The Actuarial Profession
making financial sense of the future

Pensions Convention 2004
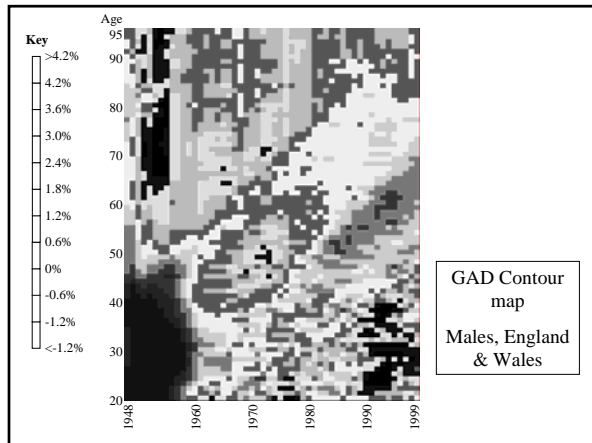CURRENT ISSUES IN MORTALITY

London – 8 June 2004
Tony Leandro

GAD Contour map

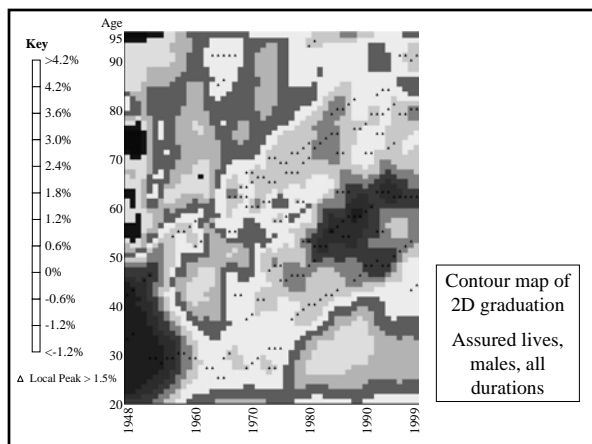Males, England & Wales

---

Contour map of 2D graduation

Assured lives, males, all durations

Expectation of life for males aged 60

Legend: a(55)M, PA(90)M, PMA80, PMA92, PMA92*mc*, PMA92*lc*, PMA92*sc*

Curves labelled: 1999 *lc*, 1999 *mc*, 1992, 1980, 1968, 1955
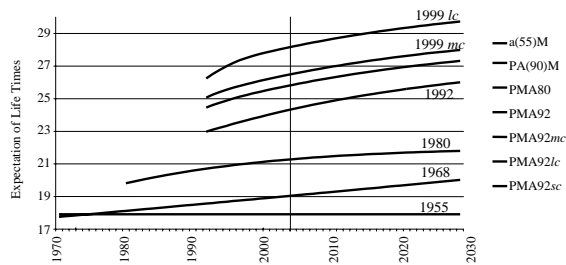
Financial effects, Males aged 65, 3%

	u=2000	u=2010
PA(90)-2	100%	
PA(90)-4	107%	
PMA92	117%	121%
PMA92 pilot	112%	118%
PMA92*mc*	128%	131%
PMA92*mc* pilot	124%	128%

Financial effects, interest adjust. from PA(90)-2, Males aged 65, 3%

year	PMA92 (u=year)*mc*	PMA92 (u=year)*mc* pilot
2000	-2.7%	-2.5%
2005	-2.7%	-2.5%
2010	-3.0%	-2.8%
2015	-3.0%	-2.8%

Current issues in mortality - Agenda

- Update on self-administered pensioner investigation
- Update on CMI investigations
    - Data collection
    - The work on the "00" Series of tables
    - Some observations
- CMI Working paper 3

The SAPS mortality investigation - Summary

- 99 Schemes
- Number of records in database 1.04m
- 6 largest schemes cover 50% of the data
- 9 Consultancies have contributed data
- Data for 1996 to 2003
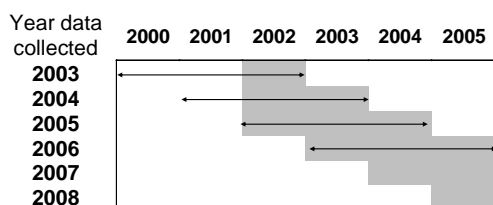- 13 industry types, significant amounts of data for 7

