FEBRUARY, 2024

Mortality Projections

Practical implications of the CMI's proposals in the United Kingdom

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Executive summary

The Continuous Mortality Investigation (CMI) produces annual updates to its mortality projection model to reflect emerging mortality data and trends. The CMI Mortality Projections Committee (MPC) have issued a consultation for the proposed calibration of the CMI_2023 model on 13 February 2024 via Working Paper 183 (WP 183). The weighting parameters given to mortality experience in 2022 and 2023 are proposed to be 10% in each year. In the following paper, we explore the practical implications of the proposed parameters, and the alternatives.

This paper focuses on longevity assumptions for annuity products. Similar considerations likely apply to other business types, but we have not considered them explicitly in this paper.

Key takeaways

- The proposed parameterisation of CMI_2023 results in relatively small impacts to expectations of life relative to the earlier version (CMI_2022), but these should be considered in the context of the large impacts introduced in CMI_2022.
- The proposed parameterisation also implies low short- to medium-term future improvements and significant permanent levels of excess mortality relative to pre-pandemic expectations.
- The decision to adopt significant reductions to expectations of life relative to pre-pandemic expectations should be taken with great care, particularly given the limited amount of data available to support a decision.
- A driver-based approach to forecasting can add significant value to a data-driven approach.

We also note that changes to historical improvements could have knock-on effects for experience analyses and the calculation of excess deaths during the pandemic.

Background

The CMI model and the pandemic

The CMI model is a framework for projecting mortality improvements into the future. For the immediate future, mortality improvements are assumed to be a continuation of those observed recently, whilst over the longer term, the improvements approach a long-term rate (LTR) that is set by expert judgement.

Within the model, the MPC set a "default" parameter for all inputs except for the long-term rate. The MPC stress that users need to ensure that all the parameters are appropriate for the business they are applied to. Nonetheless, many consider the parameters set by the MPC as a guide to a current view of best estimate. The default parameterisation is known as the core model.

The CMI model enforces smooth progression of modelled mortality rates, but the pandemic introduced a discontinuity into the historical trend. This introduces technical modelling issues, because of the incompatibility of a smooth model and a jump in the underlying data. In addition, a lack of sufficient post-pandemic data prevents definitive determination of the current trend in mortality rates. It is unclear whether current mortality trends can be treated as an interrupted-but-smooth continuation of pre-pandemic mortality trends, or whether a fundamental shift to a new mortality improvements regime has occurred.

When setting the core parameterisation, the MPC must therefore try to balance: (i) ignoring aspects of the pandemic data deemed to be temporary impacts, and (ii) being responsive to longer-term trends that might be emerging in the wake of the pandemic. This is achieved by placing weights on recent years that tailor the extent to which the model should adhere to the data in each year.

CMI_2022

For CMI_2022, the committee proposed incorporating 2022 data into the model, but down-weighting it relative to other years. In principle, this means the pre-pandemic improvement trajectory is "deflected" by the new data to give a more-pessimistic forecast that remains plausible but doesn't overreact to the new data. For this purpose, the committee proposed a weight of 25% for 2022. The weighting of 25% is of course subjective, and although this percentage was adopted after a consultation period, CMI subscribers remained split over the reasonableness of the approach and outcome.[1] The changes led to significant reduction to life expectancy relative to pre-pandemic expectations and followed a regime of life expectancy reductions between CMI_2014 and CMI_2018.

> CMI_2022 introduced large reductions to life expectancies relative to previous models, and so the proposed CMI_2023 core parameterisation represents continued pessimism regarding future improvements relative to a pre-pandemic view.

CMI_2023

The core parameterisation of CMI_2023 is now out for consultation, and the MPC have proposed weights of 10% for both 2022 and 2023. This is materially different than the 25%/50% weighting scheme signposted in CMI_2022; WP 183 describes how the 25%/50% scheme would have led to excessive falls in life expectancy relative to CMI_2022 based on the view of the committee and the wider industry. The MPC's preference for a 10%/10% weighting scheme reflects a balance between returning to a pre-pandemic trajectory and a pandemic-induced stagnation in improvements.

