

Continuous Mortality Investigation

Errata to CMI Working Papers 20, 25 and 27 on Mortality Projections

Background

After the publication of Working Paper 27 in July 2007, it came to light that the dataset for Permanent Assurances for Male lives used by the CMI in its recent research into mortality projections included initial exposures but was used as if these were central exposures.

As a result, some of the results published in Working Papers 20, 25 and 27 and the projections contained in the draft library using this dataset were inaccurate.

The issue was widely publicised, together with an initial indication of its impact on annuity values. During the re-work the CMI found an error in the projection software in the calculation of deviance residuals used in boot-strapping simulations for the Lee-Carter models which also affects some of the values in Working Paper 25. Registered users of the CMI's illustrative software were also advised of this issue.

This note provides corrections to the parts of Working Papers 20, 25 and 27 affected by these issues in Appendices A, B and C, respectively. In addition:

- The versions of Working Papers 20 and 25 on the website have been replaced with revised versions.
- Working Paper 27 has **not** been revised so that the document on which the CMI sought the views of the Profession remains as it was for consultation; as its content is effectively replaced by Working Paper 30 and the user guide being issued alongside version 1.0 of the library.
- A new release of the software is being sent to all registered users to correct the calculation of the deviance residuals.

Dataset and exposure calculations

The dataset for Permanent Assurances for Male lives used by the CMI in its recent research into mortality projections included initial exposures but was used as if these were central exposures. This dataset has also been made available to the Profession, together with the illustrative mortality projections software, without specifying what definition had been used for the exposures. As this software fits values of $\mu_{x,t}$, users could reasonably expect the dataset to include Central Exposures but it actually contained Initial Exposures. Therefore, the dataset needs to be adjusted before being used with the software.

Central Exposures can be estimated for each age and year from the Initial Exposures using the following formulae:

$$\text{Central Exposure} = \text{Initial Exposure} - 0.5 \times \text{Deaths}.$$

This issue affected the annuity values and expectation of life values calculated for the CMI dataset and contained in the three Working Papers, but did not alter the main conclusions of the research. (Values using ONS data are unaffected by this issue).

Revised values are provided in the three Appendices to this note.

The calculation of deviance residuals

During the re-work arising from the exposure issue above, the CMI found an error in the projection software in the calculation of deviance residuals used in boot-strapping simulations for the Lee-Carter models which affects some of the values in Working Paper 25. This procedure is explained in more detail in section 2.2 of Working Paper 15 (available here: <http://www.actuaries.org.uk/files/pdf/cmi/wp15/wp15.pdf>).

This affects the 2.5% and 97.5% confidence intervals for the annuities published in Working Paper 25. The central projections on the Lee Carter model that are produced by the illustrative software are unaffected; hence Working Paper 27 and the draft library of projections were not affected by this error.

The error was in the code for calculating deviance residuals where the “2” in the formulae below (taken from page 10 of Working Paper 15) was missing:

$$r_{x,t} = \text{sign}(D_{x,t} - \hat{D}_{x,t}) \sqrt{2[D_{x,t} \log \frac{D_{x,t}}{\hat{D}_{x,t}} - (D_{x,t} - \hat{D}_{x,t})]}$$

where $\hat{D}_{x,t} = \hat{\mu}_{x,t} E_{x,t}$ is the ‘expected’ number of deaths.

The deviance residuals are used in boot-strapping simulations and so this error affects the confidence intervals for the Lee-Carter and Lee-Carter APC models for both the CMI Permanent Assurances and ONS datasets. Correcting for this error has the effect of increasing the spread of the simulations.

The CMI reminds users that the projections software is illustrative and the CMI has only carried out limited testing on it. Users are responsible for carrying out their own checks to ensure that the results are appropriate for their purposes.

November 2007

Appendix A: Errata to CMI Working Paper 20

CMI Working Paper 20, on P-spline projections, was affected only by the exposure issue, in respect of projections using the dataset for Permanent Assurances for Male lives.

The tables and graphs contained in this Appendix replace those in Working Paper 20, although for many of the tables only some of the values have changed. In a number of places, references in the accompanying text referred to numerical values from the tables but we have not amended these paragraphs in this document. In no case do we believe that the inference drawn in any text has been invalidated by the revision to the numerical value.

Table M1 (*page 24 of Working Paper 20*)

Mortality basis	Projection based on male assured lives, 1947 to 1994			Projection based on male ONS data, 1961 to 1994		
	4.5% annuity value at age			4.5% annuity value at age		
	60	65	75	60	65	75
PMA92u95	14.388	12.549	8.686	14.388	12.549	8.686
PMA92u95p-s50ac	14.867	12.953	8.943	15.188	13.155	8.950
PMA92u95p-s97.5ac	15.187	13.230	9.113	15.908	13.760	9.281
PMA92u95p-s2.5ac	14.579	12.703	8.786	14.576	12.651	8.671
PMA92u95p-s50ap	14.818	12.917	8.931	15.543	13.604	9.372
PMA92u95p-s97.5ap	15.310	13.340	9.191	20.487	19.289	15.238
PMA92u95p-s2.5ap	14.405	12.559	8.705	10.192	9.114	6.829

Table M2 (*page 25*)

Annuity values in the shaded cells. Other cells show the values in Table M1 as percentages of values in the shaded cells.						
Mortality basis	Projection based on male assured lives, 1947 to 1994			Projection based on male ONS data, 1961 to 1994		
	4.5% annuity value at age			4.5% annuity value at age		
	60	65	75	60	65	75
PMA92u95	14.388	12.549	8.686	14.388	12.549	8.686
PMA92u95p-s50ac	103.3%	103.2%	103.0%	105.6%	104.8%	103.0%
PMA92u95p-s97.5ac	105.6%	105.4%	104.9%	110.6%	109.7%	106.9%
PMA92u95p-s2.5ac	101.3%	101.2%	101.2%	101.3%	100.8%	99.8%
PMA92u95p-s50ap	103.0%	102.9%	102.8%	108.0%	108.4%	107.9%
PMA92u95p-s97.5ap	106.4%	106.3%	105.8%	142.4%	153.7%	175.4%
PMA92u95p-s2.5ap	100.1%	100.1%	100.2%	70.8%	72.6%	78.6%

Figure 5 (page 27)

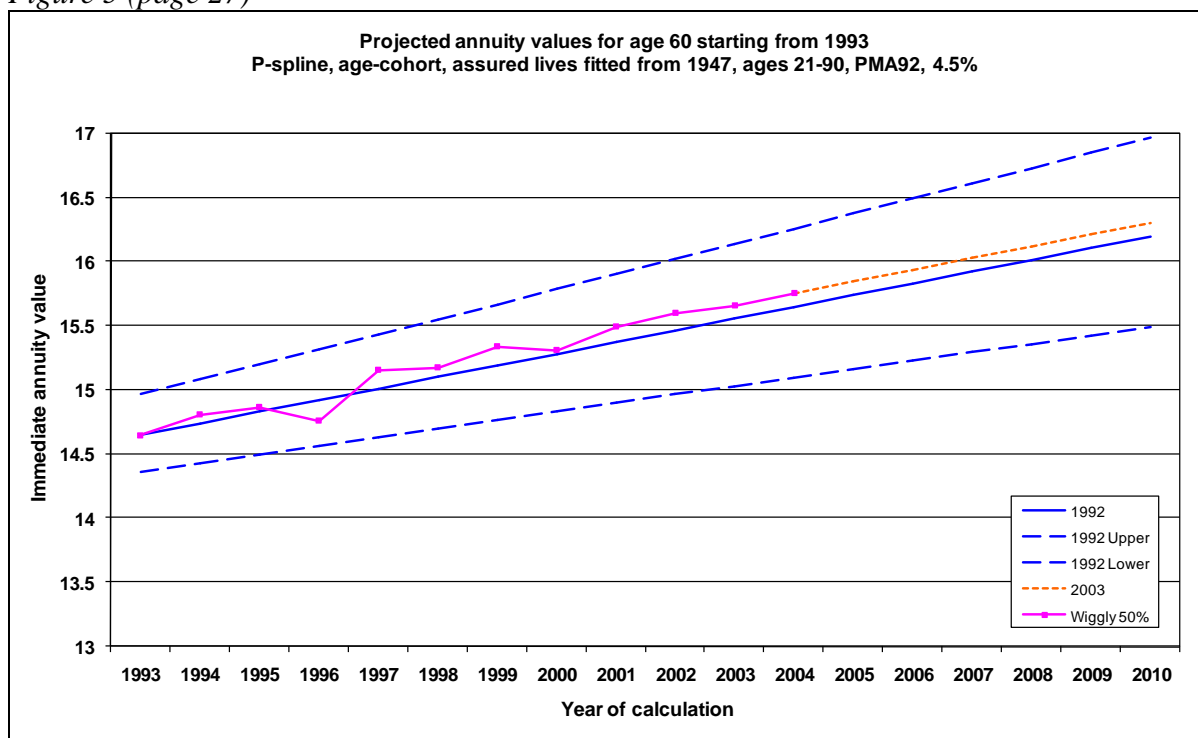
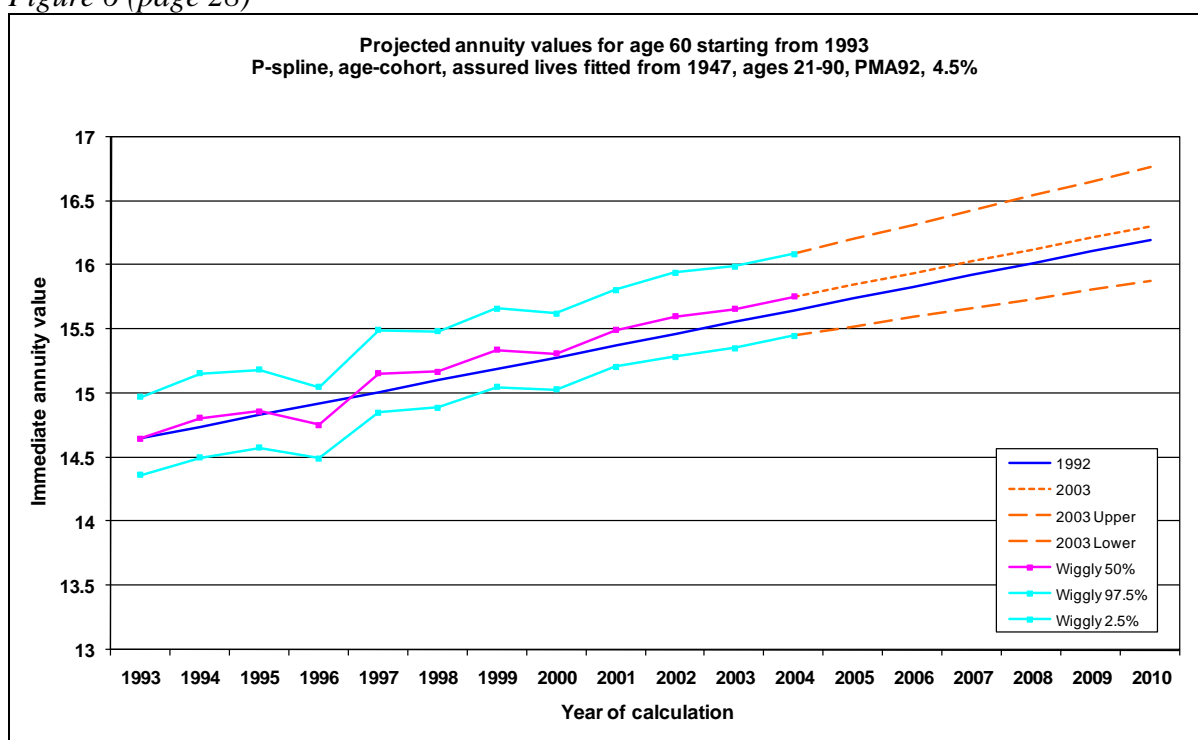


Figure 6 (page 28)



Note: Figure 7 on page 28 was based on ONS data so is unchanged.

Figure 8 (page 29)

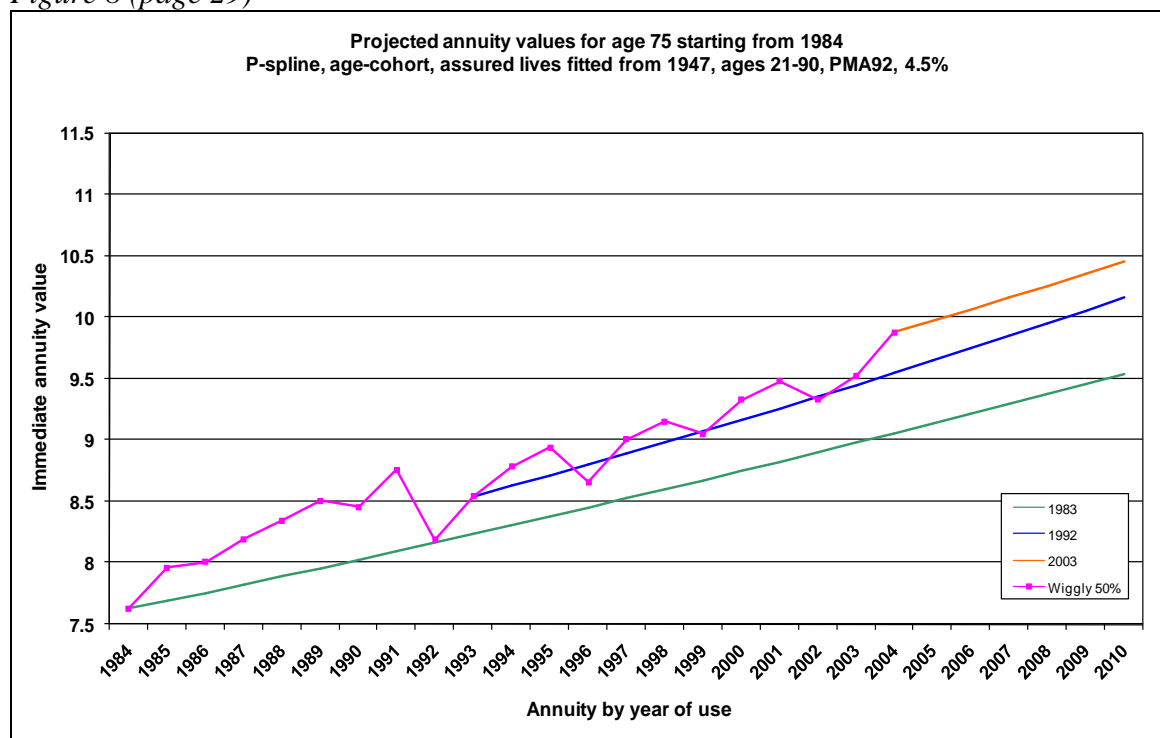


Table M3 (page 30)

Mortality basis	Projection based on male assured lives, 1947 to 2003			Projection based on male ONS data, 1961 to 2003		
	4.5% annuity value at age			4.5% annuity value at age		
	60	65	75	60	65	75
PMA92u04mc (unadjusted)	15.480	13.786	9.842	15.480	13.786	9.842
PMA92u04mc	15.218	13.640	9.902	15.218	13.640	9.902
PMA92u04lc	15.620	14.154	10.355	15.620	14.154	10.355
PMA92u04sc	15.044	13.415	9.599	15.044	13.415	9.599
PMA92u04p-s50ac	15.756	14.012	9.880	16.156	14.409	10.029
PMA92u04p-s97.5ac	16.088	14.309	10.073	16.961	15.151	10.484
PMA92u04p-s2.5ac	15.452	13.742	9.703	15.411	13.763	9.651
PMA92u04p-s50ap	15.746	14.027	9.913	14.599	13.020	9.174
PMA92u04p-s97.5ap	16.277	14.503	10.222	16.359	14.508	9.989
PMA92u04p-s2.5ap	15.291	13.621	9.645	13.653	12.203	8.676

Table M4 (page 31)

Annuity values in the shaded cells. Other cells show the values in Table M3 as percentages of values in the shaded cells.						
Mortality basis	Projection based on male assured lives, 1947 to 2003			Projection based on male ONS data, 1961 to 2003		
	4.5% annuity value at age			4.5% annuity value at age		
	60	65	75	60	65	75
PMA92u04mc	15.218	13.640	9.902	15.218	13.640	9.902
PMA92u04lc	102.6%	103.8%	104.6%	102.6%	103.8%	104.6%
PMA92u04sc	98.9%	98.3%	96.9%	98.9%	98.3%	96.9%
PMA92u04p-s50ac	103.5%	102.7%	99.8%	106.2%	105.6%	101.3%
PMA92u04p-s97.5ac	105.7%	104.9%	101.7%	111.5%	111.1%	105.9%
PMA92u04p-s2.5ac	101.5%	100.7%	98.0%	101.3%	100.9%	97.5%
PMA9204up-s50ap	103.5%	102.8%	100.1%	95.9%	95.4%	92.6%
PMA92u04p-s97.5ap	107.0%	106.3%	103.2%	107.5%	106.4%	100.9%
PMA92u04p-s2.5ap	100.5%	99.9%	97.4%	89.7%	89.5%	87.6%

Table M5 (page 32)

Annuity values @ 4.5% - "00" Series as a percentage of "92" Series, base tables adjusted to 2003						
Mortality basis	Projection based on male assured lives, 1947 to 2003			Projection based on male ONS data, 1961 to 2003		
	4.5% annuity value at age			4.5% annuity value at age		
	60	65	75	60	65	75
PMA00u04p-s50ac	100.0%	100.0%	99.8%	100.0%	100.0%	99.7%
PMA00u04p-s97.5ac	100.0%	100.0%	99.7%	100.0%	99.9%	99.7%
PMA00u04p-s2.5ac	100.0%	100.0%	99.8%	100.0%	100.0%	99.8%
PMA00u04p-s50ap	100.0%	100.0%	99.8%	100.1%	100.1%	99.8%
PMA00u04p-s97.5ap	100.0%	100.0%	99.7%	100.0%	99.9%	99.7%
PMA00u04p-s2.5ap	100.0%	100.0%	99.8%	100.1%	100.1%	99.9%

Figure 9 (page 33)

