

Continuous Mortality Investigation

Working Paper 54

Advancing the release date of the CMI Mortality Projections Model

1. Introduction.....	2
2. Calculation of high-age population estimates	4
3. A practical test for CMI_2010	6
4. Next steps	9
References	9

August 2011

© 2011 Institute and Faculty of Actuaries

The text in this document may be reproduced free of charge in any format or medium providing that it is reproduced accurately and not used in a misleading context. The material must be acknowledged as Institute and Faculty of Actuaries copyright and the title of the document specified.

The Institute and Faculty of Actuaries and the CMI do not accept or assume any responsibility for the use of this document by any party in any context. This document does not provide any form of guidance and should not be relied on as such.

1. Introduction

1.1. Introduction

The CMI published a new Mortality Projections Model, denoted CMI_2009, alongside Working Paper 41 in November 2009. An updated version of the Model, CMI_2010, was published a year later, alongside Working Paper 49, in November 2010. The structure of CMI_2010 was identical to that of CMI_2009; however, the default parameters had been updated to reflect the publication of England & Wales population mortality data for calendar year 2009. The Model was well received and is becoming widely adopted as a “common currency” for projections of future mortality.

Both versions of the Model were released in late November, driven by the availability of data from ONS. The final piece of data required by the CMI has been released towards the end of September each year. Some users, in particular life offices, have commented that issuing the Model in November does not leave them enough time to make use of the Model at that year-end. However, much of the data the CMI needs for the updates to the Model has been released earlier (by around mid-July each year), hence the CMI has investigated the possibility of developing new versions of the Model using only the data available earlier in the year.

1.2. Data sources and timing of publication

The data used by the CMI each year to update the default parameters for the Initial Rates of Mortality Improvement in the model relate to England and Wales and are published on the ONS website in three separate parts:

- **Main population estimates:** The mid-year population estimates for the previous year have been published at mid-year for recent years. These are for single year ages 0 to 89 and 90+ and are rounded to the nearest 100 lives. The population estimates are sometimes revised in light of later information.
- **Death registrations:** Detailed information on the number of deaths registered in the previous year has again been published around mid-year for recent years. These are for single year ages 0 to 109 and 110+. These figures are exact and are not usually revised in future years.
- **High-age population estimates:** The mid-year population estimates for the very elderly have been published in late September. These expand the 90+ total to provide estimates for single year ages 90 to 104 and 105+ and are rounded to the nearest 100 lives. Estimates for previous years may change when a new year of data is added.

In addition to the three data sets described above, ONS has previously provided the CMI with a full table of mid-year population estimates and death registrations, by single year of age for 0 to 104 and 105+, covering the years 1961 to 2009. These tables are a compilation of the published data except the population estimates are unrounded. In keeping with their strict protocols for the publication of data, ONS are unable to release this file to the CMI until the high-age population estimates are published in late September.

1.3. The proposed solution

The ONS derives the high-age population estimates from the main population estimates and the death registrations data using a published methodology. The CMI has investigated the feasibility of mirroring this process to produce high-age population estimates prior to the ONS release date in September and concluded that this can be achieved without material loss of accuracy in the context of using the estimates in the CMI Mortality Projections Model. This process is expected to bring forward the publication date of the Model each year by around 10 weeks if the ONS broadly maintains the release schedule it has followed in recent years.

2. Calculation of high-age population estimates

The ONS uses a version of the Kannisto-Thatcher survivor ratio method to derive the high-age population estimates.

The K-T method is an extension of the ‘method of extinct cohorts’. Once all the members of a given cohort have died, their dates of birth and death give enough information to reconstruct the numbers who were alive at earlier dates, provided that the calculations are confined to ages high enough for migration to be negligible. So, using only data on deaths grouped by year of birth and year of death, the high-age populations at each year-end can be calculated for each year-of-birth cohort.

