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Continuous Mortality Investigation

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WORKING PAPER 141

Calibration of the CMI Model for Ireland

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Summary

The Core version of the CMI Mortality Projections Model ("the Model") is intended to be suitable for the general population of England & Wales, but it can be modified for use with other populations.

This paper shows two ways in which the Model can be adapted for Irish[1] population data. While the paper is primarily aimed at actuaries considering the Model for Irish lives, it may also be of interest to actuaries considering the application of the Model to other populations or particular subgroups. It does not consider the validity of the Model but sets out areas for consideration when using the model for Irish data.

We discuss the challenges in sourcing suitable calibration data for Ireland and then compare the historical mortality experience of Ireland with that of England & Wales to inform a calibration of the Model for Ireland. We show that while Ireland had higher mortality rates in the past, it has experienced higher mortality improvements in recent years and current mortality rates are similar between the two populations. In particular, the post-2011 slowdown in mortality improvements in England & Wales data is less of a feature in data for Ireland, particularly in younger age groups.

We consider two approaches to adapting the Model for Ireland:

- A full recalibration of the Model using Irish data and associated changes to the smoothing parameters.
- Using the initial addition to mortality improvements, under an "Extended" use of the Model, to reflect historical differences in mortality improvements between Ireland and England & Wales.

Under both approaches, we only change the initial mortality improvements, not the long-term rate of improvements or the pattern of convergence between initial and long-term improvements.

Whilst period life expectancies in Ireland were generally lower than in England and Wales during the last century[2], they are currently at a similar level due to more rapid improvements in Ireland. These higher historical improvements in Ireland result in higher projected improvements for Ireland than for England & Wales. This leads to higher cohort life expectancies for Ireland, when using the same base mortality table for both populations. The increase in life expectancy is most material for older males, with life expectancies for Ireland, using the fully recalibrated Model, being over 5% higher than for England & Wales data for males aged 65 and above.

Using an Extended version of the Model, with initial additions to mortality improvements of 1.5% p.a. for males and 0.5% p.a. for females, results in life expectancies within 0.5% of those from the fully calibrated model, apart from the highest ages. This approach is simpler than a full recalibration, and may be sufficiently accurate for some users of the Model. We note however than the initial additions required to make the Extended Model suitable for Ireland are likely to change over time.

The sensitivities of life expectancies to the long-term rate, for the fully recalibrated Model, are similar to the corresponding results for England & Wales in Working Paper 119, with life expectancies for the Model calibrated to Irish data being marginally more sensitive at older ages.

We briefly consider the issue of calibrating the Model specifically for Irish assured lives, rather than the general population. With no credible dataset available to fully calibrate the model for Irish assured lives, we set out other options using the initial addition to mortality improvements under an Extended version of the Model.

[1] In this paper we use "Irish" and "Ireland" to refer to the Republic of Ireland, rather than the island of Ireland.
[2] Based on data from the Human Mortality Database (https://www.mortality.org/).

Contents

Reliances and limitations

The purpose of the Model is to allow users to produce projections of annual rates of mortality improvement. The Core version of the Model reflects recent experience of mortality in the population of England & Wales, but users can modify projections to tailor them to different populations and to their own views and purpose.

We aim to produce high-quality outputs and take considerable care to ensure that the analysis in this paper is accurate. However:

- We cannot guarantee its accuracy (see the Disclaimer on the last page of this document).
- There is a reliance on underlying data; although we have exercised judgement in the choice of dataset, the age range and period used.
- We have also applied judgement and assumptions in the choice of Model parameters and in how we have shown results.

Anyone using the Model, for any population, should ensure that it is appropriate for their particular use and that suitable values are used for the parameters. The Model (including but not limited to its default parameter values) does not provide any form of guidance and should not be relied upon as such.

1. Introduction

This paper considers how the CMI Mortality Projections Model (the “Model”) could be used for Irish lives. We:

- compare features of the available Irish population data with that of England & Wales, used in the Core version of the Model;
- consider the challenges faced when calibrating the CMI mortality projection model to populations other than England & Wales;
- show sensitivities in respect of key parameters; and
- comment on how the Model could be used for assured lives.

Although the paper looks at Irish mortality, the methods and principles may be of interest when considering how to adapt the Model for other populations.

The paper has been prepared by the Society of Actuaries in Ireland, with assistance from the CMI. It is intended to be a “one-off” rather than a regular exercise.

1.1 Background

The Model allows users to project mortality improvements. These improvements can then be used to project mortality rates and value financial products.

The Model has a set of default (“Core”) parameters that users can modify. The Core version of the Model is calibrated to historical data for the general population of England & Wales, but the CMI encourages users of the Model to adjust it to reflect the specific population that is being used for.

The latest version of the Model, CMI_2019, was published on 2 March 2020. The calculations in this paper were completed before then, using CMI_2018, but the model version is not important as we are using data for 1977-2017 for consistency with available Irish data.

The CMI has noted that it will review the Model’s method and data ahead of the release of CMI_2020, to ensure that it is appropriate in light of the current coronavirus pandemic.

1.2 Contents of this paper

This paper is organised in the following sections:

1. This introduction.
2. Description of the population mortality data used in this paper.
3. A comparison of recent mortality between Ireland and England & Wales.
4. Description of the Model, and discussion of different ways in which it can be adapted for another population.
5. Results of calibrating the Model to Irish data, using two different methods.
6. Considerations for Assured Lives

1.3 Compliance

This paper is intended to assist actuaries in adjusting the CMI Mortality Projections Model for use with Irish lives.

- It complies with the principles in the Financial Reporting Council's Technical Actuarial Standard "TAS 100: Principles for Technical Actuarial Work".
- It has been prepared in accordance with ASP PA-2 General Actuarial Practice and the Code of Professional Conduct of the Society of Actuaries in Ireland.

Any person using this paper should exercise judgement over its suitability and relevance for their purpose.

1.4 Feedback

Comments on this paper are welcome and can be sent to projections@cmilimited.co.uk for our consideration.

1.5 Acknowledgements

The members of the Society of Actuaries in Ireland Demography Committee involved in the production of this Working Paper are Sinéad Carty and Karl Murray.

We are grateful to Cobus Daneel and Matthew Edwards of the CMI for reviewing this paper.

2. Data

This section describes the data used in this paper, for Ireland and England & Wales, for the analysis in Section 3 and the calibration of the Model.

We have used CMI_2018, which is calibrated to data for England & Wales for ages 20-100 for the period 1978-2018. We would ideally use Irish data for the same age range and period; however, we only have access to Irish data to 2017. In order to make a consistent comparison between Ireland and England & Wales, we have calibrated the Model to:

- England & Wales data for 1977-2017; and
- Irish data for 1977-2017.

2.1 Data for England & Wales

The data for England & Wales was obtained from the Office for National Statistics (ONS):

- Deaths are taken directly from ONS data.
- Exposures are adjusted at high ages, and for other ages where they appear implausible.

Details are available in the "methods paper" that accompanies CMI_2018.

2.2 Data for Ireland

We obtained data for Ireland from the Human Mortality Database (HMD). The data for Ireland is provided to the Human Mortality Database by the Irish Central Statistics Office (CSO).

The data for Ireland used in section 3 of this paper are:

- Deaths for 1977-2017 by age and sex
- Exposures for 1977-2017 by age and sex

The Model adjusts exposures at high ages for Ireland and other ages where they appear implausible, consistent to the adjustment made to England & Wales data.

Further description of the Ireland HMD data can be found in the Background Documentation for Ireland on the HMD website[3]. We note that there is some evidence of age heaping in deaths data from 1950 to 1985. Death records for 2017 remain provisional at time of writing.

2.3 Differences in sources

Although we use different sources of data for England & Wales (ONS, with CMI adjustments) and Ireland (HMD), previous comparisons of ONS and HMD data for England & Wales in Working Paper 103 showed little difference between them.

2.4 Data for socio-economic groups

Actuaries using the Model are generally interested in the mortality of purchasers and beneficiaries of financial products, who are typically from a more affluent socio-economic group than average.

