The Actuarial Profession
making financial sense of the future

Update on the “00” Series

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28 September 2005

Introduction

- Graduations
  - Working paper 12 – Assured Lives
  - Working paper 16 – Annuitants & Pensioners
- Longevity projections
  - Working papers
  - Data
  - Software/Workshops
  - Illustrative results

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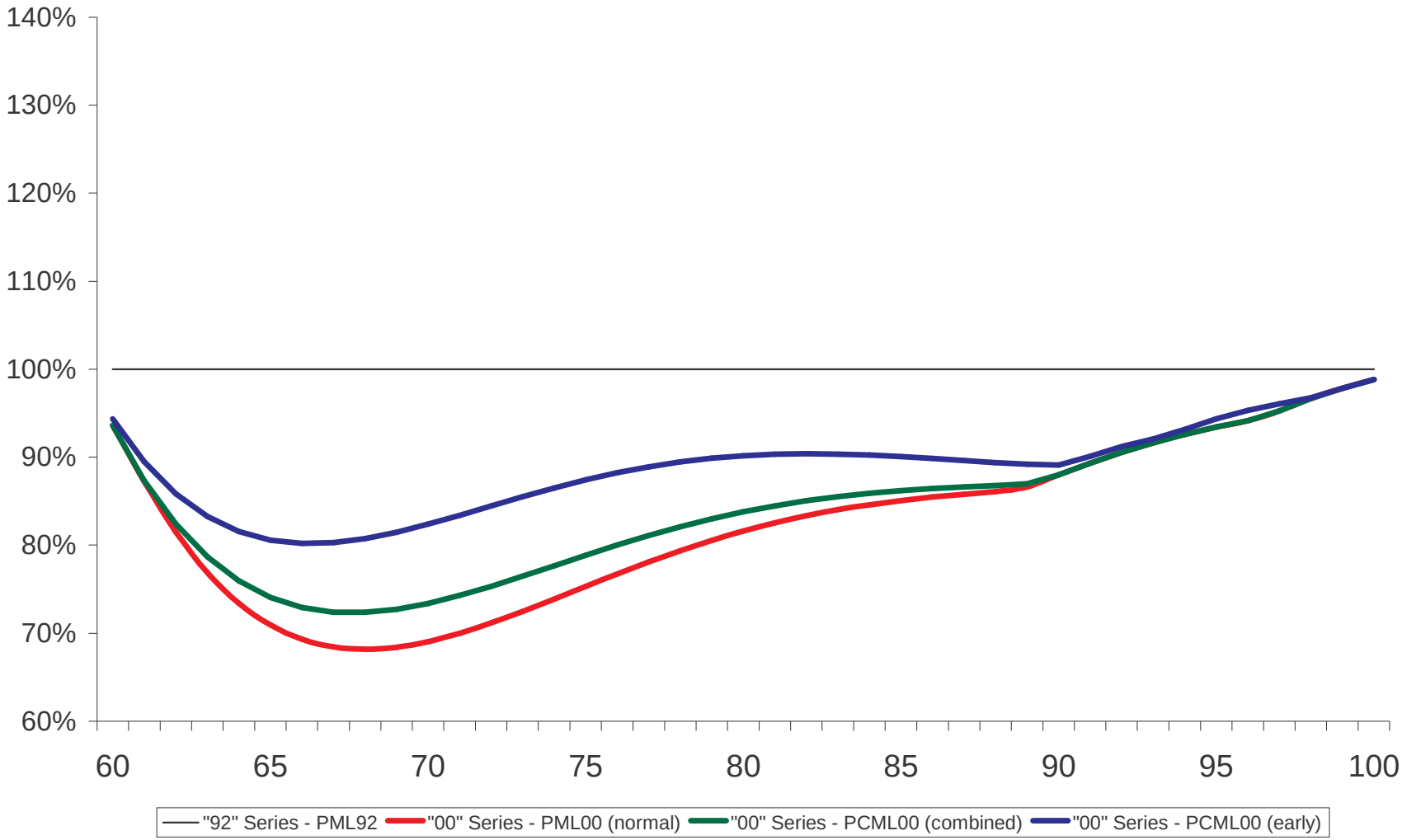
“00” Series – Pensioners & annuitants

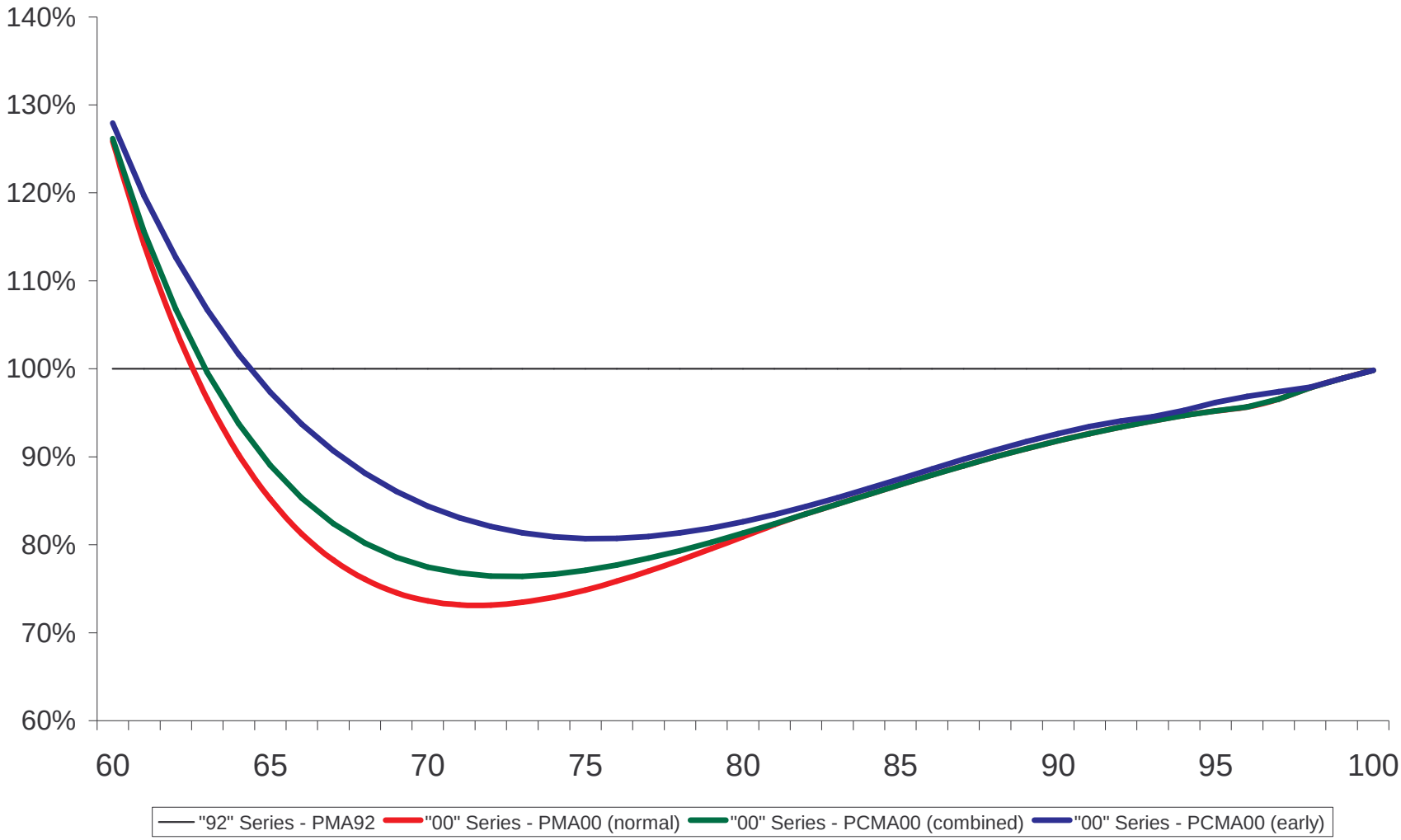
New “00” Series base tables

- 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)

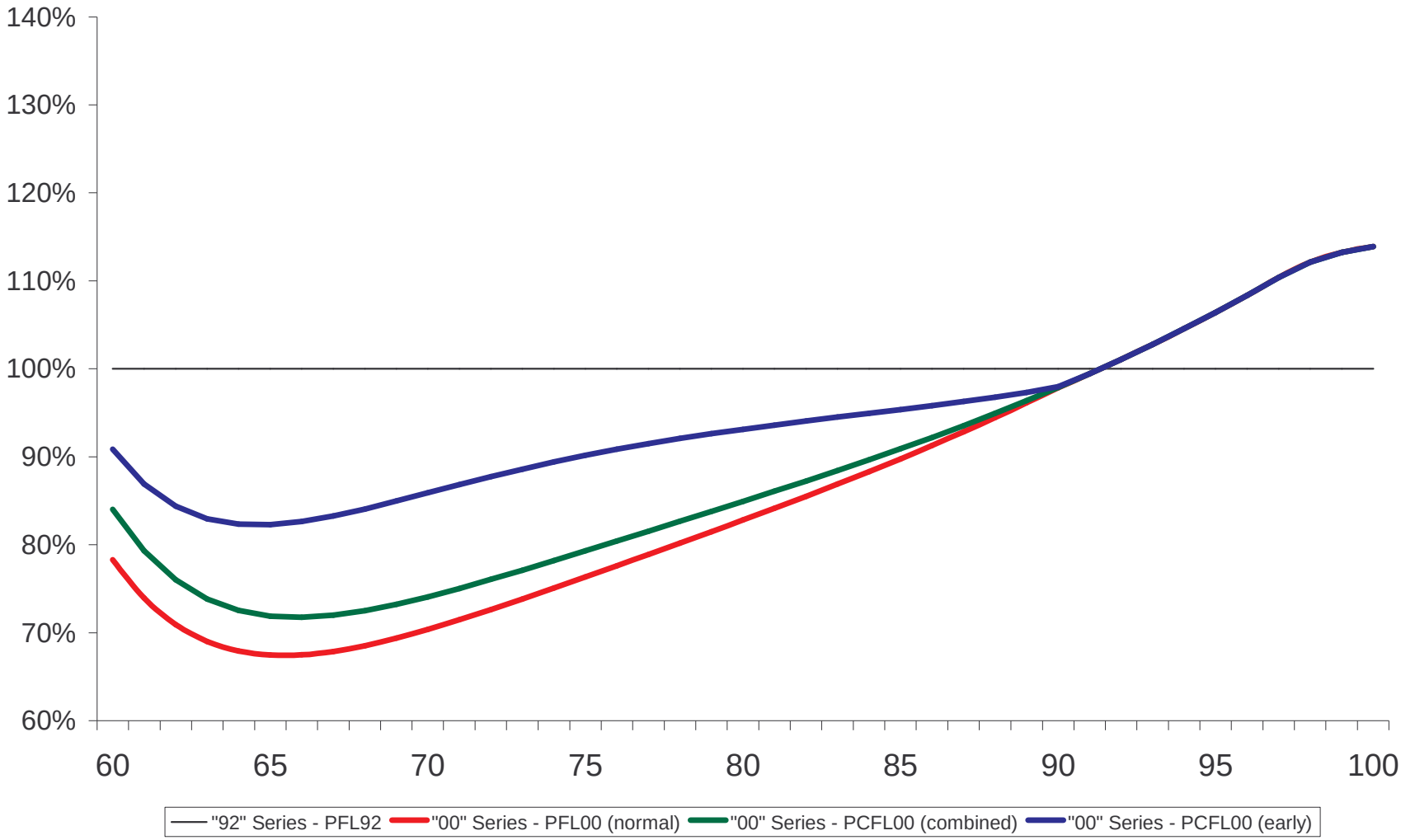
q_x - "00" Series v "92" Series - Life Office Pensioners, Males, Lives



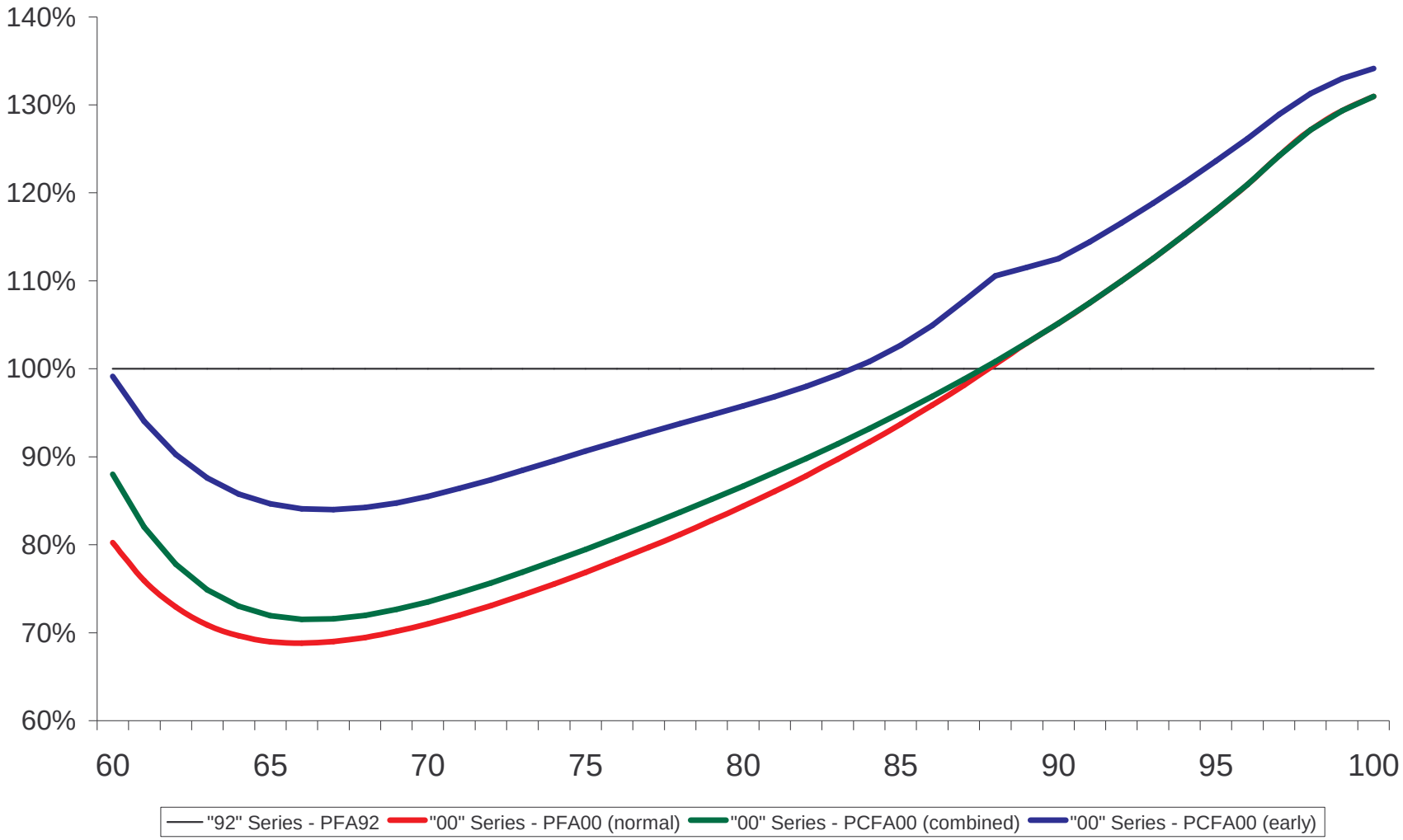
q_x - "00" Series v "92" Series - Life Office Pensioners, Males, Amounts



