

Continuous Mortality Investigation
Working Paper 41
CMI Mortality Projections Model
Feedback on Consultation and Issue of ‘CMI_2009’

November 2009

© 2009 Institute of Actuaries 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 of Actuaries and Faculty of Actuaries copyright and the title of the document specified.

The Institute of Actuaries, the 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.

Executive Summary

The CMI published a prototype Mortality Projections Model (CPMv0.0) in June 2009 for consultation. The prototype Model was accompanied by its User Guide and two CMI Working Papers: Working Paper 38 provided an overview of the Model and set out specific questions for the consultation; Working Paper 39 detailed further analysis to help inform the setting of parameter values for the Model.

Consultation meetings were held in Edinburgh and London in July 2009 and over 30 written responses to the consultation were received. The CMI is grateful to all those who contributed.

This Working Paper summarises the responses to each of the consultation questions posed in CMI Working Paper 38, together with the Working Party's comments and details of the actions taken.

The key messages emerging through the consultation exercise were:-

- There was strong support for the CMI's development of the Model and a widespread intention to use it.
- There was general support for the broad structure and key features of the Model, with the (minority) calls for changes roughly balanced either side of the prototype design.
- There was majority support for the default values given to parameters, although material debate will persist, particularly on the use of population (rather than insured or pensioner) data for estimating initial rates of mortality improvement, and on the methodology of convergence from 'initial' to 'long-term' rates of improvement.
- There were many calls for further research, especially on the potential variation in initial rates of mortality improvement across population sub-groups, and on the long-term rate.
- On balance, respondents expressed a desire for an annual review of the Model against emerging data, but more stability in respect of the Model structure and 'benchmark' projections.
- The depth and quality of research work presented in the Working Papers was warmly welcomed.

The Model has been updated and the first live version of the Model has been published alongside this paper, together with a User Guide and a set of parameter sensitivity test results.

The structure of the Model has been left broadly unchanged from the prototype version. However, the default parameters contained in the Model have been updated to reflect the publication of England & Wales population mortality data for calendar year 2008.

As a result default Initial Rates of Mortality Improvement have slightly reduced in general from those published in the prototype version, and accordingly Core Projections generated by the new version of the Model produce life expectancies and annuity values which are marginally lower than those produced by the prototype Model (with other parameters held constant).

In addition, the naming convention has been revised: the first live version of the Model will be referred to as 'CMI_2009' rather than 'CPMv1.0'.

Contents

Executive Summary	2
Contents	3
1. Introduction	4
1.1. Background and the prototype CMI Mortality Projections Model	4
1.2. Consultation on the prototype CMI Mortality Projections Model	5
1.3. Structure of the Working Paper	6
2. Summary of Responses to Consultation Questions	7
2.1. General Comments	7
2.2. Question (a): Production of the Model	7
2.3. Question (b): Broad Structure of the Model	7
2.4. Question (c): Comments on the Proposed Structure of Model	8
2.5. Question (d): Core Parameters	11
2.6. Question (e): Long-Term Rate	14
2.7. Question (f): Parameter Default Values	14
2.8. Question (g): Naming Convention	18
2.9. Question (h): Use of the Model	19
2.10. Question (i): Future Development of the Model	19
2.11. Question (j): Maintenance of the Model	21
2.12. Question (k): Other Comments	22
3. The Effect of Adding Data for Calendar Year 2008	25
3.1. Changes to the Population Dataset for England & Wales	25
3.2. Observed Rates of Mortality Improvement to 2008	25
3.3. Changes in Estimates of Current Aggregate Rates of Mortality Improvement	26
3.4. Changes in Estimates of Components of Current Rates of Mortality Improvement	26
3.5. Quantification of the Effect of Reflecting Data for 2008 in the Model	29
4. Launch of the First Live Version of the Model	31
4.1. CMI Mortality Projections Model: ‘CMI_2009’	31
4.2. User Guide for ‘CMI_2009’	32
4.3. Parameter Sensitivity Test Results Spreadsheet for ‘CMI_2009’	32
5. Future Work	33
5.1. Regular Updating of the Model	33
5.2. Further Research	33
Appendix: Errata to Prototype Model and CMI Working Papers 38 and 39	34

1. Introduction

1.1. Background and the prototype CMI Mortality Projections Model

In recent years the Continuous Mortality Investigation (CMI) has become concerned about the continuing widespread use of the Interim Cohort Projections of mortality. These projections do not take account of experience data published for calendar years after 1999 and, as a result, have become increasingly out-of-date.

A Working Party was therefore established to develop a projection Model which:-

- reflected the latest experience on trends in mortality;
- was relatively straightforward to understand and describe;
- allowed users the flexibility to modify projections to suit their own views and purpose; and
- could be regularly updated over time to reflect emerging experience.

The members of the Working Party were as follows:-

- Richard Willets (chair)
- Adrian Gallop
- Joseph Lu
- Brian Wilson
- Neil Robjohns (secretariat).

The CMI published the prototype Mortality Projections Model (CPMv0.0) in June 2009 for consultation. The prototype Model was accompanied by its User Guide and two CMI Working Papers: Working Paper 38 provided an overview of the Model and set out specific questions for the consultation; Working Paper 39 detailed further analysis to help inform the setting of parameter values for the Model.

The structure of the Model was based on the projection of annual rates of **mortality improvement** (i.e. the pace of change in mortality rates). Specifically, the Model assumes that ‘current’ (i.e. recently observed) rates of change blend over time into a ‘long-term’ rate of change specified by the user. This approach has been adopted by practitioners in a number of countries. In the UK the mortality projections that have formed part of the national population projections - now produced by the Office for National Statistics (ONS) and formerly by the Government Actuary’s Department (GAD) - have utilised this methodology for a number of years.

The prototype Model required the user to set parameter values which directly control the projection, and then produced a single, deterministic, mortality projection for each set of user inputs. The structure of the Model allows user input of:-

- base mortality rates, reflecting the estimated current or recent past position;
- initial rates of mortality improvement, reflecting the estimate of current rates of change;
- assumed ultimate / long-term rate(s) of mortality improvement; and
- an assumed speed and pattern of convergence from ‘initial’ to ‘long-term’.

‘Initial’ and ‘long-term’ rates of mortality improvement are each subdivided into two components: ‘by age’ and ‘by cohort’. These components are projected separately, by age and by year-of-birth cohort respectively, and then recombined. Convergence from ‘initial’ to

‘long-term’ rates of mortality improvement is defined (separately for ‘by age’ and ‘by cohort’ components) by user inputs for the convergence time-period and the proportion of the total change in rate remaining by the mid-point of that period.

Effectively this approach assumes that in the very short-term, a good guide as to the likely pace of change in mortality rates is the most recently observed experience. In the long-term, the forces driving mortality change are likely to be very different from those currently influencing patterns of improvement. Therefore, the long-term rate is better informed by ‘expert opinion’ and analysis of long-term patterns of change and the causes driving them. Over time, the relative weight placed on the recently observed past, versus the more subjective longer term view, can shift appropriately.

Two levels of parameters were proposed so that the Model could be operated at different levels of complexity, reflecting the needs and resources of different users and uses.

The ‘Advanced’ level contains a large set of parameters, and by selecting it users obtain unrestricted access with considerable flexibility to modify the projections generated.

However, users may choose to operate the Model at a much simpler level. When the ‘Core’ level is selected default values are applied to many of the parameters (for example, default initial rates of mortality improvement were derived from mortality experience for the population of England & Wales) leaving the user to concentrate on just two simplified parameters representing the most critical inputs:-

- the Long-Term Rate of Mortality Improvement; and
- a Constant Addition to Rates of Mortality Improvement.

It was proposed that projections produced using only the Core level of parameters should be referred to as ‘Core Projections’ and be subject to a formal naming convention (set out in Working Paper 38).

1.2. Consultation on the prototype CMI Mortality Projections Model

Working Paper 38 sought feedback on a specific list of questions with a consultation period ending on 31 August 2009. In all, 31 written responses were received. Although a broad range of firms were represented overall there was a bias, in terms of number of responses, towards firms engaged in pensions consultancy work. There were no written responses from regulators or ‘non-actuarial’ groups.

Consultation meetings to discuss the prototype Model were held in Edinburgh and London in July 2009. Both meetings provided valuable and generally positive feedback, with relatively little overlap between the areas of discussion.

The CMI, and in particular the Working Party, is very grateful to all those who contributed, whether orally or in writing, through the consultation process.

The key messages emerging through the consultation exercise were:-

- There was strong support for the CMI’s development of the Model and a widespread intention to use it.

- There was general support for the broad structure and key features of the Model, with the (minority) calls for changes roughly balanced either side of the prototype design.
- There was majority support for the default values given to parameters, although material debate will persist, particularly on the use of population (rather than insured or pensioner) data for estimating initial rates of mortality improvement, and on the methodology of convergence from 'initial' to 'long-term' rates of improvement.
- There were many calls for further research, especially on the potential variation in initial rates of improvement across population sub-groups, and on the long-term rate.
- On balance, respondents expressed a desire for an annual review of the Model against emerging data, but more stability in respect of the Model structure and 'benchmark' projections.
- The depth and quality of research work presented in the Working Papers was warmly welcomed.

The Model has been updated and the first live version of the Model has been published alongside this paper, together with a User Guide and a set of parameter sensitivity test results.

The structure of the Model has been left broadly unchanged from the prototype version. However, the naming convention has been revised: the first live version of the Model will be referred to as 'CMI_2009' rather than 'CPMv1.0'.

1.3. Structure of the Working Paper

The structure of the remainder of this paper is as follows:

Section 2 provides a summary of the responses to each of the consultation questions posed in CMI Working Paper 38, together with the Working Party's comments and details of the actions taken.

