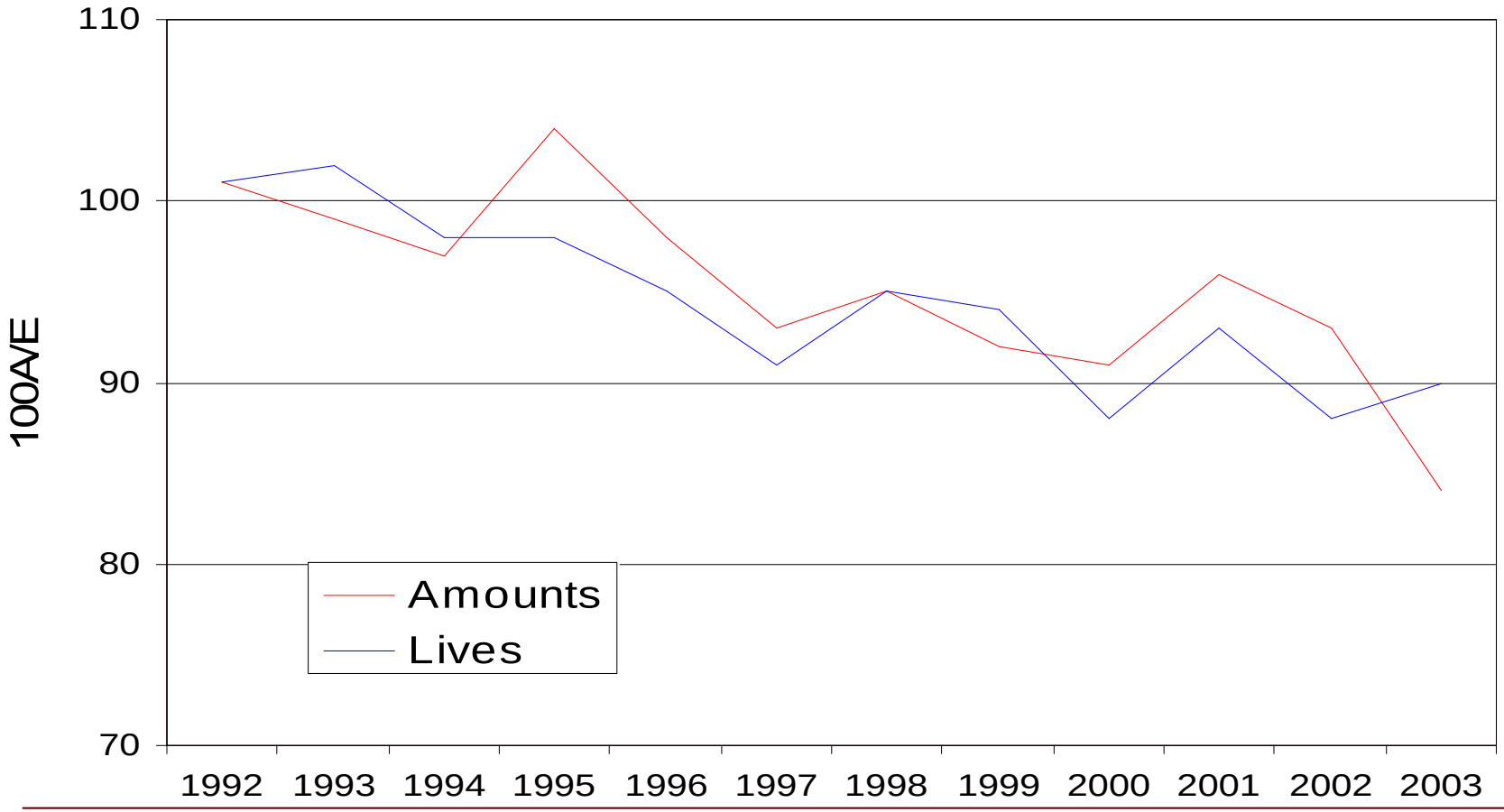
Agenda

- Recent CMI mortality experience
- New mortality tables
- Self-Administered Pension Schemes (SAPS) investigation
- Mortality Improvements
- CMI Mortality Projections work
- Where Next?

.

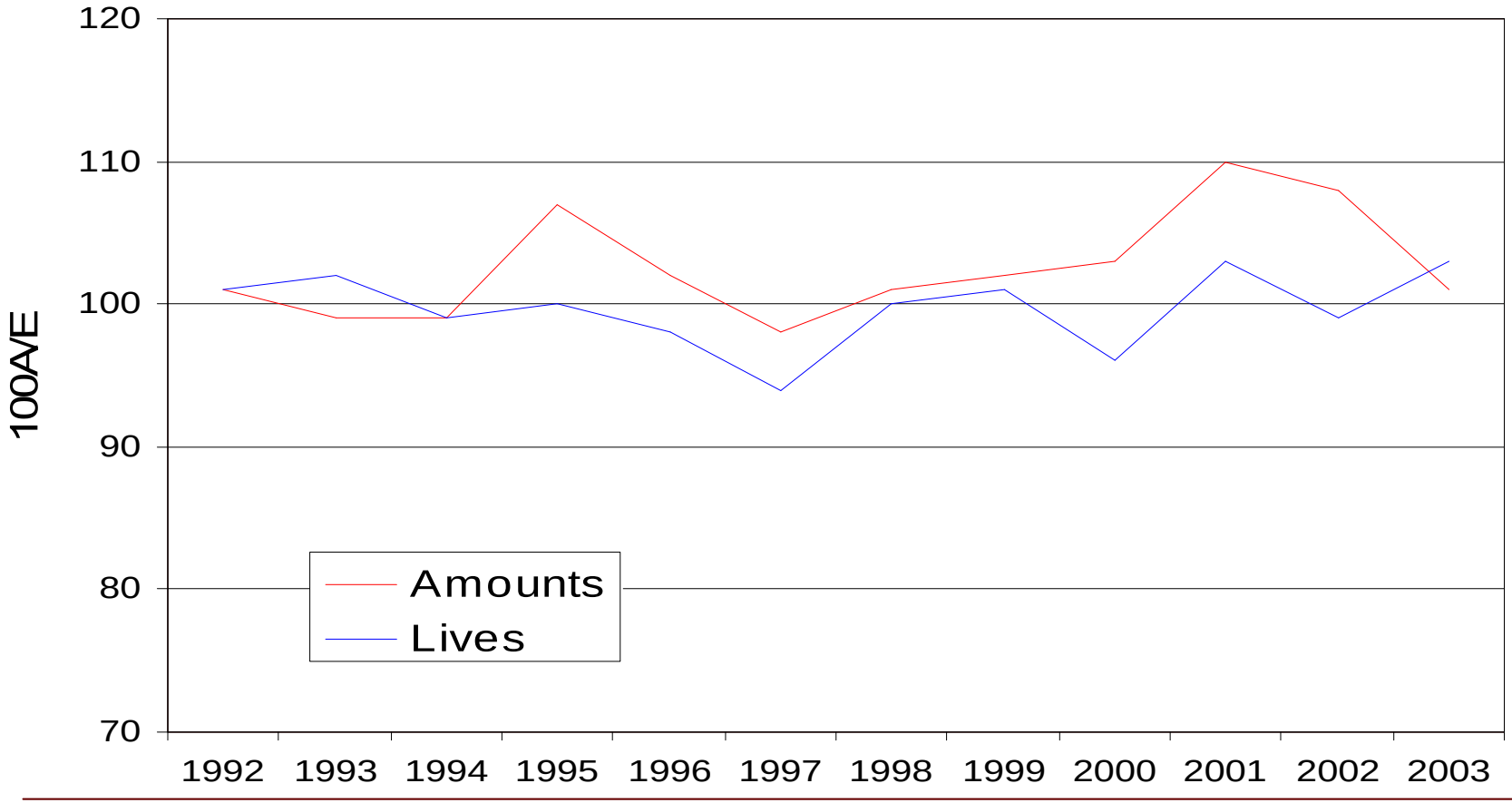
Recent CMI mortality experience

Life Office Pensioners 100A/E, E= “92” Series projected mortality rates, Males



Recent CMI mortality experience

Life Office Pensioners 100A/E, E="92" Series medium cohort projection, Males



Developments in Longevity

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- Recent CMI mortality experience
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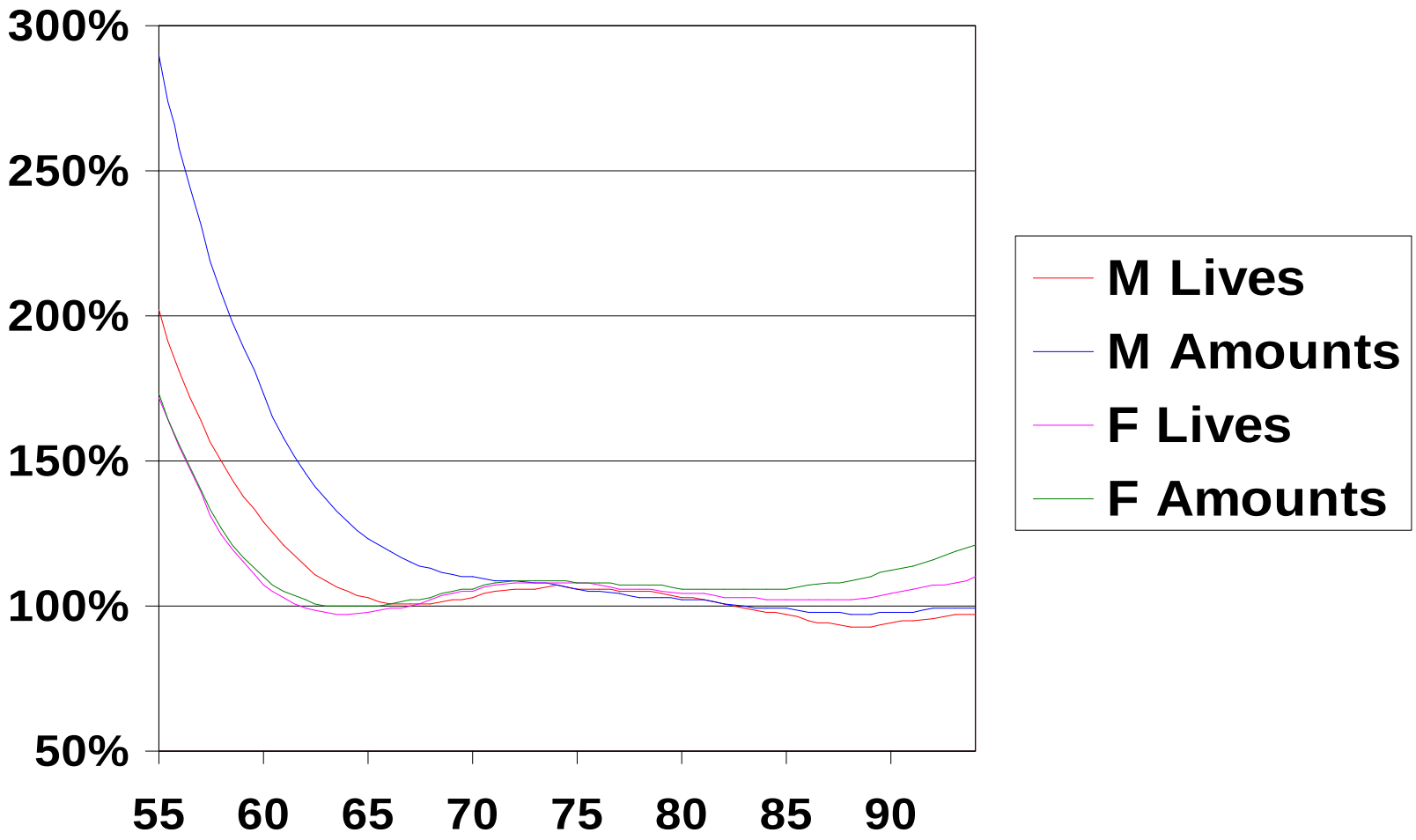
New “00” Series base tables

- AM00 & AF00, 2 year select) Combined, Smoker
- TM00 & TF00, 5 year select) & non-smoker
- PMA, PML, PFA, PFL
  - Normal, Early, Combined
- PPM,PPF (new, lives only)
  - Vested, Deferred, Combined
- IML, IFL (No amounts this time, funny data)
- WA, WL
- RM, RF (lives only, as before)
  - Vested, Deferred (new), Combined (new)

New “00” Series base tables

- Proposed Tables
  - WP12 – Assured lives – April 2005
  - WP16 – Pensioners & annuitants – Sept 2005
- Minor revisions after consultation
- Final tables due out shortly
- Will then seek approval from FIMC

