The Actuarial Profession
making financial sense of the future

CMI MORTALITY EXPERIENCE

London 28 June 2006

Developments in Longevity

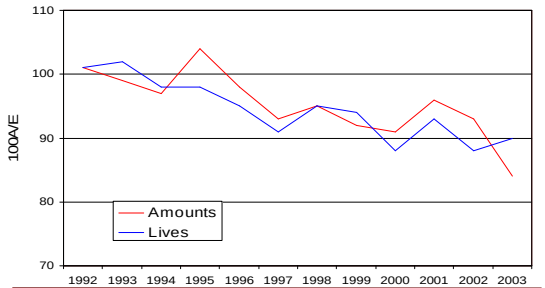
Agenda

- Recent CMI mortality experience
- New mortality tables
- Mortality Improvements
- CMI Mortality Projections work
- Where Next?

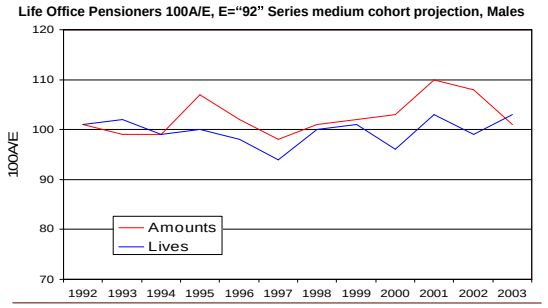
.

Recent CMI mortality experience

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



Recent CMI mortality experience



Developments in Longevity

Agenda

- Recent CMI mortality experience
- **New mortality tables**
- Mortality Improvements
- CMI Mortality Projections work
- Where Next?

.

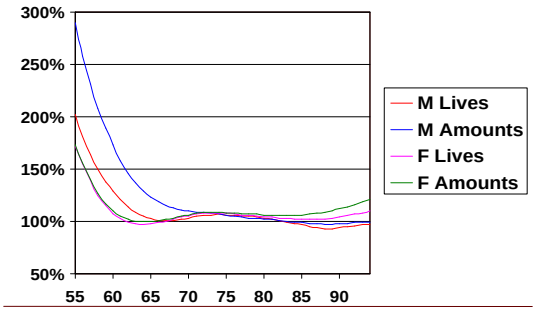
New "00" Series base tables

- 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
- Approval from FIMC for final tables will be sought shortly
- Will then be published

Comparison - 00 series q_x ÷ 92 series C2000 sc q_x



Developments in Longevity

Agenda

- Recent CMI mortality experience
- New mortality tables
- Mortality Improvements
- CMI Mortality Projections work
- Where Next?

.

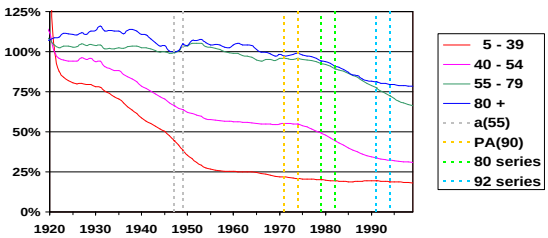
Developments in Longevity

Agenda

- Recent CMI mortality experience
- New mortality tables
- **Mortality Improvements**
- CMI Mortality Projections work
- Where Next?

.

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.

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?

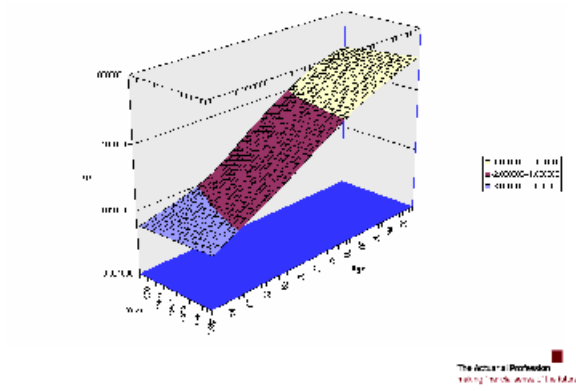
.