Section 3 describes features of the changes to the England & Wales population mortality data with the addition of data for calendar year 2008. The default parameters contained in the Model have been updated to reflect the publication of this extended population dataset, which became available on 17 September 2009.

As a result default Initial Rates of Mortality Improvement have slightly reduced in general from those published in the prototype version, and accordingly Core Projections generated by the new version of the Model produce life expectancies and annuity values which are marginally lower than those produced by the prototype Model (with other parameters held constant).

Section 4 summarises the changes made to the Model since the prototype released in June 2009.

Section 5 describes the proposed future maintenance and development of the Model.

2. Summary of Responses to Consultation Questions

CMI Working Paper 38 sought feedback on a specific list of questions with a consultation period ending on 31 August 2009. See section 1.2 for a high-level overview of the messages emerging from the written responses received and the two consultation meetings held in July. This section provides a summary of the responses to each of the consultation questions posed in Working Paper 38, together with the Working Party's comments and details of the actions taken.

The Working Party's comments and actions taken are shown in text boxes like this one.

2.1. General Comments

The Model was generally well received, with respondents grateful for the work carried out by the CMI in producing the Model and the material in Working Papers 38 and 39. The Model was seen to provide a robust, useful and flexible framework for the respondents, their clients and the wider industry to produce deterministic mortality projections. It was generally anticipated that the Model would be widely used, and that it would be of great assistance to actuarial firms, particularly through providing an up-to-date and common currency for producing and reporting mortality projections.

2.2. Question (a): Production of the Model

Do you agree that the CMI should be producing such a mortality projections model for use by practising actuaries? Please give reasons.

The response to this question was unanimously positive. Respondents typically cited the need for a model reflecting recent data (to replace the Interim Cohort Projections), the desirability of a common currency for comparing mortality projections, and a view that the CMI is uniquely and best-positioned to produce (and maintain) such a model.

There is a clear mandate to proceed with the launch of a 'live' version of the Model.

2.3. Question (b): Broad Structure of the Model

Do you agree with the broad structure of the proposed Model, i.e. a relatively simple, deterministic model with 'core' and 'advanced' level parameters, offering a common currency against which alternative methodologies could be benchmarked? Please give reasons.

There was strong and widespread support for the basic structure of the Model, and a recognition that the two-level design catered well for a broad range of users. In particular, a clear majority supported the production of a deterministic (rather than stochastic) model to meet the stated purposes. The approach of blending over time, from current rates of mortality improvement to an assumed (set of) long-term rate(s), was generally regarded as both

intuitive and supportive of relatively easy communication of the Model's structure to non-actuaries.

However, a minority of respondents voiced various concerns, as follows:-

- It was suggested that the existence of the Core parameter level may lead to 'herding' and that, to avoid this, great care would be needed in the presentation of the Model. In particular, careful consideration is required on which projections to include in the CMI Library of Mortality Projections.
- One respondent felt that the existence of the Advanced parameter level could lead to pension scheme trustees or sponsoring employers building up unnecessary costs and creating excessive work during funding negotiations by considering all alternatives. Furthermore, it was argued that sponsoring employers may attempt to manipulate results by arguing for 'low' parameters in every case with a view to reducing the liabilities.
- One respondent called for some prudence to be included within the Core parameter level, as smaller insurance companies or actuarial firms were likely to rely on the Core settings.
- Another called for an 'Intermediate' level of parameters to be added to the Model, allowing a limited degree of flexibility relative to the Core level, but still being much simpler than the Advanced level.

Whilst a number of possible modifications to the structure were suggested, there was strong support for the broad structure of the prototype Model and no consensus for any particular change.

The Working Party recognizes the possibility of 'herding', and the CMI is giving careful consideration to the choice and number of projections to be included in the CMI Library of Mortality Projections (see also section 2.12.6).

The Working Party do not consider it appropriate to include prudence within the default parameters at the Core parameter level, but note that users could include prudence, if desired, within the Core settings by using a constant addition to mortality improvement rates, or by setting a prudent long-term rate of improvement. Additional options for building in margins, if desired, are available through the Advanced parameter layer.

2.4. Question (c): Comments on the Proposed Structure of Model

Do you have any comments or suggestions on the proposed structure of the Model?

2.4.1. Excel Spreadsheet

It was appreciated that the Model is built in Excel, making it transparent and accessible to all. However, there were some comments about the size of the spreadsheet, inferring that this may cause some operational problems.

Given the small number of comments regarding the size of the spreadsheet, and the timescale for publication of this paper and the revised version of the Model, it was agreed that reviewing the size and operational efficiency of the spreadsheet could not be an immediate priority for the Working Party, but that the issue should be listed for future consideration.

The Working Party notes that users can easily delete or disable any output calculation sheets they do not require, and so create their own smaller or faster version of the Model. The User Guide provides a schematic of the Model's structure, outlining the major data and calculation flows between worksheets, which will help users identify which sheets may be safely eliminated if the user does not require their outputs. Sample annuity and expectation of life values, published in the User Guide and the parameter sensitivity test results spreadsheet, also serve to help users to check for inadvertent changes which may be introduced through such modifications.

2.4.2. Convergence Methodology

The methodology for convergence from the initial to the long-term rates of mortality improvement was commented on by several respondents. Such comments were often combined with points relating to the pattern of convergence given by the Core parameter default value of 50% for the proportion of convergence remaining at the mid-point of the convergence period.

The Model's convergence methodology does not allow for the trend in mortality improvement rates prior to the start of the projection. Therefore, if long-term rates of improvement are assumed to be less than the initial rates, then mortality improvement rates will automatically decline from the start of the projection period for Core Projections. It was argued that this was inconsistent with an observed history of increasing rates of improvement, across a broad age range over the last 10 to 15 years, with the possible inference being that that 'the CMI believes rates of mortality improvement have already peaked (at the start of the projection)'.

Various suggestions were put forward, broadly split as follows:-

- Change the methodology behind the convergence parameter; perhaps by using two splines to allow for the recent trend in improvements to continue into the projection.
- Review the proposed default value under the Core parameter level of 50% of convergence remaining at the mid-point of the convergence period (discussed further in section 2.7.3).
- Add the proportion of convergence remaining at the mid-point as a Core parameter given its importance and subjectivity (discussed further in section 2.5.1).

Further details of the reasoning behind the proposed convergence methodology were requested, together with further justification of the track of convergence (that is, immediately down from the 'high' current rates) driven by the default parameters for Core Projections.

A further suggestion was that, given the default Core assumption of 50% of convergence remaining at the mid-point, the Core Projection convergence path is not significantly different to a linear convergence track which would be easier to communicate and understand.

The Working Party had considerable sympathy with the idea of incorporating the initial trend in rates of improvement into the convergence methodology or default parameters. Indeed, this approach had been discussed at some length prior to the release of the prototype Model.

However, there were, and remain, a number of difficulties with such an approach:-

- Estimates of the ‘current trend’ (that is, the rate of change in the rate of change of mortality rates) are highly uncertain and could prove very sensitive to ‘edge effects,’ potentially varying significantly with the addition of each year’s data. This is illustrated by Figure 1 below.
- Mortality improvement rates are observed to be increasing for some ages (and birth cohorts) and decreasing for others. Attempting to take account of the differing trends by age and cohort would result in a complex basis. For example, assuming a flat default 75% of convergence remaining at the mid-point would cause anomalies for some ages and cohorts, yet a more complex basis might be regarded as spuriously ‘accurate’.
- The division of Initial Rates of Mortality Improvement into Cohort and Age/Period Components raises additional questions in determining the ‘current trend’ of those components.
- Calculation of the ‘current trend’ requires a history of improvement rates, and this could impose additional input requirements on users of the Advanced parameter layer.

Following the end of the consultation process, the ONS released mortality data for the population of England & Wales for calendar year 2008. The Working Party has carried out an analysis on how the addition of this extra year’s information affects estimates of the trend in recent mortality improvement rates. Figure 1 shows the Period Component of Initial Rates of Mortality Improvement derived from the (smoothed) mortality data for England & Wales population - first using the 1961-2007 dataset and then the 1961-2008 dataset.

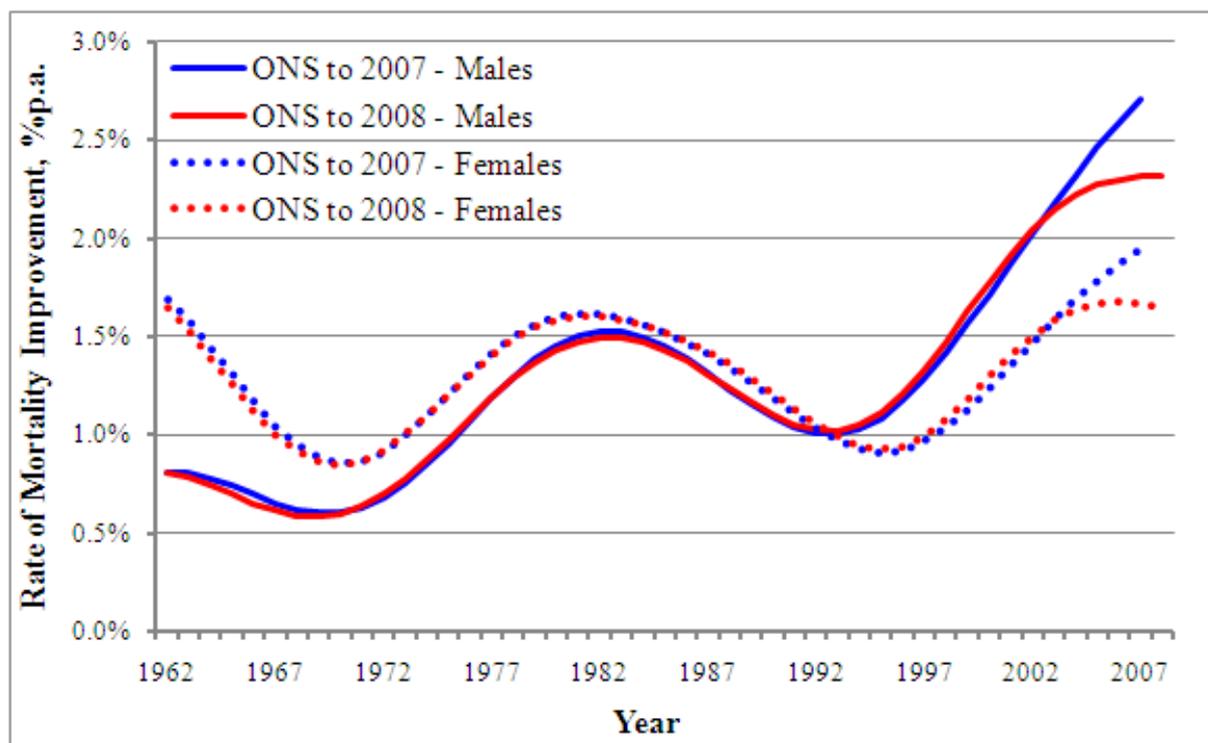


Figure 1: Period Component of the Rate of Mortality Improvement, by year, dataset, and gender; England & Wales Population