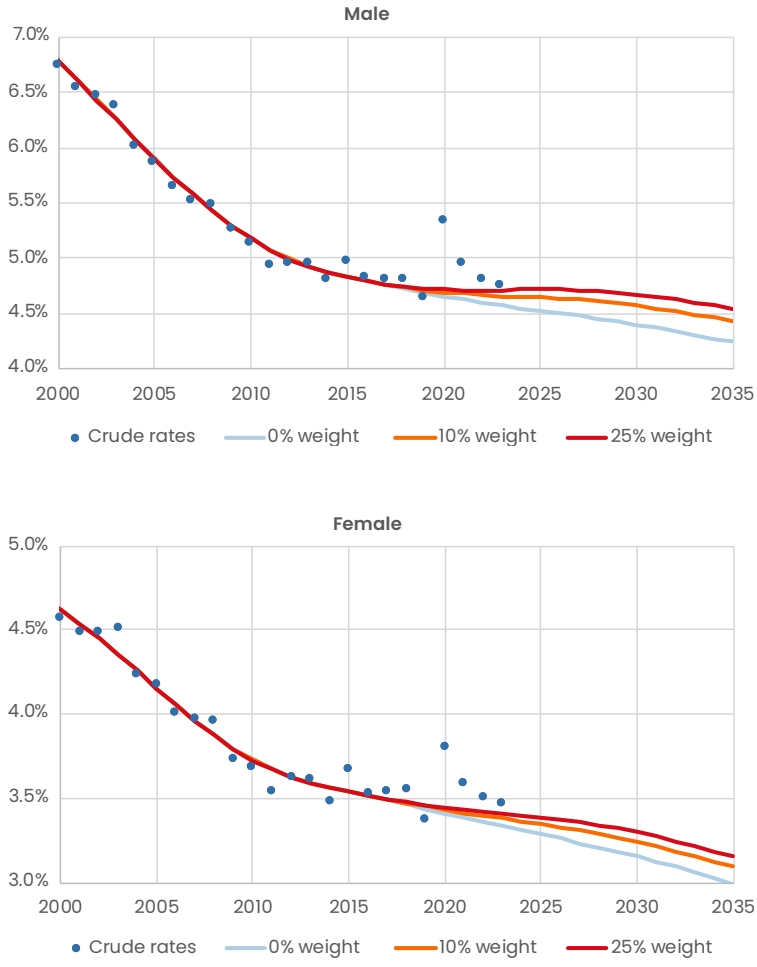
A key purpose of the CMI model is to produce plausible forecasts, and given the emerging data, the reduction in weights is perfectly reasonable. No silver bullet in the form of model parameters allows us to reliably pick up new trends using very limited amounts of data, and so the model becomes a convenient way to commit our views to a mortality basis more than it serves as a predictive model. The MPC have also proposed that years 2022+ should share a single core weight in CMI_2023 and ask subscribers whether they agree with this approach. We discuss this is more detail later.

The impact of the proposed weighting scheme relative to core CMI_2022 – when isolating the impact of changes to future improvements – is a change in cohort life expectancy at age 65 from 1 January 2024 of -0.3% for males and -0.2% for females.[2] This is a relatively small change, but CMI_2022 introduced large reductions to life expectancies relative to previous models, and so the proposed CMI_2023 core parameterisation represents continued pessimism regarding future improvements relative to a pre-pandemic view.

Figure 1 shows trajectories for age-standardised mortality rates between 65 and 95 under three scenarios, for males and females:

- The proposed core CMI_2023 parameterisation (10% weight)
- No weight on data from 2020 (a model that incorporates pre-pandemic data only, NP1 in WP 183)
- 25% weight on 2022 and 2023 (an alternative parameterisation discussed in WP 183)

Figure 1: Age-standardised mortality rates between ages 65 and 95 under three model parameterisations



Forming a view on the CMI_2023 core parameterisation

It has always been important to supplement projection models with expert judgement; before the pandemic, a relatively equal balance existed between trusting the data/extrapolative models and adjusting for exogenous information. In recent years, however, human judgement has become dominant by necessity in setting mortality forecasts, albeit that judgement is likely to be informed by multiple models or analyses of what is driving mortality and is hence still analytical and intellectually robust.