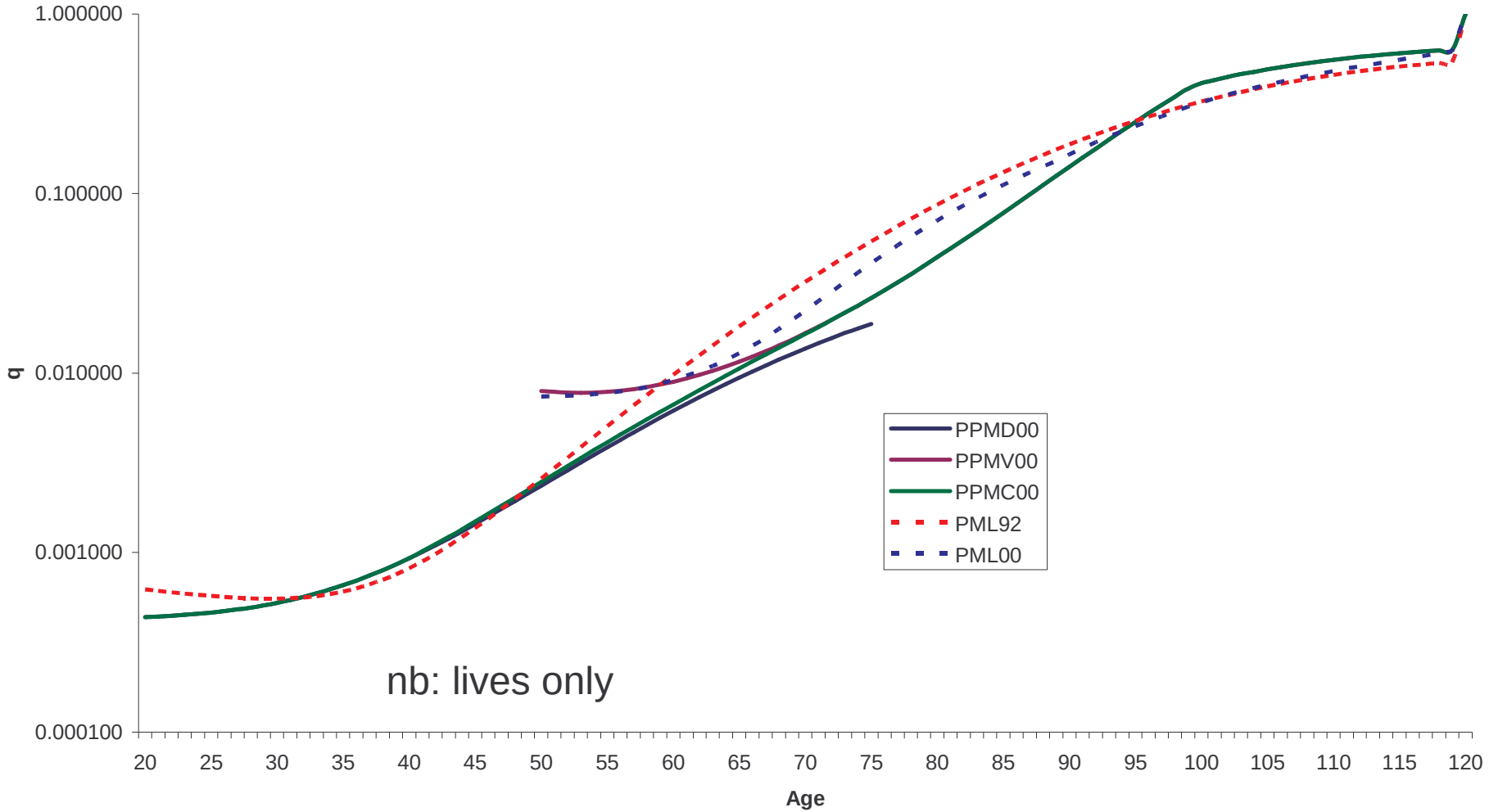
q_x - "00" Series v "92" Series - Life Office Pensioners, Female, Lives



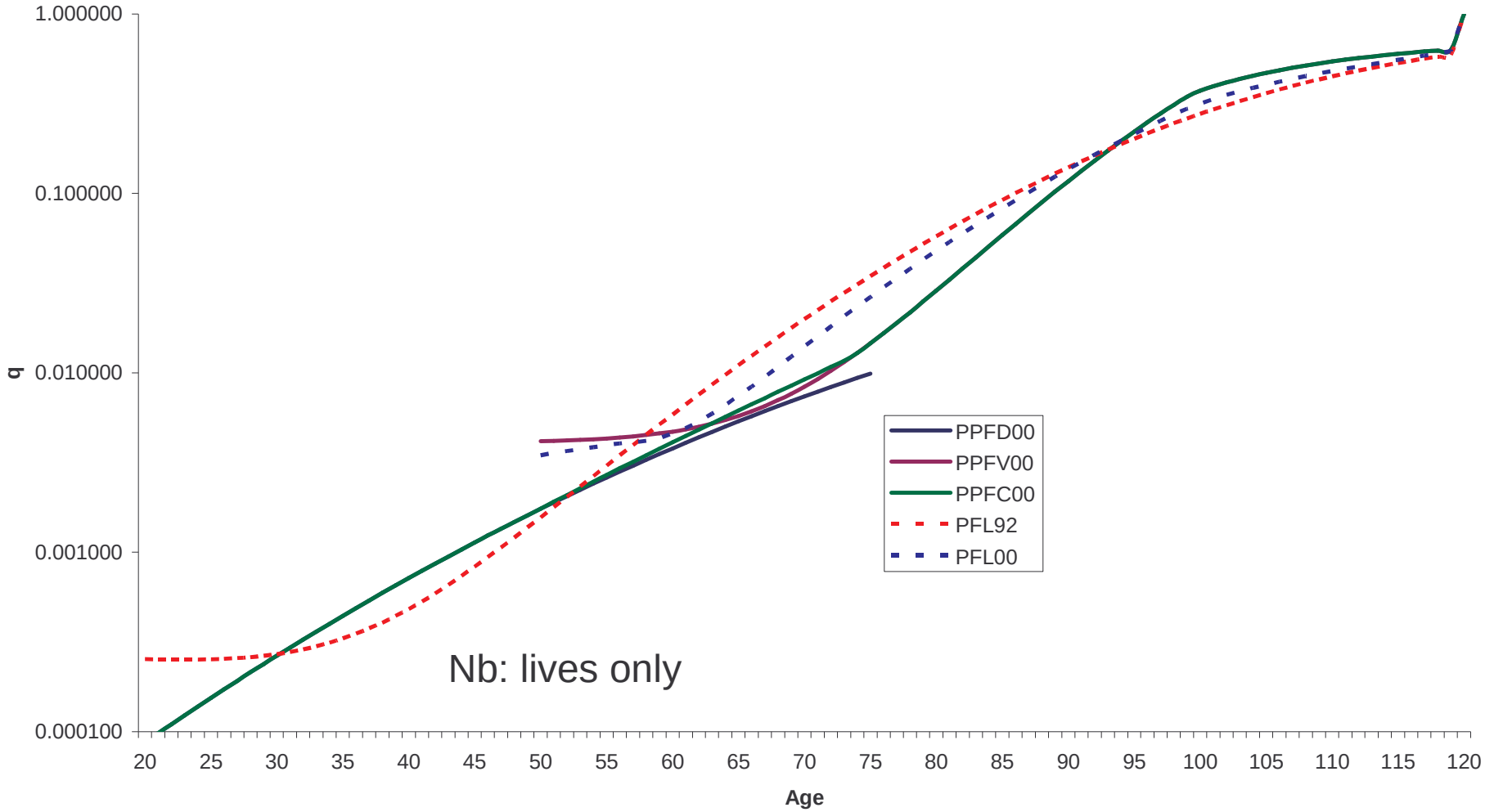
q_x - "00" Series v "92" Series - Life Office Pensioners, Female, Amounts



q_x – Personal Pensioners and Life Office Pensioners, Males



q_x – Personal Pensioners and Life Office Pensioners, Females



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Longevity Projections

Overview on recent 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

Feedback on WP15

- Broad support for stochastic methodologies
- P-Spline and Lee-Carter - no clear ‘winner’
- Support for CMI issuing illustrative software
- Software must allow appropriate adjustments
- Inappropriate for CMI to prescribe a method or basis…
- … but there was demand for some guidance
- Recognised possibility of other models

Steps …

- Already available
  - Software at workshops
  - 1947 to 1992 Assured Lives males data
  - 1961 to 2002 ONS data (continues to be revised)
- Today (website tonight)
  - WP16, “00” Series Annuitants & Pensioners base tables
  - 1947 to 2003 Assured Lives males data
  - 1983 to 2003 Assured Lives females data
  - *(All of this is enough to start calculating results)*
  - CILA presentation
- Soon – Further working paper giving more P-Splines and Lee-Carter example results

P-splines and Lee-Carter

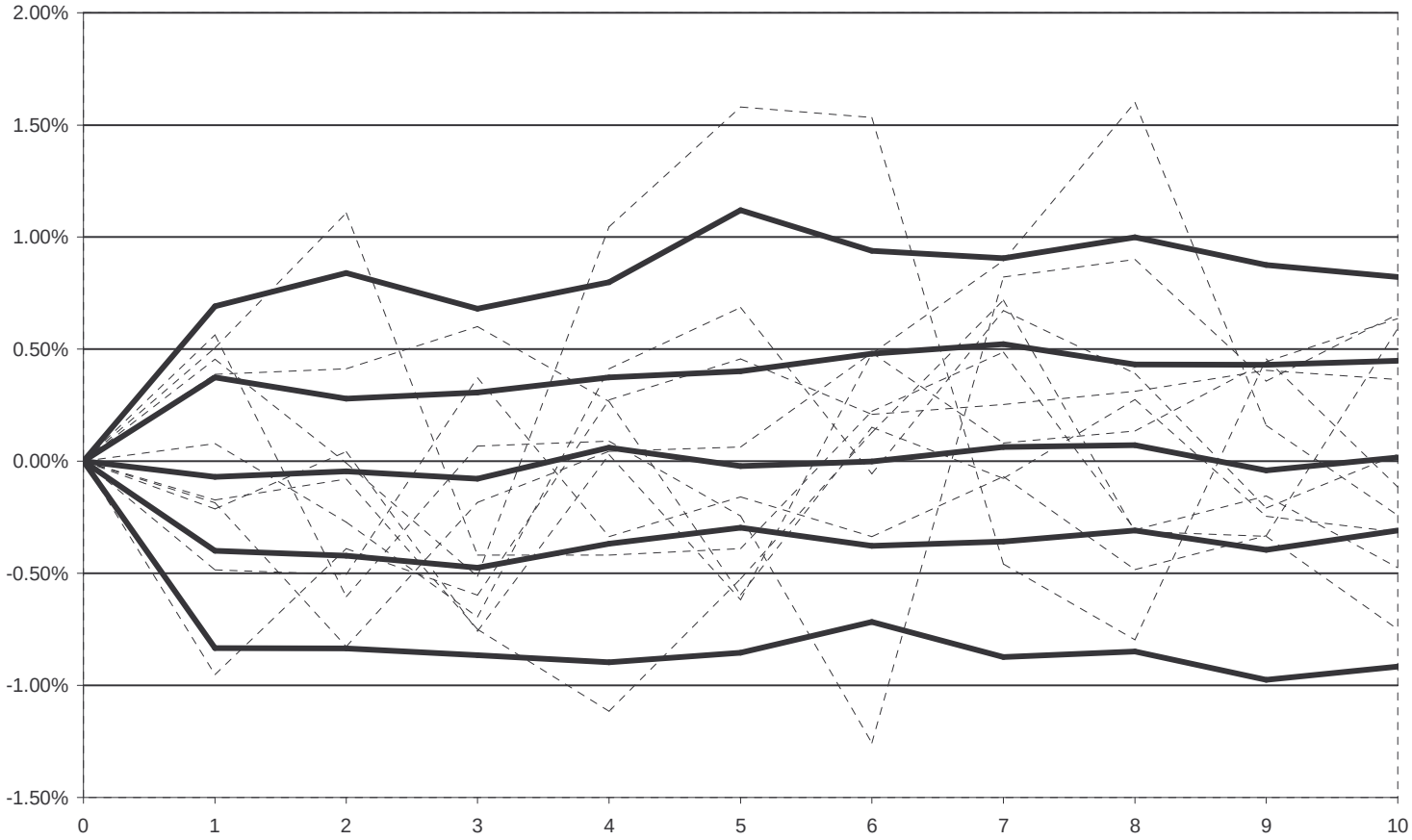
Features of P-Splines

- Can easily generate confidence intervals
  - Fit surface to data and generate 50th percentile projection all in one go
  - … and produces standard errors
- Age-cohort v age-period (knots)
- Can draw contour maps!
- Generate percentiles

Features of Lee-Carter

- Each fitting and projection different (bootstrapping)
- Confidence intervals obtained after a lot (10,000) of fittings
- Generates sample paths
- Very slow!
- May be better for risk business (young ages?)

Percentiles *v* sample paths

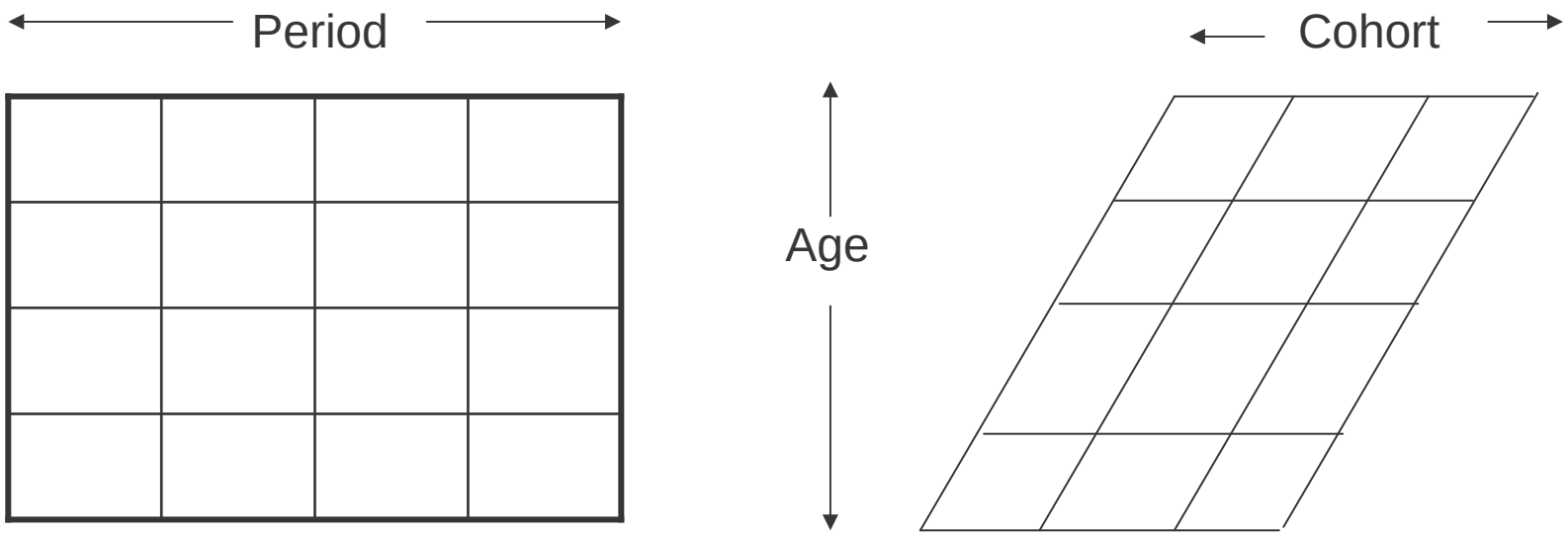


Illustrative results using P-Splines

(Lee-Carter at a later date)

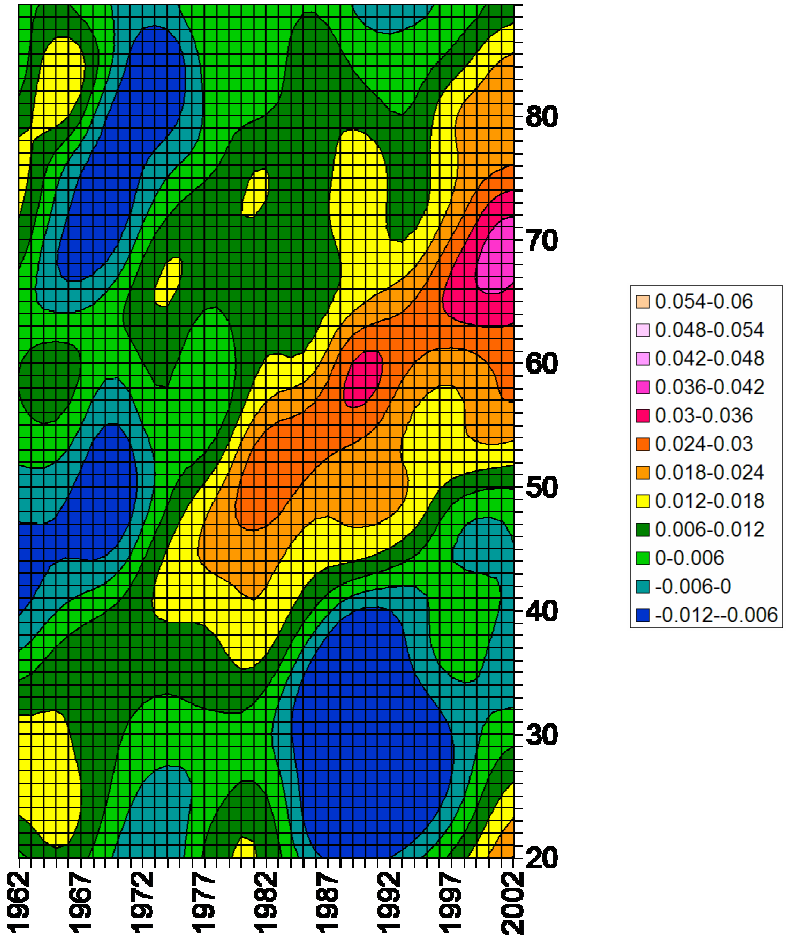
- Age-cohort v Age-period
- Males v Females
- Assured lives v ONS
- Different age ranges
- 1992 to 2004
- Postscript – other countries