Figure 1 shows that the inclusion of the additional year of data significantly changes the trajectory of mortality improvements. For both males and females, mortality improvement rates based on the dataset for calendar years up to 2007 looked to be increasing rapidly. However, once data for 2008 is added, the rate of change appears to be leveling-off.

It should also be noted that considerable smoothing of the mortality data is required in order to examine the time trends, and that observations are then subject to the chosen method of smoothing and, in particular, to the weight given to the most recent observations.

The Working Party recognises that this does not provide proof that the rate of improvement in mortality rates has reached a local peak, and considers that it is not possible to determine, with an acceptable degree of confidence, whether the general trend of improvement rates is still rising, has reached a plateau, or will now start to fall.

The Working Party was mindful that ‘following the most recent trend’ could result in projections that produced volatile results from one Model version to the next (assuming annual updates to the Initial Rates). As a result, and noting that the calls for change represented a minority of the responses, it decided to maintain the methodology of convergence put forward in the prototype Model.

The Working Party also discussed changing the convergence methodology to a simple linear function, but rejected the suggestion as it was felt that such an approach would not allow the flexibility envisaged for users of the Advanced parameter level.

2.4.3. Uncertainty Measures for Mortality Projections

Users often require a measure of uncertainty for projected mortality, and some respondents commented that the Model does not easily allow this to be determined. Some contributors to the Consultation Meetings called for a stochastic element to the projections to produce a range for projected mortality rates.

Quantifying uncertainty for parameters, and the projection as a whole, would require very significant additional research. In addition, illustrating uncertainty by adding a stochastic element would also add significant complexity to the Model, would risk alienating some users and would make it difficult to meet the “common currency” aim. The Working Party therefore does not propose to make any material structural changes to this version of the Model, but would welcome further research towards quantifying uncertainty.

2.5. Question (d): Core Parameters

Do you agree with the proposed number (two) of parameters at Core level and the choice of these parameters?

The responses were broadly symmetrical, in range and number, around the proposals embodied in the prototype Model, with very roughly one-third calling for an extra Core parameter (usually either the percentage of convergence remaining at the mid-point, or the high-age for tapering the long-term rate of improvement to zero) balanced by another third calling for the removal of a Core parameter (always the constant addition). The remaining third were in favour of the proposed structure.

Given the broad symmetry of responses around the proposed structure, and strong support for the logic supporting that structure, the Working Party decided to proceed without change to the Core level parameters. It was also mindful that any change to the originally proposed structure could have more opponents than proponents and therefore might imply a need to consult again on the revised structure.

Comments on some of the specific suggestions put forward through the consultation are set out in the following sections.

2.5.1. Convergence Parameter [possible addition to the Core level]

Those respondents who proposed adding an additional parameter in respect of the convergence process generally suggested that the Proportion of Convergence Remaining at the Mid-point of the Convergence Period should be a Core parameter and that input should be restricted to a single value to apply to all ages and cohorts. It was also suggested by some that the Period of Convergence should be a Core parameter. There was also one call for an additional Advanced parameter, of an optional period of time using the Initial Rates of Mortality Improvement (held constant) before convergence commences.

As described in section 2.4.2, there are many issues that need to be considered when setting the convergence parameters.

The complexity involved in the convergence methodology means that storing and changing a single value for the Proportion of Convergence Remaining at the Mid-point may not have the expected effect: as Initial Rates of Improvement differ across ages and birth cohorts, they are likely to be below the chosen Long-Term Rate of Improvement for some ages, and particularly for some birth cohorts, but above the Long-term Rate of Improvement for others.

The Working Party did consider allowing the user to choose from a small set of pre-input options that could be derived to take these complexities into account. However, it was judged that this would be a considerable piece of additional work, perhaps of limited value, which could imply spurious accuracy in the context of the Model. It was noted that projection results are generally far less sensitive to the assumed convergence path than to the assumed Long-Term Rates of Mortality Improvement.

The Working Party considered this matter in some depth, and concluded on balance, that it would not be reasonable to expect Core parameter level users to take a detailed view on convergence. It was agreed that the parameter for the Proportion of Convergence Remaining at the Mid-point sat more comfortably in the Advanced parameter layer where users would be expected to have a greater understanding of the issues and complexities involved, than in the Core parameter layer.

2.5.2. High-Age for Long-Term Rate Tapering [possible addition to the Core level]

There were also a number of responses suggesting that the high age at which the Long-term Rate of Improvement should start to taper to zero should be a Core Parameter.

The Working Party had previously considered this idea, but had concluded that the resulting projections at most ages were not sufficiently sensitive to changes in this assumption for this to be included as a Core Parameter.

2.5.3. Dataset for Initial Rates of Improvement [possible addition to the Core level]

Some respondents requested that a choice of dataset, from which Initial Rates of Mortality Improvement were derived, should be added as a Core parameter.

One respondent also commented that there should be a parameter enabling users to select the relevant dataset (in terms of the range of years) since in future, even if the default values continue to be based solely on England & Wales population data, there will be different default parameter sets released as each additional calendar year's data is taken into account. The respondent argued that in order to avoid confusion, and to allow previous results to be replicated, the Model should allow access to all previous versions at the Core parameter level.

The Working Party recognises that different subsets of the population may experience different rates and patterns of mortality improvement. However, as discussed further in section 2.7.1, the Working Party does not believe that an alternative dataset currently exists which would be a suitable candidate to publish and endorse in the version of the Model issued alongside this paper, and therefore considers it inappropriate to offer a choice of dataset at present. However, users may of course derive alternative Initial Rates of Mortality Improvement and incorporate them into the Model via the Advanced parameter level.

The CMI will consider, in due course, whether and how best to make previous estimates and parameter sets available.

2.5.4. Improvement Rate 'Underpin' Parameter [possible addition to the Core level]

Two respondents requested that a Core Parameter be added allowing users to select an 'underpin' to guarantee a minimum rate of mortality improvement.

In view of the low number of requests received, the crude nature of an underpin, and the observation that the Long-Term Rate of Mortality Improvements already acts in a similar manner to an underpin over the long run, the Working Party did not consider an 'underpin' to be an essential Core Parameter.

2.5.5. Constant Addition Parameter [possible removal from the Core level]

A number of respondents did not support the positioning of this parameter in the Core parameter layer for various reasons, with arguments that included:-

- Stress testing should not be part of the Core layer.
- The approach is simplistic and retaining it may encourage Core users to apply it as a prudence adjustment without considering other, arguably superior, options.

- It introduces an immediate disconnect from the current to modelled rates of mortality improvement.
- It is a constant addition, even at the highest ages, which could cause problems with closure of the mortality table.

The Working Party sympathized with these comments. However, it was decided to retain this parameter, noting that:

- There were more responses in favour of the parameter than against.
- On balance, there appears to be demand for a Core level parameter allowing a simple way of adding a margin (or indeed to reduce mortality improvement rates).
- The parameter is not at all demanding of users - it is defaulted to zero and only enters the naming convention if a non-zero value is entered.

The Working Party considered allowing the Constant Addition to taper to zero at high ages in a similar way to the Core level Long-Term Rate of Mortality Improvements, but decided that the simplicity of a constant additional rate, across all ages and cohorts, was preferable.

2.6. Question (e): Long-Term Rate

Do you feel it would be useful to allow users to vary the long-term rate over time? So, for example, in the very long term the rate of change could be allowed to approach zero?

A number of respondents indicated support for additional flexibility in determining very long-term rates of mortality improvement, although it appeared to be seen as a ‘nice-to-have’ feature rather than an essential one. Several other respondents argued that the additional complexity could not be justified.

The Working Party concluded that there was there was not enough support to merit looking at this option further at this stage.

2.7. Question (f): Parameter Default Values

Do you have any comments or suggestions on the default values given to parameters?

Many respondents indicated broad support for the proposed default values and derivation methodologies. Just under half offered more specific comments on several key issues, as set out below.

2.7.1. The Use of Population Data rather than Insured or Pensioner Data

Default values for Initial Rates of Mortality Improvement are based on England & Wales population data, rather than data for insured lives or pensioners. Respondents, on the whole, appeared to appreciate that this was warranted due to the larger population dataset giving greater credibility in the results. However, there were various responses questioning the relevance of using population data, rather than datasets specific to pensioners or insured lives. In addition, some respondents requested more refined subsets such as different social classes.