The ONS publishes mortality data for subsets of the England & Wales population by Index of Multiple Deprivation (IMD). This provides insight into differences in mortality improvements by socio-economic groups, which can help to form a view of improvements for specific populations. We are not aware of the availability of similar data for Ireland. We discuss using the Model for Irish owners of financial products further in section 6 of this paper.

[3] https://www.mortality.org/hmd/IRL/InputDB/IRLcom.pdf

3. Historical mortality

Before calibrating the Model for Ireland, we first compare historical mortality improvements between Ireland and England & Wales.

3.1 Methods

We have analysed historical mortality using the same methods as for England & Wales data in Working Paper 119, accompanying CMI_2018. We use standardised mortality rates (SMRs) in order to analyse trends in mortality rates without these being affected by changes over time in the distribution of the population by age or gender.

We calculate an SMR as:

$$SMR_t = \sum_{x,g}(StdPop(x,g) \times Deaths(x,g,t) \div Exposure(x,g,t)) \div \sum_{x,g} StdPop(x,g)$$

where

- x is age, g is gender, and t is calendar year
- $StdPop(x,g)$ uses the 2013 European Standard Population[4].
- $Deaths(x,g,t)$ and $Exposure(x,g,t)$ are the deaths and exposure for the specified age, gender and calendar year.

When we consider SMRs for subsets of the data (e.g. a specific age range) this is achieved by restricting the summations in the equation above to those subsets.

3.2 Charts in this section

Charts on the left-hand side of the page are for England & Wales. They are identical to those in Working Paper 119, including their titles, apart from changing some scales to enable a clearer comparison with results for Ireland.

Charts on the right-hand side are for Ireland.

3.3 Deaths and exposures

Charts 2A and 2B show deaths and exposures. The scales are chosen so that corresponding points on the y-axes are 15 times as large for England & Wales as for Ireland.

- Exposure for Ireland is just under 7.6% of that of England & Wales, but deaths are closer to 5.7%, reflecting Ireland's lower average age. Deaths show a similar "U-shaped" pattern for each population.
- Population growth was much faster in Ireland from 2000 to 2008, then slowed to 2014 before increasing since. The growth from 2000 to 2008 was almost exclusively in the 20- 59 age group.

[4] This is available from http://ec.europa.eu/eurostat/cache/metadata/Annexes/hlth_cdeath_esms_an1.pdf and is provided in age bands. We assume that the population within each five-year age band is split equally between its five ages; and that the open age band 95+ is split equally between the six ages from 95 to 100 inclusive.

Chart 2A: Deaths – ages 20-100, males and females combined, England & Wales

Ireland

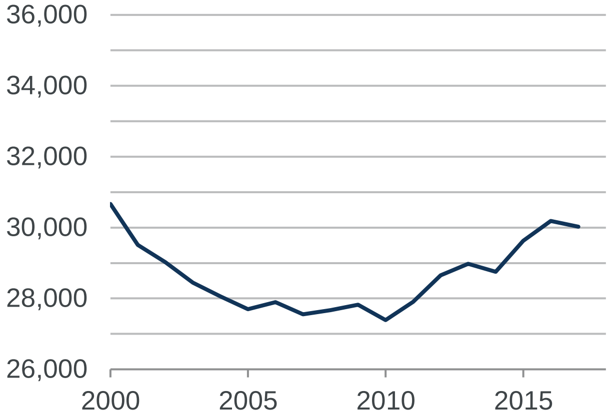
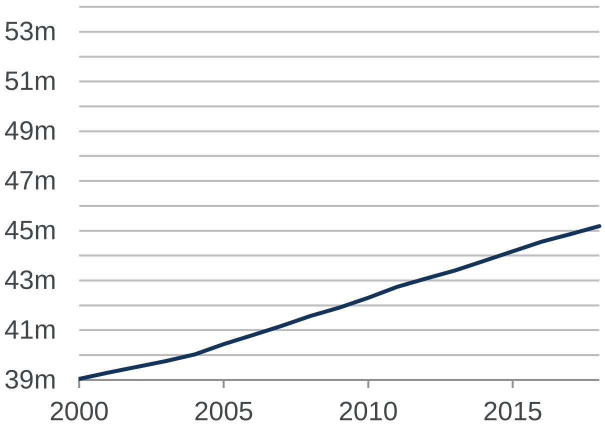
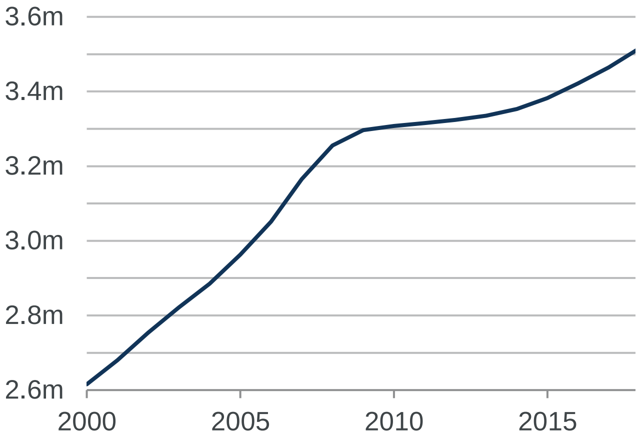


Chart 2B: Exposure – ages 20-100, males and females combined (millions), England & Wales



Ireland

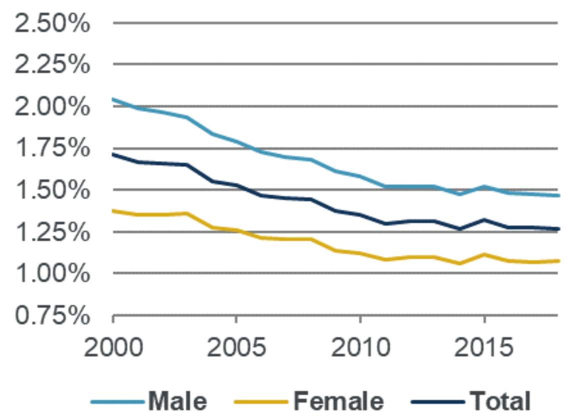


3.4 Standardised Mortality Rates

Chart 2C shows SMRs for England & Wales and Ireland. These both show falls in SMR, but have different levels and different slopes, with Ireland having higher SMRs for males and females in 2000 but falling to similar SMR levels as England & Wales by 2017. SMRs appeared to have levelled off in England & Wales in recent years while SMRs for Ireland have continued to fall, albeit at a slower rate than before.

Charts 2D and 2E show that the gap between male and female mortality has narrowed to a similar level in both datasets but was initially wider for Ireland.

Chart 2C: Standardised mortality rates (SMRs), England & Wales



Ireland

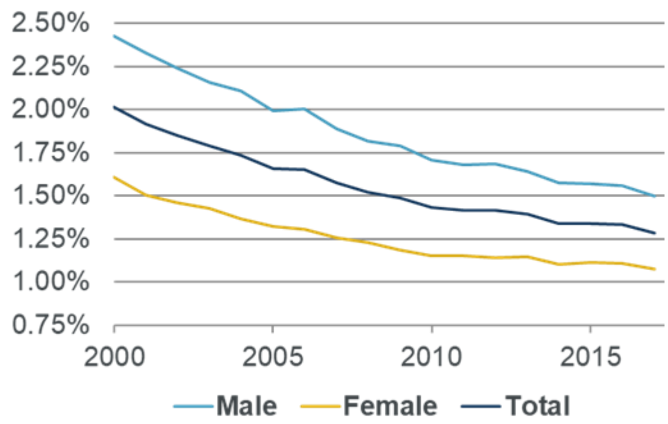
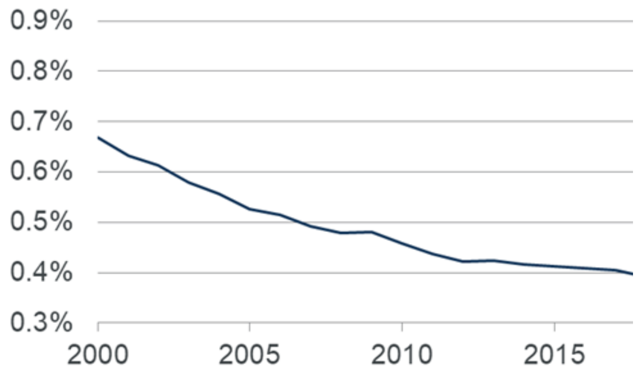