Data collection cycle

Year data collected	2000	2001	2002	2003	2004	2005
2003						
2004						
2005						
2006						
2007						
2008						

The SAPS mortality investigation - Males

		Lives	Amounts (£'000)	Average £
Exposure	2000	452,570	2,803,937	6,196
	2001	531,103	3,404,461	6,410
	2002	412,283	3,045,784	7,388
	All	1,395,957	9,254,181	6,629
Deaths	2000	16,466	70,245	4,266
	2001	19,863	88,621	4,462
	2002	14,622	73,068	4,997
	All	50,951	231,935	4,552

The SAPS mortality investigation - Females

		Lives	Amounts (£'000)	Average £
Exposure	2000	324,681	840,332	2,588
	2001	368,510	973,504	2,642
	2002	266,597	819,477	3,074
	All	959,788	2,633,313	2,744
Deaths	2000	11,137	24,226	2,175
	2001	13,364	29,571	2,213
	2002	10,064	26,302	2,613
	All	34,565	80,099	2,317

Data categories

- Male / Female
- Dependants
- Ill-health / Normal / Combined / Unknown
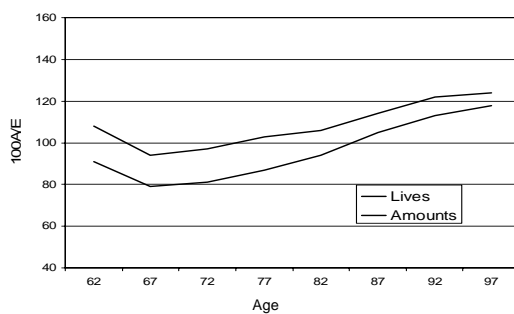- Lives & Amount of pension
- Industry category

Summary results: 2000-02 : Males

	Pensioner type	Deaths	100A/E "92" Series	100A/E PA or a(90) -2
Lives	All*	50,951	103	105
	Normal	22,792	106	108
	Combined	23,269	94	96
	Ill-health	3,251	187	171
	Dependants	1,100	111	117
Amounts	All*	£231,935k	110	78
	Normal	£109,183k	112	79
	Combined	£107,837k	102	73
	Ill-health	£12,656k	239	137
	Dependants	£1,134k	114	88

Summary results: 2000-02 : Females

	Pensioner type	Deaths	100A/E "92" Series	100A/E PA or a(90) -2
Lives	All*	34,565	108	128
	Normal	6,759	103	121
	Combined	7,769	108	126
	Ill-health	954	176	189
	Dependants	18,779	108	129
Amounts	All*	£80,099k	116	103
	Normal	£18,551k	114	101
	Combined	£18,635k	120	105
	Ill-health	£2,468k	202	164
	Dependants	£40,088k	112	100

Mortality of self-administered pensioners 2000-02
Normal : Males : Lives *v* Amounts (on PML92)

Mortality of self-administered pensioners 2000-02
All retirements : Males : Lives

PML92
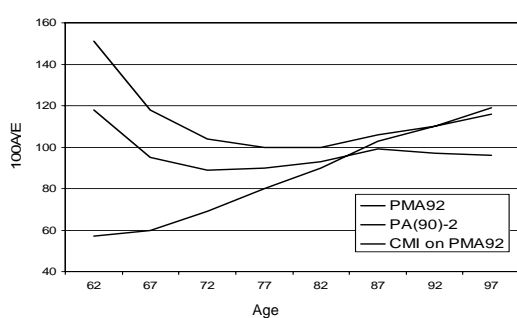a(90)-2
CMI on PML92
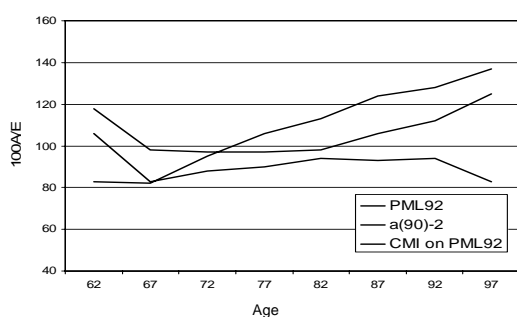
Mortality of self-administered pensioners 2000-02
All retirements : Males : Amounts