The Working Party recognises the need to balance credibility and relevance of data, and Working Paper 39 goes into some detail on the features of different potential datasets which were available to the Working Party.

The England & Wales population dataset is by far the largest available, spanning a wide age range, with data available from ages 18 to 104. This data is available from 1961, allowing a significant back history to be modelled. There are, however, some data quality issues, particularly with regard to the mid-year population estimates and their use as proxy measures for exposure.

The CMI Permanent Assurances dataset could be more relevant to a user modelling insured lives, however the dataset is very much smaller than the population dataset. Similarly, the CMI Life Office pensioners dataset could be more relevant to a user modelling pensioners, but again the dataset is very much smaller. In addition, observed trends on both these datasets may be distorted by changes over time in the mix of life offices contributing data.

There is more data available in the CMI SAPS Mortality investigation than in other CMI datasets, and this data could be more relevant for users considering a suitable mortality assumption for a pension scheme. However, this dataset is still ten times smaller than the population dataset. Furthermore there is relatively little history of data (since data collection only began in 2000). Hence any mortality improvement rates derived from this dataset are significantly less credible than those derived from the population dataset.

In addition, there are some problems associated with deriving improvement rates from the SAPS data, as the schemes submitting data vary across calendar years, so that trend calculations across time do not always relate to homogeneous datasets.

Where sufficiently long time-series of data are available, mortality improvement rates and patterns over time may be compared between datasets. It can be shown that rates of mortality improvement, averaged over say 10-year periods and across broad age bands, have differed at times in the past between population, insured and pensioner datasets. However, the uncertainty in estimating current rates of mortality improvement by age and cohort is so large, particularly for the sub-population datasets, that it is difficult to draw firm conclusions about differences in the level or features of current rates of mortality improvement. Furthermore the existence of past differentials tells us little about the future: for example, will observed differential rates of change persist or reverse in future?

The Working Party carefully considered the merits of population, insured lives and pensioner datasets in terms of credibility and relevance of the data, and decided that it is appropriate at present to retain the approach of using data at the level of the England & Wales population for Initial Rates of Mortality Improvement in the Core parameter level. A prime factor in the decision was that the Working Party considers the estimation errors on sub-population datasets to be too great to support robust conclusions about patterns of mortality improvement rates by age and by cohort. In addition, there is no single alternative dataset that would meet the needs of all users.

The CMI will review the choice of the dataset to be used to derive default assumptions during future updates of the Model.

The choice of dataset is clearly an important decision for each user. Some users may have access to data which they consider to be more relevant to the specific use to which they are interested, and may feel that greater uncertainty in estimates of mortality improvement rates (and of patterns by age and cohort) is an acceptable compromise. If so, then parameters derived using such alternative data sources can be input using the Advanced parameter layer in the Model.

Further studies are being carried out by various different entities into mortality and rates of improvement for different subgroups of the population. In addition, the CMI is currently encouraging the investigation of formal measures of uncertainty around estimates of mortality improvement rates (of the form of confidence intervals to be applied to both crude and smoothed rates of improvement). This may allow users to quantify the uncertainty of estimates of mortality improvement rates derived from alternative datasets, and to make more formal statistical comparisons of them.

2.7.2. Features of the Initial Rates of Mortality Improvement

There were some responses requesting explanations for various ‘features’ of the initial dataset (such as particularly high or low rates of mortality improvement at different ages or birth cohorts) and suggesting that further smoothing might be warranted (especially if the features cannot be credibly explained).

The Working Party would welcome research that helps to explain such features, but did not think it was feasible, or desirable, to delay publication of the Model to do this itself.

2.7.3. The Percentage of Convergence Remaining at the Mid-point

As discussed in section 2.4.2 several respondents felt that assuming 50% of Convergence Remaining at the Mid-point of the Convergence Period was not realistic given the trend of mortality improvement rates increasing over the last 10 to 15 years. It was suggested that, by having a default assumption of 50% of Convergence Remaining at the Mid-point in the Core parameter layer, the CMI was effectively ‘taking a view’ that mortality improvement rates have already peaked (at the start of the projection).

In section 2.4.2 it was noted that taking account of the recent trend in mortality improvement rates in a convergence methodology would involve deriving parameters that varied by age and cohort, rather than applying a flat percentage. This is the case because Initial Rates of Improvement (and the trend in these rates) vary by age and by cohort, and so applying a flat percentage to these would not necessarily have the desired effect on all groups of lives.

The Working Party felt that deriving such a complex basis would be of spurious accuracy, particularly given the variability of the trend in improvement rates from year to year, and the uncertainty attached to any particular trend (as illustrated in section 2.4.2).

The Working Party therefore favours the simple logic behind a default value of 50%, giving equal weight to the Initial and Long-term Rates of Mortality Improvement at the mid-point of the convergence period, and so placing emphasis on the setting of (and the uncertainty in) the Long-term Rate of Mortality Improvement assumption.

Figure 1 in Section 2.4.2 also illustrates possible emerging, but inconclusive, evidence of mortality improvement rates appearing to level-off. In the view of the Working Party this further strengthens the case for the current default value of 50%.

2.7.4. The Default Tapering to Zero of Mortality Improvement Rates at High Ages

There were concerns expressed that the implicit assumption of 0% p.a. mortality improvements at very old ages (above 120) was hard to justify. However, the majority of respondents favoured the concept of tapering rates of improvement at older ages, subject to concerns that this assumption (that is, the start and end ages for of the tapering to zero) should be kept under review over time.

This assumption will be kept under review for future versions of the Model.

2.7.5. Age/Period and Cohort Components of Initial Rates of Improvement

A few respondents expressed a concern that the split between Age/Period and Cohort Components was somewhat arbitrary. Although the Working Party had carried out some testing, at key ages, and deduced that the assumed split was not material, one respondent provided some calculations showing that this could be more significant at younger ages (say those who will reach age 65 in 10 or 20 years time). This respondent also requested that the tools used to create the split be published to allow further scrutiny.

These comments were noted, and it was decided that further research into this matter should be carried out when the Model is next reviewed. However, the Working Party did not consider it feasible to review this assumption, or to publish further data or tools (for example the tool used to derive the Age/Period and Cohort Components of Initial Improvement Rates) within the target timescale for releasing this Paper and the updated version of the Model.

2.7.6. The Constant Addition to Long-term Rate of Improvement (even at older ages)

One respondent was concerned that applying a constant addition to the Long-term Rate of Improvement at older ages (up to and including age 150) may result in a projection with a significant proportion of people assumed to live beyond the highest age achieved to date (i.e. 122 years in the case of Madame Calment). It was suggested that this addition should tend to zero at older ages, and perhaps be included as an Advanced parameter.

On balance, on grounds of simplicity, the Working Party decided to keep the Constant Addition the same at all ages.

2.7.7. Other Comments on Parameter Default Values

Other comments raised in this section included:-

- Could additional default base tables be included (in particular, the R*V00 tables)?
- Could a parameter be added to allow a certain percentage of the base table to be used?
- Could illustrative parameterisations for extreme scenarios be provided? For instance, to replicate the views of Professor Olshansky, or De Grey?

These comments were noted, but the Working Party did not feel it was possible to prioritise work such as this in advance of publication. In particular, under the Advanced parameter option it is fairly straightforward for any user to add in a base table, or a percentage of a base table of their choice.

2.8. Question (g): Naming Convention

Do you have any comments or suggestions on the proposed naming convention?

Respondents indicated general support for the proposed naming convention for the Core Projections, and also for the informal convention used in the Model for naming the Advanced Projections. However, various comments and suggestions were made in respect of both the Core and the Advanced naming conventions, as set out below.

2.8.1. Core Projections

Particular suggestions or requests received included:-

- The year of issue of the Model, or the last year of the data, should be reflected in the name of the Model and Core Projections;
- If alternative datasets are made available, the naming of Core Projections should make clear which dataset has been used;
- ‘_M’, or ‘_F’ could be used as a more succinct way to specify gender;
- The names should be made more consistent with the naming convention in the CMI Library of Mortality Projections.

2.8.2. Advanced Projections

There were some comments that the naming of the Advanced Projections should be standardised, as there are many circumstances where it is essential that actuaries are able to exactly replicate assumptions used by other actuaries.

2.8.3. Intuitive Common Usage Names

In addition, the CMI was challenged to develop projection names with greater intuitive meaning (for non-actuaries) and to find a more ‘catchy’ name to encourage an easily accessible common language.

The Working Party considered the suggestions made, and decided to name the projections the ‘CMI_’ projections of mortality improvement rates. Projections from the first live version of the Model, issued alongside this paper in 2009, will be called the ‘CMI_2009’ projections, and the individual Core Projections will be called ‘CMI_2009_M [a%] + c%’ and ‘CMI_2009_F [a%] + c%’, for males and females respectively, where a% is the long term rate and c% is any constant addition (omitted if zero).

The Working Party considers that ‘CMI_2009’ conveys more information and will be more readily adopted into common use than ‘CPMv1.0’ (the naming convention set out with the prototype Model). Direct reference to ‘CMI’ rather than the more complex acronym ‘CPM’ (CMI Projections Model) seems sensible. ‘2009’ conveys the year of publication of the

Model and so gives more sense of its currency than a version number (given that no more than one version of the Model is expected to be issued per year). Year of issue is preferred over any direct reference to the ‘data year’ as the latter is considered to be laden with problems (for example, if alternative datasets are incorporated in future).

2.9. Question (h): Use of the Model

Do you anticipate you would use the Model in practice? If so, for what purpose would you use it?

All respondents indicated that they do plan to use the Model, either directly to produce mortality projections, or as a means of benchmarking and communicating with regard to the strength of alternative mortality projections.

The Working Party was encouraged by this response, strengthening the mandate to proceed with the launch of a first, live version of the Model alongside this paper.