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	•													

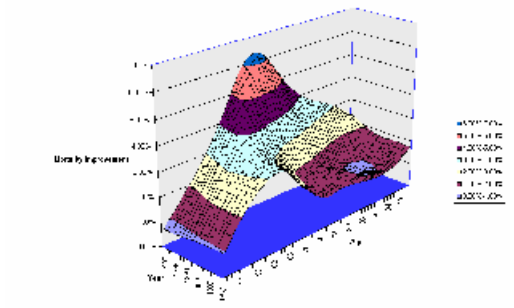
The datasets

- 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

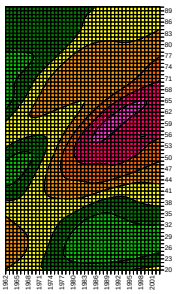


… so looked at improvement rates

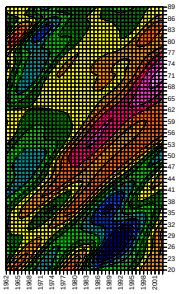
$$1 - \frac{q_{x,t}}{q_{x,t-1}}$$



Assured Lives - males



UK population - males



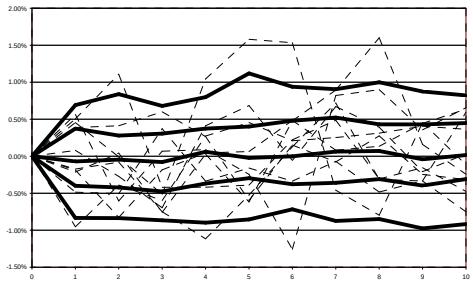
Overview on recent CMI work on projections

- 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 – April 2006
  - Guidance on P-spline (Lee-Carter to follow)