Knots & penalties

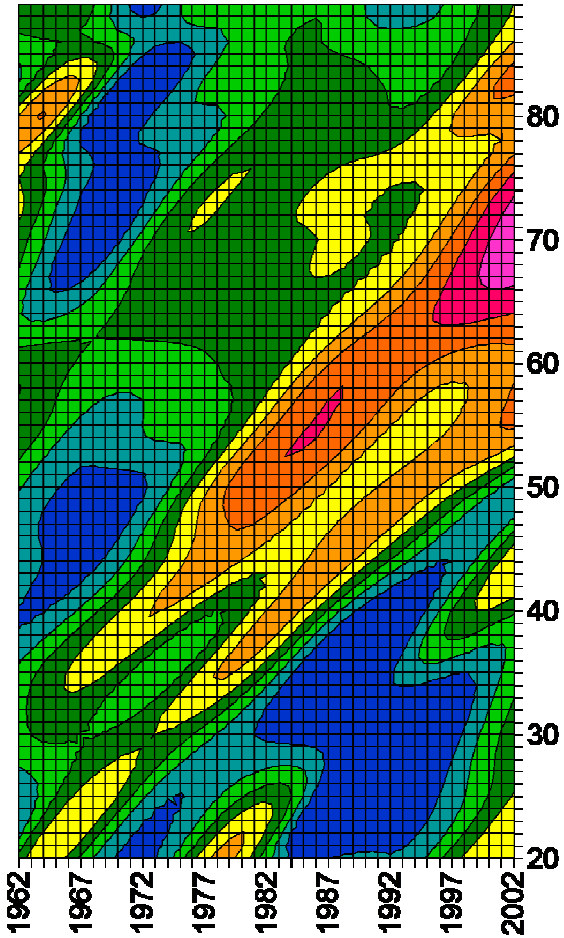


ONS data - UK Males

Period Penalty

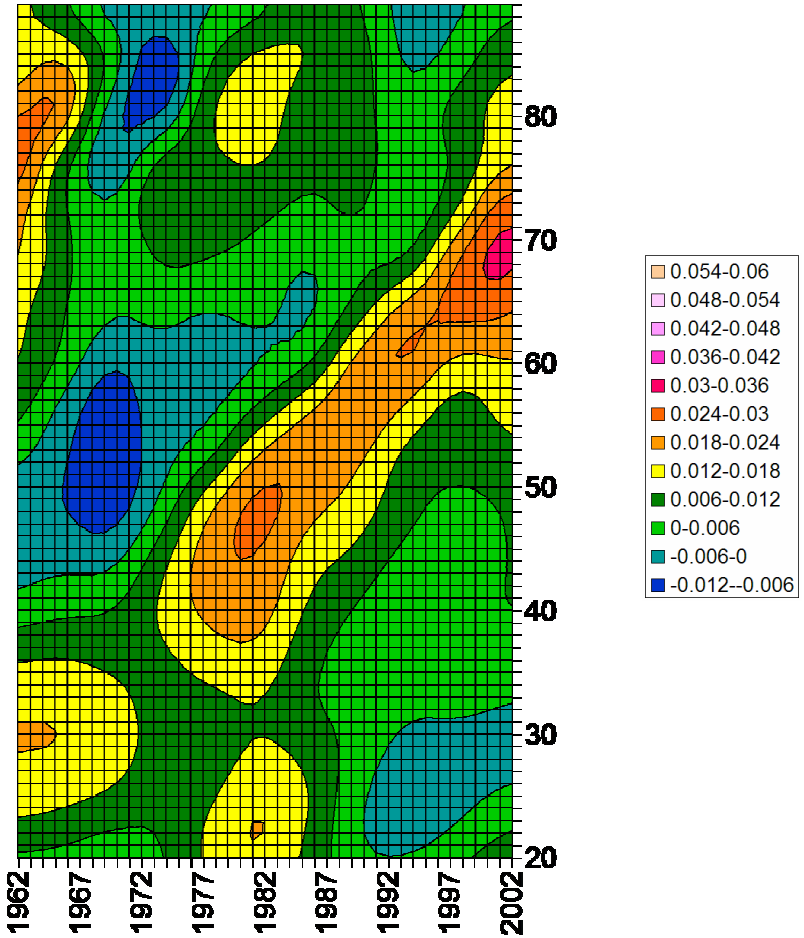


Cohort Penalty

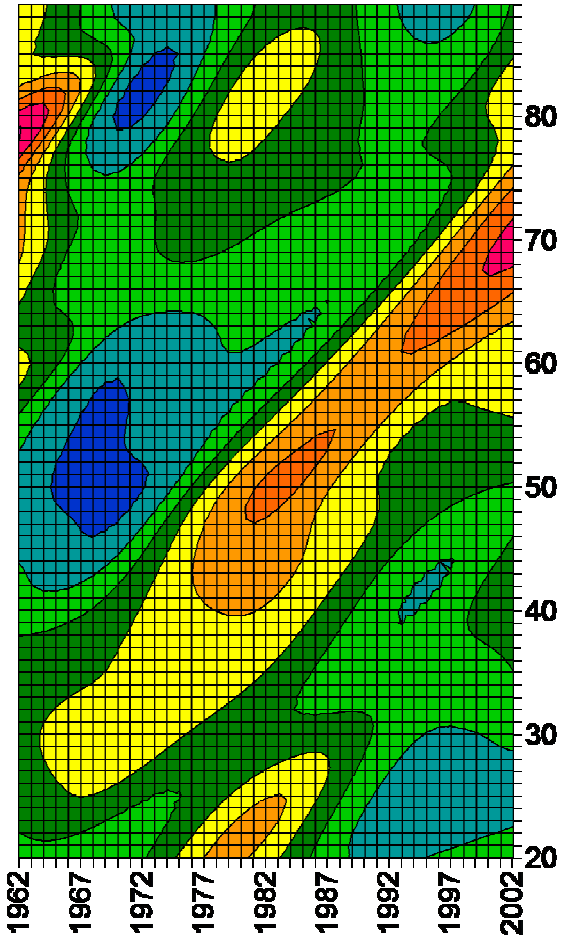


ONS data - UK Females

Period Penalty

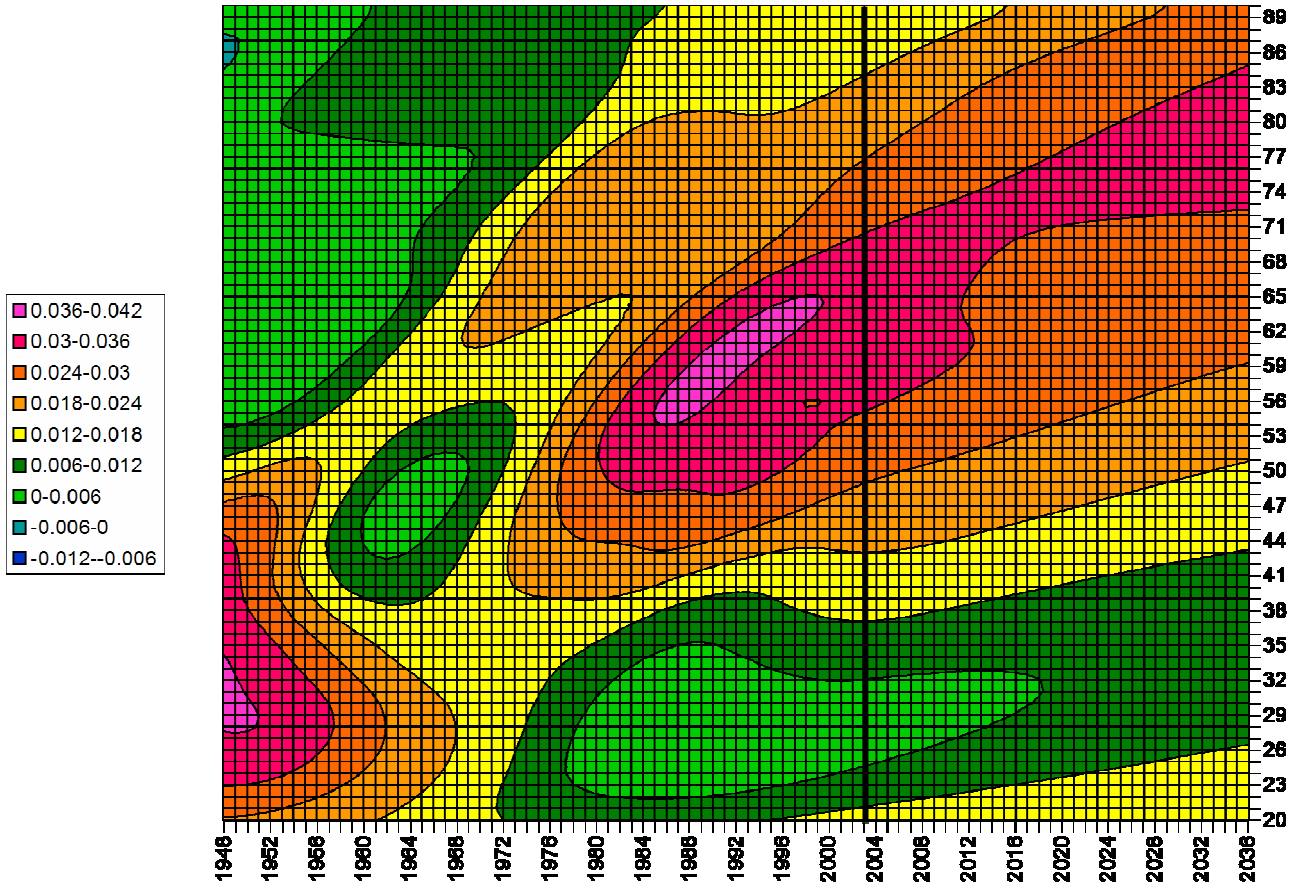


Cohort Penalty

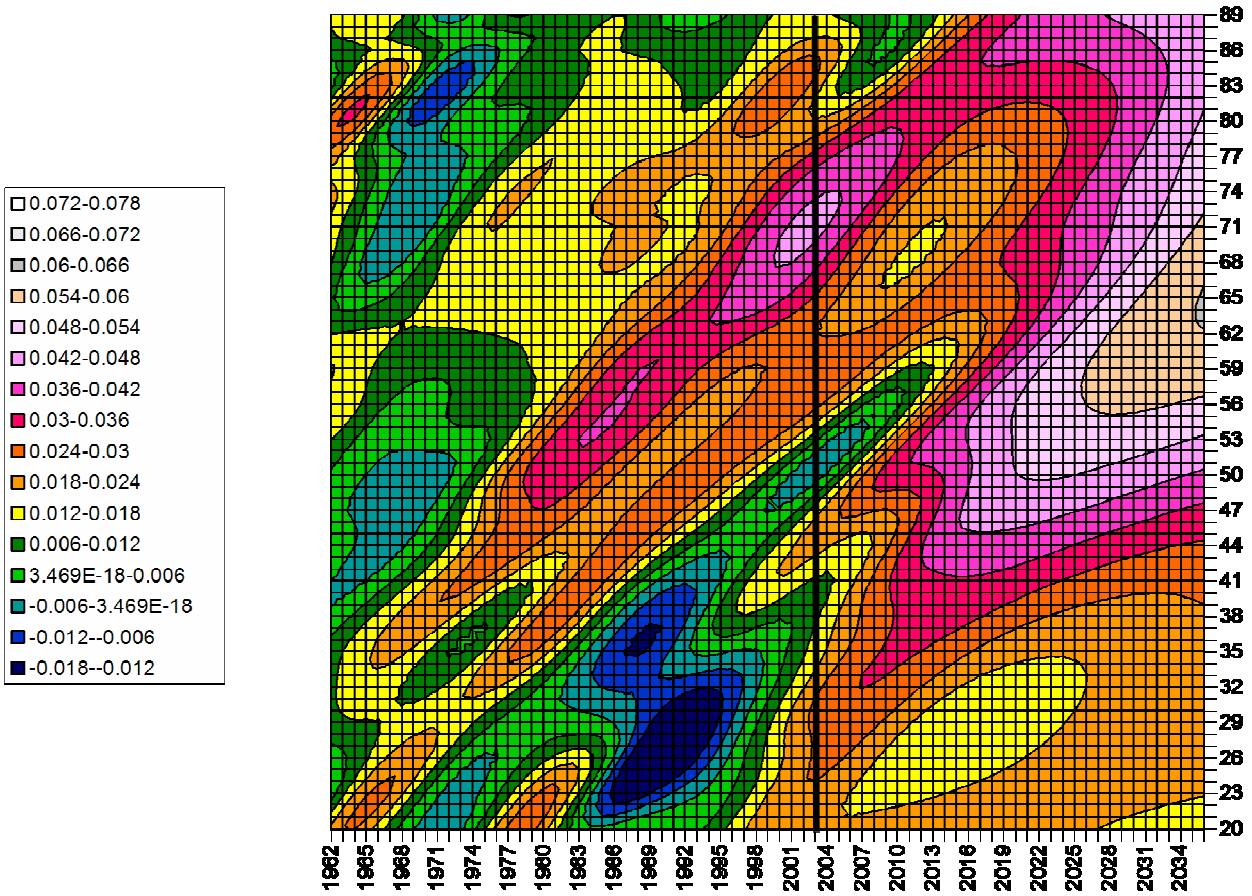


Assured lives *v* ONS

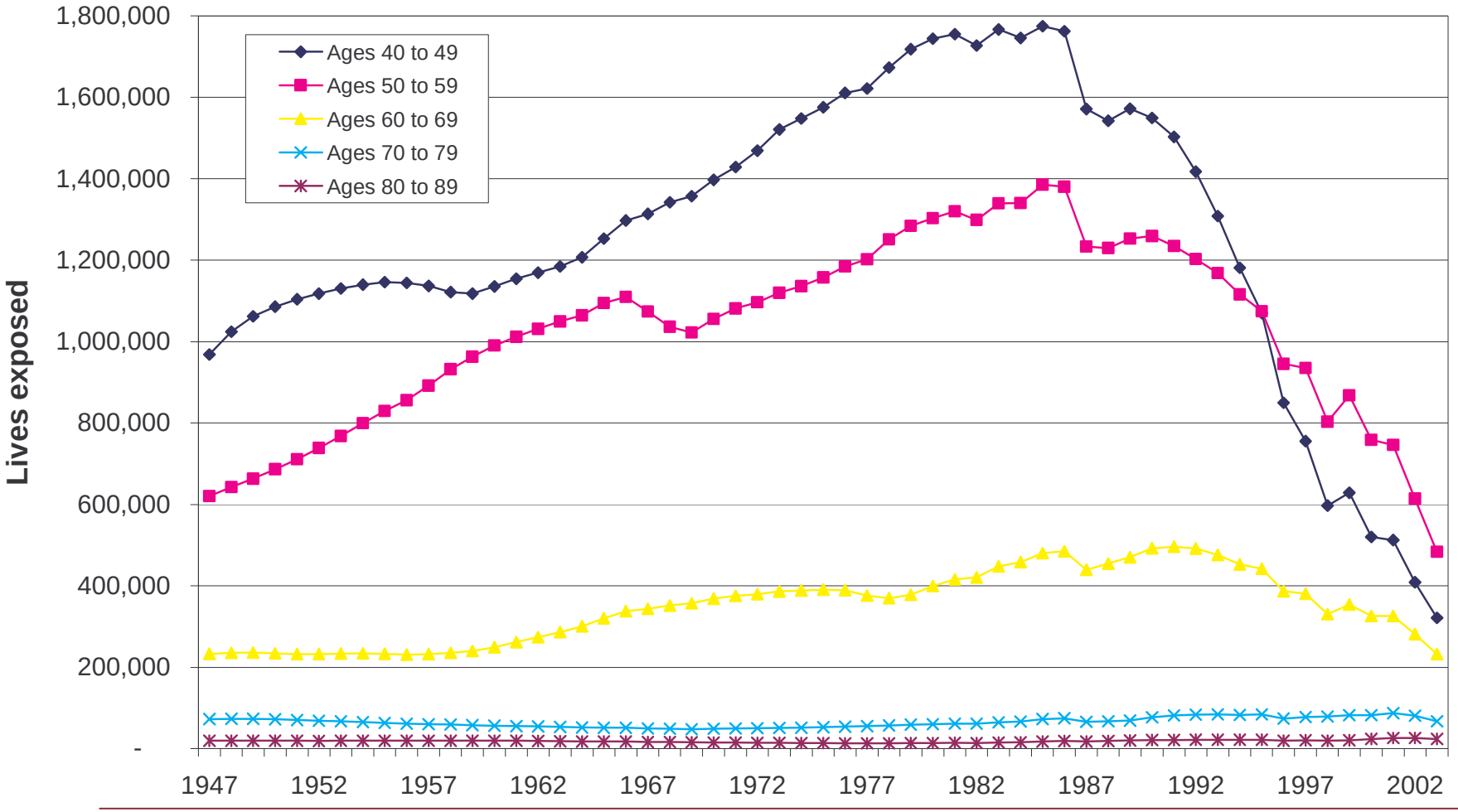
P-spline 50% : Age-Cohort penalty : Assured Lives : Age range 20-90 : Projection from 2003