For a cohort which has reached a high age, but is not yet extinct, the ratio of the (unknown) number of survivors to the (known) number of deaths in the cohort during, say, the previous five years can be projected from the experience of previous cohorts. An estimate of the number of survivors can be calculated by multiplying this projected "survivor ratio" by the number of deaths that have occurred in the given cohort during those five years. The past year-end populations for the cohort can then be reconstructed by adding back each year's deaths to the estimated number of survivors. A set of population estimates for high ages may be derived by applying the method iteratively, cohort by cohort, working down from the highest age.

The survivorship rate methodology used in these estimates means that previous years' estimates may change when a new year of data is added.

In order to join the high-age estimates onto the main set of population estimates, the ONS constrain the high-age estimates so that the total for ages 90 and above in each calendar year equals the 90+ figures published with the main set of population estimates.

As documentation of the methodology they use, the ONS references the paper entitled ‘The Survivor Ratio Method for Estimating Numbers at High Ages’ by R. Thatcher, V. Kannisto and K. Andreev. However, the paper does not fully specify how the ONS has applied the K-T methodology to their dataset. For example, various approaches could be taken to the projection of survivor ratios, to manipulating the deaths data and population estimates into year-of-birth cohorts, and to interpolating between mid-year and end-year population estimates. The CMI has therefore investigated a number of different methods in attempting to replicate the high-age population estimates derived by ONS. Two of these methods are summarised below.

Method A is a close match to our understanding of the ONS methodology. We are grateful for assistance provided by the ONS in clarifying aspects of their application of the methodology. However any remaining issues in our understanding of this are our own responsibility. In addition, there are a few minor differences to remove any reliance on data which would not be readily available around mid-year.

Method B is an alternative implementation of the Kannisto-Thatcher method. This incorporates different choices with respect to the projection of survivor ratios and to the manipulation of population estimates for different timing and age definitions.

Method B is included to provide a crude illustration of the sensitivity of estimates to some of the choices in application of the K-T methodology.

The table below compares the mid-year high-age population estimates produced by the CMI (using only the data available at mid-2010) for 2009 using the methods above to those published by the ONS in September 2010. Note that the constraint placed on the total of the estimates for ages 90+ means that the different methodologies only affect the distribution by age but not the total.

Table 1: Comparison of mid-year 2009 high-age population estimates

Age	Estimates for Males			Estimates for Females		
	ONS	Method A	Method B	ONS	Method A	Method B
90	28,600	28,600	28,900	61,600	61,600	60,800
91	20,300	20,200	20,200	46,200	46,200	46,400
92	16,500	16,500	16,400	40,500	40,600	40,700
93	13,200	13,200	13,200	35,300	35,300	35,300
94	10,000	10,000	10,000	29,200	29,200	29,200
95	7,200	7,200	7,200	22,800	22,800	22,900
96	4,900	4,900	4,800	16,900	16,900	17,000
97	3,200	3,200	3,100	12,100	12,100	12,100
98	2,000	2,000	2,000	8,400	8,400	8,400
99	1,200	1,200	1,200	5,700	5,600	5,700
100	700	700	700	3,700	3,700	3,700
101	400	400	400	2,300	2,300	2,400
102	200	200	200	1,400	1,400	1,400
103	100	100	100	800	800	800
104	100	100	100	400	400	400
105+	0	100	100	400	500	500
Total	108,700	108,700	108,700	287,700	287,700	287,700

The estimates shown here have been rounded to the nearest 100, for all three methods, for consistency with those published by the ONS. There are few differences between the ONS estimates and the CMI Method A estimates as shown, and indeed the differences are small even when the unrounded estimates are compared.

It is, however, convenient to use unrounded estimates for further work, and this approach has been taken for the practical test described in the next section. In releasing the main population estimates for mid-2010, the ONS have made unrounded estimates available, including for the age 90+ total, so we now anticipate working with unrounded estimates for future updates as well.

CMI Method B generates larger differences when compared with the ONS estimates, although even these differences do not appear to be material. Note that, as the K-T methodology is cohort-based, the differences shown in Table 1 for 2009 tend to ripple back along cohort lines through previous years (but only back to age 90).