PMA92
PA(90)-2
CMI on PMA92

Mortality of self-administered pensioners 2000-02
All retirements : Females : Lives
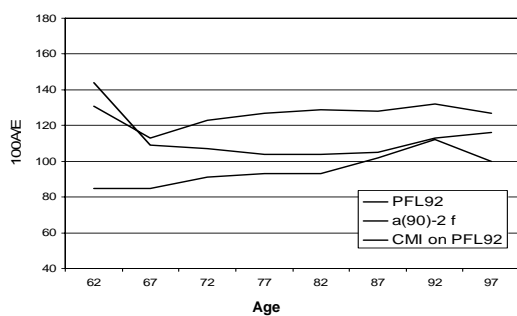
PFL92
a(90)-2 f
CMI on PFL92

Mortality of self-administered pensioners 2000-02
All retirements : Females : Amounts

PFA92
PA(90)-2 f
CMI on PFA92
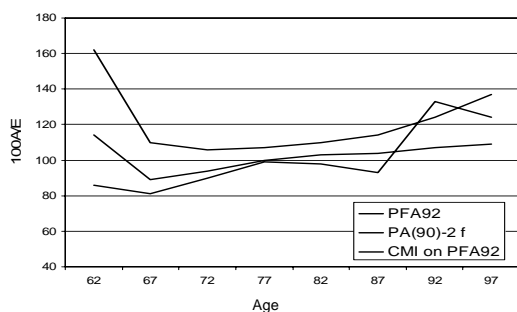
Mortality of self-administered pensioners 2000-02
Dependants : Females : Lives

PFL92
a(90)-2 f
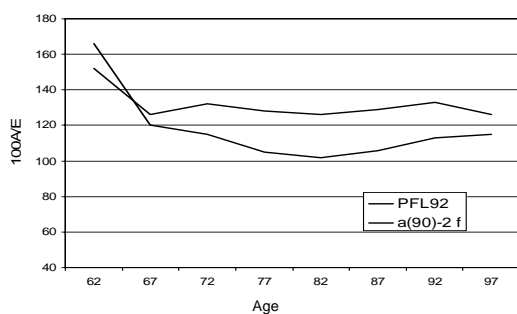
Mortality of self-administered pensioners 2000-02
Dependants : Females : Amounts
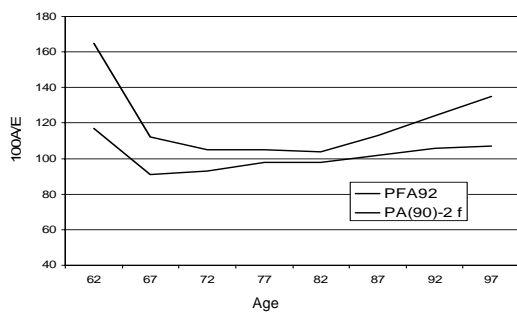
PFA92
PA(90)-2 f

Current issues in mortality - Agenda

- Update on self-administered pensioner investigation
- Update on CMI investigations
    - Data collection - 2002 quad complete
    - The work on the "00" Series of tables
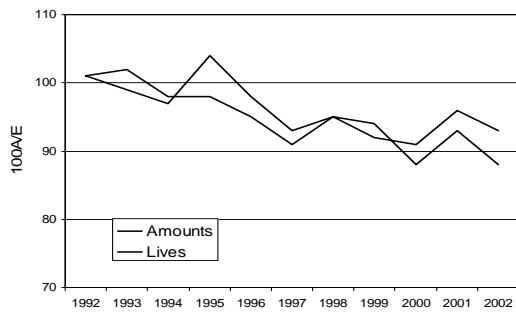   - Some observations
- CMI Working Paper 3

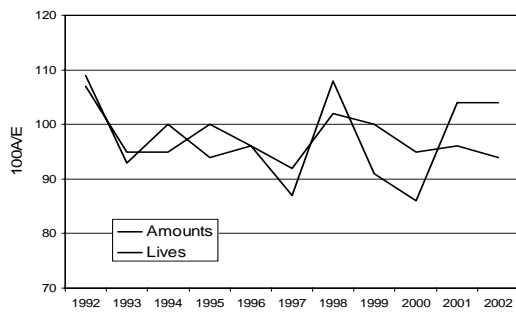**Life Office Pensioners 100A/E using the "92" Series projected mortality rates : Males**

A line chart with y-axis labeled "100A/E" ranging from 70 to 110, and x-axis showing years 1992 to 2002. Two lines labeled "Amounts" and "Lives".