Chart 2D: Male SMR minus female SMR, England & Wales



Ireland

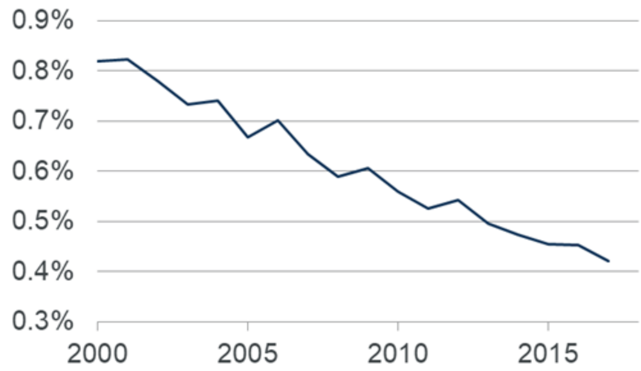
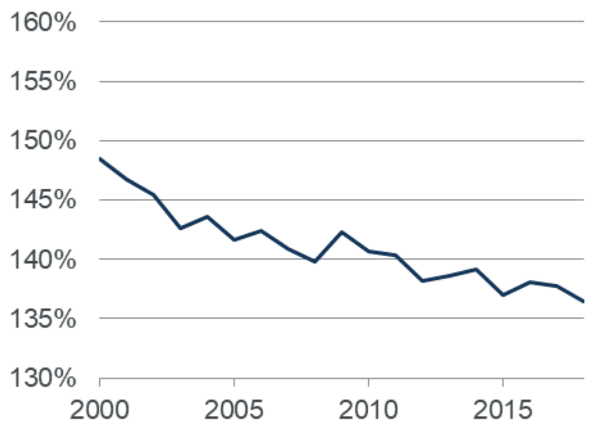
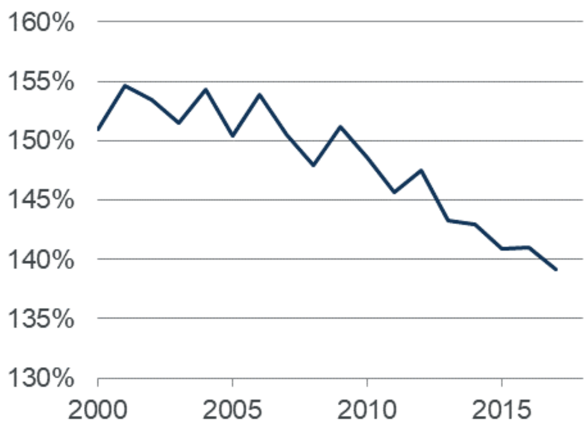


Chart 2E: Male SMR divided by female SMR, England & Wales



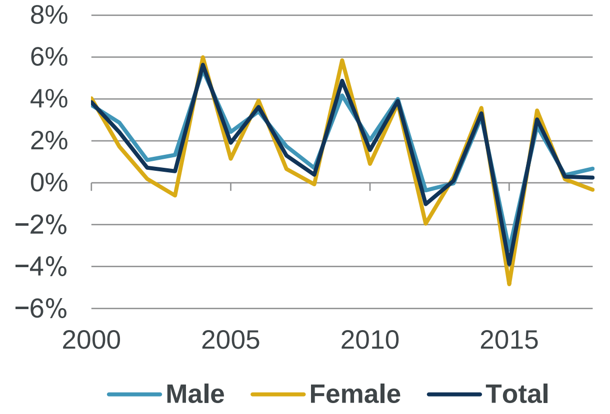
Ireland



3.5 Mortality improvements

Chart 2F shows higher mortality improvements in Ireland on average over the period, and Chart 2G shows both display a falling pattern in improvements in recent years. The slowdown in mortality improvements evident in England & Wales data is less of a feature in Ireland data. The volatility is greater for Ireland due to its smaller population size.

Chart 2F: Annual mortality improvements, England & Wales



Ireland

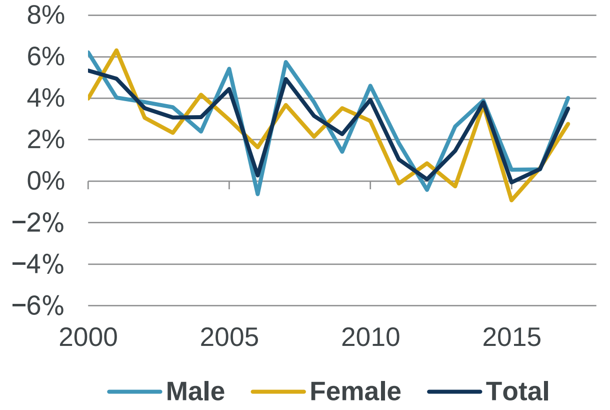
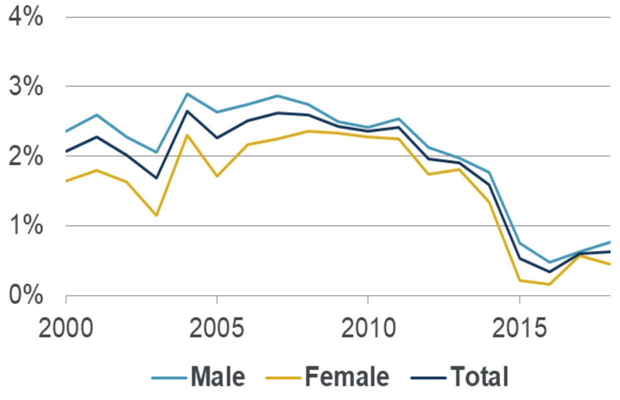
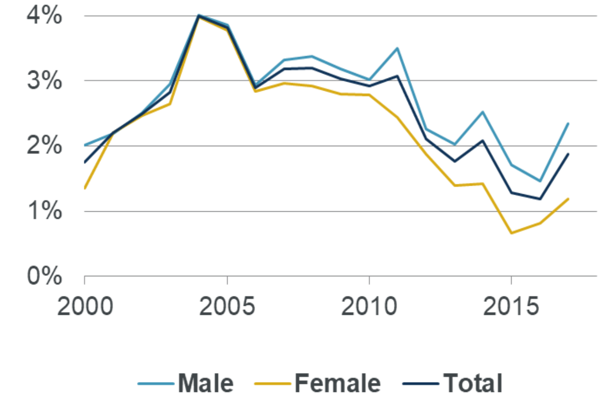


Chart 2G: Five-year average mortality improvements, England & Wales

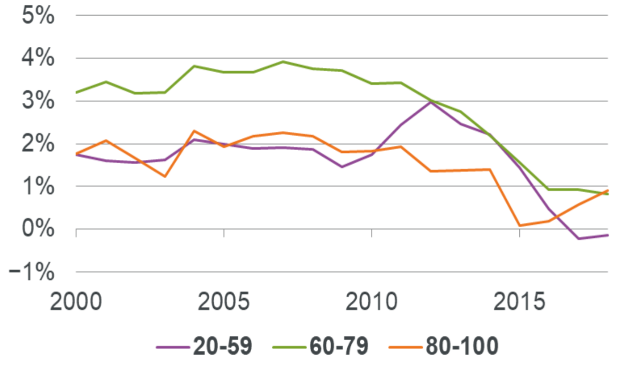


Ireland



Charts 2H and 2I show differing patterns with Ireland showing higher improvements for all age groups for the period.