2.10. Question (i): Future Development of the Model

Do you have any thoughts on how the proposed Model should be developed in the future?

A number of areas were suggested for future developments, as set out below.

The Working Party’s responses to some of these specific points are included below. As a general point, the Working Party would welcome further research in all these areas, but did not consider it feasible to advance on any of these issues within the target timescale for publishing this paper and the associated version of the Model.

Further detail on the proposed plans for the development of the Model in the future is given in section 5.

2.10.1. Analysing and Projecting Mortality Changes by Cause of Death

Many respondents indicated that they would welcome further research into changes in rates of mortality improvement by cause of death, and the development of scenarios or tools linking aggregate mortality projections to changes in mortality rates by cause of death.

2.10.2. Alternative Datasets

There were also many calls for further research into current rates of mortality improvement (and long-term rates of improvement) for different sub-groups of the population, for instance pensioners and different socio-economic classes.

2.10.3. Drivers of Mortality Change

Some respondents wanted to see further analysis on the drivers of mortality change, especially for cohort features.

2.10.4. Long-Term Rate of Mortality Improvement

The CMI was requested to keep the analysis, presented in Working Paper 39, on long-term rates of mortality improvement up-to-date, and some respondents also requested further guidance in setting the Long-Term Rate parameters. One respondent suggested that this could be supported via links to relevant papers and articles, so the CMI would not be promoting any particular value for the Long-Term Rate.

2.10.5. Parameterisation of the Convergence Process

Further analysis was requested to support the parameterisation of the convergence methodology.

The Working Party has provided more details of the reasoning behind the choice of convergence parameters in section 2.4.2. However, it recognises that further research could most usefully be carried out in this area.

2.10.6. Further Research and Development of Stochastic Mortality Models

Most respondents were content that the Model should be deterministic; however there were requests that it should be developed further to include a stochastic option, or that an alternative stochastic tool be developed. One respondent suggested that the CMI seemed to be ‘backing away’ from stochastic models by withdrawing the illustrative projections software, coupled with the release of this deterministic prototype Model.

It is not the CMI’s intention to back away from stochastic models, and the CMI would welcome further research into this area.

The illustrative projections software was withdrawn only due to technical issues, namely that the software did not work with the latest versions of R and the interface from Excel. In the light of continuing occasional requests for the software and the response to this consultation, the CMI will again make the software available on request, but it will be the responsibility of users to locate versions of R and the R(D)COM interface compatible with the software.

2.10.7. Other Suggestions for Further Research and Development

In addition, the following suggestions were made, each by one respondent:-

- The method of modelling should be extended to other territories (e.g. Ireland).
- It would be useful to provide illustrative calculations for contingent spouse’s annuities as well as single life annuities.
- It would be helpful if users could (further) tailor outputs from the Model (such as amending scales on charts, etc.).

2.11. Question (j): Maintenance of the Model

Should the CMI maintain the proposed Model as new data becomes available? If so, should this be each year, or at some lesser frequency?

A variety of views were expressed by respondents, some arguing for frequent updates, and others believing the Model should be updated less often.

Those suggesting frequent updates argued that the Model should include the latest data, soon after it becomes available, to avoid becoming out of date as the Interim Cohort Projections have done. It was also noted that including the latest available data would allow emerging patterns to be incorporated in a timely way.

Other respondents felt that the Model should be robust enough not to require constant updating, and that less frequent updates would avoid potential confusion caused by multiple versions being used in the market, and increase the credibility of the Model in use. Some respondents commented that annual updates could cause confusion, particularly in pension scheme valuations where 12 months often pass between first discussing the assumptions and the scheme valuation being signed off.

There was also a request that the CMI should provide assurances that the default parameters (other than the Initial Rates of Mortality Improvement) had been sufficiently stress-tested to ensure they would remain relatively static over several years so that frequent revisions to the Model would not be required.

It was also suggested that the CMI should, perhaps, offer an initial period of stability once the first 'live' Model is released before carrying out any updates, to allow firms time to incorporate the Model in their work.

The Working Party considered these responses, and proposes the following, noting that a balance needs to be struck between competing pressures for more or less frequent updates:-

Default Initial Rates of Mortality Improvement for Core Projections, will be updated annually, when new data becomes available. This is to ensure that the Model stays up-to-date, and to avoid the possibility of emerging patterns not being incorporated in a sufficiently timely manner, potentially damaging the credibility of the Model, and indeed of the Actuarial Profession more generally.

The Model released alongside this paper, in November 2009, reflects the latest ONS data for the England & Wales population. Assuming the ONS continue to release such data around September in each year, it is hoped that the Model can be updated and re-issued around the end of October each year to enable users to access the revised version of the Model for year-end valuations.

The Working Party has noted that moving the Initial Rates forward one year brings an implicit question on the period of convergence to Long-Term Rates: should the length of the convergence period(s) be maintained, moving the end-point on a year, or should the end-point (the year(s) from which the Long-Term Rate applies) be fixed? The former approach is driven by recognising updated patterns of Initial Rates and the period over which they might be expected to run off; the latter approach is driven by a fixed-time view of the start-point for

the Long-Term Rate (until it is next reviewed). For the version of the Model released alongside this paper, the length and pattern of convergence periods have been maintained from the prototype Model. However, the Working Party recognise that there are pros and cons to both approaches, and this issue will be considered further in time for the proposed annual update in 2010.

The Model structure, and other default parameters, will be reviewed less often to give continuity, encourage confidence in the Model design, and to reduce costs. Reviews will be undertaken when significant new features appear in the data, or to reflect changes in expert or market views, but no less frequently than every five years.

2.12. Question (k): Other Comments

Do you have any other comments?

2.12.1. Back-testing

Some respondents would like the Model to be hind-casted, or back-tested, to give an idea of how ‘reliably’ the Model might have performed in past conditions.

The Working Party felt that objective back-testing of the Model is not possible as key parameters, in particular the value assumed for the Long-Term Rate of Mortality Improvement, are not directly data driven and we cannot know what values would have been set historically. However, it was agreed that there would be some merit in taking the Model back 10 or 20 years, and then experimenting to see what parameter values would be required in order to replicate reasonably the subsequent (known) experience. There has not been time to pursue this prior to the release of this paper. However this analysis may be done in future.

2.12.2. Release of Data and Tools used in Deriving the Default Parameters

One respondent asked if the CMI could release the data and model used by the CMI to generate the smoothed rates of mortality improvements. Appreciating there may be confidentiality issues regarding the timing and release of ONS data, they feel this was essential for:-

- the sake of transparency;
- to allow users to make sensible and informed choices of parameter values; and
- to allow users to perform their own analysis using different datasets.

The CMI is in discussion with the ONS as to whether the CMI could make the data available or whether it would be better for the ONS to publish the data directly or to respond to questions as to its availability. See also the comment under section 2.7.5.

2.12.3. Provision of User Training

Some general observations were also offered stressing the need for effective training for users of the Model, and for effective communication of output from the Model.

CMI representatives have given a number of presentations on the projections Model in October and November 2009, designed to educate potential users. In addition, the Actuarial Profession is arranging a webinar, for 8 December 2009, so that any user will be able to attend a virtual training session on the Model (see www.actuaries.org.uk for details).

2.12.4. Documentation, TAS-M, and Validation of the Accuracy of the Model

It was suggested that the CMI should sign-off the accuracy of the Model, bearing in mind that users of the Model may be required to satisfy the requirements of the Board of Actuarial Standards as set out in their TAS M.

Extensive checking has been undertaken during the development of the Model, and the CMI is confident that it correctly produces projections from the various inputs in the manner described in the User Guide. However, the Institute of Actuaries, the Faculty of Actuaries and the CMI do not warrant the accuracy of the Model and do not accept or assume any liability for its use. Users should satisfy themselves that the Model, and the selected parameters (including any defaults applied) are suitable for whatever purpose they are using the Model.

At the time of writing TAS M has yet to be finalized, but the CMI's current feeling is that the documentation provided in the User Guide, together with the background material contained in Working Papers 38 and 39 and in this paper, should provide sufficient documentation for most users' needs. If feedback reveals that further explanation is required in particular areas, the CMI may augment the User Guide in future.

2.12.5. Status of the Interim Cohort Projections

There were some calls for the CMI to withdraw or clarify the status of the Interim Cohort Projections in light of the publication of this new Model.

The CMI has not withdrawn work previously published (such as 'old' mortality tables) and thinks it would not be appropriate to do so for the Interim Cohort Projections.

2.12.6. CMI Library of Mortality Projections

There were several comments on the interaction of the Model with the CMI Library of Mortality Projections. Some requested that if Core Projections were to be included in the Library, then so should Advanced Projections to avoid herding towards the Core Projections. Other respondents commented that only Core Projections should be included, to avoid problems in specifying exactly which Advanced parameter values had been used.

The CMI is currently considering how best to incorporate projections from the Model into the Library. In particular the difference between the Library and the Model in the approach to timing in applying mortality projections - noted in the Model's User Guide - needs to be addressed in a clear manner.

In terms of the range of projections, the current thinking is that a small number of projections will be included and that - in addition to sample Core Projections - projections will be included using a higher value for the percentage of convergence remaining at the mid-point.

This may help to demonstrate that the Model does not necessarily imply that the level of mortality improvements has peaked.

2.12.7. Impact on Liabilities

One respondent noted that the mortality projection resulting from the prototype Model's Core Projection gives a higher liability than using the Medium Interim Cohort Projection when the underpin applied to the Medium Cohort is the same as the Long-Term Rate of Mortality Improvement applied in the Model for the Core Projection. The respondent's suggestion was that this may discourage adoption of the Model. However, another respondent commented that the Model gave a lower liability than the Long Interim Cohort Projection (based on a similar approach) and suggested that could encourage adoption.