3. A practical test for CMI_2010

The CMI has created alternative versions of CMI_2010, using only the data which was available in July 2010 and the resulting high-age population estimates derived by the CMI using the methods described in section 2.

3.1. Initial rates of mortality improvements comparison

The graphs below compare the initial rates of mortality improvement for 2007, which is the start year for CMI_2010 projections. For both males and females, Method A gives improvement rates which are almost indistinguishable from CMI_2010; Method B generates some noticeable differences from CMI_2010 but only above age 95.

Figure 1: Comparison of annualised rate of mortality improvements in 2007 (% pa) for males

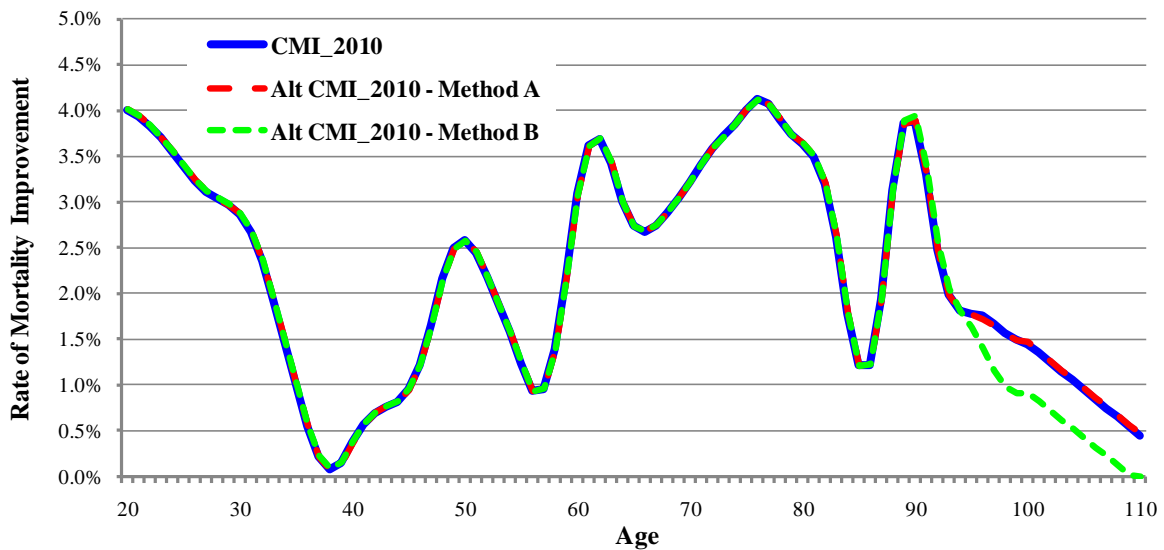
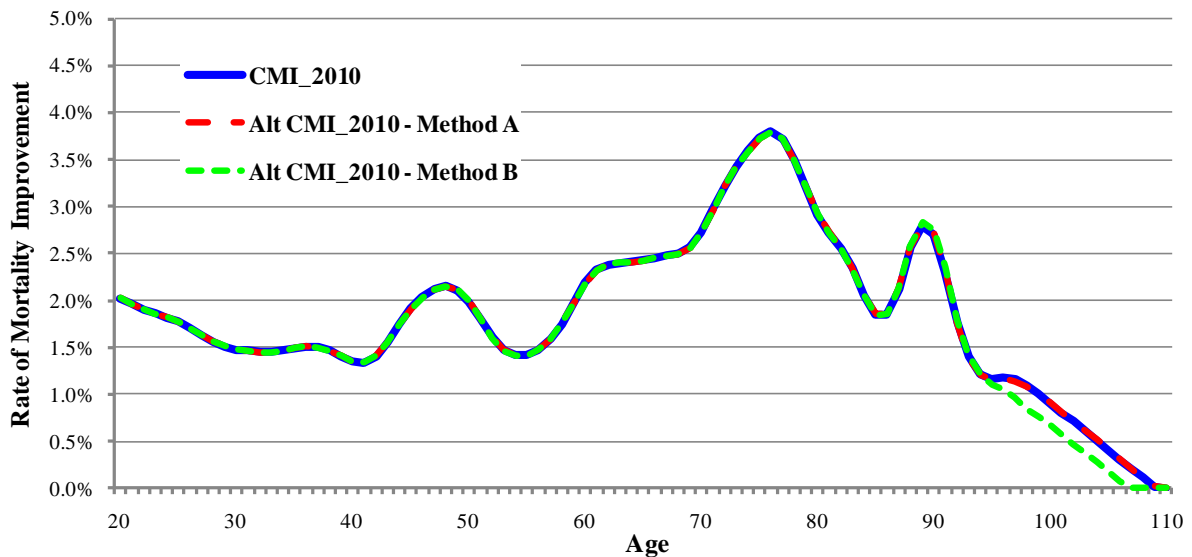