How does one go about forming a view of the CMI_2023 core parameter proposal? We believe the following are the key considerations:

1. Are the resulting mortality improvements reasonable?
2. Do the projections align with our view of current excess mortality and how it will evolve?
3. Are there any practical considerations regarding the implied mortality trajectory?

The following sections seek to answer these questions.

1. Are the resulting mortality improvements reasonable?

To form a view on this, it's helpful to compare the improvement basis against some tangible metrics of the relative optimism/pessimism of the projection of mortality improvements. Here, we do this in two ways:

1. Consider what the projections imply about excess deaths
2. Compare the projections to historical improvement rates

The core CMI_2023 model is of equivalent strength to a driver-based view where present-day excess mortality persists indefinitely.

Consider the implications for excess mortality

The IFoA post-COVID biometric assumption-setting working party offer a pragmatic way of benchmarking the strength of a post-pandemic basis vs a driver-based view of excess mortality.[3] We have extended this analysis to the proposed calibration of CMI_2023. We use CMI_2023 with no weight to 2020-2023 data, an LTR of 1.5%, and otherwise core parameters as a pre-pandemic basis (this is the NP1 counterfactual scenario described in WP 183). We derived initial excess mortality by comparing the pre-pandemic basis to observed mortality in 2023 across all ages. We then allowed the initial excess to evolve linearly for 10 years to a final level of excess (again, relative to the pre-pandemic basis) such that population expectations of life at 2024 were the same as for the proposed CMI_2023 core with an LTR of 1.5%. The analysis focused on males.

At ages 60+, significant amounts of the initial excess must remain at year 10 to achieve the same expectations of life as the CMI_2023 proposed core parameterisation. This result implies that the core CMI_2023 model is of equivalent strength to a driver-based view where present-day excess mortality persists indefinitely – i.e., we don't get back to pre-pandemic expectations of mortality levels. This is consistent with the decision-making rationale outlined in WP 183; the MPC have favoured an outcome that falls between a reversion to a "no pandemic" scenario and one in which the pandemic has induced a new persistent underlying trend.

We also show the results for the 25%/25% weighting scheme, noting that this was preferred by a substantial minority of the CMI mortality projections committee. Under this weighting scheme, the current excess is expected to increase relative to the pre-pandemic expectation at ages 60+.[4]

Table 1: Equivalent residual excess mortality analysis for 10% and 25% weighting schemes – males

Age	Initial 2023 excess[5]	Remaining excess at year 10	
		W22=10, W23=10	W22=25, W23=25
60	4.50%	4.10%	6.75%
70	4.25%	3.80%	6.55%
80	4.00%	2.90%	5.95%

WP 183 describes how users can use the overlay parameter in the CMI_2023 model to derive a mortality projection that explicitly considers how excess deaths might evolve relative to a pre-pandemic basis. This is convenient for those that maintain an in-house driver-based view of mortality improvements.

Compare projected improvements with historical values

Another option is to consider the flat age-specific improvement rates implied by the proposed parametrisation of the CMI model and ask whether those improvement rates are reasonable.

The analysis below shows that the proposed CMI_2023 core parametrisation yields future improvements over the period 2019-2039 that are comparable to the lowest seen in any historical 20-year period since 1958.[6] It also shows the 25%/25% and 0%/0% (NP1) parameterisation results for comparison. The NP1 projection implies historically low mortality improvement rates over the next 20 years, and it is arguable that this is already reflective of a post-pandemic environment of low mortality improvements.

Table 2: Average annualised England and Wales mortality improvement produced by the proposed CMI_2023 model for 2019-2039 against historic 20-year periods for constant age – males.