Comparison - 00 series q_x ÷ 92 series C2000 sc q_x



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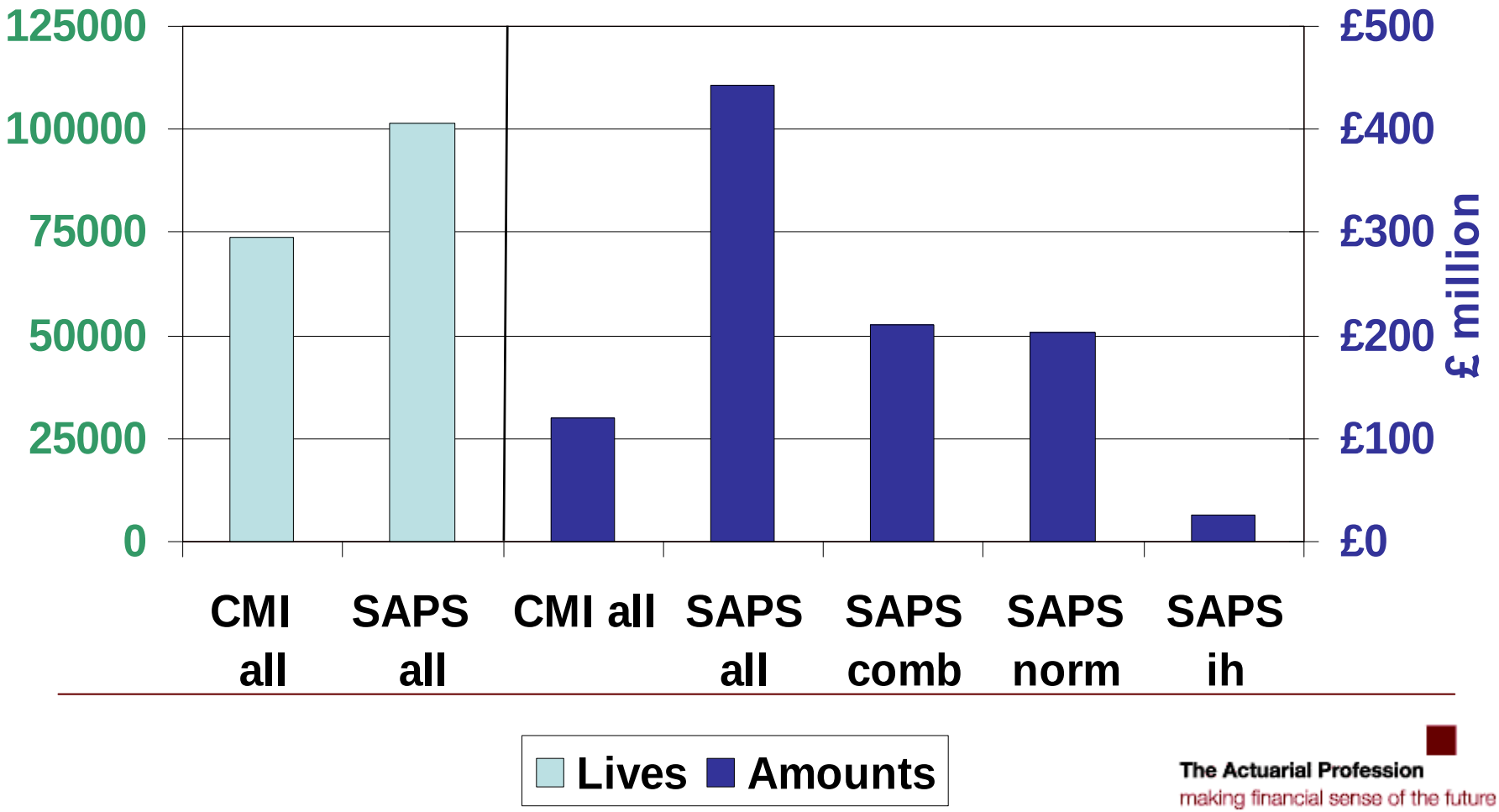
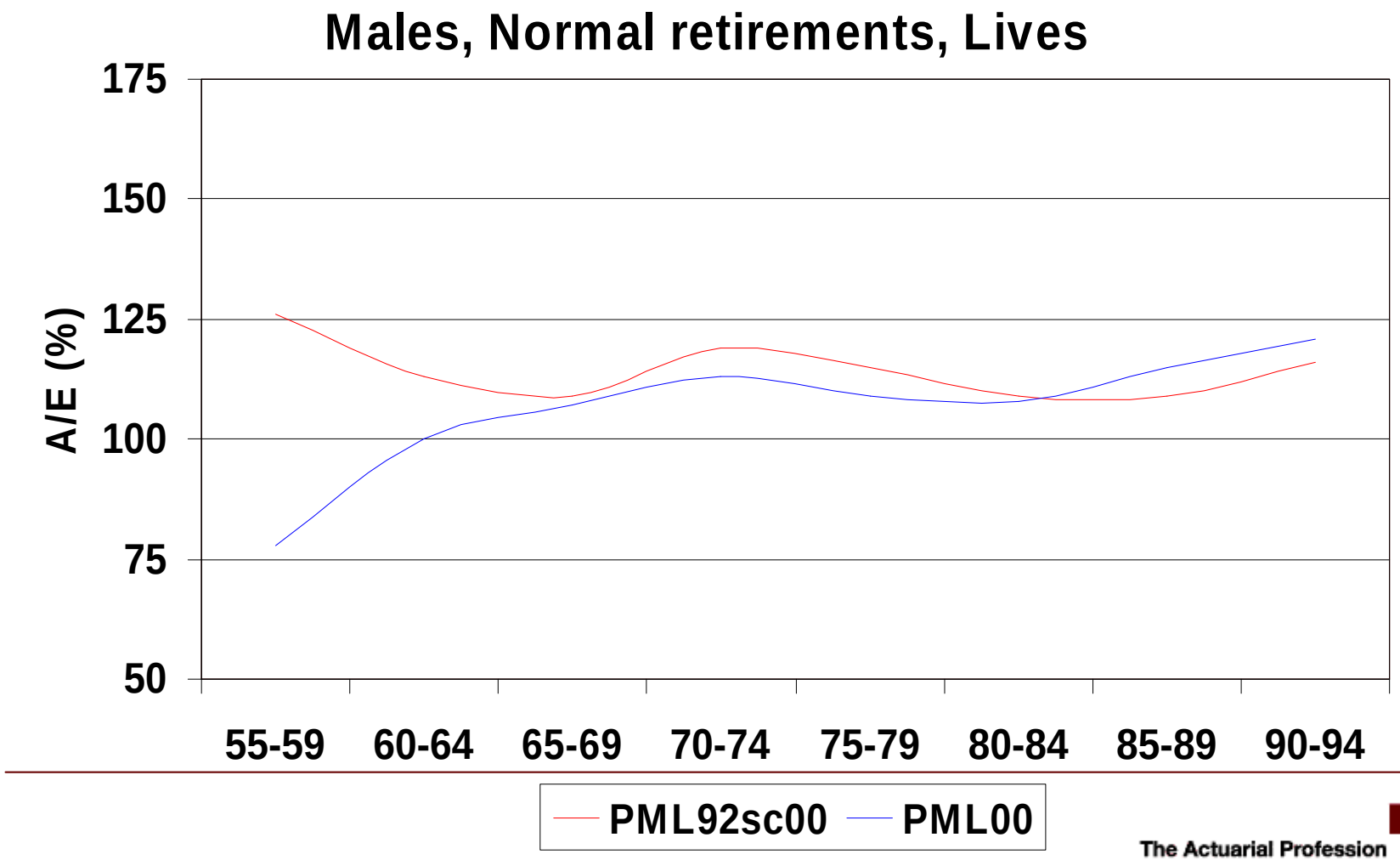
SAPS investigation

- Reports to Technical Support and Research Committee of the Pensions Board
- Based on data submitted by consultants (11 so far)
- 255 schemes with 2.67m records
- Current focus 2000 – 2003
- 13 industry types, significant amounts of data for 7
- 3 Working Papers published to date: WP4, WP9 and WP17 (all available on CMI pages of www.actuaries.org.uk)

Data – males – by deaths



SAPS v Life Office Pensioner Tables



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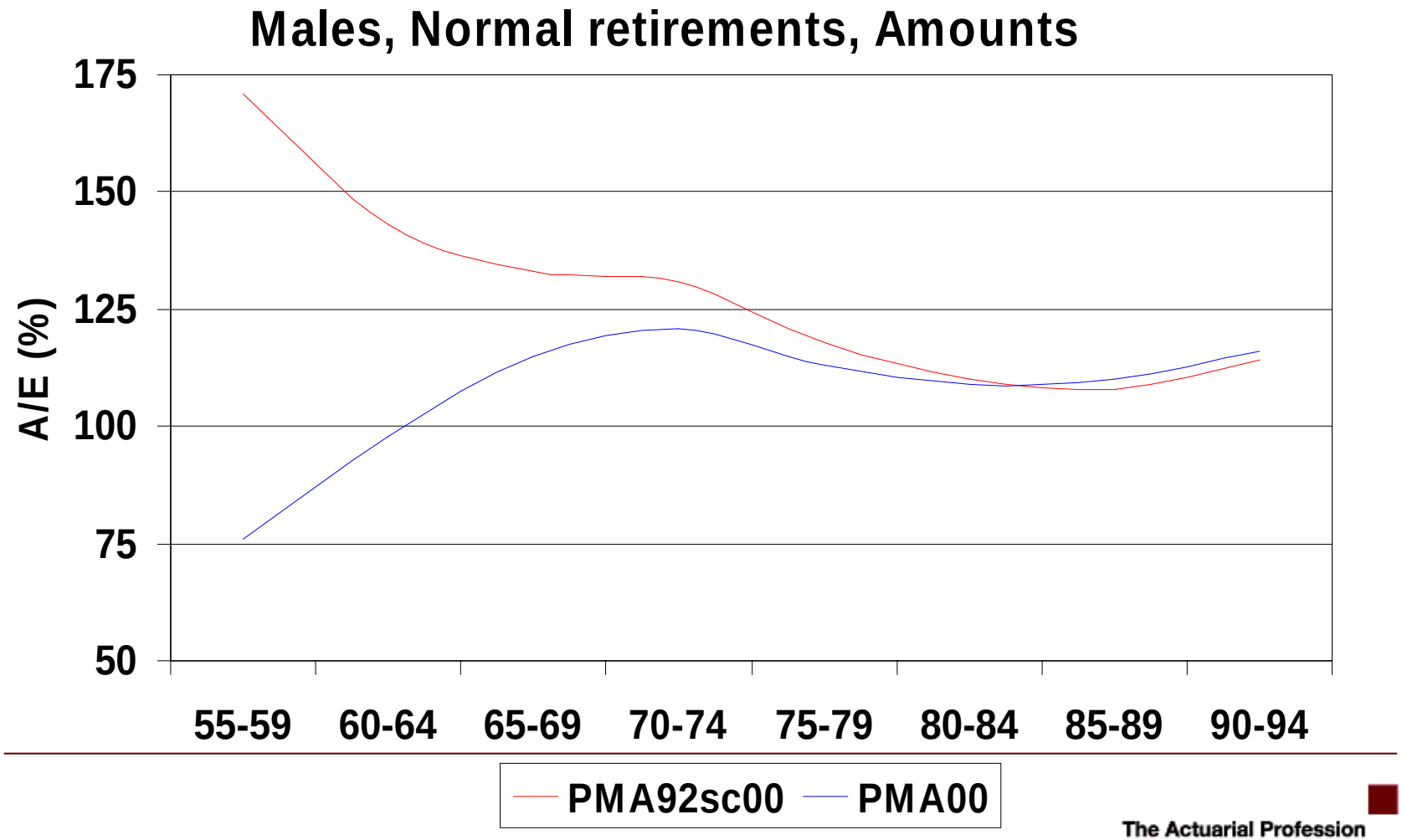