Figure 2: Comparison of annualised rate of mortality improvements in 2007 (% pa) for females



3.2. Cohort Expectations of Life comparison

The tables below provide a comparison of like-for-like cohort Expectations of Life from CMI_2010 and the ‘alternative’ versions. For males, the differences in Expectations of Life are very small for Method A: negligible below age 95 and only 0.1% to 0.2% at age 100. For Method B, the differences are also small enough to be of little practical concern in almost all circumstances: very small differences up to age 85, and only 1% to 3% at ages 95-100. For females the differences are even smaller.

Table 2: Projected cohort expectation of life for a male aged x exact on 31/12/Year
Base Rates of Mortality = 100% S1PMA as at 01/09/2002; Core Projection: CMI_2010_M [1.5%]

Age, x	2010	2020	2030	2040
20	70.13	71.62	73.06	
30	58.80	60.33	61.80	63.21
40	47.69	49.19	50.67	52.10
50	37.28	38.52	39.93	41.33
60	27.22	28.48	29.70	31.00
70	17.81	19.02	20.11	21.24
80	9.83	10.92	11.81	12.71
90	4.70	5.27	5.86	6.44
100	2.28	2.51	2.76	3.02

Table 3: % change in projected cohort Expectation of Life, using Method A

Age, x	2010	2020	2030	2040
20	0.0%	0.0%	0.0%	
30	0.0%	0.0%	0.0%	0.0%
40	0.0%	0.0%	0.0%	0.0%
50	0.0%	0.0%	0.0%	0.0%
60	0.0%	0.0%	0.0%	0.0%
70	0.0%	0.0%	0.0%	0.0%
80	0.0%	0.0%	0.0%	0.0%
90	0.0%	0.0%	0.0%	0.0%
100	0.2%	0.2%	0.1%	0.1%

Table 4: % change in projected cohort Expectation of Life, using Method B

Age, x	2010	2020	2030	2040
20	-0.1%	-0.1%	-0.1%	
30	-0.1%	-0.1%	-0.1%	-0.1%
40	0.0%	-0.1%	-0.1%	-0.1%
50	0.0%	-0.1%	-0.1%	-0.1%
60	0.0%	-0.1%	-0.1%	-0.1%
70	0.0%	-0.1%	-0.1%	-0.1%
80	-0.1%	-0.1%	-0.1%	-0.2%
90	-0.4%	-0.4%	-0.5%	-0.5%
100	-2.9%	-2.8%	-2.7%	-2.6%

Table 5: Projected cohort expectation of life for a female aged x exact on 31/12/Year
Base Rates of Mortality = 100% SIPFA as at 01/09/2002; Core Projection: CMI_2010_F [1.5%]