Chart 2H: Five-year average mortality improvements for different age bands (male), England & Wales



Ireland

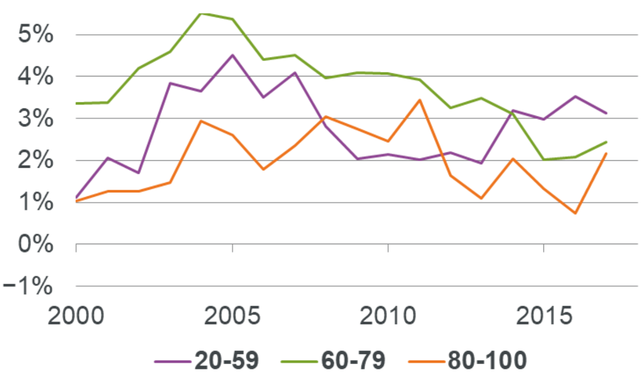
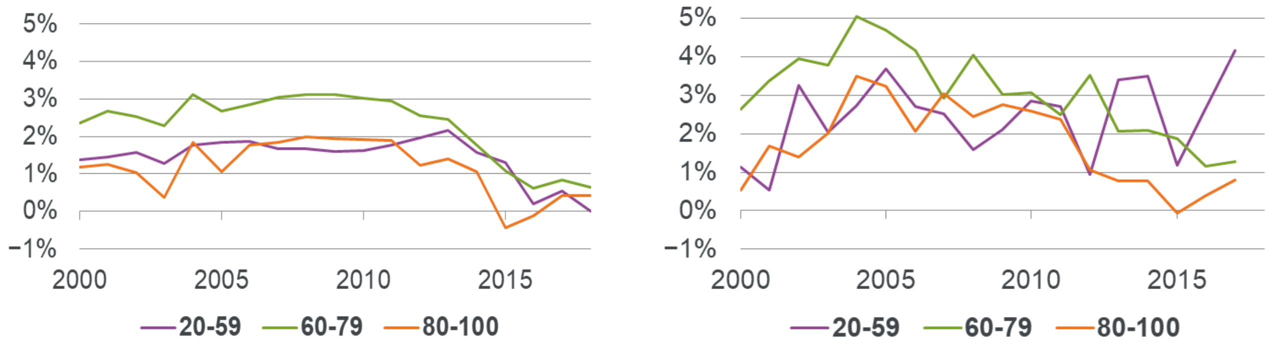


Chart 2I: Five-year average mortality improvements for different age bands (female), England & Wales

Ireland



3.6 Differences in mortality improvements

Charts 2Fd to 2Id in this section show differences (suffix “d” for difference) in mortality improvements between the two datasets. The charts are named so that e.g. Chart 2Gd shows the difference (Ireland minus England & Wales) in the figures shown in Chart 2G.

While total mortality improvements tended to be higher in Ireland than in England & Wales in the first decade shown, both have a similar falling pattern in recent years for ages group, 60-79 and 80-100. Mortality improvements for males and females at ages 20-59 have a noticeably different pattern in Ireland than in England & Wales. Improvements have been higher on average in Ireland and the recent falling trend in improvements for this age group in England & Wales is less evident than in Ireland.

Chart 2Fd: Difference in annual mortality improvements (Ireland *minus* England & Wales)

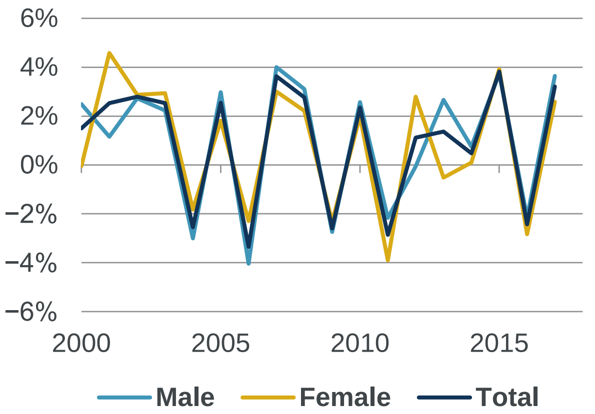


Chart 2Gd: Difference in five-year average mortality improvements (Ireland *minus* England & Wales)

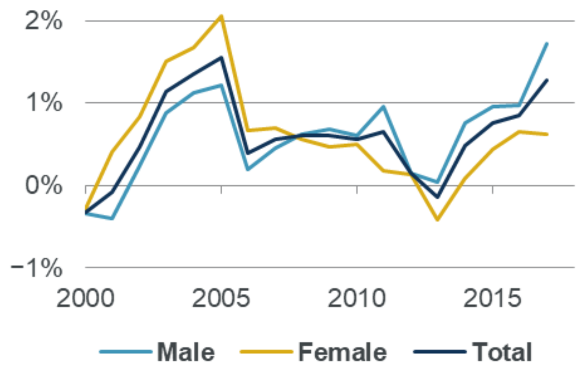


Chart 2Hd: Difference in five-year average mortality improvements for different age bands (male, Ireland *minus* England & Wales)

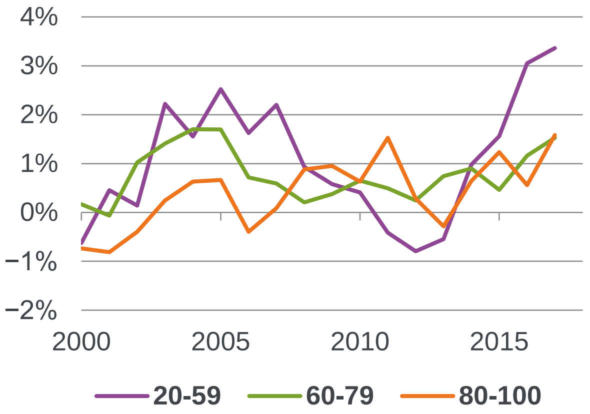
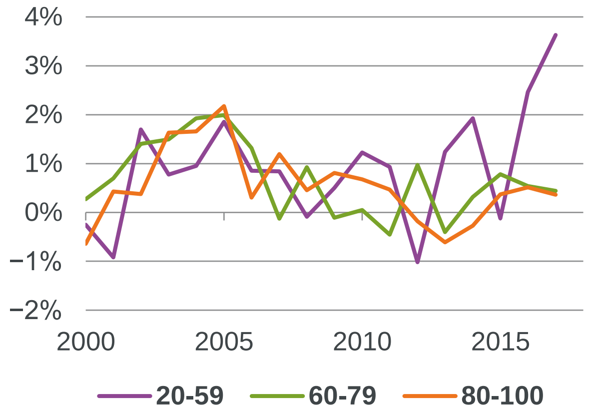


Chart 2Id: Difference in five-year average mortality improvements for different age bands (female, Ireland *minus* England & Wales)