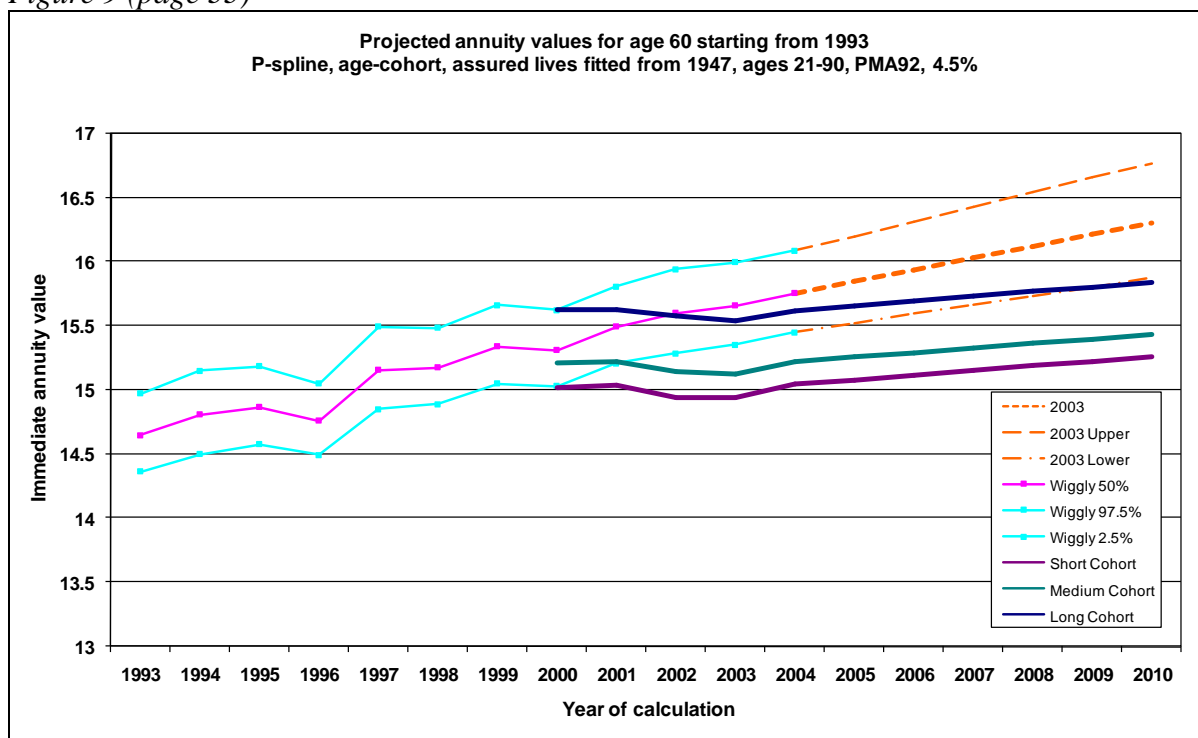


Figure 10 (page 33)

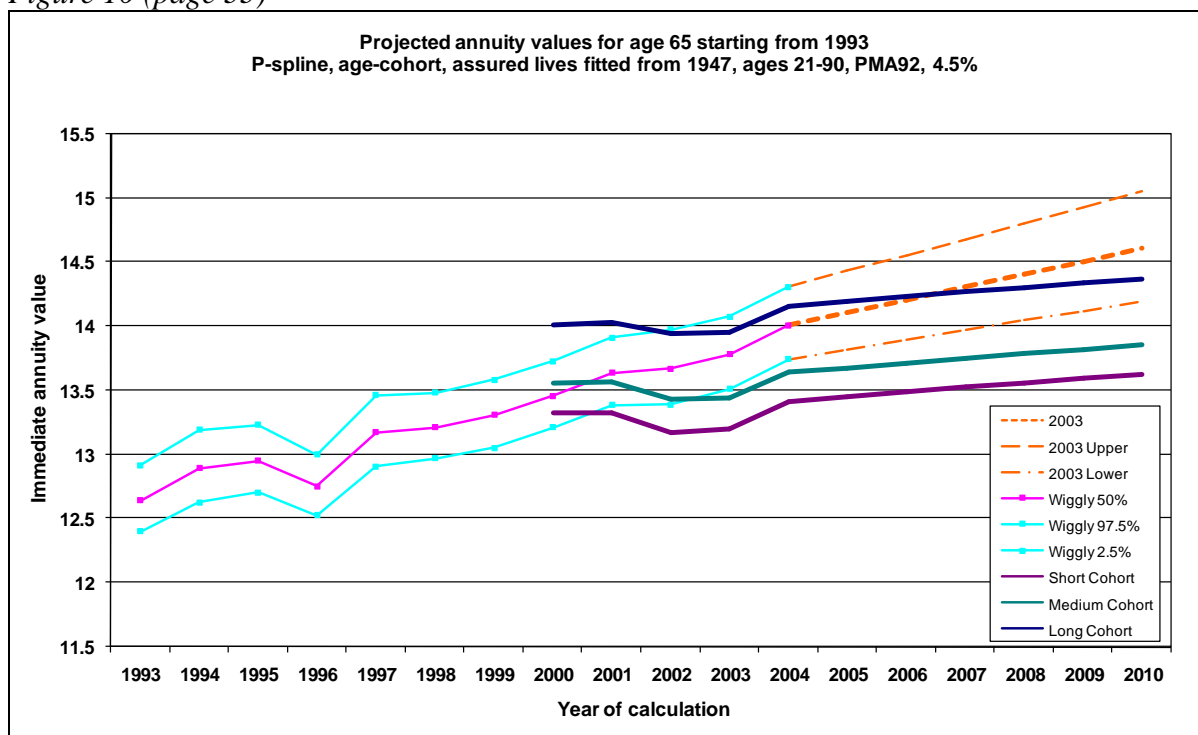


Figure 11 (page 34)

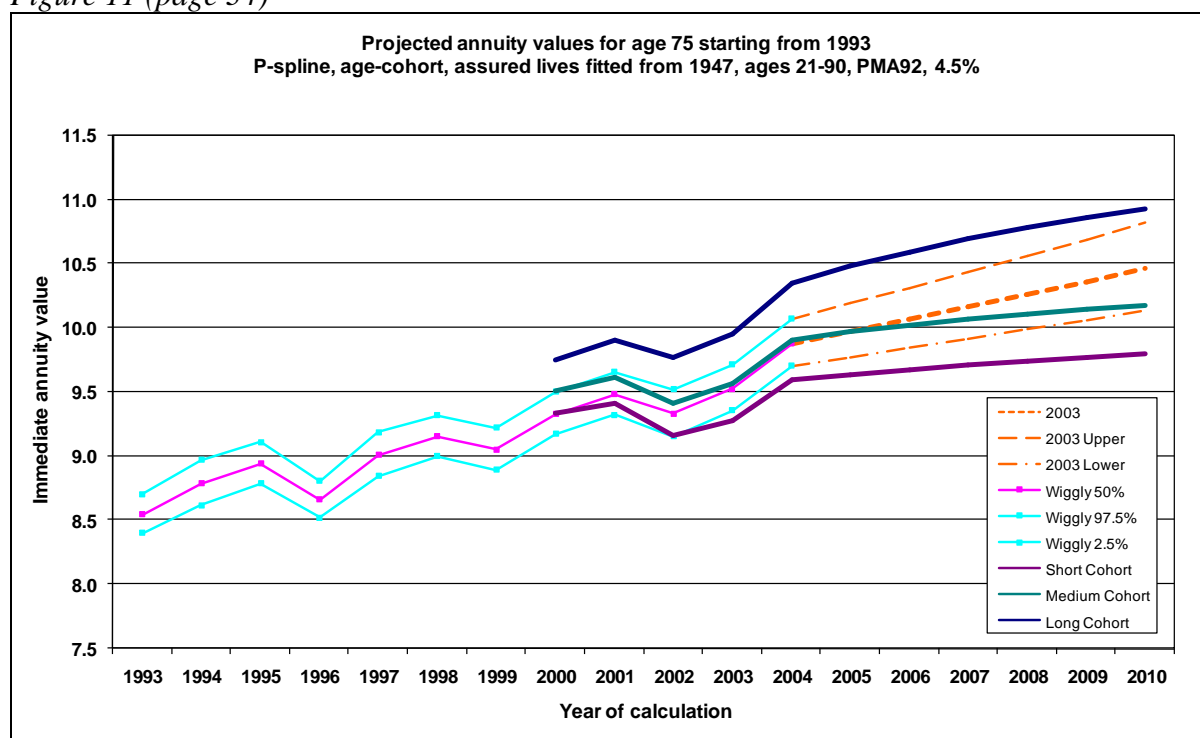


Table F1 (page 35)

Mortality basis	Projection based on male assured lives, 1947 to 1994			Projection based on female ONS data, 1961 to 1994		
	4.5% annuity value at age			4.5% annuity value at age		
	60	65	75	60	65	75
PFA92u95	15.251	13.700	9.969	15.251	13.700	9.969
PFA92u95p-s50ac	15.819	14.205	10.317	15.873	14.236	10.297
PFA92u95p-s97.5ac	16.170	14.526	10.539	16.369	14.677	10.574
PFA92u95p-s2.5ac	15.496	13.911	10.114	15.422	13.840	10.049
PFA92u95p-s50ap	15.771	14.169	10.303	15.802	14.306	10.557
PFA92u95p-s97.5ap	16.315	14.666	10.646	20.393	19.522	15.972
PFA92u95p-s2.5ap	15.299	13.741	10.005	10.869	9.970	7.703

Table F2 (page 35)

Annuity values in the shaded cells. Other cells show the values from Table F1 as percentages of values in the shaded cells.						
Mortality basis	Projection based on male assured lives, 1947 to 1994			Projection based on female ONS data, 1961 to 1994		
	4.5% annuity value at age			4.5% annuity value at age		
	60	65	75	60	65	75
PFA92u95	15.251	13.700	9.969	15.251	13.700	9.969
PFA92u95p-s50ac	103.7%	103.7%	103.5%	104.1%	103.9%	103.3%
PFA92u95p-s97.5ac	106.0%	106.0%	105.7%	107.3%	107.1%	106.1%
PFA92u95p-s2.5ac	101.6%	101.5%	101.5%	101.1%	101.0%	100.8%
PFA92u95p-s50ap	103.4%	103.4%	103.4%	103.6%	104.4%	105.9%
PFA92u95p-s97.5ap	107.0%	107.1%	106.8%	133.7%	142.5%	160.2%
PFA92u95p-s2.5ap	100.3%	100.3%	100.4%	71.3%	72.8%	77.3%

Table F3 (page 36)

Mortality basis	Projection based on male assured lives, 1947 to 2003			Projection based on female ONS data, 1961 to 2003		
	4.5% annuity value at age			4.5% annuity value at age		
	60	65	75	60	65	75
PFA92u04mc (unadjusted)	16.327	14.814	11.166	16.327	14.814	11.166
PFA92u04mc	15.976	14.482	10.819	15.976	14.482	10.819
PFA92u04lc	16.400	15.020	11.333	16.400	15.020	11.333
PFA92u04sc	15.804	14.260	10.515	15.804	14.260	10.515
PFA92u04p-s50ac	16.592	14.947	10.898	16.515	14.906	10.767
PFA92u04p-s97.5ac	16.942	15.273	11.130	16.962	15.311	11.027
PFA92u04p-s2.5ac	16.265	14.645	10.685	16.101	14.536	10.531
PFA92u04p-s50ap	16.589	14.967	10.937	14.776	13.247	9.563
PFA92u04p-s97.5ap	17.147	15.490	11.308	15.753	14.085	10.067
PFA92u04p-s2.5ap	16.090	14.509	10.611	14.122	12.673	9.193

Table F4 (page 37)

Annuity values in the shaded cells. Other cells show the values in Table F3 as percentages of values in the shaded cells.						
Mortality basis	Projection based on male assured lives, 1947 to 2003			Projection based on female ONS data, 1961 to 2003		
	4.5% annuity value at age			4.5% annuity value at age		
	60	65	75	60	65	75
PFA92u04mc	15.976	14.482	10.819	15.976	14.482	10.819
PFA92u04lc	102.7%	103.7%	104.7%	102.7%	103.7%	104.7%
PFA92u04sc	98.9%	98.5%	97.2%	98.9%	98.5%	97.2%
PFA92u04p-s50ac	103.9%	103.2%	100.7%	103.4%	102.9%	99.5%
PFA92u04p-s97.5ac	106.0%	105.5%	102.9%	106.2%	105.7%	101.9%
PFA92u04p-s2.5ac	101.8%	101.1%	98.8%	100.8%	100.4%	97.3%
PFA92u04p-s50ap	103.8%	103.4%	101.1%	92.5%	91.5%	88.4%
PFA92u04p-s97.5ap	107.3%	107.0%	104.5%	98.6%	97.3%	93.0%
PFA92u04p-s2.5ap	100.7%	100.2%	98.1%	88.4%	87.5%	85.0%

Note that the figures shown in Table F5 (page 37) were unchanged from those in the original Working Paper 20. The figures underlying this table changed, but insufficiently to alter the percentages when rounded to 1 decimal place.

The table of fitting parameters for the P-spline age-period model in Appendix A of Working Paper 20 (page 39) inaccurately referred to 'cohort dimension' but should have referred to 'period dimension'.

Contour maps of projected improvements for male assured lives using age-cohort penalties (see Appendix B of Working Paper 20)