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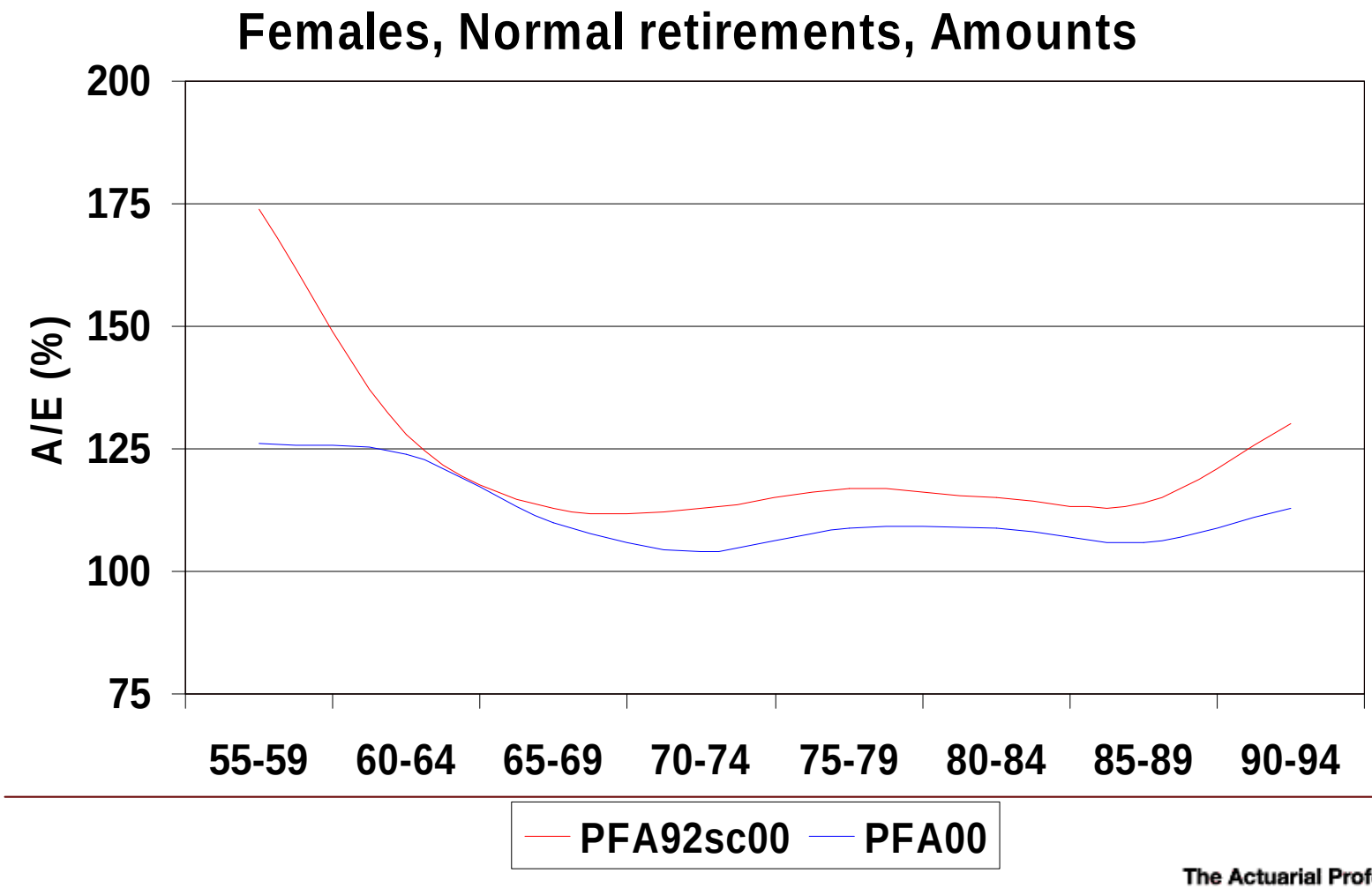
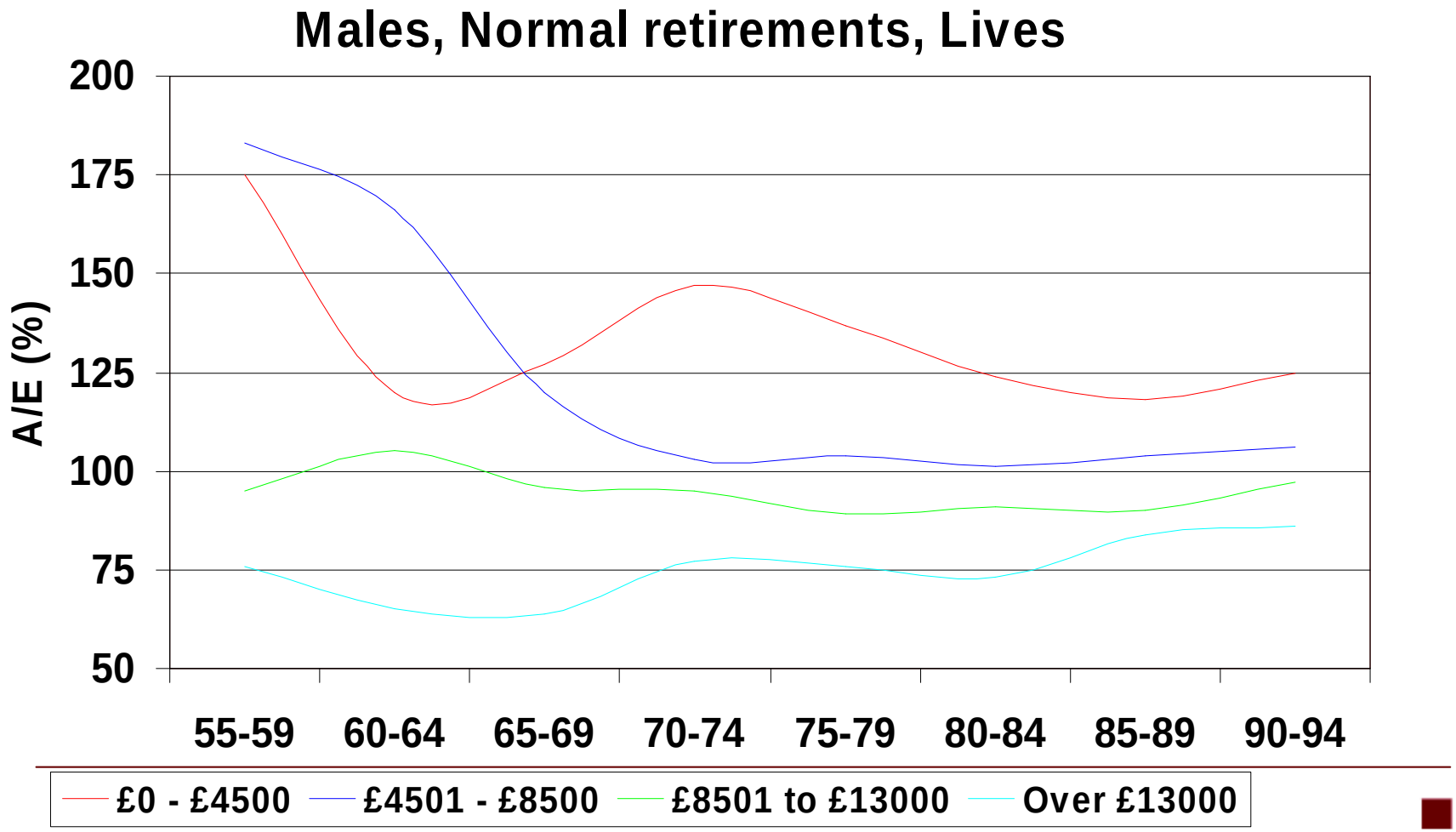
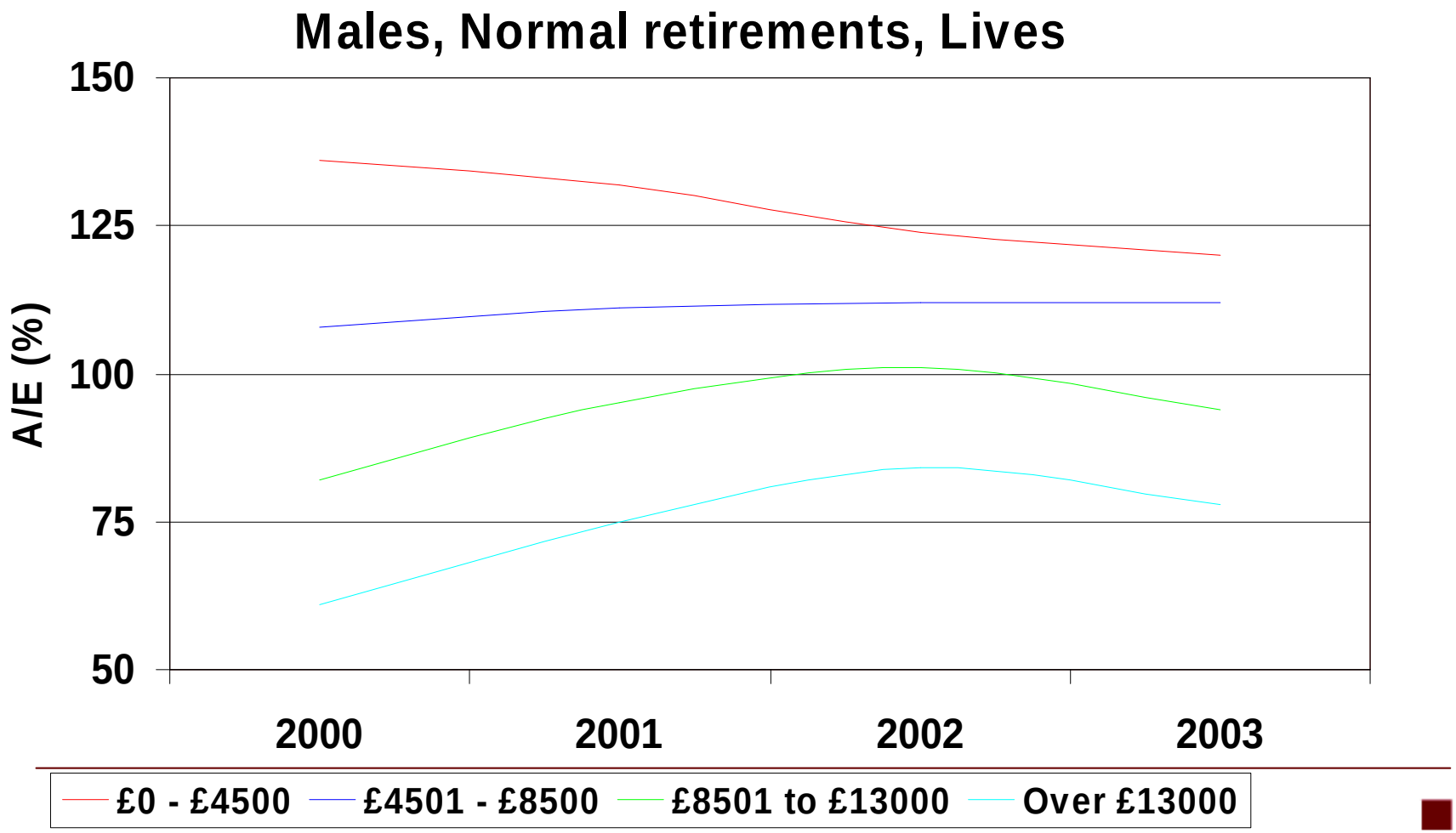


Amounts effect - Bands v 92 series sc (y=CY)



Amounts effect - Bands v 92 series sc (y=CY)



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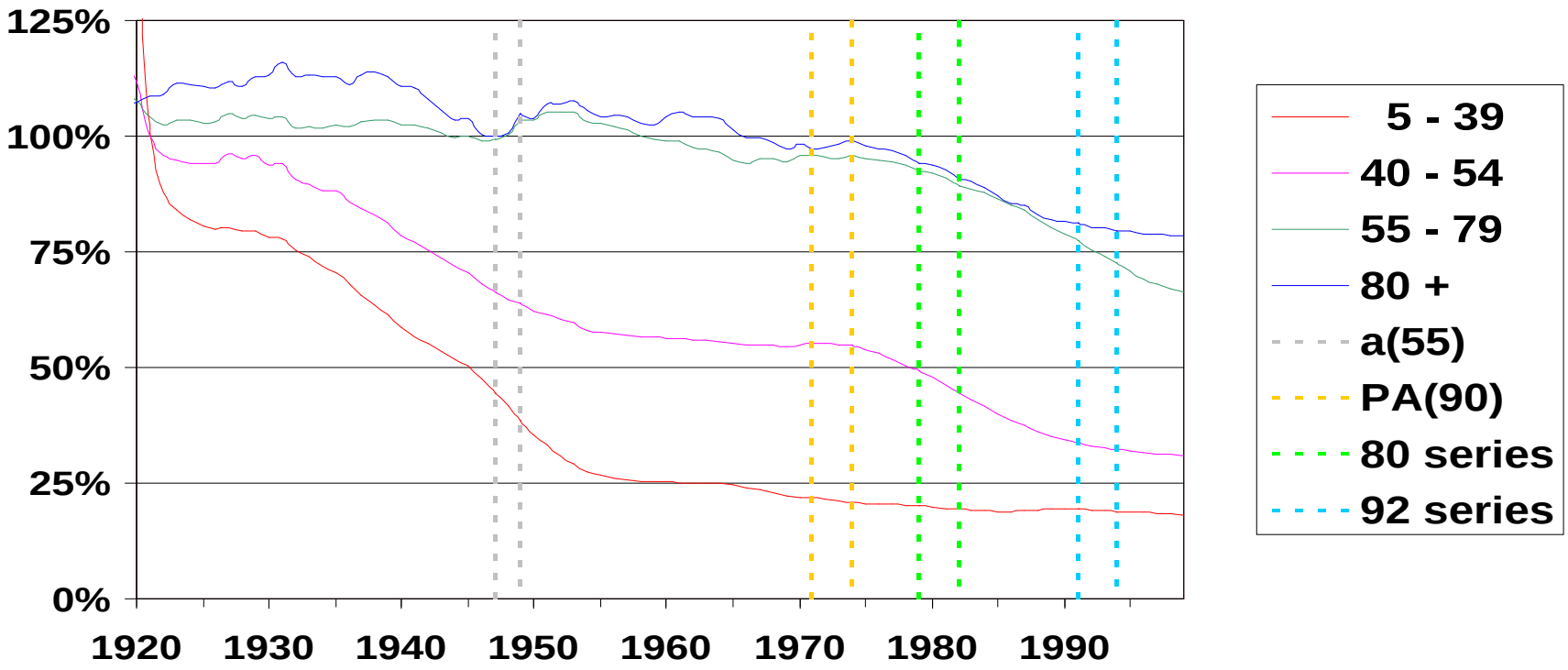
Improvements in male mortality 1920 - 1999



5-year moving averages

Improvements at younger ages

- Conquest of infectious diseases
  - TB, typhoid, measles, scarlet fever, diphtheria

% of deaths from infectious diseases (E&W)				
Ages	1901 – 1910		2001	
	Male	Female	Male	Female
1 – 14	43%	47%	6%	6%
15 – 44	46%	49%	2%	3%
45 – 64	16%	11%	<1%	<1%
65 +	4%	5%	<1%	<1%

Source – "Longevity in the 21st Century" Willets *et al* (2004)

Improvements at older ages

- Significant improvements in treatment of killer diseases
  - cancer, heart and respiratory diseases
- Smoking cessation – ongoing effects
  - Reduction in heart disease almost back to “never-smoker” status after 10 years
  - Effects on lung cancer rates take 20+ years to work off (if at all)

Source – “The Cohort Effect: Insights and Explanations” Willets (2004)

Will mortality continue to improve?