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

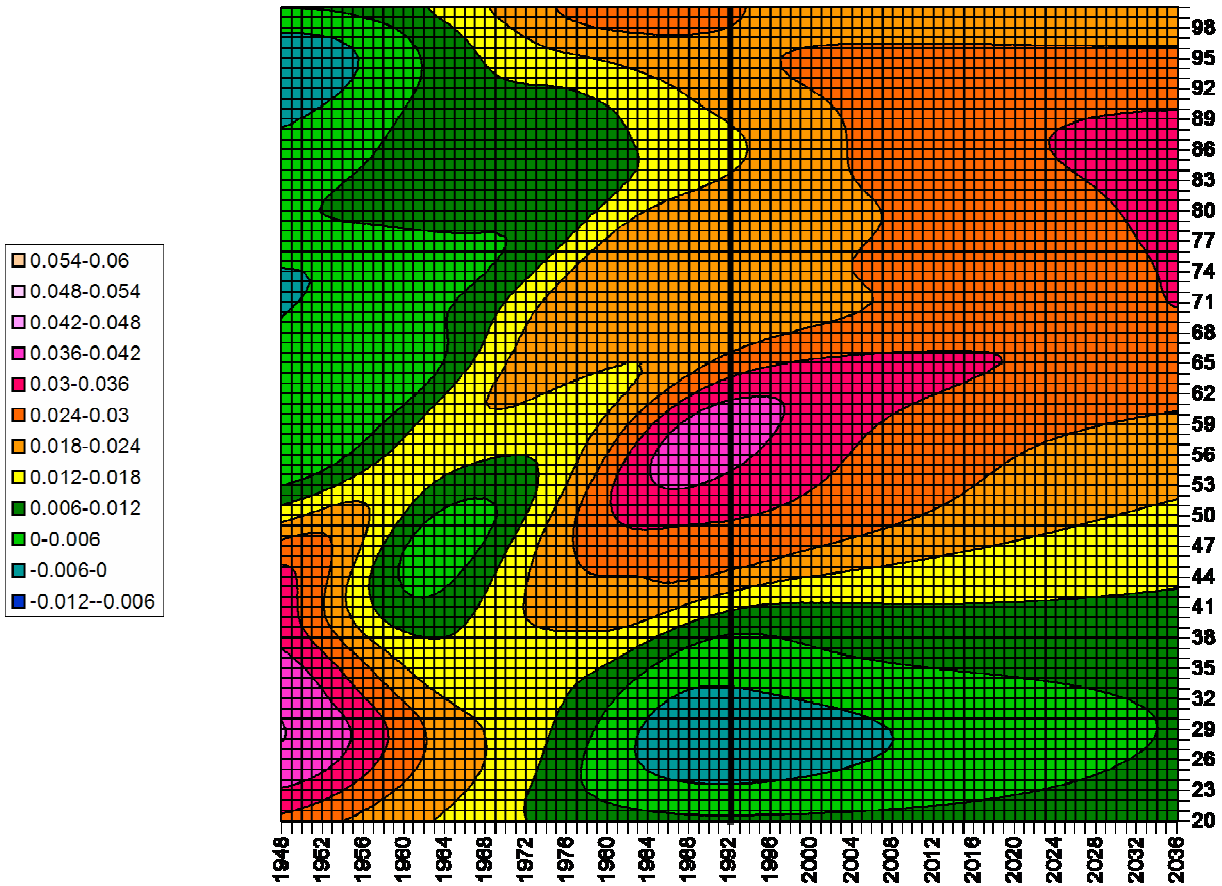


Male Exposures - CMI Assured Lives

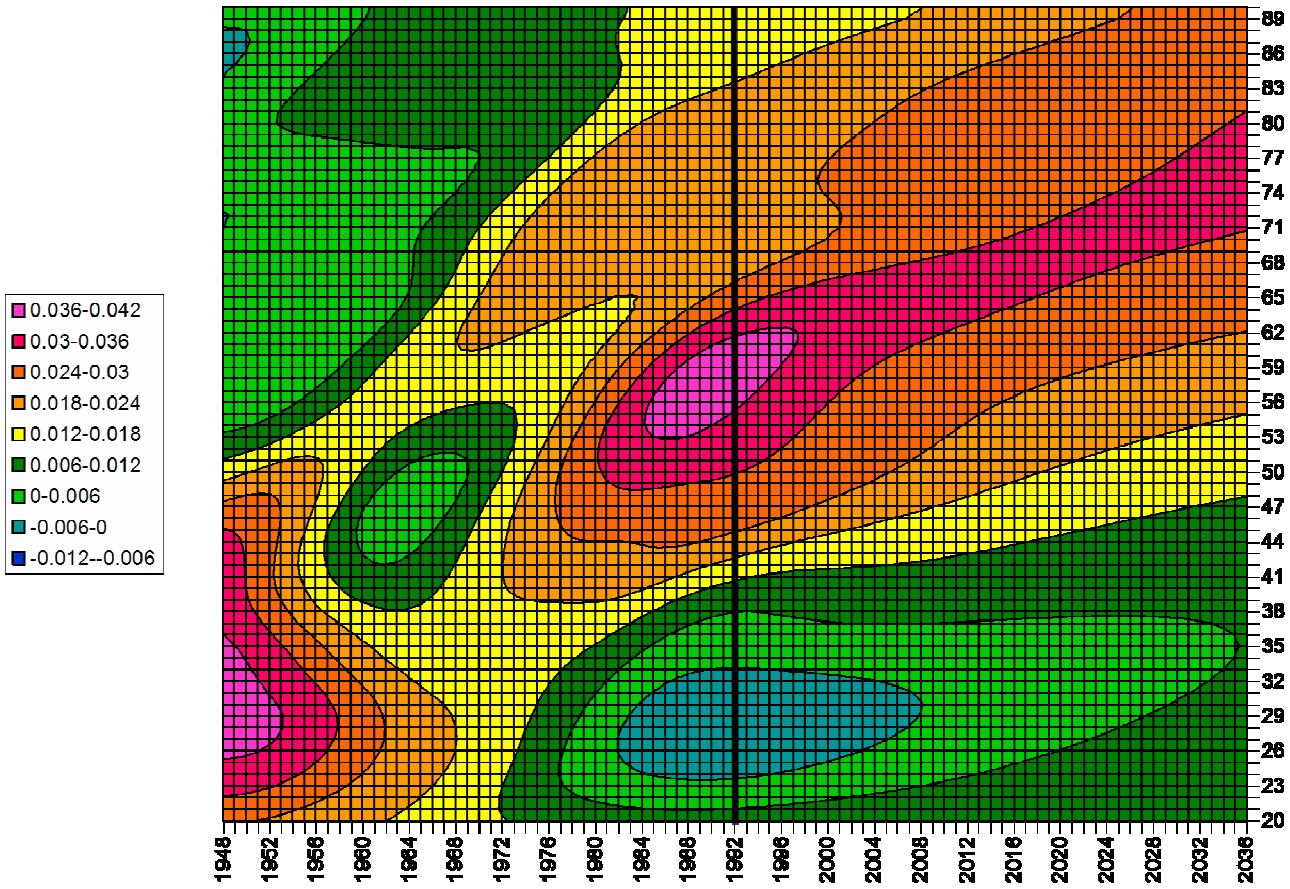


Age ranges

P-spline 50% : Age-Cohort penalty : Assured Lives : Age range 20-100 : Projection from 1992

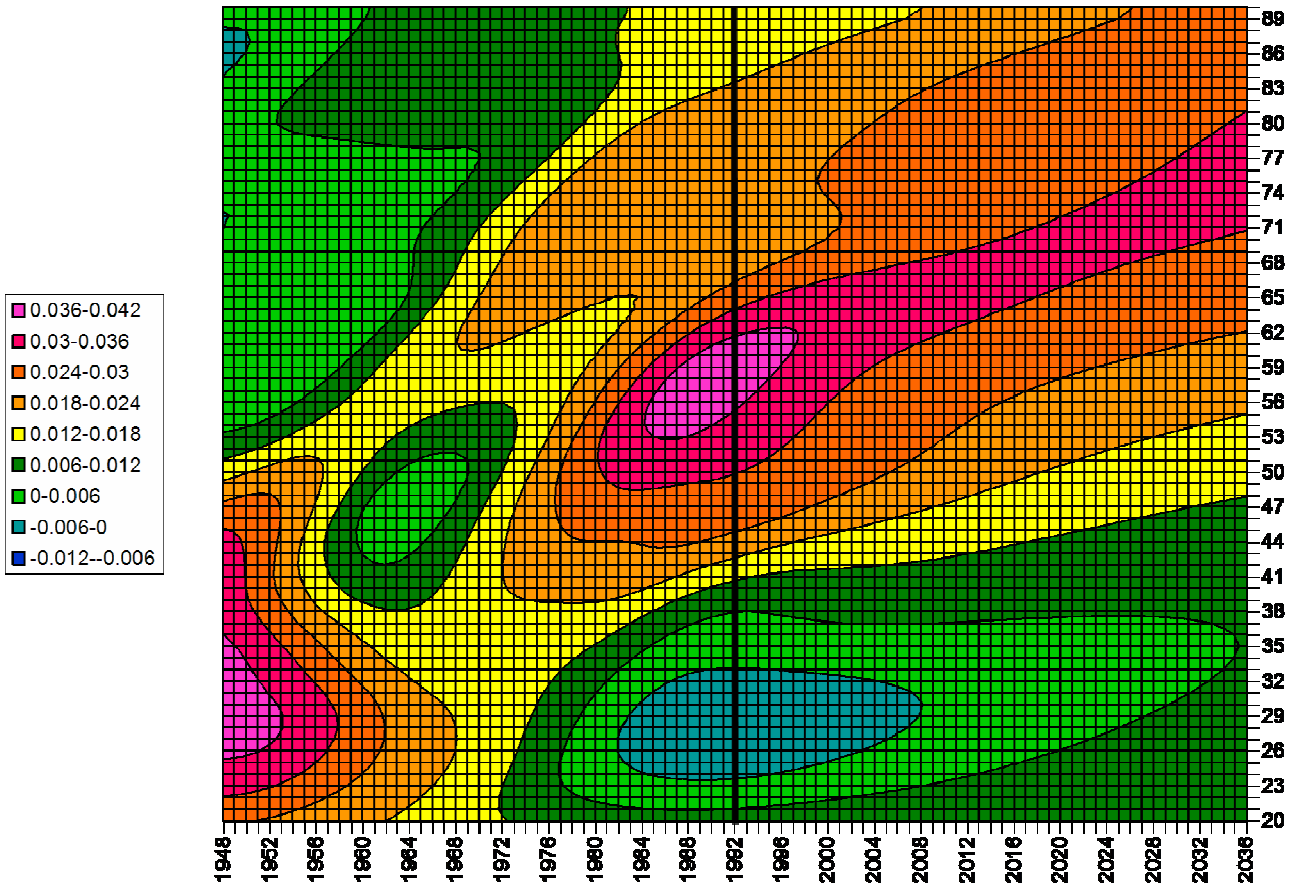


P-spline 50% : Age-Cohort penalty : Assured Lives : Age range 20-90 : Projection from 1992

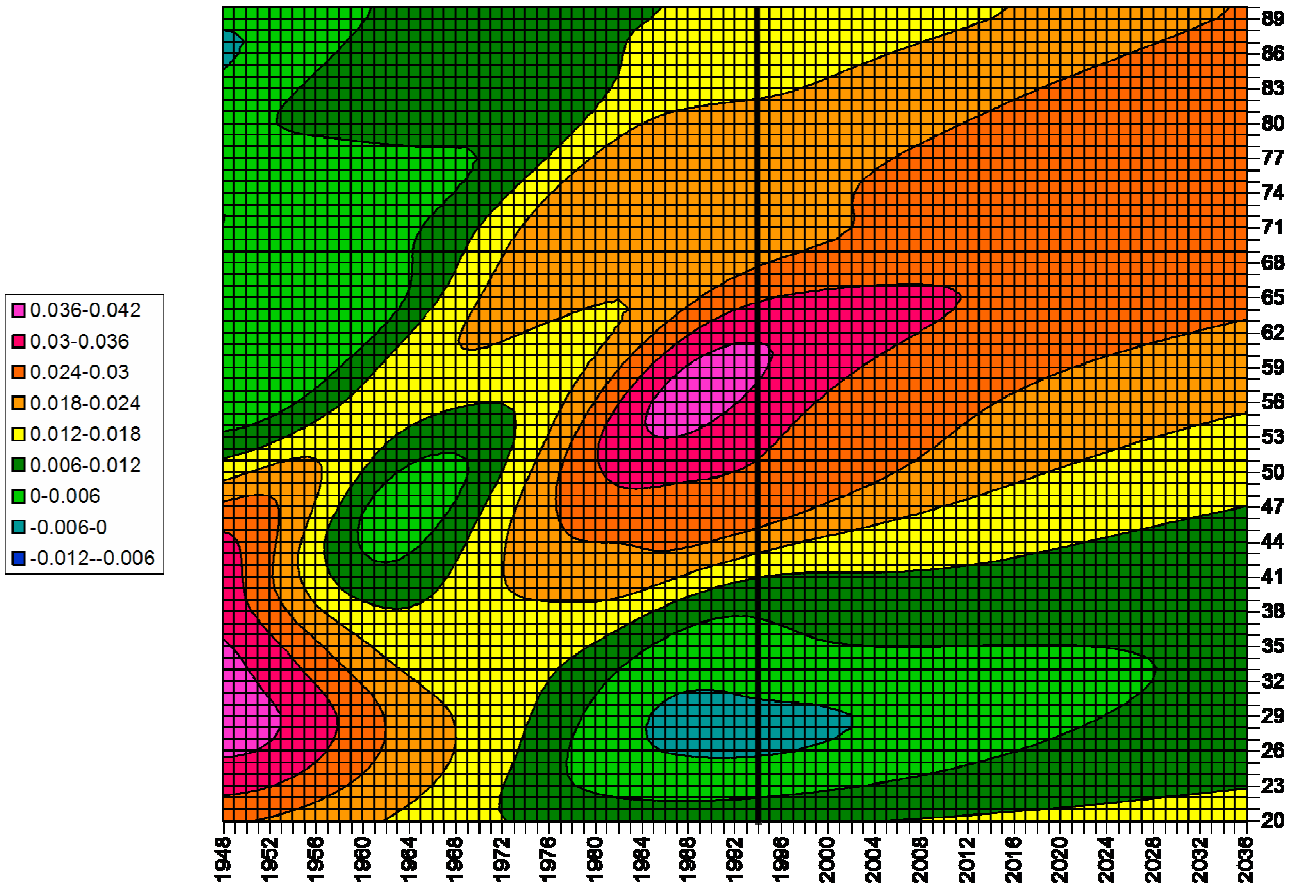


1992 to 2003

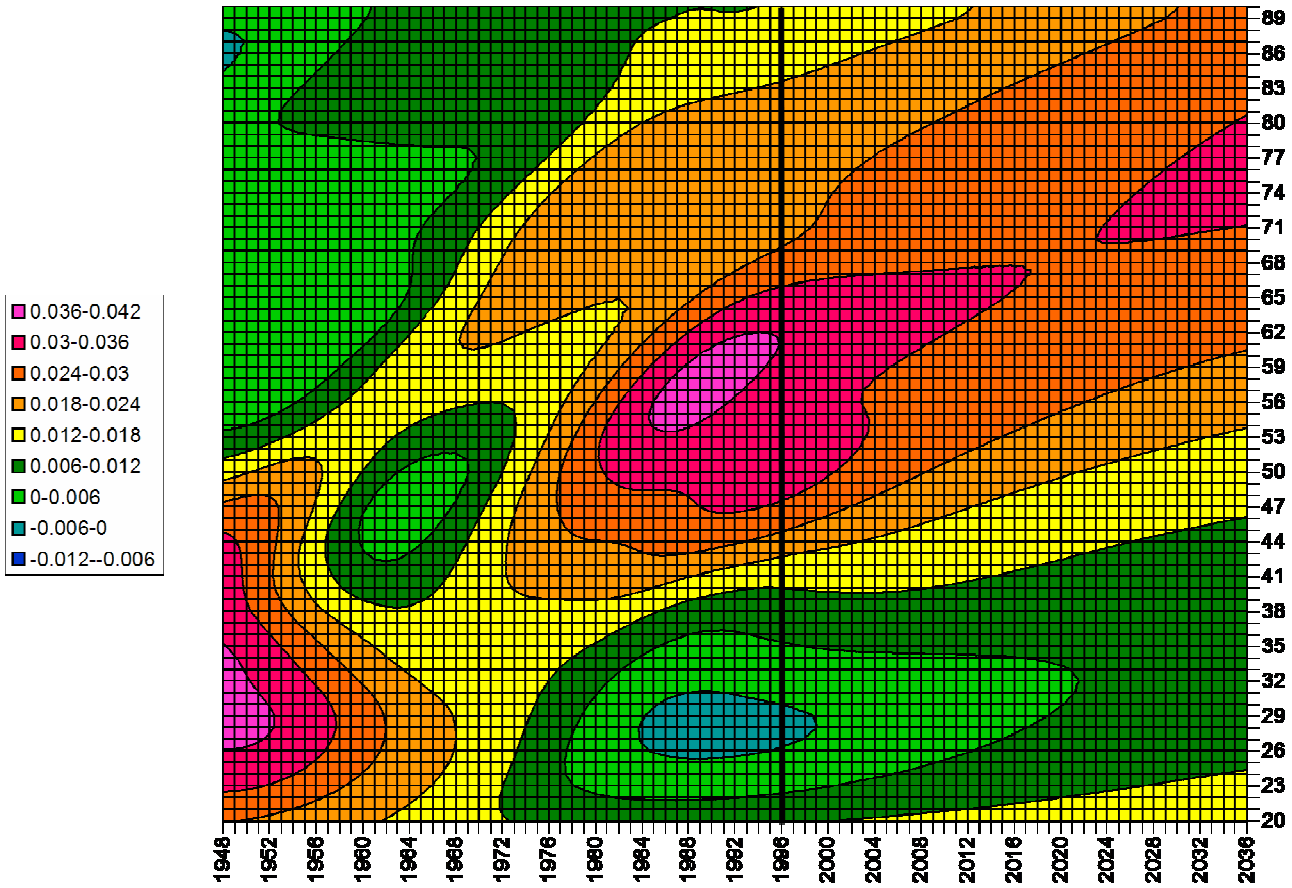
P-spline 50% : Age-cohort penalty : Assured Lives : Age range 20-90 : Projection from 1992