Figure B1

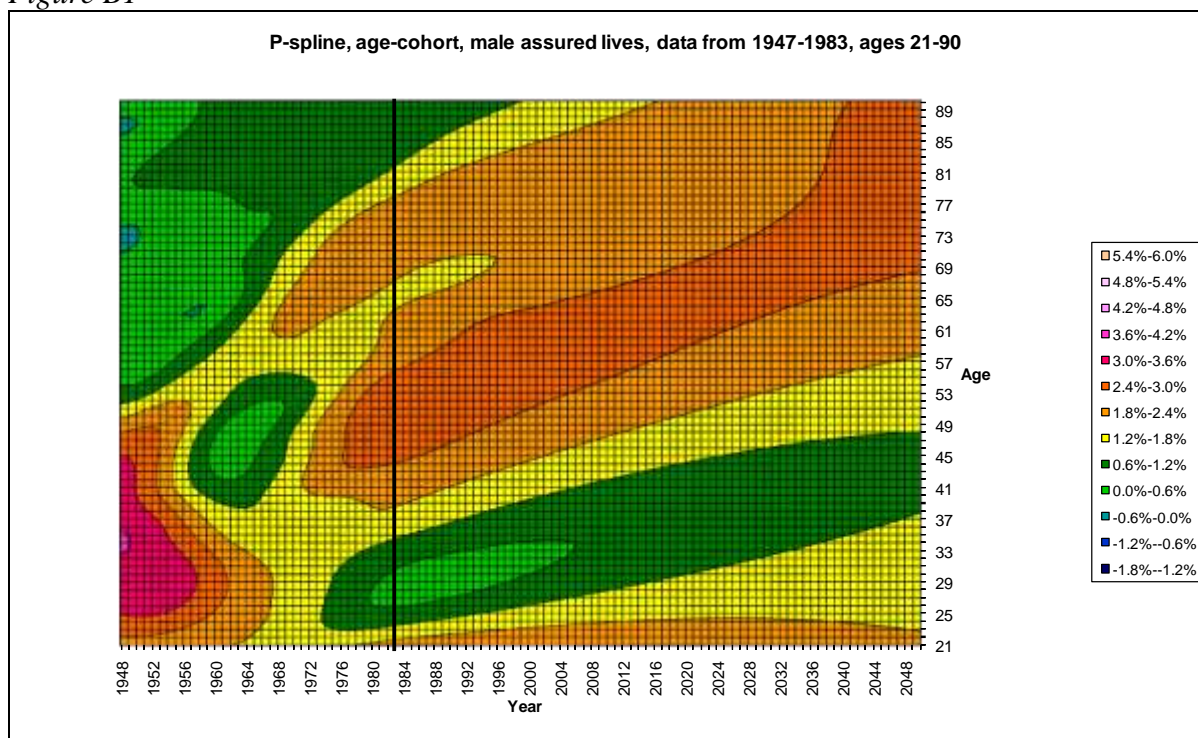


Figure B2

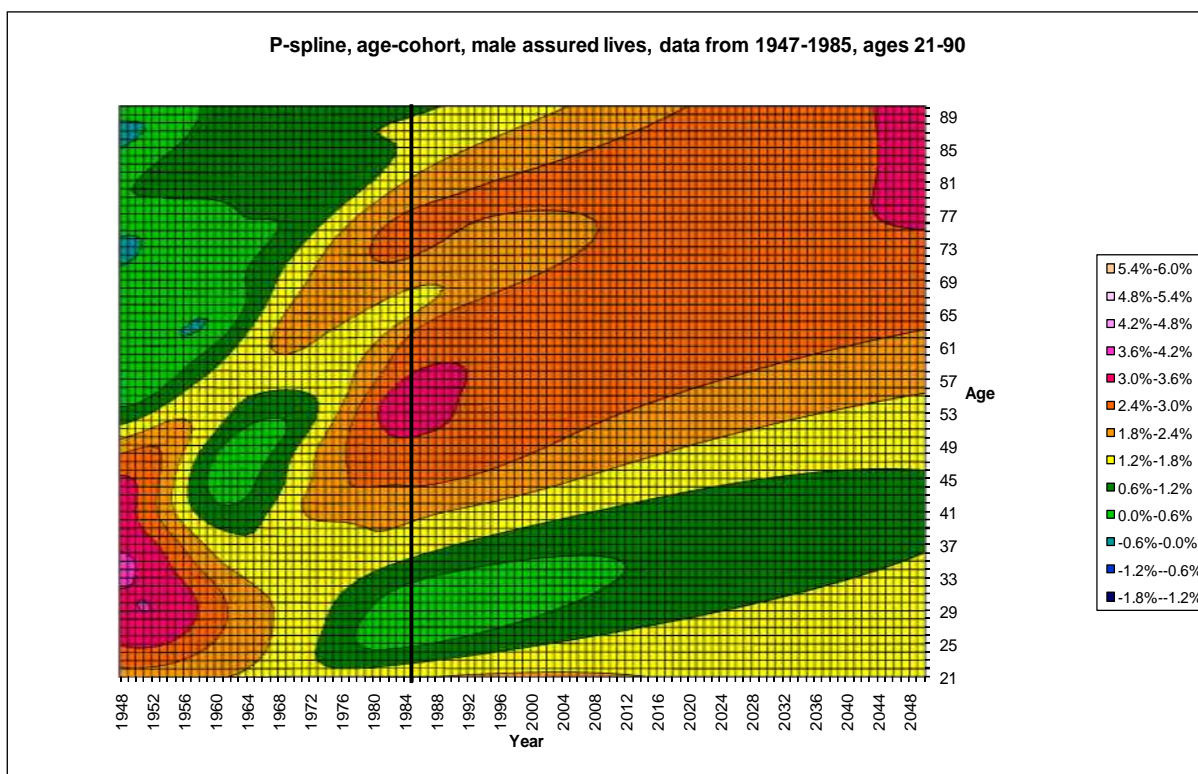


Figure B3

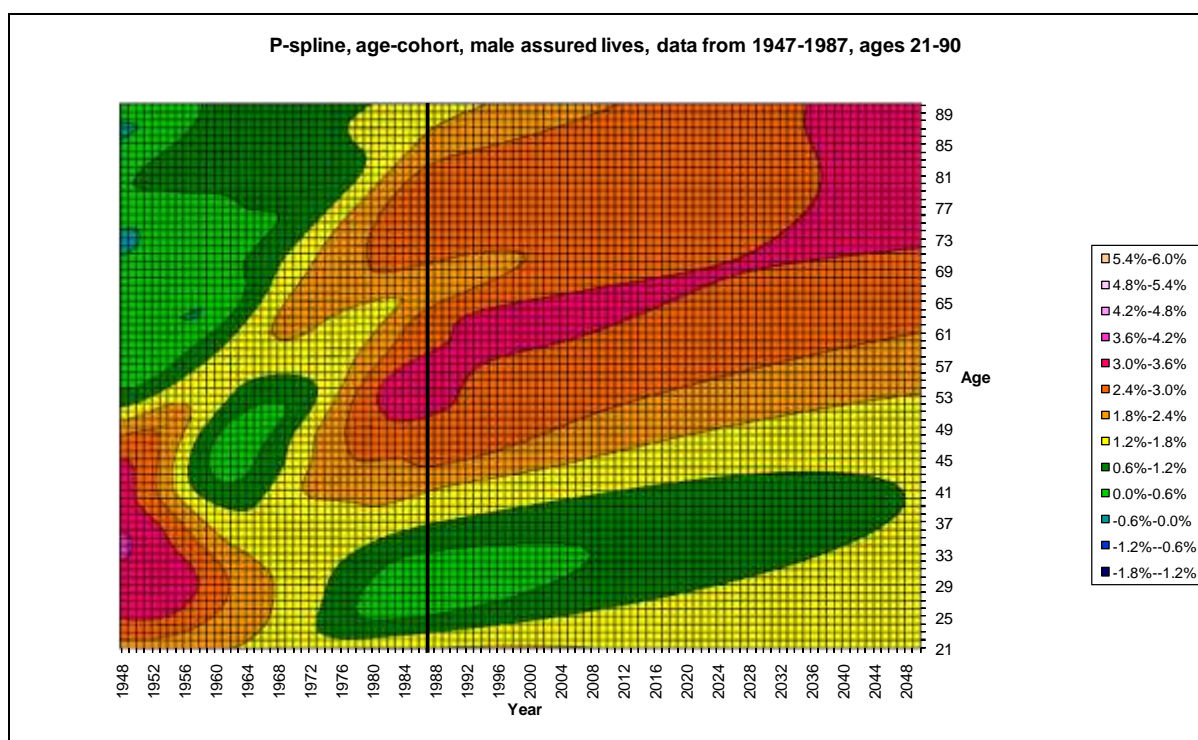


Figure B4

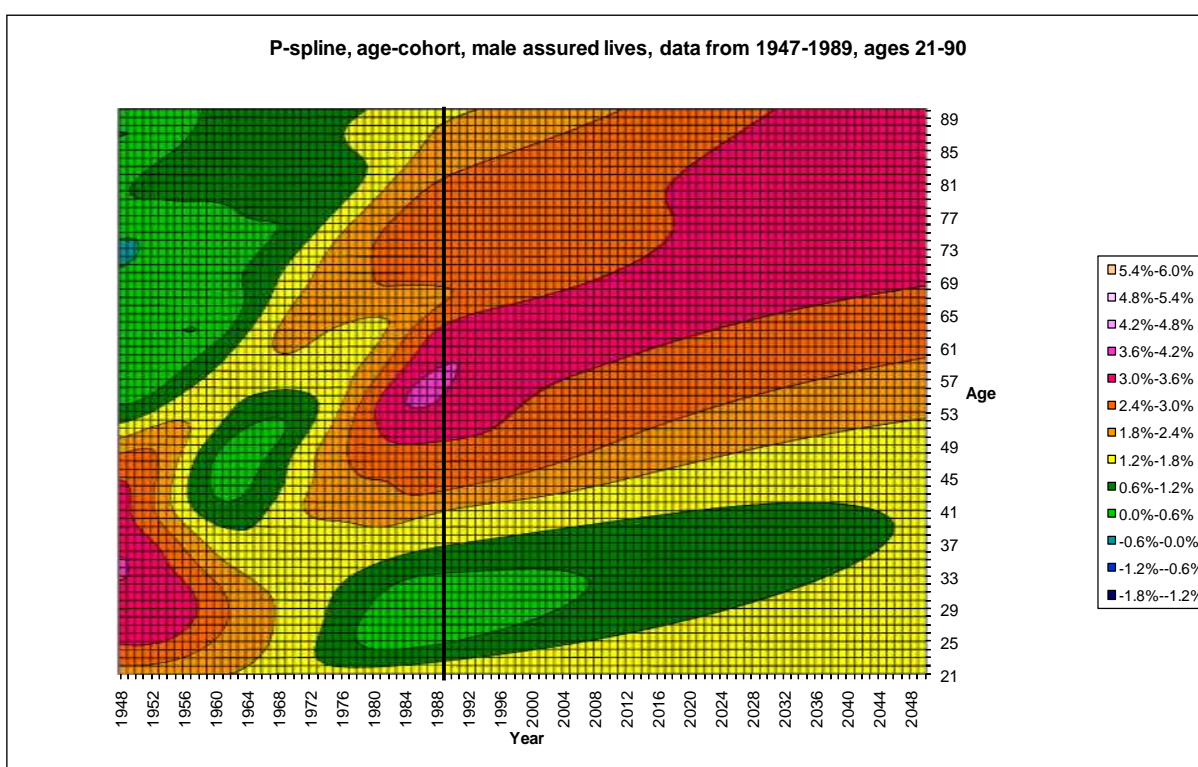


Figure B5

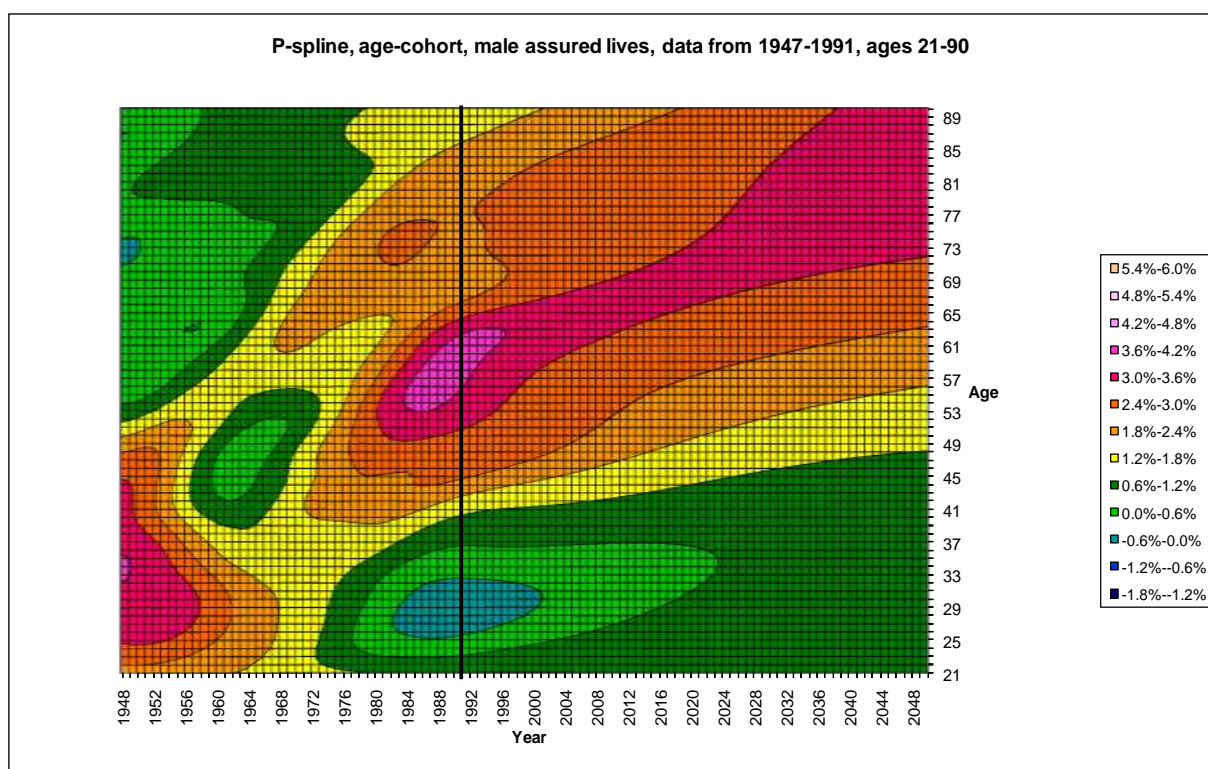


Figure B6

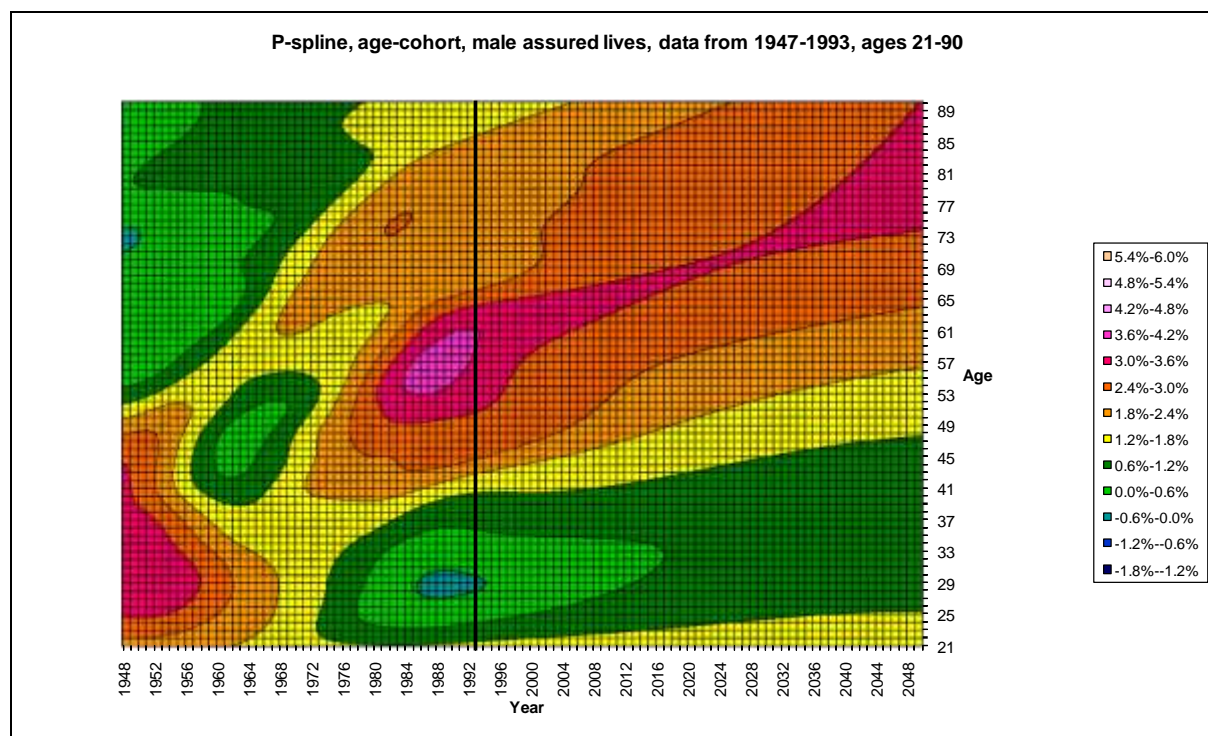


Figure B7

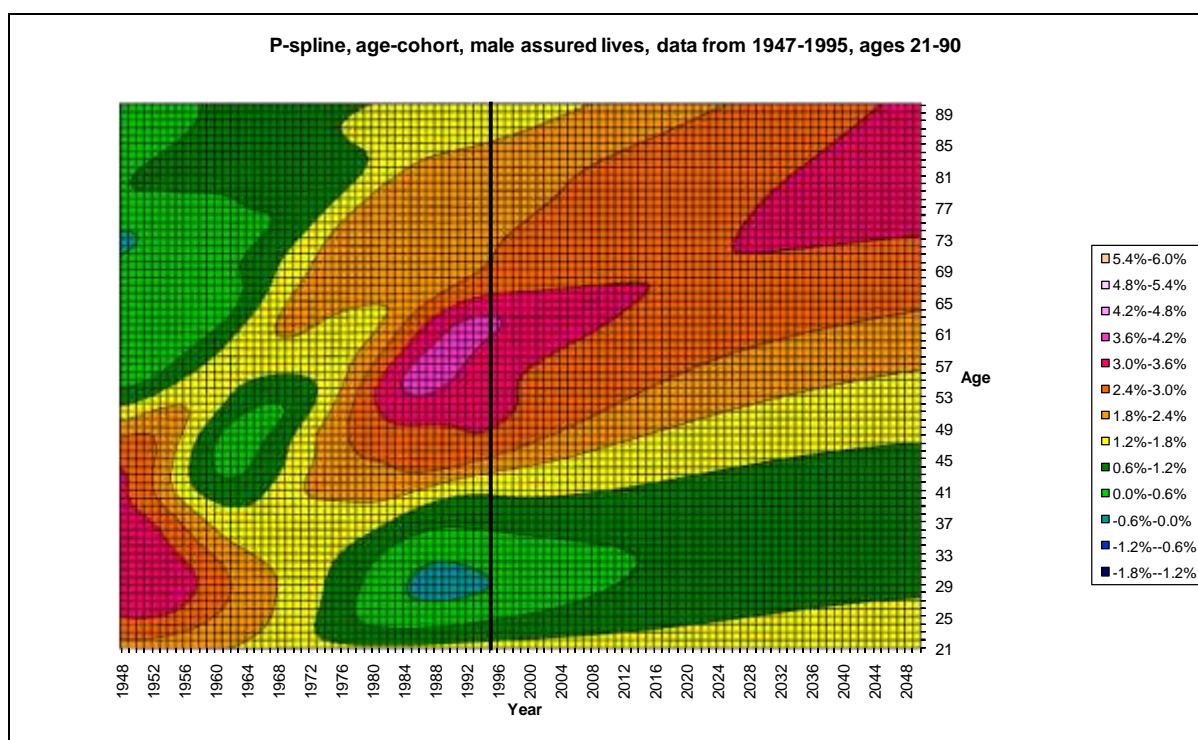