Professor Jay Olshanksy
University of Illinois, Chicago

Olshanksy argues that mortality will not continue to improve at its current rate. The main reasons he gives are obesity, the spread of disease and, most importantly, the existence of biomechanical limits on our lifespan.

Professor Shripad Tuljapurkar
Stanford University, California

Study assumes that lifespans increase in line with current trends until 2010, but that anti-ageing technologies would then become available that would prolong life much further. These drugs and therapies would cause mortality to decline five times faster than historical rates between 2010 and 2030, before normal service was resumed.

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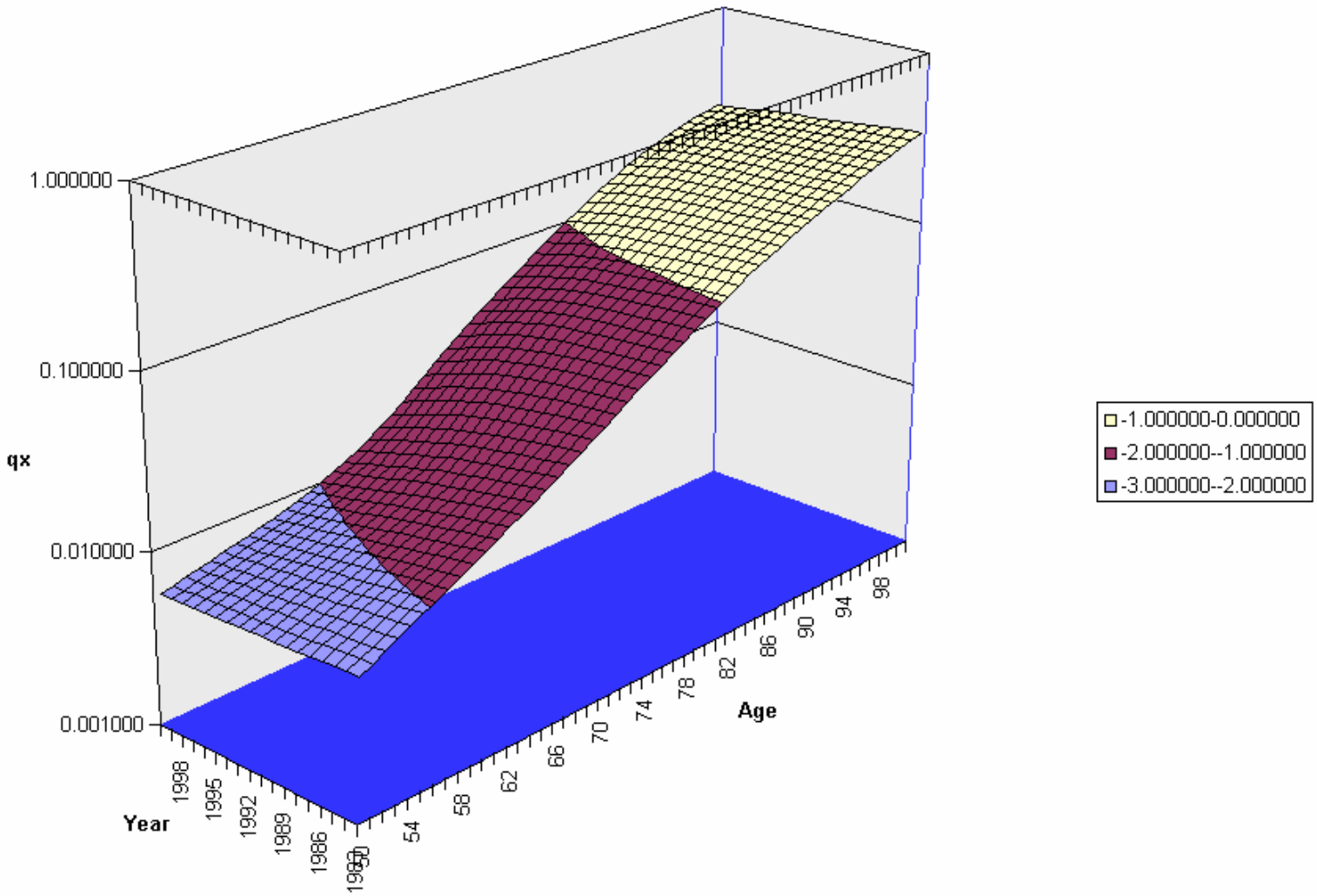
The two way table for q_x

Age	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
60														
61														
62														
63														
64														
65	●								●					
66	●									●				
67	●										●			
68	●											●		
69	●												●	
70	●													●
71	●													
72	●													
73	●													
74	●													
75	●													
76	●													
77	●													

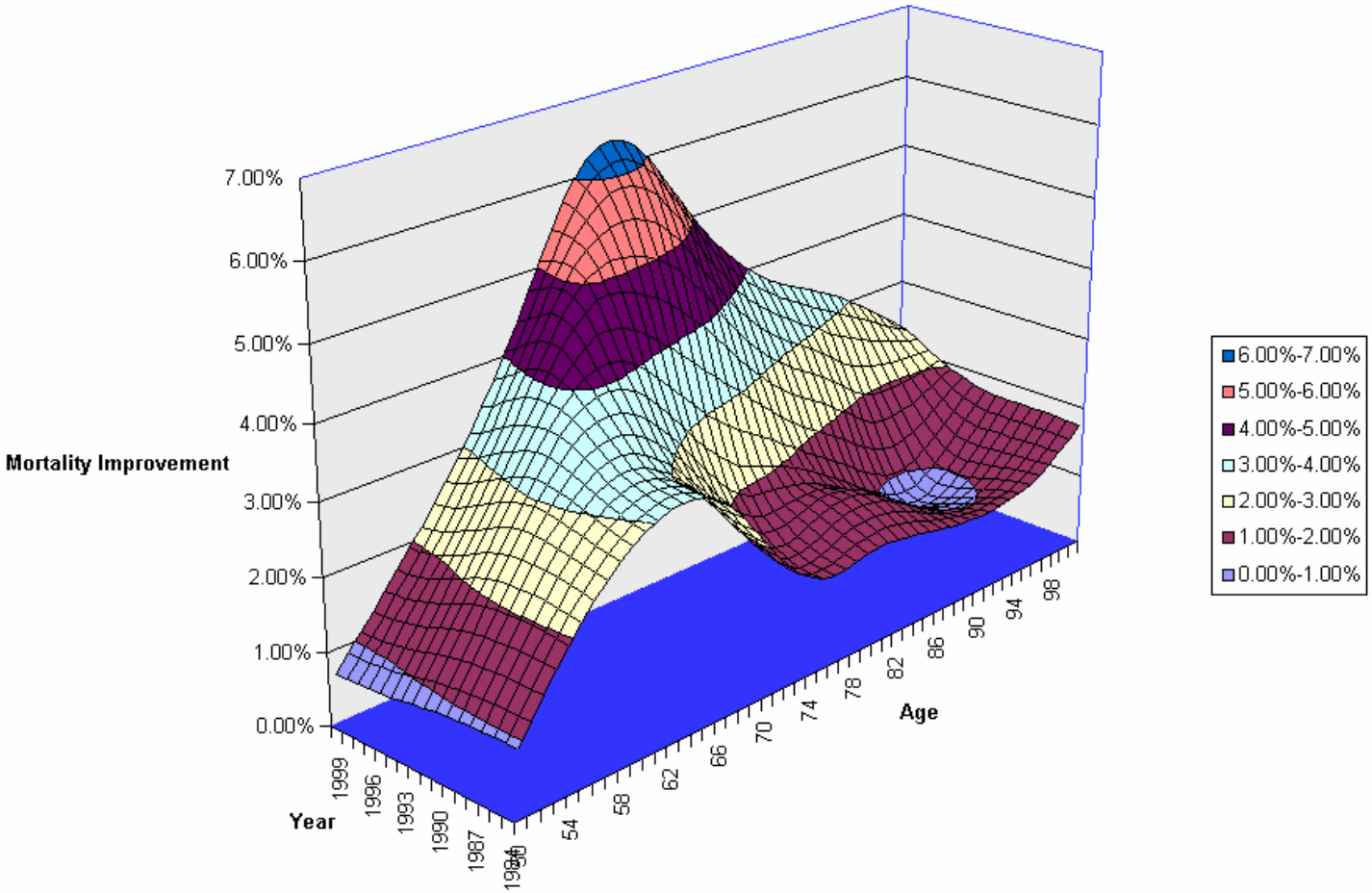
The datasets

- Crude *q(x)* by age and calendar year
- For lives with protection and savings products
  - 1947 to 2003
- For UK population
  - 1960 to 2003
- For ages 20 to 100
- Other datasets much smaller
- Used p-splines to remove noise
- Then tried to see patterns


1.000000
0.100000
0.010000
0.001000
qx
Year
1998
1995
1992
1989
1986
Age
54
58
62
66
70
74
78
82
86
90
94
98
-1.000000-0.000000
-2.000000--1.000000
-3.000000--2.000000

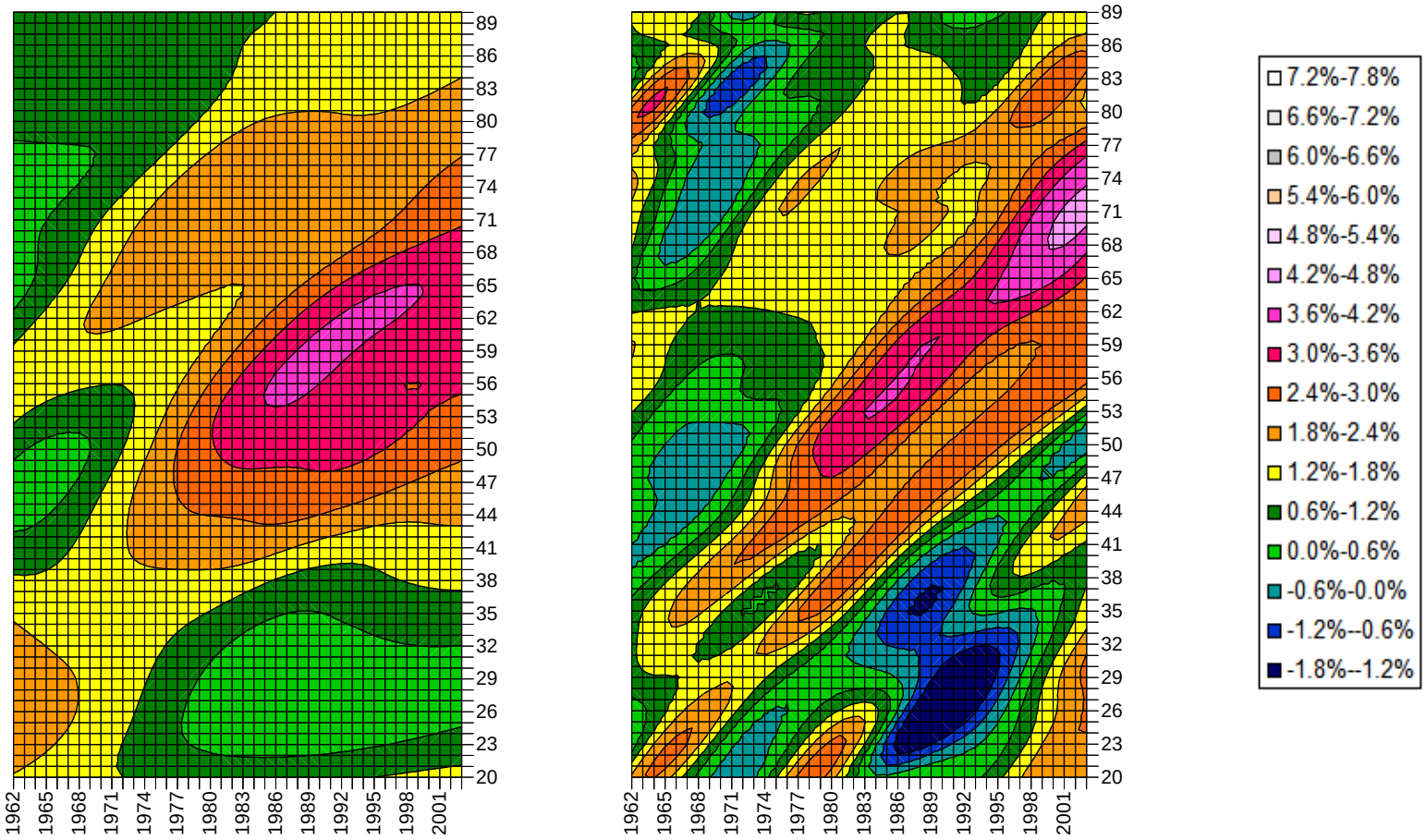
… so looked at improvement rates

$$1 - \frac{q_{x,t}}{q_{x,t-1}}$$


Mortality Improvement
7.00%
6.00%
5.00%
4.00%
3.00%
2.00%
1.00%
0.00%
Year
1999
1996
1993
1990
1987
54
58
62
66
70
74
78
82
86
90
94
98
Age
6.00%-7.00%
5.00%-6.00%
4.00%-5.00%
3.00%-4.00%
2.00%-3.00%
1.00%-2.00%
0.00%-1.00%