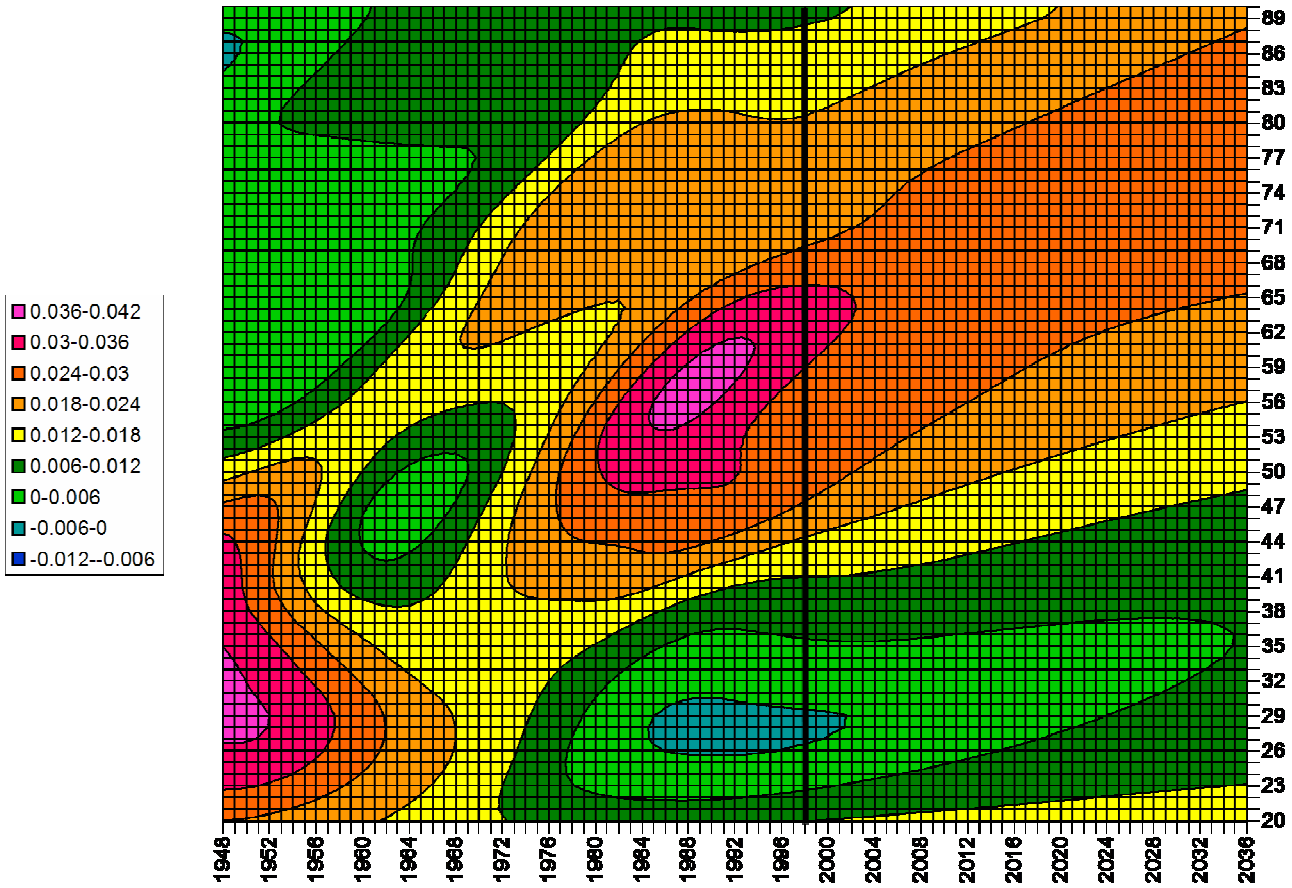
P-spline 50% : Age-cohort penalty : Assured Lives : Age range 20-90 : Projection from 1994



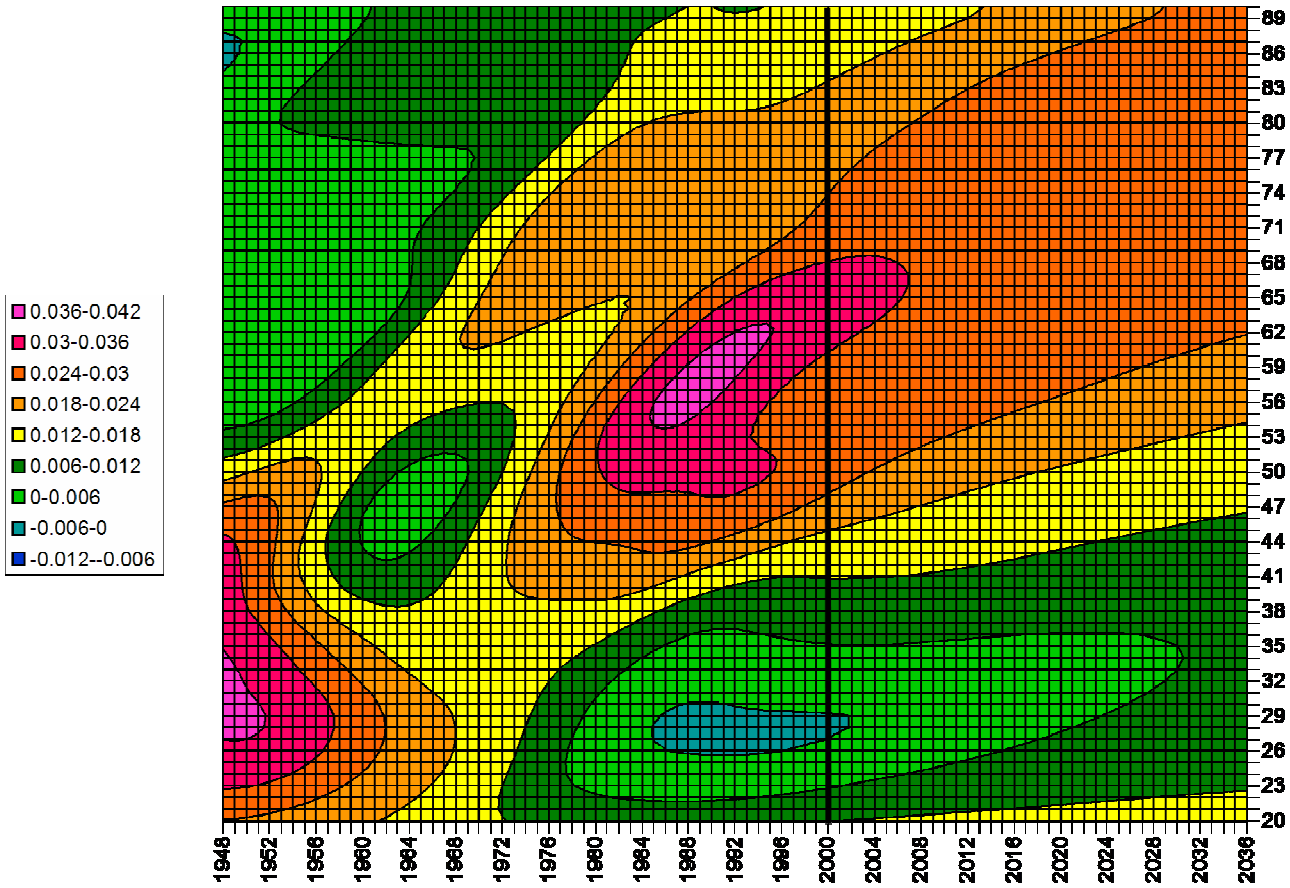
P-spline 50% : Age-cohort penalty : Assured Lives : Age range 20-90 : Projection from 1996



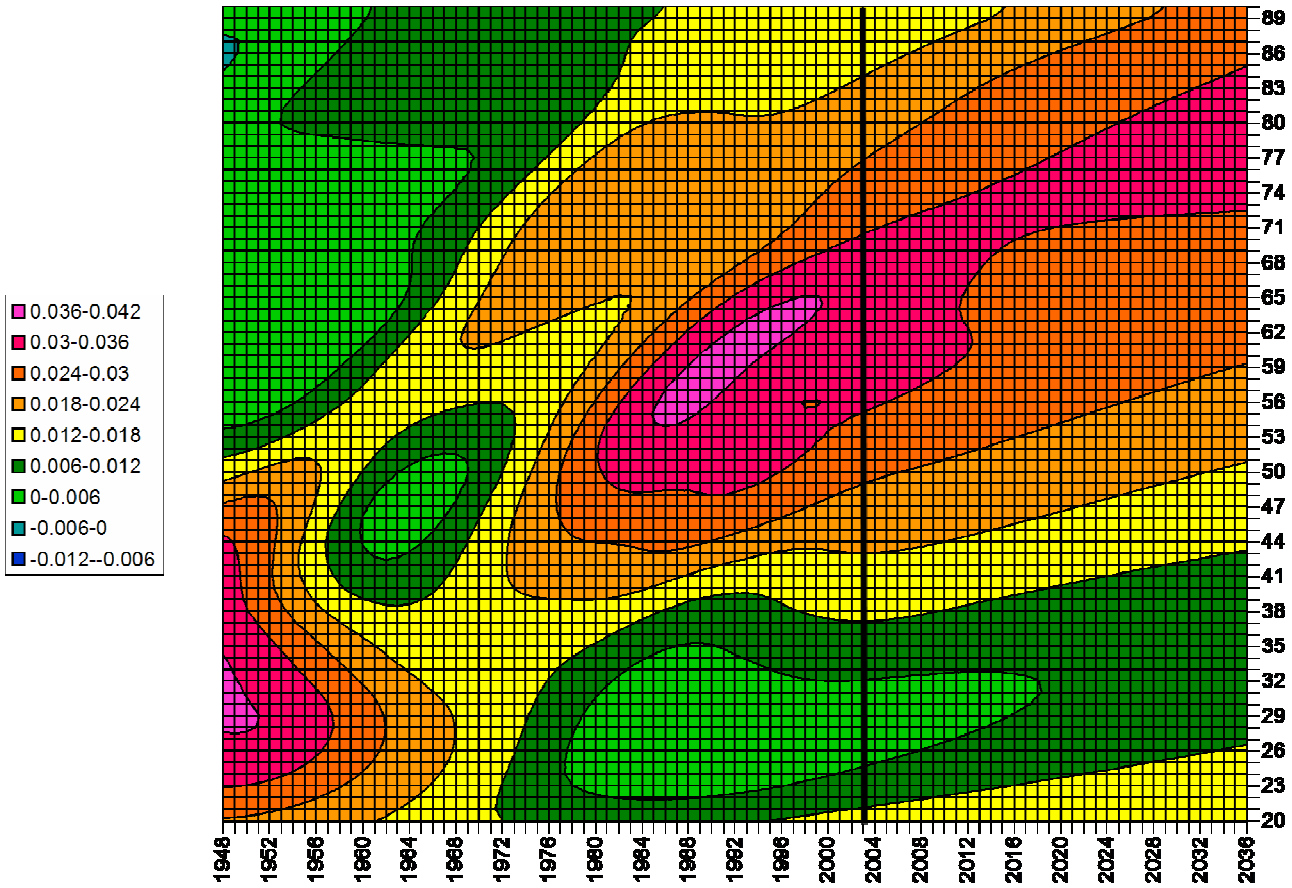
P-spline 50% : Age-cohort penalty : Assured Lives : Age range 20-90 : Projection from 1998



P-spline 50% : Age-cohort penalty : Assured Lives : Age range 20-90 : Projection from 2000

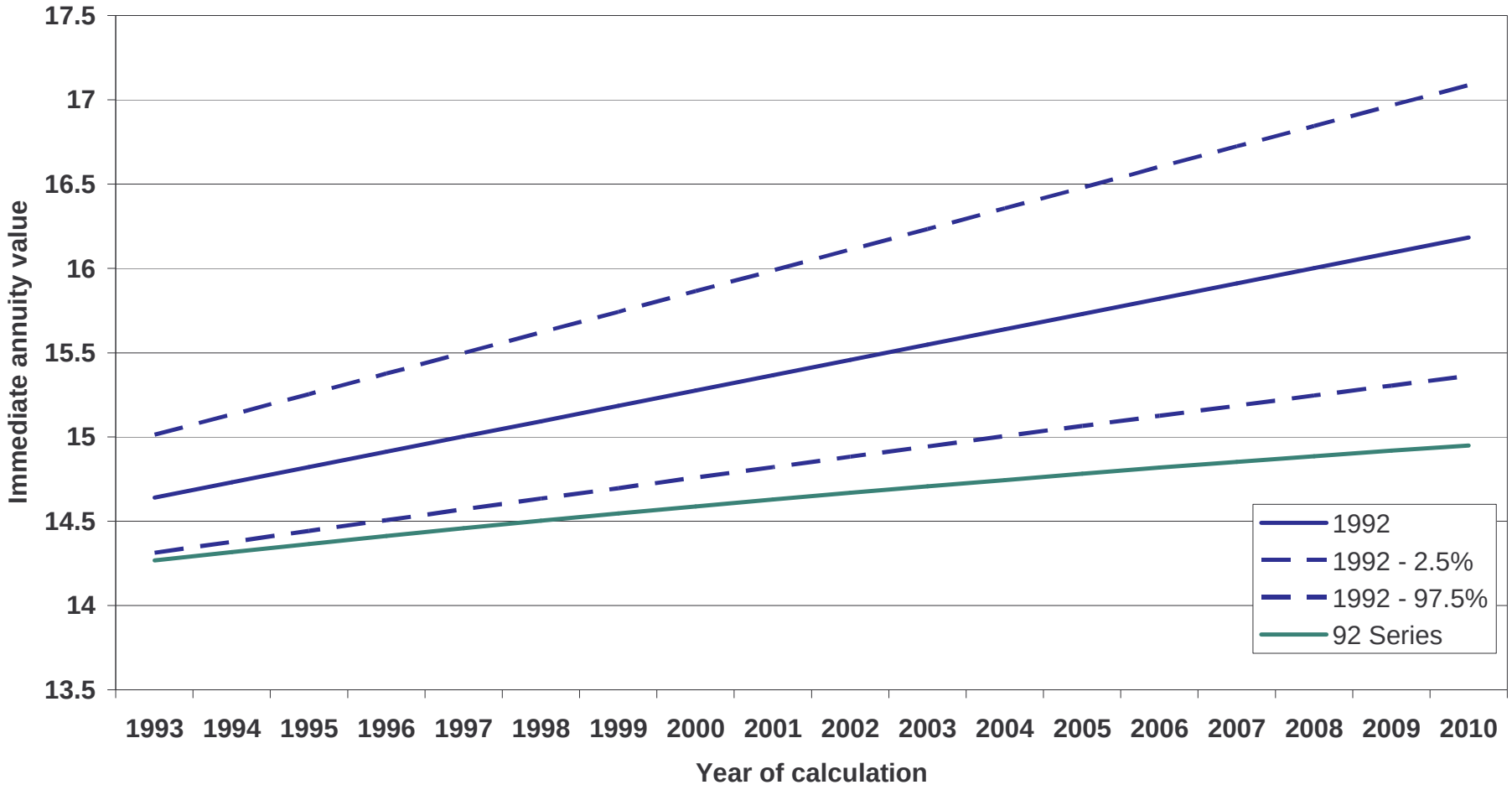


P-spline 50% : Age-cohort penalty : Assured Lives : Age range 20-90 : Projection from 2003