Life Office Pensioners 100A/E using the "92" Series projected mortality rates : Females

A line chart with y-axis labeled "100A/E" ranging from 70 to 120, and x-axis showing years 1992 to 2002. Two lines labeled "Amounts" and "Lives".

Life Office Pensioners 100A/E using the "92" Series - medium cohort, projected mortality rates : Males
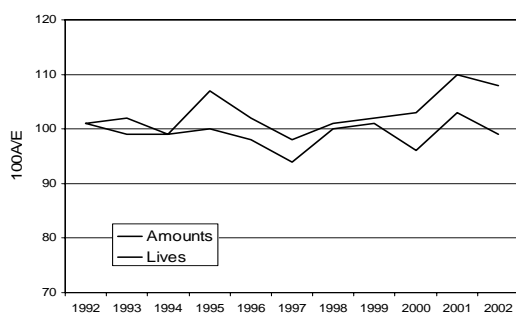
Life Office Pensioners 100A/E using the "92" Series - medium cohort, projected mortality rates : Females
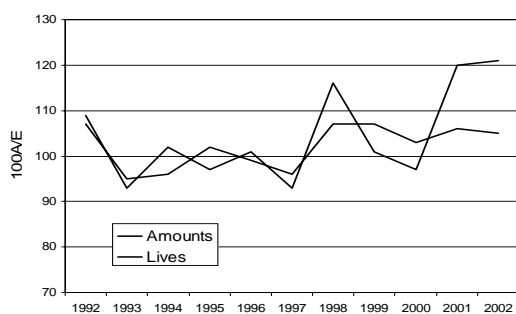
Current issues in mortality - Agenda

- Update on self-administered pensioner investigation
- Update on CMI investigations
  - Data collection
  - The work on the "00" Series of tables
  - Some observations
- CMI Working Paper 3

Work on the "00" Series mortality tables

- Projections Working Party
  - WP3
- Graduation Working Party
  - Which tables (not too many!)
  - How should they relate to each other
  - Durations, lives and amounts
  - WP 8
- Experience paper (a CMIR)

"00" Series timetable

- March 04   -   Projections WP 3
- May 04   -   WP 8 on what to graduate
- 4 June 04   -   Staple Inn seminar to discuss W/Ps
- July 04   -   Experience CMIR
- Sept/Oct 04 -   New graduations & possibly,
                            adjusted interim projections
- Sept 04   -   Internal CMI workshop on Lee-
                            Carter projection methods
- Q2 05   -   Updated projections

Current issues in mortality - Agenda

- Update on self-administered pensioner investigation
- Update on CMI investigations
  - Data collection
  - The work on the "00" Series of tables
  - Some observations
- CMI Working Paper 3

What you need to attempt mortality forecasts
(*In the absence of a crystal ball*)

- Understanding of the ageing process
    - how cells age, impact of redundancy
    - how individual genes affect the ageing process
- How do risk factors affect the ageing process?
- How soon can medical technology reduce the effects of ageing and what will be the impact?
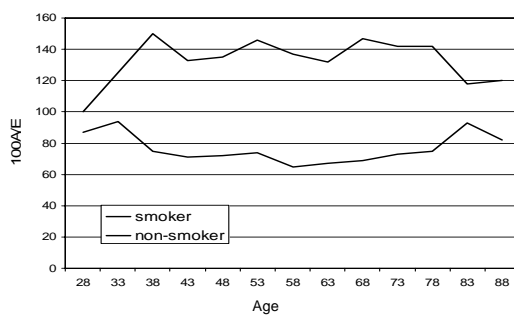- What is the impact of lifestyle on ageing?