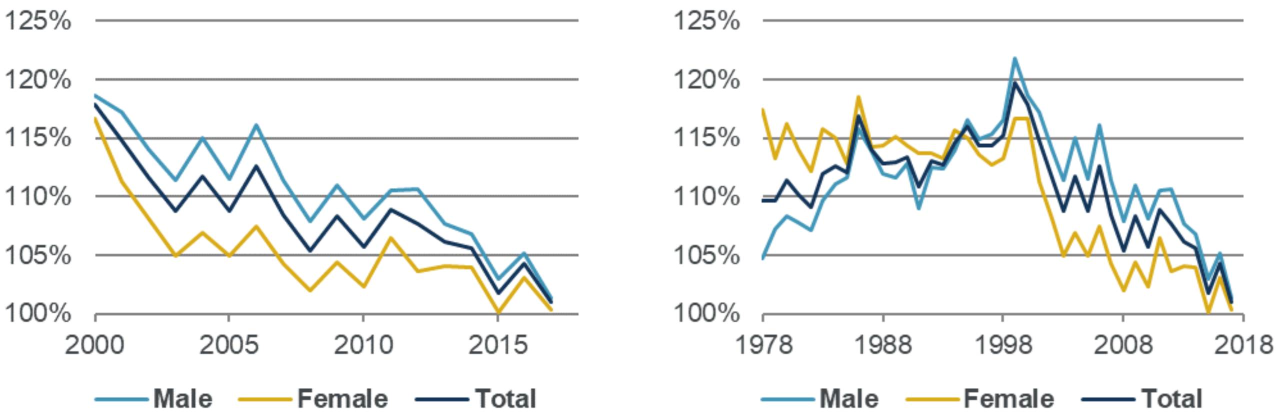


Ratios of SMR

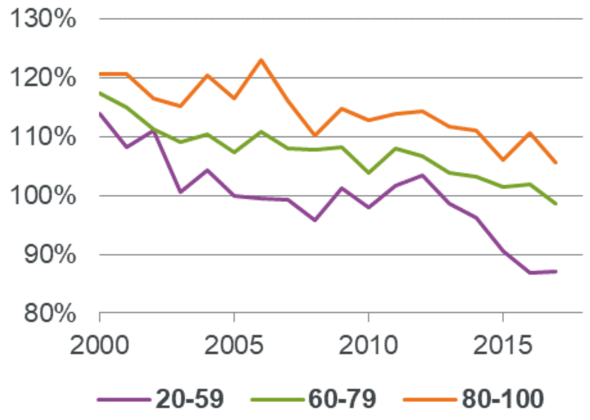
Charts in this section show ratios (“r” for “ratio”) of mortality between Ireland and England & Wales (e.g. Chart 2Cr shows the ratio between results for Chart 2C).

Chart 2Cr shows that SMRs for Ireland and England & Wales diverged until around 2000, albeit with considerable annual volatility. However, since then the ratio has fallen and is now close to 100%. The charts also show that the ratio of SMRs varies by age, and is lower for the younger age group.

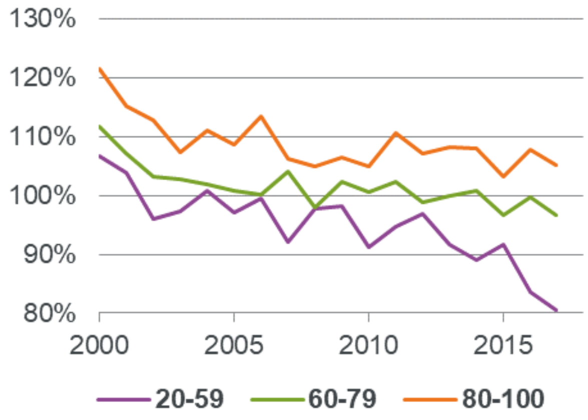
Chart 2Cr: Ratio of SMR (Ireland divided by England & Wales) for 2000-2018 and 1978-2018



Ratio of SMR (Ireland divided by England & Wales) for different age bands (male)



Ratio of SMR (Ireland divided by England & Wales) for different age bands (female)



4. Calibrating the CMI model for Ireland

In this section, we describe key features of the CMI Model, and discuss how its parameters can be adjusted to make it suitable for Irish lives. Further information on the Model is available to Authorised Users from the Mortality Projections section of the CMI website.

4.1 Background

The Model is extensively used by UK pension schemes and insurance companies, either to set assumptions of how mortality rates will change in future or as a "common language" to communicate assumptions that have been set by another method.

The CMI published CMI_2009, the first version of the Model, in November 2009. Since then the Model has been regularly updated, primarily to reflect emerging mortality data, with changes in method being relatively minor apart from more substantial changes introduced in CMI_2016.

4.2 Overview of the Model

The Model produces projected mortality improvements, by gender, age and calendar year. These can be applied to a base mortality table to obtain projected mortality rates. The Model projects mortality improvements by interpolating between "initial improvements" and a user specified "long-term rate" of improvements. The standard version of the Model treats males and females separately, with no interaction between them.

The initial improvements are estimated from historical data for deaths and mid-year populations. The standard version of the Model uses data for England & Wales for ages 20-100 and a rolling 41-year period (e.g. CMI_2018 uses data for 1978-2018). The CMI first fits an "APCI"[5] model of smoothed mortality rates, and then derive mortality improvements from this. The initial improvements are those in the final year of the historical data, and are split into a "cohort" component, linked to birth year, and an "age-period" component.

The long-term improvements are not estimated from historical data, because the factors that influence mortality in the future – such as lifestyle choices, medical advances, and economic conditions – are likely to be different from those that influenced it in the past. The CMI does not provide an assumption for long-term improvements, so users of the Model must make their own choices, which could be different for different populations.

4.3 Model parameters

As noted above, users of the Model are required to specify the long-term rates (LTR) of mortality improvement, as the CMI does not provide a default value for this parameter. As well as this, users are able to vary most features of the Model. The CMI defines three levels of use of the Model which reflect different levels of user input:

- Core – none of the default parameter values are altered.
- Extended – the user only adjusts either or both of:
  - the period smoothing parameter (S_κ) which can be used to control the responsiveness of the Model to new data; and
  - the initial addition to mortality improvements, A, which can be used to adjust the initial improvements produced by the APCI model.
- Advanced – the user varies one or more of the other parameters of the Model; for example:
  - Changing the range of ages and years over which the model is fitted, or the dataset used;
  - Changing any of the smoothing parameters other than the period smoothing parameter;
  - Changing the speed and pattern with which the initial improvements are assumed to converge to the long-term rates of improvement.

[5] The Age-Period-Cohort Improvement (APCI) model is structured so that mortality improvements derived from it are expressed as the sum of age, period (i.e. calendar year) and cohort (i.e. birth year) components.

4.4 Adjusting the Model for Ireland

There are several ways that the Model could be adjusted for Irish lives.

The most detailed approach would be to re-assess the initial mortality improvements by re-calibrating the Model to mortality data for Ireland. Changing the dataset in this way would be considered an "Advanced" use of the Model. Users could also consider the appropriateness of various parameters controlling convergence between the initial improvements and the long-term rate.

If this is done, then it would be necessary to adjust the period smoothing parameter, which controls the responsiveness of the Model to new data. The way that smoothing is implemented means that the same value of S_κ would apply more smoothing to a smaller population. So, while the CMI considers the Core value of $S_\kappa = 7$ to be appropriate for the Core calibration dataset, for England & Wales, that value would lead to too much smoothing of the smaller Irish dataset. The CMI Model software has an option to automatically adjust S_κ to reflect differences in the size of calibration datasets.

A simpler approach to adjusting the Model for Ireland which would be to set the initial addition to mortality improvements, under an "Extended" use of the Model, to reflect historical differences in mortality improvements between Ireland and England & Wales. This assumption may need to differ for males and females.

We also encourage users to consider using the initial addition to reflect the socio-economic characteristics of the population that the Model is applied to. For example, recent improvements in England & Wales have been higher for less deprived populations. Users would also need to consider a suitable value for the long-term rate

Different options may suit different users of the Model.

5. Results

In this section, we show results from the Model for Ireland, and compare these to the Core Model, calibrated to data for England & Wales.

Section 5.1 shows the result of calibrating the Model to Irish data, and Section 5.2 shows the sensitivity of results to parameter choices. Section 5.3 shows the result of changing the initial addition to mortality improvements.

The projections use an illustrative long-term rate of 1.5% p.a. and life expectancies use the S3PMA and S3PFA tables for males and females, respectively (consistent with working papers accompanying recent annual releases of the CMI Model).

5.1 Results of calibrating the Model to Irish data

We have calibrated CMI_2018 to Irish data for ages 20 to 100, and calendar years 1977 to 2017, the latest period available at the time the calculations were done. We have reduced the four smoothing parameters from their Core values, as described in Section 4.4, to reflect the smaller size of the Irish population. The smoothing parameters are reduced by 1.22 for males and 1.28 for females.

For consistency results are compared to a version of CMI_2018 calibrated to England & Wales data for 1977-2017, rather than the Core Model spanning 1978-2018.

Chart 5A and 5B show that the age-period component is higher for males and females in Ireland at all ages. The pattern by age for males and females is similar in each dataset. Males have a higher age-period component at all ages in Ireland data. The age-period component is closer in level for males and females in England & Wales at all ages.