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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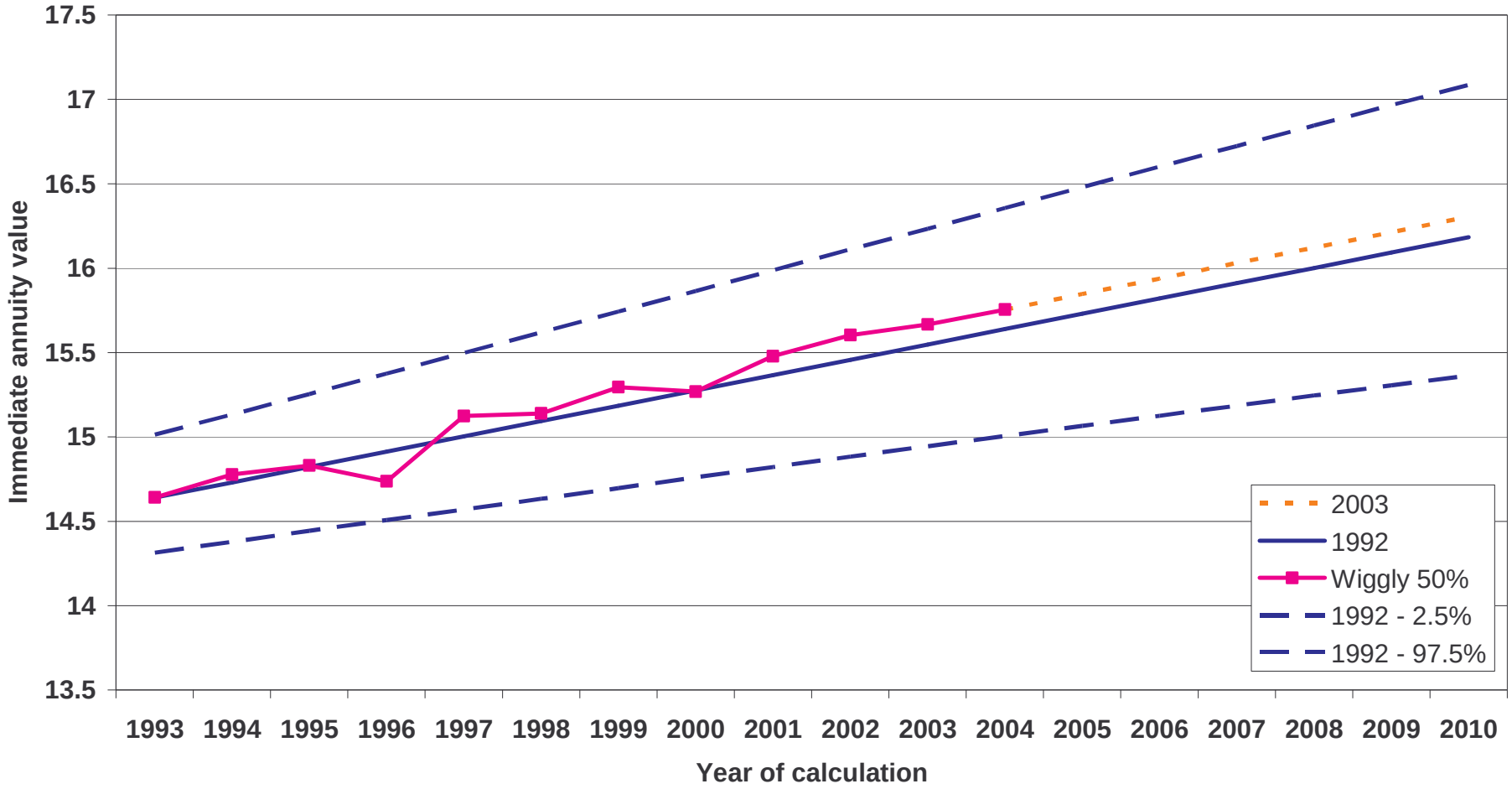

Projected annuity values for males aged 60 starting from 1993
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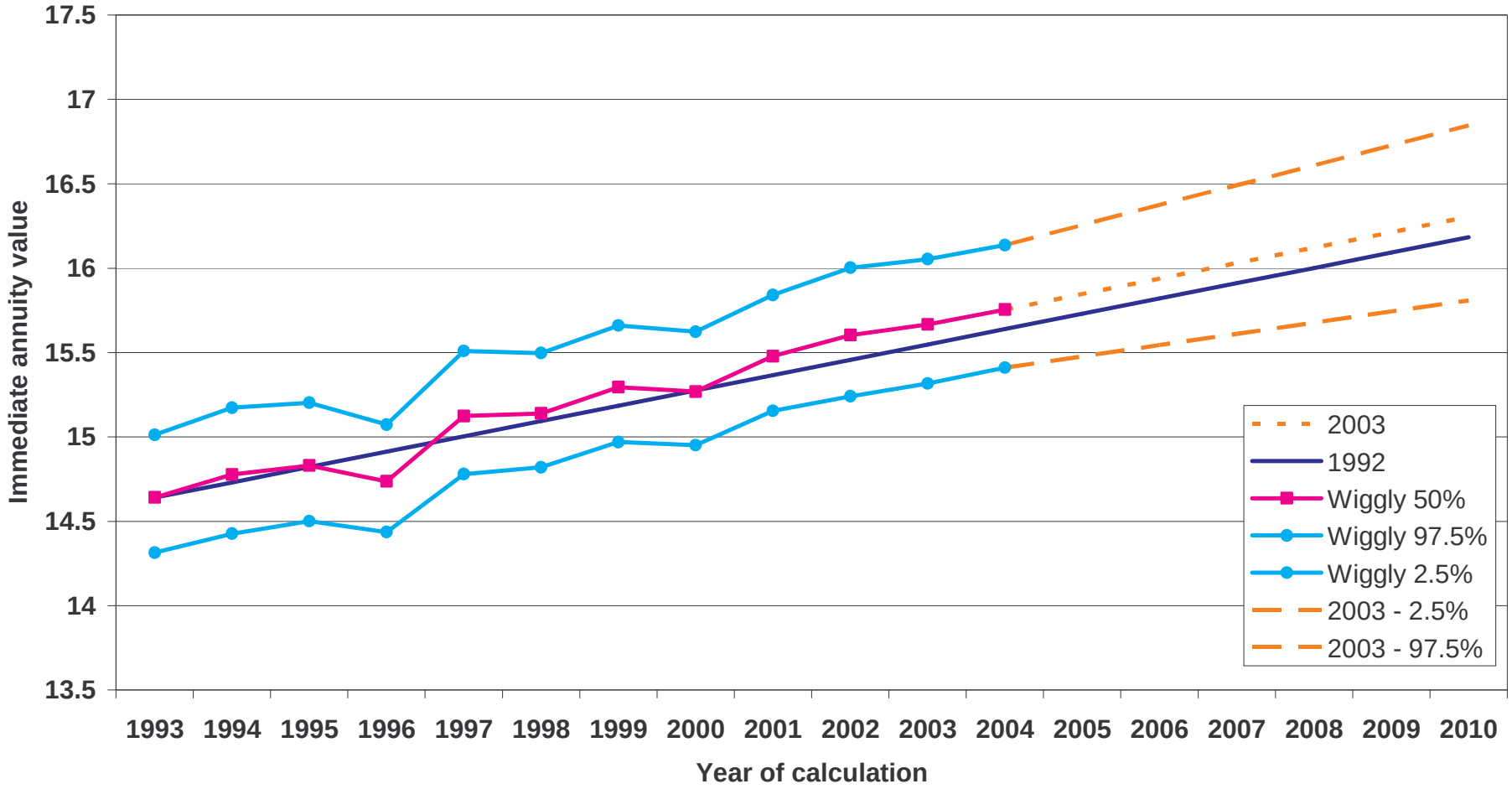
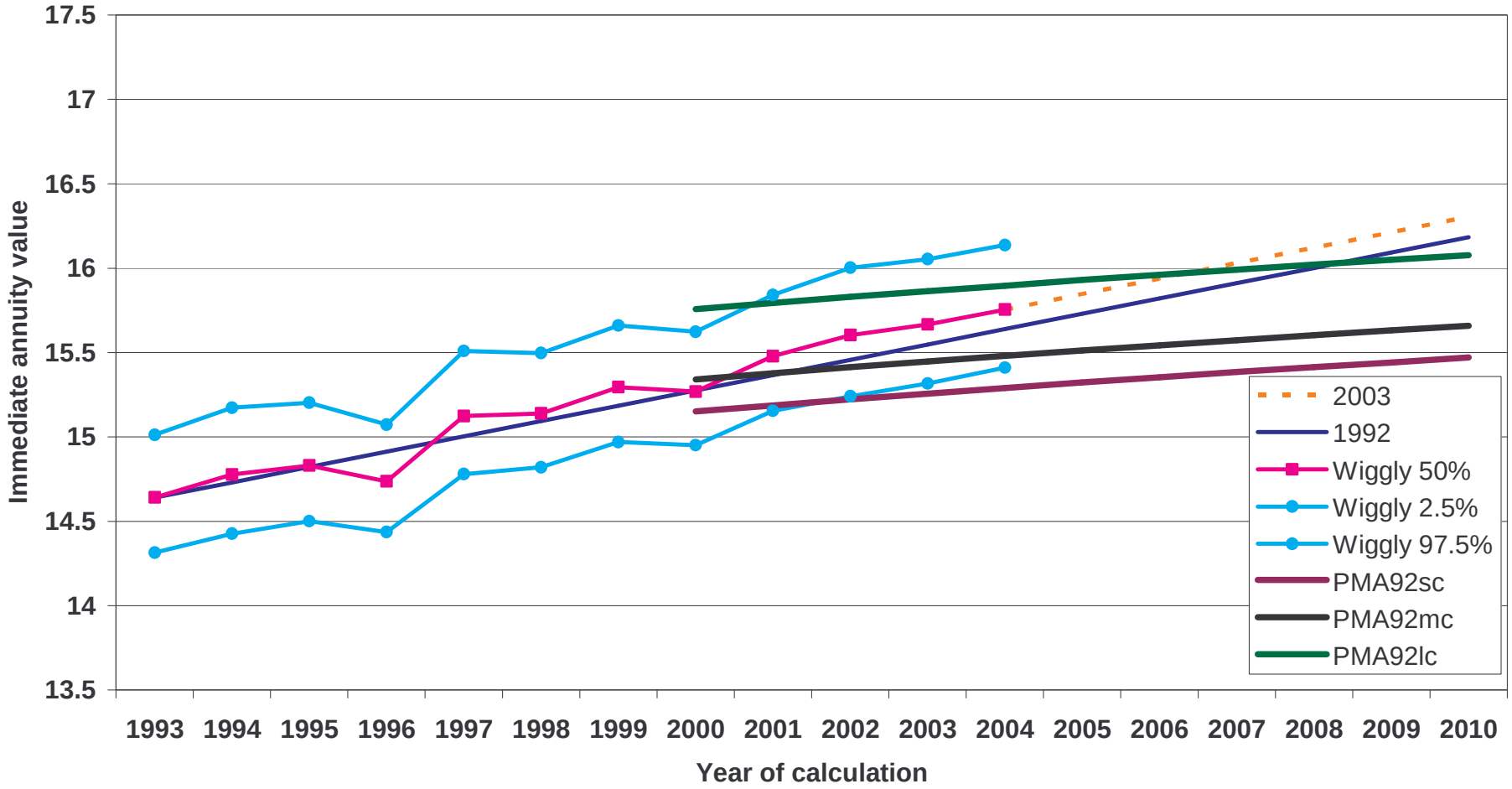
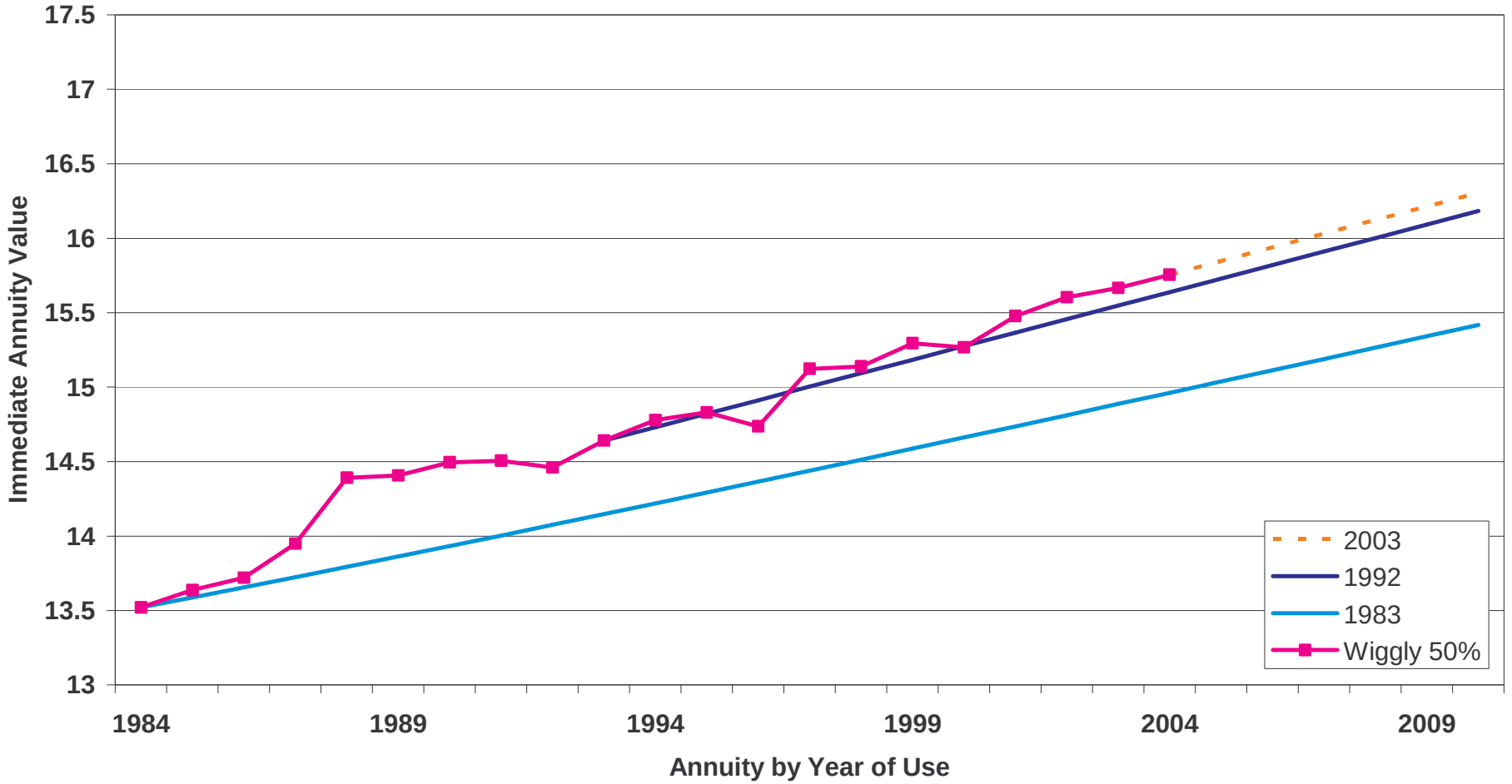


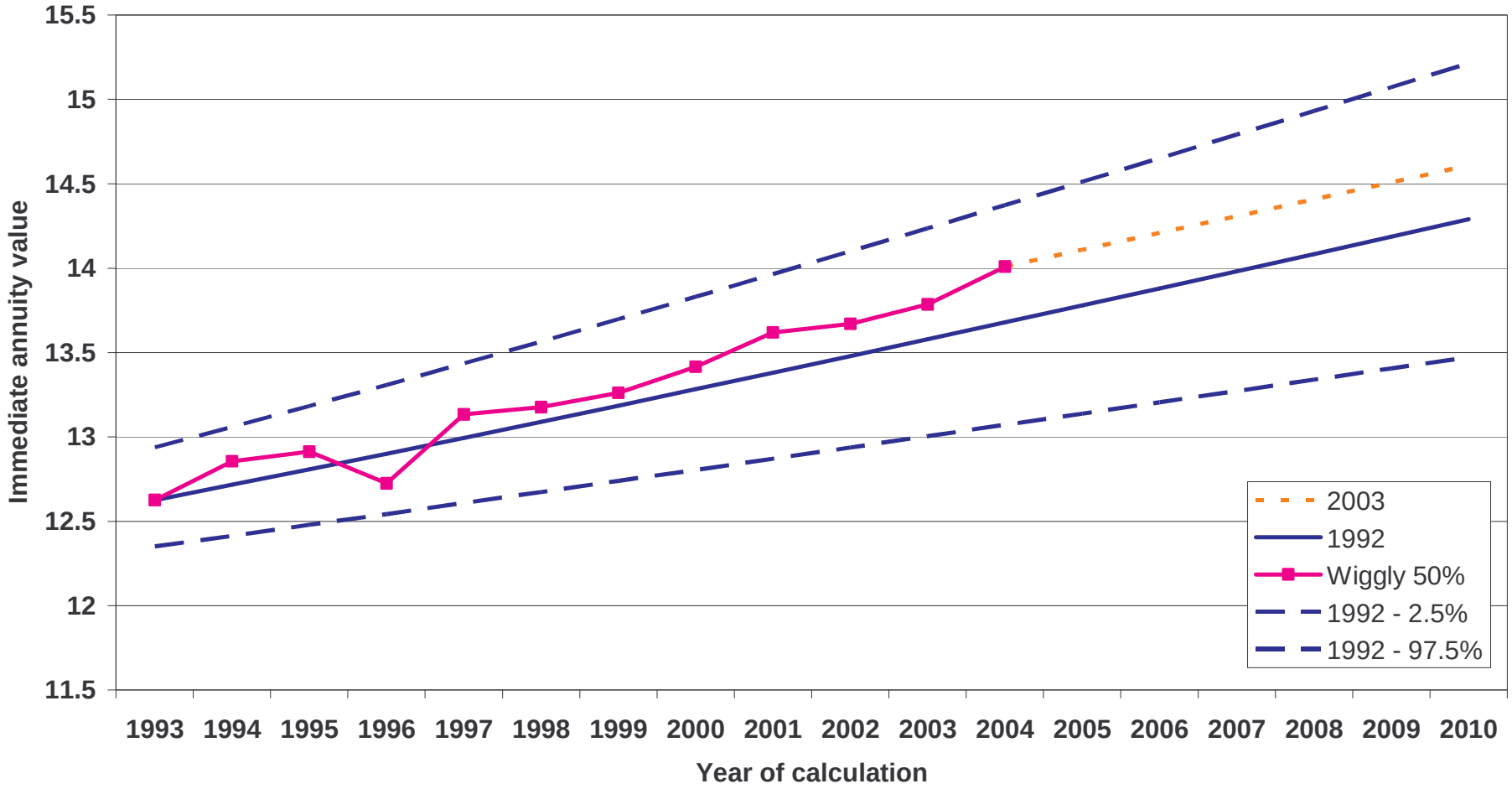
Projected annuity values for males aged 60 starting from 1993
P-Spline, age-cohort, assured lives fitted from 1947, ages 20-90, PMA92, 4.5%