Age, x	2010	2020	2030	2040
20	71.85	73.28	74.65	
30	60.56	62.04	63.45	64.80
40	49.67	51.12	52.54	53.89
50	39.51	40.85	42.18	43.47
60	29.60	30.88	32.10	33.29
70	19.87	21.09	22.19	23.28
80	11.28	12.37	13.29	14.20
90	5.41	5.98	6.59	7.19
100	2.43	2.68	2.93	3.19

Table 6: % change in projected cohort Expectation of Life, using Method A

Age, x	2010	2020	2030	2040
20	0.0%	0.0%	0.0%	
30	0.0%	0.0%	0.0%	0.0%
40	0.0%	0.0%	0.0%	0.0%
50	0.0%	0.0%	0.0%	0.0%
60	0.0%	0.0%	0.0%	0.0%
70	0.0%	0.0%	0.0%	0.0%
80	0.0%	0.0%	0.0%	0.0%
90	0.0%	0.0%	0.0%	0.0%
100	0.1%	0.0%	0.0%	0.0%

Table 7: % change in projected cohort Expectation of Life, using Method B

Age, x	2010	2020	2030	2040
20	0.0%	0.0%	0.0%	
30	0.0%	0.0%	0.0%	0.0%
40	0.0%	0.0%	0.0%	0.0%
50	0.0%	0.0%	0.0%	0.0%
60	0.0%	0.0%	0.0%	-0.1%
70	0.0%	0.0%	0.0%	-0.1%
80	0.0%	0.0%	-0.1%	-0.1%
90	-0.2%	-0.2%	-0.2%	-0.2%
100	-1.2%	-1.2%	-1.1%	-1.1%

3.3. Discussion and conclusion

For the purposes of producing initial rates of mortality improvement for use in the CMI Projections Model, Method A produces very promising results. The results demonstrate that we can update the CMI Model without waiting for the ONS high-age population estimates with negligible loss of accuracy. The CMI feels that Method A is a suitable approach, but would like to stress that it is not necessarily the only one nor indeed the best one.

However, the Method B results also demonstrate that even if the ONS were to change its methodology for high-age population estimates or the CMI have misinterpreted the methodology, the effect on calculations performed using the CMI Model is unlikely to be material for most users. Until last year, the ONS had labeled its high-age estimates as “experimental statistics” but, following an assessment by the UK Statistics Authority, all releases from the mid-2010 estimates will appear as designated National Statistics. This change of status increases confidence that the ONS methodology is less vulnerable to sudden change.

4. Next steps

The results from the practical test using 2010 data are very encouraging. The loss of accuracy from using the CMI's method of producing high-age population estimates is minimal and the CMI considers these are considerably outweighed by the benefits of releasing the Model earlier each year.

The 2010 data required to be able to use this approach for CMI_2011 are now available and work is underway to produce CMI_2011 using Method A. Provided the CMI does not receive adverse feedback to the proposal set out in this Working Paper, the CMI_2011 version of the Model is expected to be released in September 2011.

The CMI also intends to follow this process in future years; indeed it hopes the release date can be accelerated to August if the ONS broadly maintains the release schedule it has followed in recent years.

An internal check on the difference between the CMI estimates and those published by ONS will be carried out once the high-age population estimates are released by ONS in late September. The CMI would like to stress that even if differences do emerge the intention is not to republish CMI_2011; however this check will inform our approach in future years.

Feedback on this Working Paper, or on the Model generally, can be sent via e-mail to projections@cmib.org.uk or in writing to: CMI, Cheapside House, 138 Cheapside, London, EC2V 6BW.

References

CMI Working Paper 41: Feedback on Consultation and Issue of 'CMI_2009' (November 2009)

CMI Working Paper 49: The CMI Mortality Projections Model, CMI_2010 (November 2010)

These documents are available from:

<http://www.actuaries.org.uk/research-and-resources/pages/continuous-mortality-investigation>

The Survivor Ratio Method for Estimating Numbers at High Ages by R. Thatcher, V. Kannisto and K. Andreev (January 2002; Demographic Research, Volume 6, Article 1); available from: <http://www.demographic-research.org/volumes/vol6/1/>