Assured Lives - males

UK population - males



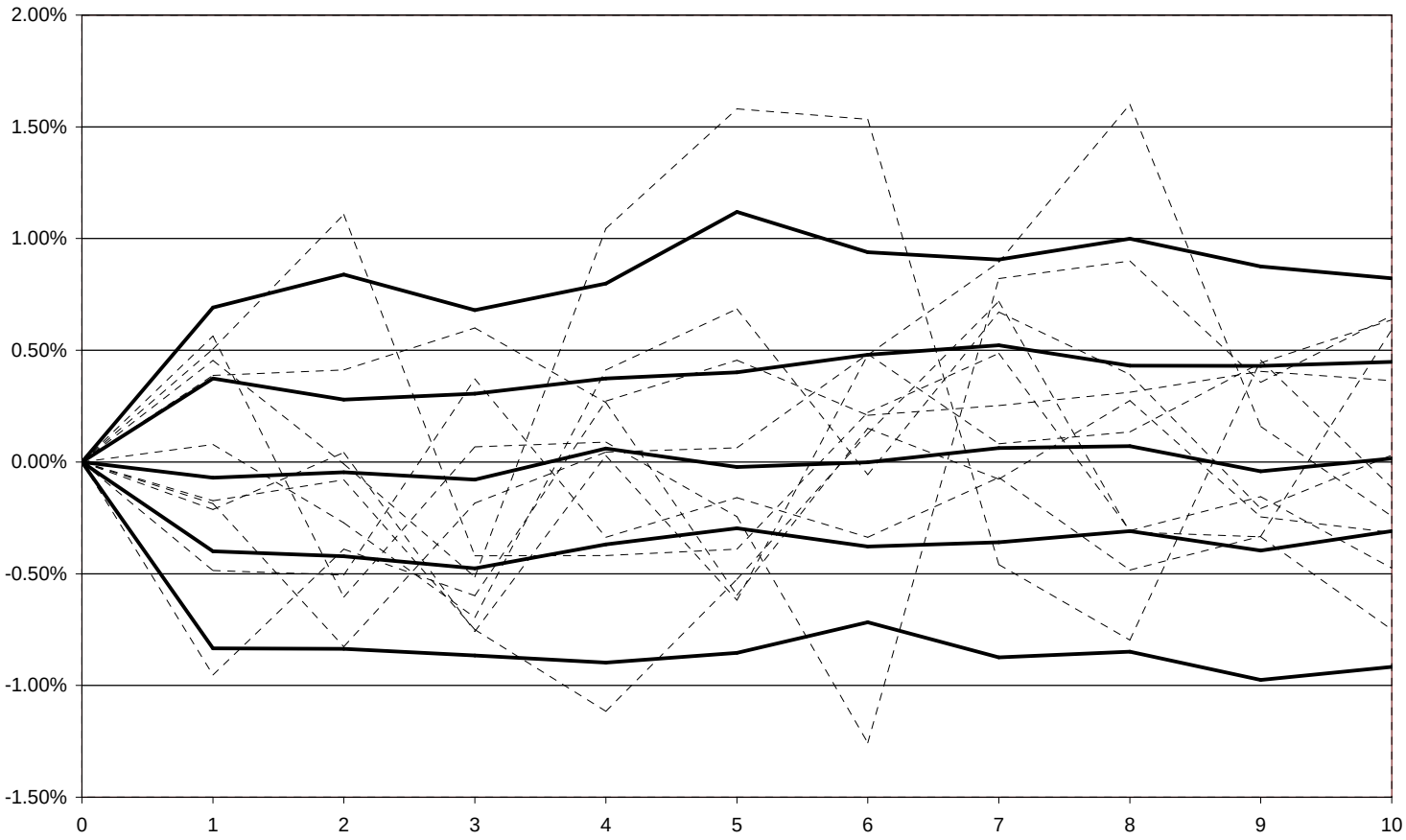
Overview on recent CMI work on projections

- Working Paper 1 – November 2002
  - An interim basis for adjusting the “92” Series mortality projections for cohort effects
  - Offered a range of projections
- Working Paper 3 – March 2004
  - Initial exposure of various projection methodologies
  - Consultation document to guide future work
- Working Paper 11 – January 2005
  - Summary of responses to WP3
  - “green light” to continue work
- Working Paper 15 – July 2005
  - Proposed 2 methods: P-spline and Lee-Carter
- Sept. 2005, Software and Data, CILA presentation
- Working Paper 20 – expected March 2006
  - Guidance on P-spline (Lee-Carter to follow)

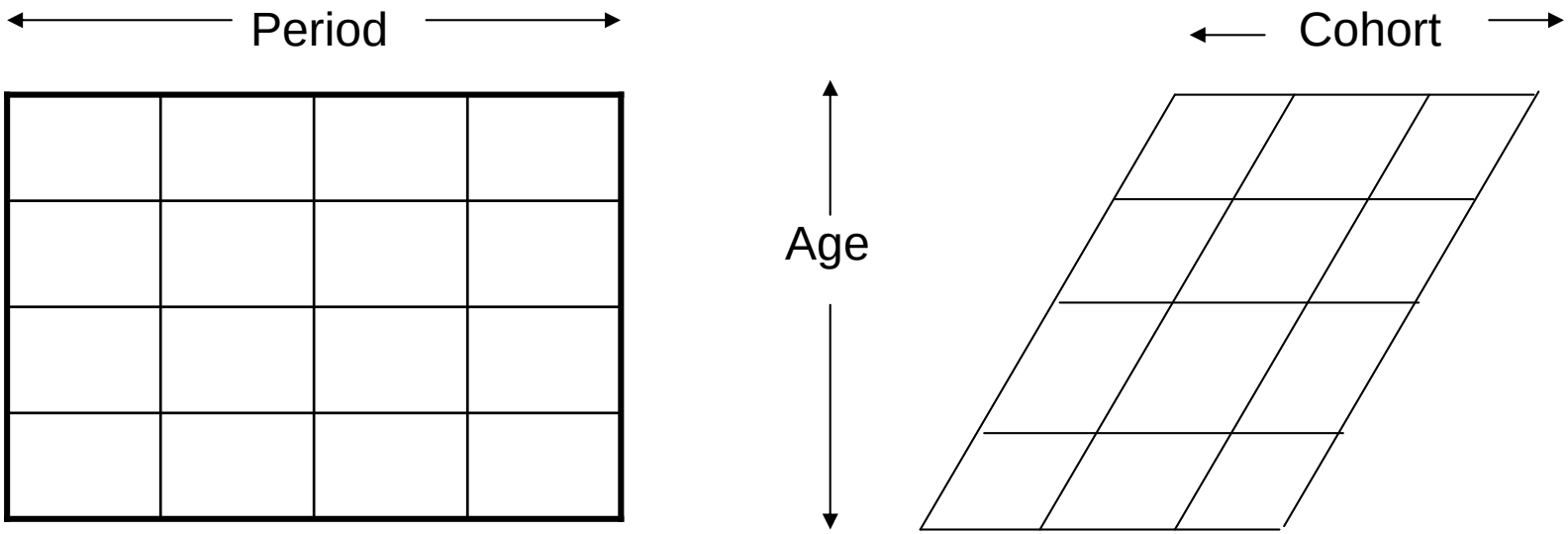
Using P-Splines to project mortality

- Percentiles v sample paths
- Age-cohort v Age-period
- Males v Females
- Assured lives v ONS
- Different age ranges – *not illustrated*
- Back-fitting