	Constant Age								
	55	60	65	70	75	80	85	90	95
1958 - 1978	0.5%	0.6%	0.8%	0.5%	0.3%	0.2%	0.4%	0.9%	1.0%
1963 - 1983	1.0%	1.1%	1.2%	1.0%	0.8%	0.6%	0.7%	0.8%	0.6%
1968 - 1988	1.7%	1.5%	1.5%	1.3%	1.2%	0.8%	0.8%	1.0%	1.0%
1973 - 1993	2.5%	2.1%	1.9%	1.7%	1.6%	1.2%	0.9%	0.6%	0.5%
1978 - 1998	2.7%	2.7%	2.3%	2.0%	1.9%	1.6%	1.1%	0.5%	0.3%
1983 - 2003	2.7%	2.8%	2.9%	2.7%	2.2%	1.8%	1.4%	0.9%	0.3%
1988 - 2008	2.1%	3.0%	3.2%	3.3%	2.8%	2.3%	1.6%	0.8%	0.3%
1993 - 2013	2.3%	2.5%	3.3%	3.3%	3.0%	2.6%	1.8%	1.1%	0.3%
1998 - 2018	1.8%	2.1%	2.4%	3.0%	2.8%	2.3%	1.8%	1.0%	0.4%
CMI_2023 (NP1): 2019 - 2039	1.5%	0.9%	0.6%	0.5%	0.5%	0.6%	0.7%	0.8%	0.6%
CMI_2023 (core): 2019 - 2039	1.2%	0.7%	0.4%	0.2%	0.3%	0.4%	0.5%	0.6%	0.5%
CMI_2023 (w2022 = 25%, w2023 = 25%): 2019 - 2039	1.1%	0.5%	0.3%	0.1%	0.2%	0.3%	0.4%	0.6%	0.5%

Table 3: Average annualised England and Wales mortality improvement produced by the proposed CMI_2023 model for 2019-2039 against historic 20-year periods for constant age – females.

	Constant Age								
	55	60	65	70	75	80	85	90	95
1958 - 1978	0.0%	0.5%	0.9%	1.0%	1.2%	0.9%	0.7%	0.9%	0.8%
1963 - 1983	0.4%	0.4%	0.8%	1.1%	1.3%	1.3%	1.1%	0.8%	0.6%
1968 - 1988	1.0%	0.7%	0.6%	0.9%	1.4%	1.3%	1.3%	1.2%	0.9%
1973 - 1993	2.0%	1.4%	1.0%	1.1%	1.4%	1.5%	1.3%	0.9%	0.6%
1978 - 1998	2.2%	1.7%	1.5%	1.2%	1.2%	1.5%	1.4%	0.6%	0.2%
1983 - 2003	2.2%	2.2%	2.1%	2.0%	1.4%	1.3%	1.2%	0.8%	0.3%
1988 - 2008	1.8%	2.4%	2.7%	2.4%	2.1%	1.6%	1.3%	0.8%	0.3%
1993 - 2013	1.5%	2.1%	2.7%	2.7%	2.4%	1.9%	1.3%	0.9%	0.3%
1998 - 2018	1.5%	1.8%	1.9%	2.4%	2.3%	1.9%	1.4%	0.8%	0.3%
CMI_2023 (NP1): 2019 - 2039	1.1%	1.0%	1.0%	0.9%	0.9%	0.8%	0.9%	1.0%	0.7%
CMI_2023 (core): 2019 - 2039	0.9%	0.8%	0.9%	0.8%	0.7%	0.6%	0.8%	0.9%	0.6%
CMI_2023 (w2022 = 25%, w2023 = 25%): 2019 - 2039	0.8%	0.7%	0.7%	0.7%	0.6%	0.5%	0.7%	0.8%	0.6%

Ultimately, a view of what projection is reasonable depends on what we consider to be the sources of current excess, how these might be addressed, and what the outlook for future improvements appears to be. This leads us to the next key question.