The methodology behind the Model has been given considerable thought and has been consulted on, and the Working Party does not feel that the Model should be calibrated against the outdated Interim Cohort Projections. The liabilities resulting from the Model are sensitive not only to the long-term rate, but also to the age and sex profile, and the level of initial rates of mortality improvement which will vary as the underlying data is updated.

3. The Effect of Adding Data for Calendar Year 2008

3.1. Changes to the Population Dataset for England & Wales

Default values for Initial Rates of Mortality Improvement in the Core parameter layer of the prototype Model were derived from an ONS dataset for the population of England & Wales, covering calendar years from 1961 to 2007.

England and Wales population mortality data for 2008 was made available to the CMI by the ONS on 17 September 2009. The version of the Model issued alongside this paper contains default values based on the expanded dataset (i.e. 1961 to 2008), with a base year for the projection of 2006 (as opposed to 2005 in the prototype Model).

Aside from the addition of data for 2008, the ONS made some relatively minor changes to mid-year population estimates for earlier years. These affected:-

- Ages 90+ for recent years, but with some ‘rippling back’ to much earlier years. Some changes at these ages were expected as they occur naturally in the iterative method used to derive population estimates for the very elderly; however these changes do not have a significant impact on derived mortality rates, with the majority of changes to $m_{x,t}$ typically being within 1% (of $m_{x,t}$).
- Ages 85-89 for years 1961 to 1970. These changes were not anticipated by the Working Party and typically increase derived mortality rates during this period by around 3% (the revised values range from 100% to 106% of the original values of $m_{x,t}$). However, these changes do not materially affect the estimates used for CPMv0.0, which relied more heavily on the more recent years’ data, and similarly have little effect on the default parameter values produced for the revised version of the Model.

3.2. Observed Rates of Mortality Improvement to 2008

At an aggregate level, mortality rates have fallen more slowly since 2006 than over the preceding years. This is illustrated in the following table, which shows crude annual mortality improvement rates for all-age mortality (ages 18-102, age-standardised using 2001 population estimates) for recent years:

**Table 1: Observed Crude Annual Mortality Improvement Rates
England & Wales Population, ages 18-102**

Year	Males	Females
2001	+3.0%	+1.8%
2002	+1.5%	+0.1%
2003	+1.8%	-0.5%
2004	+5.4%	+6.2%
2005	+2.7%	+0.9%
2006	+3.5%	+4.0%
2007	+2.4%	+0.9%
2008	+1.5%	+0.2%

As there is considerable natural variation in mortality from year from year, it is necessary to apply some form of smoothing mechanism over time in order to try to detect time trends. Although the last two years have shown a slower pace of improvement, it is difficult to discern whether the general pace of mortality change is still increasing or has peaked (as discussed in section 2.4.2). From the analysis carried out so far by the Working Party, it is not possible to draw any firm conclusion.

3.3. Changes in Estimates of Current Aggregate Rates of Mortality Improvement

In order to calculate default values for initial rates of mortality improvement, the Working Party fitted age-cohort P-Spline models to the extended (and revised) population dataset. As expected, the addition of a year's data does affect the fitted surface for earlier years. The following table shows two measures of the difference in estimated mortality improvement rates for recent years - the all-age mean difference, and the all-age mean absolute difference (where the all-age means are calculated over the age range 18-102).

Table 2: Mean Difference and Mean Absolute Difference in fitted P-Spline model Estimates of Rates of Mortality Improvement comparing results for datasets (A) 1961-2007 and (B) 1961-2008 England & Wales Population, ages 18-102

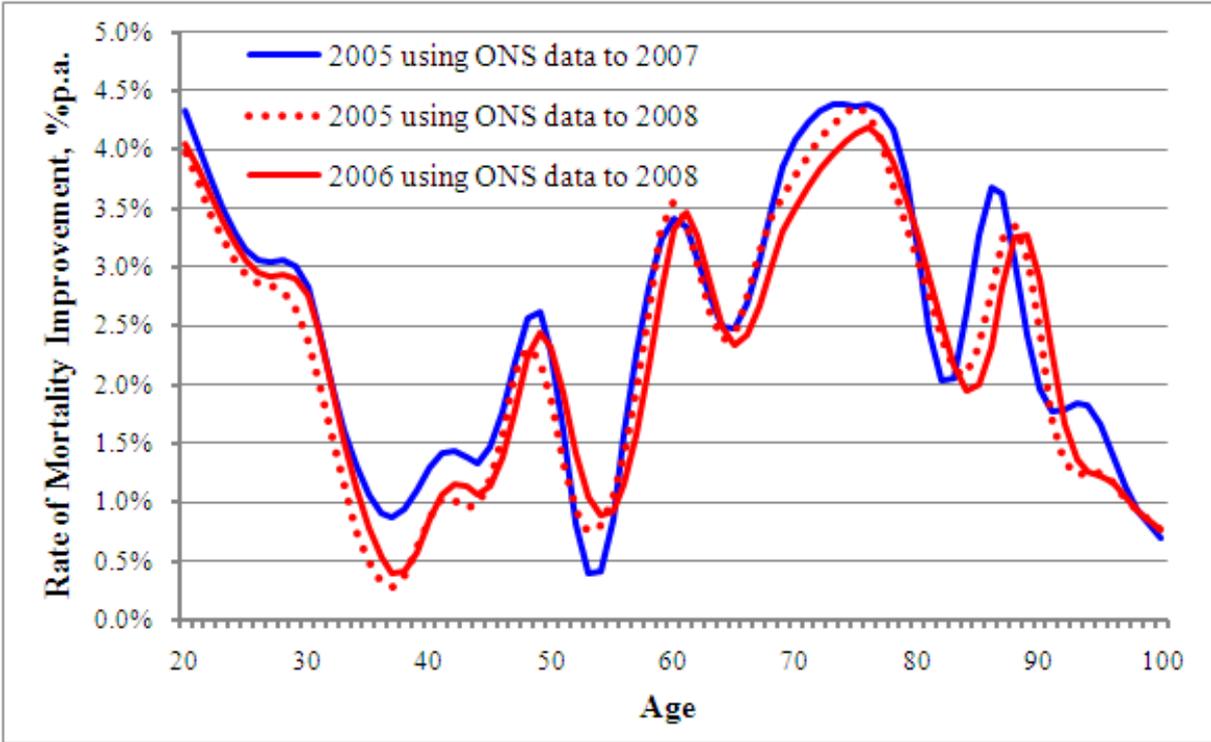
Year	Mean Diff (% p.a.)		Mean Absolute Diff (% p.a.)	
	Males	Females	Males	Females
2001	+0.03	+0.02	0.14	0.07
2002	+0.00	-0.01	0.16	0.08
2003	-0.05	-0.04	0.19	0.09
2004	-0.12	-0.09	0.24	0.13
2005	-0.21	-0.16	0.30	0.19
2006	-0.31	-0.23	0.37	0.26
2007	-0.42	-0.31	0.46	0.34

The differences are slightly smaller than the averages derived from the Working Party's back-testing (see section 3.1.2 of Working Paper 39) and suggest that there is nothing too unusual about the development of the time-series data. This endorses the decision to step two years inside the edge of the data when deriving the start-point for the Model.

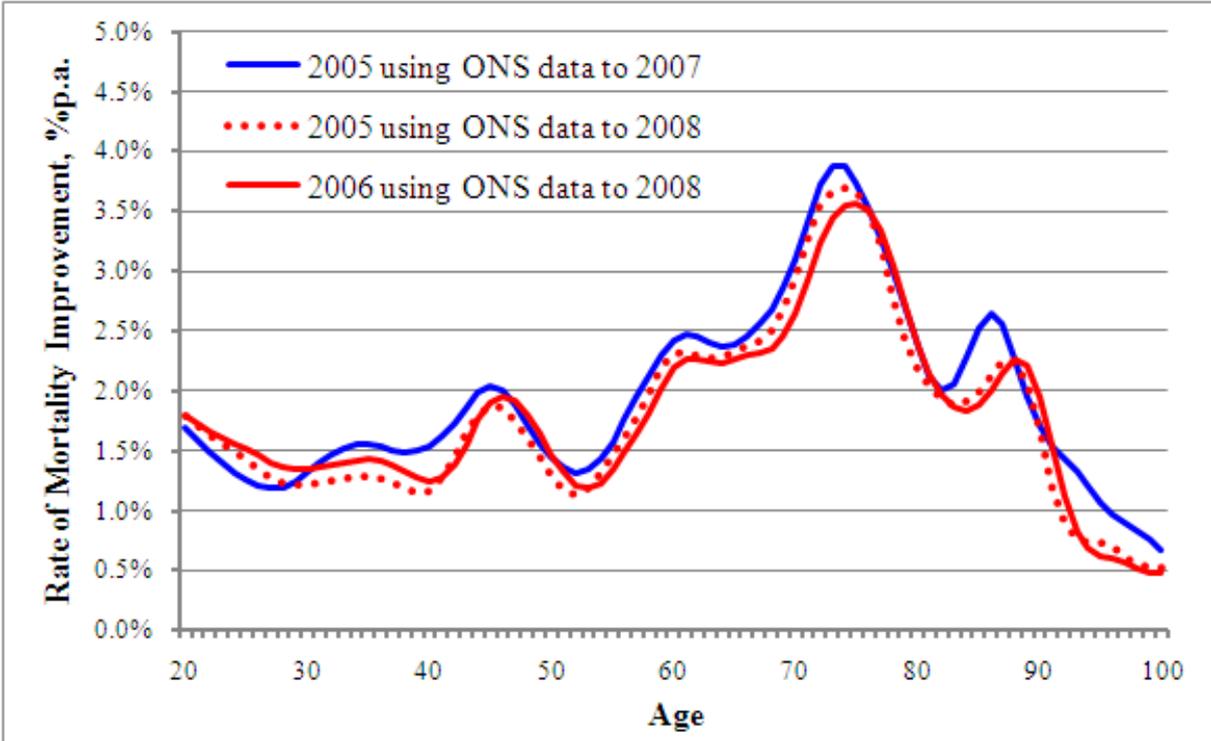
Figures 2 and 3 compare the Working Party's original estimates for mortality improvement rates in 2005 (based on ONS data to 2007) against revised estimates (based on data to 2008). The estimates for 2006 (based on ONS data to 2008) are also shown. The revised estimates show some modest shape changes and are generally a little lower, consistent with the high-level data and results shown in Tables 1 and 2.