Variation by smoker status,1995-98, Males (AM92)

Variation by smoker status,1995-98, Females (AF92)
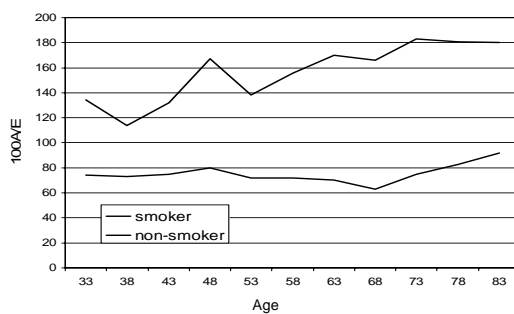
Mortality by social class

Social-class differentials

Source: ONS data
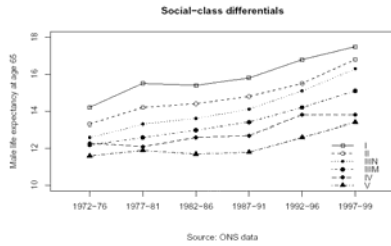
Claims by cause as percentage of All Claims
Critical Illness *v* Life Assurance - Males

Cause of Claim / Death

Life Assurance
Critical Illness
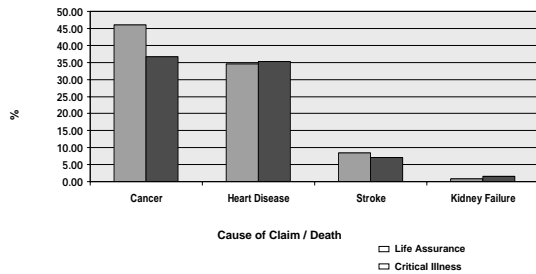
Claims by Cause as percentage of All Claims
Critical Illness *v* Life Assurance - Females

Cause of Claim / Death

Life Assurance
Critical Illness
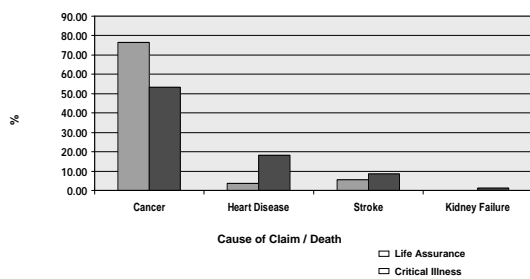
Expectation of life at age 65 in 2000

Country	Male	Female	Country	Male	Female
Japan	17.50	22.40	Greece	15.91	18.56
France	17.19	21.63	Norway	15.79	19.68
Switzerland	16.77	20.93	Belgium	15.70	19.65
Australia	16.73	20.23	Austria	15.66	19.61
Sweden	16.65	20.01	Denmark	15.27	17.77
Israel	16.64	18.87	Netherlands	15.13	19.54
New Zealand	16.56	19.93	Finland	15.07	19.18
Italy	16.46	20.57	**United Kingdom**	**15.06**	**18.54**
Spain	16.22	20.23	Germany	15.06	18.91
USA	16.02	19.15	Portugal	14.31	18.01
Canada	15.95	19.75	Ireland	14.25	18.05
Singapore	15.92	18.65			

Current issues in mortality - Agenda

- Update on self-administered pensioner investigation
- Update on CMI investigations
  - Data collection
  - The work on the "00" Series of tables
  - Some observations
- CMI Working Paper 3

Projection methodologies

- Process-based
- Explanatory-based
- Extrapolative

Process-based methodologies

- Model mortality rates from bio-medical perspective
- Processes causing death need to be understood
- Mathematical models need to be developed
- Not really practical at present….
- ...but could become more relevant in future

Explanatory-based methodologies

- Explanatory links need to be understood
- Underlying economic or environmental factors need to be modelled…
- … not just for short term but for 50+ years
- May provide partial attempts for projecting minimum/maximum improvements (e.g. links with patterns of smoking)

Extrapolative methodologies

- Project historical trends into the future
- Include some subjective element
- Simple extrapolation only reliable to extent that conditions leading to changes in past mortality have similar impact in the future
- Can be invalidated by medical advances or emergence of new diseases

Projection methodology

- Trend projection – relationship between mortality at different ages often ignored
- Parametric methods – e.g. fitting parameterised curves to past data and projecting trends in parameters forward
- Targeting approach – interpolating between current mortality rates and targets assumed to hold at a given future date