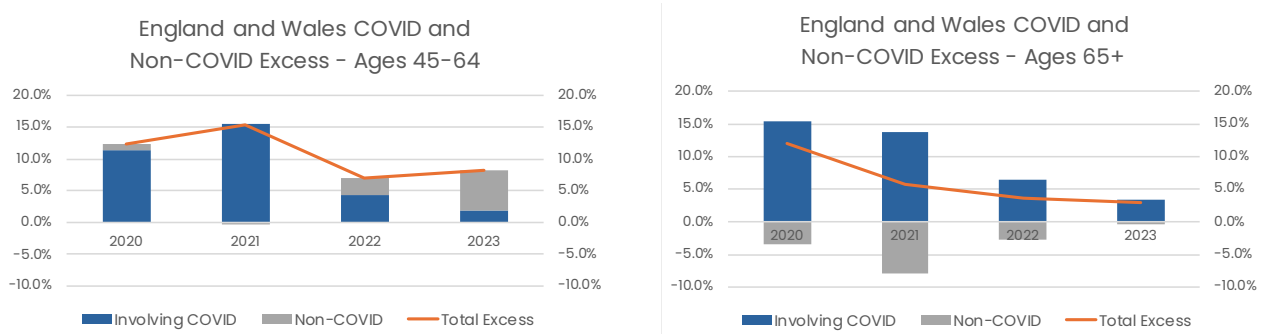
2. Do the projections align with our view of current excess mortality and how it will evolve?

The critical question for mortality forecasting is: What is driving the higher-than-expected mortality rates in 2023 and will it persist?

Excess mortality since 2020

The chart below shows how the split in excess mortality (for males and females combined, relative to an NP1 expected basis from WP 183) due to COVID and non-COVID causes has changed over time.[7] The general trend is that COVID appears to be contributing less to excess mortality in recent years, but excess mortality from non-COVID causes has evolved in a complex manner that varies across age groups.[8]

Figure 2: COVID and non-COVID excess mortality by age and year – males and females combined



At older ages (65+), non-COVID excess has been consistently negative since 2020, which likely reflects deaths from other causes that have been displaced by COVID, and the suppression of influenza seasons throughout much of the pandemic. In 2023, the non-COVID excess remained negative but at a reduced magnitude to previous years, likely reflecting the reemergence of influenza as well as lower COVID mortality reducing the scope for displacement of deaths.

At younger ages (45-64), considerable non-COVID excess mortality in 2022 and 2023 reflects factors such as deterioration in cardiovascular mortality and diseases of despair, such as suicides, accidental poisonings, and alcoholic liver diseases.

Candidate drivers and outlooks

A large body of research already in the public domain attempts to dissect and explain the drivers of this excess mortality at a more-granular level. In the UK, pressure on the NHS and residual COVID (and its sequelae) are generally cited as the major underlying drivers of post-pandemic excess. Forming a view on how these drivers will evolve is therefore an important aspect of assessing the reasonableness of short-term improvement rates.[3]

If users take the view that the cause of current excess is temporary, it's reasonable to view the core CMI model parameterisation as pessimistic. This view might be supported by the reduction in ambulance response times in 2023 relative to 2022, reduced COVID deaths (and potential for longer-term sequelae), and implementation of the NHS's recovery plan.

On the other hand, some users might believe that current excess is here to stay. Potential reasons include drivers persisting into the longer term and the resolution of issues such as NHS A&E waiting times coming at the expense of mortality improvements anticipated before the pandemic.

Still other users might consider the current excess a sign of worse things to come, contending that the impact of factors such as the cost-of-living crisis and increased NHS waiting lists have not yet manifested as increased mortality rates but eventually will.

The proposed CMI projection is consistent with the view that much of the current excess is here to stay, and that we can expect a period of historically low improvements in the short-to-medium term. A projection under a weighting scheme of 25%/25% reflects the view to expect additional excess mortality in the coming years.

It is clear the pandemic and its aftermath have impacted mortality rates, and there is considerable uncertainty around how mortality trends will emerge from the pandemic. Material changes in life expectancy relative to pre-pandemic expectations should be scrutinised carefully, and assumption changes should recognise the limited data we have on post-pandemic trends.

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3. Are there any practical considerations regarding the implied mortality trajectory?