Chart 5C and 5D show the initial cohort component results. The cohort improvements are relatively high in both populations for males and females in their eighties and males in their thirties. The cohort effect for males and females now in their 80s is well documented. The cohort effect results for males in their thirties is uncertain. It is possible this is a period effect that only affects younger ages or it may be an artefact of uncertain population estimates, due to high net migration at younger ages.

Chart 5E and 5F show the total initial improvements for males and females.

Chart 5A: Initial age-period component (male)

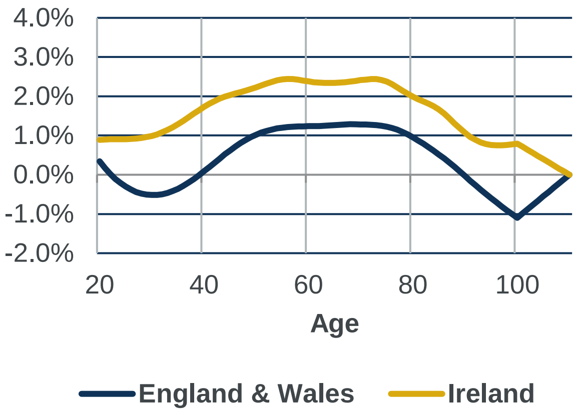


Chart 5B: Initial age-period component (female)

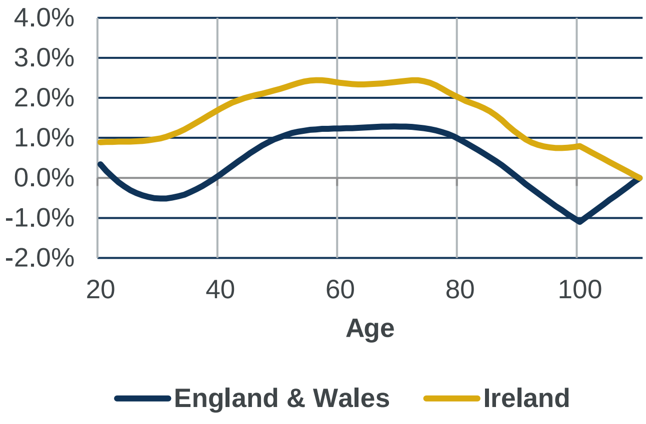


Chart 5C: Initial cohort component (male)

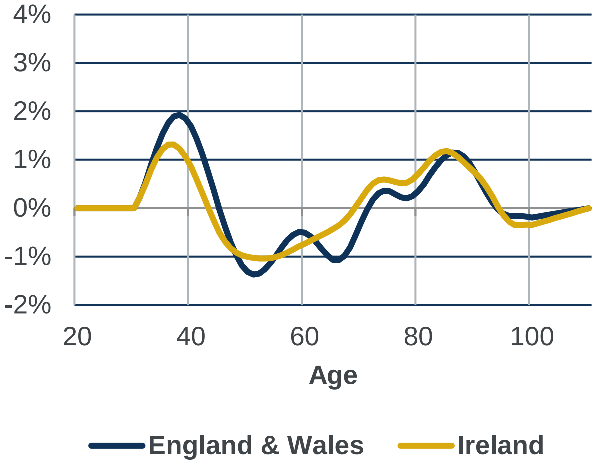


Chart 5D: Initial cohort component (female)

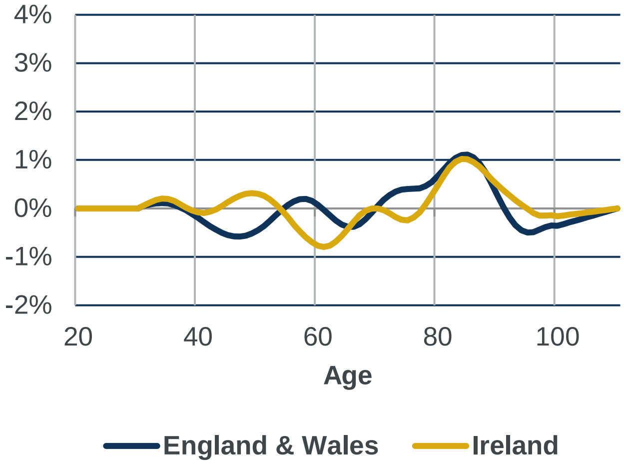


Chart 5E: Total initial improvement (male)

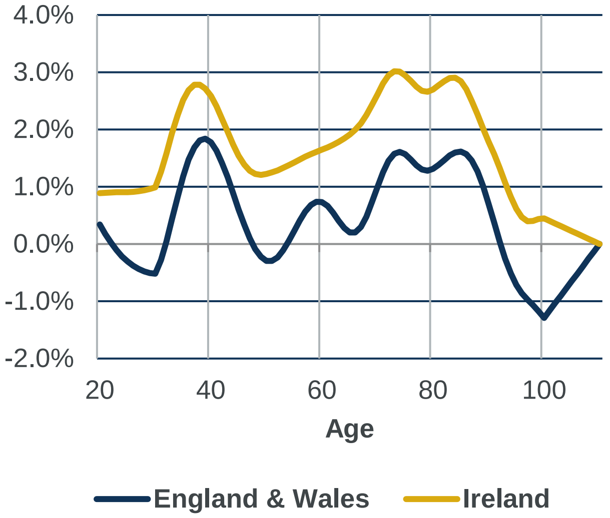


Chart 5F: Total initial improvement (female)

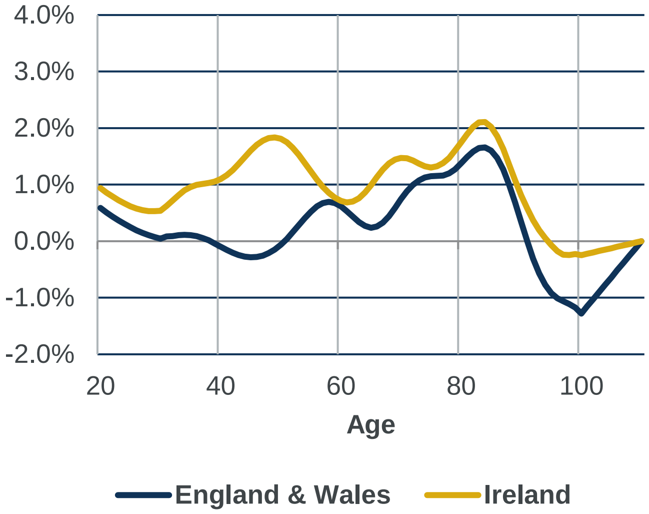
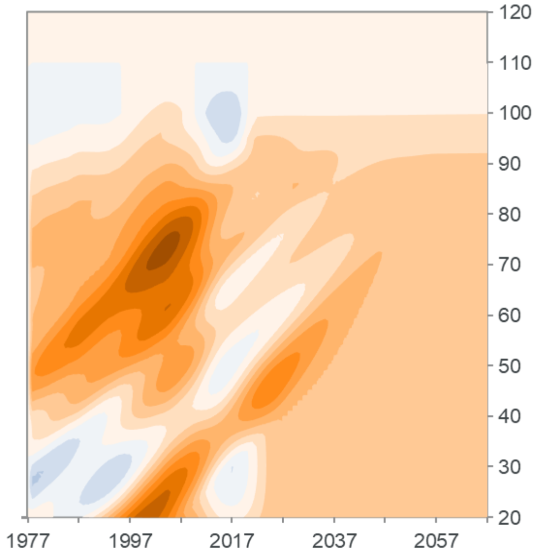


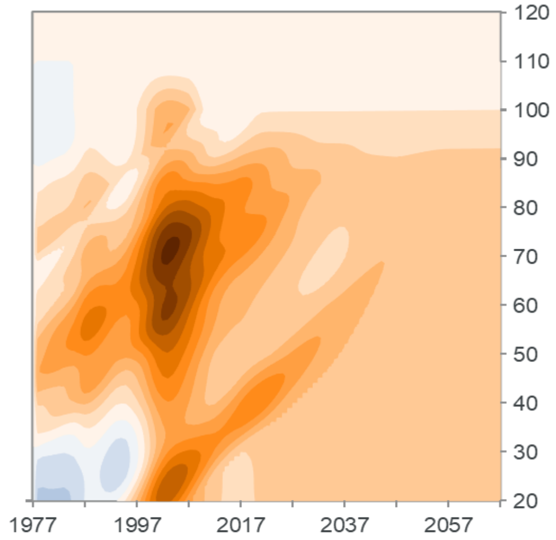
Chart 5G shows heatmaps of past and projected mortality improvements, using an illustrative long-term rate of 1.5% p.a.