Figure B8

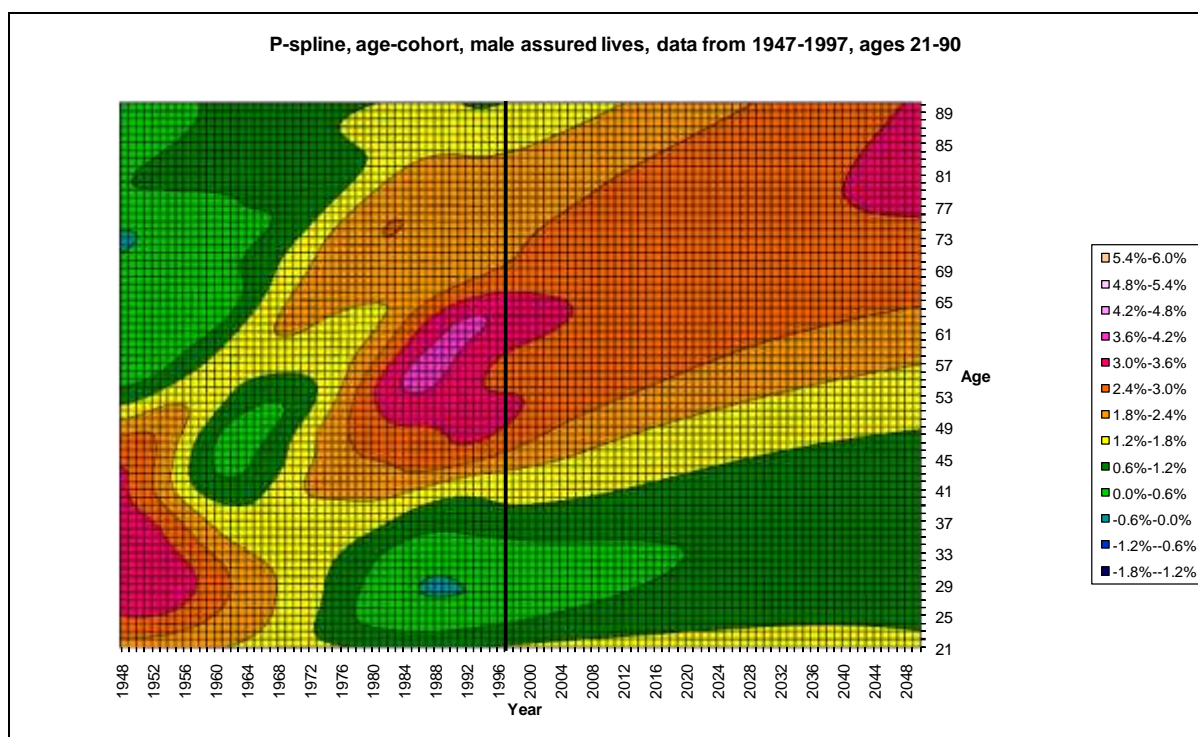


Figure B9

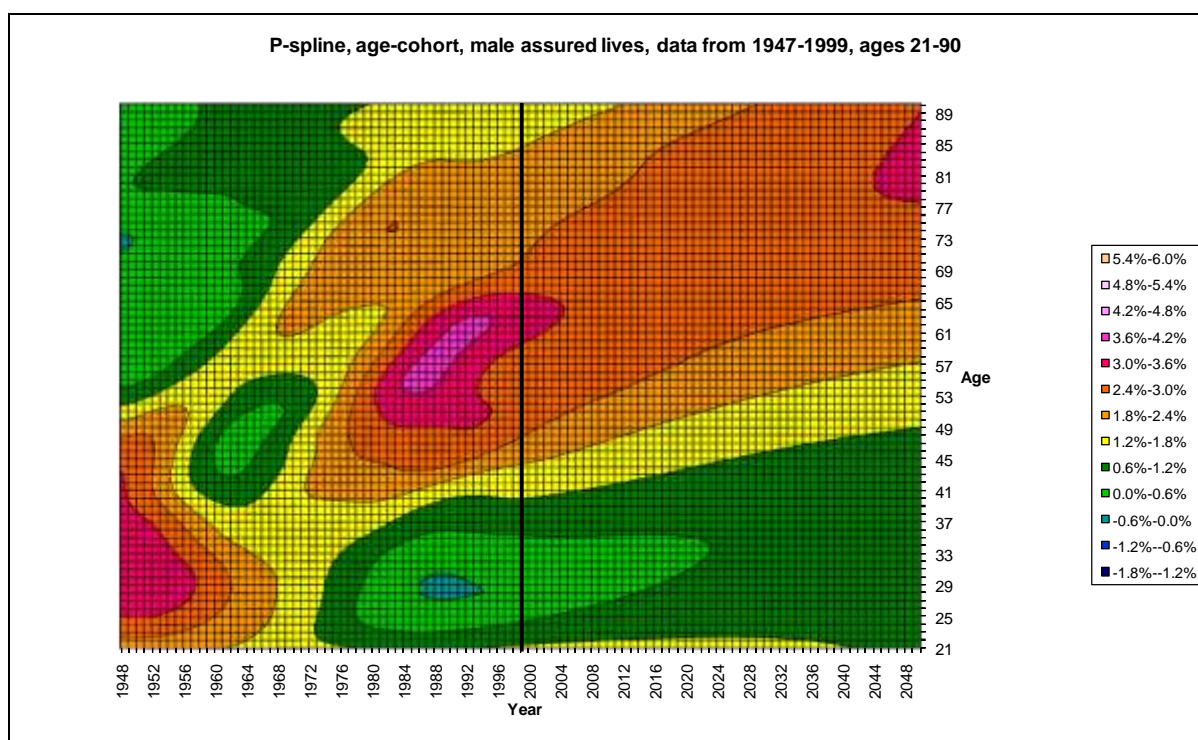


Figure B10

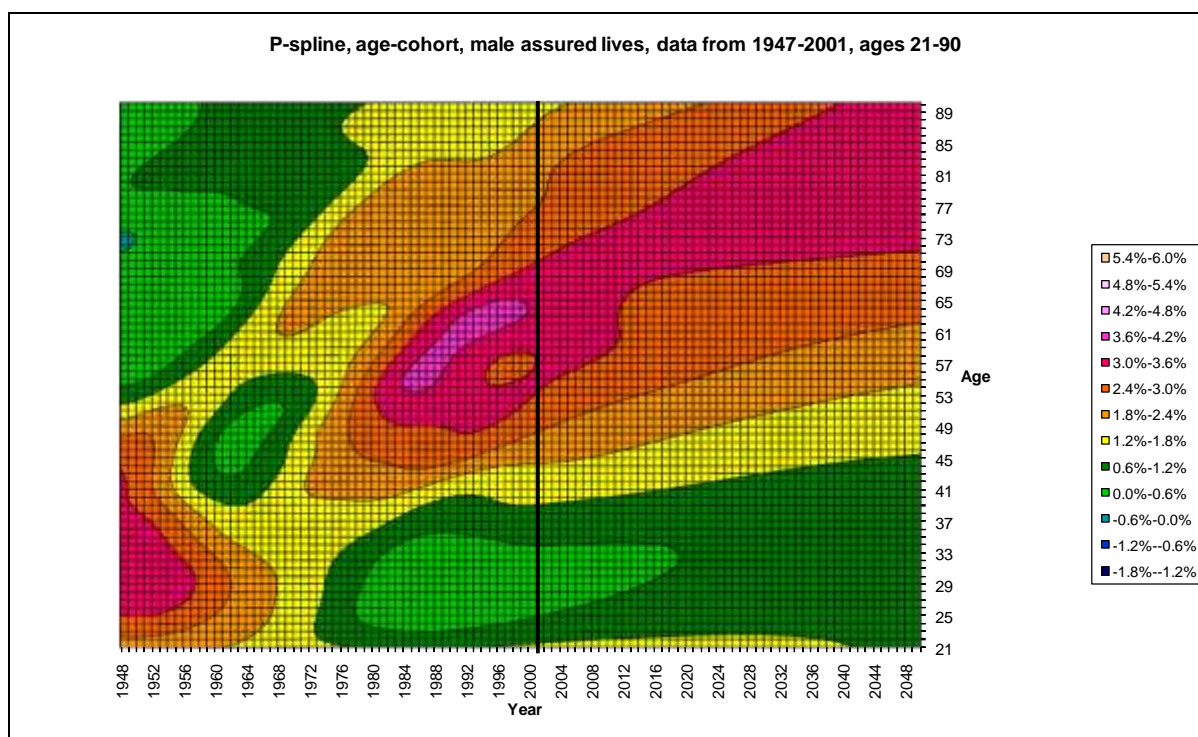
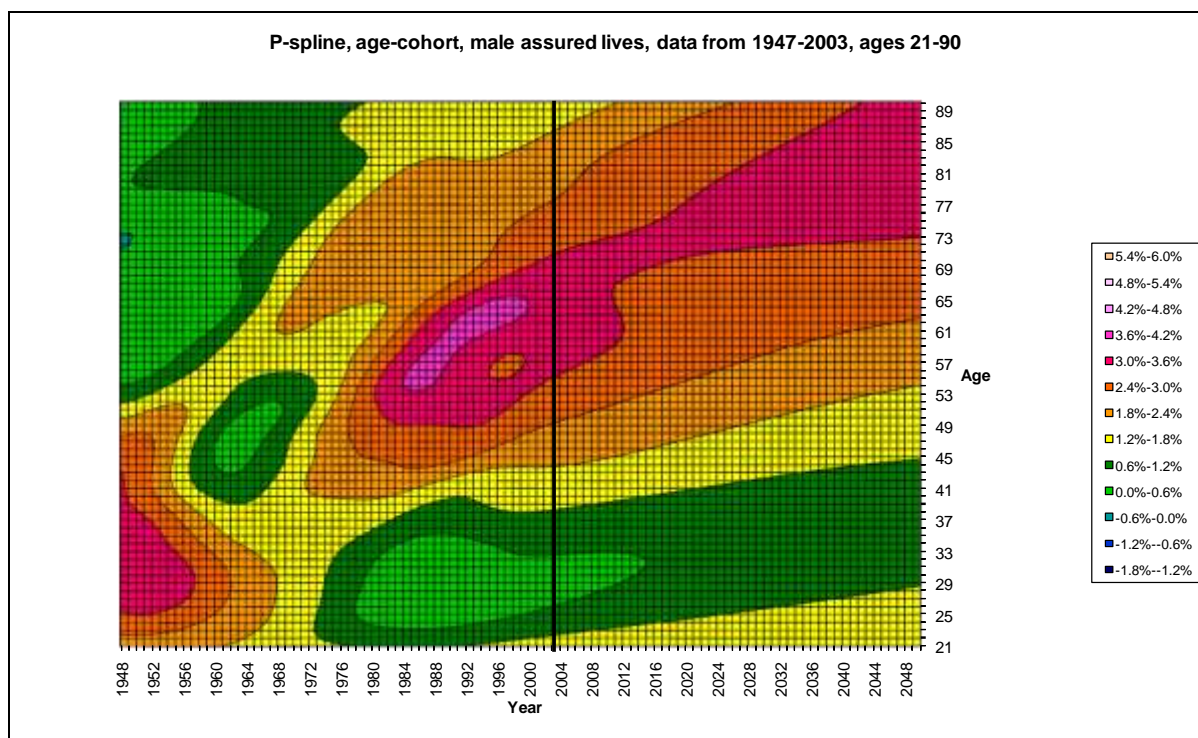


Figure B11



Contour maps of projected improvements for male assured lives using age-period penalties (see Appendix C of Working Paper 20)