3.4. Changes in Estimates of Components of Current Rates of Mortality Improvement

The Working Party also fitted the Age-Period-Cohort (APC) model to determine Age/Period and Cohort Components for the (new) 2006 Initial Rates of Mortality Improvement. The results and comparisons against the 2005 component rates used in the prototype Model (CPMv0.0) are shown in Figures 4 and 5.



**Figure 2: Estimated Aggregate Rates of Mortality Improvement, by age and dataset
Males, England & Wales Population**
Estimates derived by fitting age-cohort P-Spline models



**Figure 3: Estimated Aggregate Rates of Mortality Improvement, by age and dataset
Females, England & Wales Population**
Estimates derived by fitting age-cohort P-Spline models

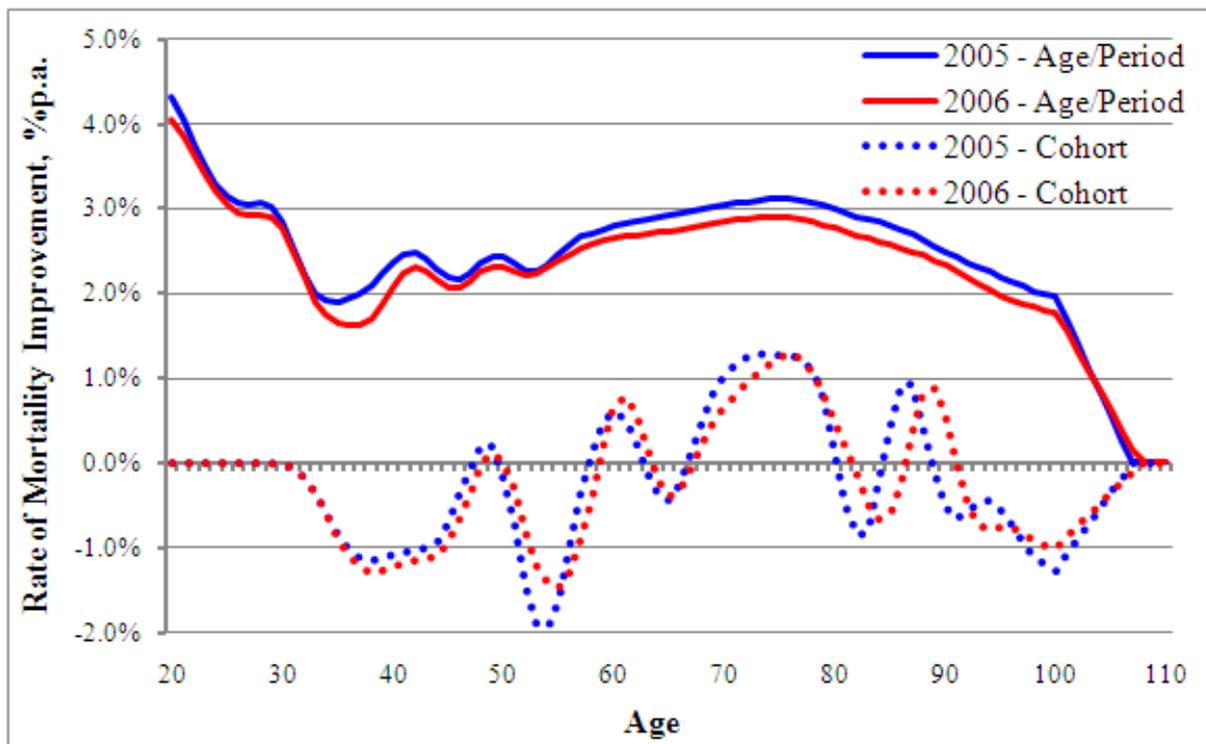


Figure 4: Estimated Age/Period and Cohort Components of Mortality Improvement, by age and dataset; Males, England & Wales Population
 Estimates derived by fitting APC models to smoothed mortality improvement rates

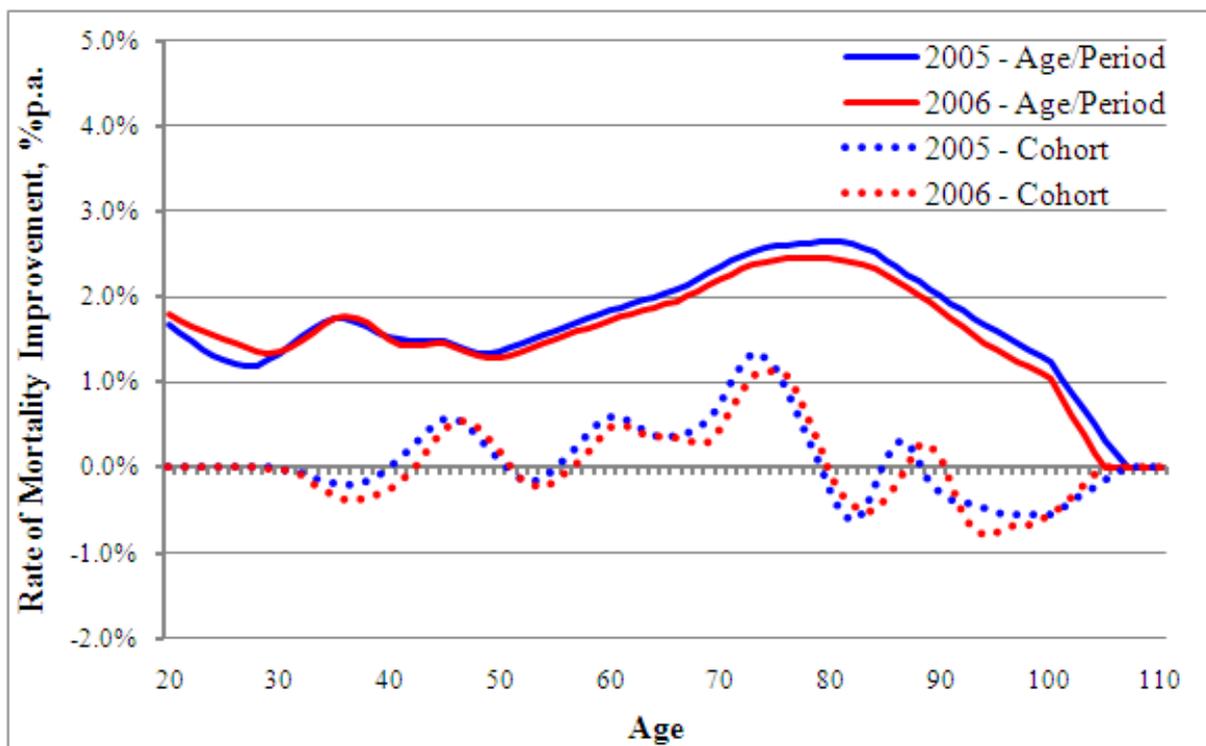


Figure 5: Estimated Age/Period and Cohort Components of Mortality Improvement, by age and dataset; Females, England & Wales Population
 Estimates derived by fitting APC models to smoothed mortality improvement rates

Figure 6, also presented earlier in section 2.4.2, illustrates how the Period Components have changed. Extending the analysis to include 2008 data results in a marked change of shape, for the years after 2000, in the curve of derived period components of mortality improvement rates. As discussed earlier, this degree of change, resulting from the addition of one year's data, emphasises the difficulty in drawing sound conclusions regarding the current trajectory of rates of mortality improvement.

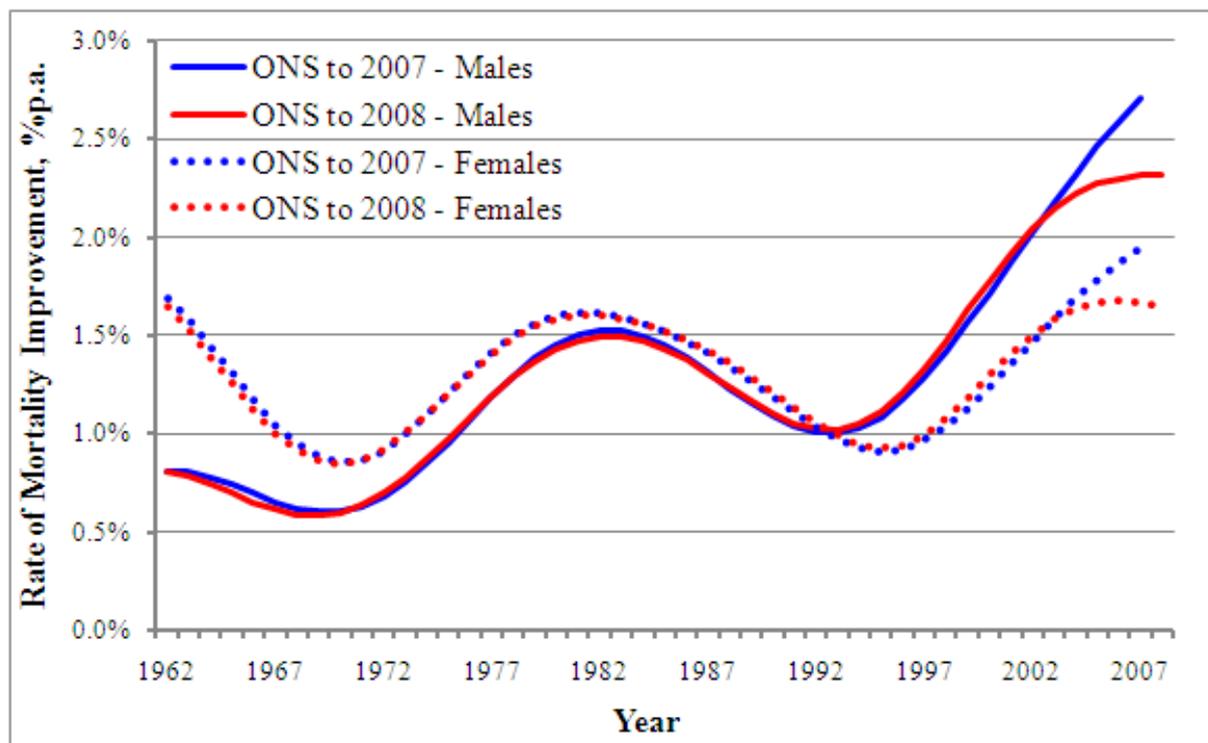


Figure 6: Period Component of the Rate of Mortality Improvement, by year, dataset, and gender; England & Wales Population
Estimates derived by fitting APC models to smoothed mortality improvement rates

