



CMI_2018: the latest version of the CMI Mortality Projections Model

March 2019

Purpose

This briefing note provides an overview of CMI_2018, the latest version of the CMI Mortality Projections Model (“the CMI Model”), to assist individuals presented with results from the CMI Model – such as pension scheme trustees and non-executive directors of insurance companies. We strongly encourage actuaries using CMI_2018 to refer in addition to Working Paper 119 and its associated outputs. This briefing note is publicly available and its use is not subject to CMI’s Terms and Conditions for Subscribers or Terms and Conditions for Academics and CMI Committee Members.

Summary

We introduced two key changes in CMI_2018 following consultation:

- The default value of the period smoothing parameter, S_κ (pronounced “ess-kappa”), was reduced from 7.5 to 7.

There is a growing consensus that the slower mortality improvements observed in the general population since around 2011 represents a new trend rather than a ‘blip’. The lower value for S_κ places more emphasis on this recent experience and leads to lower estimates of current mortality improvements.

- A new extended parameter, the “initial addition to mortality improvements”, that allows users to adjust initial mortality improvements more easily, has been added.

The Core CMI Model is parameterised to reflect best estimate mortality improvements for the general UK population (based on England & Wales data). Increasingly, users are adjusting the Core CMI Model to reflect their views on appropriate improvements for specific subsets of the wider population. Without this new parameter, users had either to adjust the advanced parameters or to approximate a similar effect by adjusting S_κ , neither of which is ideal.

We have also made a routine update to the experience data used to calibrate the Model (using the years 1978-2018 compared with 1977-2017 for CMI_2017) and a minor change regarding adjustments to data at older ages (which did not have a material impact),

The observed slowdown in general population mortality improvements since 2011 has continued into 2018. Taken together with the lower period smoothing parameter, this has resulted in markedly lower initial mortality improvements in CMI_2018 leading to lower **cohort life expectancies** than in all previous versions of the CMI Model¹.

Cohort life expectancies at age 65 are around 6 months lower in CMI_2018 than in CMI_2017, for both males and females. The differences are more pronounced when comparing to earlier versions of the CMI Model; for example life expectancies at age 65 are over a year lower in CMI_2018 than in CMI_2015, for both males and females.

Background

This briefing note is issued alongside Working Paper 119, the model software and associated documentation, which are aimed at actuaries using the CMI Model to formulate mortality assumptions. However, unlike this briefing note, those documents are not publicly available.

Further information regarding the CMI Model and CMI_2018 in particular is in appendices to this note:

[Appendix 1: The CMI Model](#) provides an overview of the CMI Model.

[Appendix 2: Experience](#) sets out recent experience and how it was allowed for in CMI_2018

[Appendix 3: Definitions](#) defines terms in **bold italics** that may be unfamiliar to non-actuaries.

¹ Cohort life expectancies as at 1 January 2019. Please see the section on interpreting results from the CMI Model in Appendix 1 and the definition of “cohort life expectancy” in Appendix 3.



Appendix 1: The CMI Model

About the CMI

The Continuous Mortality Investigation (CMI) provides authoritative and independent mortality and sickness rate tables for actuaries advising UK life insurers and pension funds.

The CMI operates as a private company which is wholly owned by the Institute and Faculty of Actuaries (IFoA). The company has a board of two directors, appointed by the IFoA, and an Executive Committee which oversees the CMI's work. The CMI is funded by subscriptions from commercial users. Subscribers have access to all outputs produced by the CMI; these are also made available to academics and researchers for non-commercial use².

A key area of the CMI's work is to consider future changes in mortality experience, including the development and production of the CMI Model.

Background to the CMI Model

Actuaries often need to make assumptions about **mortality rates** which they typically consider in two stages – first assessing current mortality rates for that portfolio or pension scheme, perhaps reflecting its own recent experience, and then considering how these rates may change over time. The CMI Model relates only to the second stage.

The CMI Model was introduced in 2009 and has been updated regularly since then:

- to take account of emerging mortality data; and
- occasional changes to reflect evolving thinking on the most appropriate methodologies.

Many UK pension schemes and insurance companies use the CMI Model either to set their assumptions of how mortality rates will change in future or as a “common language” to communicate assumptions that have been set by another method.

How the CMI Model works

The CMI Model is a model of **mortality improvements**, i.e. reductions in mortality rates from year to year³.

The CMI Model smooths historical mortality rates, reducing the effect of volatility, to produce estimates of current mortality improvements by age and gender. It then blends between current and long-term future mortality improvements.

The CMI Model itself does not make an assumption for long-term mortality improvements; users need to make their own assessment about the long term, and different users will have different opinions. So the CMI Model is a framework for mortality assumptions, rather than giving a single answer.

As a minimum, users need to input the long-term rate of mortality improvement. Default values are provided for all the other parameters. If none of these parameters are changed, this is referred to as the “Core” version of the CMI Model.