Figure C1

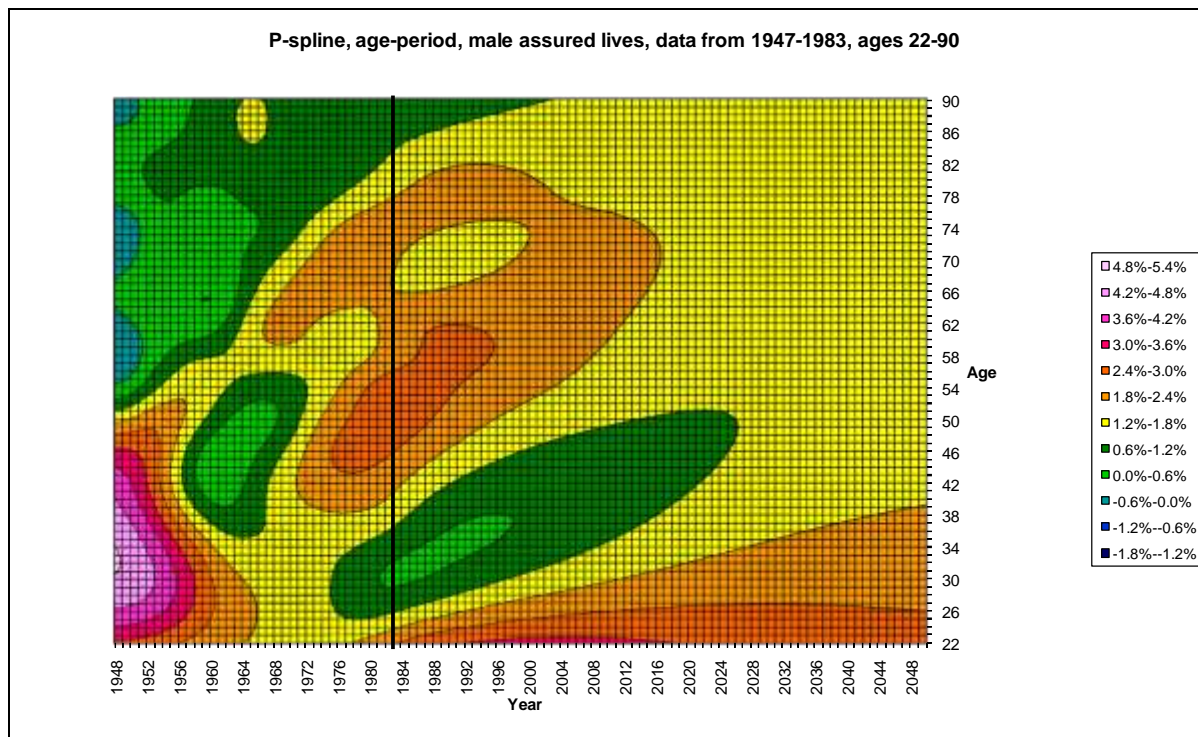


Figure C2

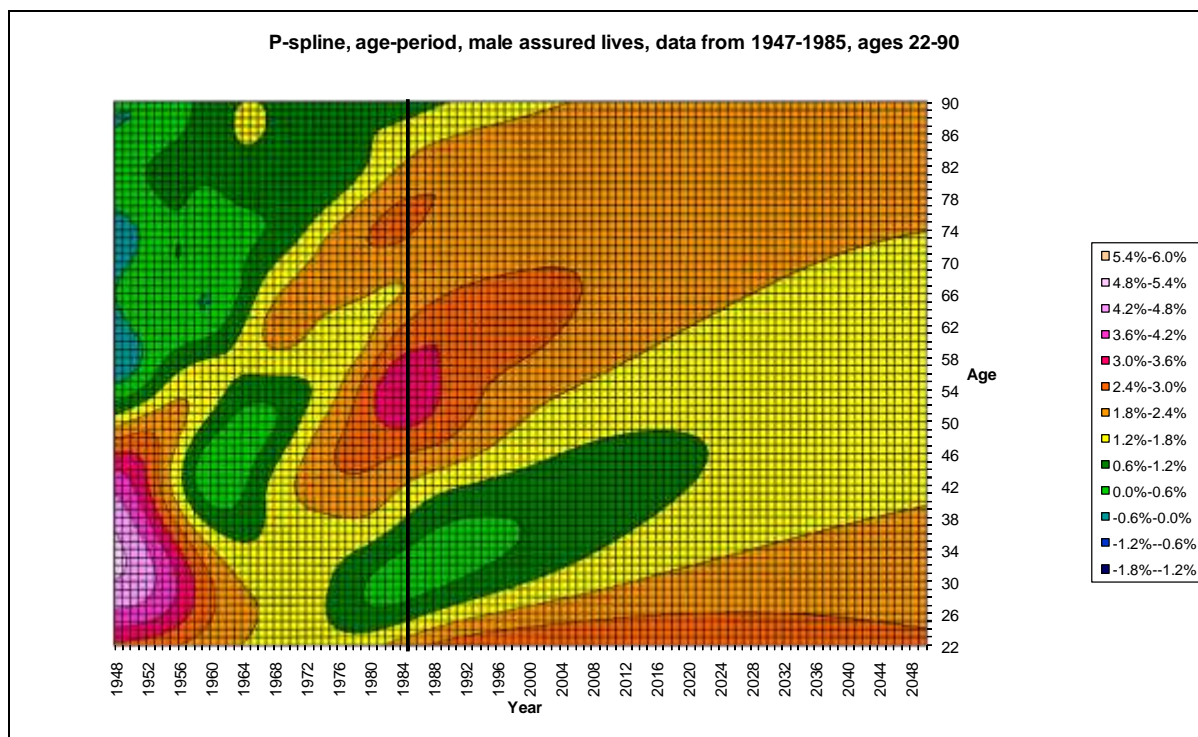


Figure C3

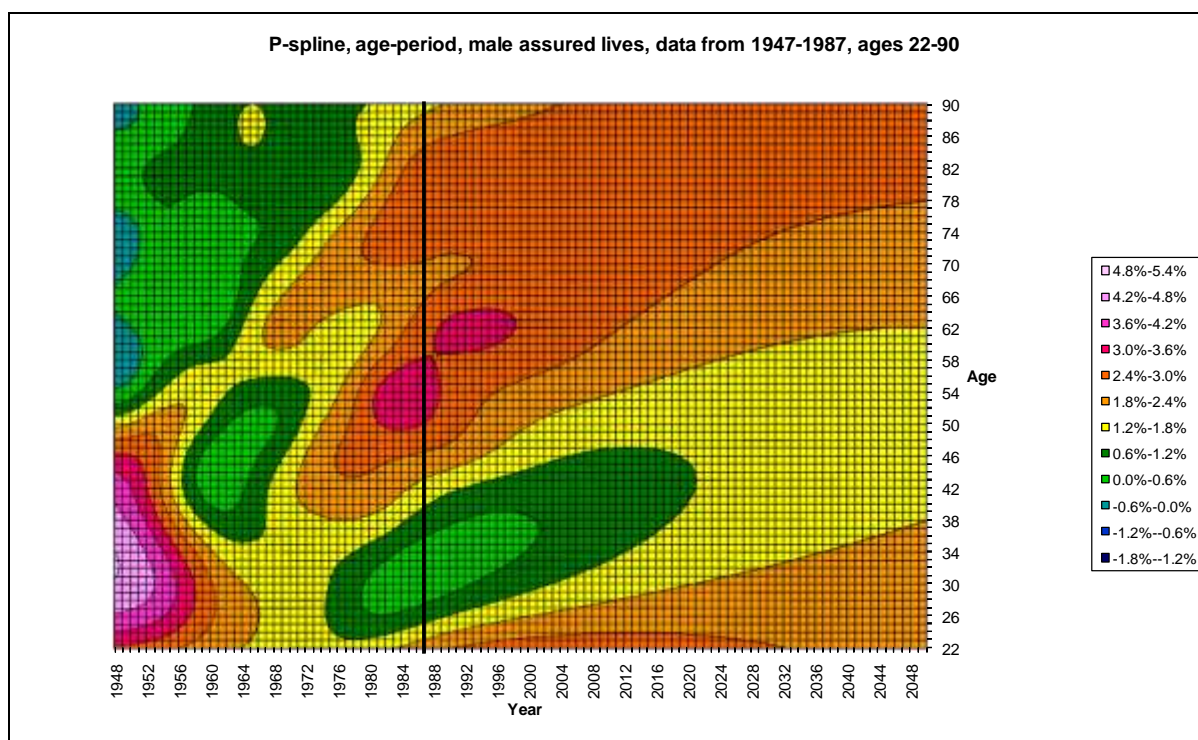


Figure C4

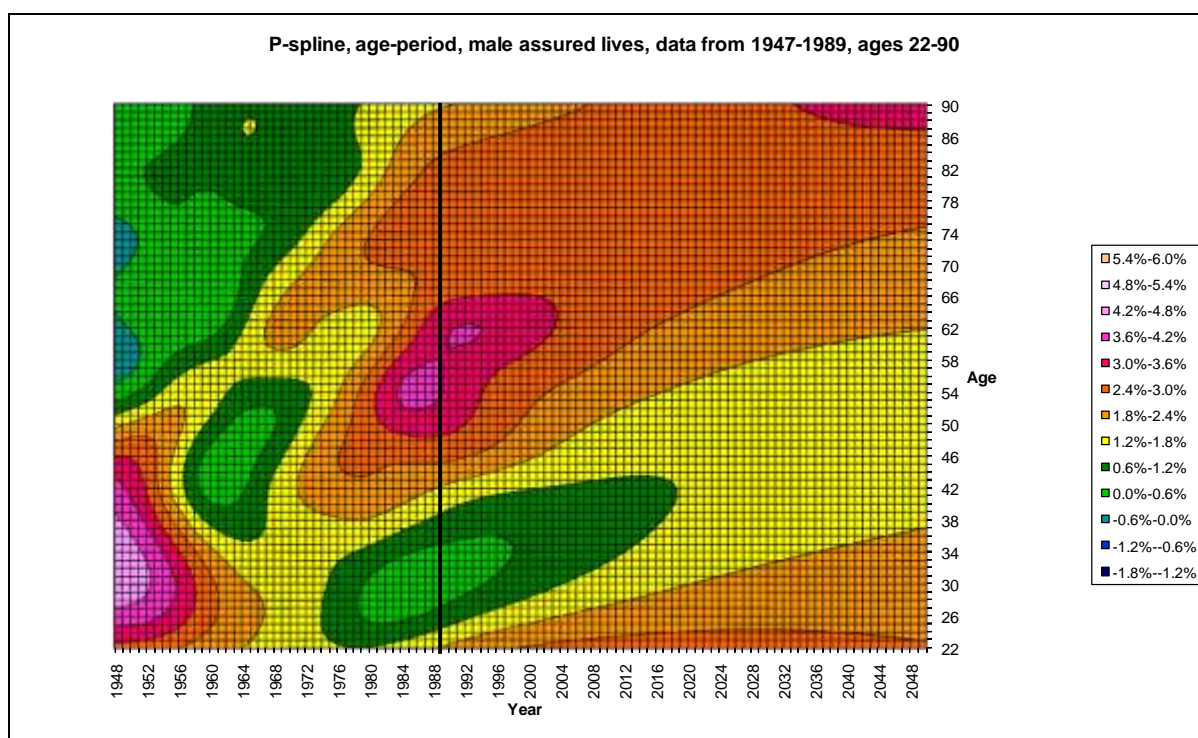


Figure C5

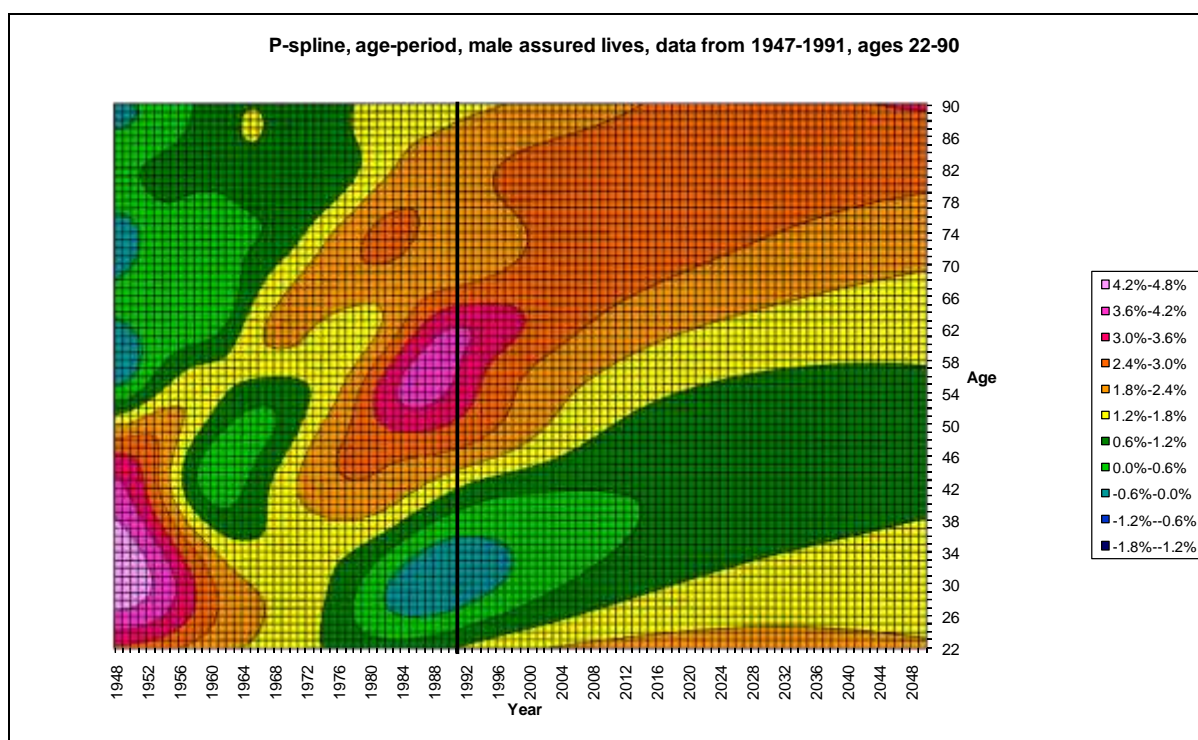


Figure C6

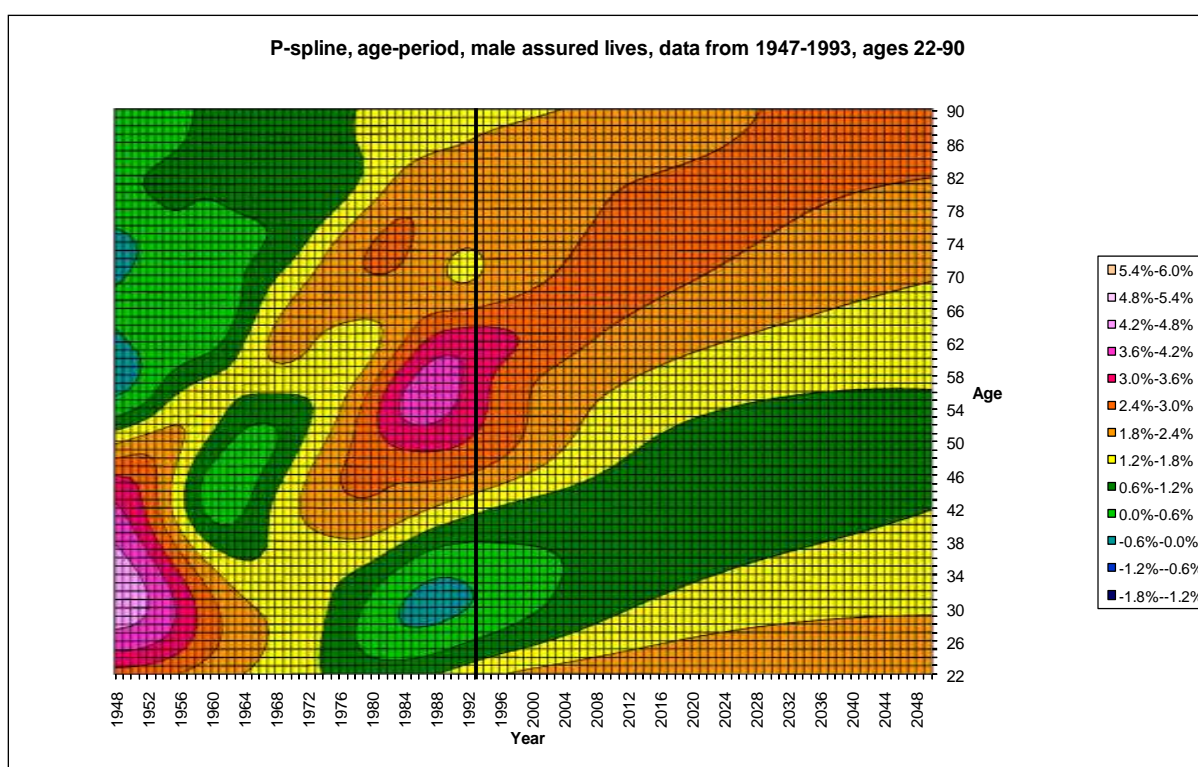


Figure C7

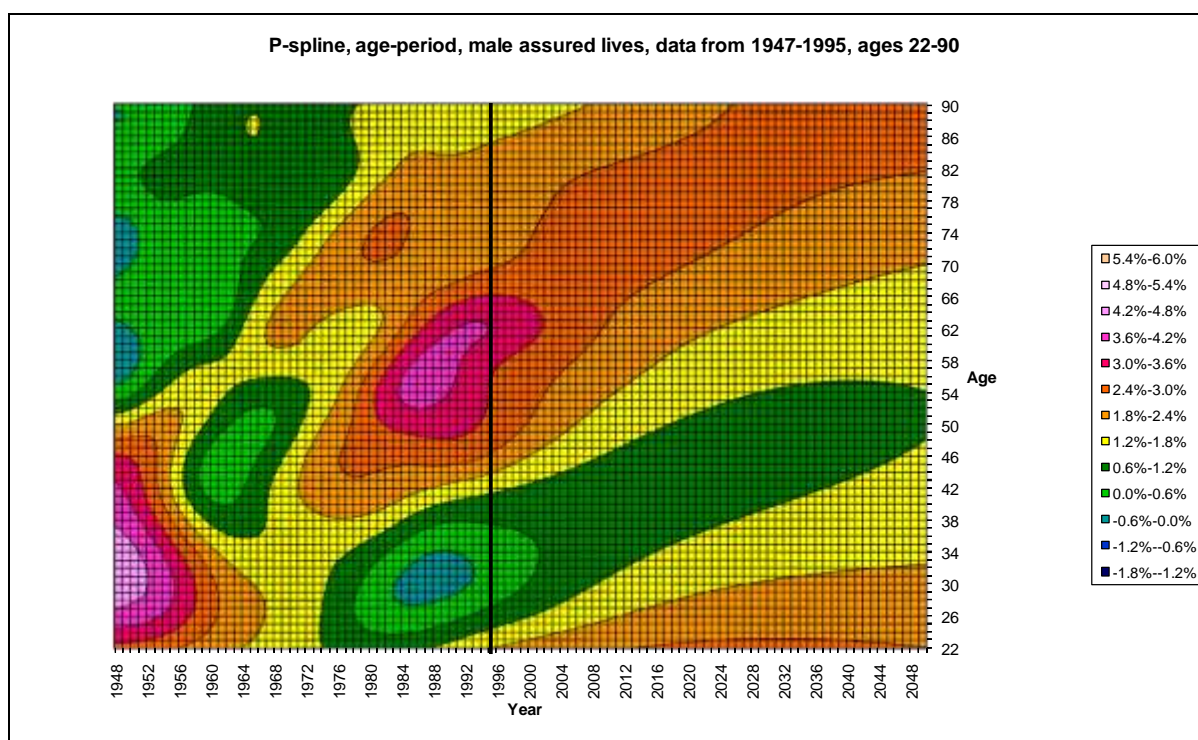


Figure C8

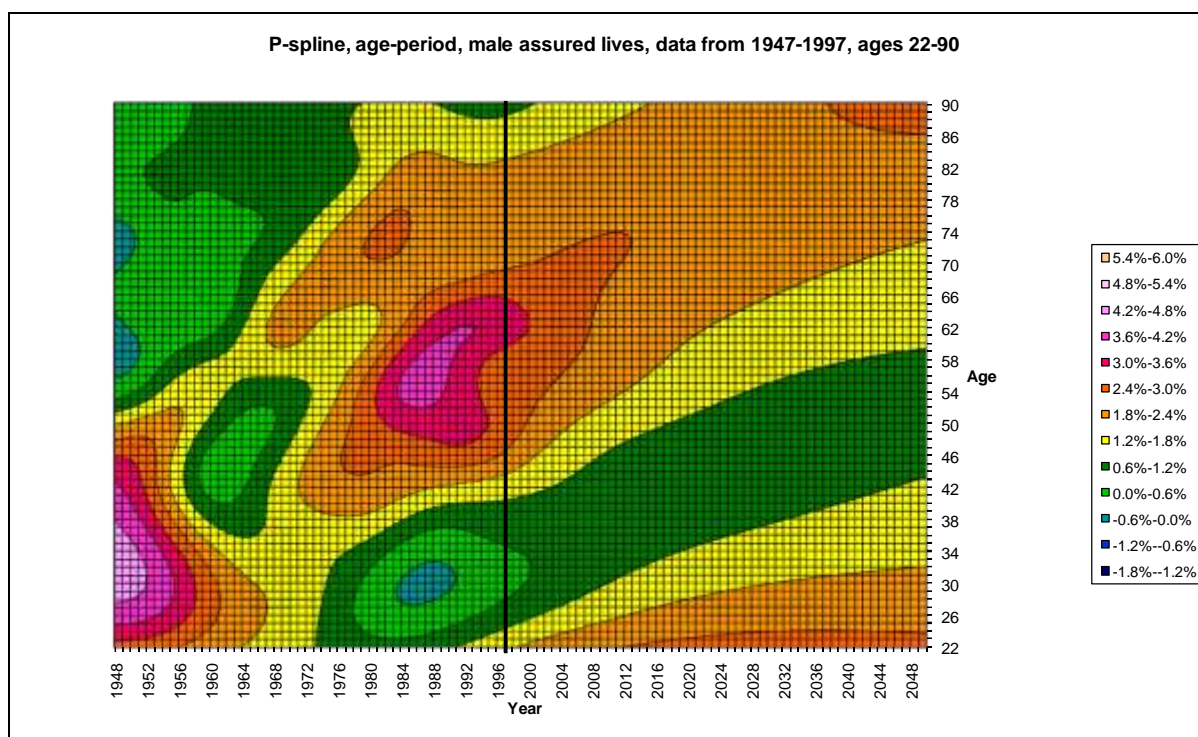


Figure C9

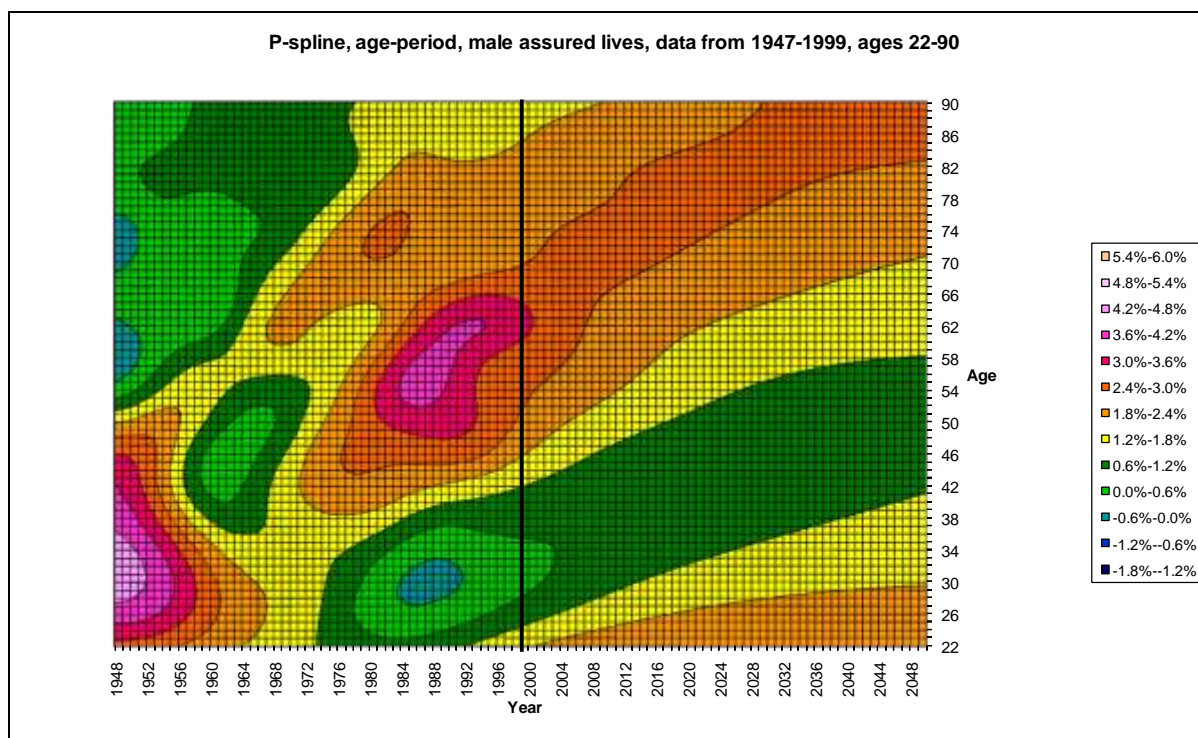


Figure C10

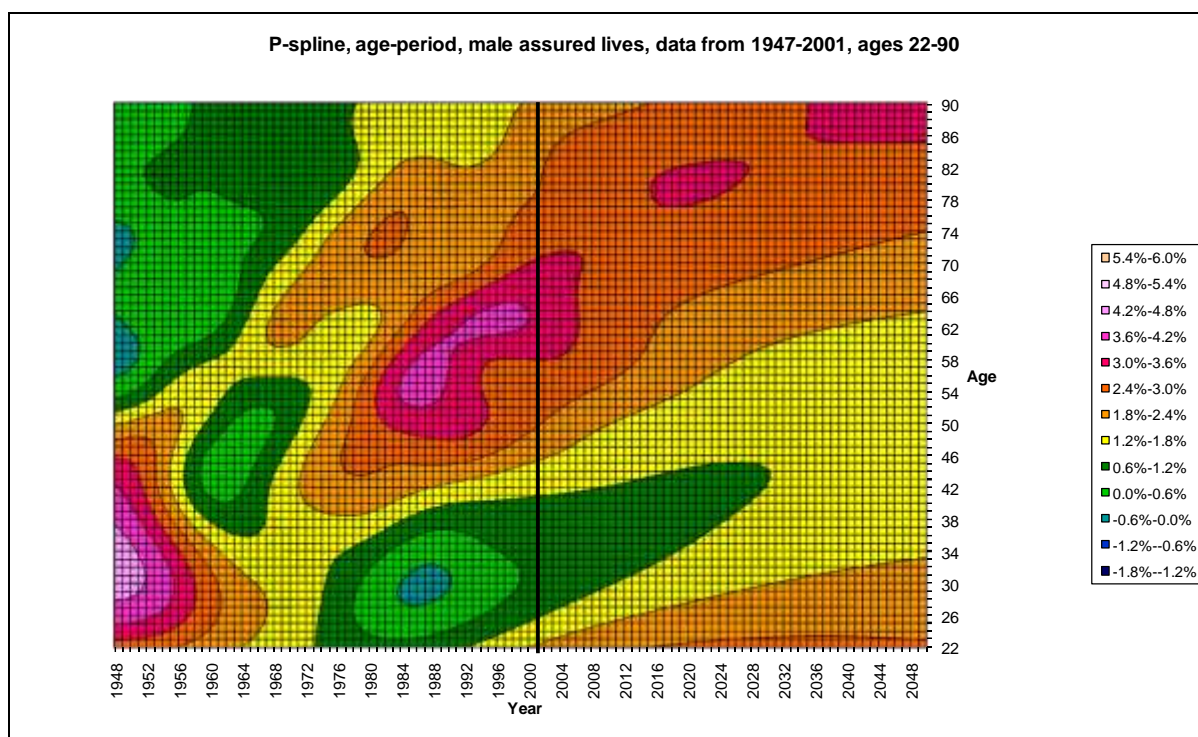
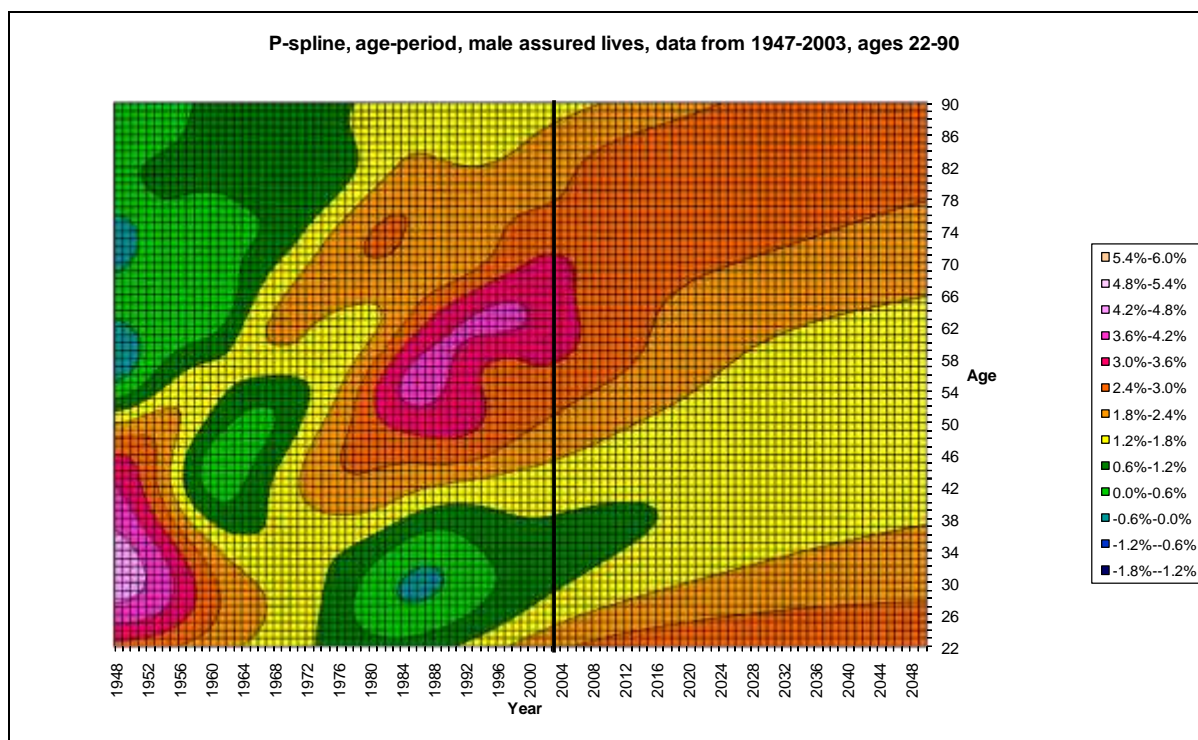


Figure C11



Effect of reducing the age range on projected improvements: contour maps of projected improvements for male assured lives using age-cohort penalties (see Appendix D of Working Paper 20)