3.5. Quantification of the Effect of Reflecting Data for 2008 in the Model

The version of the Model published alongside this paper includes Core parameter default values for Initial Rates of Mortality Improvement as at 2006, derived using population data up to 2008 - that is, taking account of an extra year's observations in the underlying dataset compared to that used for the prototype Model 'CPMv0.0'.

The effect of this change is illustrated below by comparing cohort expectation of life values, for males and females, for sample model points, on the following basis:

- Like-for-like Core Projections using a Long-Term Rate of 1.5% p.a.
- Base Rates of Mortality are the published S1PxA tables (as at 01/09/2002)
- Calculation Date(s) are 01/07/year.

Table 3 shows the percentage change in expectation of life values produced by the 'CMI_2009' version of the model measured against the equivalent values produced by 'CPMv0.0'.

**Table 3: % Change in Cohort Expectation of Life for lives aged x exact on 01/07/Year
Base Rates of Mortality = 100% S1PxA as at 01/09/2002
Core Projections: CMI_ 2009 [1.5%] against CPMv0.0 [1.5%]**

Age, x	Year						
	Males				Females		
	2009	2019	2029		2009	2019	2029
20	-0.1%	-0.1%	-0.1%		-0.3%	-0.3%	-0.2%
30	-0.2%	-0.1%	-0.1%		-0.4%	-0.3%	-0.3%
40	-0.2%	-0.2%	-0.2%		-0.4%	-0.4%	-0.4%
50	-0.1%	-0.2%	-0.2%		-0.5%	-0.5%	-0.5%
60	-0.2%	-0.2%	-0.2%		-0.5%	-0.5%	-0.5%
65	-0.4%	-0.2%	-0.2%		-0.6%	-0.6%	-0.6%
70	-0.5%	-0.4%	-0.3%		-0.7%	-0.7%	-0.7%
75	-0.6%	-0.5%	-0.4%		-0.8%	-0.8%	-0.8%
80	-0.5%	-0.5%	-0.4%		-0.8%	-0.9%	-0.9%
90	0.0%	-0.1%	-0.1%		-1.1%	-1.1%	-1.2%
100	0.0%	0.0%	0.0%		-1.4%	-1.4%	-1.3%

Cohort life expectancies have fallen by around 0.4% on average for males and 0.7% for females (assuming a typical spread of ages within a portfolio). To put this in context, increasing the Long-term Rate of Mortality Improvement by 1% p.a. adds around 5% to Cohort life expectancies at age 65.

Further details and results of this comparison are presented in the User Guide to the Model.

4. Launch of the First Live Version of the Model

Alongside this Working Paper, the CMI has published the first live version of the Model, to be referred to as ‘CMI_2009’, together with a User Guide and a spreadsheet containing the results of a series of parameter sensitivity tests.

This section briefly sets out the changes that the Working Party has made to these items in the transition from the prototype Model ‘CPMv0.0’ to the first live version ‘CMI_2009’.

4.1. CMI Mortality Projections Model: ‘CMI_2009’

4.1.1. Update of the Initial Rates of Mortality Improvement

The default parameters supplied in the Core parameter layer for Initial Rates of Mortality Improvement have been updated to reflect the publication of England & Wales population data for calendar year 2008.

The revised population dataset, published by the ONS and supplied to the CMI on 17 September 2009, has been extended to include calendar year 2008 (the prototype Model used only data up to 2007) and also contains revised population estimates for some earlier years. The methodology used for deriving smoothed estimates of mortality improvement rates for the prototype Model has been reapplied to the updated data; similarly the age-period-cohort (APC) Model used to separate aggregate rates into age/period and cohort components has also been reapplied.

The effect of adding data for calendar year 2008 is covered in detail in section 3.

4.1.2. Expansion of the Sample of Expectation of Life and Annuity Values Calculated

The outputs worksheet [Sample EoL & Annuities] in the Model has been expanded by adding the facility to set a ‘grid’ of model points (17 ages by 7 calendar year calculation dates) for which expectation of life and annuity values are calculated (on both ‘cohort’ and ‘period’ life projection bases).

This change extends the range of results shown but does not alter the values calculated.

4.1.3. Change to Naming Conventions

The naming convention for the Model and for Core Projections has been revised - see section 2.8.

4.1.4. Miscellaneous

The following minor changes have also been made:

- A warning has been added to the [Inputs] worksheet to prompt the user to enter a value for the Long-Term Rate on first use of the Model
- Minor corrections have been made to column headings and table titles where required.

These changes do not alter either the range of results shown or the values calculated.

4.2. User Guide for ‘CMI_2009’

The User Guide has been updated for changes to the Model and additional sections have been added to cover:-

- The derivation of default values for the Core parameter layer
- A summary of the results of parameter sensitivity tests
- A quantification of the effect of the changes from the prototype Model ‘CPMv0.0’ arising from the updated dataset.

For the prototype Model, the first two items were covered by Working Paper 39. However, it is deemed more appropriate for the ‘live’ Model to have its default parameter values documented within the User Guide.

4.3. Parameter Sensitivity Test Results Spreadsheet for ‘CMI_2009’

A parameter sensitivity test results spreadsheet was issued alongside Working Paper 39 to augment the summary and commentary presented there. The spreadsheet has been updated to show the results of a similar (slightly expanded) range of tests on ‘CMI_2009’.

5. Future Work

5.1. Regular Updating of the Model

As outlined in section 0, the Working Party proposes that the Model should be updated annually, in particular to incorporate each successive year's population mortality data into the default Core parameters for the Initial Rates of Mortality Improvement. Assuming the ONS continues to release such data around September in each year, it is hoped that the Model can be updated and re-issued around the end of October each year to enable users to access the revised version of the Model for year-end valuations.

In order to avoid potential confusion and the disruption of frequent changes, the structure of the Model itself and the remaining default parameter values (that is, parameters other than the Initial Rates of Mortality Improvement and associated Age/Period and Cohort Components) will only be reviewed when this is felt necessary, although a general review will be carried out every five years at the latest.

5.2. Further Research

As discussed in section 2, there were many calls for additional research and development of the functionality of the Model. The Working Party felt that many of these requests were valid and such further work would be beneficial. However, it is not currently in a position to commit further (financial) resources to moving these issues forward and hence does not feel able to commit to a timetable of specific future developments.

The CMI will be considering such requests in the context of planning its future activities.

Appendix: Errata to Prototype Model and CMI Working Papers 38 and 39

A small number of minor errors have been noted in the prototype Model, Working Papers and associated items published by the CMI in June and July 2009. The Working Party is confident that none of these errors will have created material problems for readers of the published material or users of the prototype Model. However, the known errors are recorded below, together with a note of the remedial actions taken.

CPMv0.0

[CMI CPMv0.0 June 2009.xls ; published on 19 June 2009]

Error in column headings: column A in each of the worksheets [Convergence Fn by Cohort] and [Proj by Cohort] is labelled as 'Age' but should be labelled 'Year of birth'.

The column headings have been corrected for the version of the Model issued alongside this paper.

CMI Working Paper 38

[MPMwp - Working Paper 38 - FINAL.pdf ; published on 19 June 2009]

Chart error: Figure 2 in Working Paper 38 should show the default cohort component of initial rates of mortality improvement. However the chart shows a different set of cohort components, being incorrectly based on an age-period rather than age-cohort P-Spline model of the underlying data. A correct version of the chart is shown in Working Paper 39 as Figure 3.32.

No further action has been taken as the correct chart is shown in Working Paper 39, the material features of the charts are similar, and the underlying data is directly accessible by users through the [Core Parameters] worksheet in the prototype Model CPMv0.0.

CMI Working Paper 39

[MPMwp - Working Paper 39 - FINAL.pdf ; published on 7 July 2009]

Error in title for chart: the title for Figure 3.26 on page 33 states 'male' whereas it should state 'female'.

No further action taken as both the error, and the correct interpretation, are clear from the Figure's context and commentary in the paper.

Sensitivity Spreadsheet

[CPMv0.0 Sensitivity Test Results.xls ; published on 7 July 2009]

Error in column headings: in worksheet [Data - Library Comparison] the headings for cells C4:D4 and S4:T4 are reversed, in error, although the data values in those columns are correct and do feed through correctly to the other worksheets.

The column headings have been corrected for the updated parameter sensitivity test results spreadsheet published alongside this paper.