Percentiles *v* sample paths

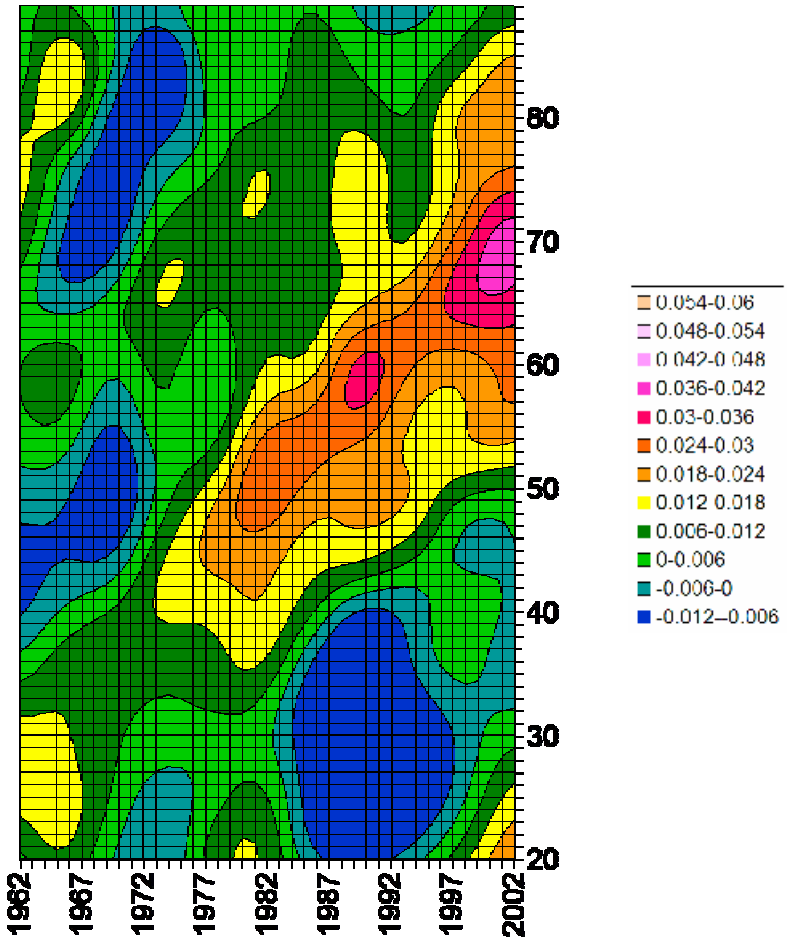


Knots & penalties

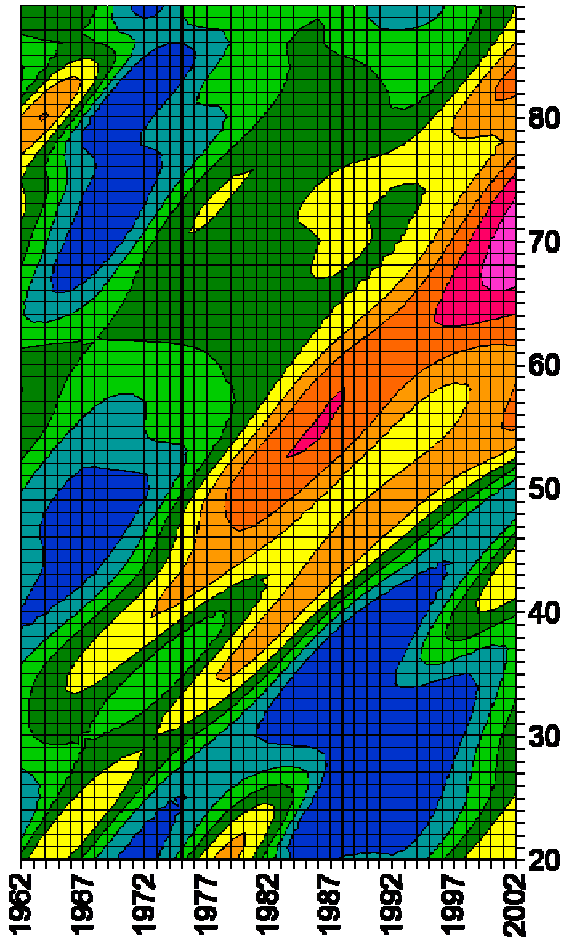


ONS data - UK Males

Period Penalty

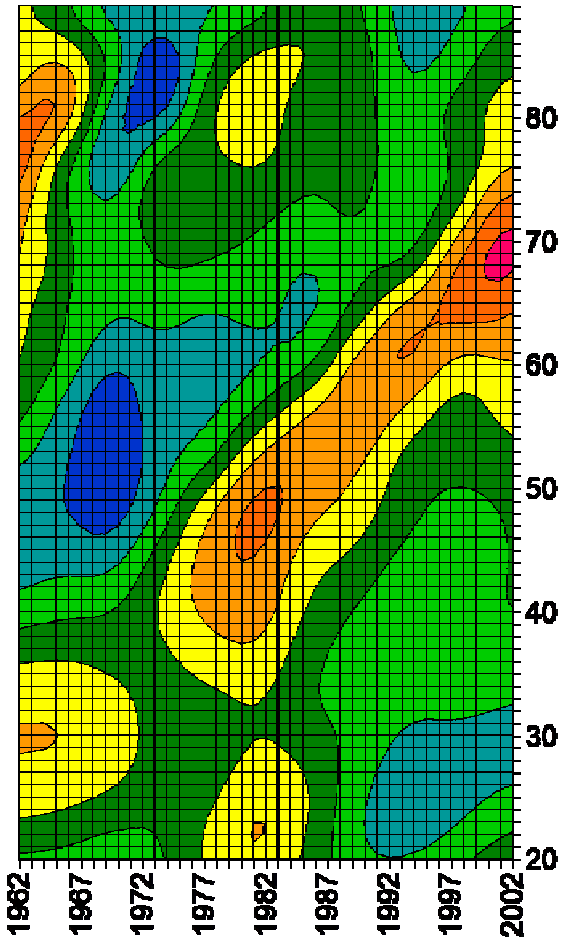


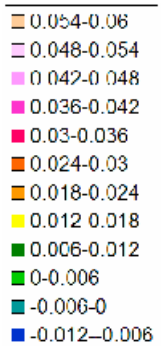
Cohort Penalty



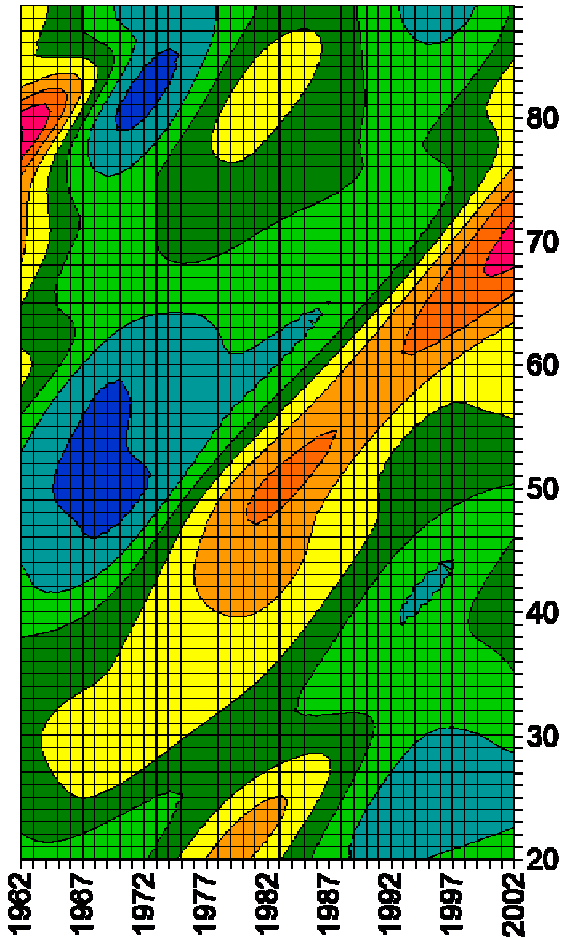
ONS data - UK Females

Period Penalty



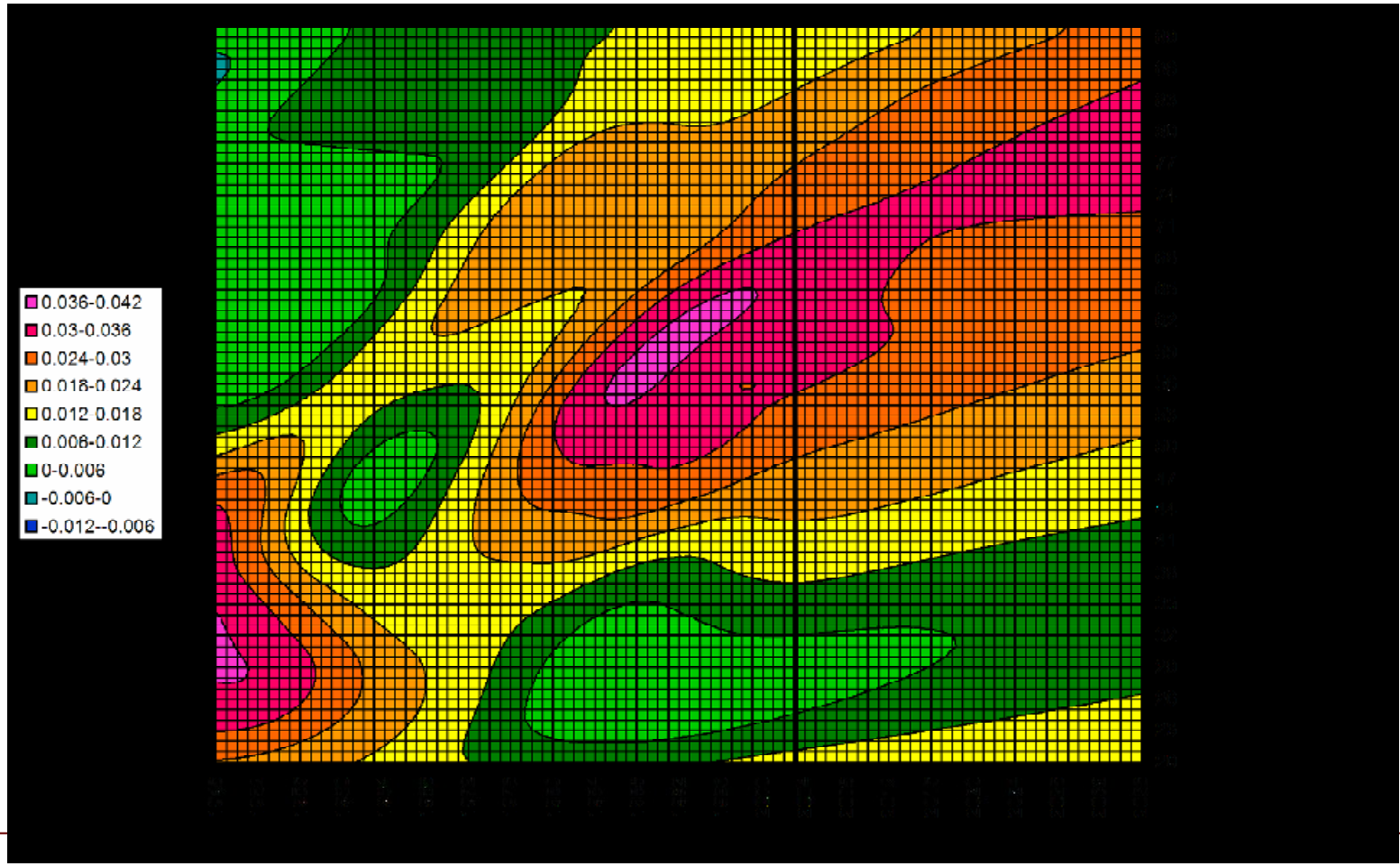


Cohort Penalty

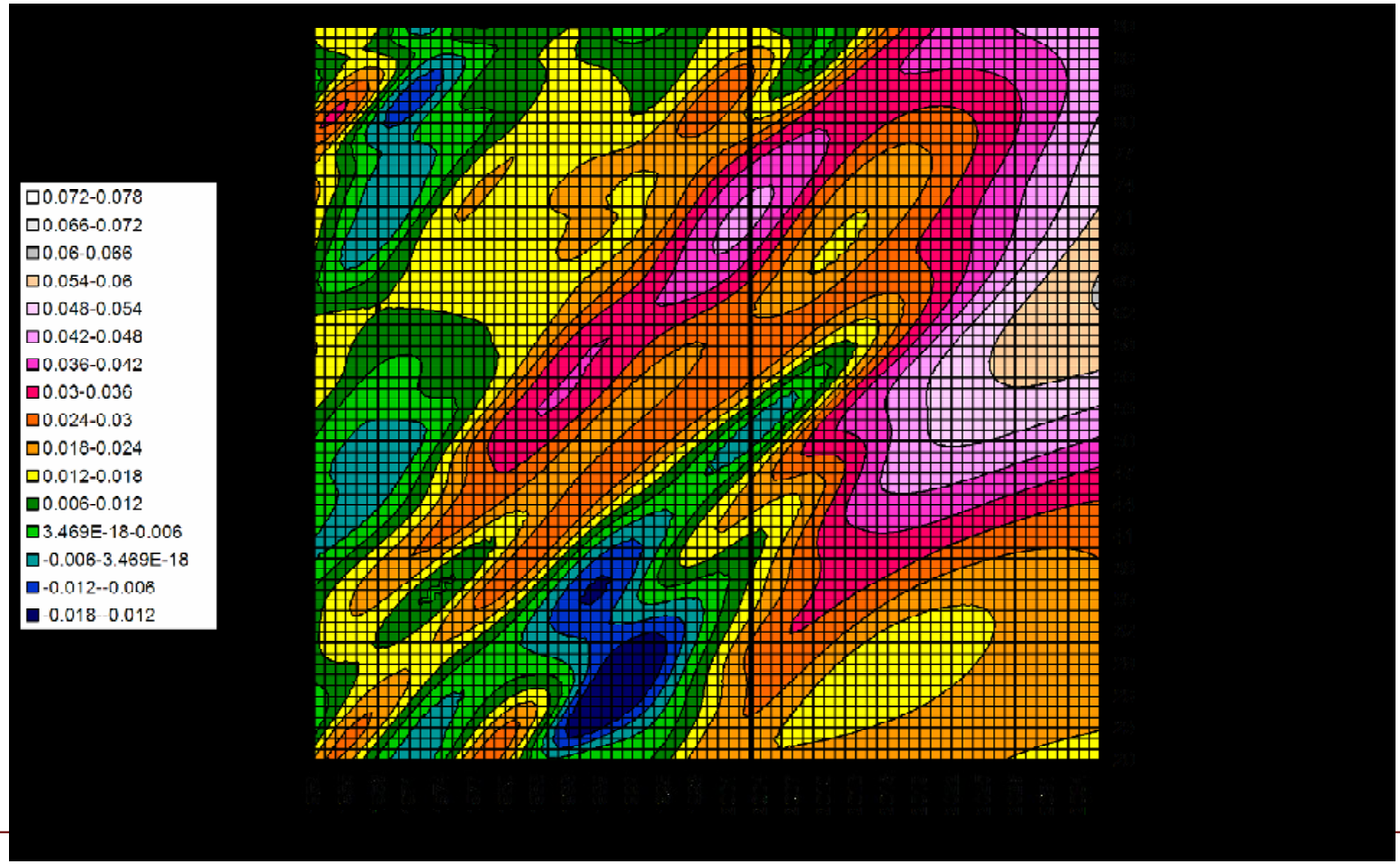


Assured lives *v* ONS

P-spline 50% : Age-Cohort penalty : Assured Lives : Age range 20-90 : Projection from 2003

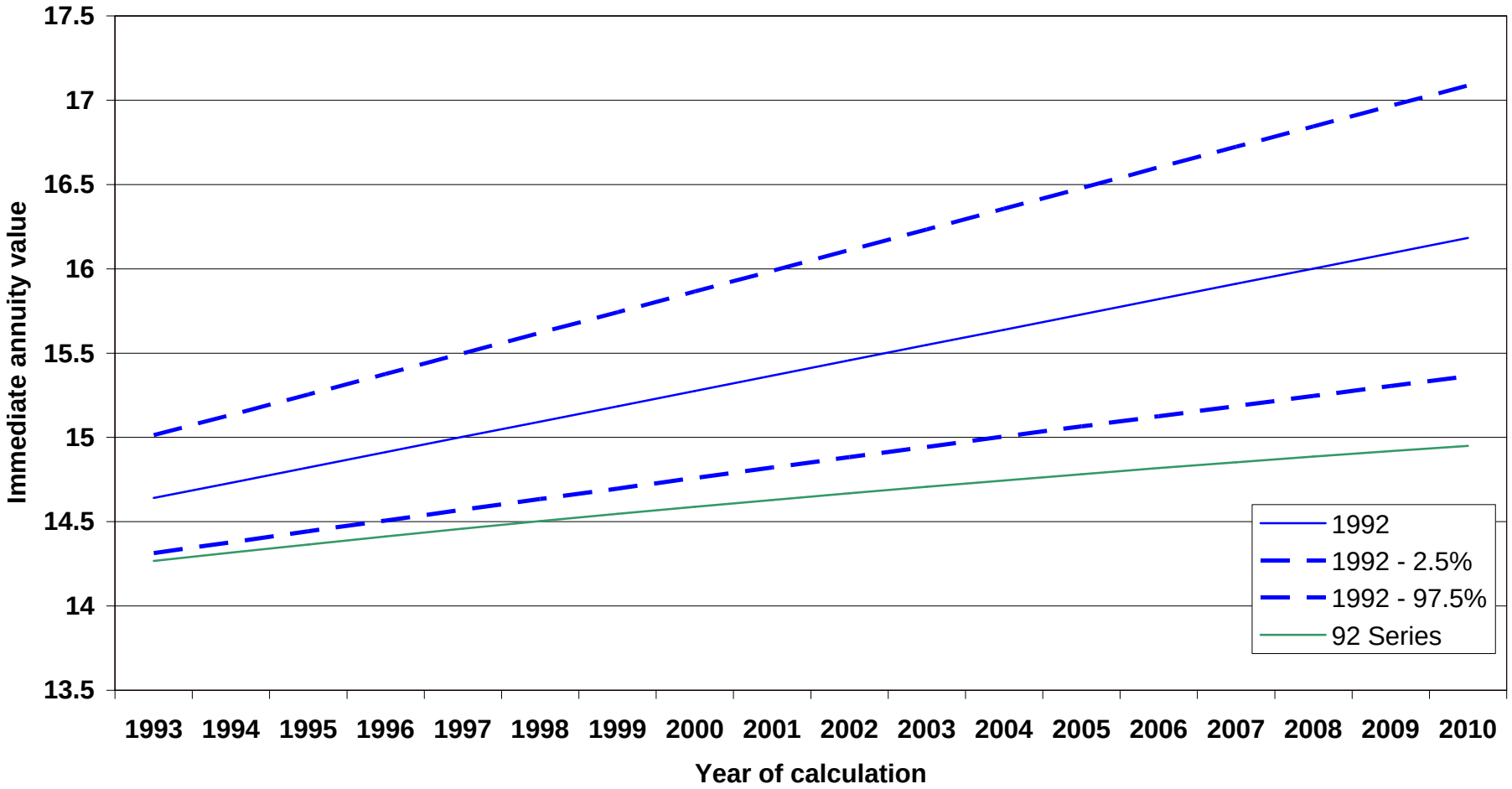


P-spline 50% : Age-Cohort penalty : ONS data Males : Age range 20-89 : Projection from 2003