Figure D1 – Ages 21 to 90

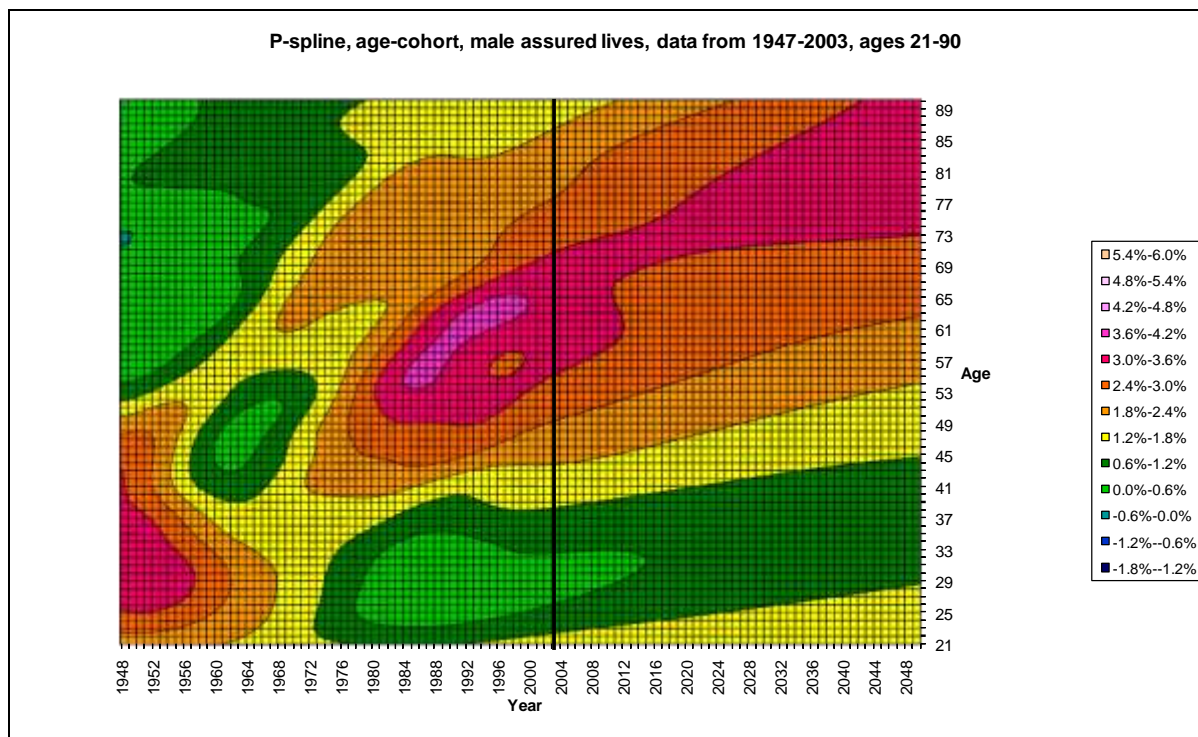
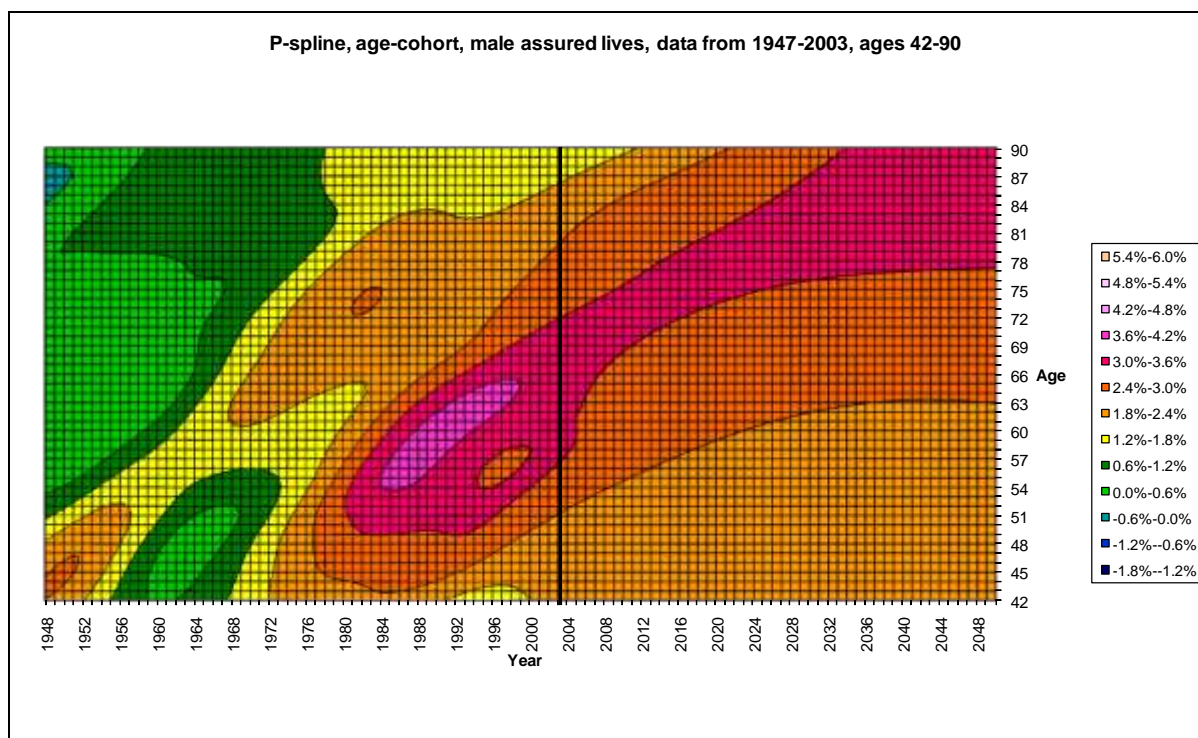


Figure D2 – Ages 42 to 90



Appendix B: Errata to CMI Working Paper 25

CMI Working Paper 25, on Lee-Carter projections, was affected by the exposure issue and the software error. As a result the projections based on all the datasets, CMI Permanent Assurances for Male lives, ONS Male data and ONS Female data, were affected.

The tables and graphs contained in this Appendix replace those in Working Paper 25. In a number of places, references in the accompanying text referred to numerical values from the tables but we have not amended these paragraphs in this document. The comments in several paragraphs have been invalidated by the revisions – amendments to these paragraphs are indicated in this Appendix.

Table M1 (*page 8*)

Mortality basis	Projection based on male assured lives, 1947-2003			Projection based on male ONS data, 1961-2003		
	4.5% annuity value at age			4.5% annuity value at age		
	60	65	75	60	65	75
PMA92u04mc	15.218	13.640	9.902	15.218	13.640	9.902
PMA92u04lc	15.620	14.154	10.355	15.620	14.154	10.355
PMA92u04sc	15.044	13.415	9.599	15.044	13.415	9.599
PMA92u04LC50psac	15.056	13.411	9.549	15.001	13.349	9.481
PMA92u04LC97.5psac	15.338	13.685	9.775	15.261	13.598	9.661
PMA92u04LC2.5psac	14.765	13.136	9.321	14.750	13.113	9.296
PMA92u04LC50psap	15.057	13.412	9.550	14.998	13.347	9.480
PMA92u04LC97.5psap	15.334	13.686	9.772	15.257	13.588	9.656
PMA92u04LC2.5psap	14.771	13.140	9.322	14.747	13.115	9.297
PMA92u04LC50LC	15.059	13.414	9.552	14.993	13.343	9.478
PMA92u04LC97.5LC	15.333	13.688	9.782	15.254	13.598	9.654
PMA92u04LC2.5LC	14.763	13.134	9.320	14.752	13.116	9.303

Table M2 (page 9)

Annuity values in shaded cells. Other cells show the values in Table M1 as percentages of values in the shaded cells.						
Mortality basis	Projection based on male assured lives, 1947-2003			Projection based on male ONS data, 1961-2003		
	4.5% annuity value at age			4.5% annuity value at age		
	60	65	75	60	65	75
PMA92u04mc	15.218	13.640	9.902	15.218	13.640	9.902
PMA92u04lc	102.6%	103.8%	104.6%	102.6%	103.8%	104.6%
PMA92u04sc	98.9%	98.3%	96.9%	98.9%	98.3%	96.9%
PMA92u04LC50psac	98.9%	98.3%	96.4%	98.6%	97.9%	95.7%
PMA92u04LC97.5psac	100.8%	100.3%	98.7%	100.3%	99.7%	97.6%
PMA92u04LC2.5psac	97.0%	96.3%	94.1%	96.9%	96.1%	93.9%
PMA92u04LC50psap	98.9%	98.3%	96.4%	98.6%	97.8%	95.7%
PMA92u04LC97.5psap	100.8%	100.3%	98.7%	100.3%	99.6%	97.5%
PMA92u04LC2.5psap	97.1%	96.3%	94.1%	96.9%	96.1%	93.9%
PMA92u04LC50LC	99.0%	98.3%	96.5%	98.5%	97.8%	95.7%
PMA92u04LC97.5LC	100.8%	100.3%	98.8%	100.2%	99.7%	97.5%
PMA92u04LC2.5LC	97.0%	96.3%	94.1%	96.9%	96.2%	94.0%

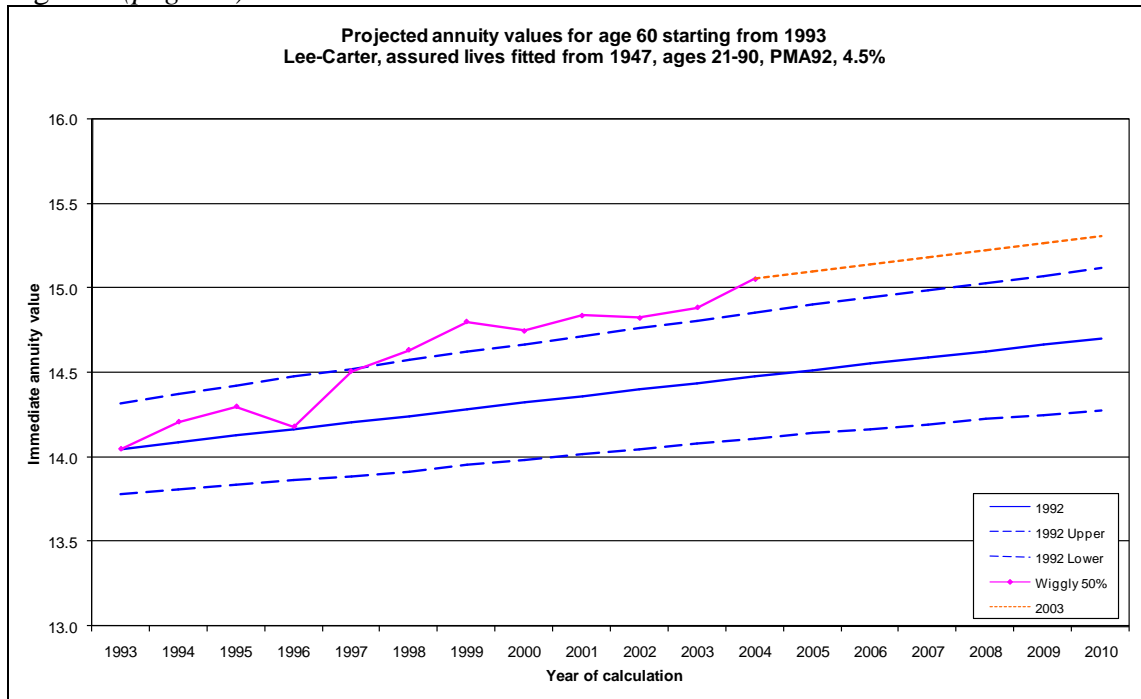
Paragraph 5.9 (page 10)

Working Paper 25 commented that “most annuity values using the Lee-Carter model are lower than annuity values using the Medium Cohort projections.” As will be noted from the revised Table M2 (above), half of the annuity values using the Lee-Carter model are lower than annuity values using the Medium Cohort projections now.

Paragraph 5.10 (page 10)

Working Paper 25 commented that “...the 50th percentile annuity values produced by the Lee-Carter model are generally lower than those calculated on the “92” Series basis with short cohort adjustment.” This is true for 5 of the 6 values shown in the revised Table M1 (above), but is no longer true for the value at age 60 based on the CMI data.

Figure 1 (page 11)



Paragraph 5.15 (page 11)

Working Paper 25 commented that a further 4 years data (to 1996) would produce a projection outside the 95% confidence interval of the projections using data to 1992. As will be noted from the revised Figure 1 (above), this figure now sits within the 95% confidence interval, but that projections outside are produced using a further 5 years data to 1997 (or more).

Figure 2 (page 12)

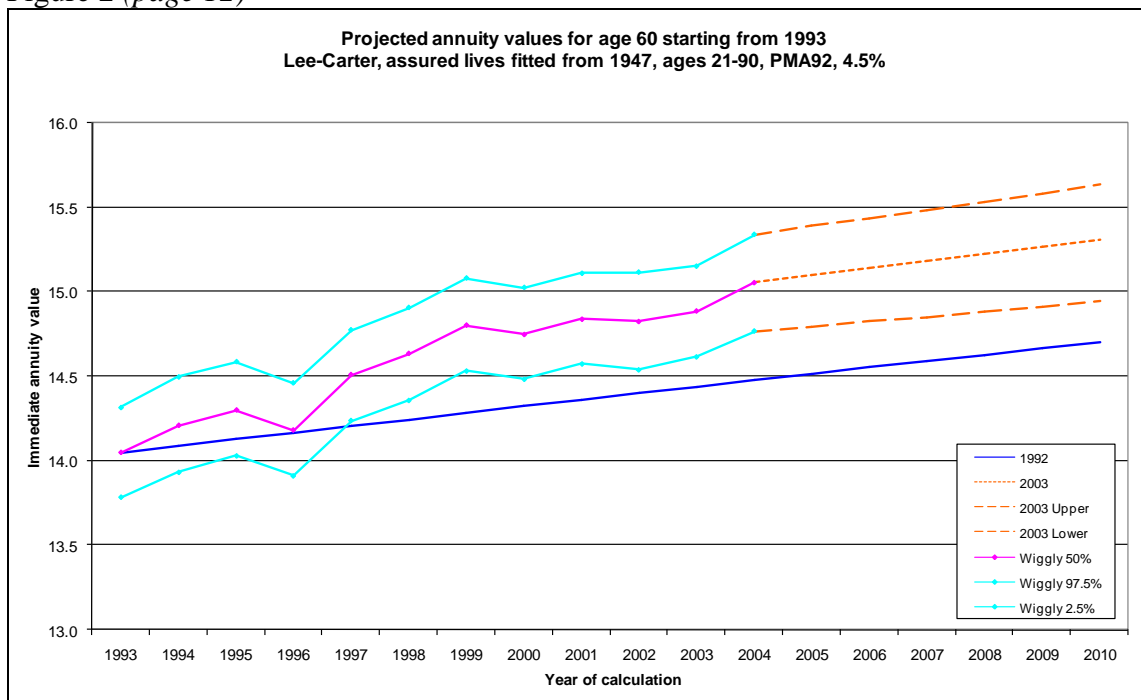


Figure 3 (page 13)

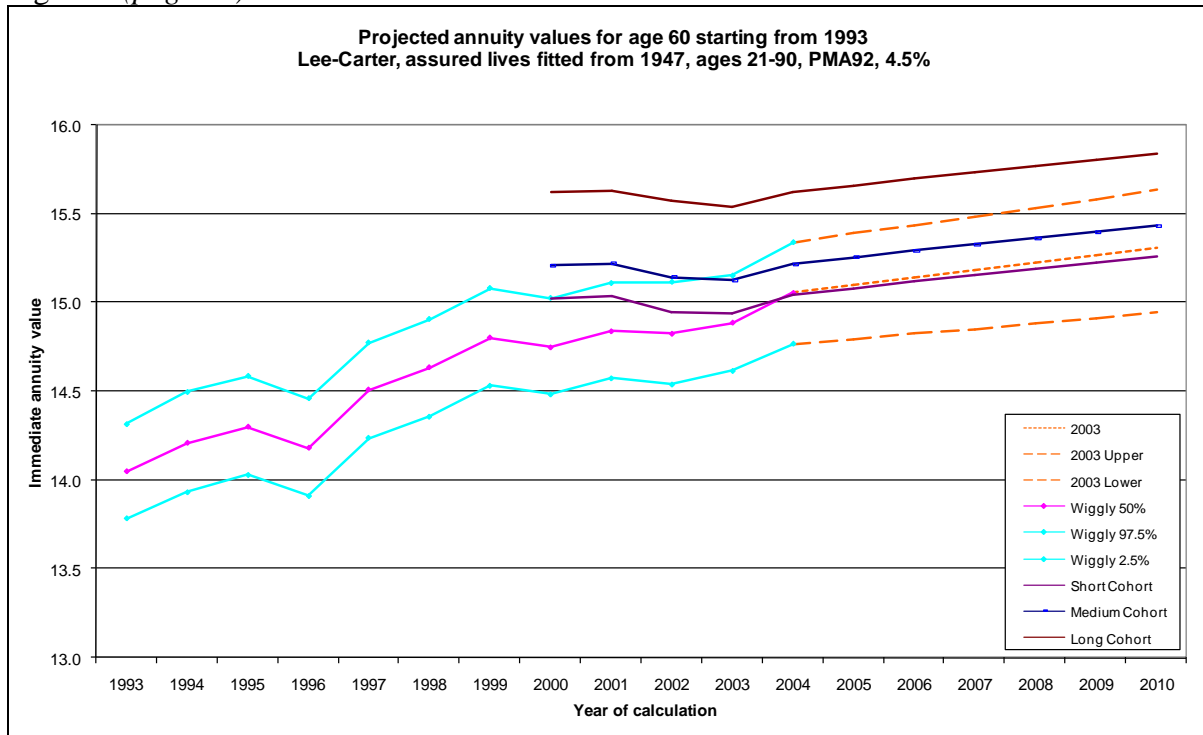


Figure 4 (page 13)

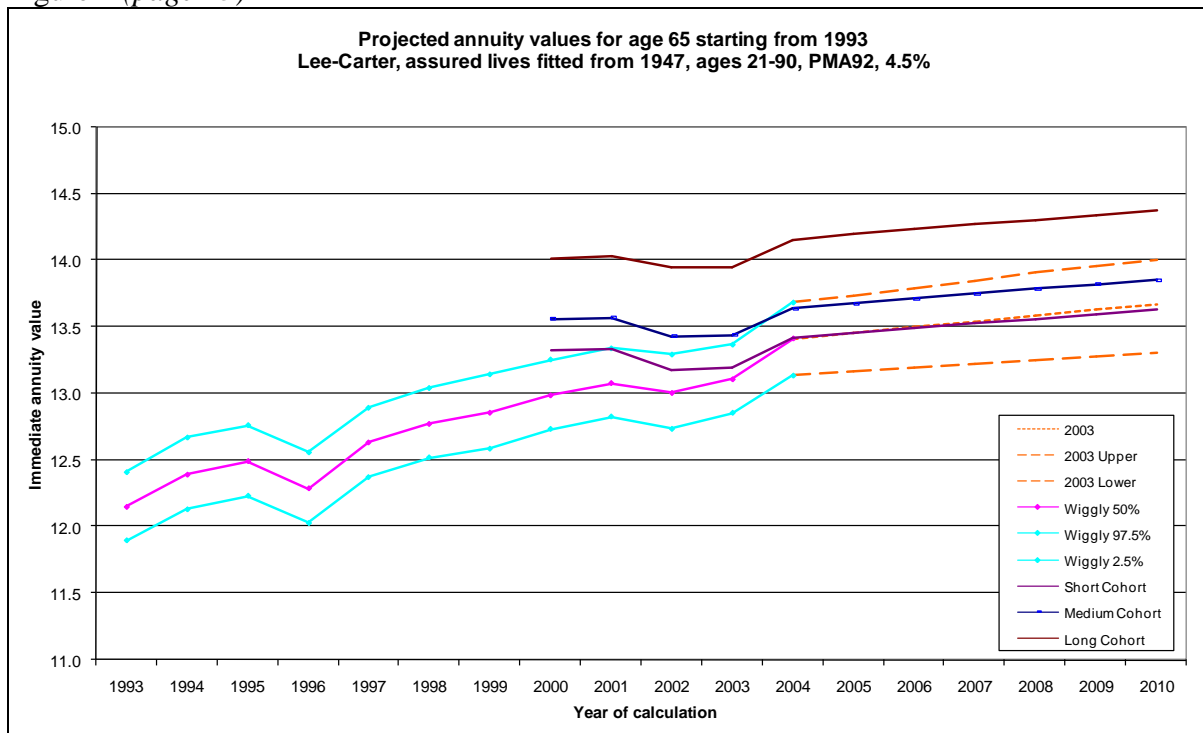


Figure 5 (page 14)