However, there is still uncertainty about the appropriate level of initial mortality improvements both for the general population and when applying the CMI Model to other portfolios – such as insured annuitants or pension scheme members – and about how much emphasis should be placed on recent experience. Because of this, we encourage users of the CMI Model to consider the impact of different choices for the CMI Model's parameters, including the period smoothing parameter and the initial addition to mortality improvements.

² Details of how to access the CMI's research can be found on the [CMI section of the IFoA's website](#). The website also sets out current subscription fees which vary according to the type and size of the organisation.

³ This terminology reflects the predominant direction of change – it does not preclude negative improvements.



The data underlying the CMI Model

The CMI Model is based on mortality data for the general population of England & Wales⁴, published by the Office for National Statistics (ONS). We use population data, rather than datasets collected by the CMI, in order to have a consistent dataset over a long period and to reduce volatility by age.

Exposure data is based on estimated mid-year populations, derived from decennial censuses. The CMI makes two types of adjustment to it:

- a “high-age” adjustment, introduced in CMI_2018, to all exposures at ages 85 and above; and
- adjustments to selected data points where the implied mortality rates are implausible, as in earlier versions of the CMI Model.

For the final year of the data, the CMI makes its own estimate of exposures and estimates deaths based on ONS provisional weekly deaths data.

CMI_2018 is calibrated to data for ages 20-100 and calendar years 1978-2018. The previous version, CMI_2017, was based on data for the same ages but for calendar years 1977-2017.

Interpreting results from the CMI Model

As noted above, the CMI Model is a framework to allow others to project mortality, rather than giving an answer itself. However, when each version of the CMI Model is published, the CMI also publishes illustrative results, including cohort life expectancies, based on commonly-used assumptions. In particular, these life expectancy values depend on the initial mortality rates and on the chosen long-term rate of mortality improvement, as well as the CMI Model itself.

Cohort life expectancy is a subjective measure that depends on assumed future changes in mortality. Although cohort life expectancy, under typical assumptions, has been falling in recent years, this does not necessarily mean that mortality itself is increasing – instead it typically reflects lower projected rates of future mortality improvement.

⁴ The CMI Model uses data for England & Wales only, as the relevant data is available earlier than for the whole of the United Kingdom. The CMI has previously demonstrated that the results of the CMI Model would be little different if data for the whole of the UK were used.

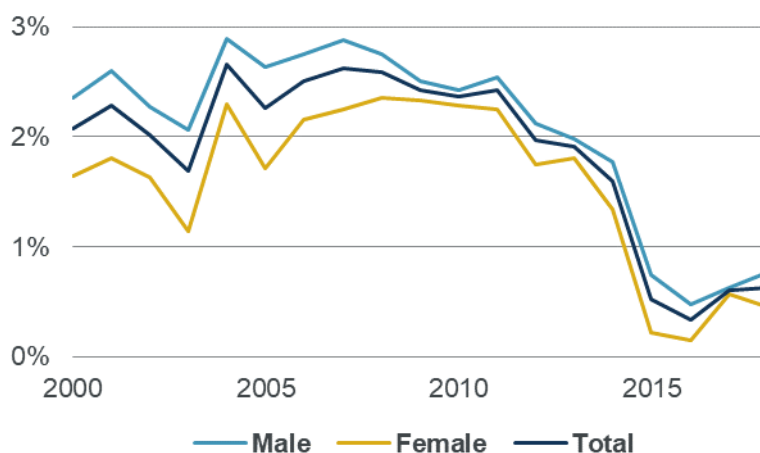
Appendix 2: Experience

Recent mortality improvements

Mortality improvements in the general population since 2011 have been much lower than in the earlier part of this century.

Annual mortality improvements are volatile due to short-term influences such as winter temperatures and the prevalence of influenza. In order to reveal longer-term patterns more clearly, Chart 1 shows mortality improvements, derived from **standardised mortality rates** (SMRs), averaged over five years. Average mortality improvements were 2% p.a. or higher for most of the period 2000-2011, but have since fallen to around 0.5% p.a.

Chart 1: Five-year average mortality improvements, based on SMRs



“Average mortality improvements were 2% p.a. or higher for most of the period 2000-2011, but have since fallen to around 0.5% p.a.”

There is considerable debate about the causes of this slowdown, whether low improvements will persist and for how long. The latest data provides increasing evidence that the low level of recent mortality improvements may be due to medium- or long-term influences, rather than just short-term events such as influenza in early 2015. However almost all users of the CMI Model expect that mortality will continue to improve, even if this is at a slower rate than in the first decade of this century.

The change in the period smoothing parameter, S_k

The CMI Model estimates current mortality improvements by smoothing historical mortality rates. The period smoothing parameter, S_k , allows users to control the amount of smoothing by calendar year when determining the level of current improvements.

Following consultation, we have used a value of 7 for S_k in the Core version of CMI_2018, rather than 7.5 in CMI_2017 and CMI_2016, when the parameter was introduced. The lower value places a greater weight on more recent mortality experience, reflecting a growing consensus that the slower mortality improvements since about 2011 represents a new trend rather than a “blip”.