Chart 5G: Heatmaps of mortality improvements

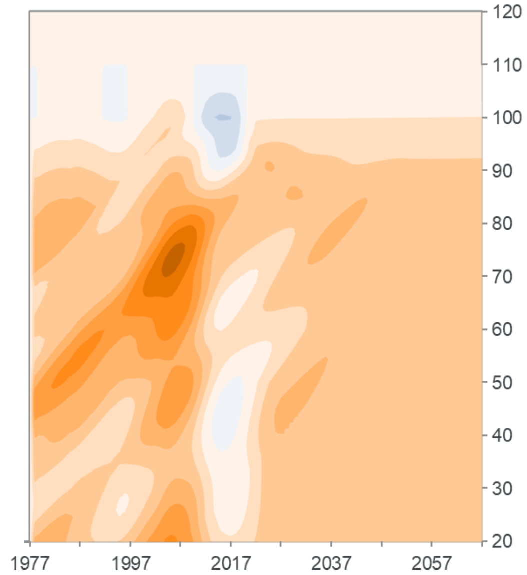
England & Wales (Male)



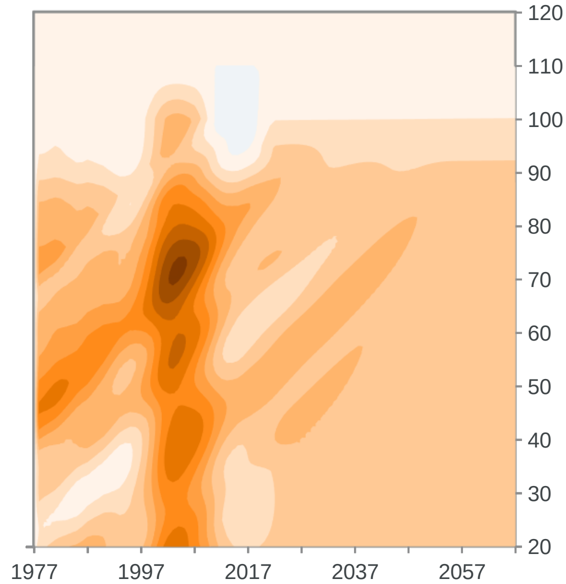
Ireland (Male)

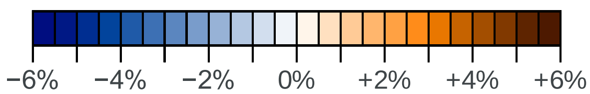


England & Wales (Female)



Ireland (Female)





Mortality improvements in Ireland for males and females share common features. Mortality improvements are higher for those born in the early 1930s than in surrounding years. This can be seen in the diagonal pattern on the heatmaps.

Mortality improvements peaked some time ago. Highest mortality improvements are seen at a similar age and time for males and females – a maximum of 5.2% for age 71 in 2003 for males, and a maximum of 4.7% for age 72 in 2004 for females. Mortality improvements are highest in the first decade of the 21st century. Improvements tend to be lower at the oldest ages. Male mortality improvements have had a wider range than female improvements – they have higher peak and show negative improvements at some younger ages in the earliest years shown.

Projected mortality improvements show a continuation of cohort effects into the short to medium term. The model projects higher projected mortality improvements in Ireland than England & Wales for all ages in the short term. Projected improvements converge to the selected long term rate and taper to zero at ages 110 and above, as for the Core Model.

Table 5.1 shows life expectancy calculations, again using an illustrative long-term rate of 1.5% p.a. Note that we use a base table of S3PxA in both cases, so the differences in life expectancy only reflect differences in projected improvements, not differences in base mortality.

Table 5.1: Impact of projected mortality improvements on life expectancy for Ireland relative to that for England & Wales

Age	25	35	45	55	65	75	85	95
Male (years)	1.193	1.214	1.288	1.232	**1.136**	0.701	0.339	0.178
Male (%)	1.9%	2.3%	3.1%	3.9%	**5.1%**	5.2%	5.1%	6.5%
Female (years)	0.368	0.385	0.368	0.186	**0.245**	0.137	0.153	0.118
Female (%)	0.6%	0.7%	0.8%	0.5%	**1.0%**	0.9%	2.0%	3.8%

The adjusted lower smoothing parameter value for Ireland weights projected improvements to recent improvements that are higher for Ireland than for England & Wales leading to projected higher live expectancies at all ages for Ireland (assuming the same base mortality). The largest differences are for males aged 65, corresponding to the stronger cohort peaks at older ages for Ireland.

5.2 Sensitivities to parameters

In this section we consider how life expectances change as certain Model parameters are varied. We define the “sensitivity” of the Model to mean the percentage change in cohort life expectancy as the parameter is varied relative to the base model calibrated for Ireland data described in section 5.1.

Life expectancies are at 1 January 2019 using the S3PFA or S3PMA tables.

Long-term rate

Tables 5.2 and 5.3 show sensitivities to the long-term rate. Increasing the long-term rate increases life expectancy at all ages and the sensitivity is highest at younger ages, for both males and females.

Table 5.2: Sensitivity to the long-term rate, compared with the Ireland base case (males)

Age	25	35	45	55	65	75	85	95
LTR=0%	-7.8%	-7.3%	-6.6%	-5.6%	**-4.5%**	-3.2%	-2.1%	-1.2%
LTR=0.5%	-5.2%	-4.9%	-4.4%	-3.8%	**-3.0%**	-2.2%	-1.4%	-0.8%
LTR=1%	-2.6%	-2.4%	-2.2%	-1.9%	**-1.5%**	-1.1%	-0.7%	-0.4%
LTR=1.5%	-	-	-	-	**-**	-	-	-
LTR=2%	2.5%	2.4%	2.3%	2.0%	**1.6%**	1.1%	0.7%	0.4%
LTR=2.5%	4.9%	4.8%	4.5%	4.0%	**3.2%**	2.3%	1.5%	0.8%
LTR=3%	7.2%	7.2%	6.8%	6.0%	**4.9%**	3.5%	2.2%	1.2%

Table 5.3: Sensitivity to the long-term rate, compared with the Ireland base case (females)

Age	25	35	45	55	65	75	85	95
LTR=0%	-7.2%	-6.8%	-6.3%	-5.5%	**-4.5%**	-3.4%	-2.2%	-1.2%
LTR=0.5%	-4.8%	-4.6%	-4.2%	-3.7%	**-3.0%**	-2.3%	-1.5%	-0.8%
LTR=1%	-2.4%	-2.3%	-2.1%	-1.9%	**-1.5%**	-1.1%	-0.7%	-0.4%
LTR=1.5%	-	-	-	-	**-**	-	-	-
LTR=2%	2.3%	2.2%	2.1%	1.9%	**1.6%**	1.2%	0.8%	0.4%
LTR=2.5%	4.5%	4.4%	4.2%	3.8%	**3.2%**	2.4%	1.5%	0.8%
LTR=3%	6.5%	6.6%	6.3%	5.8%	**4.8%**	3.6%	2.3%	1.2%

The sensitivities to the long-term rate are very similar to those shown in section 6 of working paper 119 for England & Wales with the exception that the Ireland model is marginally more sensitive to the long-term rate at ages 85 and 95.

Period Smoothing Parameter

Table 5.4 to 5.6 show sensitivities to the period smoothing parameter, S_κ which has a value of 7 in the Core model but is adjusted for the population size in the Ireland model as described in section 3.4. The tables show the values of the smoothing parameters for Ireland alongside the corresponding values for the Core model.