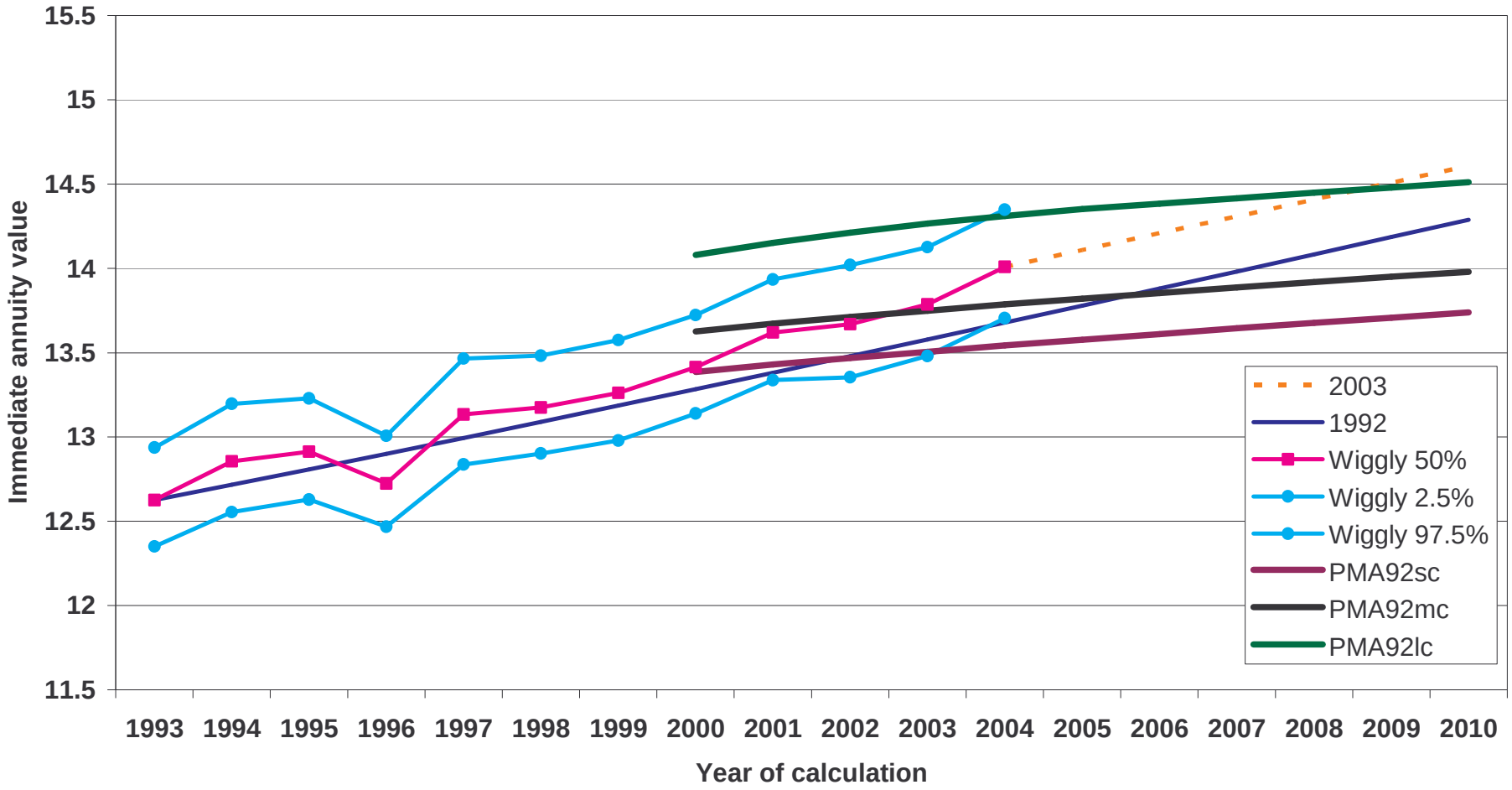
Projected annuity values for males aged 60 starting from 1984
P-Spline, age-cohort, assured lives fitted from 1947, ages 20-90, PMA92, 4.5%



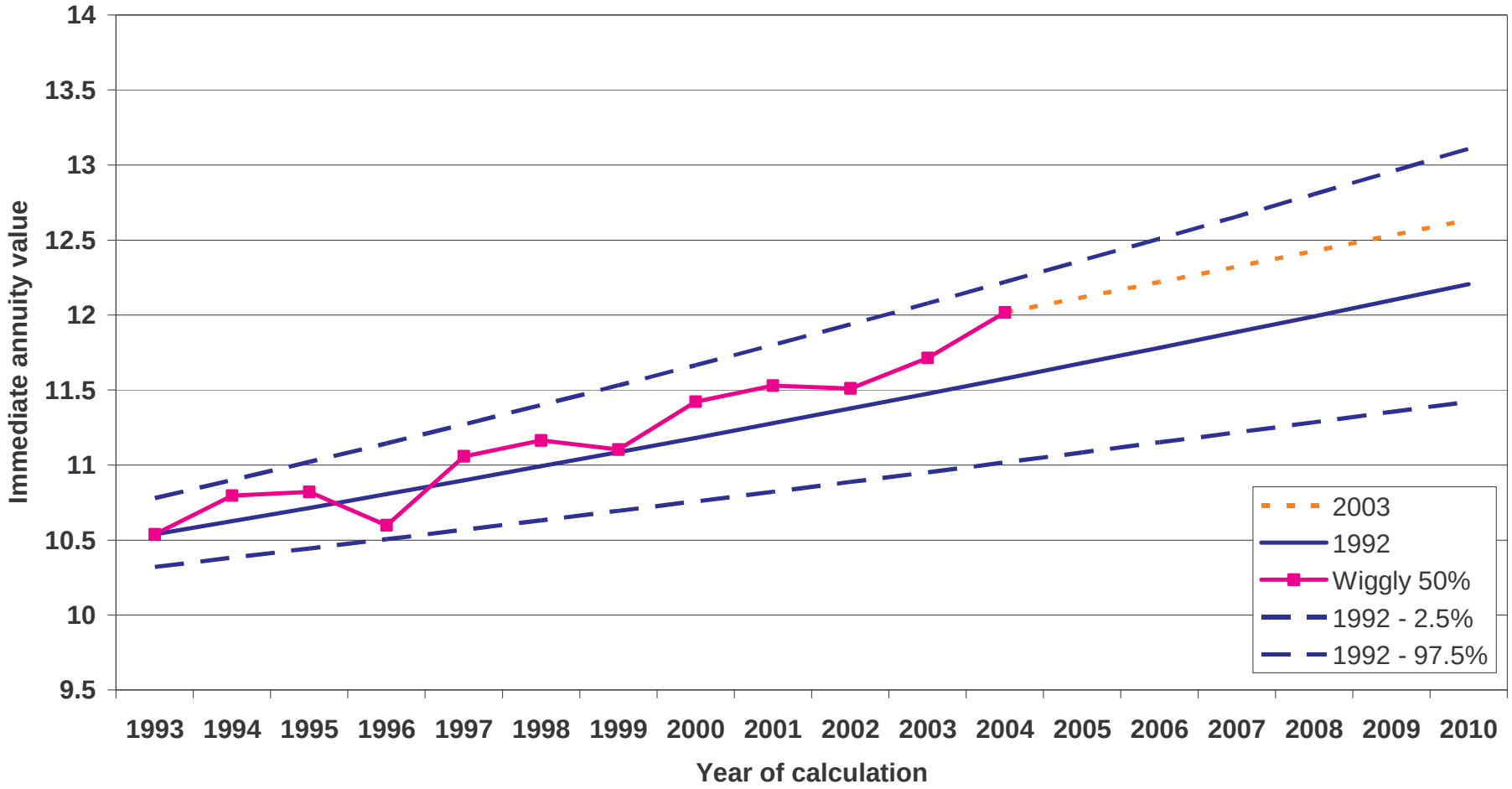
Projected annuity values for males aged 65 starting from 1993
P-Spline, age-cohort, assured lives fitted from 1947, ages 20-90, PMA92, 4.5%



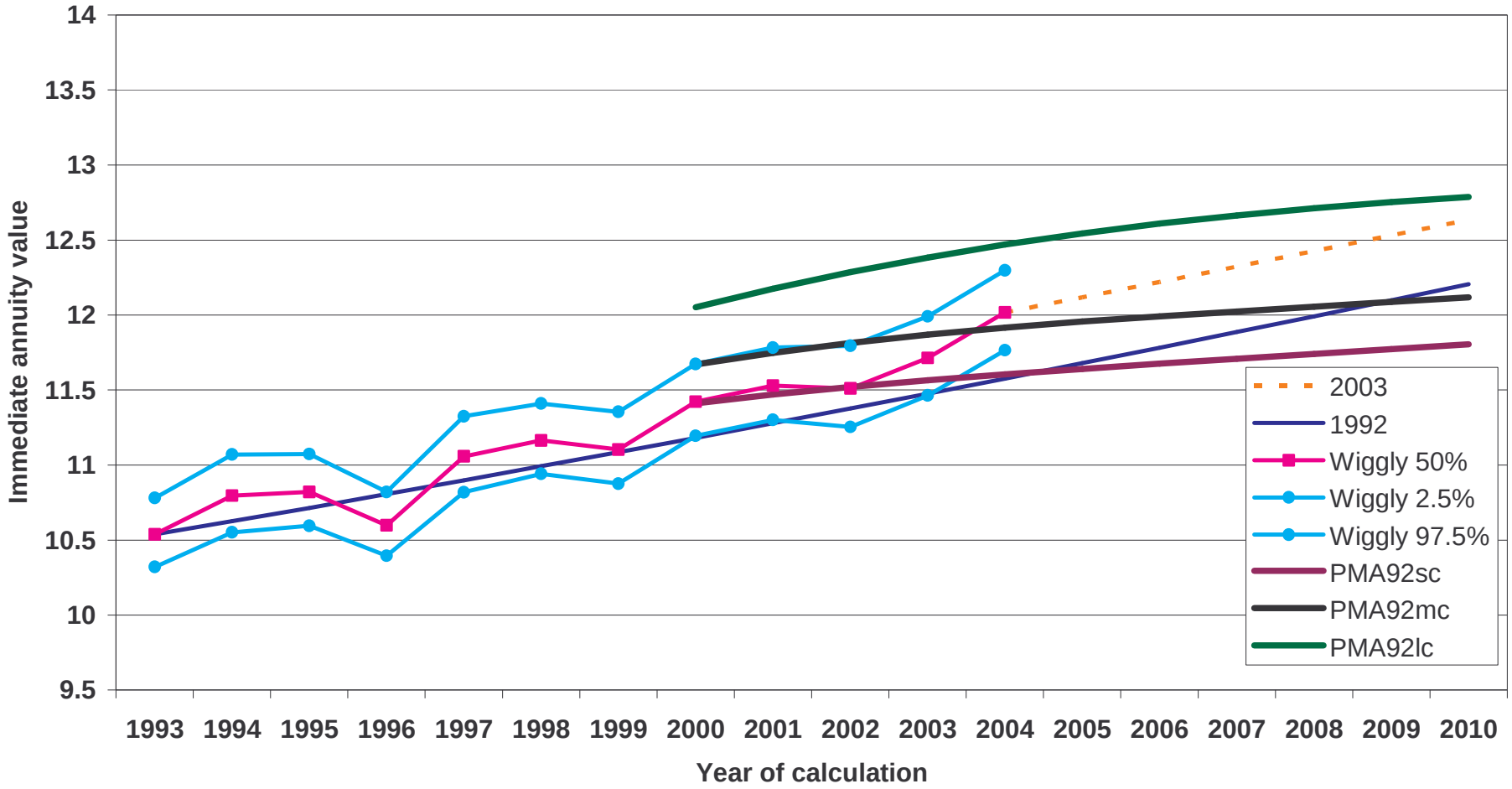
Projected annuity values for males aged 65 starting from 1993
P-Spline, age-cohort, assured lives fitted from 1947, ages 20-90, PMA92, 4.5%



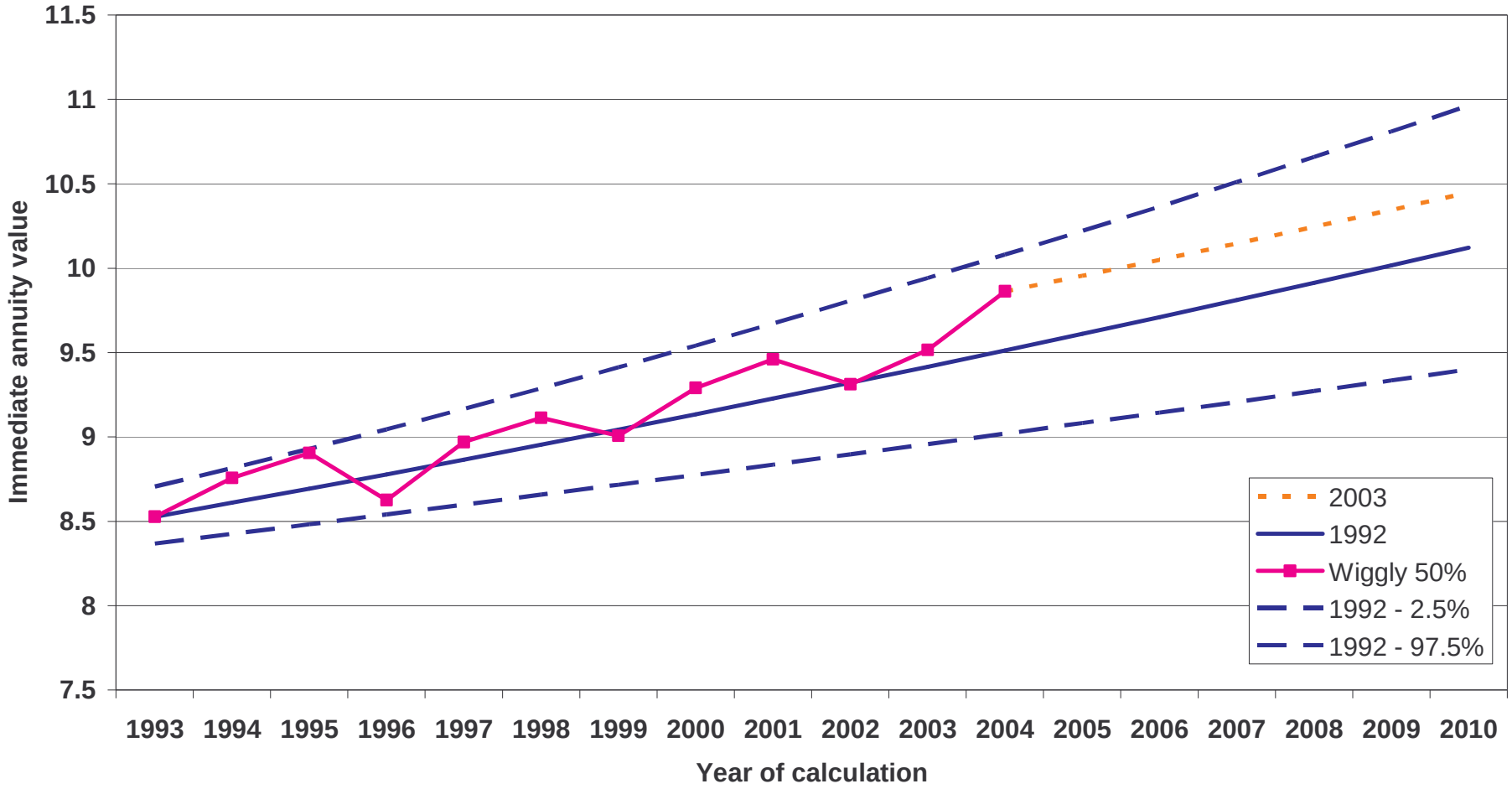
Projected annuity values for males aged 70 starting from 1993
P-Spline, age-cohort, assured lives fitted from 1947, ages 20-90, PMA92, 4.5%