Annuity values – 1993 and on

Projected annuity values for males aged 60 starting from 1993
P-Spline, age-cohort, assured lives fitted from 1947, ages 20-90, PMA92, 4.5%



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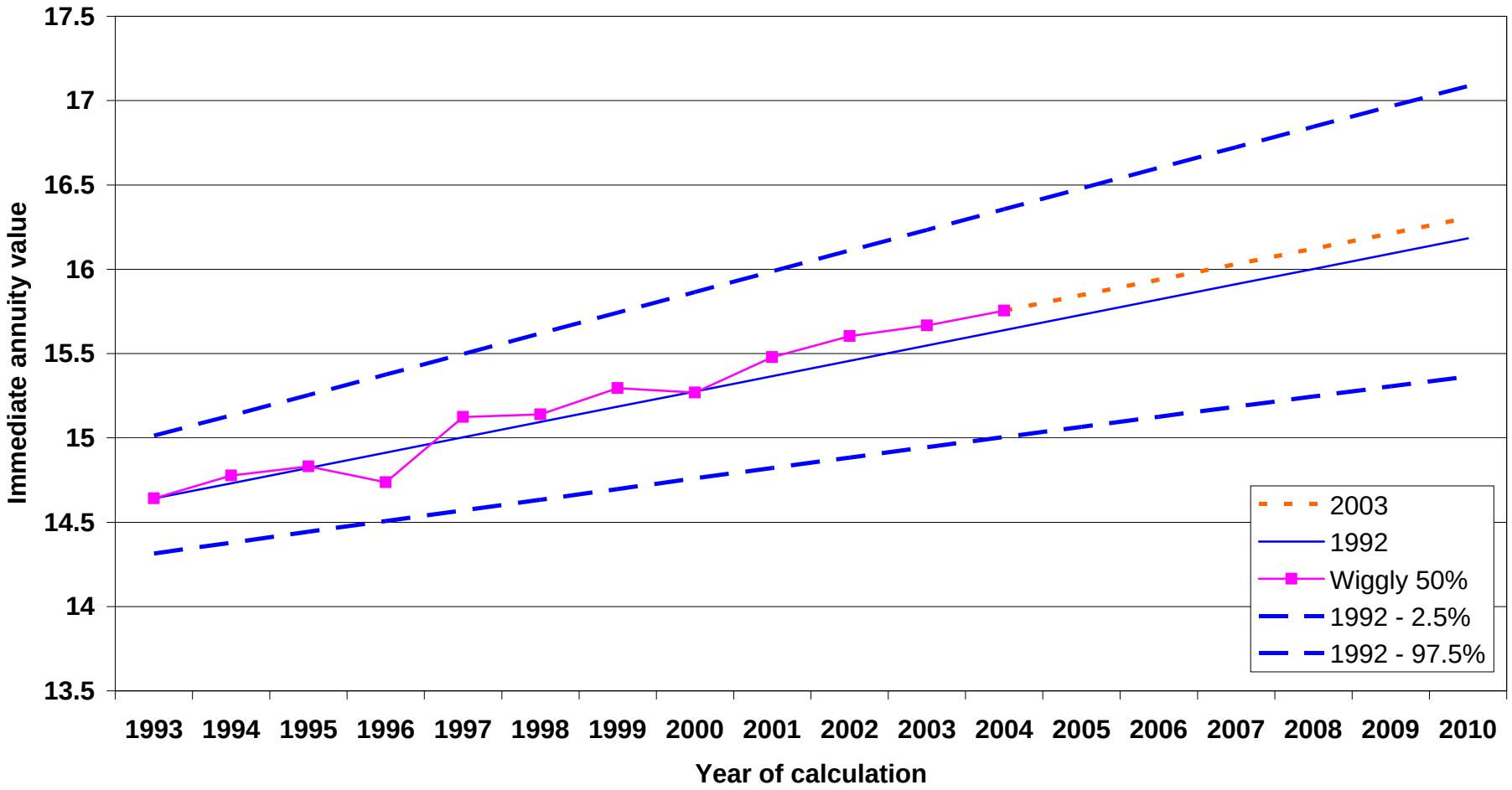

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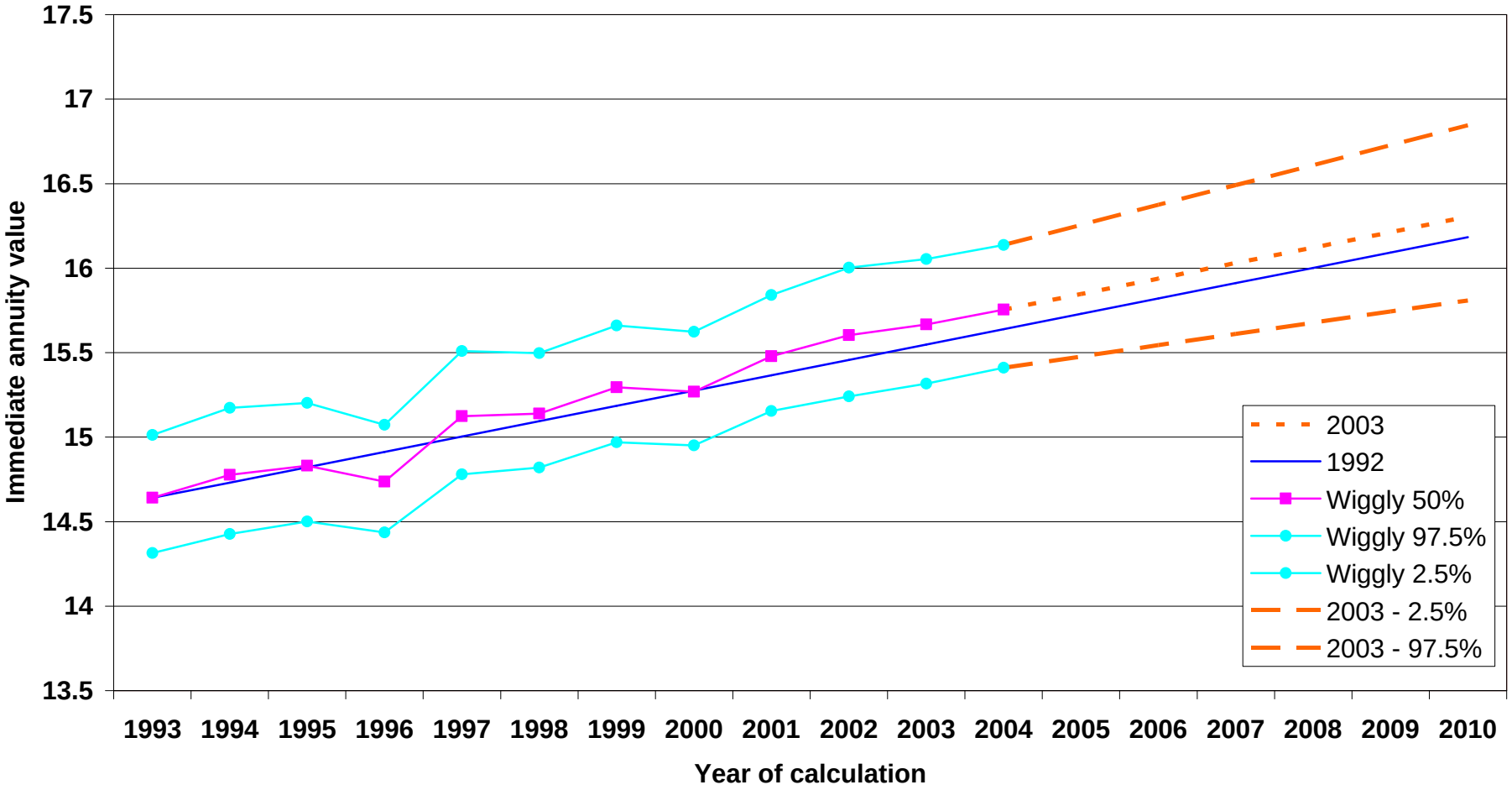