Initial rates of mortality improvement

Initial mortality improvements for the Core version of the CMI Model are lower in CMI_2018 than in CMI_2017 due to lower mortality improvements in 2018 than what would have been expected based on CMI_2017 as well as the lower value for the period smoothing parameter, S_k .

Initial mortality improvements are slightly higher for males than females at most pensioner ages but lower for males than females at the youngest ages.

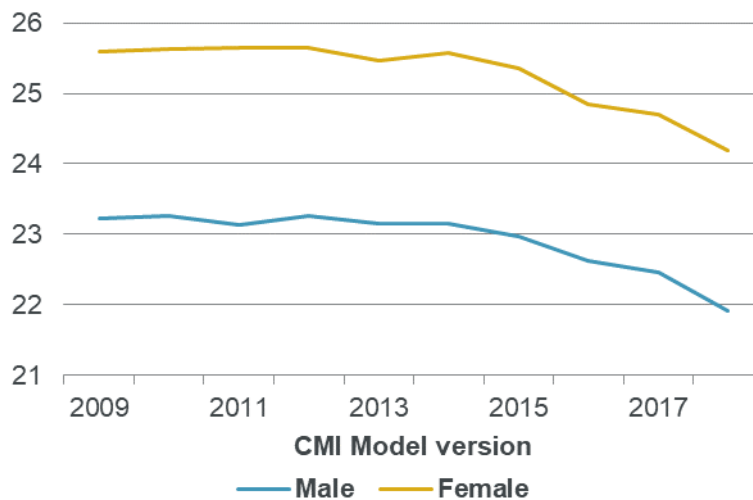


The impact on life expectancies

The lower initial mortality improvements in CMI_2018 lead to lower cohort life expectancies than in all previous versions of the CMI Model. Chart 2 shows cohort life expectancies as at 1 January 2019 at age 65 from each version of the CMI Model, using illustrative assumptions of:

- current mortality rates from the latest CMI tables based on pension scheme data; i.e. S3PMA for males and S3PFA for females; and
- a long-term rate of 1.5% per year

Chart 2: Cohort life expectancies as at 1 January 2019 at age 65 from CMI_2018 and earlier versions



“...CMI_2018 has lower cohort life expectancies than all previous versions of the CMI Model...”

Life insurers are most likely to be interested in how CMI_2018 compares with the previous version, CMI_2017. The life expectancies at age 65, shown in the chart above, are around 6 months lower in CMI_2018, for both males and females, at 21.9 years and 24.2 years, respectively.

In the context of triennial valuations, pension scheme trustees may also be interested in how CMI_2018 compares with CMI_2015. Here, the life expectancies at age 65 are 13 months lower for males and 14 months lower for females in CMI_2018; reflecting the low improvements during the intervening years.



Appendix 3: Definitions

A **mortality rate** is the proportion of people, of a given age and gender, that are expected to die in the following year.

Because mortality rates vary by age and the age-profile of the population changes over time, actuaries and others interested in longevity often use a **standardised mortality rate** (SMR) as a measure of how mortality rates are changing across a range of ages. We have used an age range of 20 to 100 and the 2013 European Standard Population as our “constant” age-profile.

A **mortality improvement** measures the reduction in mortality rates from one year to the next. (Note: actuaries typically refer to “improvements”, not “changes” because – over several years – mortality rates tend to fall. However, mortality rates in a particular year can be higher than the previous year – perhaps due to a harsh winter or a flu epidemic – giving rise to negative improvements in that year.)

For example:

- Last year, an actuary expected 100 of every 1,000 85-year old males to die within a year. This is a mortality rate of 10%.
- This year, the actuary expects only 98 of every 1,000 85-year old males to die within a year. This is a mortality rate of 9.8%.
- This year’s mortality improvement for 85-year old males is 2%, as they are 2% less likely to die within a year.

Life expectancy is a measure of how long – on average – someone of a particular age and gender will live. There are two different measures of life expectancy, which are sometimes confused:

- **Period life expectancy** depends only on known past mortality rates – it takes no account of future mortality improvements. This means that it is an objective measure and, for that reason, it is often reported by e.g. the Office for National Statistics.
- **Cohort life expectancy** takes account of future changes in mortality. These changes are unknown and therefore it is a subjective measure. It is typically used by actuaries who need to use realistic assumptions about what may happen in the future. Consequently, these values are generally used in the CMI’s illustrations, as is the case in this briefing note.

For example, for males aged 65, using the same assumptions as used in Chart 2 in CMI_2018 at 1 January 2019:

- Period life expectancy is 20.9 years.
- Cohort life expectancy is 21.9 years.
- The cohort life expectancy is higher as it includes an allowance for mortality improvements in 2019 and beyond.

A change in cohort life expectancy does not necessarily mean that mortality itself is changing – instead it typically reflects a change in views of future improvements. Such a change can also arise from a different view of the long-term rate of mortality improvement, or other parameters, as well as the version of the CMI Model.

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