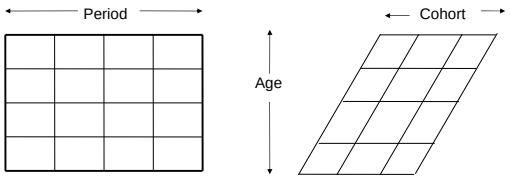
Using P-Splines to project mortality

- 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



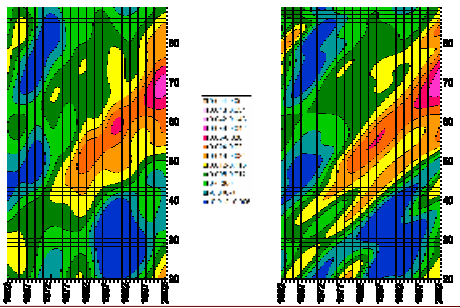
Knots & penalties



ONS data - UK Males

Period Penalty

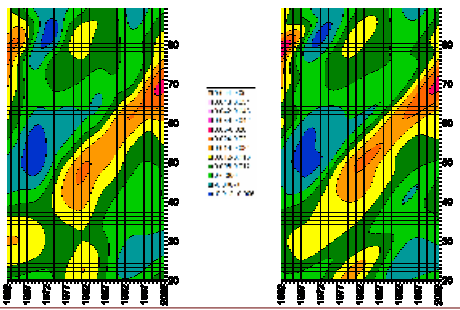
Cohort Penalty



ONS data - UK Females

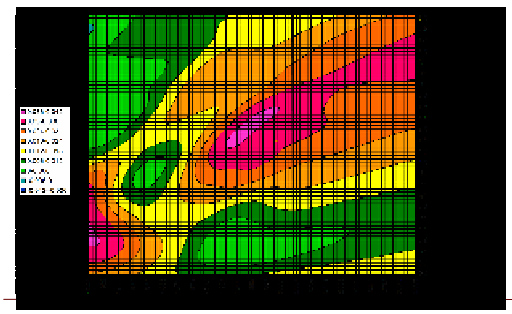
Period Penalty

Cohort Penalty

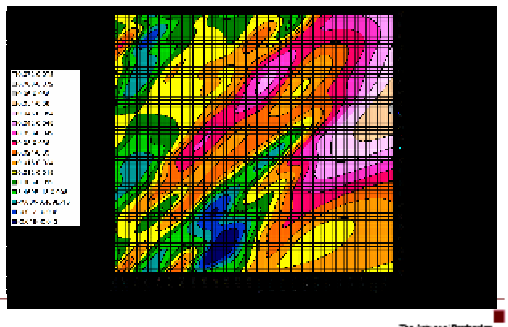


Assured lives *v* ONS

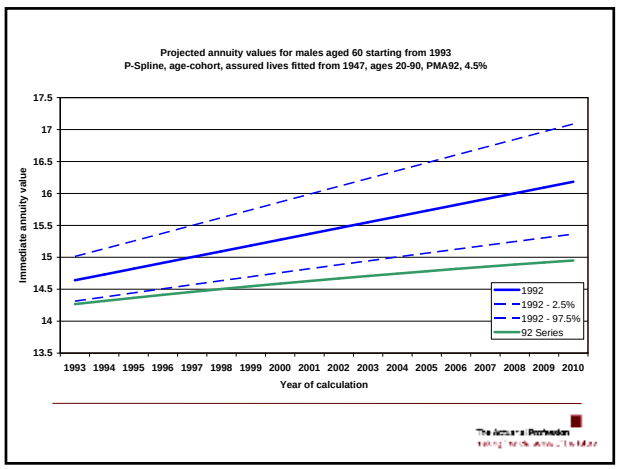
P-spline 50% : Age-Cohort penalty : Assured Lives : Age range 20-90 : Projection from 2003

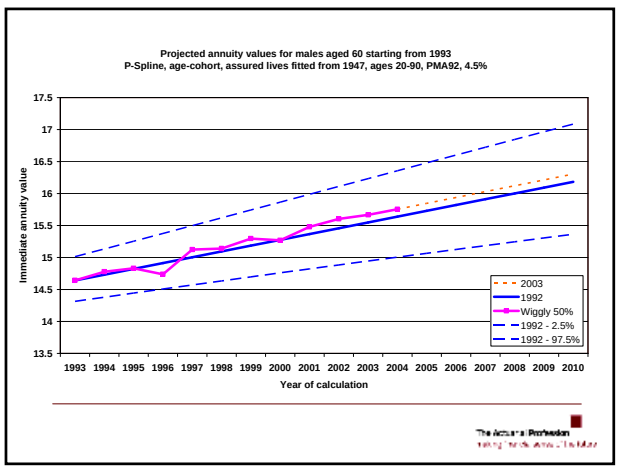


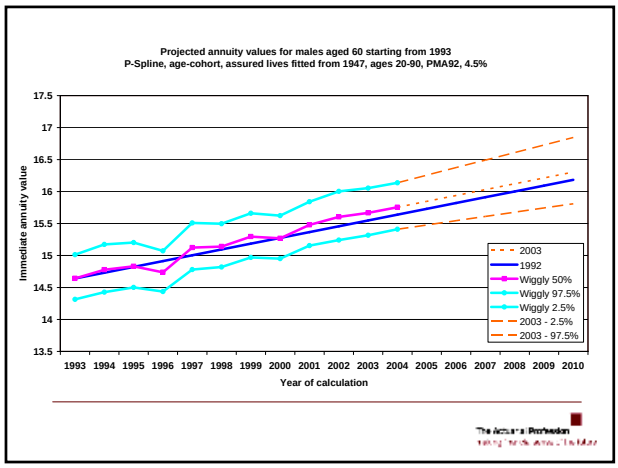
P-spline 50% : Age-Cohort penalty : ONS data Males : Age range 20-89 : Projection from 2003