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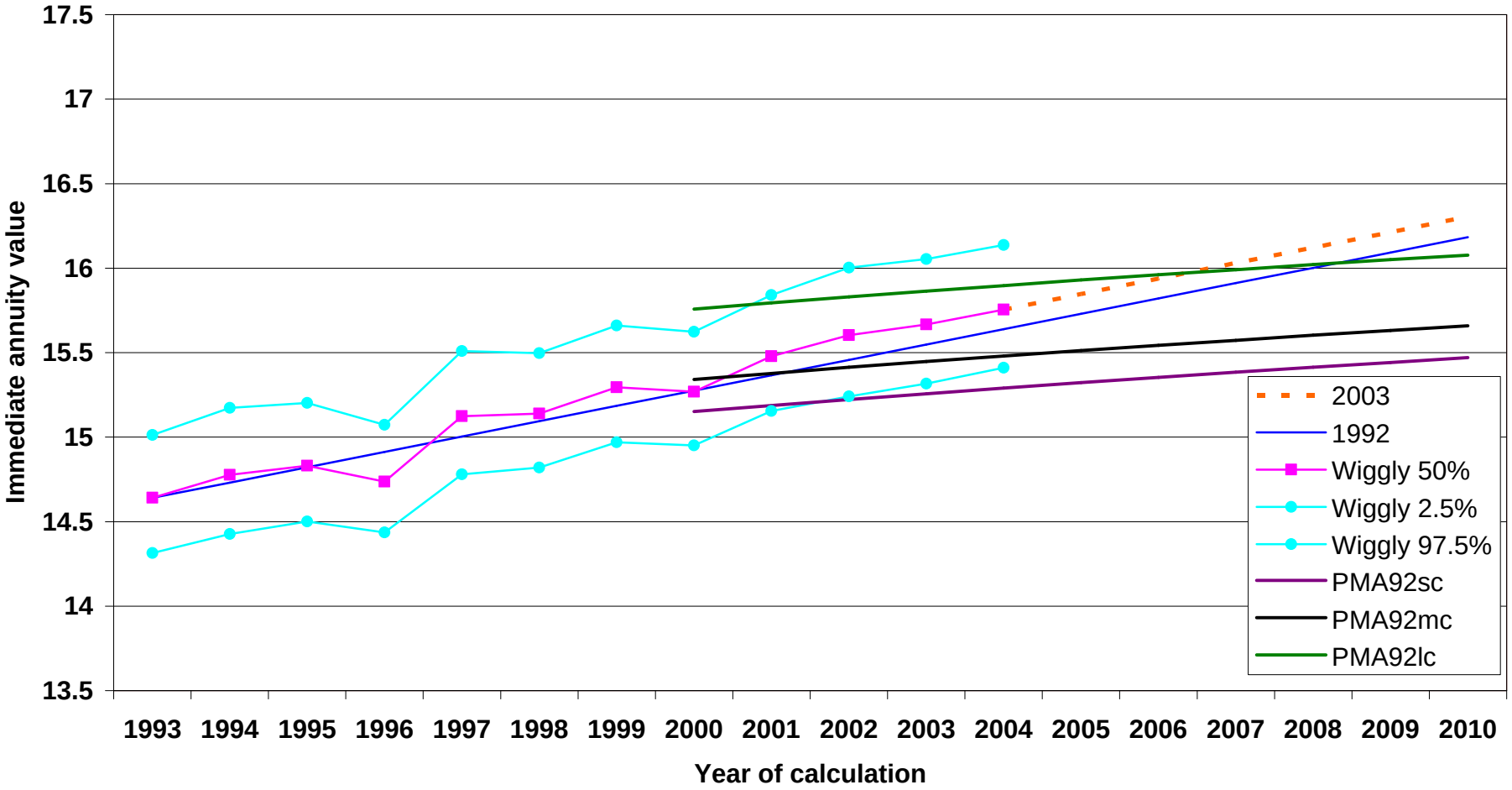
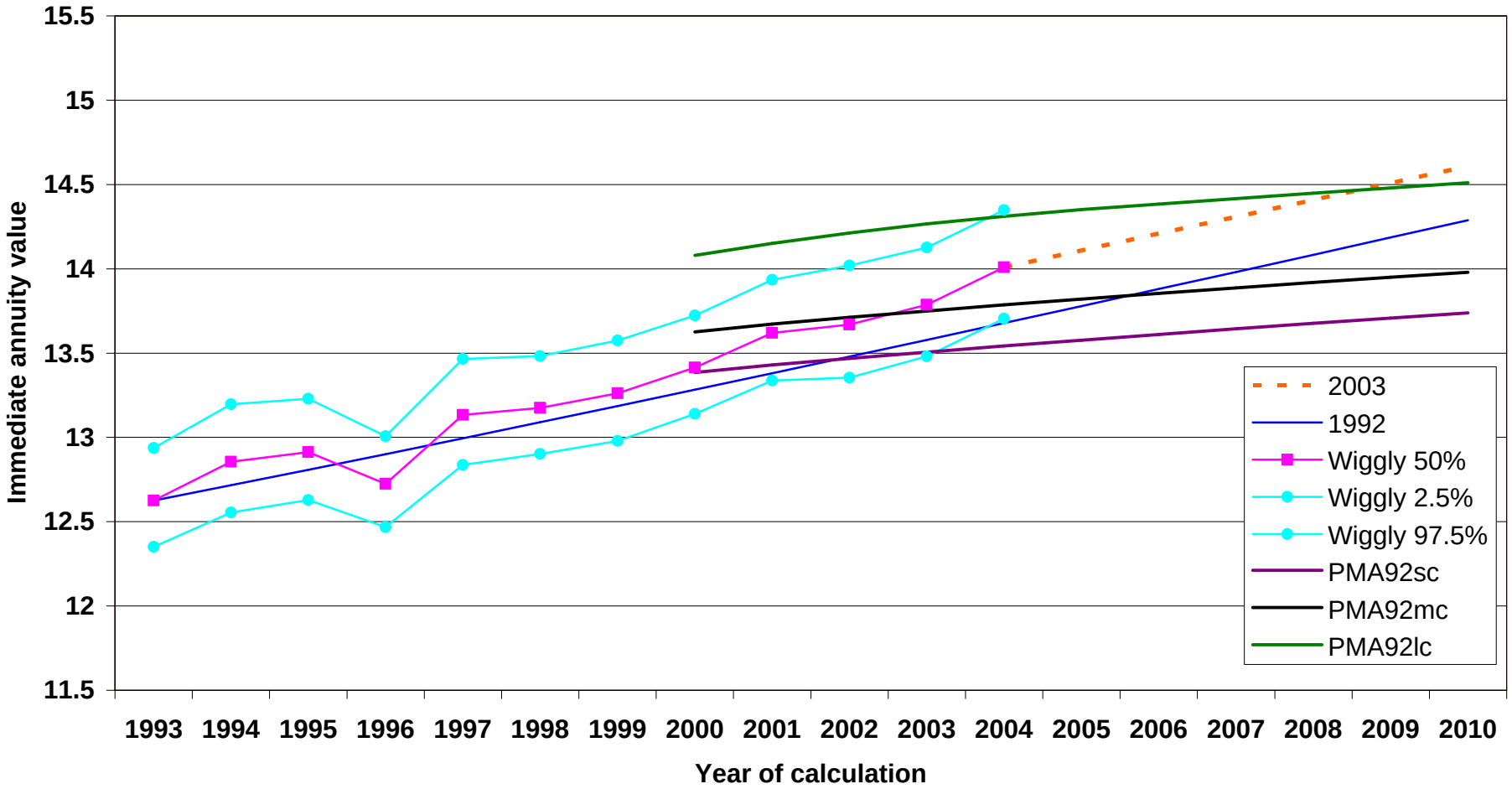
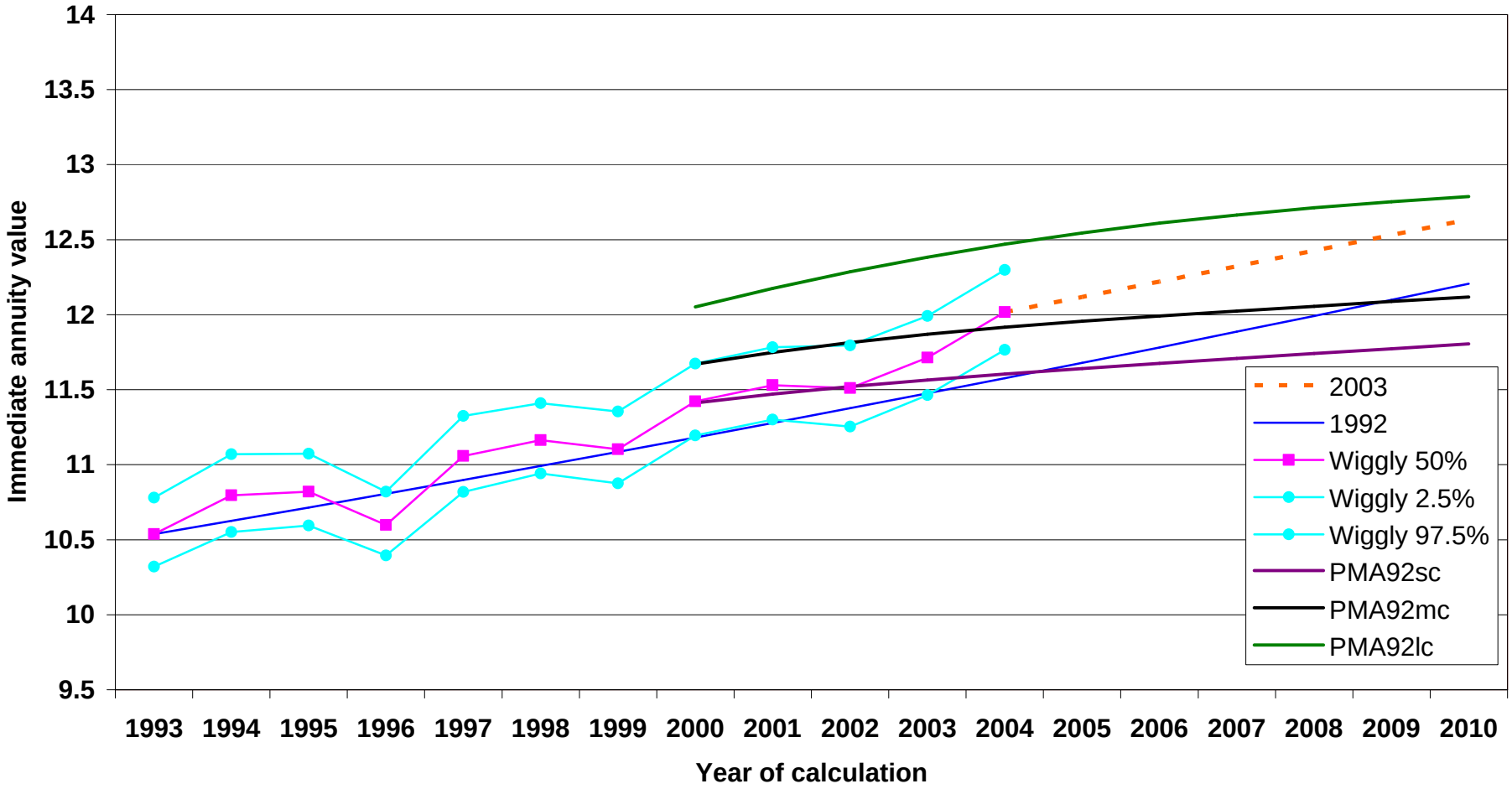


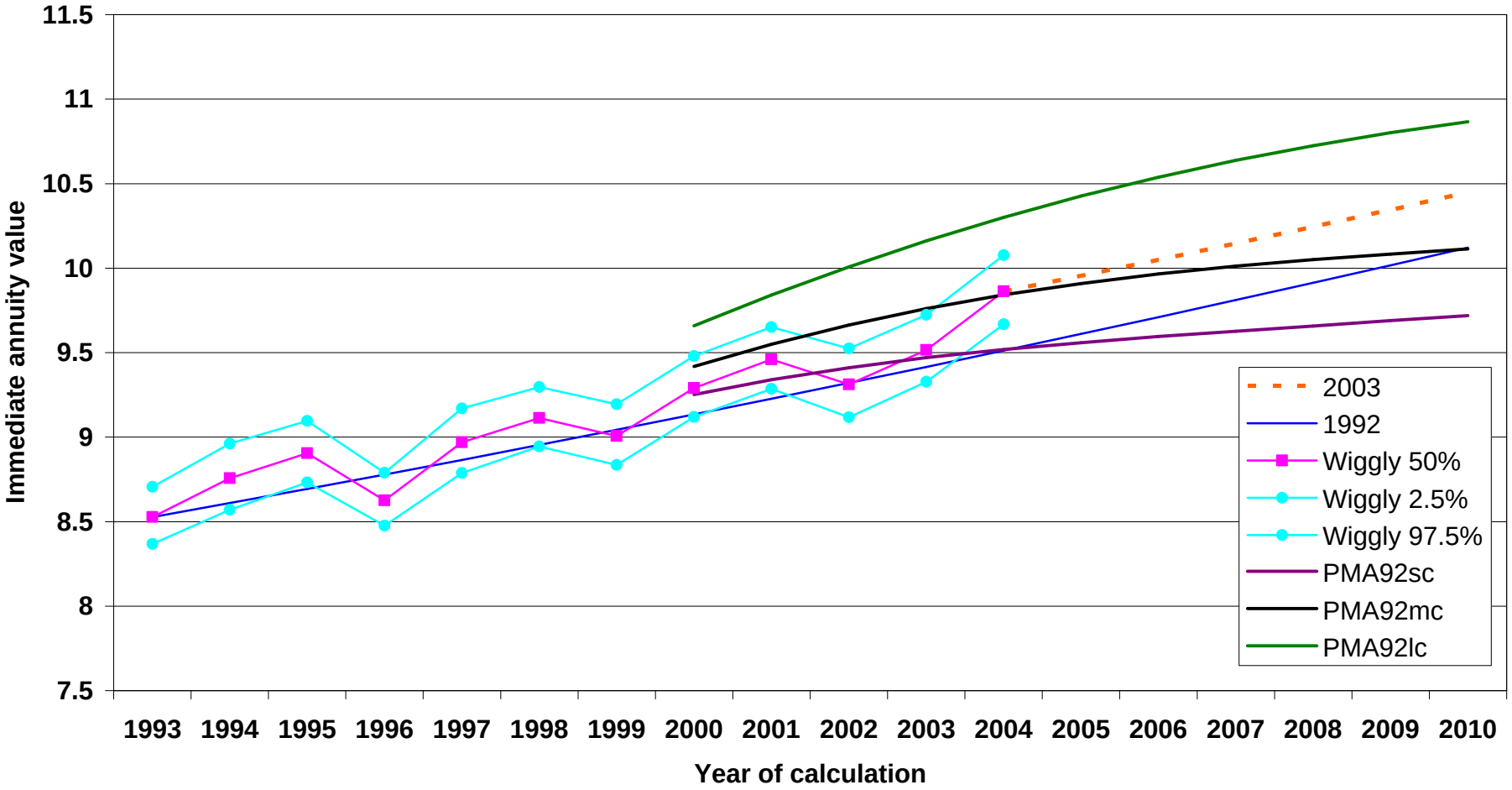
Projected annuity values for males aged 65 starting from 1993
P-Spline, age-cohort, assured lives fitted from 1947, ages 20-90, PMA92, 4.5%



Projected annuity values for males aged 70 starting from 1993
P-Spline, age-cohort, assured lives fitted from 1947, ages 20-90, PMA92, 4.5%



Projected annuity values for males aged 75 starting from 1993
P-Spline, age-cohort, assured lives fitted from 1947, ages 20-90, PMA92, 4.5%



$\ddot{a}_x$ @ 4.5%
Projection basis = male assured lives,1947 to 2003

Mortality Basis	Male aged					
	60		65		75	
PMA92u04mc	15.480		13.786		9.842	
PMA00u04p-s50ac	15.711	**101.4%**	13.969	**102.4%**	9.846	**99.4%**
PMA00u04p-s97.5ac	16.035	**104.7%**	14.258	**104.5%**	10.034	**101.3%**
PMA00u04p-s2.5ac	15.416	**98.6%**	13.706	**100.5%**	9.674	**97.7%**
PMA00u04p-s50ap	15.700	**101.4%**	13.982	**101.4%**	9.876	**100.1%**
PMA00u04p-s97.5ap	16.216	**104.7%**	14.443	**104.7%**	10.175	**103.1%**
PMA00u04p-s2.5ap	15.259	**98.6%**	13.589	**98.6%**	9.617	**97.5%**

These results are based on particular "knot" parameters – different parameters will give different results.
Age-cohort figures based on ages 21-90, age-period on ages 22-90
Source: CMI Working Paper 20 (unpublished)

$\ddot{a}_x$ @ 4.5%
Projection basis = male assured lives,1947 to 2003

Mortality Basis	Male aged					
	60		65		75	
PMA92u30mc	16.066		14.433		10.564	
PMA00u30p-s50ac	17.966	**111.8%**	16.508	**114.4%**	12.618	**119.4%**
PMA00u30p-s97.5ac	18.762	**116.8%**	17.404	**120.6%**	13.636	**129.1%**
PMA00u30p-s2.5ac	17.124	**106.6%**	15.606	**108.1%**	11.670	**110.5%**
PMA00u30p-s50ap	17.640	**109.8%**	16.234	**112.5%**	12.515	**118.5%**
PMA00u30p-s97.5ap	18.925	**117.8%**	17.676	**122.5%**	14.174	**134.2%**
PMA00u30p-s2.5ap	16.313	**101.5%**	14.834	**102.8%**	11.057	**104.7%**

These results are based on particular "knot" parameters – different parameters will give different results.
Age-cohort figures based on ages 21-90, age-period on ages 22-90
Source: CMI (unpublished)

Projections - sources of uncertainty

- Model uncertainty
- Parameter uncertainty
- Stochastic uncertainty
- Measurement error
- Heterogeneity
- Past experience may not be good guide (e.g. change in business mix)

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- Recent CMI mortality experience
- New mortality tables
- Self-Administered Pension Schemes (SAPS) investigation
- Mortality Improvements
- CMI Mortality Projections work
- **Where Next?**

Where Next?

- "00" Series base tables
  - Final proposals, all tables – Q1 2006
  - FIMC adopt base tables May 2006?
- Status of CMI projections work (work in progress)
  - P-spline working paper currently being reviewed
  - Lee-Carter working paper will follow
  - Peer reviewed, not approved - exposing work to the profession will allow full review and issues to surface
- Future work
  - Other methodologies
  - Further research

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