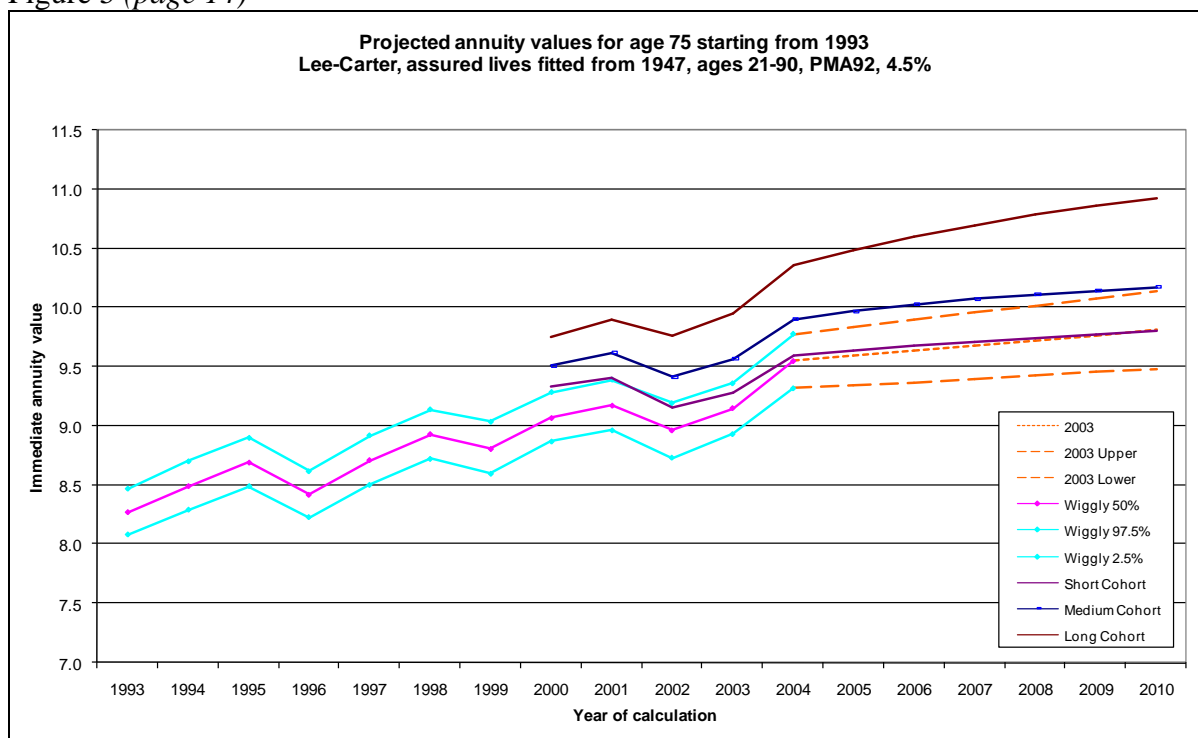


Table M3 (page 16)

Mortality basis	Projection based on male assured lives, 1947-2003			Projection based on male ONS data, 1961-2003		
	4.5% annuity value at age			4.5% annuity value at age		
	60	65	75	60	65	75
PMA92u04mc	15.218	13.640	9.902	15.218	13.640	9.902
PMA92u04lc	15.620	14.154	10.355	15.620	14.154	10.355
PMA92u04sc	15.044	13.415	9.599	15.044	13.415	9.599
PMA92u04LCapc50	15.126	13.497	9.598	16.348	14.575	10.217
PMA92u04LCapc97.5	15.557	13.899	9.908	17.151	15.386	10.759
PMA92u04LCapc2.5	14.675	13.081	9.296	15.640	13.907	9.789

Table M4 (page 17)

Annuity values in shaded cells. Other cells show the values in Table M3 as percentages of values in the shaded cells.						
Mortality basis	Projection based on male assured lives, 1947-2003			Projection based on male ONS data, 1961-2003		
	4.5% annuity value at age			4.5% annuity value at age		
	60	65	75	60	65	75
PMA92u04mc	15.218	13.640	9.902	15.218	13.640	9.902
PMA92u04lc	102.6%	103.8%	104.6%	102.6%	103.8%	104.6%
PMA92u04sc	98.9%	98.3%	96.9%	98.9%	98.3%	96.9%
PMA92u04LCapc50	99.4%	99.0%	96.9%	107.4%	106.8%	103.2%
PMA92u04LCapc97.5	102.2%	101.9%	100.1%	112.7%	112.8%	108.7%
PMA92u04LCapc2.5	96.4%	95.9%	93.9%	102.8%	102.0%	98.9%

Paragraph 7.18 (page 18)

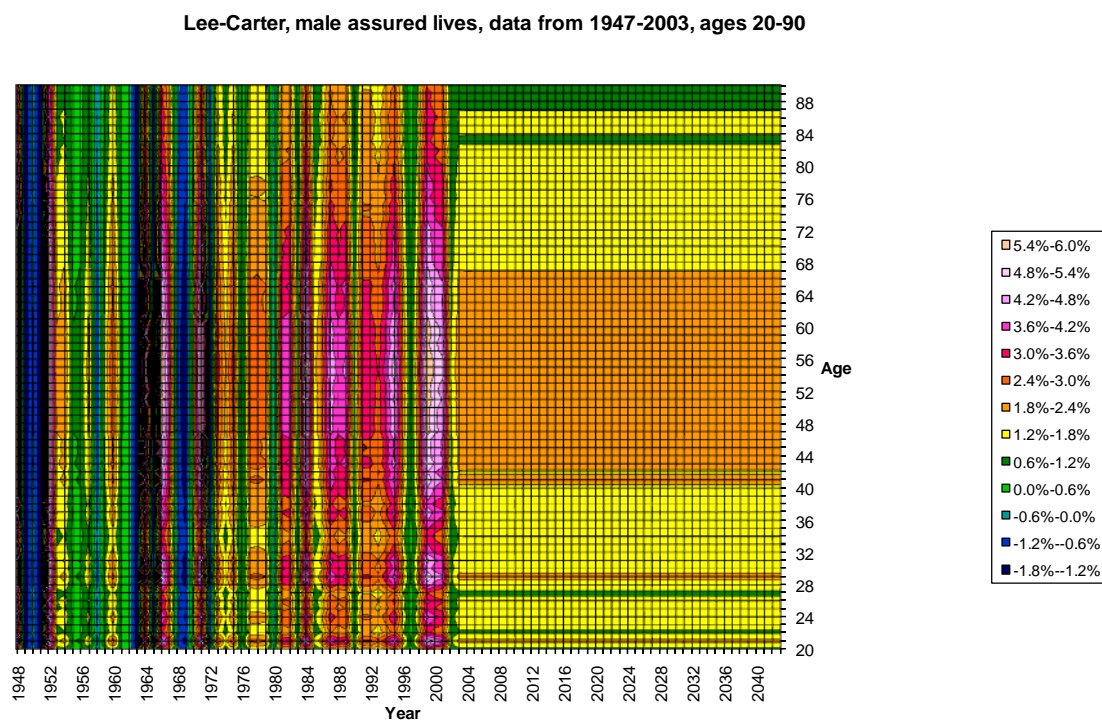
Appendix G of Working Paper 25 showed the fitted parameters for the Assured Lives dataset with the age range extended to cover ages 25-90. It did not make clear that these graphs used a different set of constraints to the graphs in Appendix F.

In the revised Appendix G in this document we have used two different sets of constraints:

- The first set of graphs uses the constraints used in Appendix F of Working Paper 25. This shows that the fitted cohort parameters do appear to be stable as the age range fitted is changed, contrary to paragraph 7.18 of Working Paper 25. However this set of constraints did not work with all age and year ranges.
- Using alternative constraints that fit some of these subsets of data shows that this stability is affected. The second set of graphs illustrates that using the alternative constraints, the cohort parameters do not appear to capture the cohort effects for the generation born between 1922 and 1946. For this fit, some of these cohort effects may have been captured in the coefficients describing the pattern of deviations from the age profile ($b_2(x)$) as the cohort parameters vary.

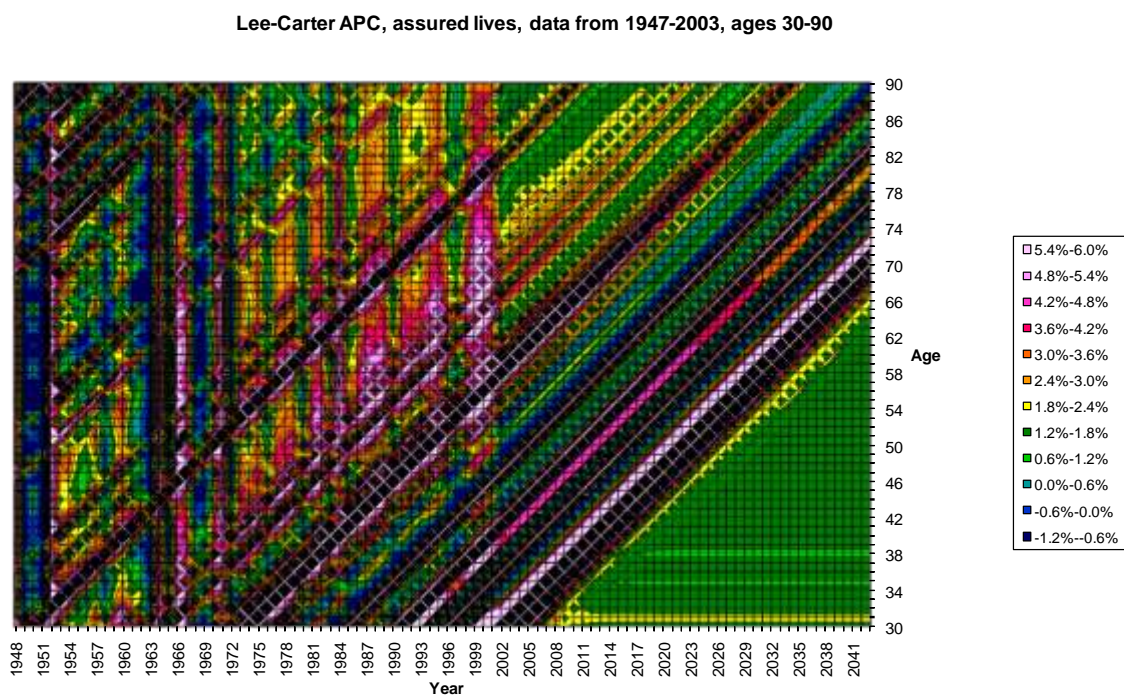
Contour maps of projected improvements using the Lee-Carter model (see Appendix B of Working Paper 25)

Figure B1



Contour maps of projected improvements using the Lee-Carter APC model (see Appendix C of Working Paper 25)

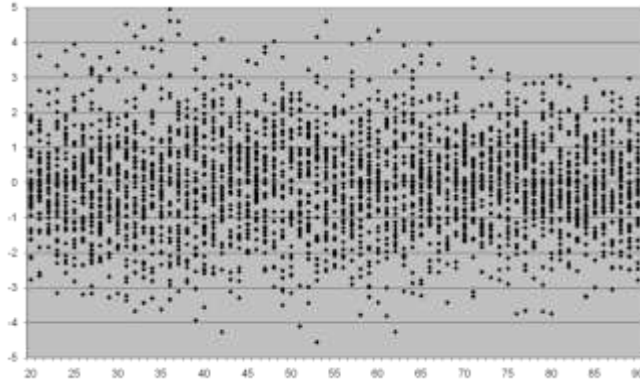
Figure C1



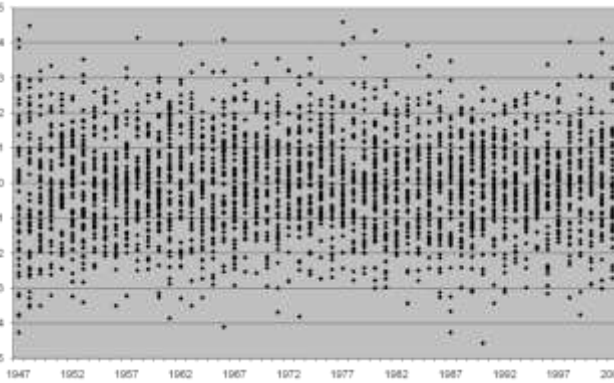
Deviance Residuals of Lee-Carter Fits (see Appendix D of Working Paper 25)

Figure D1 – Assured lives, data from 1947-2003, ages 20-90

(a) Age



(b) Year



(c) Cohort

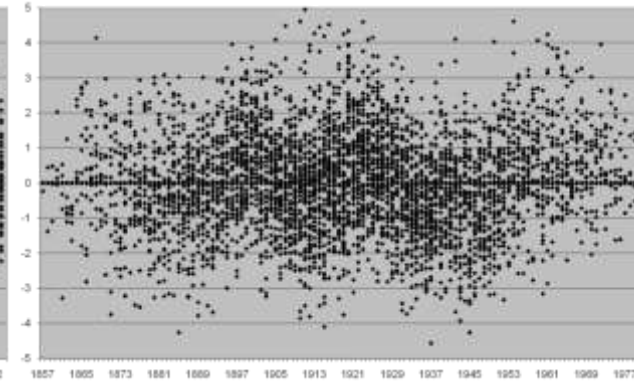
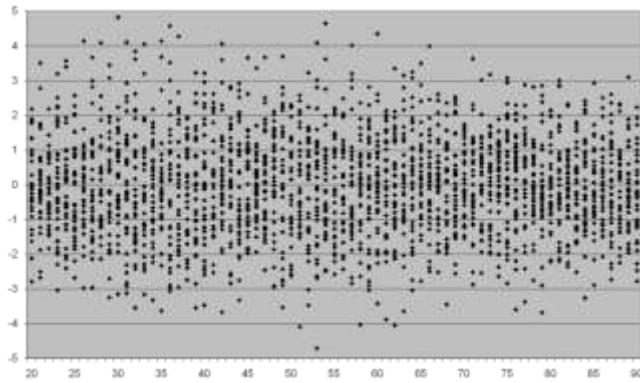
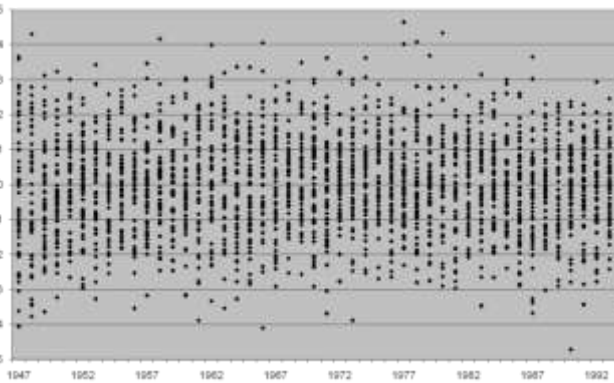


Figure D2 – Assured lives, data from 1947-1994, ages 20-90

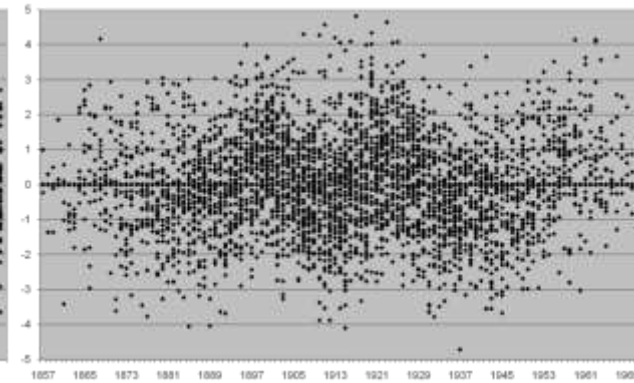
(a) Age



(b) Year



(c) Cohort

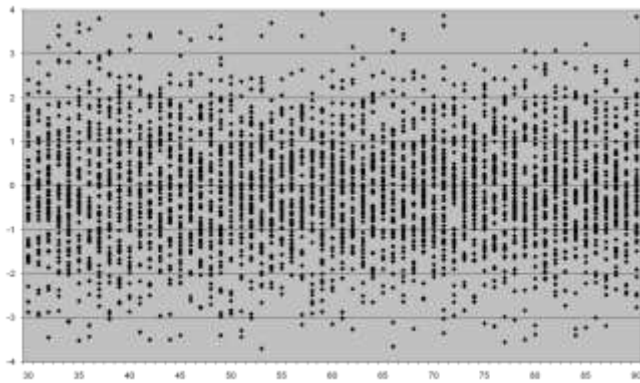


Deviance Residuals of Lee-Carter APC Fits (see Appendix E of Working Paper 25)

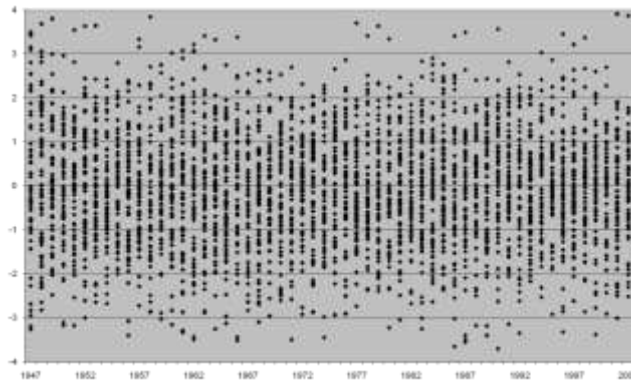
Note: The graphs in Appendix E of Working Paper 27 were not created using the software and were not affected by the deviance residual calculation error. As a result, the graphs of the deviance residuals for the ONS dataset were unaffected. The graphs of the deviance residuals for the Assured Lives dataset have been reproduced to reflect the changes to the exposure.