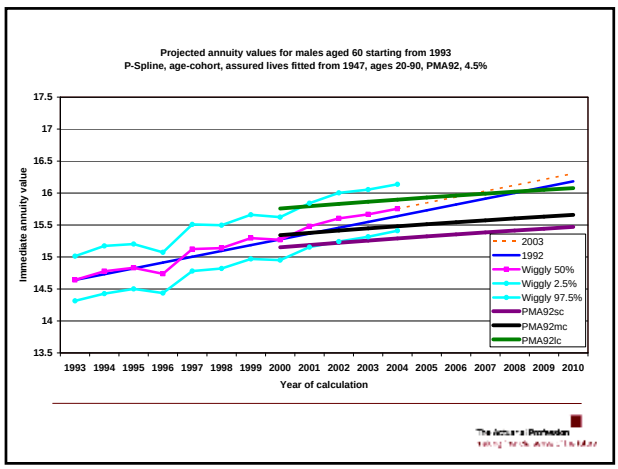


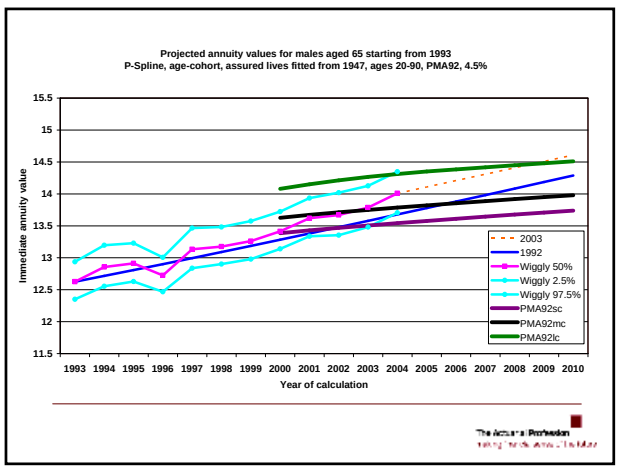
Annuity values – 1993 and on

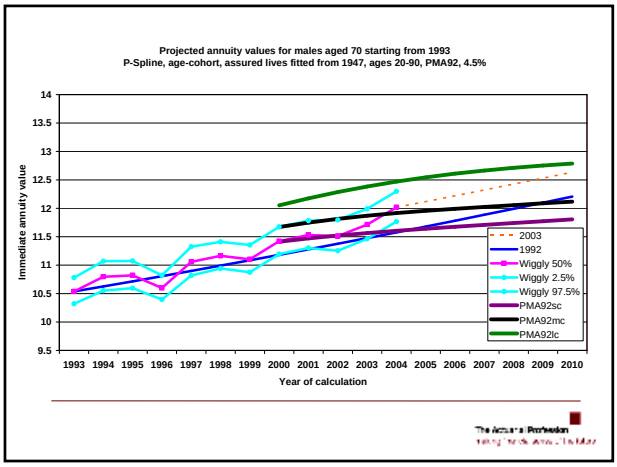


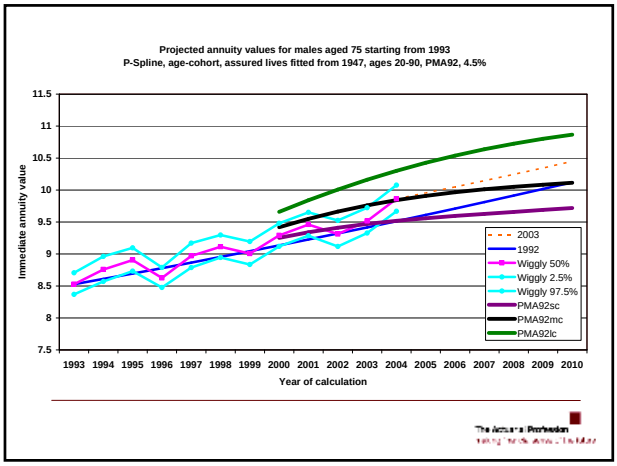



Projected annuity values for males aged 60 starting from 1993
P-Spline, age-cohort, assured lives fitted from 1947, ages 20-90, PMA92, 4.5%
Immediate annuity value
17.5
17
16.5
16
15.5
15
14.5
14
13.5
1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
Year of calculation
2003
1992
Wiggly 50%
Wiggly 97.5%
Wiggly 2.5%
2003 - 2.5%
2003 - 97.5%


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%
Immediate annuity value
17.5
17
16.5
16
15.5
15
14.5
14
13.5
1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
Year of calculation
2003
1992
Wiggly 50%
Wiggly 2.5%
Wiggly 97.5%
PMA92sc
PMA92mc
PMA92lc


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%
Immediate annuity value
15.5
15
14.5
14
13.5
13
12.5
12
11.5
1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
Year of calculation
2003
1992
Wiggly 50%
Wiggly 2.5%
Wiggly 97.5%
PMA92sc
PMA92mc
PMA92lc





$\ddot{a}_x$ @ 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

$\ddot{a}_x$ @ 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)

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?**

Where Next?

- "00" Series base tables
  - Final proposals, all tables to FIMC shortly
  - Publication immediately thereafter
- 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