A lower value of S_κ places more weight on recent mortality experience. Because of the pattern of recent mortality, at S_κ=6.5, this leads to lower initial mortality improvements and lower life expectancies but at S_κ=6, this leads to higher initial mortality improvements and higher mortality improvements overall.

A higher value of S_κ places more weight on the longer-term trend and currently gives higher life expectancies, placing more weight on the past high improvements.

Table 5.4: Sensitivity to the period smoothing parameter, compared with the Ireland base case (males)

Males: Age		25	45	65	85
S_K = 6.0	Adj S_K = 4.78	0.1%	0.2%	**0.2%**	0.2%
S_K = 6.5	Adj S_K = 5.28	0.0%	0.0%	**0.0%**	-0.1%
S_K = 7.0	Adj S_K = 5.78	-	-	**-**	-
S_K = 7.5	Adj S_K = 6.28	0.3%	0.5%	**0.7%**	1.0%
S_K = 8.0	Adj S_K = 6.78	0.7%	1.2%	**1.8%**	2.5%

Table 5.5: Sensitivity to the period smoothing parameter, compared with the Ireland base case (females)

Females: Age		25	45	65	85
$S_K = 6.0$	Adj $S_K = 4.72$	0.1%	0.2%	**0.3%**	0.2%
$S_K = 6.5$	Adj $S_K = 5.22$	0.0%	-0.1%	**-0.1%**	-0.2%
$S_K = 7.0$	Adj $S_K = 5.72$	-	-	**-**	-
$S_K = 7.5$	Adj $S_K = 6.22$	0.3%	0.5%	**0.8%**	1.3%
$S_K = 8.0$	Adj $S_K = 6.72$	0.8%	1.3%	**2.0%**	3.1%

5.3 Adjusting the initial improvements

Section 4.4 notes that the Model can be adjusted to reflect Irish mortality experience without needing to calibrate it to data for Ireland, as in section 5.1. Instead one can use the initial addition to mortality improvements parameter (A) in the model to reflect to reflect differences in historical improvements between England & Wales and Ireland.

For illustrative purposes, in this section, we show the results of the model with the Initial Addition Parameter (A) set to:

- +1.5% for males; and
- +0.5% for females.

An Initial Improvements Addition (A) can be added by selecting the Extended Projection Assumption option in the CMI model inputs and entering the chosen Initial addition to mortality improvements.

The results are compared to the model results in section 5.1, obtained by calibrating the Model to Irish data.

Table 5.6: CMI_2018 model results using England & Wales data for 1977-2017 with A set to +1.5% for Males and+ 0.5% Females compared to CMI model fully calibrated for Ireland data

Age	25	35	45	55	65	75	85	95
Male (years)	0.031	0.051	0.015	-0.003	**-0.095**	0.028	0.018	-0.076
Male (%)	0.0%	0.1%	0.0%	0.0%	**-0.4%**	0.2%	0.3%	-2.6%
Female (years)	-0.022	-0.021	0.007	0.173	**0.071**	0.095	-0.031	-0.081
Female (%)	0.0%	0.0%	0.0%	0.5%	**0.3%**	0.6%	-0.4%	-2.5%

Using the simpler approach with the selected parameters results in lower projected improvements at all ages for males than the model fully calibrated with Ireland data. The results for females are much closer. The simpler approach understates the improvements the most for age 95 for both males and females.

6. Assured Lives Considerations

Although the Model is not developed specifically for use with pensioners/annuitants, this is a key focus for the CMI Mortality Projections Committee, which oversees the Model, in considering:

- The choice of dataset, and the adjustments to make to that data; and
- The structure and calibration of the Model.

Working Paper 110 considers the use of the Model by actuaries involved in the pricing and financial management of life assurance policies. It sets out areas that the CMI think should be considered when using the Model and its core assumptions in the context of protection portfolios. In this section, we set out additional considerations for use of the Model for life assurance policies in the case of Irish lives.

6.1 Use of the Model for Irish Assured Lives

Some aspects of the Model may not be too important when used for older ages and longevity business but may be more significant when used for younger lives. For example:

- The Model fitting at younger ages. High mortality improvements at younger ages cannot be assigned to age or period effects so they have been assigned to a cohort effect. Users may wish to consider if this is appropriate when more material for their projections.
- The Model is calibrated to data for ages 20-100 and the period effects from the Model will reflect the numbers of deaths and will largely be influenced by older ages. Users may wish to consider calibrating to a younger age range.

No credible data is currently available to fully calibrate the Model using Irish assured lives data.

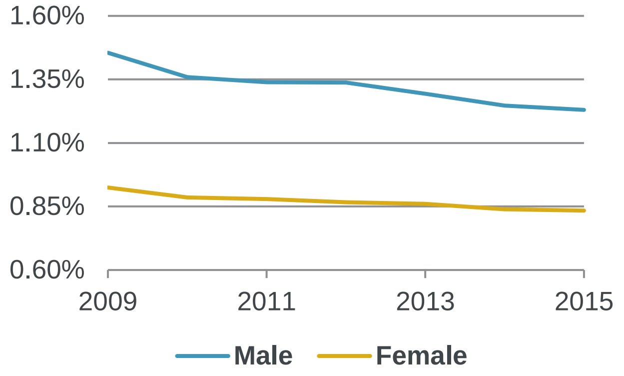
The SAI Demography Committee completed its first Irish Insured Lives Mortality Investigation (IILMI)[6] in 2019. IILMI provides analysis of the recent mortality experience of Irish annuitants and assured lives over the period 2009 to 2015. The dataset is relatively small and not fully credible but the IILMI study results and future iterations of the investigation can provide insight into the difference in experience between population and assured lives.

Chart 6A compares the SMR using Ireland population data for males and females from 2009 to 2015 with SMR using the IILMI dataset. We use this period of analysis to align with the corresponding period of investigation for the IILMI study.

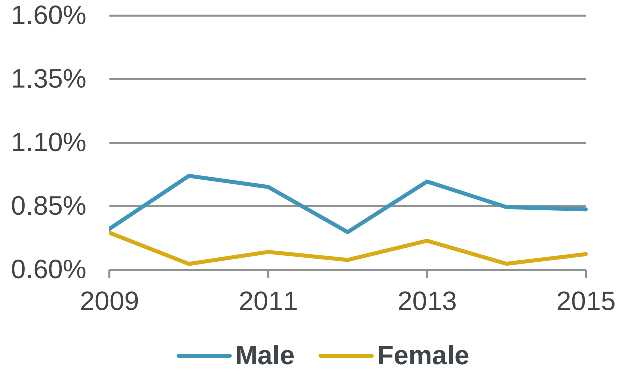
The smaller size of the IILMI dataset leads to volatile SMR results. Comparison of the population SMR and the SMR of assured lives in the IILMI study shows a clear difference in the level of mortality for both males and females. The gap between males and females is also wider in the population than in the IILMI study data.

[6] https://web.actuaries.ie/sites/default/files/2019-03/190306%20-%20Irish%20Insured%20Lives%20Mortality%20Investigation%20Report%20Final.pdf

Chart 6A: SMR Ireland Population 2009 – 2015



SMR IILMI Data 2009 - 2015



Without fully credible data available to calibrate the model for Ireland assured lives, a possible approach is to use the Initial Addition feature as described in section 5.3. This could be used to adjust the initial improvements in the Model to allow for variation in experience between England & Wales population data and Irish assured lives. Another option the user may wish to use is the Initial Addition applied to the model fully calibrated to Irish Population data to allow for variation between the Irish population data and Irish assured lives. The IILMI study or similar investigations may be useful to inform the level of the Initial Addition if this approach is considered.

Different options may suit different users of the model.

References

Working Paper 103: "CMI Mortality Projections Model – Mid-year update" (2017)

Working Paper 110: "Using the CMI Mortality Projections Model for assured lives" (2018)

Working Paper 119: "CMI Mortality Projections Model: CMI_2018" (2019)

These papers are only accessible to CMI Authorised Users (i.e. to employees of Subscribers and to researchers, for non-commercial use).

The Irish Insured Lives Mortality Investigation is accessible to all users on the Society of Actuaries in Ireland website.

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