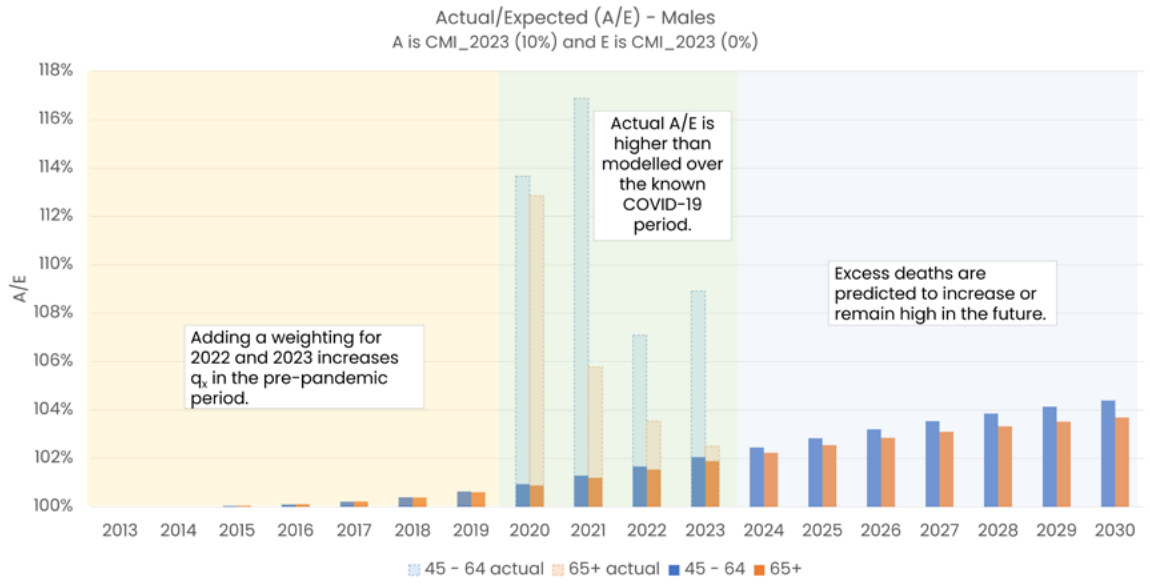
In this section we consider some of the practicalities of using mortality improvements derived from the CMI_2023 model. These are not reasons to favour the proposed parameterisation or otherwise per se, but they highlight some important implications of using a smooth mortality trajectory in the presence of discontinuous data. Actuaries are well equipped to handle these kinds of technicalities; users should remain vigilant, however, and ensure that points are well understood by those who work with the model's outputs.

WP 183 is very clear in prescribing that the improvements from the core parameterisation should be applied to a pre-pandemic base table. This is helpful in removing any ambiguity around how the improvements should be applied, but we should consider three additional factors when implementing the model:

1. Weighting post-pandemic data can have a material impact on pre-pandemic improvements.
2. The mortality trajectory understates mortality in the period 2020-2023 (considerably so in 2020 and 2021).
3. A shared 2022+ weight parameter may lead to unintended consequences.

The following chart highlights the first two of these factors; it compares the proposed core weighting to a scheme in which the years 2020-2023 receive no weight (both using a base year of 2013), and measures this against actual population mortality in 2020-2023. The analysis focuses on males.

Figure 4: CMI_2023 model with 10% weight compared to NP1, plus actual data for 2020-2023 – males



Impact on pre-pandemic improvements

The change in pre-pandemic trajectory has important implications for experience analyses; actual vs expected mortality ratios for a portfolio of lives will change by more than 0.5% in 2019, depending on whether we use a pre-pandemic basis or CMI_2023. This restating of historical mortality rates has always been a feature of CMI models and is a consequence of the smoothing mechanism. In normal times, this is a reasonable approach – the smoothing removes noise from the raw mortality rates, and observing data after a given year helps refine what the real underlying mortality rate is in that year. For example, it took a significant number of years post-2011 to understand whether we were observing statistical noise or an underlying change in mortality trend. It seems tenuous to make the same link between 2019 and 2023, however, as it is less clear that 2019 should be viewed as a smooth precursor to what has occurred since the pandemic.

Understatement of 2020-23 mortality rates

Understating 2020-2021 mortality rates is a desirable feature of the CMI model. The spikes in mortality are not expected to be indicative of mortality trends, and ignoring these years in the model is very reasonable. It's worth noting that understating 2022-2023 mortality is also a deliberate feature of the model, as referencing this data too closely would lead to very pessimistic forecasts, as explained previously.