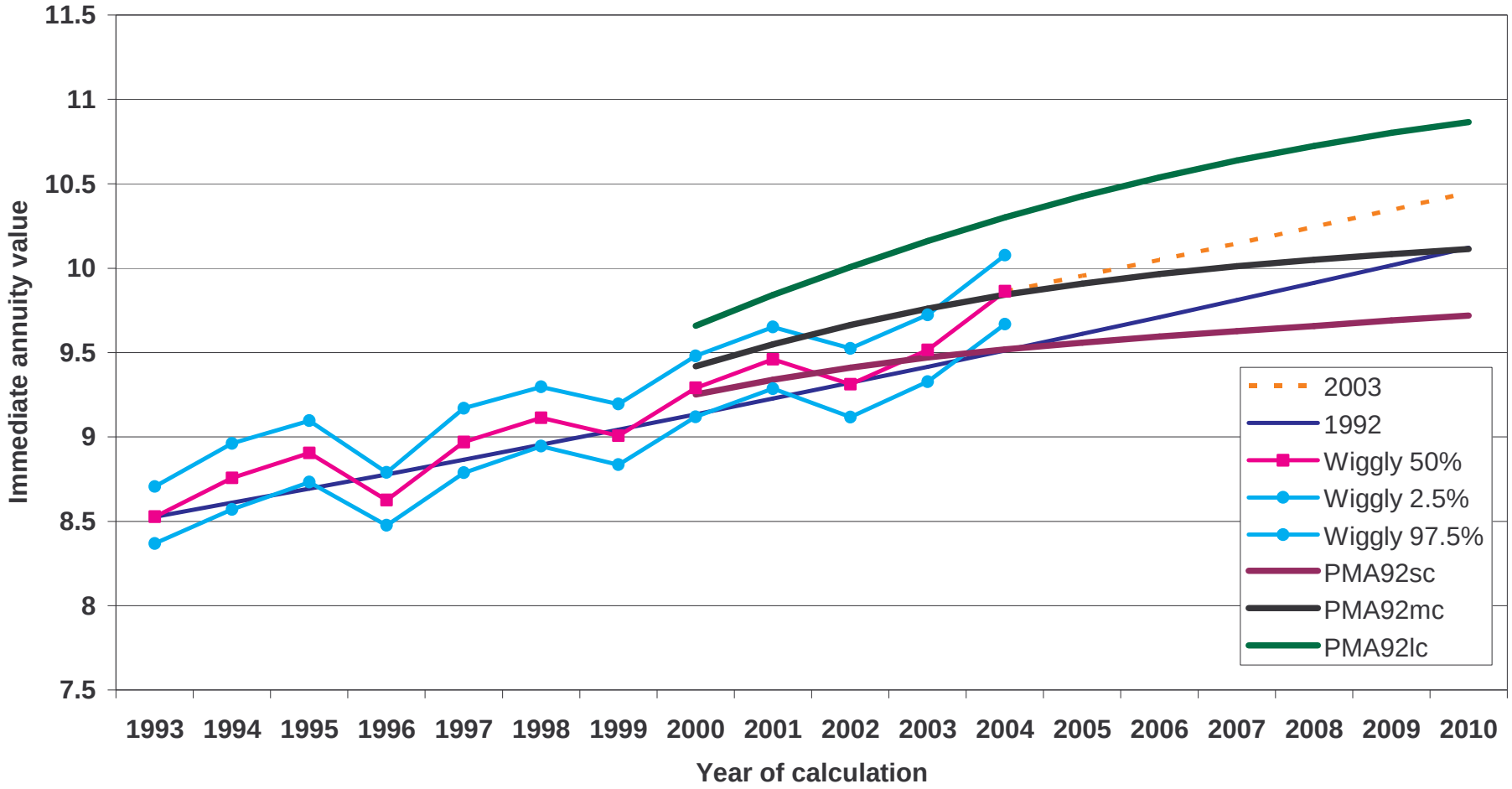
Projected annuity values for males aged 70 starting from 1993
P-Spline, age-cohort, assured lives fitted from 1947, ages 20-90, PMA92, 4.5%



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%



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%



Projected annuity values for males aged 65 starting from 1993
P-spline, age-cohort, ONS data fitted from 1961, ages 20-89, PMA92, 4.5%

$\ddot{a}_x$ @ 4.5%

Projection basis = male assured lives,1947 to 2003, ages 20 - 90

Mortality Basis	Male aged					
	60		65		75	
PMA92u04mc	15.480		13.786		9.842	
PMA00u04p-s50ac	15.753	**101.8%**	14.008	**101.6%**	9.840	**100.0%**
PMA00u04p-s97.5ac	16.132	**104.2%**	14.344	**104.0%**	10.051	**102.1%**
PMA00u04p-s2.5ac	15.413	**99.6%**	13.707	**99.4%**	9.649	**98.0%**
PMA00u04p-s50ap	15.688	**101.3%**	13.978	**101.4%**	9.863	**100.2%**
PMA00u04p-s97.5ap	16.171	**104.5%**	14.411	**104.5%**	10.144	**103.1%**
PMA00u04p-s2.5ap	15.271	**98.6%**	13.606	**98.7%**	9.616	**97.7%**

Illustrative numbers not yet agreed by the Working Party
These results are based on particular "knot" parameters – different parameters will give different results

$\ddot{a}_x$ @ 4.5%

Projection Basis = ONS UK males,1961 to 2003, ages 20 - 89

Mortality Basis	Male aged					
	60		65		75	
PMA92u04mc	15.480		13.786		9.842	
PMA00u04p-s50ac	16.057	**103.7%**	14.325	**103.9%**	9.876	**100.3%**
PMA00u04p-s97.5ac	17.189	**111.0%**	15.361	**111.4%**	10.462	**106.3%**
PMA00u04p-s2.5ac	15.070	**97.3%**	13.494	**97.9%**	9.429	**95.8%**
PMA00u04p-s50ap	14.944	**96.5%**	13.356	**96.9%**	9.470	**96.2%**
PMA00u04p-s97.5ap	16.146	**104.3%**	14.402	**104.5%**	10.098	**102.6%**
PMA00u04p-s2.5ap	14.160	**91.5%**	12.660	**91.8%**	9.019	**91.6%**

Illustrative numbers not yet agreed by the Working Party
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Female $\ddot{a}_x$ @ 4.5%

Projection Basis = male assured lives,1947 to 2003, ages 20 - 90

Mortality Basis	Female aged					
	60		65		75	
PFA92u04mc	16.327		14.814		11.166	
PFA00u04p-s50ac	16.506	**101.1%**	14.907	**100.6%**	10.825	**96.9%**
PFA00u04p-s97.5ac	16.904	**103.5%**	15.276	**103.1%**	11.077	**99.2%**
PFA00u04p-s2.5ac	16.139	**98.9%**	14.572	**98.4%**	10.596	**94.9%**
PFA00u04p-s50ap	16.444	**100.7%**	14.880	**100.4%**	10.850	**97.2%**
PFA00u04p-s97.5ap	16.955	**103.8%**	15.358	**103.7%**	11.188	**100.2%**
PFA00u04p-s2.5ap	15.990	**97.9%**	14.462	**97.6%**	10.553	**94.5%**

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Female $\ddot{a}_x$ @ 4.5%

Projection basis = ONS UK females,1961 to 2003, ages 20 - 89

Mortality Basis	Female aged					
	60		65		75	
PFA92u04mc	16.327		14.814		11.166	
PFA00u04p-s50ac	16.431	**100.6%**	14.841	**100.2%**	10.641	**95.3%**
PFA00u04p-s97.5ac	16.991	**104.1%**	15.349	**103.6%**	10.957	**98.1%**
PFA00u04p-s2.5ac	15.922	**97.5%**	14.391	**97.1%**	10.364	**92.8%**
PFA00u04p-s50ap	12.421	**76.1%**	11.157	**75.3%**	8.199	**73.4%**
PFA00u04p-s97.5ap	20.732	**127.0%**	20.037	**135.3%**	17.214	**154.2%**
PFA00u04p-s2.5ap	8.590	**52.6%**	7.940	**53.6%**	6.167	**55.2%**

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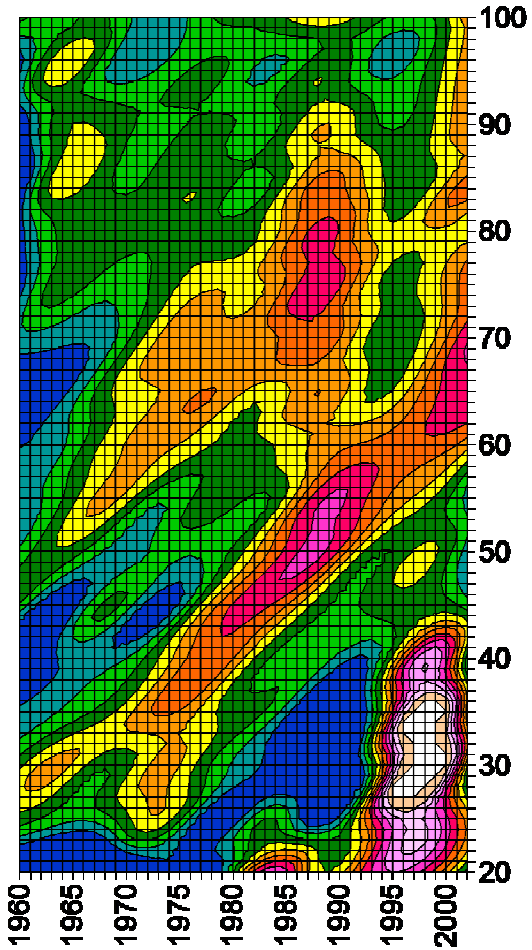
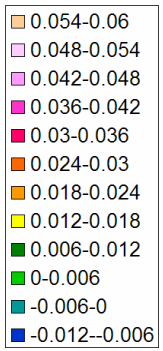
Other countries

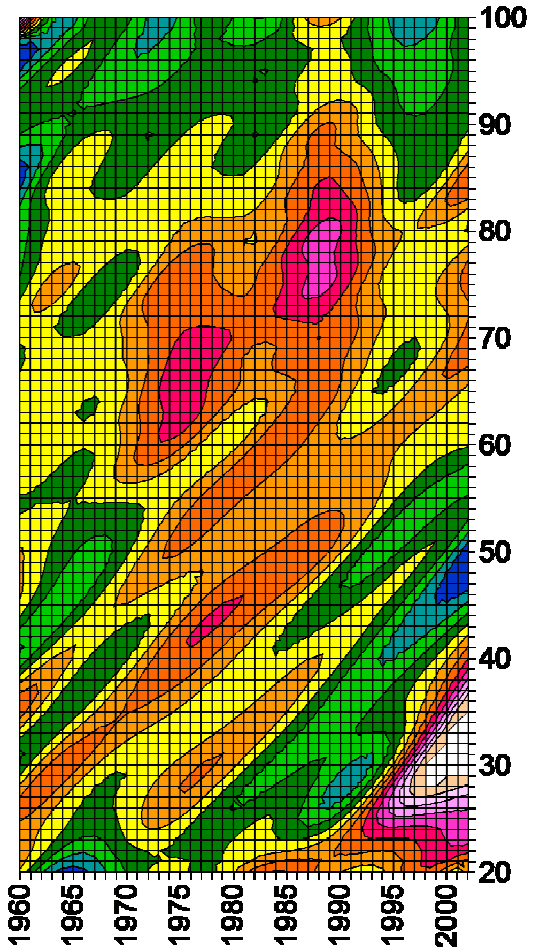
France, P-spline, age-cohort

Males



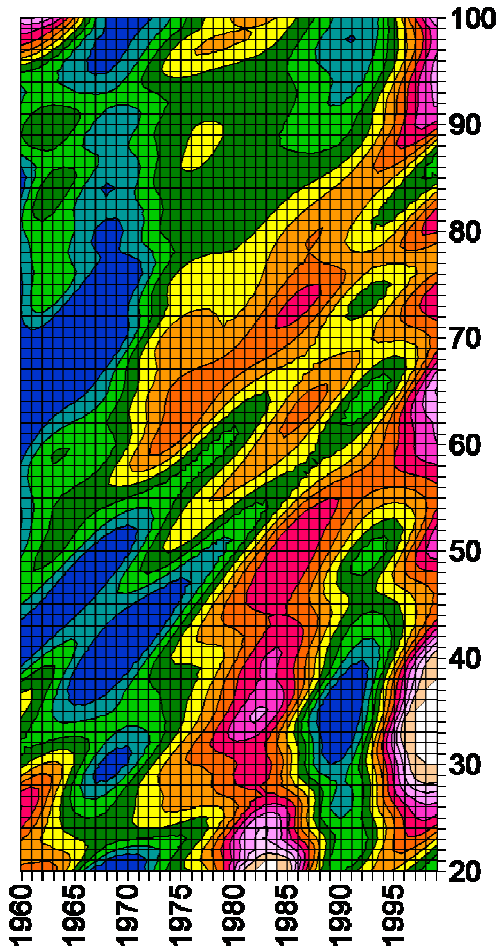


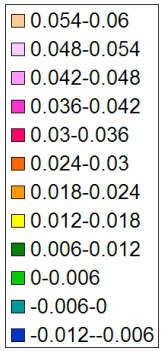
Females



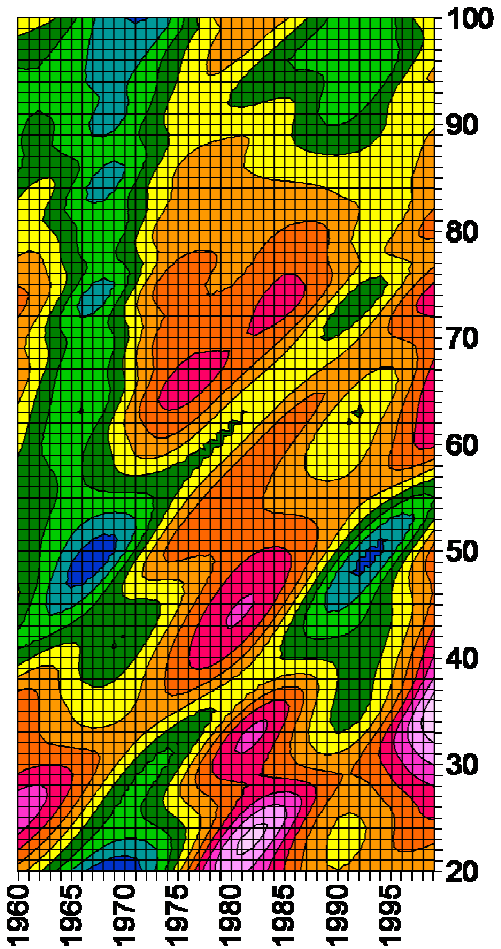
West Germany, P-spline, age-cohort

Males



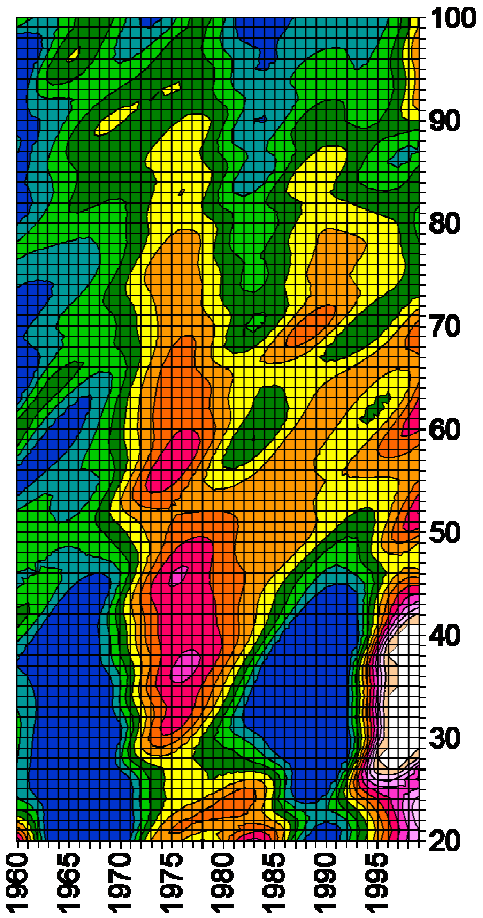


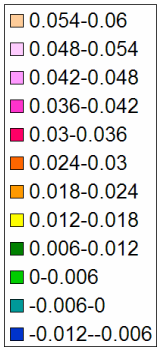
Females



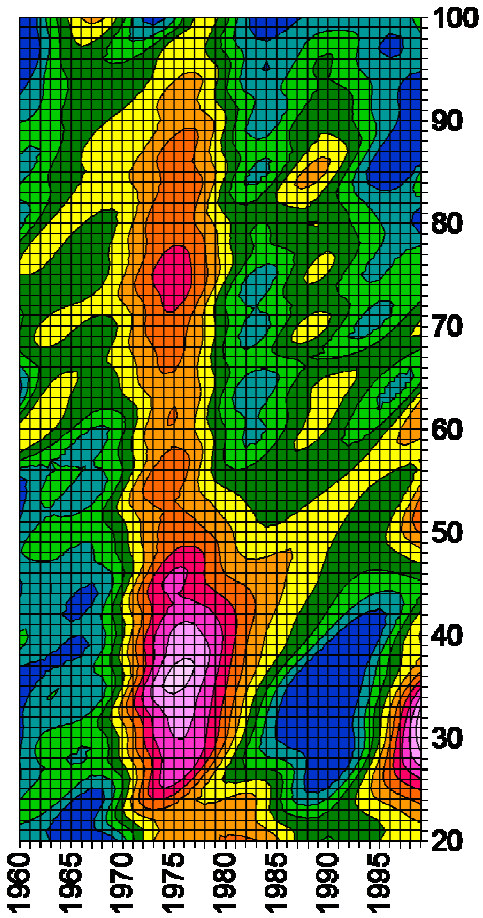
USA, P-spline, age-cohort

Males





Females



What happens next

- Timescale for consultation & approval of base tables
  - Consultation WP16 till 31 October
  - Final proposals, all tables – end 2005
  - FIMC adopt base tables Q1 2006?
- Status of CMI projections work (work in progress)
  - Further working paper currently being reviewed
  - Peer reviewed, not approved
  - Exposing work to the profession will allow full review and issues to surface
  - Digestion period ?
- Future work
  - To be decided as feedback is received and analysed

The Actuarial Profession
making financial sense of the future

Update on the “00” Series

Tony Leandro

28 September 2005