Figure E1 - Assured lives, data from 1947-2003, ages 30-90

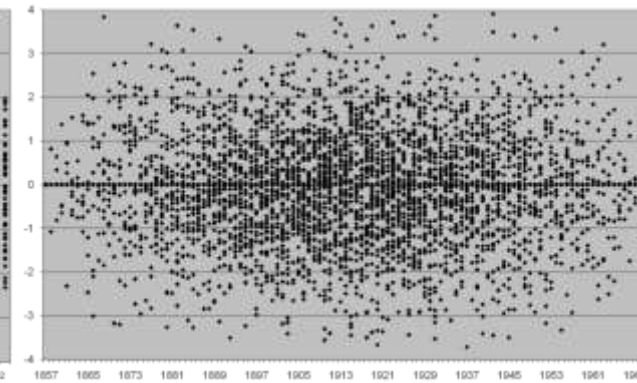
(a) Age



(b) Year

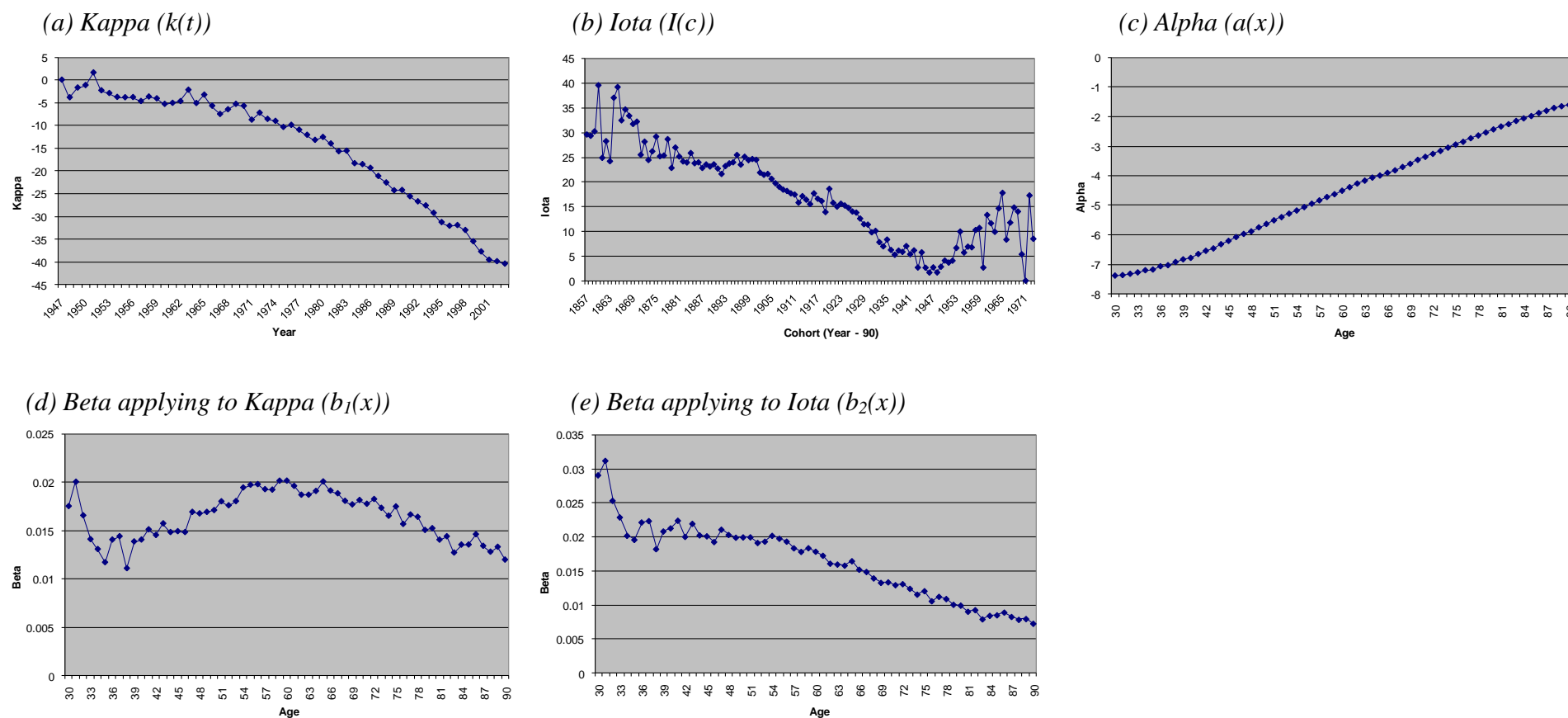


(c) Cohort



Parameter Graphs of Lee-Carter APC Fits (see Appendix F of Working Paper 25)

Figure F1 - Assured lives, data from 1947-2003, ages 30-90

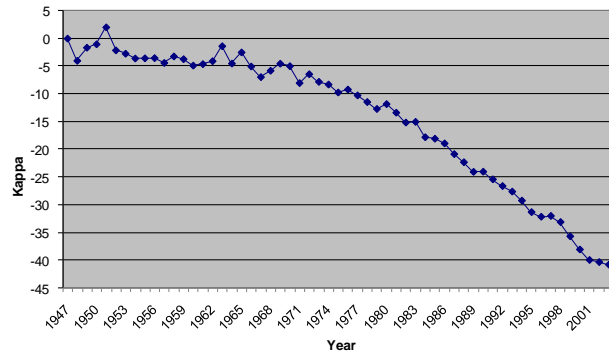


Parameter Graphs of Lee-Carter APC Fits – Extended Age Range (see Appendix G of Working Paper 25)

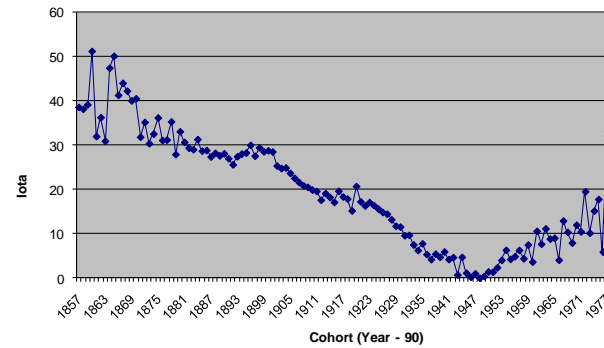
Figure G.1 - Assured lives, data from 1947-2003, ages 25-90 (constraints as used in Appendix F)

N.B. This is an additional set of graphs and does not correspond to Figure G.1 in Working Paper 25.

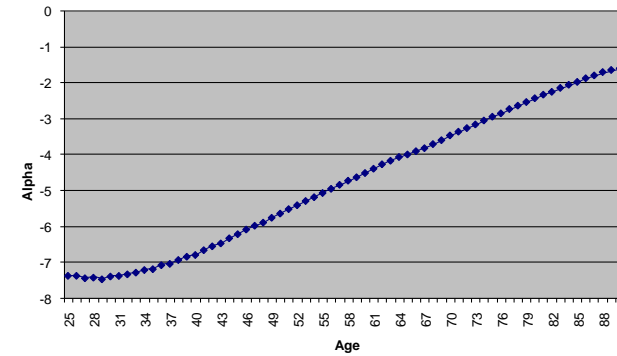
(a) Kappa ($k(t)$)



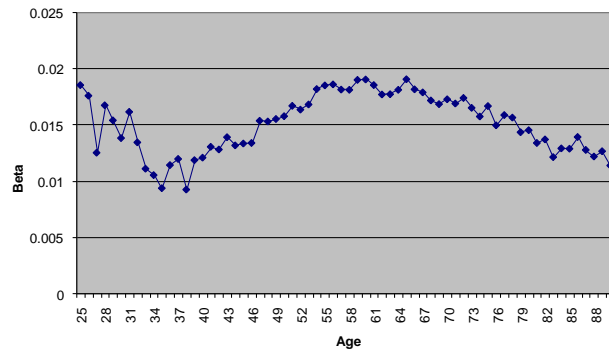
(b) Iota ($I(c)$)



(c) Alpha ($a(x)$)



(d) Beta applying to Kappa ($b_1(x)$)



(e) Beta applying to Iota ($b_2(x)$)

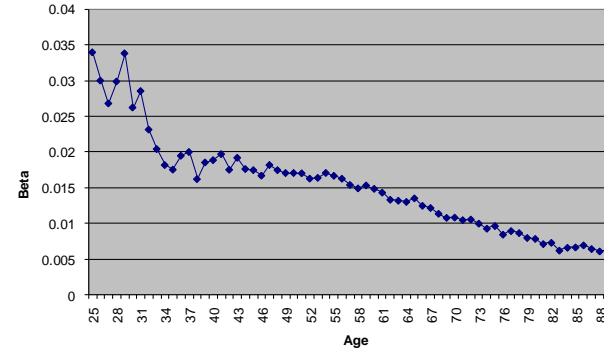
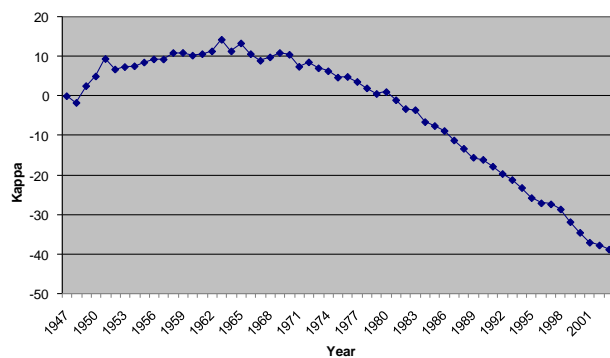
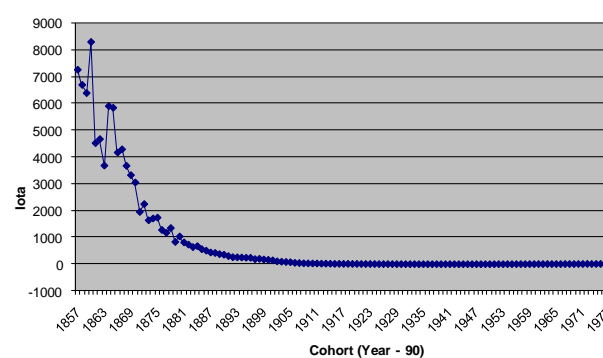


Figure G2 - Assured lives, data from 1947-2003, ages 25-90 (new constraints)
 N.B. This set of graphs corresponds to Figure G.1 in Working Paper 25.

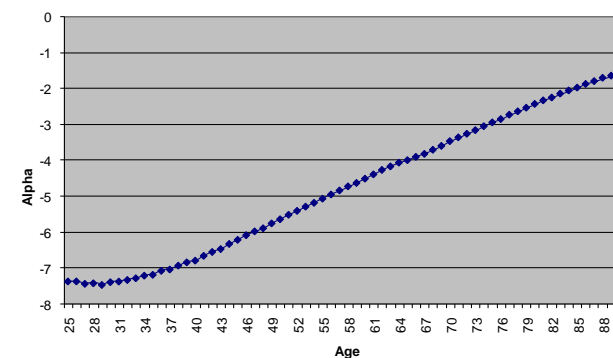
(a) Kappa ($k(t)$)



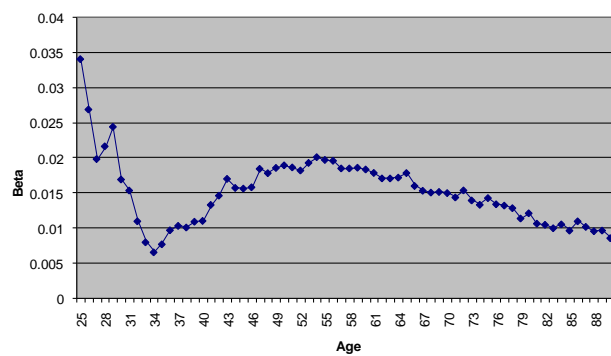
(b) Iota ($I(c)$)



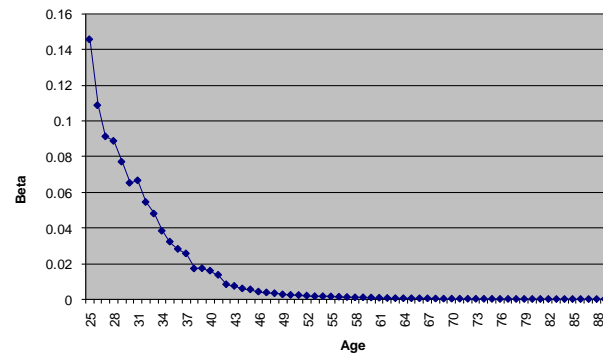
(c) Alpha ($a(x)$)



(d) Beta applying to Kappa ($b_1(x)$)



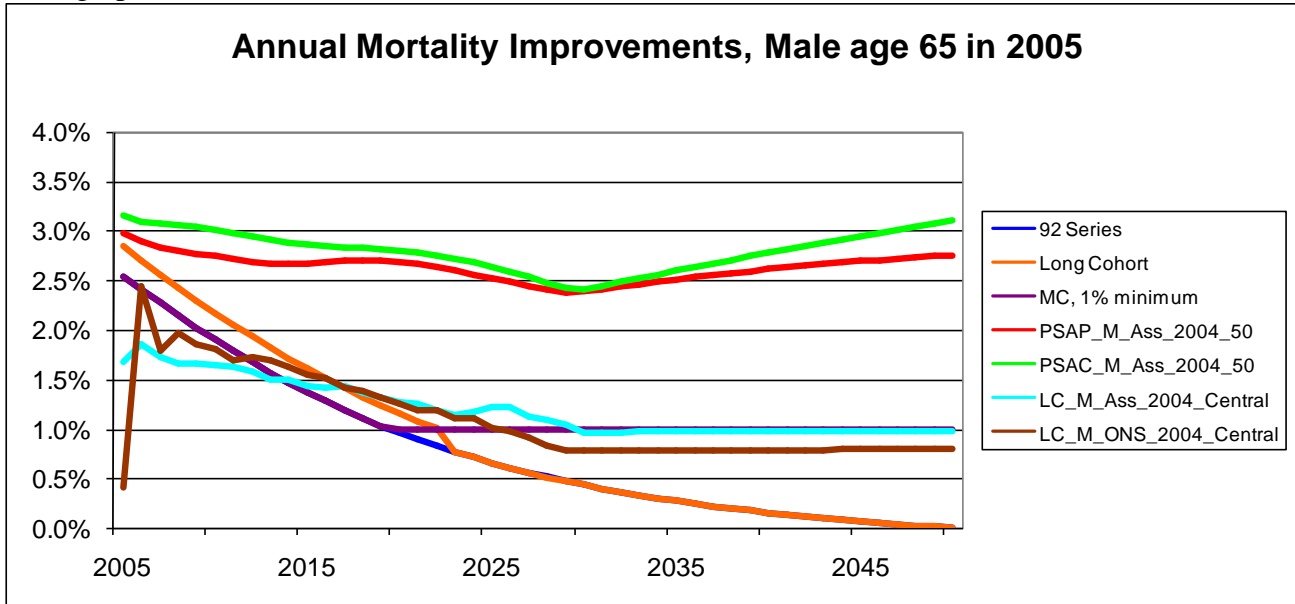
(e) Beta applying to Iota ($b_2(x)$)



Appendix C: Errata to CMI Working Paper 27

CMI Working Paper 27 and the draft library of projections were affected only by the exposure issue, in respect of projections using the dataset for Permanent Assurances for Male lives. The CMI is not issuing a corrected version of the draft library as it is effectively replaced by version 1.0 of the library.

The mortality improvement graph included in (b) of section 8 included illustrations of P-spline and Lee-Carter projections based on the Permanent Assurances dataset. A revised graph is shown below:



Some of the annuity and expectation of life values included in section 8 were also affected.

The table below shows only the values that differ from Working Paper 27, and also shows the revised value as a percentage of the original, incorrect value. Please see Working Paper 27 for more details on the calculation of these values.

Note that no projections were included in the draft library using CMI data for females, so the revisions apply only to males.

Males	Annuity values at 5% p.a. for a life aged x exact on 1 July 2005						Expectation of life for a life aged 65 exact on 1 July		Expectation of life for a life aged x exact on 1 July 2005			
Projection	${}_{20 }\ddot{a}_{45}$	${}_{10 }\ddot{a}_{55}$	\ddot{a}_{60}	\ddot{a}_{65}	\ddot{a}_{70}	\ddot{a}_{80}	2025	2015	e_{60}	e_{65}	e_{70}	e_{80}
PSAP_Male_Ass_2003_50	5.135	8.190	14.865	13.280	11.415	7.473	28.949	25.692	28.280	22.740	17.601	9.453
PSAP_Male_Ass_2004_50	5.107	8.152	14.825	13.242	11.382	7.456	28.536	25.419	28.074	22.590	17.501	9.418
PSAP_Male_Ass_2005_50	5.175	8.232	14.907	13.323	11.463	7.530	29.451	26.038	28.543	22.949	17.773	9.570
PSAC_Male_Ass_2003_50	5.215	8.231	14.880	13.272	11.387	7.443	29.619	25.842	28.290	22.670	17.501	9.390
PSAC_Male_Ass_2004_50	5.199	8.210	14.858	13.252	11.370	7.436	29.420	25.712	28.191	22.600	17.457	9.377
PSAC_Male_Ass_2005_50	5.241	8.260	14.912	13.305	11.425	7.488	30.001	26.116	28.502	22.841	17.643	9.484
LC_Male_Ass_2003_Central	4.605	7.536	14.188	12.643	10.870	7.185	22.726	21.588	25.170	20.457	16.042	8.881
LC_Male_Ass_2004_Central	4.618	7.553	14.209	12.664	10.891	7.201	22.778	21.641	25.230	20.510	16.087	8.907
LC_Male_Ass_2005_Central	4.679	7.635	14.303	12.762	10.990	7.289	23.179	21.981	25.563	20.796	16.328	9.063
Corrected values as a percentage of the values in Working Paper 27:												
PSAP_Male_Ass_2003_50	100.63%	100.49%	100.29%	100.33%	100.38%	100.51%	101.83%	101.39%	100.95%	100.91%	100.87%	100.88%
PSAP_Male_Ass_2004_50	100.61%	100.48%	100.28%	100.33%	100.37%	100.51%	101.78%	101.34%	100.91%	100.87%	100.85%	100.87%
PSAP_Male_Ass_2005_50	100.70%	100.55%	100.32%	100.37%	100.43%	100.57%	101.99%	101.53%	101.06%	101.01%	100.98%	100.98%
PSAC_Male_Ass_2003_50	100.62%	100.49%	100.28%	100.33%	100.37%	100.49%	101.74%	101.32%	100.90%	100.85%	100.81%	100.81%
PSAC_Male_Ass_2004_50	100.60%	100.48%	100.28%	100.33%	100.36%	100.49%	101.73%	101.30%	100.89%	100.84%	100.81%	100.81%
PSAC_Male_Ass_2005_50	100.65%	100.51%	100.31%	100.35%	100.40%	100.52%	101.85%	101.42%	100.97%	100.93%	100.89%	100.88%
LC_Male_Ass_2003_Central	100.44%	100.35%	100.19%	100.23%	100.27%	100.38%	101.07%	100.80%	100.53%	100.53%	100.54%	100.59%
LC_Male_Ass_2004_Central	100.46%	100.35%	100.20%	100.23%	100.28%	100.39%	101.08%	100.81%	100.55%	100.55%	100.56%	100.62%
LC_Male_Ass_2005_Central	100.49%	100.38%	100.22%	100.27%	100.32%	100.48%	101.20%	100.90%	100.62%	100.63%	100.65%	100.74%