Other considerations

- Aggregate mortality or cause of death
- Cohort effects
- Measures of uncertainty
- Model should be sensible in the region of the data (trade-off between smoothness and goodness-of-fit)
- In the region of the projection, should behave in reasonable or plausible way

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)

Quantifying uncertainty

- Estimates of parameter uncertainty can be made for regression and time series models, after model has been chosen
- For model uncertainty, can try different models and assess sensitivity of results, but ….
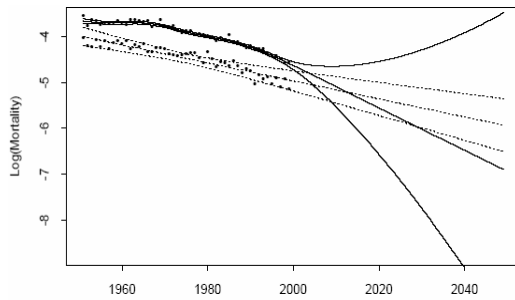- …. no easy method for providing probabilistic statements on model risk

Fitted and projected model of larger (top) and smaller (bottom) mortality experience. P-spline model with separate smoothing parameters. 95% c.i.s shown.
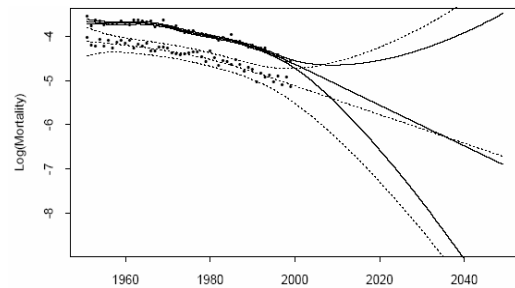
Fitted and projected model of larger (top) and smaller (bottom) mortality experience. P-spline model with smoothing parameter chosen to favour goodness-of-fit. 95% c.i.s shown.

Fitted and projected model $\log \mu_{65}(t) = a + \log \mu_{65}(t)$ of larger (top) and smaller (bottom) mortality experience. P-spline model with smoothing parameter chosen to favour goodness-of-fit. 95% c.i.s shown.

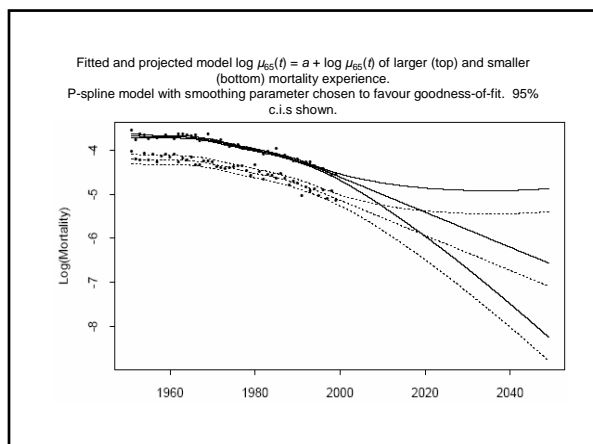**Invitation to comment**

- What base tables and projections do offices use now?
- What level of aggregation is appropriate in projecting future mortality?
- Should we continue to project cohorts?

Invitation to comment

- Do we need quantitative measures of uncertainty? If so, what form should they take?
- Are distributions or percentiles of future rates of mortality, derived from statistical models of past data, sufficiently meaningful?
- Should projections and any measures of uncertainty be based on the largest available appropriate population?

Things to read

- Working paper 1&2 (SIAS paper) – cohort
- Working paper 3 – projections
- Working paper 4 – SAPS investigation
- Working paper 8 – Which tables?
- Longevity in the 21st Century
- Plus more to come …

Summary

- In recent years mortality rates have improved very quickly
- It is likely that this trend will continue
- Any forecast will be wrong – the range of possible results is wide
- The financial consequences are equally uncertain
- Mortality models need to be developed to reflect this uncertainty
- Actuaries need to implement techniques that use these models
- Mortality and Longevity are on the political agenda, which adds another level of uncertainty

The Actuarial Profession
making financial sense of the future

Pensions Convention 2004
CURRENT ISSUES IN MORTALITY

London – 8 June 2004
Tony Leandro