As with pre-pandemic mortality rates, the actual vs expected values observed through the pandemic will change if the expected basis is moved between a pre-pandemic basis and CMI_2023. We must take care when explaining the differences to stakeholders, as the pandemic impact has effectively been re-stated in moving to a new basis. Similarly, any adjustments made to pre-pandemic bases to account for COVID must be recalculated before being applied to the new basis to avoid double-counting COVID impacts.

A single weighting parameter for 2022+

WP 183 introduces the concept of a single shared weight in the core parameters for years 2022+. The weight can change in different model releases, and we interpret this to mean that future versions of the model (e.g., CMI_2024) will also contain a shared parameter that applies to years 2022+.

Users retain the flexibility of applying year-specific weights by using advanced parameters. In principle, a single weight parameter for 2022+ is appealing. Intricate tailoring of the weighting parameters for individual years introduces unnecessary complexity in the model parameterisation as more years come into scope, and thus reduces the appeal of the model as a common currency between actuaries.

We should, however, be mindful of unintended consequences brought about by this decision. It would be useful to know how sensitive future iterations of the CMI model might be to the choice of shared weight and how that might compare to scenarios in which the forecasts are managed via changes to the smoothing parameter. It's possible that we end up discussing combinations of weight and smoothing parameters in the future, and while this might be a necessary consequence of producing reasonable post-pandemic forecasts, we should favour simple and robust methods where possible.

Conclusion

The exceptional circumstances in which we find ourselves as we emerge from the pandemic necessitate careful scrutiny of projected mortality improvements, the recently proposed CMI_2023 core parameterisation in particular. We have noted that:

- The changes introduced between CMI_2022 core and CMI_2023 core result in relatively small impacts to expectations of life, but these should be considered in the context of the large impacts introduced in CMI_2022.
- The CMI_2023 core population forecast implies life expectancies akin to a driver-based approach in which significant levels of current excess mortality are permanent.
- Short-term mortality improvements implied by the CMI_2023 core model are very low compared to historical improvement rates.
- Users must understand subtle practical considerations when adopting the CMI_2023 model, specifically: the impact on historical mortality rates; the interpretation of COVID excess; and implications of a shared weighting parameter for years 2022+.

The decision to adopt a core parameterisation that implies a significantly lower life expectancy than pre-pandemic expectations should not be taken lightly, particularly given the limited evidence we have available to form a view of the post-pandemic mortality trajectory. It is unclear whether sufficient evidence exists to support the fall in life expectancy implied by the CMI_2022 core parameterisation, which followed a series of reductions in life expectancy between CMI_2014 and CMI_2018. In light of these considerations, the introduction of a CMI_2023 core parameterisation that refrains from further significant reductions in life expectancy can be seen as a reasonable approach, but the 10% weight should not be seen as a lower bound.

Mortality improvements are notoriously hard to predict, and we recognise that others will have a different outlook than ours. We look forward to the discussions that arise as part of the CMI_2023 consultation and are grateful for the work the CMI Mortality Projections Committee does on behalf of the actuarial profession at a time of great uncertainty.

The introduction of a CMI_2023 core parameterisation that refrains from further significant reductions in life expectancy can be seen as a reasonable approach, but the 10% weight should not be seen as a lower bound.

Notes

1. CMI Working Paper 173
2. The impact is smaller if the change in recent historical improvements is considered in addition to future improvements, and we explore the consequences of changes to historical improvements in more detail later in the paper.
3. Report of the post-COVID biometric assumption-setting working party.
4. We acknowledge the subjectivity of picking the pre-pandemic basis and note that, had we chosen something more akin to the NP1* scenario outlined in WP 183 (i.e., ignoring 2019 data as mortality is very low in that year), the initial and residual levels of excess would both be lower than in the analysis presented here.
5. The raw excess between ages 58 and 82 is fitted using a straight line and rounded to the nearest 0.25%.
6. Historical improvements are derived from raw q_x values that are smoothed by 3-year averaging, and hence 2019 data are included in the data period to 2018. CMI modelled values are derived from the CMI model output with no additional smoothing.
7. We note that the split of COVID and non-COVID deaths is further complicated by changes in surveillance and reporting of COVID infections; it's possible that COVID-related deaths in 2022/23 are underreported relative to 2020/21.
8. ONS data is used for deaths including COVID.